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Final Report

on

Environmental Impact Assessment (EIA) on

Rehabilitation of Polder 30

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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
BGP	Blue Gold Program
BMD	Bangladesh Metrological Department
BNBC	Bangladesh National Building Code
BOD	Biochemical Oxygen Demand
BQ	Black Quarter
BRAC	Bangladesh Rural Advancement Centre
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBO	Community Based Organizations
CCDA	Centre for Community Development Assistance
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
DDCC	District Development Coordination Committee
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 the Netherlands
EMP	Environmental Management Plan
ERD	Economic Relations Division
ETo	Evapo-transpiration
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
GPP	Guidelines for Peoples Participation
GPWM	Guidelines for Participation of Water Management
GSB	Geological Survey of Bangladesh
GW	Ground Water
Ha	Hectare
HH	Household
HS	Hemorrhagic Septicemia
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
LLP	Low Lift Pump
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
PIO	Project Implementation Officer
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
SSAO	Sub-Assistant Agriculture Officer

SIA	Social Impact Assessment
SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SW	Surface Water
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UAO	Upazila Agriculture Officer
UDCC	Upazila Development Coordination Committee
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	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, supplemental irrigation needed in places during dry spell.
Arat	Generally an office, a store or a warehouse in a market place from which Aratdar conducts his business.
Aratdar	Main actor act as a wholesaler or commission agent or covers both functions at the same time; carries out public auctions and is the main provider of credit in the marketing chain.
Aus	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed 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. One type of houses used by very poor community members.
Kacha	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal	A drainage channel usually small, sometimes man-made. The channel through which the water flows. 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	Powerful intermediary in the value chain or traditional money lender.
Perennial khal	Water available in the khal all the year round.
Pacca	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 an district.
Water sealed	A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. A water sealed latrine has a bowl fixture that has a set amount of water retained in it. It is operated on the pour to flush system. These types of latrines can be connected to a septic tank system.

Conversion Units

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

Executive Summary

Background

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

Objective

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

Approach and Methodology

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

Project Description

Polder 30 is located in Batiaghata, Gangarampur and Surkhali unions in Batiaghata upazila of Khulna district (Map 1.1). The Polder was constructed in 1967-72 and later rehabilitated under the IPSWAM project (2003-2011). The polder is surrounded by rivers from all directions having largest river Kazibacha River on the east side which is formed by the Rupsa-Pasur and Solmari rivers at the upstream. The polder covers an area of 6,455 ha, with a Net Cultivable Area (NCA) of 4,240 ha (66%).

The polder area is bounded by a 40.27 km embankment that was built to protect the area against tidal and storm surges as well as salinity intrusion. Besides, there are 8 drainage sluices, 10flushing sluices, 3 drainage-cum-flushing sluices, and 6 inlets in the area. The

existing situation of the embankment is good, offering protection against tidal and storm surges and salinity intrusion, and facilitating the communication system as well. However, the existing water control structures are not functioning up to desired level. There are also 37 km internal channels inside the polder area. These channels have been highly silted up over the years due to erosion and also due to lack of proper maintenance.

Existing problems and works under the proposed interventions

The existing problems of the project area are drainage congestion in the South-West part of the polder area and saltwater intrusion that contaminates both surface and ground water, increasing salinity in the soil. Other problems are internal canal bed siltation and river bed erosion. These problems are contributing negatively to agricultural production, communication system, health, safety etc. and ultimately increasing unemployment and poverty.

To address the problems the BGP proposed the repair of the water control structures, re-sectioning of embankment, providing temporary protection works at selected locations and khal re-excavation. These proposed interventions will improve the situation of the entire project area.

Environmental and Social Baseline

Meteorology and Physical Resources

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

In measuring the water quality, values of TDS (Total Dissolved Solid) were found very high (above 1,960 ppm) for locations inside the polder. Values of DO (Dissolved Oxygen) 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 higher salinity and one among three deep tube wells had saline (3 ppt). In the month of May, highest salinity was observed to be 22 pptin Amtala Khal. About 60% of land of the areas has elevation between 1.33 to 1.54 m +PWD, whereas 40% have elevations above 1.54 m +PWD. Wind speed of the polder area is the highest in April (around 160 kph) and the lowest in November (around 40 kph).

The study area falls under the Earthquake Zone-III, which is characterized by low earthquake prone sites and a basic seismic coefficient of 0.075g. In consideration of seismicity and stratigraphy, Polder 30 falls on a relatively safer (seismically quiet and tectonically stable) side. The study location can be regarded as a residential area and the observed noise levels are less than the permissible limits for daytime at Amtala Khal, BatiaGhata Khal, Khariar Khal and Gongarampur Union Parishad.

Water Resources

Polder 30 is 80 km away from the Bay of Bengal and undergoes diurnal tidal influence. Sholmari and KaziBacha rivers surround the polder area which is connected with the Rupsha-Pasur River. A number of khals exist within the polder such as Haniakhal, Hugolbuniakhal, Botiaghata-Baraiyabadkhal, Amtalakhal, Khoriakhal etc. Surface water levels along the Rupsa-Passur River during high tide range from 2 to 2.86 m above Mean Sea Level (MSL), and the low tidal water levels range from 0.61 to 0.7 m below MSL. Average daily use of water is around 30 lpc for domestic use. On the other hand, approximately 0.2625 Mm^3 water is used each year for irrigation of water melons and vegetables (CEGIS Field Survey, 2014)

Land and Agriculture Resources

The polder 30 area lies under the Ganges Tidal Flood Plain (AEZ-13). The most prominent cropping pattern is Fallow- Lt. Aman-Sesame, which occupy about 42% of the Net Cultivable Area (NCA). The next dominant cropping pattern is Fallow-HYV Aman- Sesame, which cover about 27% of the NCA. Total cropped area is about 8,226 ha of which the coverage of rice is 51% and that of non-rice is 49%.Cropping intensity of the project area is about 194%.Surface water is the only source of irrigation water here. The annual total crop production is about 17,134 tons of which about 8,268 tons of rice and 8,866 tons of non-rice are produced. Total loss of rice production is about 751 tons in 486 ha and loss of non-rice production is about 491 tons in 323 ha due to drainage congestion, siltation of khals and drainage channels, effect of salinity and natural calamities.

Fisheries Resources

The estimated fish habitat area is 440 ha where capture fishery constitutes the major share (250 ha) and culture fish habitat shares the rest. The estimated total fish production of the polder area is about 176 tons. The bulk of the fish production of about 76% comes from culture fisheries and the rest is contributed by capture fisheries. 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 (both pond and gher) are Rui, Catla, Tilapia, Pungus, Khorsula and Putietc. Amtalikhal and Khariakhal are used as feeding and spawning ground of most of the open water fishes.

Ecological Resources

The polder area encompasses two of these bio-ecological zones; namely the Ganges Tidal Floodplain and the Saline tidal floodplain. Terrestrial ecosystems of this polder are divided into homesteads, field crops, and roads and embankments. The dominant species of settlement vegetation are Sirish, Babla,KhaiBabla, Tal, Narikel, Bot, etc. Homestead vegetation is also important for fruit production. Roadside vegetation also makes a major contribution in terms of timber and fuel wood production. The protein demand of the local people is met by fish which comes from wetlands like khals, homesteads ponds, etc. No Ecologically Critical Area (ECA) or designated protected area is located within or near the polder area.

Socio-economic Condition

The 9,490 households in the polder area have a total population of 38,240 of which 18,940 are male and 19,300 are female. The density of population is about 1007 persons per sq. km. The average household size is 4.02. In the polder area, about 30% of the total population is

employed, 48% is engaged in household work, only one percent is looking for work and about 21% of is not working. At present, most of the population is engaged in the agriculture sector (83%).The average literacy rate in the study area is 55.9%. There are 59 primary schools, 8 high schools and 10 ebtedaye/ Dakhil Madras has in the polder area. The area has one upazila health complex, 3 union health complexes and 9 community clinics, but these health services are not adequately functioning. Most of the people dwell in their own houses.

Public Consultation

A total of six public consultation meetings were conducted in the study area in Khulna Sadar, Gangarampur, Daskin Sholmari of Khulna Sadar upazila. The meetings were attended by 70 participants including different types of professionals and key informants. They expressed their views on the Project, discussed other problems and gave their suggestions, which are presented in Chapter-6.

Impact Assessment

Implementation of the proposed work plan by the BGP will prevent salt water intrusion in the polder area; surface water would be available for domestic and irrigation purposes; siltation would be reduced and overall drainage congestion would be improved. Besides, temporary bank protection works would protect the polder area from further erosion.

An additional 2,157 tons of rice and 1,348 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 506 tons of rice and 374 tons of non-rice crops. Irrigated area would be about 175 ha and fish habitat quality and productivity will improve. It is expected that about 10–15% of fish production would increase compared to the baseline condition. Water depth as well as fish habitat quality will be improved. Hatchling movement from river to polder area through water control structures would be obstructed.

Overall habitat condition, i.e. habitat improvement as well as species diversity of both flora and fauna would be improved in the long run. Creating new employment opportunities would increase income generation of the people which would ensure betterment and well-being and thus improve the living standard. Additional income would bring solvency and steadiness of the family.The standard of living of 1700 households of the polder will be benefited since they will have access and share open water bodies which would ensure social use of water.

Furthermore, the cumulative and induced effects of the proposed interventions in Polder 30 have been investigated based on qualitative assessments. The study infers positive long-term cumulative effects in Polder 30 due to other proposed regional and local projects. The proposed Ganges Barrage may largely change the surface water salinity frontier of the area in the future whereas other large scale projects like the Bangladesh Delta Plan 2100 would have significant positive impacts on the polder. The implementation of the Coastal Embankment Improvement Project (CEIP) in adjacent polders may generate some risks of storm surge and tidal inundation as well as river erosion in the future. The rehabilitation works in Polder 30 may generate some minor effects in connection with river siltation, employment generation and food security. The reciprocal impacts of climate change and the polder have also been assessed. Impacts of climate change have been evaluated through advanced applications of hydrological (SWAT) and hydrodynamic (Delft3D) modelling tools.

The study infers that water level and surface water salinity in adjacent areas may increase in the future due to climate change, whereas dry season water availability may decrease. The climate resilience of local people in Polder 30 has also been found to have been enhanced due to the installation of many capacity development initiatives.

Environmental Management Plan

The following EMP measures will minimize the negative impacts and enhance the positive impacts due to the proposed interventions:

EMP Measures for Negative Impacts

- Avoid re-excavation during fish migration period e.g. from May to August.
- Spoil should 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 meter of each khal should be about 0.5 meter deeper than the normal design to protect fish brood.
- Trees should be planted along the slopes of embankments after the earthworks.
- Construction activities should not be run in early morning and night to avoid disturbance to wild fauna.
- The works should be completed in scheduled time to minimize disturbance to wildlife habitat
- The deepest points of the khals should kept untouched as much as possible.
- New habitats should be created adjacent to existing habitats before undertaking re-excavation of khals.

EMP Measures for Positive Impacts

- Repaired sluice gates should be closed during dry season for protection against tidal water intrusion.
- Dissolved salts must be washed-out by rain water from the surface soil through sluice gate during monsoon season.
- Crop rotation with leguminous crops, application of more organic materials, organic manure, and green manuring and soil management should be practiced to improve soil fertility in the project area.
- Crop diversification with multiple-crops might improve the environmental condition of the soil.
- Organic manure should be applied for the restoration of soil fertility.
- Irrigation should be provided at optimum level with minimum conveyance loss from khals.
- Awareness development on use and conservation of natural resources, campaign against indiscriminate fishing and reinforcement of fisheries laws and regulations in the polder area will be necessary.

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

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

1 Introduction

1.1 Background

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

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

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

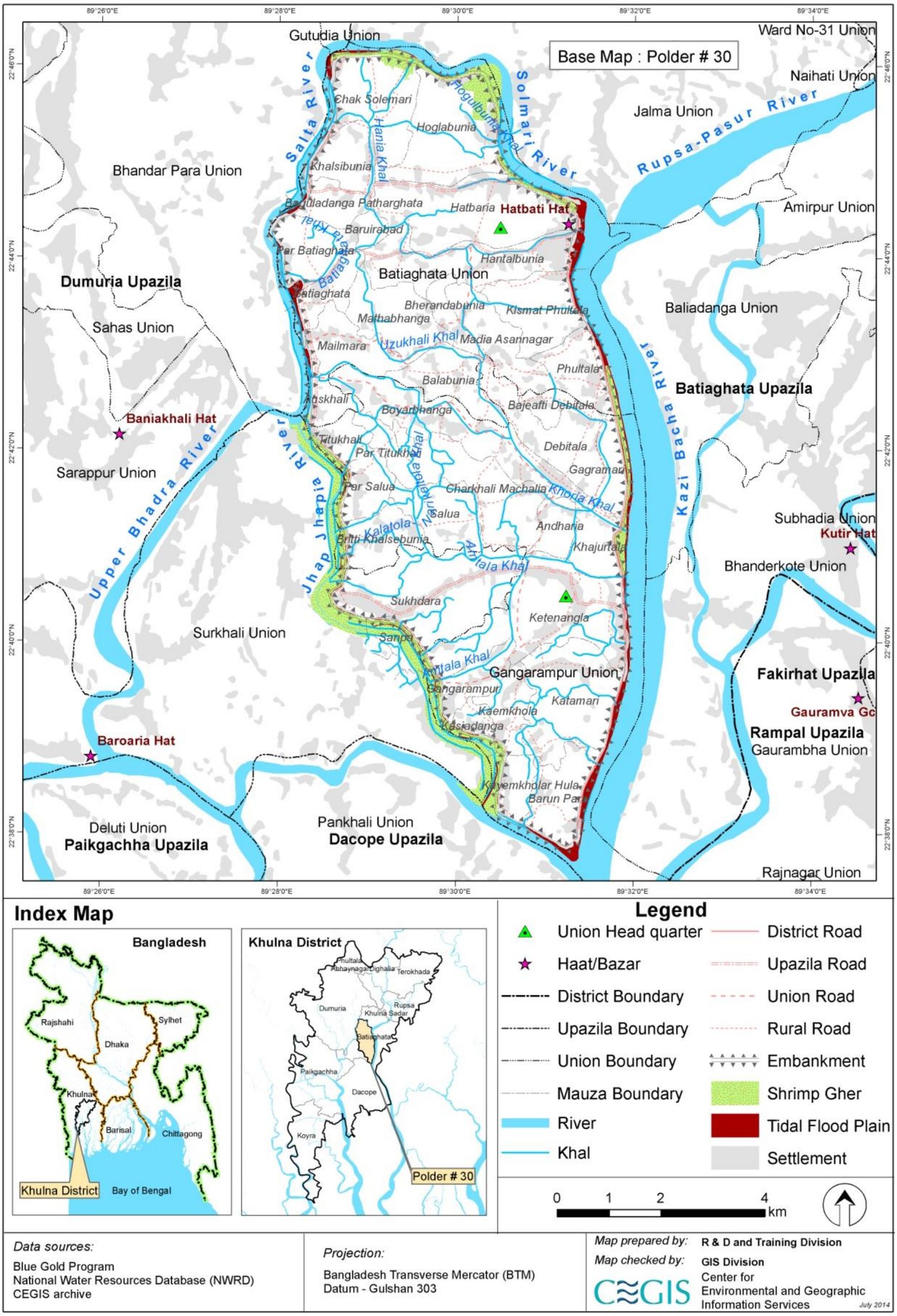
Table 1.1: Tentative District wise Distribution of Polders based on the Preliminary Selection

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

Source: Inception Report, Blue Gold Program, 2014

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

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



Map 1.1: Base Map of the Polder 30

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 the agricultural lands, settlements, homesteads etc from tidal flooding. However, polders are playing crucial role to the economic development of the country, simultaneously have some adverse effect on the ecosystem. Considering the importance, GoB has declared the construction/ reconstruction/ expansion of flood control embankment, polder, dike, etc are '**red**' category projects which must be subjected to Environmental Impact Assessment (EIA) study (ECR, 1997).

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

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

1.3 Study Area

9. Study area of this EIA is Polder 30 which is located in Batiaghata, Gangarampur, and Surkhali Unions of Batiaghata Upazila of Khulna District (Map 1.1). The geographical coordinates of the polder ranges from $22^0$37'59.0"N to $22^0$46'05.0"N as latitudes and $89^0$27'55.0"E to $89^0$31'57.0"E as longitudes. The polder covers an area of 6,455ha, with a Net Cultivable Area (NCA) of 4,240 ha (66%).

1.4 Objectives of the Study

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

a. To improve understanding of the physical processes and the interactions among the physical systems, human systems and implications of interventions;

- To identify key environmental issues/concerns that are likely to be impacted by the proposed interventions;
- To assess potential environmental impacts (cumulative, induced and reciprocal) of the proposed interventions on the natural system (water, soil, air, biological system, human health), anthropogenic systems (settlements and infrastructure), social and economic systems (work, education, recreation, health services) and cultural systems (beliefs, art, literature);
- To identify mitigation measures for mitigating the negative impacts and enhancement measures to boost up the positive impacts;

- To prepare Environmental Management Plan (Mitigation and enhancement plan, compensation and contingency plan) with monitoring plan.

1.5 Scope of Work

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

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

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

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

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

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

vi. Preparation of landuse map and ground truthing.

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

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

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

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

1.6 Limitations

12. Time allocated for the EIA study of Polder 30 was the major limitation which had to be overcome by employing more resources from CEGIS than the allocation of the TOR.

1.7 EIA Study Team

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

1 Dr. Ahmadul Hassan, Water Resources Engineer/ Team Leader
2 Mr. Mobsher Bin Ansari, Socio-economist
3 Mr. Md. Ebrahim Akanda, Soil and Agriculture Specialist
4 Dr. Ashraful Alam, Fishery Specialist

5 Mr. Md. Amanat Ullah, Ecologist
6 Mr. Mohammad Saidur Rahman, GIS/RS Specialist
7 Mr. Fahad Khadim Khan, Junior Engineer
8 Ms. Laila Sanjida, GIS/RS Analyst
9 Mr. Md. Azizur Rahman, Field Researcher
10 Mr. Md. Shahadat Hossain, Field Researcher
11 Mr. Md. Shahidur Rahman, Enumerator

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

1 Mr. Mujibul Huq, Environmental Advisor
2 Mr. Syed Ahsanul Haque, Disaster Management Specialist
3 Ms. Anushila Mazumder, Environmentalist
4 Ms. Sarazina Mumu, Urban Planner
5 Ms. Tahmina Tamanna, Civil Engineer
6 Mr. Tanvir Ahmed, Water Resource Modeller
7 Mr. Md. Shafi-Ul-Alam, GIS Analyst

1.8 Report Format

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

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

Chapter 2: The policy, legal and administrative framework.

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

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

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

Chapter 6: Socio-economic condition describes the demography, livelihood, communication, quality of life etc.

Chapter 7: Public Consultation and Disclosure .

Chapter 8: Important environmental and social components likely to be impacted by the interventions of the proposed rehabilitation plan; Assessment of the impacts of the proposed rehabilitation plan on the environmental and social components pertaining to water resources, land resources, agriculture, livestock, fisheries, ecological resources and socio-economic condition are described in this chapter.

Chapter 9: Assessment of cumulative, induced and reciprocal impact of climate change

Chapter 10: Environmental Management Plan (EMP).

Chapter 11: Conclusion and Recommendations.

2 Policy, Legal and Administrative Framework

16. 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 National Conservation Strategy (NCS) 1992

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

2.1.2 The National Environment Policy, 1992

18. 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.

19. 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).

20. 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).

2.1.3 National Environmental Management Action Plan (NEMAP) 1995

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

22. 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)

2.1.4 Proposed National Wetland Policy (draft 1998)

23. 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.

2.1.5 The National Water Policy, 1999

24. 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.

25. 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.

26. 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).

2.1.6 The National Biodiversity Strategy and Action Plan for Bangladesh 2004

27. 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).

2.1.7 Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

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

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

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

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

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

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

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

2.2 Legal Framework

2.2.1 Water Resource Management Legislation

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

29. 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)

30. 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

31. 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.

32. 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.

33. 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)

34. 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)

35. 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)

36. 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)

37. 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)

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

Panishampad Parikalpana Ain (Water Resource Planning Act, 1992)

39. 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 Environmental Legislation

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

40. 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.

41. 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)

42. 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.

43. The main objectives of ECA '95 are:

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

44. 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.

45. 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

46. 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).

47. 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.

48. 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.

49. 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.

50. 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)

51. 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

52. 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)

53. 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

54. .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.

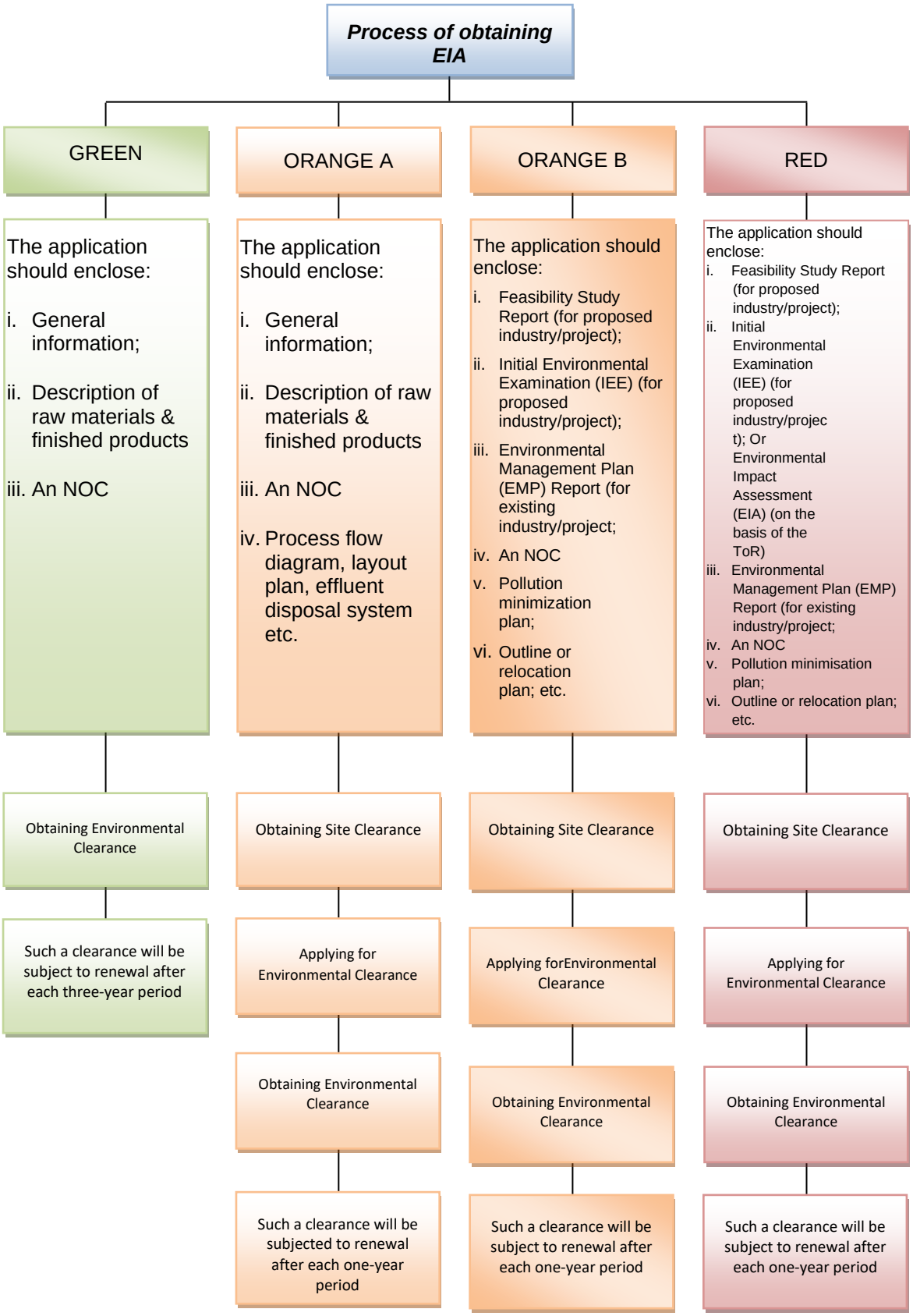


Figure 2.1: Steps Involved in Environmental Clearence following DoE Clearence

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

56. 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

57. 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

58. 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.

59. 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

60. The guideline for environmental impact assessment of water sector projects, developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by the Water Resources Planning Organization (WARPO) in 2003 is followed for conducting the Environmental Impact Assessment (EIA) study of 'Environmental Impact Assessment of Rehabilitation of Polder 30'.

61. The process followed for conducting the EIA study included 9+1 steps as shown in Figure 3.1 and activities undertaken on each step is described in the following sections.

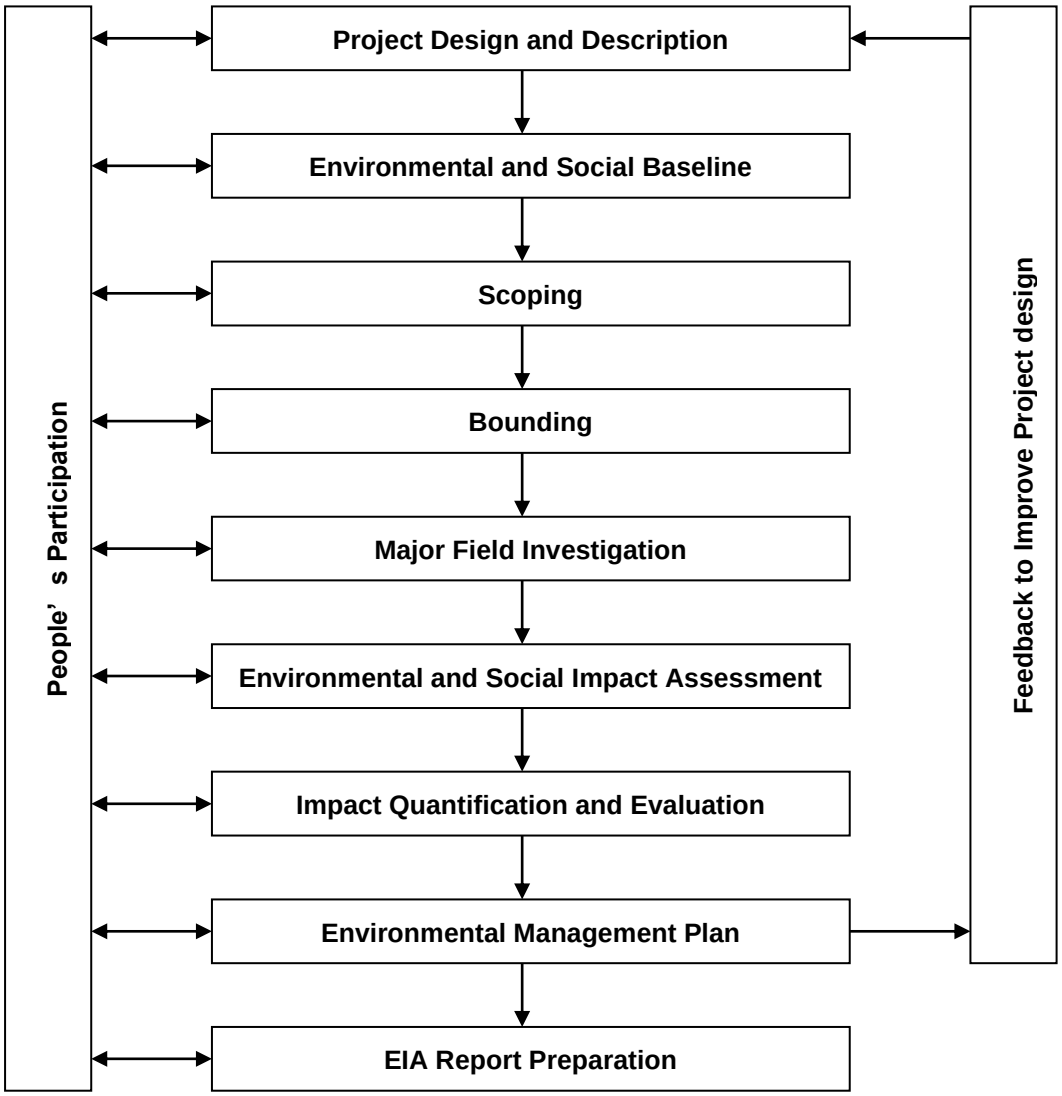


Figure 3.1: The EIA Process

3.2 Project Design and Description

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

3.3 Environmental and Social Baseline

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

3.3.1 Source and Methodology of Data Collection/Analysis

Climate and Meteorology

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

Topography and Seismicity

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

Water Resources (Both Surface Water and Ground Water)

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

67. Field visits were made to the study area and primary data on water resources components were collected through discussion with stakeholders. A checklist was used to obtain the information on different resources. Local knowledgeable persons and community representatives were also interviewed. During field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the 'Rehabilitation of Polder 30' on water resources components were assessed by analyzing collected data, community knowledge analysis and professional justification of water resources managers. The management plan for water resources components was incorporated to assess impact risk and water resources status using stakeholders' requirement and experts' judgment.

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

Land Resources

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

Agricultural Resources

70. Data on agricultural resources included farming practices, crop production constraints, existing cropping patterns, crop variety, crop yield, crop damage and agricultural inputs used.

Agriculture data were collected from primary sources through extensive field survey by developing questionnaire and in consultation with local people and concerned agricultural officials. Agricultural resources data were also collected from secondary sources from the upazila Department of Agriculture Extension (DAE) office. Crop production was determined using the formula:

71. Total crop production = damage free area × normal yield + damaged area × damaged yield.

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

Livestock Resources

73. Present status of livestock [(Cow/Bullock, Buffalo, Goat and Sheep and poultry (Duck and Chicken)] in the study area have been evaluated at field level survey in consultation with the local people through PRA, (Participatory Rural Appraisal) RRA (Rapid Rural Appraisal) and KII. Livestock resources data were also collected from secondary sources from upazila livestock office.

Fisheries Resources

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

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

76. **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.

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

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

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

80. **Secondary Data Collection:** Relevant secondary data were collected from the upazila fisheries office from their annual report and from various literature/study.

81. **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, total fish production of the study area were estimated. Secondary information those were collected from the UFOs and literatures were blended with primary data for production estimation.

Ecological Resources

82. 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 collection of ecosystem and habitat information, sensitive habitat identification, identifying ecological changes and potential ecological impact.

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

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

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

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

Socio-economic Condition

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

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

a) Data was collected from BBS, 2011

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

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

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

3.4 Scoping

88. A scoping process was followed for selecting Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions of 'Rehabilitation of Polder 30'. Scoping was done in two stages. Individual professionals of EIA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholder opinion obtained in the scoping sessions was considered in selecting the IESCs.

3.5 Bounding

89. Area likely to be impacted by "Rehabilitation of Polder 30" was delineated in consultation with the Blue Gold Authority and feedback received from the local people during baseline consultation. In addition, processed RS tools were also used for this purpose. A semi-distributed hydrological model SWAT (Soil and Water Assessment Tools) was setup in order to assess availability of water for the study area. Hydrodynamic modeling was simulated using Delft 3D as modeling tool. All data used in the model calibration (including topography, soil maps, land use maps, and weather data, river network and cross-section, water level, discharge and salinity) and simulation were obtained from different sources. Furthermore, participatory public consultations were carried out for validation of the model outputs, and drawing socio-technical conclusions.

3.6 Major Field Investigation

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

3.7 Environmental and Social Impact Assessment

91. Environmental and social impacts of the proposed interventions for "Rehabilitation of Polder 30" on the IESCs have been assessed through several sets of activities. Impacts are caused as a result of interaction of specific project activities with the existing environmental settings. The impacts of proposed interventions were estimated on the basis of difference between the future-without-project (FWOP) condition and the future-with-project (FWIP) condition. FWOP conditions were generated through trend analysis and consultation with the local people. This reflected conditions of IESCs in absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions were assessed to generate the FWIP condition. Comparison and projection methods were used for impact prediction. This included both positive and negative impacts which were considered in preparation of the environmental management plan.

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

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

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

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

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

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

3.8 Impact Quantification and Evaluation

93. 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

94. 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.

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

3.8.2 Magnitude

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

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

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

Table 3.1: Parameters for Determining Magnitude

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

3.8.3 Sensitivity

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

Table 3.2: Criteria for Determining Sensitivity

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

3.8.4 Assessment of Residual Impacts

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

3.9 Environmental Management Plan

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

3.10 EIA Report Preparation

101. At the end of the process, the present report on “Environmental Impact Assessment of rehabilitation of Polder 30” is prepared incorporating all findings of the EIA study.

4 Project Description

4.1 General

102. Blue Gold Program covers many aspects of development in polder 30, 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. Among these five components of Blue Gold Program, the EIA investigation entails component (ii) namely, water resources management, the descriptions of interventions provided in this chapter only deals with the rehabilitation of water resources management infrastructures in the polder. To make the polder effective against emerging challenges of erosion and sedimentation, 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

103. The objective of the component two of Blue Gold Program in Polder 30 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 polders 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.
- Re-excavation of khals so as to ensure efficient drainage as well as irrigation, and rainwater storage to enhance water use
- Protect vulnerable hot spots along the peripheral embankment from river erosion on a temporary basis (due to fund constraints), and improve the other associated development sectors

4.3 Polder 30 Overview

104. Polder 30 is located in Batiaghata, Gangarampur, and Surkhali Unions of Batiaghata Upazila, Khulna District. Polder was constructed during 1967-72, and later ofwas rehabilitated under the IPSWAM project from 2003 to 2011. The polder is located in the South-Western hydrological region of Bangladesh, with administrative jurisdiction lying within the Khulna O&M Division, BWDB, Khulna. The polder is surrounded by Sholmari River in its North-East direction, Kazibacha river along its Eastern and South-Eastern periphery, Salta River along its North-West corner and Jhopjhopia River along its South-West boundary (Map 1.1).

4.4 Present Status of Water Management Infrastructures

105. Water Management Infrastructures are the physical interventions that are used to ensure sustainable management, optimal use and equitable sharing of water resources. In Polder 30, there are some typical water management infrastructures in place i.e. peripheral embankments, drainage sluices, drainage outlets, flushing inlets and culverts. Based on field investigation carried out in May 2014, the study team perceived the following information regarding the existing infrastructure status.

Embankments

106. The Embankment is of 40.27 km length, with top width varying from 2.15 m to 2.60 m, and crest levels varying from +3.20 m PWD to +3.50 m PWD. Existing side slopes at some locations are as low as 1:1.1 (River Side) and 1:1.4 (Country Side), with a setback distance of up to 20 m. The existing situation of the embankment is good, offering protection against tidal and storm surges and salinity intrusion, facilitating the communication system as well. In dry season, the embankment remains dry and various modes of transportations are found through it. However the unstable condition ofR/S causes risk on its overall stability. In addition, the setback distance is not uniform throughout the embankment length; there are some points along the polder (at Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ, and Hogalbunia) which are often subjected to river bank erosion (Map 4.1). Considering these, the embankment needs re-sectioning works to mitigate the associated risks. Furthermore, temporary bank protection works may also be carried out.

Photo 4.2: Existing Status of Embankments(a) Narrow earthen surface along the peripheral embankment (b) Erosion point at Sholmari with nominal setback distance)

Water Control Structures and Culverts

107. There are eight drainage sluices, ten flushing sluices, three drainage cum flushing sluices, and six inlets within the area (as shown in Map 4.1). These structures need repairing as almost all of these are not functioning upto the desired level. The drainage outlets cannot drain out water properly during heavy rainfall events, and especially during post monsoon. The sluice gates are not able to provide full protection against salinity intrusion (due to mis-fitting issues of the gates, the saline water enters into the polder even when the gates are closed). There are also mismanagement issues regarding the water control structures. The water control structures need immediate repairing. Furthermore, there is a culvert at Katamari which severely impedes drainage flow. The culvert would need re-construction.

Photo 4.3: Drainage Sluice at (a) Katia Nangla Khal which needs replacement of gate and railing, (b) Moisher Danga khal which needs similar replacements

4.5 Present Status of Drainage Khals

108. The internal channels of the polder consist of 37 km length in total. Some channels have been silted up due to top soil erosion from its adjacent land areas, coupled with the improper maintenance over the years. Local people opined that saltwater during high tide is allowed to enter the polder sometimes to facilitate shrimp cultivation as well as prevention of water hyacinth growth, which may be another reason for siltation of some khals. Siltation of drainage channels has also created other problems, e.g. reduced water availability and limited water availability for domestic purpose and irrigation, creation of drainage congestion and water logging etc.

Photo 4.4: Narrow and Silted up Khals (a)Batiaghata khal, (b) Mailmara khal

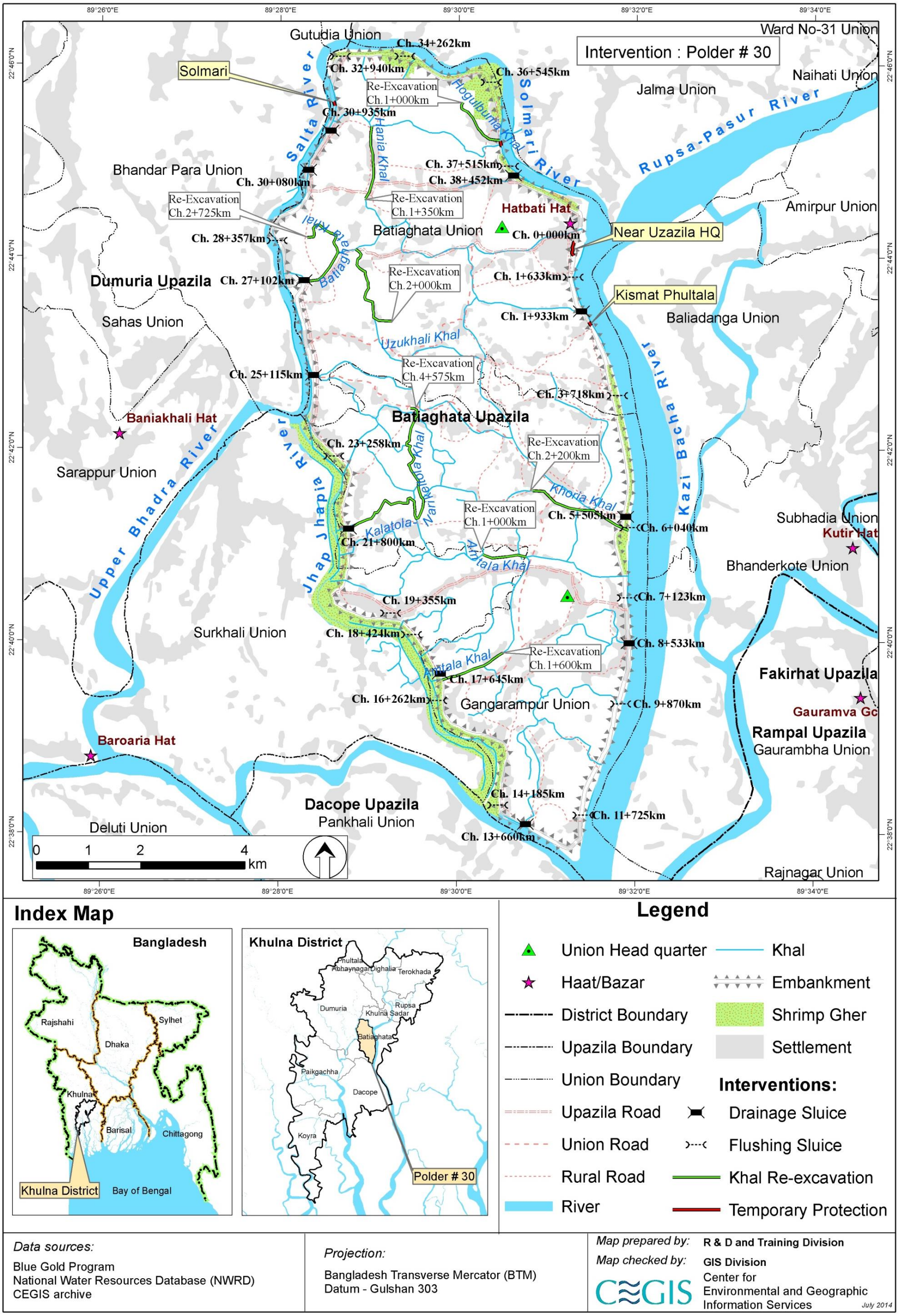
4.6 Problems and Issues in the Polder

109. The polder as a whole carries immense potential for development. However, a number of internal problems and issues are hindering its development potential at the moment. The most severe problem within the area is the drainage congestion, which occurs when the internal drainage channels cannot drain out water into the Jhopjhopia River, located south west of the polder. Saltwater intrusion is another prominent issue, which has contaminated both the surface water as well as ground water system. Soil salinity, internal canal bed siltation are the other major problems. In addition, riverbank erosion is also a threat that destroys homestead vegetation every year. Non-functioning of water control structures like

regulators caused insufficient drainage and flashing capacity of the polder area that triggered vegetation damage. Intrusion of saline water increases soil salinity that increases stress on vegetation. Furthermore, low level of employment and poor communication system are other noteworthy problems in the area.

4.7 Proposed Interventions in Polder 30

110. Taking the status of existing infrastructures into account, and the problems resulting from their damaged state, the Blue Gold Program has the following category of interventions in Polder 30. The locations of interventions have also been shown in Map 4.1.



Index Map

Legend

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

Interventions:

- Drainage Sluice
- Flushing Sluice
- Khal Re-excavation
- Temporary Protection

Data sources:

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

Projection:

Bangladesh Transverse Mercator (BTM)
Datum - Gulshan 303

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

Map 4.1: Proposed Intervention Map of Polder 30

4.7.1 Re-sectioning of Embankment

111. Along the entire peripheral embankment, re-sectioning works would be carried out. Re-sectioning works may not be repaired all along the polder, depending on the status of embankment stability and damage. The design crest width of the embankment is 4.27m, with varying side slopes at different chainages. The total length of the embankment is 40.27 km, and the design elevation of the crest of the embankment is roughly at +4.27 m PWD. The cross sections of the proposed re-sectioned embankments at different chainages are provided in Appendix 2.

4.7.2 Repairing of Water Control Structures and Culverts

112. All existing sluices, inlets and gates will be repaired. The locations of the water control structures are shown in the Map 4.1. Two sluices at Kalatola and Amtola have become redundant as the river at the outfall has been silted up. Moreover, three (3) new inlets (600 mm) at Deuatola, DakhinSholmari and Fultola will be constructed (Map 4.1).

4.7.3 Temporary Protection

113. There are some erosion hotspots at Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ, and Hogalbunia Darunmallik and Bigordana. Some temporary protection works are proposed in these reaches by the WMA (Map 4.1). From the major field investigation carried out by the study team in May 2014, the following information about vulnerable locations were collected regarding the temporary bank protection works proposed.

Table 4.1: List of Vulnerable Erosion Points in Polder 30

Location	GPS	River	Cause of Erosion	Remarks
Dakhin Sholmari	N: 22º45’37.2” E: 89º26’22.5”	Sholmari River	Change in river morphology	Around 30 m was eroded in last 5 years
Kismat Fultola	N: 22º43’46.0” E: 89º31’05.5”	Kazi Bacha River	Change in river morphology	Around 20 m was eroded in last 5 years
Batiaghata Upazila HQ	N: 22º44’26.3” E: 89º31’16.2”	Kazi Bacha River	Change in river morphology	Around 15 m was eroded in last 5 years
Hogalbunia	N: 22º45’13.5” E: 89º30’18.4”	Sholmari River	Change in river morphology	Around 20 m was eroded in last 5 years

4.7.4 Khal Re-excavation

114. A total number of eight khalsin Polder 30has been proposed to be re-excavated under Blue Gold program (Map 4.1). The total length of re-excavation is 17.025 km, which is approximately 46% of the total length of water courses inside the polder. The design bed width, bed level, and design slopes vary with khals, as well as along the chainages of each

khal. Some relevant long and cross sections of each khal under the re-excavation plan are shown in Appendix 2.

4.8 Construction Details

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

4.8.1 Description of Activities

Works on Embankment

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

Works on Drainage Sluices and Outlets

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

Construction/ Repairing of Flushing Inlets

118. A suitable site for the construction material of the structure will be selected and prepared accordingly. Alternative diversion channels will be constructed before the starting of construction works. Pipe and machine pipe along with construction allied and fittings will be made along with construction of and collar joints will be made as and where required. After completion of all activities, the approach embankments will be constructed and turfed with grass. Finally, a channel is to be excavated through lead cut and tail cut to make the flow to be channeled through the flushing gate.

Re-excavation of Drainage Channels

119. At first the required tools will have to be procured for re-excavation of the drainage channels. A schematic diagram showing centerline and layout plan will be prepared for the re-excavation work and the design depth and width of excavation are to be noted. The entire channel will then be divided into a number of segments. The excavation will be started from the upstream portion of the channel. Cross dams are to be provided at the starting and final locations of the reach, and then soil from the channels will be excavated and removed upto required depth and width. The excavated soil/ sludge should be disposed along the sides of khals. Proper compaction would be made on khal banks, and after finalizing the excavation in one reach, the other reach at its downstream would be excavated following similar procedures as stated for the first reach. Accordingly, all the reaches of the khal will be re-excavated.

Temporary Bank Protection Works

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

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

121. To summarize, a list of activities under each phase is shown in Figure 4.1 below. These activities would be considered during the assessment of environmental impacts on different phases.

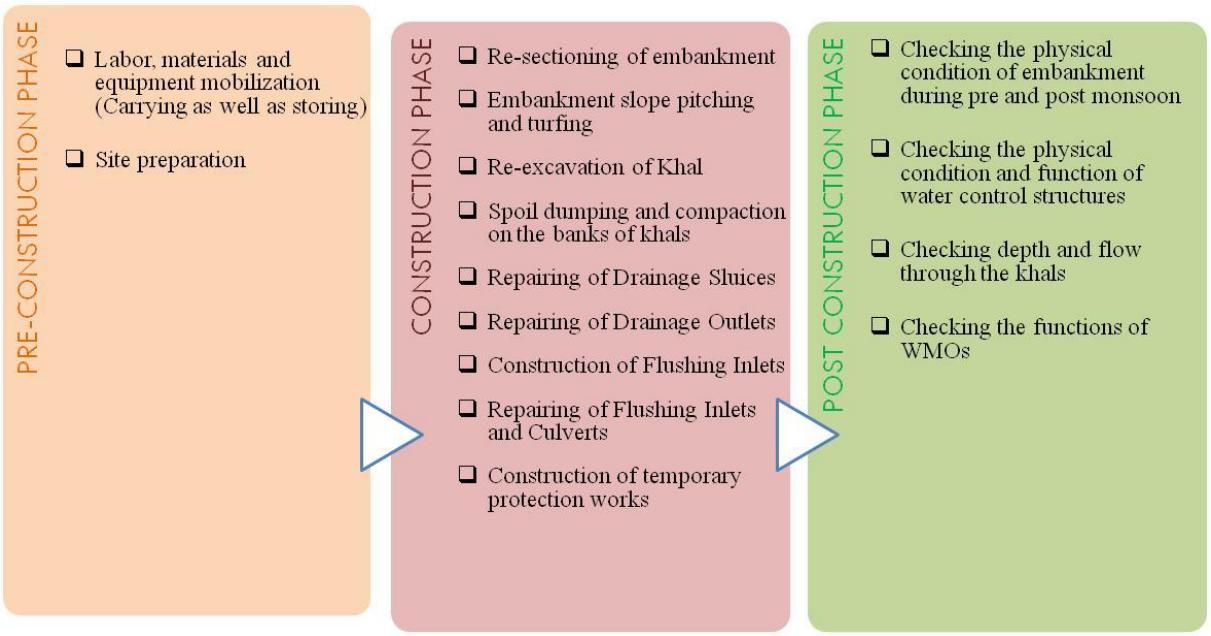


Figure 4.1: Phase wise List of Activities in Polder 30

4.8.2 Construction Schedule

122. The construction works would be carried out during dry season, and will be kept at abeyance during wet season. Other supportive works would be carried during the entire year. The interventions proposed in Polder 30 are likely to be completed by June 2015.

Table 4.2: Construction Schedule in Polder 30

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												

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

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

4.8.3 Materials Requirement

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

Table 4.3: Construction Materials Requirement in Polder 30

Sl. No.	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for Earthwork	80,500 m^3	From the set-bag location and other khas lands as well as materials dug out from river bed
2	Hoe, Shovel and Basket	800 nos.	To be procured
3	Compactor	100 nos.	To be procured
Repairing of sluices and flushing inlets			
4	Lift Gate	4 (1.5 m x 1.8 m)	To be procured
5	Flap Gate	4 (1.5 m x 1.8 m)	To be procured
6	Pipe	3 (dia: 0.600 m)	To be procured
7	Materials for Plastering, Railing and other repairing works	As per requirement	To be procured
Temporary Bank Protection			
8	Bamboo	400 nos.	To be procured
9	Geo-bags	50 nos.	To be procured
10	Other materials	N/A	N/A

Sl. No.	Description	Quantity	Sources
Khal Re-excavation			
11	Hoe and Basket	70 nos.	To be procured
12	Compactor	20 nos.	To be procured
13	Earth Material (for temporary cross dam)	60 m^3 for each Khal	River and khal bed

Source: Blue Gold Program 2014 and CEGIS Estimations 2014

4.8.4 Manpower Requirement

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

4.8.5 Construction Camps and Labour shed

125. The office of WMA of Polder 30 is located in Bigordana. The WMA will carry out the monitoring of the project. Moreover, the project works will be carried out by the local people, and therefore no labor shed would be required. Labors will come from their respective houses and will return back.

4.9 Project Management and Implementation

126. The project will be implemented in a participatory manner, ensuring local community based participation at all stages of the project. The issues considered for implementation of the project, the responsibilities of different stakeholders and actors, and the status of WMOs/ CBOs functioning within Polder 30 are discussed in the following sections.

4.9.1 Implementation Considerations

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

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

on-the-job training will be provided to the Government staff as to further reinforce their capacity.

129. The Water Management component of Polder 30 will be integrated through BWDB, as the BWDB staff will be directly responsible for the overall implementation process from planning to approval of the works to be completed and O&M of the main infrastructures. Technical assistance will be mainly deployed in fields where BWDBs capabilities are not sufficiently developed.

130. District Commissioners, and the elected chairpersons of the Upazilas and Unions will be regularly be informed about the progress. For implementation, TA-consultant will call upon the Union Chairman/ Councilor to actively participate during the mobilization phase of the cooperatives. Table 4.4 below shows the list of major actors and stakeholders, as well as their responsibilities to be involved in the implementation of Blue Gold program of Polder 30.

Table 4.4: Major Actors and Stakeholders for Project Implementation of Polder 30

Type	Organization/ Agency	Roles And Responsibilities
Donor Agency	Embassy of the Kingdom of the Netherlands	✓ Program approval, monitoring and supervision. ✓ Initiation/approval of innovations.
National Agencies	Planning Commission/ ERD	✓ Program approval, monitoring and supervision
	Inter-Ministerial Steering Committee	✓ Coordination of contributions of involved GoB agencies at national level.
	BWDB	✓ Overall management, implementation of component two in Polder 30.
	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	District Development Coordination Committee (DDCC)	✓ Coordination of BG interventions with District level development agencies. Participation of BG representatives in coordination meetings
	Upazila Development Coordination Committee (UDCC)	✓ Coordination of BG interventions with Upazila level development agencies.
	Union Parishad	✓ Coordination of interventions. Participation of BG ✓ representatives in coordination meetings

131. 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.

4.9.2 Community Participation through WMO/CBO

132. BWDB managers and field staffs in Divisions, Sub-Divisions and Section Offices might not have adequate expertise and experienced manpower to carry out the O&M of coastal polders properly. The numbers of field staffs are also insufficient and inadequate in some places with respect to the actual requirement. In such case participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) are needed to ensure sustainable operation of the project,. Therefore, a three tier organizational

structure comprising of Water Management Groups (WMG) at the lowest level, Water Management Associations (WMA) at the mid-tier and Water Management Federation (WMF) at the apex would be in place. These groups, associations and federations in a particular sub-project are together termed as the Water Management Organizations (WMOs) which has been considered in this project. Polder 30 comprises of 14 WMGs and one WMA, under Blue Gold Program.

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

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

Water Management Committee (WMC)

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

Labor Contracting Society (LCS)

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

4.10 Operation and Maintenance Plan

137. Since construction, Polder 30 has been playing a vital role in safeguarding the polder area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, the area remains vulnerable to storm surges, tidal flooding, river bank erosion; drainage congestion etc. As it was observed, some of the structures within the area were not adequate to cater to the diversified needs of local people. Changes in land use pattern also created social disputes at some places and newer dimensions for the existing structures were proposed as such, to allow flows of water both ways. Therefore, maintaining the polder system with embankments and structural elements built and rehabilitated over there has become a permanently important task. In this regard, ‘Guidelines for O&M Planning and Budgeting, August 2001; CERP-II’ has been studied and an O&M plan for the Blue Gold Program in Polder 30 has been proposed.

4.10.1 Operational Plan

138. Operational plan involves setting out the schedule of activities related to operation of gates of structures by the users' organization to control water levels best suited to water management and agricultural needs. The activities given below have been recommended for the operation plan of Polder 30.

Regulation of Gates

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

Frequent Monitoring of Embankments and Structures

140. 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 polders will assist in the problem detection process.

Supervision of Preventive Maintenance Works

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

4.10.2 Maintenance Plan

142. Maintenance of embankments and structures is necessary because it helps keeping the infrastructure in good and functional condition so as to protect investments, and prevent high rehabilitation costs. Since this is included in the day-today tasks schedule and needs continuous efforts, maintenance of coastal polders put emphasis on simple and cost effective community based interventions. Under the ‘component II’ of Blue Gold program in Polder 30, only those works which directly serve water management should be regularly maintained.

Preventive or Routine Maintenance

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

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

Periodic Maintenance

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

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

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

Emergency Maintenance

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

4.11 Expected Benefits and Outcome

The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 30 are listed in Table 4.5 below.

Table 4.5: Expected Benefits and Outcome of Proposed Interventions

Interventions	Benefits
Re-sectioning of Embankment	✓ Protection of salinity intrusion. ✓ Increased side slopes will enhance the stability of the embankment. ✓ Communication facilities may improve.
Repairing of Water control structures	✓ Sluices will functional properly, agricultural activities during dry and pre-monsoon seasons may be improved. ✓ Drainage situation would improve; salt water intrusion may be prevented.
Temporary bank protection	✓ Temporary protection from river bank erosion. ✓ Schools, offices and other infrastructures may be secured.
Khal re-excavation	✓ Potential rainwater storage may take place ✓ Better irrigation during dry and pre-monsoon seasons ✓ Better navigation as well as drainage

Interventions	Benefits
Outcome of the Project	Apart from the aforementioned foreseeable benefits, the project may create some socio-economic developments i.e. employment generation, reduction of poverty etc. As a result, the local economy in the area may further boost up.

4.12 No Objection Certificate

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

5 Environmental Baseline

5.1 Physical Environment

5.1.1 Meteorology

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

Rainfall

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

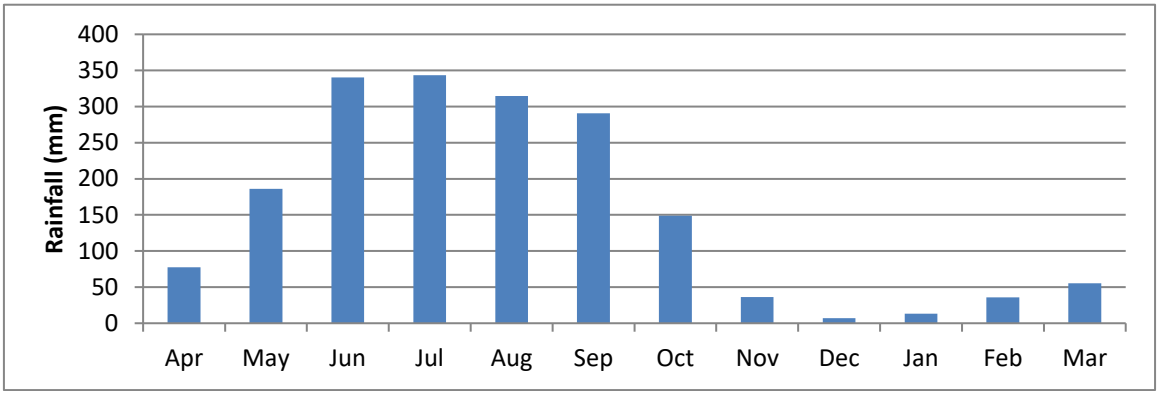


Figure 5.1:AverageMonthly Rainfall at Khulna BMD

149. For better representation of the real world scenario, values on rainfall from 1978 to 2008 have also been collected from the three BWDB stations located at Dumuria (8 km from polder), Khulna (9 km from polder) and Chalna (2.5 km from the polder). To take account of the spatial variation of rainfall, Theissen's Polygon have been delineated around these stations (Subramanya, 1994), which have been shown in **Map 5.6**. The area-weighted average values of monthly rainfall in Polder 30 has been plotted in **Figure 5.2** and the peak rainfall is observed as 503 mm in June, which is around 1.5 times higher than the same observed in **Figure 5.1**

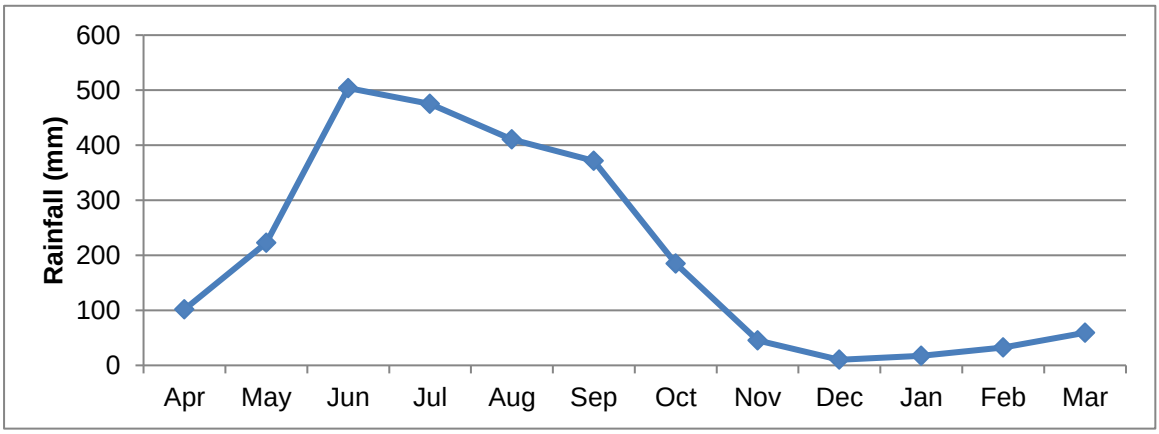


Figure 5.2: Average Monthly Rainfall in Polder 30 (using Theissen Polygon Method)

Temperature

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

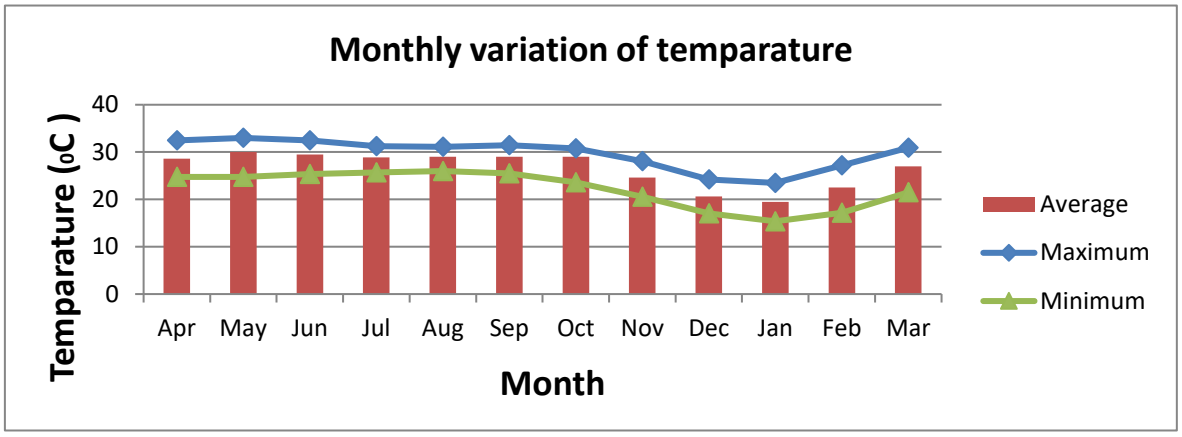


Figure 5.3: Average of Maximum and Minimum Temperatures at Khulna BMD Station

Relative Humidity

151. Relative humidity is the ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature. The value depends on temperature and the pressure of the system of interest. As the temperature of the atmosphere increases, vapor carrying capacity in water increases, and thus the atmospheric vapor pressure also increases. **Figure 5.4** below shows the variation of monthly relative humidity, as recorded by the Khulna BMD station (1978~2011). A significant fluctuation has been observed as relative humidity values start to increase from April (start of summer) due to the increase in atmospheric water vapors coupled with temperature rise. Relative humidity rises above 85% in monsoon (June to September), and starts decreasing from post monsoon season following the monsoon rainfall.

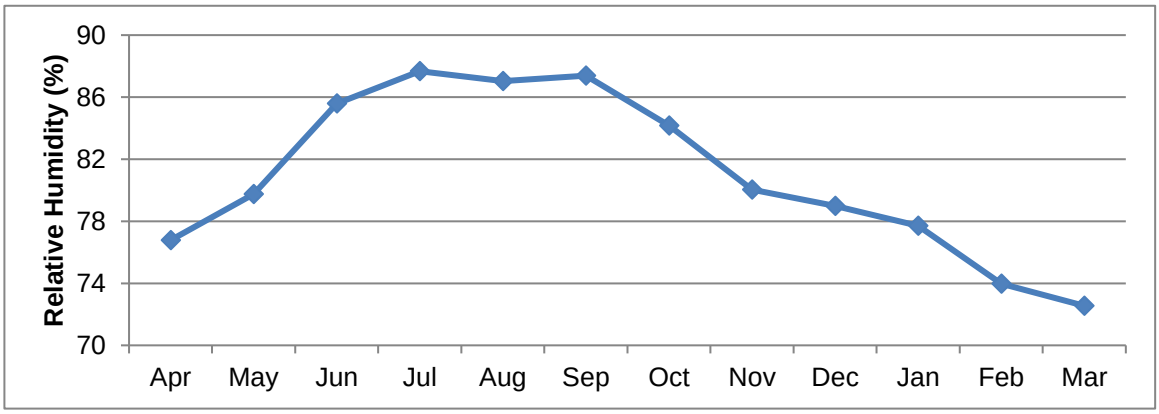


Figure 5.4: Average Relative Humidity at Khulna BMD station

Evaporation

152. Values of reference evapo-transpiration, ETo (from 1984 to 1998) and pan evaporation (from 1992 to 2011) have been collected from the Khulna BMD station. Later on, pan

evaporation values have been multiplied by a co-efficient of 0.8 to compute the actual evaporation values, whereas the ETo values have been multiplied by suitable crop coefficients used in *Bangladesh IWRA supplementary report in May 2014,* to get the actual evapo-transpiration. An understanding of transpiration is then found for all the months (by deducing actual Evaporation from actual Evapo-transpiration). **Figure 5.5** below provide the monthly variations of evaporation, actual ET and reference ET. Evapo-transpiration has been observed as the maximum during monsoon (June to September) and except dry season all the other months experience significant evapo-transpiration. ET is actually an indicator that defines crop and plant health, and observed results in Polder 30 therefore implies for better plant health (especially in Kharif-I and Kharif-II seasons).

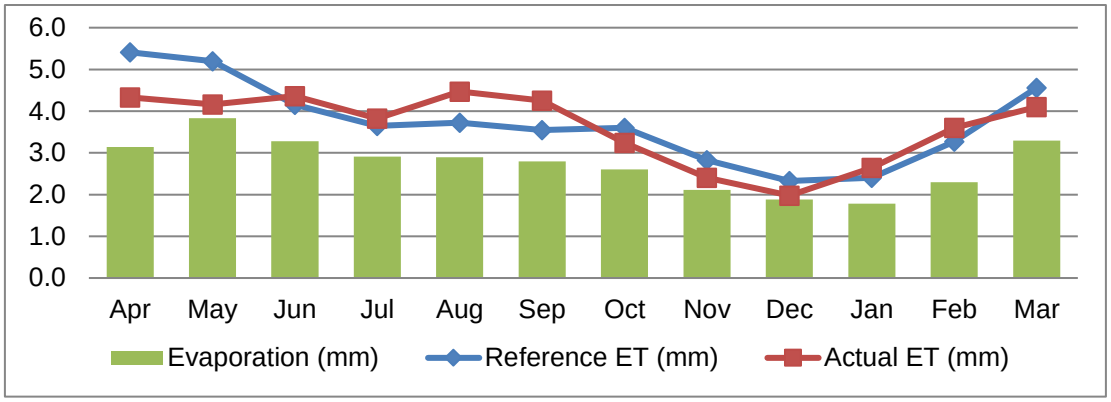


Figure 5.5: Monthly Variation of Evaporation, Reference ET and Actual ET for Khulna BMD Station

Wind Speed

153. **Figure 5.6**below shows the distribution of average monthly wind speeds, at Khulna BMD station (from 1978 to 2012). Wind speed is the highest in April (around 160 kph) and the lowest in November (around 40 kph). During cyclone Sidr (2007) and Aila (2009), 1 minute sustained wind speeds were recorded as 260 kph and 120 kph respectively, the former one created devastating impacts due to the high wind speed whereas the later one is more related to the increased storm surge.

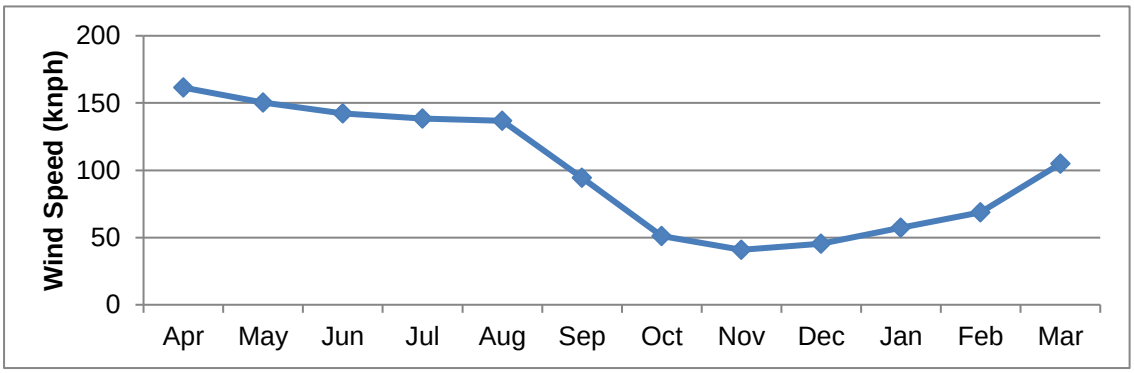


Figure 5.6: Variation of Average Wind Speed at Khulna BMD station

154. As per Bangladesh National building Code, the basic wind speeds for Khulna is 238 kph. Basic wind speeds of BNBC refer to the speeds above 10m from ground surface, with terrain exposure B (open terrain with scattered obstructions having heights generally less than 10m and extending 800m or more from the site in any full quadrant).

155. The wind roses generated using observed data at Khulna BMD station (source: SMEC, 2006) show average wind direction and speed for different period of a year. The yearly

average wind rose shows that the prevailing wind flows from south to north during most periods of the year (**Figure 5.7a)**. During November to February, maximum prevailing wind flows from north and north-west to south and southwest direction and for the rest of the period it flows from south (**Figure 5.7 b**). During March to April wind mostly flows from south and southwest to north and northeast (**Figure 5.7 c**), and for May to October it flows from south and southeast to north and northwest direction (**Figure 5.7 d**).

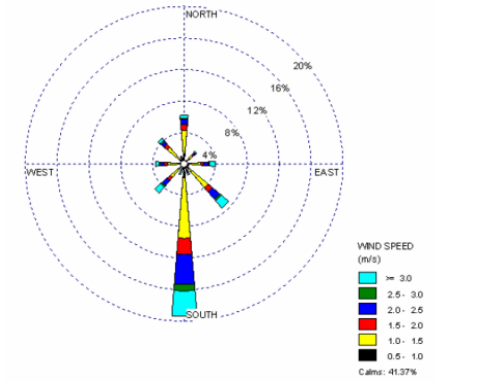


Figure 5.7(a): Wind Rose for Khulna for a Full Year

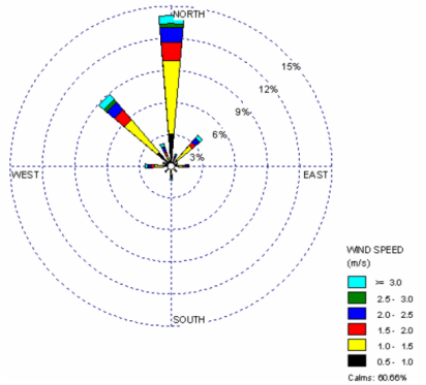


Figure 5.7(b): Wind Rose for Khulna from November to February

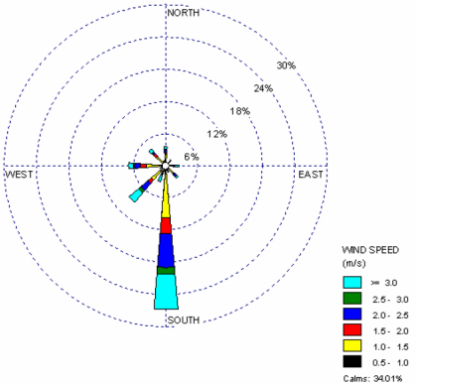


Figure 5.7(c): Wind Rose for Khulna from March to April

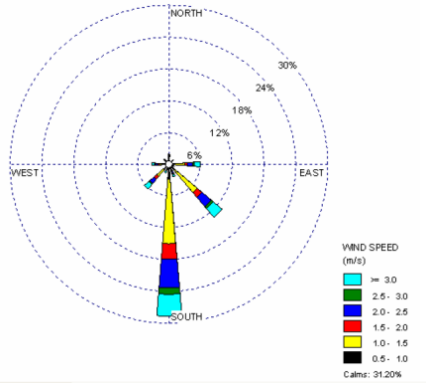


Figure 5.7(d): Wind Rose for Khulna from May to October

Sun-Shine Hour

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

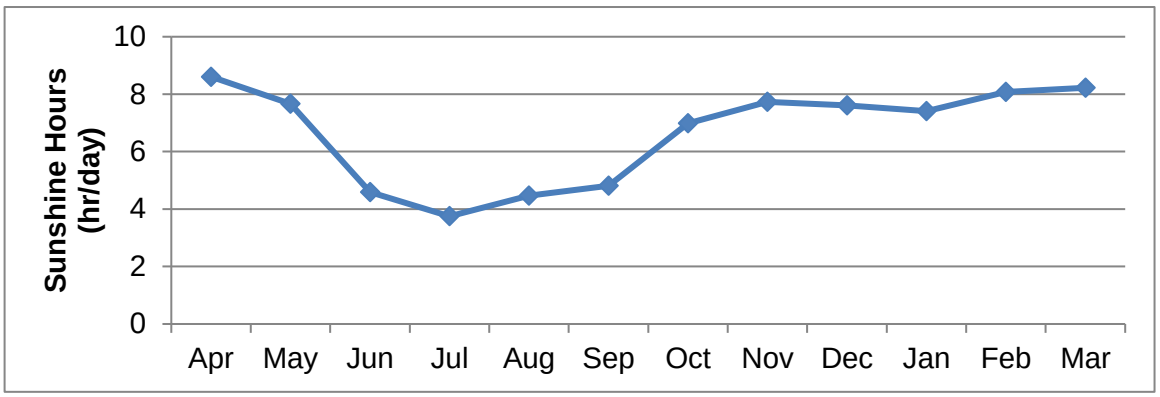
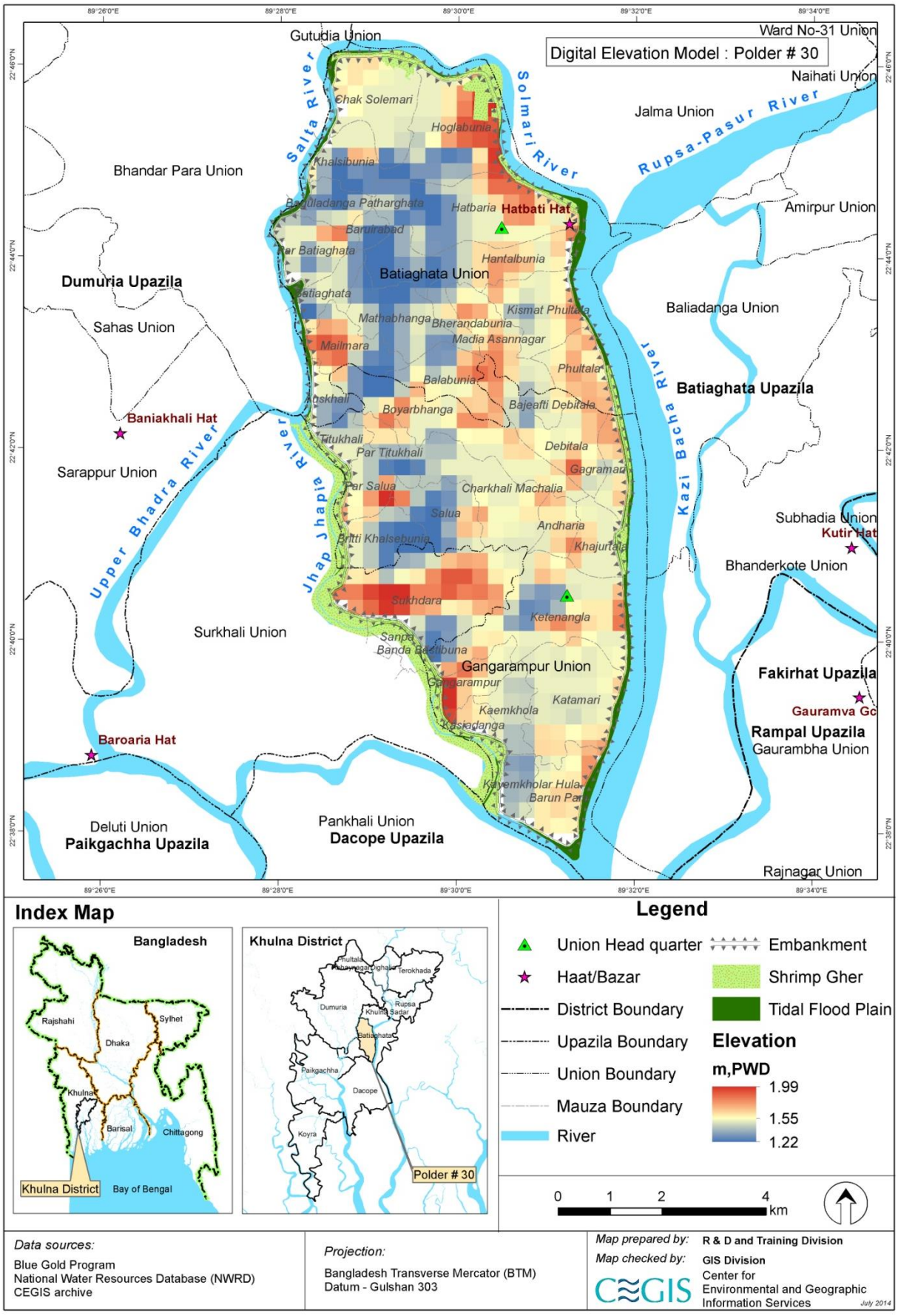


Figure 5.8: Monthly Variation of Average Sunshine Hours at Khulna BMD Station

5.1.2 Topography

157. The study area is located in the southern hydrological zone of the country, with very low average elevations. Re-sampled 500m×500m grid reduced levels 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 1.33to 1.99 m PWD (from Mean Sea Level), with average RL of around 1.55 m +PWD. The entire portion of Polder 30 is actually lower than the highest tidal water levels observed in Rupsa-Pasur River, and higher than the lowest tidal water levels for the same.

158. From the DEM it is found that 60% land of the areas have elevation between 1.33 to 1.54 m above MSL, whereas 40% have elevations are above 1.54 m above MSL. The elevations are more or less the same, with a very minor downward sloping from north to south, which eventually draws water from the up-stream basins to the Rupsha-Pasur River through the peripheral rivers (Sholmari, Salta, Jhopjhopia and Kazi Bacha). **Map 5.1** below shows the topography of the study area, identifying the rivers and water bodies as well as categorizing land elevations.



Map 5.1: Digital Elevation Model (DEM) and Flow Direction around Polder 30

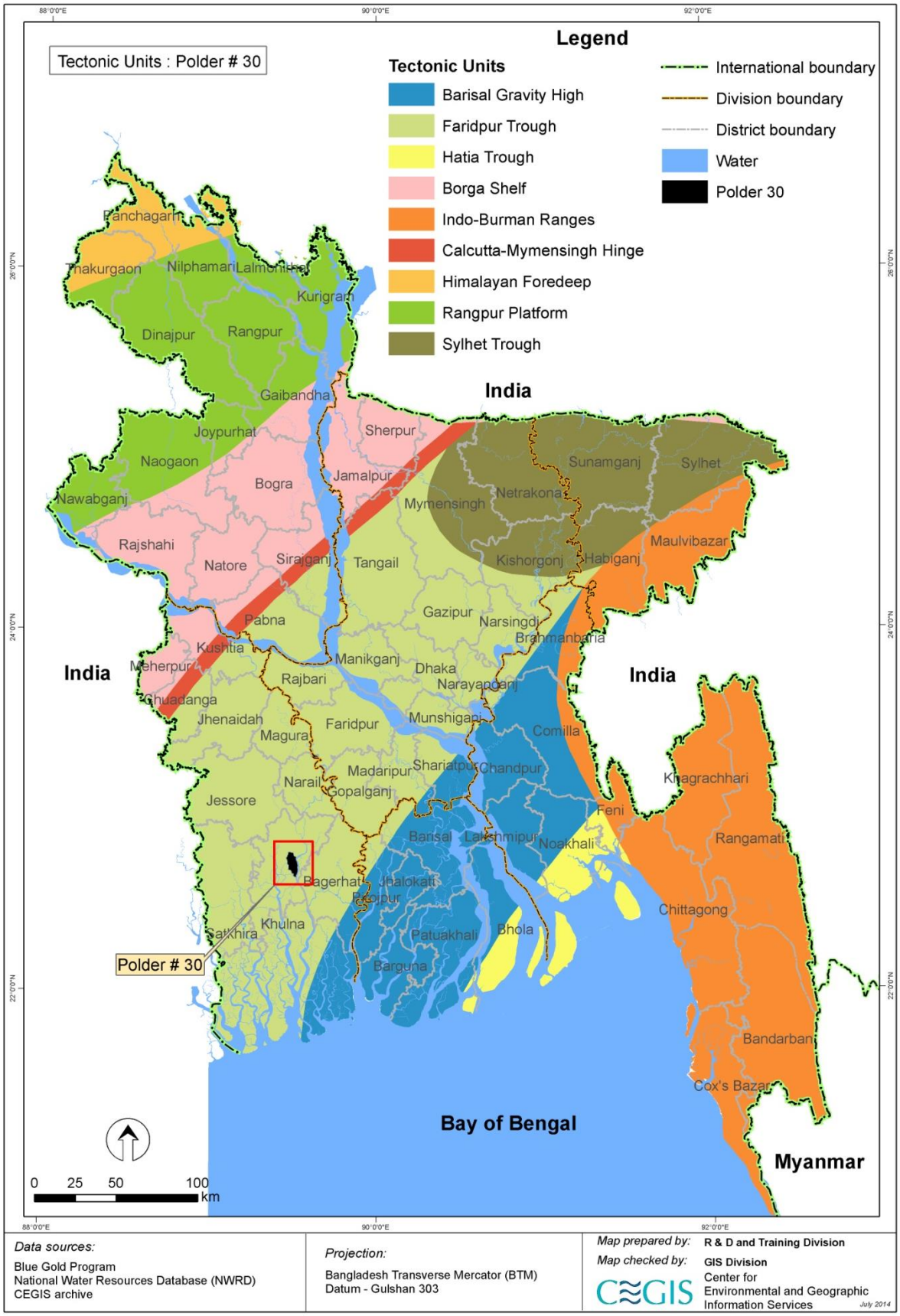
5.1.3 Seismicity

159. Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes in the past 200 years. Major active fault zones of the country have been delineated through geological trenching and dating methods. A seismic zoning map of Bangladesh was proposed in 1979 by Geological Survey of Bangladesh (GSB) dividing the country into three seismic zones: zone-I, zone-II, and zone-III. Later, a new updated seismic zoning map and detailed seismic design provisions have been incorporated in Bangladesh National Building Code (BNBC 1993) . Polder 30 falls under Zone-III which is considered as a seismically quiet zone with a Seismic Zone coefficient of 0.075, comprising the southwest portion of Bangladesh. 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** below shows the seismic location of polder 30.

160. Furthermore, the concept of tectonic frameworks has been studied to provide a comprehensive stratigraphic understanding of the area. Bangladesh is divided into two major tectonic units: i) Stable Pre-Cambrian Platform in the north-west, and ii) Geosynclinal basin in the south-east (and both units are separated by a narrow zone called the hinge zone). Stable Pre-Cambrian Platform refers to the stable shelf of the Bengal basin which can be divided into three major zones i.e. Dinajpur slope, Rangpur Saddle (Indian Platform) and Bogra slope. The tentative boundary of the Rangpur Saddle separates the Bengal Foredeep from the Himalayan Foredeep. Bengal Foredeep plays the most important role in the tectonic history of Bengal Basin and can further be divided into the Western Platform Flank and Eastern Folded Flank. Faridpur Trough is one of the five major troughs within the Western Platform flank. This is where Polder 30 is located. The trough is situated adjacent to the Hinge Zone, and is characterized by a general gravity-low with the development of Neogene sequence. **Map 5.3** below represents the tectonic units available in Bangladesh and the location of Polder 30 (within the Faridpur Trough).

161. It is therefore observed that both in consideration of seismicity and stratigraphy, Polder 30 falls on a relatively safer (seismically quiet and tectonically stable) side.

Map 5.2: Earthquake Zones of Bangladesh and location of Polder 30



Map 5.3: Tectonic Units Bangladesh and location of Polder 30

5.1.4 Agro-ecological Zone

162. Thirty agro-ecological zones and 88 sub-zones have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. These layers are:

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

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

164. The polder 30 area constitutes of one agro-ecological zone, namely Ganges Tidal Flood Plain (AEZ-13). The polder area is situated at Batiaghata, Gangarampur and Surkhali Union of Batiaghata Upazila of Khulna district.

165. This region occupies an extensive area of tidal floodplain land in the south-west of the country. The greater part of this region has smooth relief having large area of salinity. There is general pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, non-calcareous, heavy silty clays in the extensive basins. Non-calcareous Grey Floodplain soil is the major component of General Soil Types. Acid Sulphate soils also occupy significant part of the area where it is very strongly acidic during dry season. In general, most of the top soils are acidic and sub-soils are ne10utral to slightly alkaline. Soils of the Sundarban area are alkaline. General fertility level is high with low to medium organic matter content and very high CEC and K status. There are limitations of high exchangeable Na and low Ca/Mg ratio. The Zn status is low to medium and the B and S status is medium to optimum.

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

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

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

Source: Fertilizer Recommendation Guide-2012, BARC.

5.1.5 Soil Fertility Status of Polder Area

166. Soil fertility is an important factor for crop production. In general the coastal regions of Bangladesh organic matter content of the soil are pretty low, (Haque, 2006). Thus in addition to salinity, plant nutrients in soils affect plant growth. Farmers reported that the soils are in general poor in organic matter content. Soil sample were collected from four locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month of May, 2014. But in the month of April salinity may be high. The collected soil samples analyzed the Soil Resource Development Institute (SRDI), Dhaka. Analyzing result presented in the Table 5.7.We found from the table, Salinity level is ranges from 3.18-5.27 in top soil in all locations. The pH ranges from 4.5-8.4 in AEZ 13 and we observed that, pH ranges from 6.8-7.6 in all locations of the polder. It indicates that, pH ranges within the limit in the polder area. OM content ranges from 1.0-2.5 in all locations. But OM status in the AEZ is low to medium. It indicates that, soil of the polder area is quite suitable for crop production. K, ranges from 0.22-0.44 in all locations of the soil. But, it was found in the soils of AEZ is ranges from medium to optimum. It is suitable from 0.17-3.30 for crop production. N level is low in the AEZ. We found from the table that, N ranges from 0.08-0.14 in all locations of the polder area and ranges from 0.02-0.50 are good for crop production. P level is very low to low in the over all AEZ area and 0.01-0.20 is suitable for crop production. On the otherhand, it ranges from 3.83-13.52 in locations of the polder. However, the polder areas soil is good for crop production. In case of the quality of S in the soils of AEZ is medium to optimum. But it was observed, in S ranges 13.05-87.78 in all locations of the polder. It was found from the table S level of the polder area. 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
30	Hatbati	E-89° 29′39″ N-22° 44′9″	0-10	5.27	7.3	2.5	0.44	0.14	4.88	26.96
			10-20	2.85	6.9	1.5	0.39	0.08	4.55	87.78
			20-30	4.07	6.8	1.9	0.44	0.11	13.52	72.31
	Dabitola (West)	E-89° 30′14″ N-22° 44′45″	0-10	3.18	7.2	2.3	0.32	0.13	5.03	44.86
			10-20	2.84	7.4	2.5	0.29	0.14	4.96	25.66
			20-30	2.29	7.5	2.3	0.32	0.13	4.97	45.75
	Dabitola (East)	E-89° 30′26″ N-22° 42′17″	0-10	4.75	7.2	2.3	0.30	0.13	4.92	13.05
			10-20	3.22	7.6	2.2	0.22	0.12	4.47	19.75
			20-30	2.78	7.4	1.0	0.25	0.05	3.83	55.22
	Sukdara	E-89° 29′57″ N-22° 40′37″	0-10	4.33	7.1	2.3	0.37	0.13	3.90	18.74
			10-20	3.06	7.4	2.4	0.36	0.13	17.01	19.72
			20-30	2.73	7.0	1.7	0.34	0.10	4.85	31.23

Source: SRDI laboratory analysis, 2014-07-20

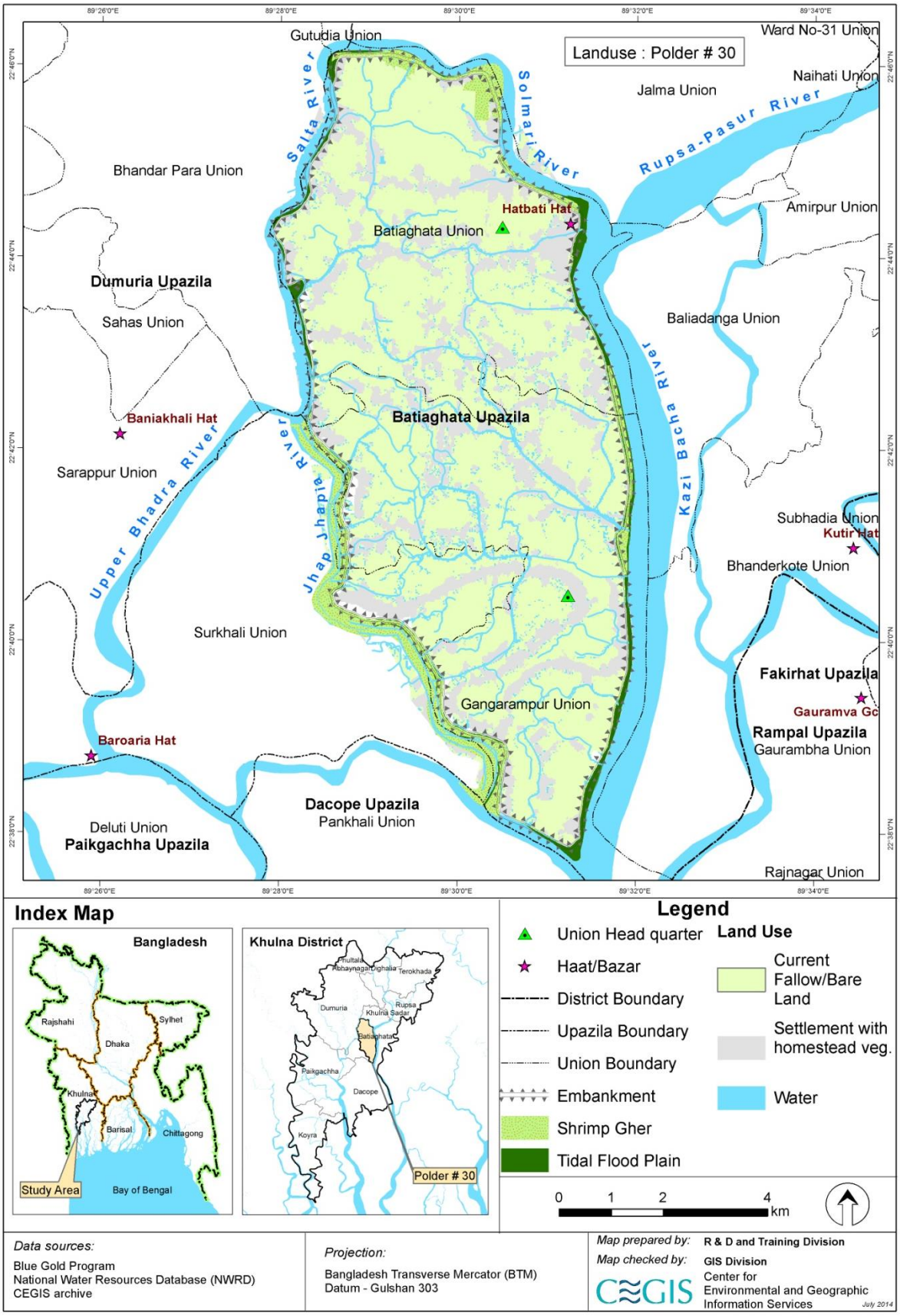
5.1.6 Land Use

167. The total polder area is about 6,455 ha of which about 66% is net cultivable area (NCA). Settlements, water bodies (khals) and road occupy about 29%, 4% and 1% respectively of the total polder area. Detailed of land use/land cover 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
Net Cultivable Area (NCA)	4,240	66
Settlements	1,900	29
Water bodies (khals)	250	4
Road	65	1
Total Area	6,455	**100**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.4: Land Use of the Polder Area

5.1.7 Land Type

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

5.1.8 Soil Texture

169. Soil texture is the relative proportions of sand, silt and clay. It is very important for agriculture crop production. The polder area is clay soil texture (97%) which is followed by clay loam (3%). Detailed distribution of soil texture is presented in Table 5.4.

Table 5.4: Detailed Soil Texture of Top Soil (0-15cm)

Texture	Area(ha)	% of NCA
Clay	4,100	97
Clay Loam	140	3
Total	**4,240**	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006

5.1.9 Soil Salinity

170. The soils of the polder area become saline in the dry season (Jan-May). The soil and water salinity gradually increases with dryness from January and 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 period'\s soil salinity inside the polder increases gradually. For instance, in 1973, 52% of the NCA inside the polder was slightly saline whereas in 2000, there was no slightly saline area but 12% of the NCA becomes strongly saline and in 2009, 19% of the NCA became moderately saline. However, one of the objectives behind polder construction is to protect the area inside the polder from salinity. In this polder, it is found that most of the water control structures are not functioning properly. As a result, this cannot restrict the saline water to intrude inside the polder which is reported as the major cause of the salinity increment inside polder. 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	Location (Union/ Mouza)	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
4.1 - 8.0	Very slightly saline with some slightly saline	Batiaghata, Gangarampur, Surkhali	2,040	48			20	0
8.1 - 12.0	Slightly		2,200	52	3,740	88	3,420	81

Soil Salinity Class (Ec=DS/m)	Description	Location (Union/ Mouza)	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
	saline with some moderately saline							
12.1 - 16.0	Moderately saline with some strongly saline						800	19
> 16.0	Strongly saline with some very strongly saline				500	12		
		Total	**4,240**	**100**	**4,240**	**100**	**4,240**	**100**

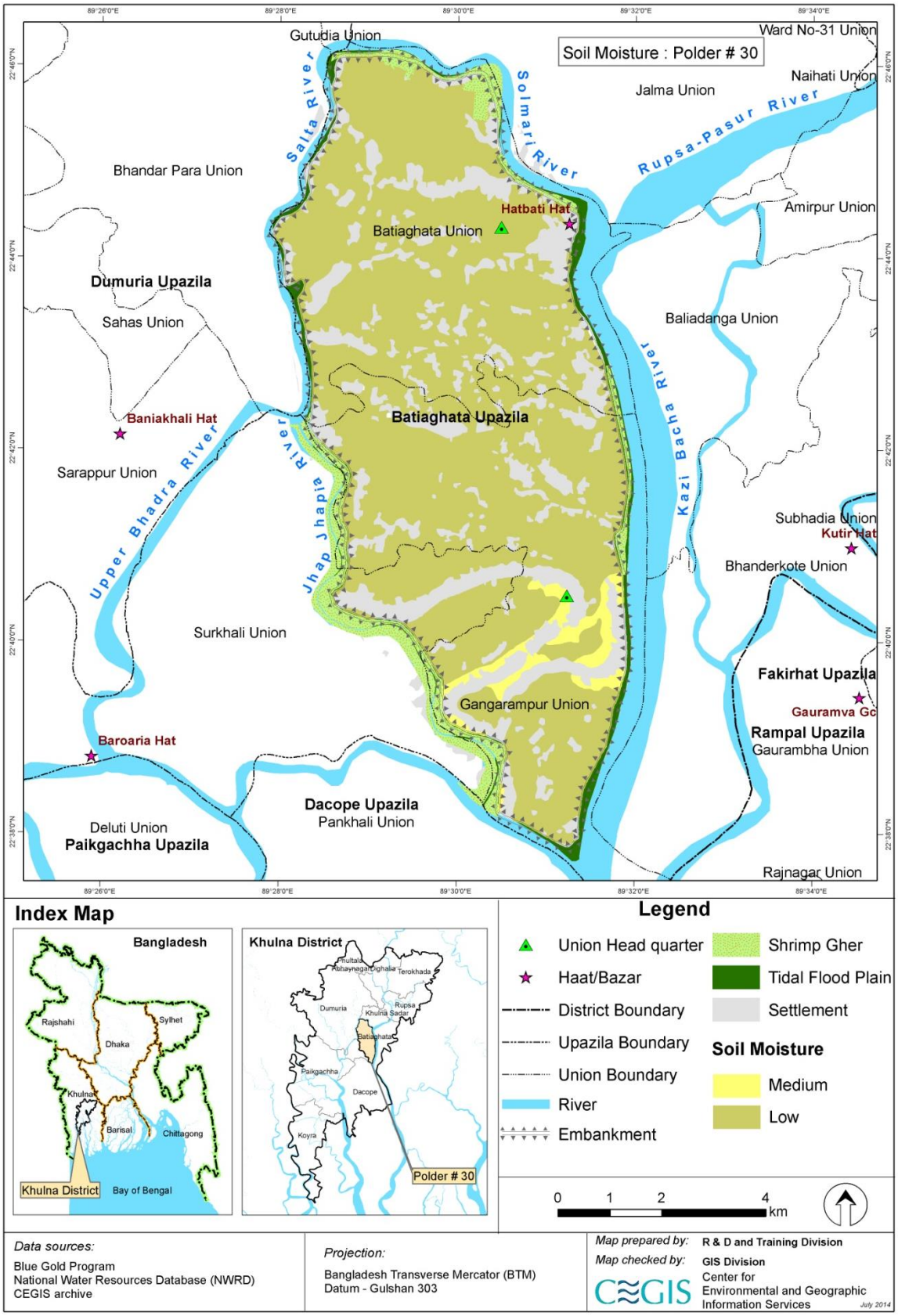
Sources: CEGIS estimation from SOLARIS-SRDI, 2006

5.1.10 Available Soil Moisture

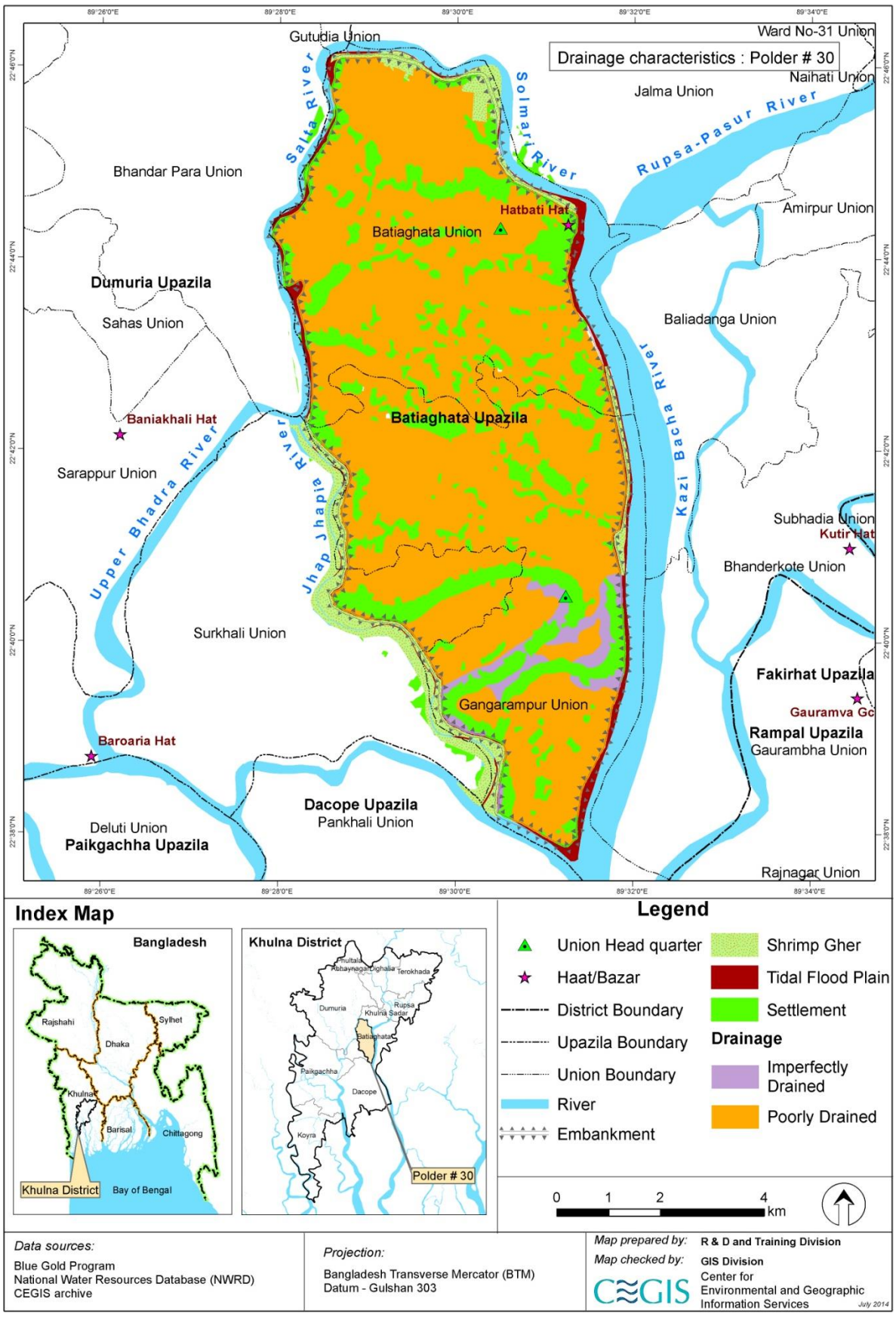
171. The available soil moisture is very important for the cultivation of rabi/dry season crops. The entire polder area (100%) is covered with low level of available soil moisture (Plant extractable soil moisture remained in the field level less than one month). Detailed distribution of available soil moisture is presented in Map 5.5.

5.1.11 Drainage Characteristics

172. Drainage plays a vital role in the management of soil (salinity, soil health) in the polder area. As per the SRDI (1988), the drainage characteristics have been divided into six classes from the agriculture point of views. Total area of the NCA is under poorly drained condition i.e, the soil remains under water from 15 days to 7/8 months and water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season. Soil of the polder area indicates that the removal of water in rainy/ 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 5.6.



Map 5.5: Available Soil Moisture of the Polder Area



Map 5.6: Drainage Characteristics of the Polder Area

5.1.12 Farming Practices

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

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

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

5.1.13 Crop Production Constraints

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

i) Soil salinity is the problems for crop production;

ii) Drainage congestion during transplanting period in Aman season;

iii) The level of sea water increases due to impact of climate change which is responsible for natural calamities such as tidal surge, cyclone etc.

iv) Severe scarcity of irrigation water in dry season especially for rabi crops cultivation; and

v) The siltation caused raise of bed of different internal drainage khals.

177. Above situations are unfavorable for crop production.

5.1.14 Cropping Pattern by Land Type

178. Total land in the polder area is medium highland (F_1). The most prominent cropping pattern is Fallow- Lt Aman-Sesame which is occupied about 42% of the Net Cultivable Area (NCA). The next dominant cropping pattern is Fallow-HYV Aman- Sesame which is covered

about 27% of the NCA. For HYV Aman, BR23 is the only variety practiced here. In case of local Aman, kalamadari, haitta, karangal, dudkalam sarnamasuri, kajalshail etc. are the common. Among the crops and varieties (sesame-BARI Sesame-2, mungbean-Mubarik, watermelon-Local, sunflower-Kironi) farmers are using In addition the vegetables crops, red amaranth, Indian spinach, bottle gourd, ash gourd, ridge gourd etc (BARI, developed crop varieties) are popular among the farmers. Detailed cropping patterns along with land type are presented in Table 5.6. Department of Agriculture Extension (DAE) just started demonstration in Rabi season with rice BR28.Here it is mentioned that about 65 ha of land where rice cum fish culture practice in going on.

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	Fallow	HYV Aman	Fallow	254	6
	Fallow	HYV Aman	Sesame	1,145	27
	Fallow	Lt Aman	Mungbean	763	18
	Fallow	Lt Aman	Sesame	1,781	42
	Fallow	Lt Aman	Watermelon	85	2
	Fallow	Lt Aman	Sunflower	127	3
	Vegetables	Vegetables	Vegetables	85	2
			Total	**4,240**	**100**
			Cropping Intensity (%)	***194***	

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

Photo 5.1: View of Sesame Field in the Polder Area

Photo 5.2: View of Rice Demonstration in the Polder Area

5.1.15 Cropped Area and Cropping Intensity

179. Total cropped area is about 8,226 ha of which the coverage of rice is 51% and non rice is 49%. The single and double cropped area is 6% and 94% of the NCA respectively. Therefore, cropping intensity of the project is about 194%.

5.1.16 Crop Damage

180. Crop damage in the polder area by drainage congestion, salinity, hail storm etc. was reported by farmers. Crop damage, percent of area and timing are presented in Table 5.13.Total loss of rice production is about 751 ton in 486 ha and loss of non-rice production is about 491 tons in 323 ha due to drainage congestion, siltation of khals and drainage channels, effect of salinity, natural calamities etc. Detailed information of crop damage is presented in Table 5.7.

Table 5.7: Crop wise Damage in the Study Area

Crop name	Location	% of damage area	Timing	Causes of damage
HYV Aman	Entire polder area	15	July-August	Heavy rainfall & drainage congestion
Lt. Aman	Entire polder area	10	July-August	Heavy rainfall & drainage congestion
Sesame	Entire polder area	10	April-May	Heavy rainfall & drainage congestion
Watermelon	Pocket area in the polder	20	April-May	Heavy rainfall & drainage congestion
Sunflower	Entire polder area	10	April-May	Heavy rainfall & drainage congestion

Source: Based on field information; 2014, SAAO, DAE and UAO, DAE.

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

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

Seed

182. 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 5.8 (BARI 2011-2012 and BRRI 2011). The seed rate used by the farmers in the polder area is also presented in the same Table 5.8. In case of rice, farmers are using more seed than recommended as they normally use more seedlings per hill. Most of the cases, seedlings are affected by monsoon flood and salinity. Sometimes, they 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. The lands were prepared smoothly. The price of seeds was high. For this reason, farmers of the area used less seeds than the

recommended rate. Local farmers reported that sesame seed and fertilizer were provided by Blue Gold program and BRAC.

Labor

183. In the polder area, almost 70% 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. The average number of labor (male and female) used per hectare in the polder area is presented in Table 5.8.

Fertilizers

184. The rate of fertilizer use per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Compost, Urea, TSP, MP and Gypsum. The other hand they are using less chemical fertilizer than the recommended dozes in all crops. According to UAO, SAAO and local farmers, there is four fertilizer dealers near the upazila head quarter, they said farmers are not aware about recommended rate. On the other hand they don't have enough money to buy fertilizer too. About 50-60% household has compost pit in there homestead area. Compost is mainly used in watermelon pits. Fertilizer recommendation rate as developed by BARC, 2012 on the basis of agro-ecological zone (AEZ 13) is presented in Table 5.8

Pesticides

185. The use of pesticides depends on the degree of pest infestation. The major insects as reported by the farmers are Stem borer, green leaf hopper, and Rice bug. Local farmer reported that they are using different types of pesticides such as Basudin, Furatar, Fighter, Rovral, Ridomil gold etc. Both liquid and granular pesticides are being used to prevent pest infestation in the rice, watermelon and sweet gourd cultivation. Ripcord and trap used in watermelon for prevention of pest infestation. Detailed information of pesticides used is presented in Table 5.8.

Table 5.8: Inputs Use (Seed, Labor, Fertilizers and Pesticides) of the Polder Area

Crop name	Seed			Farmers using fertilizer (Kg/ha)						Recommended doze (kg/ha)						Pesticide using by farmers	
	Farmers used (Kg/ha)	Recommended seed (kg/ha)	Labor No./ha)	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) approx.
HYV Aman	40*	40	150	0	70	50	30	0	0	0	163	35	30	0	0	2	1000
Lt Aman	50	40	120	0	30	30	0	0	0	0	97	14	17	0	0	0	0
Sesame	5*	7	70	0	15	10	0	0	0	0	170	60	31	0	1.3	0	0
Mungbean	16*	25	150	0	45	25	15	0	0	0	45	67	20	0	0	3	1500
Watermelon	0.9	0.8	150	700	80	60	25	0	0	6,000	141	56	30	0	3	4	1500
Sunflower	12*	12	120	0	20	10	0	0	0	5,000	160	150	150	0	0	0	0
Red Amaranth	1.2	2	100	500	30	0	0	0	0	5,000	59	13	17	4	0	1	200
Indian spinach	0.6	0.5	100	400	60	20	10	0	0	5,000	163	29	25	0	0	1	200
Bottle gourd	4.5	5	50	0	50	20	10	0	0	5,000	141	80	33	0	1	1	200
Ash gourd	4.5	5	60	0	50	20	10	0	0	5,000	141	55	25	0	0	0	0
Dhundal	3.6	Not found	50	0	50	10	10	0	0	No recommended doze was found						0	0

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

5.1.18 Integrated Crop Management (ICM)

186. 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, watermelon, mungbean and vegetables crops. Field information (Farmers and SAAO of DAE) indicates that ICM is being practiced in the fields covering about 7-10% of the cultivated areas and the impact has been found very encouraging.

Irrigated Area by Crops

187. The surface water is the only source of irrigation water reported by local farmers. Pond and khal are source of surface water for very limited time. Irrigation is provided only in watermelon and sometimes in homestead vegetables garden. Occasionally, Low Lift Pumps (LLPs) are being used in watermelon cultivation for surface water irrigation as supplementary irrigation. Farmers also reported that per hectors of land it needs tk. 4,500 to 5,000. Detailed information on irrigation is presented in Table 5.9.

Table 5.9: Irrigated Area by Crop

Crop name	Irrigation (Surface water)		
	Irrigated area (ha)	% NCA	Charge (tk/ha)
Watermelon	75	2	4,500
Vegetables	30	1	5,000

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

Crop Yield Level (Normal and Damaged) and Production

188. Soil salinity and drainage congestion are the major constraint to crop production inside the polder. Normally, HYV Aman, watermelon, sesame and sunflower crops are being damaged due to salinity and rain water. In addition, early rain causes damage of sesame, sunflower and watermelon crops in the field and Aman seedbed and Aman crops at early growing stages. This causes reduction of average yields. Detailed normal and damaged yield of crops are presented in Table 5.10

Table 5.10: Crop Yield Level by Different Crops

Crop name	Yield (ton/ha)		
	Normal (about)	Damage (about)	Damage free (about)
HYV Aman	2.9*	0.9*	2.0*
Lt. Aman	1.8*	0.6*	1.2*

Crop name	Yield (ton/ha)		
	Normal (about)	**Damage (about)**	**Damage free (about)**
Sesame	1.1	0.2	0.99
Mungbean	1.1	0	1.1
Watermelon	25	12	13
Sunflower	0.95	0.3	0.92
Vegetables	12	0	12

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

Crop Production

189. In the polder area, the annual total crop production stands at about 17,134 tons of which about 8,268 tons of rice is produced and 8,866 tons non-rice is produced. The contribution of rice crops about 48% and non-rice is about 52% of total crop production. Among the rice crops, the contribution of HYV Aman and Lt Aman are about 44% and 56% respectively. Detailed crop production and crop production loss with percentage are presented in Table 5.11.

Table 5.11: Existing Crop Production and Crop Production Loss of the Polder Area

Crop Name	Crop Area (Ha)	Damage Free		Damaged		Total Production	Production	Production (%)	Production Loss (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)	(ton)	loss(ton)		
HYV Aman	1,399	1,189	2.9	210	0.9	3,638	420		56
LT.Aman	2,756	2,480	1.8	276	0.6	4,630	331		44
Total rice	**4,155**	**3,670**		**486**		**8,268**	**751**	**48**	
Sesame	2,926	2,633	1.1	293	0.2	2,955	263		
Vegetables	255	255	12	0	0	3,060	0		
Watermelon	85	68	25	17	12	1,900	220		
Mungbean	763	763	1.1	0	0	840	0		
Sunflower	127	114	0.95	13	0.3	113	8		
Total non-rice	**4,156**	**3,834**		**323**		**8,866**	**491**	**52**	
Total	**8,311**	**7,503**		**809**		**17,134**	**1,242**	**100**	

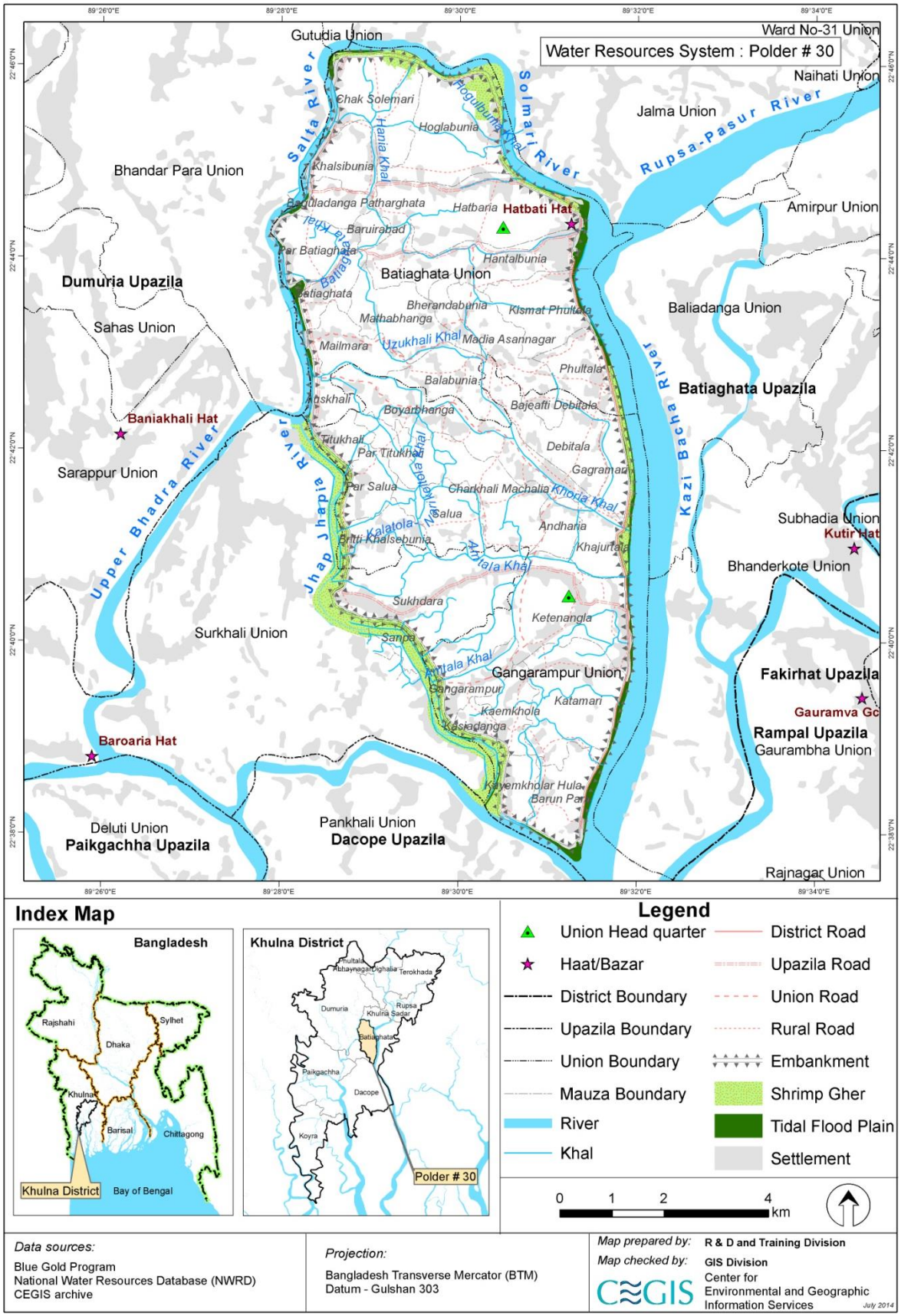
Source: CEGIS field estimation, 2014, UAO, DAE. Clean rice*

5.1.19 Water Resources

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

Rivers System

191. Polder 30 is 80 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is directly surrounded by Sailmari River (north), Kazi Bacha River (east), and Salta River and Jhopjhopia River (west). Sholmari and Kazi Bacha rivers are connected together to form the Rupsha-Pasur river. The river system of the area is shown in **Map 5.7**.



Map 5.7: Water Resources System of the Polder Area

Hydrological Connectivity

192. During high tide, water flows from Bay of Bengal to the Rupsa-Pasur and other peripheral rivers (Sholmari River, Salta River, Jhopjhopia River and Kazi Bacha River). A number of khals exist within the polder i.e. Hania khal, Hugolbunia khal, Botiaghata-Baraiyabad khal, Amtala khal, Khoria khal etc.). Local people opined that in order to remove the rampantly growing water hyacinth inside within the stagnant water courses, tidal water is allowed to enter during dry season through some sluice gates. Water then circulates within the polder and during low tides drain out through the existing gates into the peripheral rivers. The khals of Polder 30 are also shown in **Map 5.7**.

Surface Water Level

193. The surface water levels of two BWDB stations at Chalna (Rupsa-Pasur) have been analyzed (**Figure 5.9**). Water levels during high tide range from 2 to 2.86 m +PWD, and the low tidal water levels range from 0.61 to 0.7 m below the MSL.

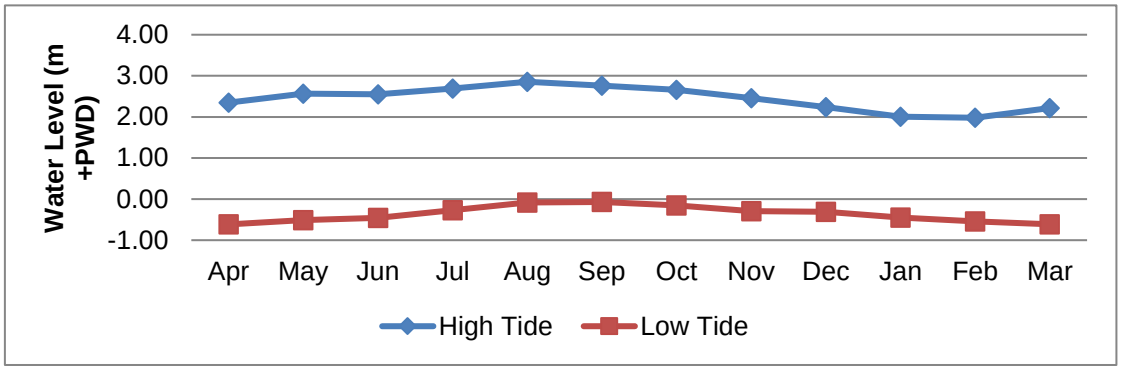


Figure 5.9: Surface Water Level at Chalna (Rupsa-Pasur River)

Ground Water

194. Monthly variations in ground water levels for year 2000-2013 have been plotted in **Figure 5.10** for the ground water observation well at Chalna (named as KHU003).The variation pattern shows that the Ground Water Table (GWT) is the lowest during March and the highest in September.

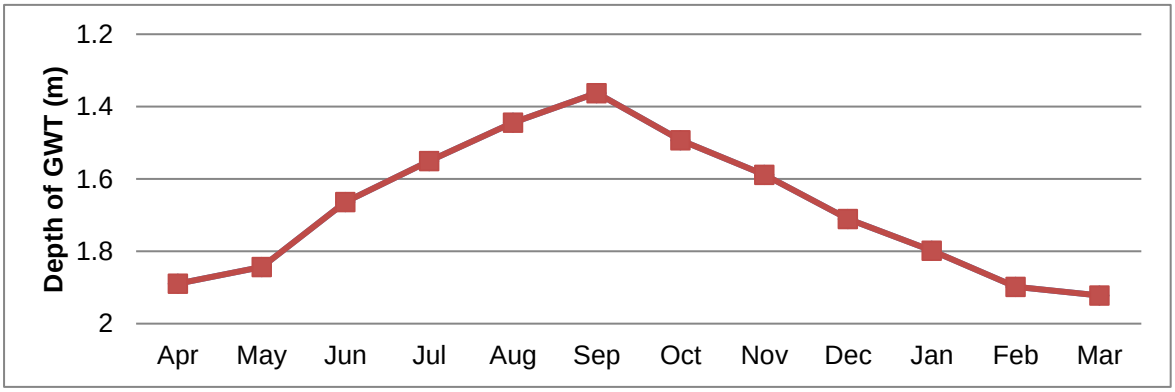


Figure 5.10: Average Monthly Variations of Ground Water Table

195. Analyses have also been carried out to understand the annual variations of GWT at KHU003 station for March and September (from 1980-2012). The values show a decreasing trend in both cases (Figure 5.11 and 5.12)

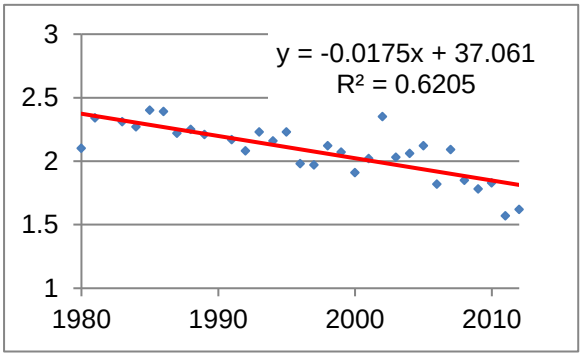


Figure 5.11: Variation of GWT at KHU003 in March (1980 – 2013)

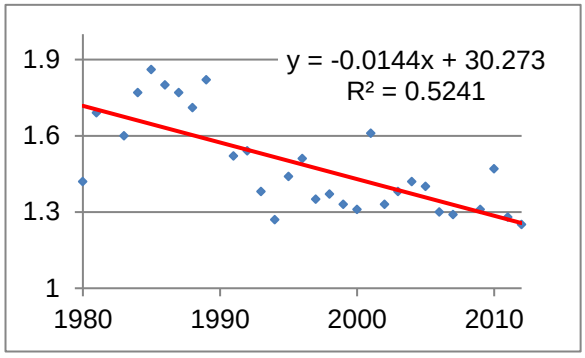


Figure 5.12: Variation of GWT at KHU003 in September (1980 – 2013)

Source: NWRD, 2013

5.1.20 Water Resources Problems

Tidal and Storm Surge Flooding

196. Local people in polder 30 opined that the peripheral embankment effectively offers protection from regular tidal flooding in the area. And even though some of the water control structures are subjected to flow leakage, the amount of flow entering the polder are minimal. As such it can be said that, no tidal flooding takes place inside Polder 30. Local people also alleged that there was very minor storm surge flooding in Polder 30during Aila (2009) and Sidr (2007).

Water Logging and Drainage Congestion

197. Drainage congestion mainly occurs in Gangarampur union, which is in southern part of the polder. The Amtali and the Kolatola khal drain the internal water to the Jhop Jhopia river. Siltation in Jhopjhopia river has raised the bed level by 1.5~2 m above the sill level of the Amtali and Kolatola regulators, which results severe drainage congestion of the drainage areas of the above two khals. In other part of the polder, some minor drainage congestion occurs due to the siltation of internal khals. About 10% of the total river system inside the polder is severely impacted while 14% of the river is slightly impacted by drainage congestion problems. Local people also opined that at present no dry season water logging problems exist in Polder 30.

Erosion

198. There are some erosion hot spots along the peripheral embankment of the polder. Erosion takes place continually, due to the morphological shift of peripheral rivers. During field investigations on May 2014, four locations namely, Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ and Hogalbunia were identified as locations vulnerable to river bank erosion. Dakkhin Sholmari and Hogalbunia are the along the Sholmari River whereas the locations near Upazila HQ and Hogalbunia are along the Kazibacha River. The rates of

erosion along these locations, and their GPS co-ordinates have previously been shown in **Table 4.1** of the Project Description chapter.

5.1.21 Water Resources Functions

Water Use

a. Domestic Use

199. The average daily demands of water for domestic and drinking purposes in rural areas are considered as 50 lpc [19].However in polder 30, the field investigations found that average daily use of water is around 30 lpc. Therefore for the 382,400 people living in the area (BBS, 2011), roughly around 11,472m^3 water is being consumed per day. The domestic demands are mostly met using surface water; and ground water sources are used to meet up the drinking water requirements.

b. Irrigation Use

200. The local farmers in Polder 30 practice LT Aman and HYV Aman during Kharif-II season (July-October) and Watermelon, Seasame and other vegetables during Rabi season (November-February). From field investigations it has been found that around 300 mm water is required for each ha of LT and HYV Aman cultivation whereas 250 mm water should be available for each ha for water melon and vegetables (**Table 5.12**). The local farmers do not need surface water irrigation for practicing Aman as the rain water availability is sufficient enough. For irrigation in watermelon and vegetables, approximately 0.2625 Mm^3 water is used each year.

Table 5.12: Irrigation water requirements in Polder 30

Season	Aman (ha)	Watermelon, Vegetables(ha)	Water Required (Mm Per ha)	Water Used (Mm^3)	Source of Irrigation
Kharif-II	4240	-	300	12.72	Rain Water
Rabi	-	105	250	0.2625	Surface Water

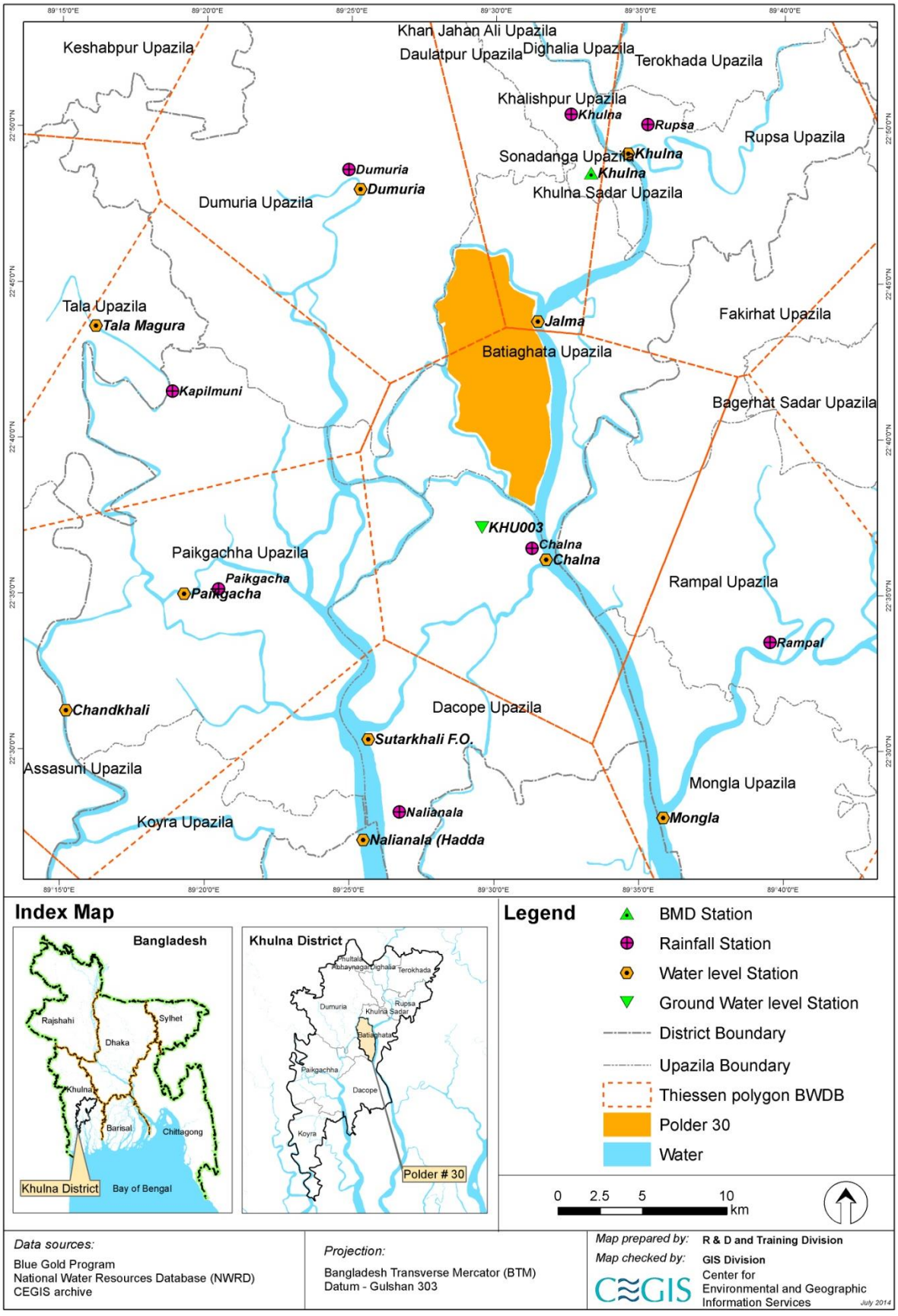
Source: CEGIS Estimation

201. From different agricultural studies carried out by CEGIS, it is understood that Irrigation for Aus crops in Kharif-I season (March-June) requires approximately 300 mm water per ha area. Therefore, an additional amount ofalmost12.72 Mm^3 water during Kharif-I season would be required to bring the entire NCA of polder 30 under Aus cultivation.

Navigation

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

203. Map 5.8 below is a reference map, showing the locations of noise quality measurement sites; the stations used for collected secondary data on water resources (both surface and ground water); and the Thiessens polygons used for spatial distribution of rainfall.



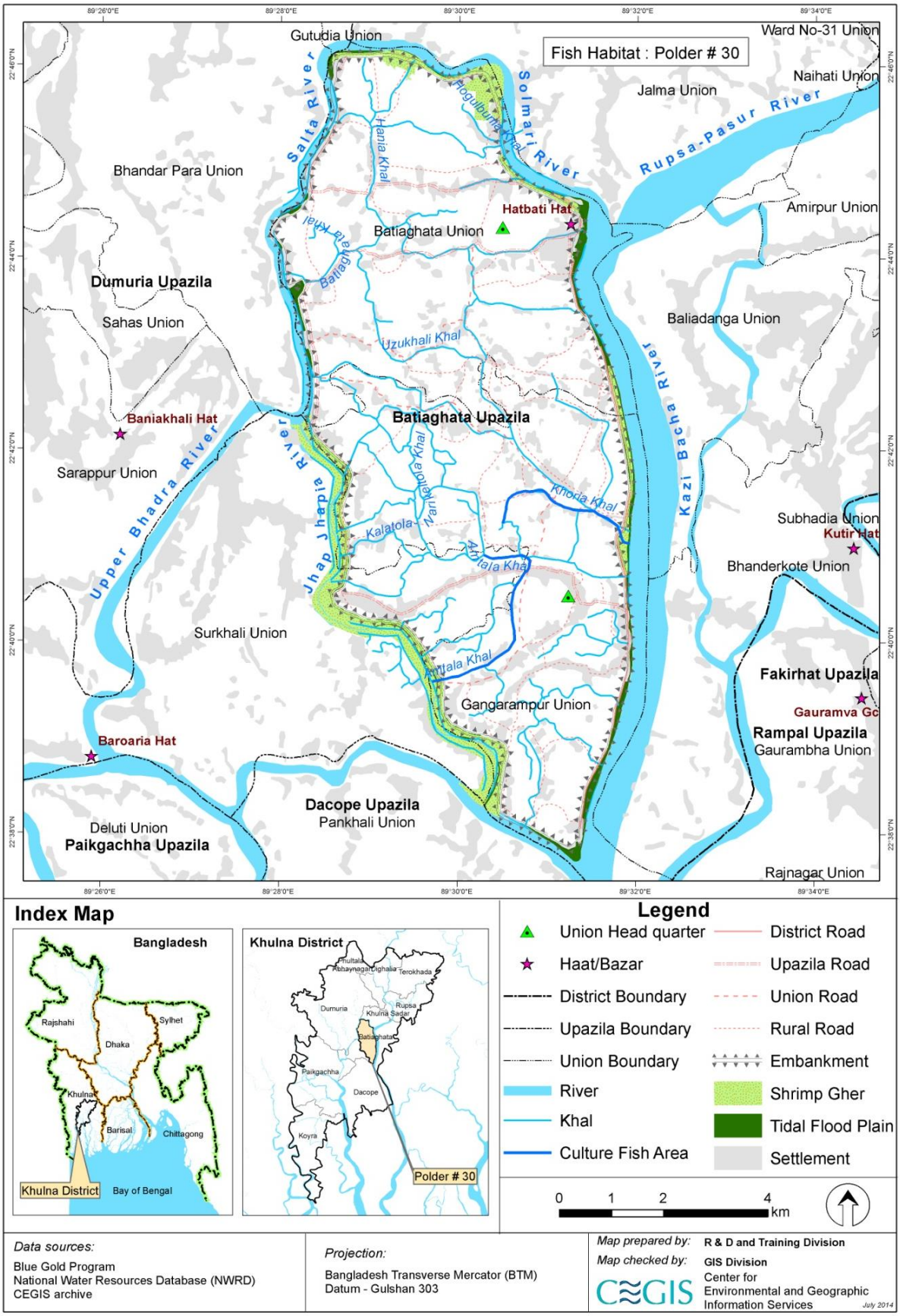
Map 5.8: Map showing BWDB Stations of Rainfall, Theissens Polygon, Water Level Measuring Stations and GW Observation Wells

5.2 Biological Environment

5.2.1 Fish Habitat

204. The polder area is surrounded by the Bhadra, the JhapJapia and the Manga rivers on the south-west; the Sholmari River on the north-east and the Rupsa - Passur River on the south-east. The rivers are tidal in nature having potentials of appearing saline water fish species. Good numbers of seasonal and perennial khals exist in the polder area. These khals are act as open water fisheries connectivity between polder and adjacent rivers. Therefore, fisheries resources of the area are diversified with different fresh and brackish water fish habitats. Fish habitats of the polder area are primarily classified under two broad categories, such as capture and culture fishery. Capture fisheries habitats include Periphery River, tidal floodplain, intertidal floodplain and internal khals (Map 5.9). Most of the tidal floodplain is occupied by shrimp gher. The open water fish habitats of the area are khals and floodplain which are acting as major arteries of fish migration into the study area. These are playing vital role in maintaining fisheries productivity of the open water fish habitats inside the polder area. There is no beel/wetland in the polder area. The culture fishery of the polder area is dominated by culturable fish pond. The culture fish habitats include rice cum fish culture and cultured pond.

Photo 5.3: Open Water Fish Habitat of the Polder Area



Map 5.9: Fish Habitat of the Polder Area

Capture Fisheries

205. The estimated fish habitat area is 460 ha where capture fishery contributes the major share (250 ha) and the culture fish habitat shares the rest. The open water fish habitat is represented by khal and floodplain while the culture fish habitat is represented by cultured fish pond as shown in the following Table 5.13. In the study, the peripheral rivers and tidal floodplain has not been considered for fish production estimation of the polder area.

Table 5.13: Fish Habitat Status in the Polder Area

Sl. No.	Category	Habitat Types	Area (Ha)
1	Capture	Khal	250
		Floodplain	20
		Sub-total	***270***
2	Culture	Gher (Rice-cum-golda)	*65*
		Fish pond	125
		Sub-total	***190***
		Total	**460**

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

206. Among the khals, Khoria khal, Amtali khal, Batiaghata khal are playing important role. The depths of these internal khals range from 0.7-1.7 m (Table 5.14) 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 muscle men and practicing culture fishery by developing barriers through net. Photo 5.4 (a & b) shows the internal khals in the polder area.

a. Amtoli Khal (Encroached for Fish Culture)

b. Kalatola Khal (Silted Up)

Photo 5.4: Open Water Fish Habitat (Khal) in the Polder Area

Table 5.14: Detailed Information of Importance Khals in Polder 30

Sl. No.	Name of Khal	Wide (m)	Depth (m)	Length (km)	Type of Water Bodies
1	Amtola Khal	20.0	1.7	4.41	Perennial

Sl. No.	Name of Khal	Wide (m)	Depth (m)	Length (km)	Type of Water Bodies
2	Botiaghata - Baraiyabad Khal	15.6	1.7	2.57	Seasonal
3	Hania Khal	10.1	0.7	3.16	Seasonal
4	Hugolbunia Khal	13.4	2.3	1.13	Perennial
5	Khoria Khal	20.6	1.7	3.28	Perennial
6	Kolatola-Narikeltola Khal	7.2	1.7	4.78	Seasonal
7	Uzukhali Khal	9.7	1.2	4.35	Seasonal

Sources: GIS data, CEGIS, 2014

207. Siltation is found one of the major problems of the khals to make the habitat unsuitable for larger 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. Rotten duckweed induced water pollution also plays important role in fish declining.

Culture Fisheries

208. Different types of fish culture systems are adopted by the local people, such as rice-cum-golda (prawn) with white fish culture, mixed culture in pond, golda-cum-white fish etc. Among the aquaculture practices, golda-cum-white fish culture is found increasing trend as such culture yield more benefit than other culture practices even than the agriculture practice. This culture practice is expanding gradually in the polder area. Rice-cum-white fish cultivation is found less pronounced in Batiaghata union in compared to other unions of the polder are because of higher land elevation. The gher and pond fish culture of this area are mainly traditional in nature while improved technology is also adopted by some big farmers (Photo 5.5).

Fish pond

Gher with white fish

Photo 5.5: Different Type of Fish Culture in the Polder Area

5.2.2 Fish Habitat Quality

209. Aquatic environmental quality is satisfactory in the study area though some pollutants are released from crop fields and are substantially causing damage to fish. However, some surface water quality parameters (Table 5.15 in Baseline Chapter of water resource) that are related to fish habitat suitability measured in the peripheral river, pond and khal in the polder area. From the data it is observed that pH values little higher but within the limit of usable for fisheries. Dissolved oxygen concentrations of 5 mg O_2/L or more are acceptable for most aquatic organisms (Stickney 2000). The measured DO values are found within the permissible limit for fish and aquatic biota habitation. The salinity value of both river and khal is comparatively higher than the tolerable limit for fresh water fish species.But it is suitable for shrimp and marine fisheries. Turbidity is the term for the amount of dissolved, suspended dirt and other particles in the water, which give the water a brown color. High turbidity of water can decrease fish productivity, as it reduces light penetration into the water and thus oxygen production by the water plants. Dissolved, suspended solids also cause clog filters and injure fish gills (Eira *et al*, 2008). However, Total dissolved suspended (TDS) or turbidity in all water bodies is recorded as higher (>2000 ppm) than the permissible limit for fish.

Table 5.15: Standard Values of Different Parameter of Water Quality for Fisheries

Sl. No.	Parameters					
	P^H	**EC (mmhos/cm)**	**TDS(ppm)**	**Temp (ºC)**	**DO(mg/l)**	**Salinity (ppt)**
1	(6.5-8.5)*	(800-1000)*	1000*	(28-34)**	4.0-6.0*	(0-4) for prawn and (5 -35) for shrimp**

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

Aquatic Vegetation

210. Aquatic plants or vegetation play an important role in the structure and function of the aquatic ecosystem. Different types of hydrophytes like emergent, submerged and floating with leafs is used as habitat and spawning ground of fisheries and other insects and crustaceans. So, low abundance of hydrophytes may harm to fish breeding and production. In the wetland, some fishes lay eggs in the body of plants. Beside these, some fishes 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. Among the water bodies, canals are abounded with free floating and rooted floating hydrophytes like Water Hyacinth (*Eicchornia crassipes*), Water Lettuce (*Pistia sp*), Water fern (*Azolla sp, Salvinia sp*,), Helencha (*Enhydra flactuans*) etc.

211. Submerged plants are prevalent both in perennial and seasonal wetland in the polder area. Almost all of these plants are closely related families like Aponogetonaceae, Hydrocharitaceae and Potamogetonacea. These plants start growing with the rise of water level and persist as long as water is present. *Hydrilla verticillata* are most common in this vegetation type. Moreover, some sedges and meadows plants called amphibian species is found in the polder area. This type of vegetation has the highest species diversity and one of the most important wetland's plant communities in the area. This type commonly includes Dhol kolmi (Ipomoea aquatica) and, Kochu *(Colocasia* sp.).

5.2.3 Fish Production

212. The estimated total fish production of the polder area is about 181 tons. Bulk of the fish production about 73% is coming from culture fisheries and the rest is contributed by the capture fishery. Fish production trend of the capture fishery is downward in the polder area. The downturn of the production is caused due to obstruction to fish migration, unsuitability of the khals for fish habitation, encroachment of khal, less availability of nutrients. Gher culture is increasing gradually in the area by converting the farmlands. Fish production in the polder area is shown in Table 5.16.

Table 5.16: Fish Production from Different Habitats of the Study Area

Sl. No.	Category	Habitat Types	Fish Production (T)
1	Capture	Khal	43
		Floodplain	5
		Sub-total	**48**
2	Culture	Gher (Golda with white fish)	45
		Culturable pond	88
		Sub-total	**133**
		Total	**181**

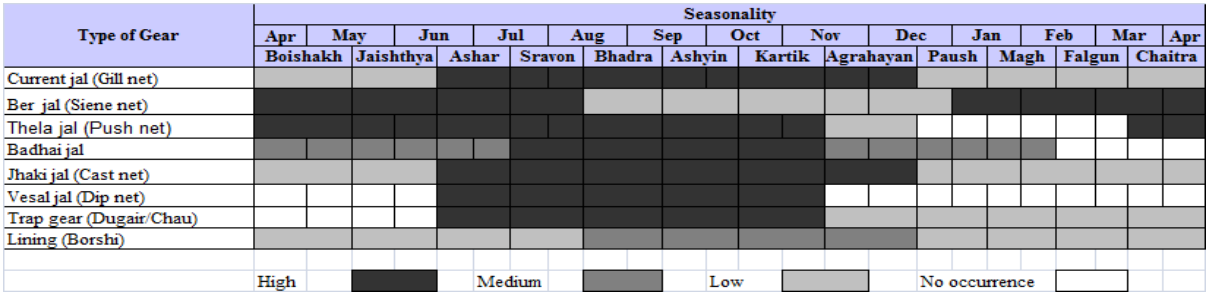
Source: CEGIS estimation based on field data and FRSS, 2011-12

5.2.4 Fishing Effort

Fishing Seasonality

213. Fishing in the khals as well as in the peripheral rivers starts in April/May and continues up to October. The dominant gear in the polder area are *Jhaki jal, current jal and Veshal jal* . The seasonality of major fishery is furnished in the Table 5.17.

Table 5.17: Fishing Seasonality of the Polder Area



Source: Field Survey, 2014

Fishing Crafts and Location

214. The commercial fishermen of the study area catch fish in the peripheral rivers and internal khals and peripheral rivers by using mechanized boat, Jala Nouka and Dingi fishing boats.

Photo 5.6: Fishing Boat in the Polder Area

Fishing Gears

215. Different types of nets/gears are used for fishing: (a) Mono filament net, locally known as Current jal, which is used to catch *poa, chingri, tengra, gulsha*, 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. Around 10% of fishermen have fishing boats and around 70% fishermen have fishing gears/nets. Traditional fishing gears of the study area include cast net (Jhaki jal), push net (Thela jal), lining (Borshi), fishing traps etc. (photo 5.7).

Photo 5.7: Fishing Gear

5.2.5 Fish Migration

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

5.2.6 Fish Biodiversity

217. 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 fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (Photo 5.9). Checklist of the fishes of different habitats reported by local fishermen is analyzed to draw an indicative scenario of the local fish biodiversity of the study area. List of fishes of different habitat in the study area are presented in Table 5.18. Among the fish species *Chingri,Bele, Tengra, Shol, Taki, Puti, Koi, Shing* etc are dominant fresh water fish species.

Photo 5.8: Composition of Fish Catch of the Polder Area

218. The dominant cultured fish species (both pond and gher) are *Rui, Catla, Tilapia, Pungus, Khorsula* and *Puti* etc.

Table 5.18: Indicative Fish Species Diversity of Different Fish Habitats in the Study Area

Scientific Name	Local Name	Habitat Type			
		Periphery Rivers	Khal	Gher	Pond
Brackish water fish species					
Tenualosa ilisha	Ilish	M	NA	NA	NA
Metapeneaus monocerus	Horina Chingri	H	L	NA	NA
Penaeus monodon	Bagda chingri	H	L	H	M
Terapon jarbua	Barguni	H	NA	NA	NA
Harpodon nehereus	Lottiya	L	NA	NA	NA
Lates calcarifer	Koral/Bhetki	M	L	NA	NA
Setipinna taty	Phasa	M	NA	NA	NA
Mugil cephalus	Bata	M	NA	NA	NA
Trypauchen vagina	Sada Cheowa	H	L	NA	NA
Apocryptes bato	Chewa bele	M	L	NA	NA
Mystus gulio	Guila Tengra	H	M	NA	NA
Sillago domina	Tolar dandi	M	NA	NA	NA
Liza parsia	Pairsa	M	L	NA	NA
Liza tade	Bata mach	M	NA	NA	NA
Pangasius pangasius	Pungus	L	NA	NA	NA
Polynemous paradiseus	Topsa	L	NA	NA	NA
Macrobrachium rosenbergii	Golda chingri	M	NA	NA	NA
Trichiurus haumela	Chhuri mach	L	NA	NA	NA
Scylla serrata	Kankra	M	L	L	L
Fresh water fish species					
Puntius chola	Chola puti	NA	L	L	L
Channa punctatus	Taki	NA	M	L	L
Glossogobius giuris	Bele	M	M	NA	NA
Channa striatus	Shol	NA	L	NA	NA
Clarius batrachus	Magur	NA	L	NA	L
Mystus vittatus	Tengra	H	M	L	L
Mastacembelus pancalus	Chirka baim	M	NA	NA	NA
Mastacembelus aculeatus	Tara baim	NA	M	L	L
Wallago attu	Boal	M	NA	NA	NA
Sperata seenghala	Guijja Ayre	L	NA	NA	NA

Scientific Name	Local Name	Habitat Type			
		Periphery Rivers	Khal	Gher	Pond
Puntius sophore	Datina puti	L	NA	NA	NA
Eutropichthyes vacha	Bacha	M	NA	NA	NA
Lepidocephalus guntea	Gutum	NA	L	L	NA
Culture fish species					
Labeo rohita	Rui	L	NA	M	M
Catla catla	Catla	L	NA	M	M
Telapia nilotica	Telapia	L	NA	L	H
Puntius sarana	Sharputi	L	NA	M	L
Pungasia pungasia	Pangus	L	NA	NA	H
Ctenopharyngodon idella	Grass Carp	L	NA	NA	M
Cyprinus carpio	Carpio	L	L	NA	L

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

5.2.7 Species of Conservation Significance

219. 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 5.19.

Table 5.19: List of Species of Conservation Significance

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Aorichthyes aor	Ayre	√	
Ompok pabda	Pabda	√	
Nandus nandus	Veda/Roina	√	
Heteropneustes fossilis	Shing		√
Clarius batrachus	Magur	√	
Acanthopagrus latus	Datina		√
Wallago attu	*Boal*	√	

Source: Field Survey, 2014

5.2.8 Area of Conservation Significance

220. Amtali khal and Kharia khal are used as feeding and spawning ground of most of the open water fishes. The local musclemen encroach most parts of the khal and are cultivating shrimp by making barrier of pata jal. For shrimp cultivation, they enter saline water into the khals during dry season. Saline water intrusion in the dry season is degrading the congenial environment for fresh water fishes which cause damage to feeding and spawning ground of

the fishes. Due to siltation and losing of water depth, there is no scope for fish sanctuary development in the remaining khals within the polder area.

5.2.9 Fisheries Management

221. There is no community based fisherman association. The fisherman have limited fishing right on existing fish habitats particularly fishing in the internal khals because the local musclemen has encroached most of parts of the perennial khals for fish cultivation. Department of Fisheries (DoF) has limited activity for fisheries resource conservation and management in this area. Every year they arrange a upazila and union level training program for the fish farmers. Some NGOs BRAC, Grameen Bank, ASA, Novolok, Buro Bangladesh are working, but they are very much limited in micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation is weak inside the polder area. During Ilish catch prohibition period, the activity of DoF is very strong. No fishermen can catch any fishes in the surrounding rivers during this time.

5.2.10 Bio-ecological Zone

222. IUCN-The World Conservation Union has identified 25 bio-ecological zones (2002) in Bangladesh. The aspects of which these zones 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 is situated at Batiaghata, Gangarampur and Surkhali Union of Batiaghata Upazila of Khulna district. The polder area encompasses two of these bio-ecological zones; namely The Ganges Tidal Floodplain and Saline tidal floodplain is6,456 ha. A brief ecological description of the bio-ecological zone is presented below.

Ganges Tidal Floodplain

223. The Ganges floodplain basically consists of the active floodplain of the Ganges River and the adjoining meandering floodplains, and is mostly situated in the administrative districts of greater Jessore, Kushtia, Faridpur and Barisal.

224. The adjoining meander floodplains mainly comprise of a smooth landscape of ridges, basins and old channels. Noteworthy aspect here is that the Gangetic alluvium is readily distinguishable from the old Brahmaputra, Jamuna and Meghna sediments by its high lime content. Besides, the relief is locally irregular alongside the present and former river courses, especially in the west, comprising of a rapidly alternating series of linear low ridges and depressions. The Ganges channel is constantly shifting within its active floodplain, eroding and depositing large areas of new char lands in each flooding season, but it is less braided than that of the Brahmaputra-Jamuna.

225. Interestingly enough, both plants and animals move and adapt with the pattern of flooding (Brammer, 1996). This floodplain is characterized by mixed vegetation. Mangrove patches are also commonly found along the riverside or even beside homestead forest.

226. A lot of stagnant water bodies and channels, rivers are present in this zone. The dominant aquatic floral types are in the polder area: the Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Helencha (*Alternanthera philoxeroides*), Topapana, (Pistia strateotes), Chechra (*Schenoplectus articulatus*), Keshordam (*Ludwigia adscendense*), Kolmi (Ipomoea aquatica), Dhol kolmi (I. fistulosa), Hijal (*Barringtonia acutangula*), Tamarind (*Tamarindus indica*), Panibaj (*Salix tetrasperma*), etc. Moreover, grass species are Cyperus rotundus, C. diformis, Eleocharis sp., Hemarthria sp. etc. (GoB-IUCN, 1992) are found in the

polder area. Nearly all the major groups of the oriental birds are represented in this zone by one or more species. In addition, a large number of migratory birds are found here during the winter. The amphibian species found in this zone include a few species of toads, frogs and tree frogs. Among the mammalian fauna, foxes, rats, mice, squirrels, bats, etc. are seen everywhere. (GoB-IUCN, 1992).

Saline Tidal Floodplain

227. Saline tidal floodplain has a transitional physiography, which is located in the administrative district of Satkhira, Khulna, Bagerhat, Jhalokathi and Borguna. It has a low ridge and basin relief, crossed by innumerable tidal rivers and creeks. Local differences in elevation are less than 1 m. The sediments are mainly composed of non-calcareous clays, although in the riverbanks, they are silty and slightly calcareous. The soil is non-saline throughout the year over substantial amount of areas in the north and east, but they become saline to varying degrees in the dry season in the south west and remain saline for much of the year in Sundarban. The rivers carry fresh water throughout the year to the east and northeast, but saline water penetrates increasingly further inland towards the west mainly in the dry season, and for most or all of the monsoon season in the southwest. In the northeast, there is moderately deep flooding during the monsoon season, mainly due to accumulation of rainwater on the land when water level in the Ganges distributaries and the lower Meghna are high. Elsewhere, there is mainly shallow flooding at high tide, either throughout the year or only in the monsoon season, except where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater (Brammer, 1996).

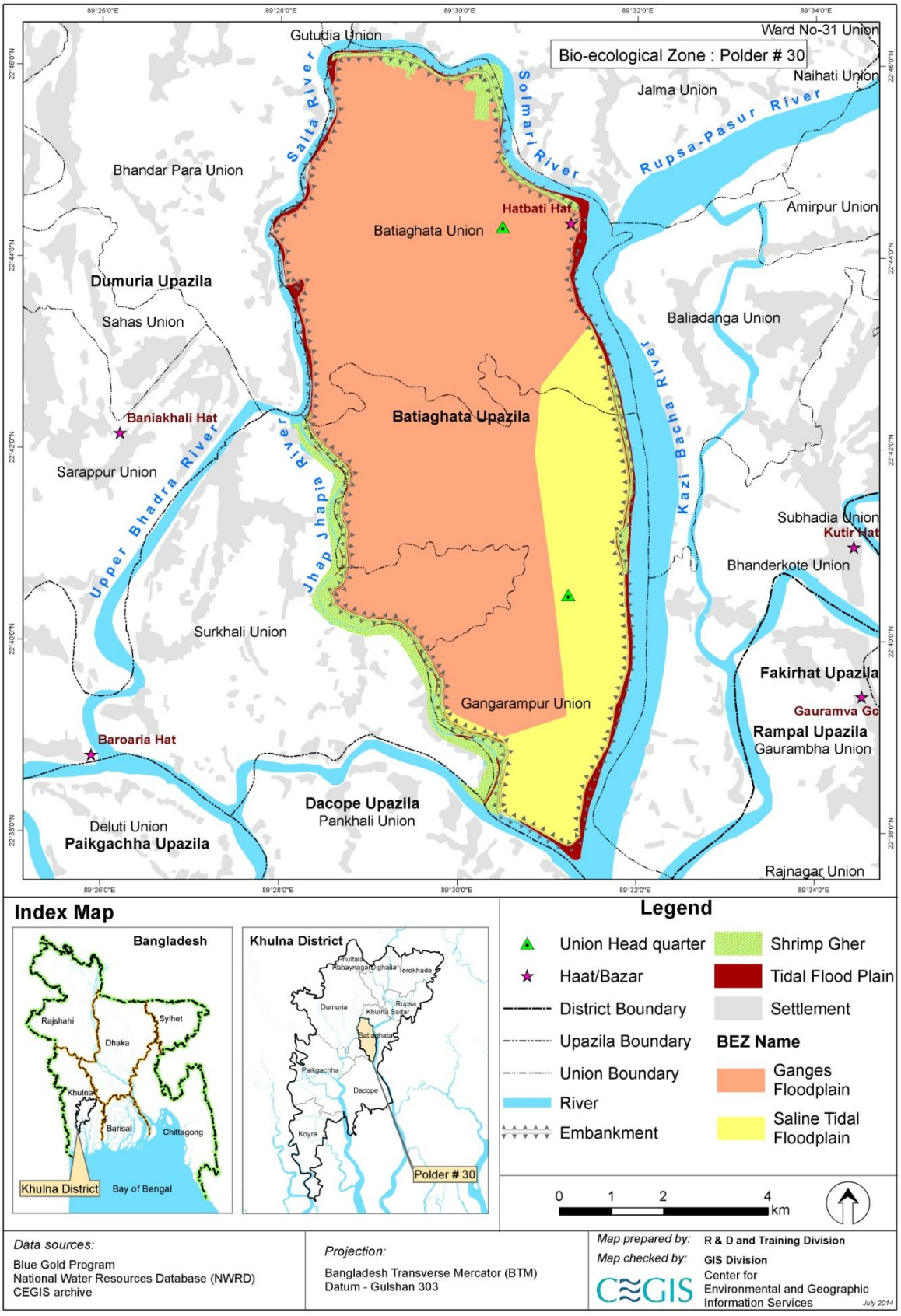
228. Several types of palms and bamboo clumps grow in almost all the villages in the polder area. Narikel *(Cocos nucifera)* and Supari *(Areca catechu)* is two commonest palm of this area. The mango *(Mangifera indica ,* Sirish *(Albizia saman)*,Babla *(Acacia Arabica),* Khai Babla *(Pithocelobium dulci),*Taal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

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

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

BEZ	Area (Ha)	Percentage (%)	District
Ganges Tidal Floodplain	5,076	79	Khulna
Saline Tidal Floodplain	1,380	21	
Total	**6,456**	**100**	

Source: NWRD Database, 2012



Map 5.10: Bio-ecological Zones in Polder 30

5.2.11 Terrestrial Ecosystem

231. Terrestrial ecosystems of this polder can be divided in the following types:

a. Homesteads

b. Field Crops

c. Roads and embankment

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

a. Terrestrial Flora

i. Settlement/Homestead Vegetation

233. Homestead vegetation which is the single most important plant community in this polder extends over 1,900 ha. Besides meeting food, fodder, medicine, fuel and other household requirements, settlement vegetation plays an important role by providing shelter for various types of wild animals. According to the vegetation survey, most of the households are vegetated by local plants. Several tree species are present and their composition is almost similar all over the polder area. The dominant species of settlement vegetation are *Sirish, Babla, Khai Babla, Tal, Narikel, Bot,* etc. The major tree species of homestead vegetation areshown in Table 5.20. In terms of canopy layers, Sirish, Narikel, Tal occupies the top canopy. Shrubs and herbs occupy lower canopy.

Photo 5.9: Homestead Vegetation

Table 5.20: Major Tree Species within the Homesteads in the Polder Area

Tree species name	Family name	Saline susceptibility	Local Status	Habit	Utilization	Ecological Value
Suparee *(Areca catechu)*	Palmae	2	VC	Monocot	Fruit and Thatching	3
Narikel *(Cocos nucifera)*	Palmae	3	VC	Tall monocot	Fruit and Thatching	1,2
Aam*(Mangifera indica)*	Anacardiaceae	1	VC	T	Fruit and timber	1,2
Jaam *(Syzygiumsp)*	Myrtaceae	1	C	T	Fruit and timber	1,2
Kola (*Musa sp)*	Musaceae	2	VC	H	Fruit	1,2,3
Safeda*(Manilkara zapota)*	Zapotaceae	2	VC	T	Fruit	1
Bot*(Ficus benghalensis)*	Moraceae	1		T	Timber	1,2,3
Babla *(Acacia nilotica)*	Fabaceae	3	VC	T	Timber ,fuel wood and fruit	1,2,3
Khai Babla*(Pithocelobium dulce)*	Mimosaceae	2	VC	T	Timber ,fuel wood and fruit	1,2,3
Akashmoni *(Acacia auriculiformis)*	Mimosaceae	2	R	T	Timber and fuel wood	3
Gab*(Diospyros pregrina)*	Ebenaceae	2	C	T	Fruitr and fuel wood	1,2
Boroi*(Zizyphus sp)*	Rhamnaceae	2	C	T	Fruit and fuel wood	2
Khejur *(Phoenix sylvestris)*	Palmae	3	VC	Monocot	Fruit	1,2
Bash(*Bamboosa* sp.)	Gramineae	1	VC	CL	Thatching	1,2,3
Bel *(Aglemarmelos)*	Rutaceae	1	R	T	Fruit and Medicine	2
Tetul*(Temarindus indica)*	Leguminosae	2	VC	T	Timber and Fruit	2
Nim *(Azadirachta indica)*	Meliaceae	2	VC	T	Timber and fuel wood	2
Ipil ipil*(Leucauna laucocephalata)*	Mimisaceae	2	C	T	Timber	2

Tree species name	Family name	Saline susceptibility	Local Status	Habit	Utilization	Ecological Value
Sirish(Albizia saman)	Leguminosae	2	VC		Timber and fuel wood	2
Tall*(Boassus flabeliffer)*	Palmae	2	VC	Tall monocot	Fruit and thatching	1,2
Peyara*(Psidium guajava)*	Myrtaceae	2	VC	T	Fruit	2
Jambura(*Citrus grandis)*	Rutaceae	1	C	T	Fruit	2
Dumur*(Ficus religiosa)*	Moraceae	2	C	S	Fruit, Fuel wood	2,3
Tulshi*(Ocimum sanctum)*	Labiatae	1	VC	H	Medicine	3
Kathal(Artocarpus heterophyllus)	Moraceae	1	R	T	Timber, fuel wood and fruit	1,2
Mahogany (*Swietenia mahagoni)*	Meliaceae	2	R	T	Timber	2

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

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

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

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

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

ii. Crop Field Vegetation

235. Crop field vegetation extends over 4,200 hectares of the polder area. Land is used mainly for HYV Aman and LT. Aman in rain-fed condition in Kharif–II season, in Kharif-I season land remains fallow. In Rabi season, farmers grow sesame, watermelon, mungbean, sunflower and very little vegetables. Different crop plants and cropping patterns are discussed in the agricultural section of this report.

236. A part of crop fields remain fallow for 3-4 months of a year. During this time, the land is covered with grassy vegetation with some other wild herbs. The major weeds growing with the crop in this area are: Durba (*Cynodon* sp.*), Echinochloa colonum, Croton bonplandianum, Chynodon dactylon,Panicum repens,Cheratopteris sp, Clerodendrum inerme, Heliotropium indicum, Cyperus sp* etc. This type of vegetation provides feeding habitats for various types of insects and wildlife like Rat, Shrew, Frogs, and Jackal etc. But, during the dry season (especially from late December to late April) there is grazing land but shortage of grass due to salinity which acts as the main barrier for the grasses to grow.

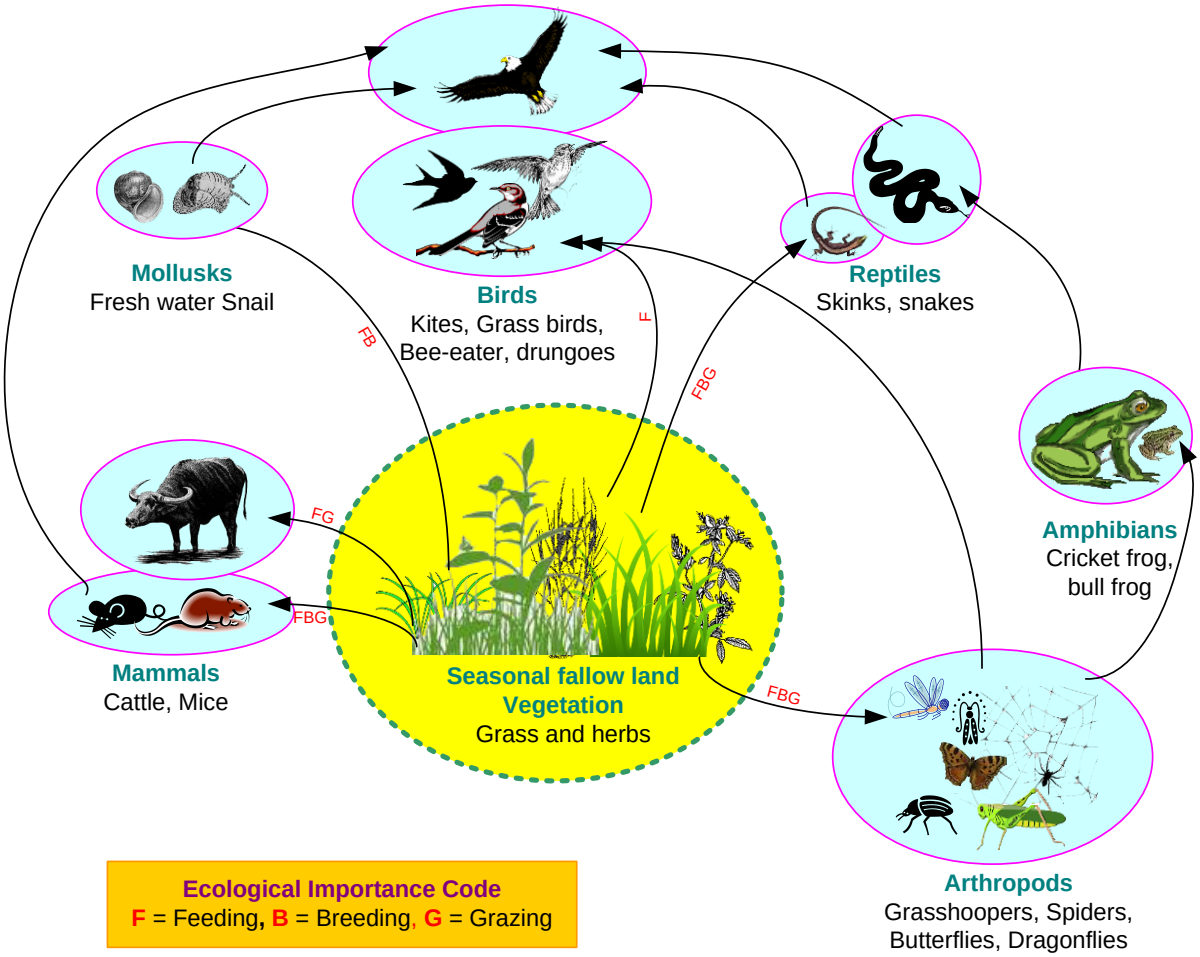


Figure 5.13: Ecological Importance of Seasonal Fallow Land's Vegetation for Different Faunal Commodities along with Partial Food Web

Photo 5.10: View of Sesame Field in the Polder 30 Area

iii. Embankment /Roadside Vegetation

237. Most of the village roads ar*e* covered with local plants like Tal *(Boassus flabelifer)*, Khajur*(Phonix sylvestris),*Sirish(*Albizia odoratissima),* Tetul *(Temarindus indica),* Narikel *(Cocos nucifera),* etc.Some herbs and vines are also noted as roadside vegetation: the Bhant(*Clerodendrum viscosum*), Sech *(Euphorbia* sp*)*and Durba (***Cynodon dactylon)* are common of all plants**

238. Riverside embankment is exclusively dominated by Babla *(Acacia Arabica),*Sirish (*Albizia odoratissima)* which have good adaptation in saline low moisture in soil. These plants are mostly planted by villagers for providence of timber and fuel wood. Vegetation of this type supports good habitats for local avifauna.

Photo 5.11: A Portion of Internal Village Road showing Tal, Khejur and Sirish Plant

Photo 5.12: Rows of Babla and Sirish Tree along the Embankment Sides at the Polder

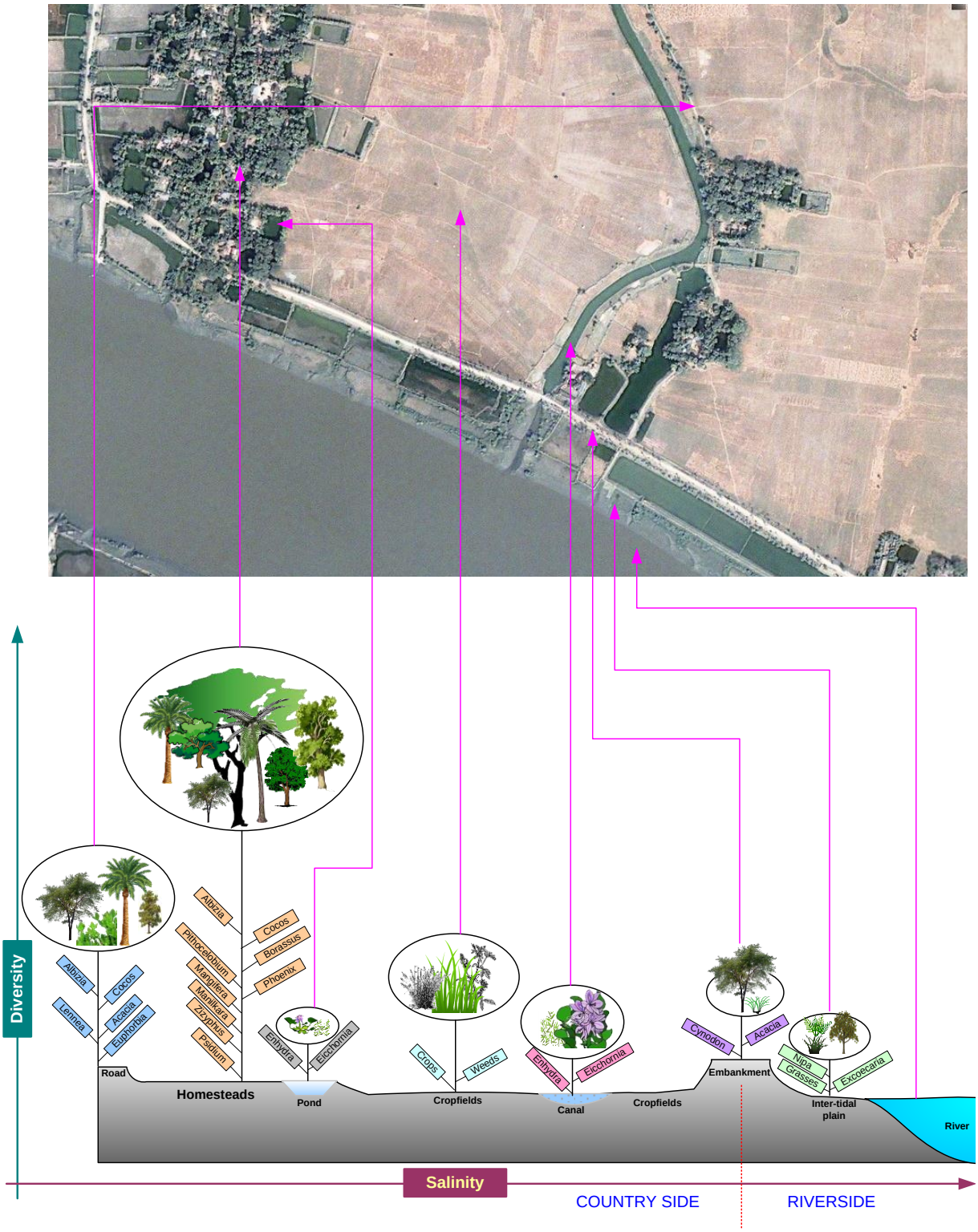


Figure 5.14: Different Types of Ecosystems and Vegetation Composition of Polder 30

b. Terrestrial Fauna

i. Amphibians

239. Among amphibians, the Common Toad (*Bufo melanostictus*), usually visits human habitation/settlements. During day time, it hides under logs, piles of bricks, crevices of tree trunks and most of the cases they stay at dark corner of the village huts. Cricket frog (*Fejervarya Sp*.) prefer the cool, damp habitats.

ii. Reptiles

240. The terrestrial reptiles are large in numbers in any given area of the country compared to aquatic fauna. Common Garden lizard (*Calotes versicolor*), Common Skink (*Mabuya carinata*), House Gecko (*Gekko gecko*) are very frequent within the study area. These lizards visit different gardens, orchards and low bushes in the vicinity of the homestead area. Some snakes like Striped Keelback (*Amphiesma stolata*), Monocled Cobra (*Naja kouthia*) were observed during the field visit.

iii. Mammals

241. Population and diversity of mammalian wildlife are comparatively low than other groups. Small mammals are found in the polder area, such as 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*), Jackal (*Canis aureus*), Grey mask shrew (*Suncus murinus*) and small Indian civet (*Viverricula indica*) which prefer bamboo thickets, cropped fields or bushy areas.

iv. Avifauna

242. Species richness of terrestrial fauna is mainly concentrated in homesteads forest and birds are higher in number of species than other classes. Common bird of prey species found in the polder area are Black Drongo (*Dicrurus macrocercus*), Brahminy Kite *(Heliastur indus),* Brown Fish Owl (*Ketupa zeylonensis*).Other common bird species in the project area are Common Myna *(Acridotheres tristis),* Red-vented Bulbul (*Pycnonotus cafer),* Oriental Magpie Robin *(Copsychus saularis),* Spotted Dove *(Streptopelia chinensis),* Blue Rock Pigeon *(Columba livia),*Asian Koel (*Eudynamys scolopa cea*), and Large-billed crow (*Corvus macrohynchos).*

5.2.12 Aquatic Ecosystem

Wetlands

243. There are about 250 ha of wetland inside the polder. Wetland contains rich variety of flora and fauna and mostly provides food and habitat to the aquatic fauna. The major wetlands are homesteads ponds, Khal and ditches. Homestead ponds are usually used for domestic purposes and fish culture. Seasonal ditches are depressed land observed between settlement and agricultural field.

244. The aquatic ecosystem is classified into two categories on the basis of duration of holding water: seasonal and perennial wetlands.

Seasonal Wetland

245. The seasonal wetlands remain inundated for a short duration of 4-6 months. The seasonal wetlands provide nourishment to aquatic fauna by flourishing aquatic vegetation. Canals, tidal floodplains and ditches are considered as seasonal wetlands.

Permanent wetland

246. The other type of wetland is perennial those hold water throughout the year. Rivers and homestead ponds are considered under this category.

Aquatic Flora

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

248. Canals are abounded with free floating and rooted floating hydrophytes like Water Hyacinth (*Eicchornia crassipes*), Water Lettuce (*Pistia sp*), Water fern (*Azolla sp, Salvinia sp*,), Helencha (*Enhydra flactuans*) etc.

249. Submerged plants are prevalent in the project area, both in perennial and seasonal wetland. Almost all of these plants are closely related families like Aponogetonaceae, Hydrocharitaceae and Potamogetonacea. These plants start growing with the rise of water level and persist as long as water is present. *Hydrilla verticillata* are most common in this vegetation type.

250. Sedges and meadows plants are called amphibian species. This type of vegetation has the highest species diversity and one of the most important wetland's plant communities in the polder area. This type commonly includes Dhol kolmi(Ipomoea aquatica) and Kochu *(Colocasia* sp.).

Photo 5.13: Internal Canal occupied by Free Floating Plant of Polder 30

Photo 5.14: Water Hyacinth (*Eicchornia crassipes*) in a Perennial Ditch of Polder 30

Mangrove Vegetation

251. The area is tidal in nature. A good number of mangrove vegetation and bush are found along the marginal lands of canals side of the polder area. The common mangrove species is Keora (*Sonneratia apetala*), Gewa (*Excoecaria agallocha*), Golpata (*Nypa fruticans*),

Baien (*Avicennia officinales*), Hantal (*Phoenix pelludosa*), Sundari (*Heritiera fomes*), kankra (*Bruguiera gymnorrhiza*), etc.

Photo 5.15: Bush of Golpata (*Nypa fruticans*) that found Some of Brackish Shallow Ditches inside the Polder

Aquatic Fauna

252. The life cycle of aquatic fauna is depended on fluctuation of water level due to seasonal variation of wetlands. Naturally, wetlands provide food and shelter to the aquatic fauna. A brief description of aquatic fauna is presented below.

i. Amphibians

253. Among amphibians, the skipper frog *(Euphlyctis cyanophlyctis)* is common and found in all wetland habitats and has been the most successful in adapting to the existing habitats. Bullfrogs are also found frequently near wetlands and agricultural field during rainy season.

ii. Reptiles

254. Common aquatic snakes include the checkered keelback *(Xenocrophis piscator),* smooth water snake *(Enhydris enhydris),* Rat snake*(Ptyas mucosus),*Common wolf snake *(Lycodon aulicus)*and Smooth Water Snake *(Enhydris enhydris*) are found in all types of wetlands.

iii. Avifauna

255. The aquatic bird like Little Egret *(Egretta garzetta),* Great Egret *(Casmerodious albus),* Common Kingfisher *(Alcedo atthis),* Little Cormorant *(Phalacrocorax niger*), Grey Heron *(Ardea cinerea)* and various type of migratory birds are frequently found along mudflats, canal systems and seasonal wetlands whole of the year. During winter, small numbers of migratory birds roam along the riverside of the polder.

Ecosystem Services

a. Output of Ecosystem Services

256. Cereal crops, fuel wood, thatching materials and timber are the major contributions from different types of vegetation inside the locality. Most of the house owners use tree or

shrub branches, leaves, and agricultural residues as fuel wood, which come from homesteads or crop field vegetation. Homestead vegetation is also important for fruit production. Kola (*Musa* Sp), Aam (*Mangifera indica*), Payara (*Psidium guajava)*, Narikel (*Cocos nucifera*), supari (*Areca catechu*), etc are various types of fruit species those are grown in homestead area. Timber for house and furniture making are provided from homestead's timber trees. Roadside vegetation has also major contribution for timber and fuel wood production. Fishes meet protein demand to the local people and it comes from wetlands like khal, homesteads ponds, etc. Total amount of fish production are included in fisheries section of this report. Aquatic plants also used as vegetables and bio-fertilizers.

Table 5.21: Ecosystem Goods and its Services within the Polder Area

Item	Source	Goods/Services
Food	Supari *(Areca catechu),* Narikel *(Cocos nucifera),* Aam*(Mangifera indica),* Jam *(Syzygiumsp),* Kola (*Musa sp),* 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 aristata*) etc.	Leaf and stem
Wood, timber	Aam*(Mangifera indica),*Jam *(Syzygiumsp),* Bot*(Ficus benghalensis),*Babla *(Acacia nilotica),* Mahogany (*Swietenia mahagoni),*	Trunk
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)*	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.	Brunches, Leaf
Bio-fertilizer/Guano	Kochuripana	As compost,
Hydroponics	Kochuripana to make baira (floating platforms)	to grow seedlings and vegetables
Bio-gas	Kochiripana, Khudipana (*Lemna* and *Spirodela spp.*) and other aquatic plants.	All parts of the pant

5.2.13 Present Threats on Ecosystem

257. Soil salinity, internal canal bed siltation and riverbank erosion are the main threats on ecosystems of this polder. In addition, drainage congestion and illegal saline water intrusion are also another problem that posses threats to fresh water ecosystem. Intrusion of saline water creates stress for vegetation and its succession. Non-functioning of water control

structures like regulators, causes insufficient drainage and flashing capacity of the polder area that damages vegetation. Loss of vegetation density and succession ultimately impact on wildlife habitats.

5.2.14 Livestock and Poultry

Livestock and Poultry

258. A large number of populations of the polder area earn their livelihood through work associated with raising livestock / poultry. About 65% of households are rearing cows/ bullock, 40% of household are rearing goat, 20% of household are rearing sheep, 75% of household are rearing chicken, 40% of household rearing duck, 4% of household rearing pigeon and 25% of household rearing pig. According to local people, there are about 200 small poultry farms in the polder area. Detailed status of livestock and poultry in the household level 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	65	12,493
Goat	40	7,688
Sheep	20	3,844
Chicken	75	28,830
Duck	40	15,376
Pigeon	4	2,306
Pigs	25	4,805

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

Photo 5.16: View of Duck in the Polder Area

Photo 5.17: View of Poultry Firm in the Polder Area

Feed and Fodder

259. The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to non-availability of grazing land. During monsoon, aman crops remain in the field, when rice straw is the main sources of fodder. In addition, rice husk and oil cakes, etc. are other common fodders in this polder area. But,

during the dry season (especially from late December to late April) there is grazing land but shortage of grass due to salinity which acts as the main barrier for the grasses to grow. Poultry population and dug at family level survives by scavenging and generally no feed supplements are provided.

Livestock and Poultry Diseases

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

5.3 Environmental Quality

5.3.1 Sound Quality

261. A number of suitable sites have been selected along the peripheral embankment for carrying out in-situ sound level measurements, considering some criterion in connection with sound generation (project interventions and other secondary activities), and places which are to be affected by any anomalies in sound level (settlements, schools). The Environmental Conservation Rules 1997, of Department of Environment, Bangladesh has defined standard noise levels as 50 dB during day time for residential zones.

262. During field inspection, sound levels were collected near the construction site with 10 minute sampling periods. L50 values have been 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 our study area L50 value was found within the standard Leq limit (for residential zone). As the project implementation works are to be carried out manually, i.e. without the use of any typical heavy loading vehicles, 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	Deviations From Standard
Amtala Khal	22º39’42.4’’ 89º29’38.2’’	50	50 dB (Residential Zone)	Up to 20%
Batia Ghata Khal	22º44’07.1’’ 89º29’45.9’’	48		Within limit
Khariar Khal	22º41’35.9’’ 89º31’06.9’’	49		Up to 40%

Location	GPS	L50 Values (dB)	Standard Level	Deviations From Standard
Gongarampur Union Parishad	22º40'47.8" 89º30'39.2''	50		Up to 20%

Source: CEGIS field survey, May 2014

5.3.2 Water Quality

263. Four major water quality parameters have been measured in May 2014, from four different locations of the study area (**Table 5.24**). The pH values in these locations are higher than neutral scale (pH=7) which means the water in these locations is alkaline in nature during May; this may be because typical pre-monsoon rainfall did not yet start by then (as opined by local people during field visits). Values of TDS were found very high (above 1960 ppm) for locations inside the polder. This may be because of the increased sediment load carried by the tidal water which enters the polder. From the field observation it was found that local people willingly allow tidal water to enter the polder through some sluice gates and this might be the reason of higher dissolved solids concentration in the Khals. Values of DO were mostly found close to the standards set by DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l).

Photo 5.18: Collection of Water Samples from Rupsa River, near Batiaghata Upazila

Table 5.24: Water Quality Parameters

Location	GPS Reading (Lat-Long)	pH	TDS (ppm)	Temp (ºC)	DO (mg/l)	Remarks
Amtala Khal	22º39'42.4''N 89º29'38.2''E	8.1	>1960	31.6	5.8	Inside polder
Batia Ghata Khal	22º44'07.1''N 89º29'45.9''E	7.9	>1960	32.2	5.8	Inside polder

Location	GPS Reading (Lat-Long)	pH	TDS (ppm)	Temp (ºC)	DO (mg/l)	Remarks
Khariar Khal	22º41’35.9’’N 89º31’06.9’’E	8.5	>1960	30.9	6.0	Inside polder
Gongarampur UP	22º40’47.8’’N 89º30’39.2’’E	8.2	>1960	34.5	5.6	Inside polder
Jopjopia River	22°39'42.4"N 89°29'38.2"E	8.0	>1960	32.0	5.7	Outside polder
Kazi Bacha River	22°40'24.1"N 89°31'46.9"E	7.9	>1960	31.7	4.8	Outside polder

Source: CEGIS field survey, May 2014

264. Furthermore, salinity levels in some locations have been measured at site (Table 5.25). Almost all the surface water samples were found having higher salinity, whereas one DTW was found saline (with 3 ppt) near the Amtali union parishad. Two other DTWs near Batiaghata khal and Khorniar khal had no salinity, which indicates that the saltwater intrusion has contaminated by upto 3 ppt in the southern portion of the polder, whereas no salinity has been observed on the northern portion. Salinity values from outside the polder were found approximately three times higher than that inside the polder. In the month of May, highest salinity was observed as 22 ppt in Amtala Khal outside the polder.

Table 5.25: Salinity Level in Different Locations

Observation Location	Sampling Water Source	GPS Readings	Salinity (ppt)
Amtala Khal (Outside polder)	SW	22º39’42.4’’ 89º25’22.9’’	22
Zhap Zhapia (Outside polder)	SW	22º39’42.0’’ 89º25’22.8’’	16
Batia Ghata Khal	SW	22º44’07.1’’ 89º29’45.9’’	7
Khariar Khal	SW	22º41’35.9’’ 89º31’06.9’’	7
Gongarampur UP	SW	22º40’47.8’’ 89º30’39.2’’	7
Tube well (near Amtala Khal)	GW	22º39’42.5’’ 89º25’22.7’’	2

Source: CEGIS field survey, May 2014

Note: SW: Surface water and GW: groundwater.

5.4 Climate Change

5.4.1 Climatic Trends

265. Khulna is identified as one of the 15 most climate change vulnerable areas of the world. Cyclone, storm surge induced flooding, riverine coastal flooding, water logging, salinity intrusion and coastal erosion are the main climate and hydrologic hazards in the area. Commissioning of the Farakka Barrage on the Ganges River in India in 1975 has reduced the fresh water inflows to the region, and construction of coastal polder has gradually reduced the flood-plain storage areas for tidal waters from the Bay of Bengal (Mondal, 2012).The following sections provide a comprehensive discussion on the trends in temperature, sunshine hour, humidity, rainfall in Khulna,and trends of variation in annual

maximum and minimum tidal water levels at Chalna in Rupsha-Pasur River, a location which is around 2.5 km downstream of Polder 30.

Temperature

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

267. The number of extremely cold nights having temperature less than or equal to 9.7°C, which corresponds to the 10thpercentile of the daily minimum temperature in the month of January, was found to be decreasing. However, the number of extremely hot days having temperature greater than or equal to 37.2°C, which corresponds to the 90thpercentile of the daily maximum temperature in the month of April, was found not to be changing significantly. The long-term temperature data indicated an increasing trend in the diurnal temperature range the difference between the daily maximum and minimum temperatures during the months of May to October.

Sunshine

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

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

Humidity

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

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

Rainfall

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

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

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

Tidal Water Level

275. The annual maximum high tidal water levels at Rupsa-Pasur are increasing at a rate of 18 mm per year and the annual minimum low tidal water levels are decreasing at a rate of 8 mm per year (Figures 5.15 and 5.16). Both these trends were found to be statistically significant at a confidence level of 99%. The possible reasons for the decreasing trends in annual minimum water levels at Khulna could be the reduction in sweet water flow from upstream areas or the reduction in storage areas of saline tidal water or both. The increasing trends in annual maximum water levels could result either from silting up of the rivers, reduction in flood tide propagation areas, or a rise in the sea level, or a combination of these factors. However, if sea level rise had any effect on the observed trends, the effect had been much lower than that of anthropogenic interventions as the high and low tidal levels have significant opposite trends.

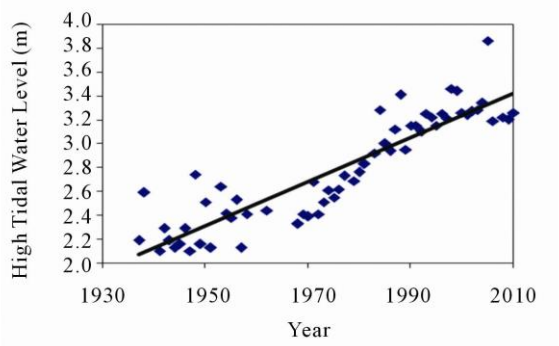


Figure 5.15: Trend in Annual Maximum High Tidal Water Levels at Rupsa-Pasur River (Mondal, 2012)

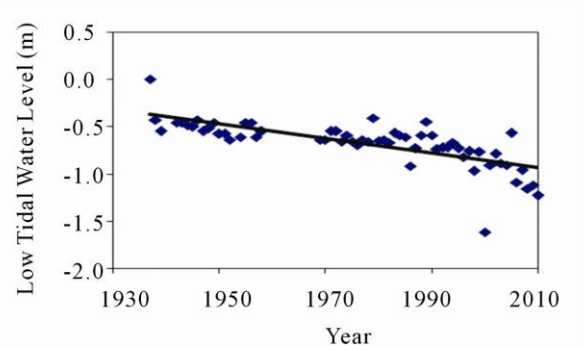


Figure 5.16: Trend in Annual Minimum Low Tidal Water Levels at Rupsa-Pasur River (Mondal, 2012)

5.4.2 Climate Change Projection

276. Two greenhouse gas emission scenarios, A2 and B1, from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC) were used because they represent the high and low brackets of the estimated global temperature increases under the report story lines. A2 is the business-as-usual scenario, a very heterogeneous, market-led world, with high population growth slow economic development, and slow technological change. B1, however, is the sustainable development scenario, a convergent world with rapid changes in economic structures toward a service and information economy, with resulting lower greenhouse gas emissions **(Table 5.26**).

Table 5.26: Summary Features of Climate Projections for Khulna

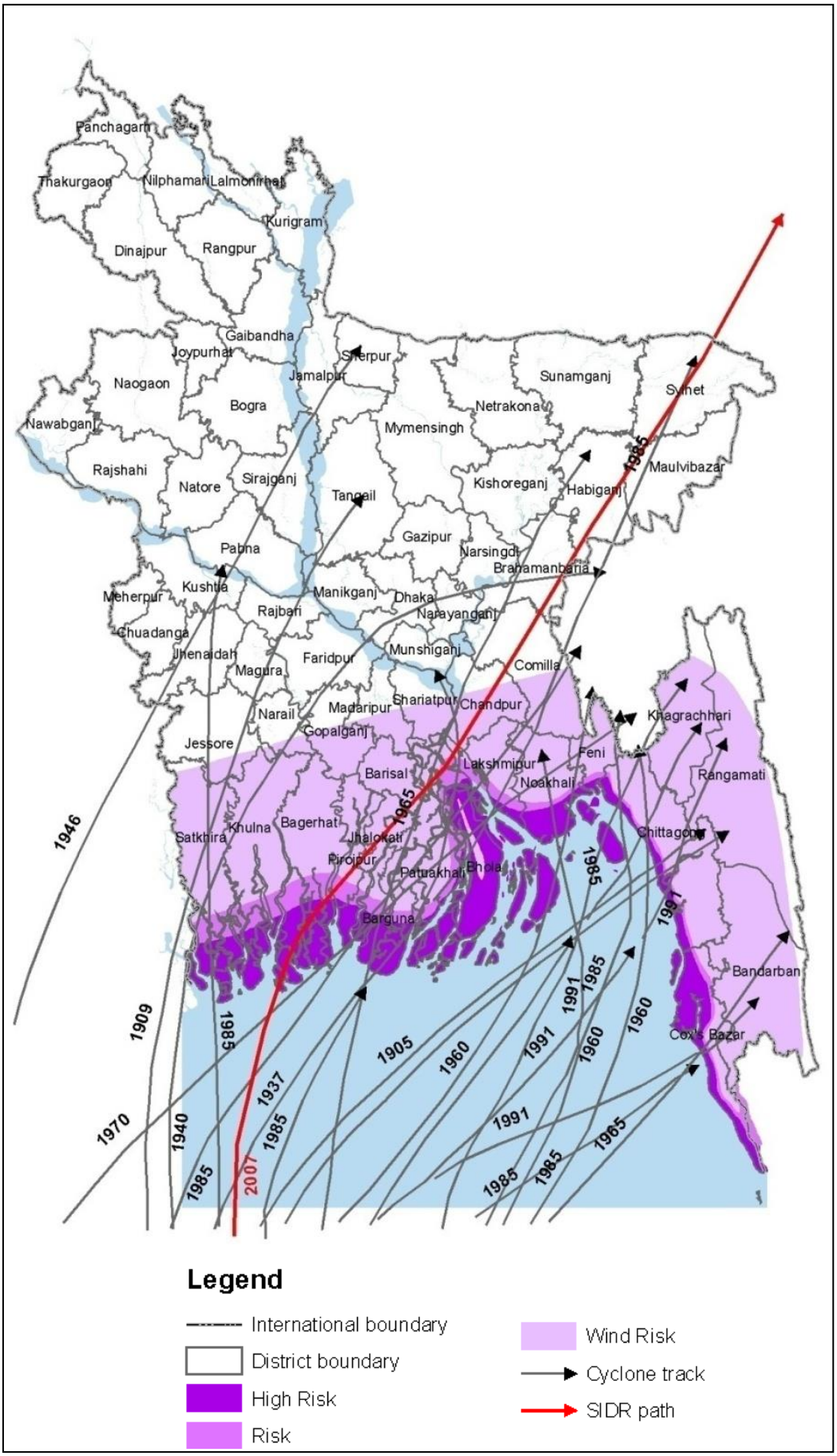
Scenario	A2	B1
Temperature	The average monthly temperature rise by 2050 varies from +0.5^{0}C in October to +1.7^{0}C in January and February.	The average monthly temperature rise by 2050 varies from +0.5^{0}C in June, July, and August to +1.5^{0}C in February and April.
Rainfall	The annual rainfall increases by about 5% by 2050 (1,860 mm per year) from the reference value (1,769 mm)	The annual rainfall increases by about 9.3% by 2050 (1,739 mm per year) from the reference value (1,591 mm)
Seasonal Rainfall	Increase in July-September by 4.6% and a decrease December-February by 2.6%	Increase in July-September by 10.5% and a decrease in December-February by 46.2%.
Rainfall Intensity	50 mm or more rainfall in 6 hours increases from 4.2 times per year to 5.9 times per year in 2050.	50 mm or more rainfall in 6 hours marginally increases from 4.2 times per year to 4.25 times per year in 2050.

5.4.3 Cyclones and Storm Surges in Polder 30

277. Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal regions in Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of even more than 9m. For example, the 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m. Observing the tracks of different cyclones affecting the country in the last decade, the countries southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (**Map 5.11**). Polder 30 falls in the wind risk zone which possesses some vulnerability due to the strong winds, and surge heights associated with cyclones. From field observations it was found that the polder did not undergo any major damage during the recent cyclones.

Photo 5.19: Kazi Bacha River at Barun para

Photo 5.20: Salta River at Mailmara



Map 5.11: Cyclone Tracks in Bangladesh and Risk Areas

6 Socio-Economic Condition

6.1 Demography

278. The 9,490 households in the polder area have a total population of 38,240 of which 18,940 are male and 19,300 are female. The female population is found to be higher than the male population. The average male-female sex ratio is 98 of which there are 98 males per 100 females which is lower than the national figure of 100.3 (BBS 2011). The density of population is about 1007 persons per sq. km which is also smaller the national density of 1,015 populations per sq. km. About 75% of total populations in the polder area are Hindu while 25% are Muslim and rests of 22 people are Christian. The key demographic data of the Polder is presented in Table 6.1.

Table 6.1: Demographic Data of Polder

Unions	HHS	Total Population					
		Both	Male	Female	Hindu	Muslim	Christian
Batiaghata	4427	18292	9064	9226	15335	2945	12
Gangarampur	4370	17078	8464	8614	12332	4737	9
Surkhali	693	2870	1412	1460	980	1890	0
Percentage (%)	**-**	**100%**	**49.53%**	**50.47%**	**74.91%**	**25.03**	**0.06**
Total	**9,490**	**38,240**	**18,940**	**19,300**	**28,647**	**9,572**	**22**

Source: Population Census 2011, BBS

6.1.1 Age Composition

279. Figure (Figure 6.1) shows the age group composition of the people of the polder area. About 25% of the population is less than 15 years, 63% is between 15 to 59 years and 12% are over 60 years of age. It is observed that 38% of total population is still belonging between 30-49 years age category. Thus, it can be said that they are the main working force for development of society. Details of this age composition are shown in the given table (Table6.2).

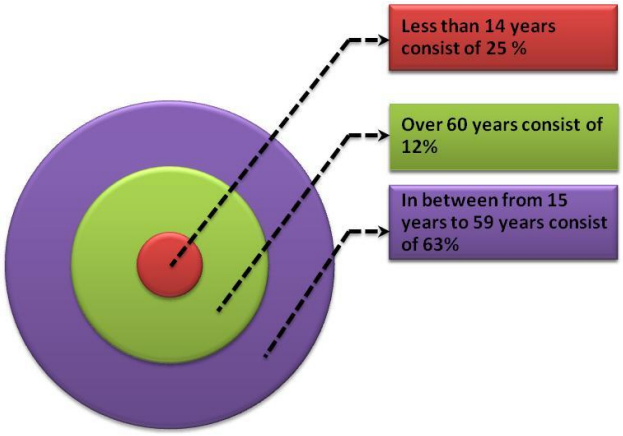


Figure 6.1: Age Composition at Polder Area

Source: Population Census 2011, BBS

Table 6.2: Age Distribution at Polder 30

Unions	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+
Batiaghata	6.9	7.4	8.6	6.9	8.2	9.2	31.0	9.4	3.8	8.6
Gangarampur	6.8	8.9	8.3	7.6	8.1	8.9	30.2	9.3	3.4	8.5
Surkhali	8.8	10.9	9.5	7.1	8.6	9.6	27.0	7.6	3.2	7.6
Total/Average	**7.5**	**9.1**	**8.8**	**7.2**	**8.3**	**9.2**	**29.4**	**8.8**	**3.5**	**8.3**

Source: Population Census 2011, BBS

6.1.2 Dependency Ratio

280. 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 37% of the population depends on the 63% of the earning members of their households. Hence, the dependency ratio is 59 which are higher than national rate 56. BBS data also shows Surkhali union comprises the highest dependency ratio than other unions within the polder (Table 6.3).

Table 6.3: Categorical Distribution of Population by Union

Unions	0-14 Children (%)	15-59 Active Work forces (%)	60+ Old (%)
Batiaghata	22.9	64.7	12.4
Gangarampur	23.9	64.1	11.9
Surkhali	29.3	59.9	10.9
Polder 30	25.4	62.9	11.7

Source: Population Census 2011, BBS

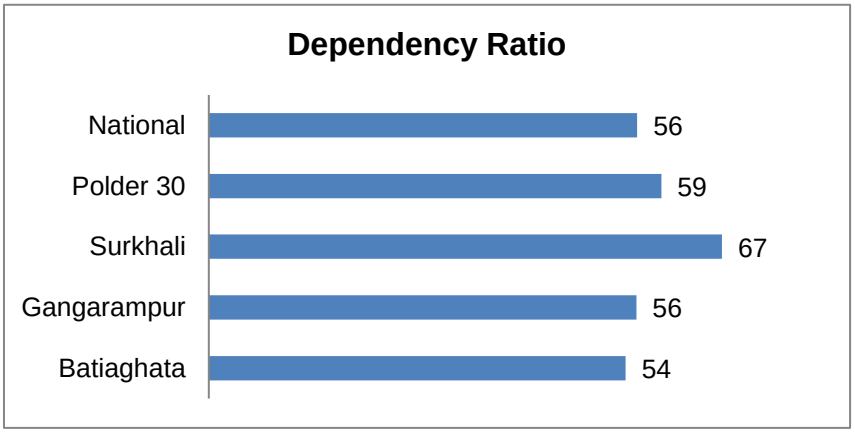


Figure 6.2: Dependency Ratio of the Polder Area

6.1.3 Marital Status

281. According to BBS, around 67% people are ever married where as 18% people are never married (it includes children). There has been discrepancy seen for male population is (32%) and female counterpart is (18%) in terms of never married persons. It indicates that young people are gradually becoming interested to be involved in business and entrepreneurial activities. Among all population, there are 25% are never married, 67% are married 7% are widow and 1% is divorced or separated. Following table (Table 6.4) shows the marital conditions at polder area.

Table 6.4: Male-female Marital Status at Polder Area

Unions	% of Male				% of Female			
	Never Married	Married	Widowed	Divorced/ Separated	Never Married	Married	Widowed	Divorced/ Separated
Batiaghata	32.5	65.9	1.4	0.1	18.3	67.6	12.8	1.3
Gangarampur	30.9	66.9	2.1	0.1	18.3	67.1	12.9	1.7
Surkhali	30.9	67.7	1.0	0.3	17.8	69.5	11.1	1.6
Total/average	31.5	66.9	1.5	0.2	18.1	68.1	12.3	1.5

Source: Population Census 2011, BBS

6.2 Household Size and Types of Family

282. The average household size is 4.02, which is smaller than the national household size of 4.50 (HIES 20101). According to local people, household size is 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
Batiaghata	3.3	11.3	24.8	27.2	16.0	8.8	4.1	4.6
Gangarampur	3.7	13.8	26.1	26.1	16.6	8.1	2.7	2.8
Surkhali	2.9	11.5	22.6	27.7	17.7	9.8	4.3	3.7
Total/average	3.3	12.2	24.5	27.0	16.8	8.9	3.7	3.7

Source: Population Census 2011, BBS

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

283. On the other hand, In terms of the types of family2, most of the households (68%) are live in either a nuclear or a conjugal family while only 32% live in extended or joint family (Figure 6.3). Local people opined that within the process of modernization, development of communication, growth of education, closeness to Khulna cities, now they are being conscious about nuclear family and declining structure of kinship is observed all over the polder.

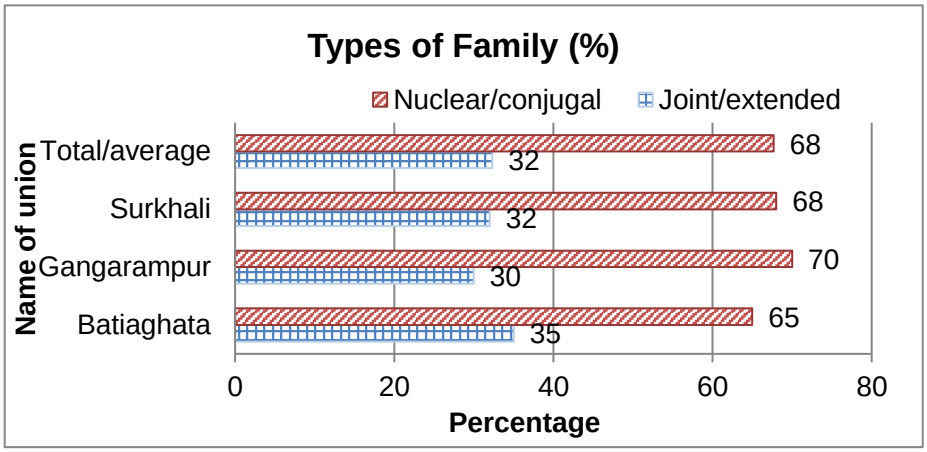


Figure 6.3: Distribution of Population by the Types of Family

Source: CEGIS fieldwork, 2014

6.3 Livelihood Status

6.3.1 Employment and Occupation

284. In the polder area, about 30% of total population is employed, 48% is engaged in household work, only one percent is looking for work and about 21% of total population is not working (it includes children and physically challenged population). Figure 6.4 shows the employment status of the people in the Polder area.

[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 (for detail, see, Schaefer, Richard T. Sociology: A Brief Introduction, Fifth Edition, Macgraw Hill, 2004, Pg-281)

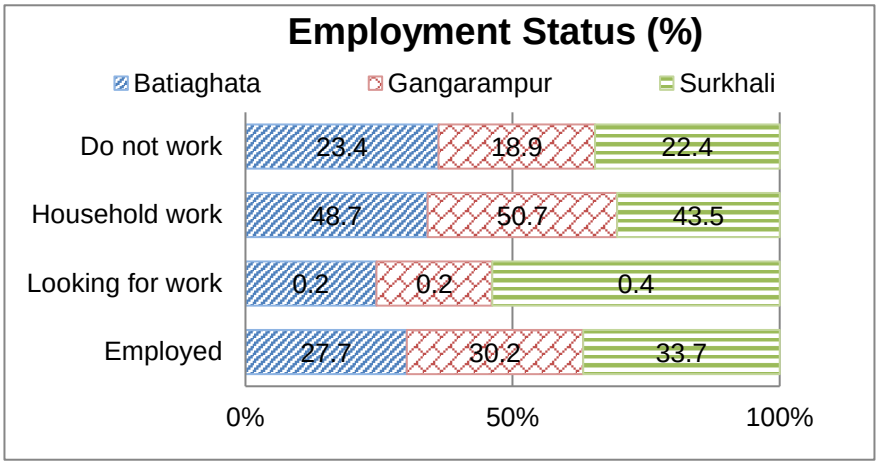


Figure 6.4: Distribution of Employment Status by Polder Area

Source: Population Census 2011, BBS

285. 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 13% population is engaged in salaried service sector and only 4% is engaged in industry, petty trade, handicrafts and other manual sectors. (Figure 6.5).

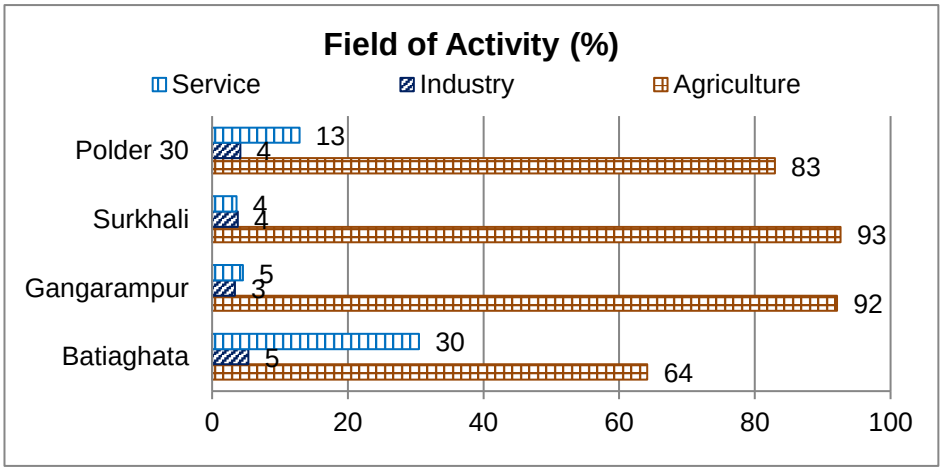


Figure 6.5: Distribution of Population by Field of Activity

Source: Population Census 2011, BBS

286. Field findings also shows that these large section of agricultural group which includes farmer 42%, agricultural labor 28%, fishers 25%, day labors and other 5% etc. Local fishermen sale bulk of their catch either directly to the local fish market at Batiaghata, Rathkhola, Shutra bazar, Katianangla bazar or to the fish traders. The fish traders or buyers (*Bepari*) coming from Khulna, Batiaghata to purchase the Prawn/shrimp and other fishes. No structured fish-landing centers are found in the polder area. There is an ice factory in Batiaghata bazar. Ice from this plant is collected and is used for icing the harvested fish. Some time they collect ice from Chalna and Khulna.

287. Fish storage facility in or in adjacent to the polder area is not satisfactory as reported by local stakeholder. The fish traders store their fishes in a local fish deepo which are located in the said bazaars for a while. On the other hand, transportation facility at root level of polder area has been found moderately developed. There is a private hatchery inside the polder area. Availability of fish feeds for culture ponds are insufficient. Fish seeds for culture fishery are collected from the hatcheries and nurseries which are situated at Khulna and Bagerhat.

Photo 6.1: Different Modes ofLivelihood Activites at Polder 30

6.3.2 Availability of Labor and Wage Rate

288. Filed findings shows, there have been a growing tendency that people trying to cultivate their own land rather depends on sharecropping system. About 10-12% 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. A notable women's participation is observed in agricultural or fishing sector. During harvesting period, they take part in action with men in same agricultural field. Some of them are also collect fry fish from river, earthwork etc (Photo 5.23).

6.4 Population Migration

289. Migration[3] scenario is seldom 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 Gopalganj, Khulna, Dhaka for better livelihood and lack of employment opportunity over the polder (10-12%) 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	Gopalganj, Khulna, Dhaka	10-12	Periphery from the polder	20-25
Permanent household migration	Khulna, Dhaka	20-25 HHs	-	-

Source: CEGIS fieldwork 2014

290. 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.

6.5 Education

291. The average literacy rate in the study area is 55.9% which is slightly better that national level (51%) (Figure 6.6andFigure 6.7). It is observed like other part of Bangladesh that the male population (63.5%) is more educated than their female counterpart (48.4%) 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. Most of the girls at anyhow are trying to complete their secondary level and some them are also studying Khulna or Dhaka 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.

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

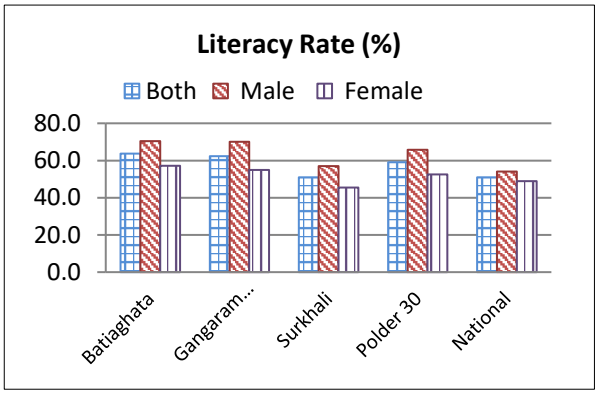


Figure 6.6: Literacy Rate at Polder 30 Area

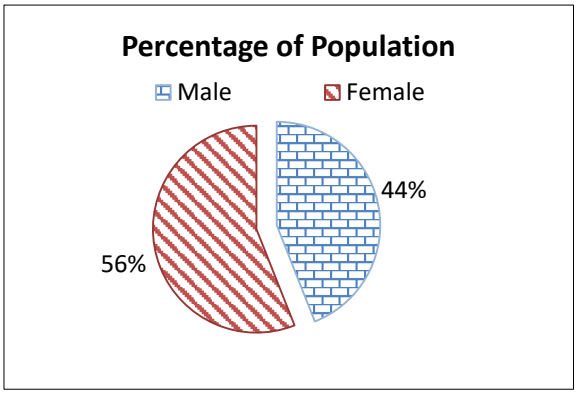


Figure 6.7: Percentage of Population (%) Aged 7+ years not Attending School

Source: Population Census 2011, BBS

6.5.1 Educational Institutions

292. According to the field findings there are 59 primary schools, 8 high schools and 10 ebtedaye/ Dakhil Madrashas in the polder area (Table 6.7 and Photo 6.2). There are two colleges seen the polder area except Surkhali union *(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 6.7: Academic Institutions at Polder

Union Name	No of Primary School	No of Madrasha	No of High School	No of Collage
Batiaghata	18	3	3	1
Gangarampur	23	3	3	1
Surkhali	18	4	2	-
Total/Average	59	10	8	2

Source: CEGIS field work, 2014

Photo 6.2: Local Educational Institution at Polder Area

6.6 Health Condition

6.6.1 Disease Prevalence

293. The health profile of the local people living in the Polder is presented in the Table 6.8. According to the ranking, the incidence of Diarrhea and dysentery is the most prevalent ailment for dry season whereas cough/cold, skin diseases are also common for winter season in the Polder area.

Table 6.8: Disease Profile in the Polder

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

Source: CEGIS fieldwork, 2014

6.6.2 Health Services and Facilities

294. Field findings show that there are one upazila health complex, 3 union health complexes and 9 community clinics in the polder area. These health services are not adequately functioning (Table 6.9). As a result, local people are to receive health service and facility from these peripheral hospitals. However, it is observed that communication between polder area and upazila is so good that patients can easily go to these peripheral hospitals.

Table 6.9: 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
Batiaghata	1	1	4	Khulna
Gangarampur	-	1	2	Khulna
Surkhali	-	1	3	Mongla, Khulna
Total	**1**	**3**	**9**	

Source: CEGIS fieldwork, 2014

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

6.7 Land Ownership and Land Price

296. 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%

[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

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 Boro paddy due to water crisis and salinity. The large farmers are mostly from absentee category. They usually are living in the Khulna or Batiaghata and appoint caretaker to take care their land. (Figure 6.8).

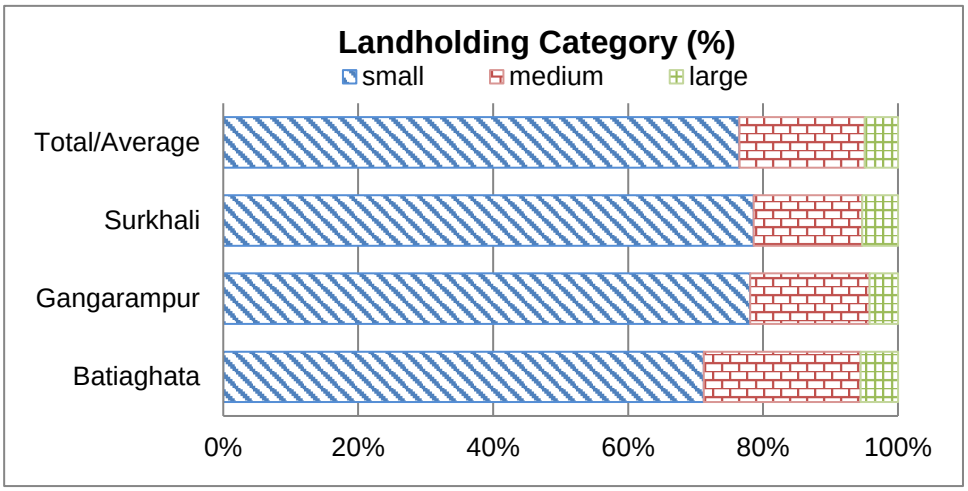


Figure 6.8: Landownership Pattern in Polder Area

Source: BBS, Agriculture Census, 2008

297. Land price in the study area is increasing day after day in whole polder area. According to the local people, agricultural land prices are relatively lower than Gher. The land price of homestead land is the highest in comparison to other land. The details lands prices are shown in the Table 6.10.

Table 6.10: Sell Value of Land at Polder 30

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

Source: CEGIS fieldwork, 2014

6.8 Household Income and Expenditure

298. The income and expenditure at the household level within the Polder area is shown in Table 6.11. 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.

acres; b) medium: having operated land in between 2.50 to 7.49 acres; and c) large: having operated land 7.50 acres and above.

Table 6.11: 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	45	48
60,001to 108,000	7	6
108,001 to 240,000	5	5
More than 240,000	3	3

Source: CEGIS fieldwork, 2014

6.9 Sectors of Income and Expenditure

299. Field findings shows that most of the income comes mainly from two sectors i.e. agriculture (45%) and fishing (32%). On the other hand, most of the expenditure costs for household consumption 50% (it includes everyday food, clothing and other necessary things) and education purpose (20%). In to some extent, they are now feeling discomfort due to current price hike in every sector of expenditure. In most of the cases, expenditure is become two times greater than income. Some of them are lending money from NGOs for well being of their family or livelihood (Figure 6.9 and Figure 6.10).

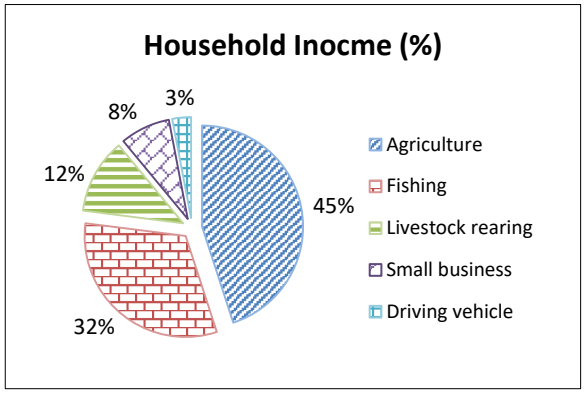


Figure 6.9: Proportionate Distribution of Household Income

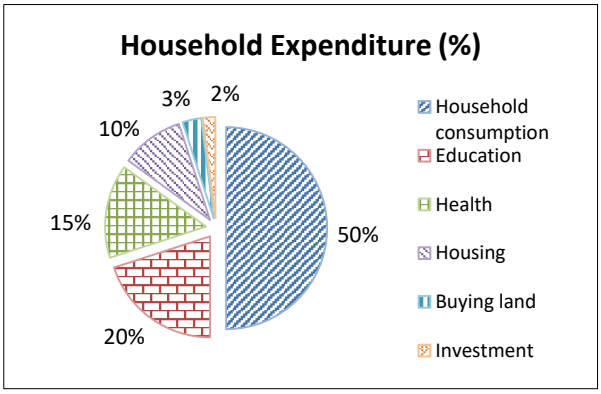


Figure 6.10: Proportionate Distribution of Household Expenditure

Source: CEGIS fieldwork, 2014

6.10 Susceptibility to Disasters

300. The local inhabitants of Polder 30 have identified tidal flooding, salinity intrusion 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 little bit 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, salinity problem and drainage congestion has gradually increased and crop production, the income source village from homestead gardening, livestock rearing and wage labour has been hampered. Besides, sources of pure drinking water, freshwater fish culture has also hampered. They feel risk due to such kind of vulnerable factors and mentioned necessary mitigation measures to risk reduction from GOs or NGOs level. Details about the disasters and their affects on their livelihood in the area are presented in table (Table 6.12).

Table 6.12: Effects of Recent Natural Disaster within the Polder

Disaster	Affected Year	Affected Area (%)	Affected Households (%)	Crop Damaged (%)	Major Damaged Crop
Tidal Flood	2007	40	30	30	Rice, water melon, sesame etc.
Salinity	2007, 2009, 2011	30	25	20	Rice, water melon, sesame etc.
Cyclone	2007 (Sidr), 2009 (Aila)	40	30	30	Rice, water melon, sesame etc.

Source: CEGIS fieldwork, 2014

6.11 Quality of life

Housing Tenancy and Housing Condition

301. 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 94% people possessed own household within the polder area whereas around 4% people are living without rent free and rest of 3% are living in rented house (Figure 6.11).

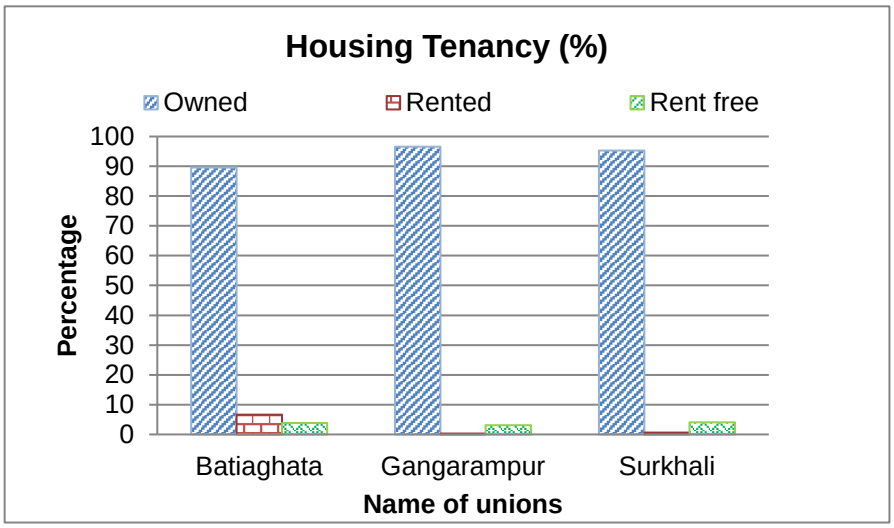


Figure 6.11: Distribution of Housing Tenancy by Union at Polder Area

Source: Population Census 2011, BBS

302. In the polder area, overall housing condition[5] is not satisfactory. On an average only 6.4% of houses are Pucka, 7% houses are semi-pucka and 1.4% houses are semi pucka whereas 85% percent are kutcha (made of wood/bamboo, and other local materials). 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 Batiaghata union comprises the highest pucka household (9%) whereas Gangarampur union comprises the highest kutcha households (90 %). Table 6.13 and Photo 6.3 to 6.6 present some photographs of these housing types.

Table 6.13: Types of Housing Structure by Union at Polder 30

Union	Type of Structure (%)			
	Pucka	Semi-Pucka	Kutcha	Jhupri
Batiaghata	9.5	12.7	76.5	1.3
Gangarampur	5.0	4.4	90.0	0.6
Surkhali	4.8	3.9	88.8	2.5
Total/Average	6.4	7.0	85.1	1.4

Source: Population Census 2011, BBS

Photo 6.3: Jhupri House

Photo 6.4: Kutcha House

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

Photo 6.5: Semi-pucka Hhouse

Photo 6.6: Pucka House

6.11.1 Sanitation

303. The sanitation facilities[6] adopted by households of the polder area are presented in Table 6.14 and Photo 6.7. It shows that, about 61 %households have hygienic sanitation facility (water-sealed), 28 % have not water-sealed sanitation facility, 7% have non-sanitary sanitation facility and 4%have no sanitation facility. Local people face the worst situation regarding the sanitation facility.

Table 6.14: Sanitation Facilities by Union at Polder 30

Union	Toilet Facility (%)			
	Sanitary (Water-Sealed)	Sanitary (Non Water-Sealed)	Non-Sanitary	None
Batiaghata	81.8	13.4	3.3	1.6
Gangarampur	70.9	22.4	2.8	3.9
Surkhali	31.3	46.6	15.4	6.6
Total/Average	61.3	27.5	7.1	4.0

Source: Population Census 2011, BBS

304. Sanitation facility is satisfactory in Batiaghata and Gangarampur unions (82% and 71% eater-sealed sanitary) whereas in Surkhani union it shows only 31%. Similarly, about 4% and 7% HHs have no sanitation facility respectively at Gangarampur and Surkhali unions.

[6] BBS defined four types sanitation in Bangladesh such as **(i) Sanitary (water-sealed):** A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. **(ii) Sanitary (not water-sealed/ring slab),** latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing in-sects from flying into or coming out of the pit; and **(iii) Non-sanitary (Kucha)**:latrine is aframe 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 6.7: Sanitation Facility in the Polder Area

6.11.2 Drinking Water

305. Overall status of drinking water in the area is not satisfactory. On an average, 94% people can collect drinking water from tube well and rest of the 6% can collect drinking water from other sources such as ponds, PSF; rain water etc. like Polder 22 salinity is the main problems in the polder area but not severe condition. Database also shows that, Batiaghata union comprises highest (100%) user tube well for collecting drinking water whereas Sukhali union comprises lowest percentage (86%) about tube well users. It is notable that, there is no use of tap as sources of drinking water within the polder. The detail is presented in Table 6.15, which shows that percentage of tube-well coverage is insignificant. People are to collect drinking water from different source.

Table 6.15: Sources of Drinking Water in Polder by Union

Union	Source of Drinking Water (%)		
	Tap	Tube-Well	Other
Batiaghata	-	100.0	-
Gangarampur	-	95.3	4.7
Surkhali	-	86.1	13.8
Total/Average	-	93.8	6.2

Source: Population Census 2011, BBS

Photo 6.8: Community Level PSF

Photo 6.9: Domestic Level Tube Well

Photo 6.10: Domestic Level Rain Water Harvesting

6.11.3 Electricity and Fuel Consumption

306. Electrification as reported in the Population Census is moderate in the polder area. On an average, only 32.8% households are under electricity coverage for Polder 30. BBS data shows Batiaghata Union comprises highest (44%) electricity coverage whereas Gangarampur Union comprises lowest (25%) coverage among other unions of this polder. Moreover, almost 35% households are now use solar electricity in the polder area (CEGIS fieldwork, 2014). 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.

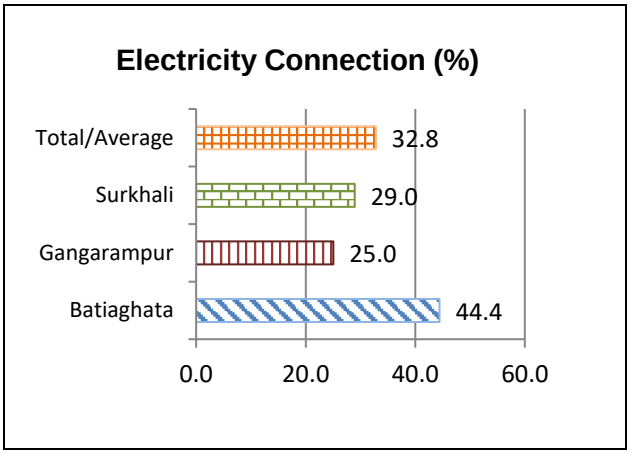


Figure 6.12: Distribution of Electricity Connection by Union at Polder Area

6.12 Social Amenities

Roadways

307. Road networks and communication system is not better in the polder area. Local people communicate through both roadways and waterways. There are some roadways cum embankments along the polder (at Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ, and Hogalbunia) which are often threats to river bank erosion and triggered vegetation damage (Table 6.16) and (Photo 6.11). The some of the peripheral roads of the polder are paved and brick soling.

Table 6.16: Road Network in Polder 30

Road Type	Length (Km)	Width (Km)	Area (Ha)
District	11	0.009	10.10
Upazila	23	0.008	17.35
Union	16	0.005	7.92
Rural	79	0.004	29.03
Total	129	0.026	64.4

Source: NWRD, 2014

Photo 6.11: Paved and Soling Roads in the Polder Area

Markets and Growth Centres

308. The current status regarding market and growth center at polder area is not satisfactory. There is only one growth center and only 15 markets/bazaars are observed in polder 30 area. Among them growth center is in Batiaghata union which is open in every day and another every Tuesday it is open as weekly bazaar day. According to local people, these facilities are not enough to serve all necessary purpose in their day to day life.

6.13 Socio Cultural Capital

6.13.1 Social Safety Nets

309. A number of local, national and international NGOs are working in the polder area. The main activities of these NGOs are operating micro credit programs among the rural poor and landless women/men. The major NGOs working in the area include BRAC (Bangladesh Rural Advancement Centre), ASA (Association for Social Advancement), Bureau Bangladesh, Nobolok, CCDA (Centre for Community Development Assistance) Heed Bangladesh (Table 6.17 and Photo 6.12). These NGOs are serving with micro credit while BRAC working for non-formal education, Health, human rights, water and sanitation, gender and children development programs. About 45% of households are found to benefit from the NGOs interventions. After disasters (Sidr and Aila) the Nobolok was appeared the most important NGO for the local people.

Table 6.17: NGOs and Their Programs in Polder Area

NGOs	Type Of Programs						
	Credit	Education	Water And Sanitation	Health	Seeds	Gender	Children
BRAC	✓	✓	✓	✓	✓	-	-
ASA	✓	-	-	-	-	-	-
Nobolok	✓		-	-	✓	-	-
Bureau bangladesh	✓	-	-	-	-	-	-
Grameen Bank	✓						
Heed bangladesh	✓	-	-	-	-	-	-
CCDA	✓						

Source: CEGIS fieldwork, 2014

Photo 6.12: Some Glimpses of Social Safety Net Programs

Rituals and Festivities

Traditional Hindus are the dominant inhabitants (75%) at the polder area followed by Muslims and a very few Christians. In terms of rituals and festivities, there exists good social bonding and cohesion between the Hindus and Muslims. Hindus mainly gather for their largest religious festival as Durga puja, amid much fanfare and festivity during occasion. On the other hand Muslims and other religions group take part their rituals and festivities simultaneously in a peaceful way (Photo 6.13).


Photo 6.13: Hindu Temple in Polder Area

6.13.2 Common Property Resources

310. The common property places/resources of the area are 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 6.18).

311. There are 51 mosques, 55 temples, 23 Eidgah, 31 graveyards and 46 crematoriums in the polder area. Besides there are 13 cyclone shelters among them four are under construction. However, there are no known historical and archeological sites declared by government in the Polder area.

Table 6.18: Common Property Places/Resources in Polder 30

Sl. No	Union Name	No of Mosque	No of Temple	Eidgah	No of Graveyard	No of Cremation	No of Cyclone Salter	
							Functional	Under Construction
1	Batiaghata	16	26	**8**	10	16	3	2
2	Gangarampur	17	25	8	11	18	2	2
3	Surkhali	18	4	7	10	12	4	-
Total		**51**	**55**	**23**	**31**	**46**	**9**	**4**

Source: Union website, 2014

6.13.3 Conflict of Interest

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

6.14 Poverty Situation

Self-assessed Poverty

313. Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories (Figure 6.13). It is observed that about 48% of the households in average are in the 'deficit' category, 8% are surplus and rest of 44% households are in balance situation. These households have been identified in the RRA as the poor households of the Polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals in a day in the lean period since they could not afford three full meals.

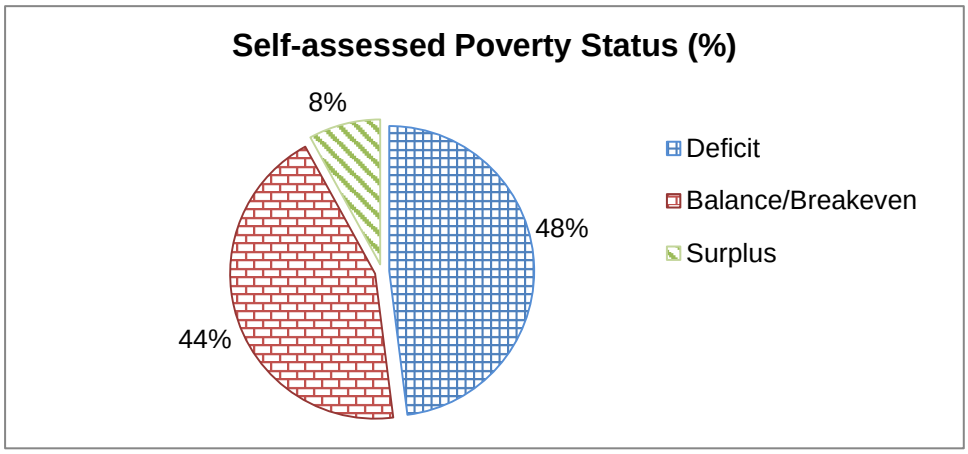


Figure 6.13: Self-assessment of Poverty Status

Source: CEGIS fieldwork, 2014

6.15 Gender Issue

Education Enrolment

314. Enrolment in education shows the difference regarding attending and not attending school for both sexes. In terms of attending school both male and female rate of education for 6 to 10 years and 11 to 14 years is almost similar while this situation is very awful for higher studies. It is clear that women are still backward than the male counterpart to become educated. This tradition has now been changing and people of the area are now concentrating on female education (Figure 6.14).

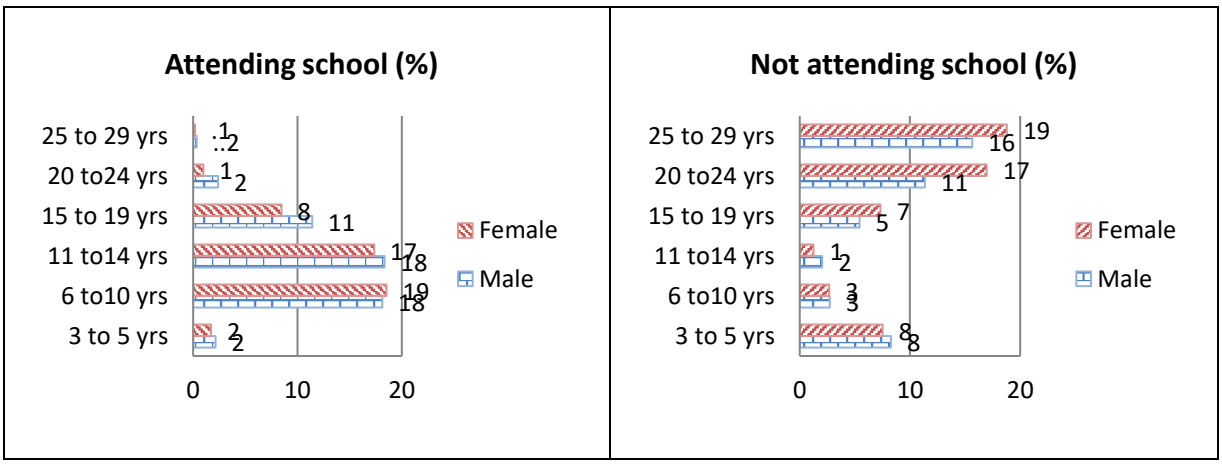


Figure 6.14: Male-Female Education Enrolment at Polder Area

Health

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

Employment

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

Empowerment

317. In the polder, women's status has changed greatly during the last few decades. Many of the Hindu women have come out of the kitchens. They are working hand in hand with men in all spheres of work i.e. from earthwork tailors, teachers etc. Like other part of the country, Muslim women are little bit restricted to household works. They are mostly stay at home except when going for medical treatment, fetching water and visiting relatives (Photo 6.14).

Photo 6.14: Women are Working in Different Income Generating Activities

Vulnerable Communities

318. In the Project 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. Local economy is mostly agriculture based and most of the land owners cultivate their land by themselves. Some of the land lords give their land for sharecropping to the marginal farmers and other vulnerable groups. Some people of the Project area depend on fishing from the open water bodies. According to local people, about 10% male population and 5 percent female population is involved in fishing or fish culture. Besides, almost all households catch fish for their daily use during monsoon.

7 Public Consultation and Disclosure

319. This Chapter provides details of the consultations held with the stakeholders at the Project site and framework for consultations to be carried out during construction phase. Also included in the Chapter are the disclosure requirements for the EIA.

7.1 Overview

320. 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.

321. 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

322. 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

323. 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

324. Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed Project in Polder 30, the primary stakeholders include the people living within the Project area particularly those who reside within and in the immediate vicinity of the Polder. The primary stakeholders of the Project include the farmers, fishermen, local business community as well as women groups, and caretakers of community properties. Primary stakeholders identified and consulted during the present EIA include communities to be benefitted and/or affected by the Project, local leaders, community members and other local representatives.

7.3.2 Secondary Stakeholders

325. 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.

326. 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 Khulna, the Netherlands govt. officials and general public at large.

7.4 Approach and Methodology

327. Participatory approach was followed in conducting the public consultation meetings in the Polder 30. The consultants discussed first with the BWDB officials and then the Upazila Parishad Chairman (UZPC) and/or the Upazila Nirbahi Officers (UNOs), the Blue Gold officials, the Project Implementation Officers (PIOs) of the polder area to share the Feasibility and EIA process of the Blue Gold program. The BWDB and local government officials/representatives were consulted to identify the potential stakeholders at the Polder level. With the available support from the Blue Gold officials and UP chairman, the union level public representatives as well as the key persons were contacted over telephone and informed about the specific consultation meetings and requested them to be present in the meeting. In this way, the venue, date and time of the consultation meetings were fixed. Later, the consultant team organized the meetings at the local level. The participants provided their names, occupations and addresses in that meeting.

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

329. During the discussions, the EIA team displayed maps of the Project area, shared the initial concepts on proposed interventions and facilitated the response of the participants. The stakeholders of the Polder 30 were asked to share their needs, problems, possible sustainable solutions, and their views on the Project interventions. The stakeholders' perceived views on important environmental and social components (IESCs) and Project's impacts on them, along with perceived benefits, risks, threats and demand from the Project were identified during discussions.

7.4.1 Consultation Process

330. Two PCMs and number of discussions were conducted at different locations of the Polder 30. The details of these meeting and discussions are presented in Table 7.1 and some photographs of these meetings are given in Photo 7.1 to .7.2.

Table 7.1: Consultation Details

Sl. No.	District	Upazila	Union	Meeting Venue	Type of Consultation	Meeting date	Time
1	Khulna	Batiaghata	Sadar	Blue gold office	Sharing meeting with Blue gold officals	30/04/2014	10:00
2	,,	,,	Sadar	Batiaghata Bazar	FGD	30/04/2014	12:00
3	,,	,,	Gangarampur	Baronpara	FGD	30/04/2014	14:00
4	,,	,,	,,	Debitala		30/04/2014	16:30
5	,,	,,	Daskin Sholmari	Battola	"	01/05/2014	10:00
6	,,	,,	Gangarampur UP	Gangarampur UP office	FGD	02/05/14	10:00
7	,,	,,	Gangarampur UP	Gangarampur UP	PCM	02/09/14	10:00
8	,,	,,	Batiaghata UP	Batiaghata UP	PCM	04/09/14	10:00


Photo 7.1: Knowledge sharing Consultation Meeting with Blue Gold Officials, Khulna


Photo 7.2 Meeting with Executive Engineer, BWDB; Khulna


Photo 7.3: PCM at Gangarampur Union


Photo 7.4: PCM at Batiaghata Union

7.4.2 Consultation Participants

331. The main participants of these consultation meetings included Blue gold officials, local representative, farmer, trader, members of WMO and daily-wage laborers of the Polder 30 and nearby areas. A total of 148 participants attended these consultations. The participant details are provided in Table 7.2 and Photo 7.4 to Photo 7.6 below.

Table 7.2: Participant Details

Sl. No.	Meeting Venue	Type of Consultation	Type of Participants	No. of participants
1	Blue gold office	Consultation	Secondary stakeholders	15
2	Gangarampur UP	PCM	Primary and secondary stakeholders	40
3	Batiaghata UP	PCM	,,	38
4	Batiaghata Bazar	Inofrmal discussions	Primary stakeholders	12
5	Baronpara	"	,,	9
6	Debitala	"	,,	16
7	Battala	"	,,	10
8	Gangarampur UP	,,	,,	08


Photo 7.5: Meeting at Gangarampur UP, Batiaghata


Photo 7.6: Consultation at Gondhomari village, Batiaghata UP


Photo 7.7: Consultation at Debitola Village, Gangarampur

7.5 Issues Discussed in FGDs and Meetings

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

a. Water Resources:

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

b. Land Resources:

- cropping practice,
- Yield and production,
- Crop damage.

c. 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)

d. Disasters:

- Cyclones
- River erosion
- Associated damages

e. 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.

f. Community involvement

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

7.6 Community Concerns and Suggested Solutions

333. The outcomes of the PCMs and discussions 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	Salinity intrusion, drainage congestion and cyclone 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	• The water control infrastructures are not suitably functional in this polder and salinity intrusion due to damaged gates of the structures and height of embankment has reduced; • Water unavailability • Siltation of khals and create drainage congestion • Severe drainage congestion near the peryphery of Gangarampur union due to siltation at Jhapjhapiya River	• Damaged part of the embankment should be re-sectioned as early as possible and slope of embankment must include protection with forestation. • Bank protection measures should be taken in the critical river bank erosion prone areas. • Replace the damaged/non-functional sluice gates and construct new ones where required • Re-excavation of proposed khals • Re-excavation of Jhapjhapiya river
Agriculture resources	▪ Soil salinity is the problems for crop production; ▪ Drainage congestion during transplanting period in Aman season; ▪ The level of sea water increases due to impact of climate change which is responsible for natural calamities such as tidal surge, cyclone etc. ▪ Severe scarcity of irrigation water in dry season especially for rabi crops cultivation; and ▪ The siltation caused raise of bed of different internal drainage khals.	• Sluice gates repair • Khal re-excavation • Training for WMOs • Giving training facilities to the local farmers • Providing loan facilities at easy terms and conditions to the local people
Fishery resources	• Deterioration of habitat quality due to salinity and siltation in the khal • Pond overtopping during heavy rain	• Repairing the water control structure • Re-excavation of the silted up khals • Application of fisheries rules and

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	• Illegally fish culture in the internal khal through pata jal by the local musclemen	regulations strictly by the Government • Strengthening WMA/WMO activities
Ecological resources	• Soil salinity, internal canal bed siltation and riverbank erosion are the main threats on ecosystems of this polder. • Encroachment of saline water will change and slowly destroy fresh water ecosystem. • In addition, drainage congestion (Dabitola, Amtola village) and natural disaster is also another threat that destroys homestead and riverside vegetation. • Loss of vegetation density and succession ultimately impact on wildlife habitats.	• Removing siltation by re-excavation of khal. • Embankment re-sectioning and repairing water control structure along the embankment to protect settlement, road, inter tidal area and crop fields from existing problem.
Socio-economic resources	• The proposed *khals* that will be re-excavated are being used by local power elites for shrimp cultivation. Therefore, the local people do not get any access to those open water bodies. Besides, a large quantity of saline water is being taken into those *khals* which creates severe salinity problem. As a result, bread and butter of the local people are being threatened. • There is severe drainage congestion in certain parts of Gangarampur union. As a result, agricultural lands go under water due to a slight rainfall and the people suffer from a huge economic loss. • Scarcity of fresh water is another problem in the polder area during dry season. Due to malfunctioning of water control structures, lack of reserve sweet water in khals, saline water is being trapped for long time in almost whole polder area and this is responsible for intrusion of salinity in the groundwater aquifers. • Lack of adequate expertise and experienced manpower to carry out the O&M of the polder and the numbers of field staffs are also insufficient and inadequate in some places of the polder with respect to the actual requirement. • Local powerful persons, including the political leaders illegally interfere on the water control/ management infrastructure. • Lack of employment opportunity for local people	• Strengthening of WMGs so that mass people can have access to open water bodies easily. So, it is necessary to create mass awareness about the bad effect of entrance of saline water into *khals*. • It is proposed on behalf of blue gold program that pumping of water may be introduced as a solution to the drainage congestion. But local people vehemently opposed this proposal and they rather proposed to re-excavate the linking khals along with the Jhapjhapiya River as solution to this problem. • Scope of sweet water storage may be improved within internal khals and protective ponds by proper functioning of associated water control structures; • It is necessary to ensure sustainable operation of the project, effective participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also to manage water control structures properly i.e. embankment, sluice gate, regulator, inlets, culverts etc and to create 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; • Ensure employment opportunity for local people i.e. small business,

7.7 Participant List

334. 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. No.	Name	Gender	Occupation	Age	Address/Mobile No
01	Md. Abdul Gani Biswas	M	Chairman, Gangarampur UP	55	01929-603667
02	Md. Ferdous Hasan	M	C/A Batiaghata UP	40	01733-073238
03	Koushalla Roy	F	House wife	30	-
04	Tulashi Sarkar	F	,,	45	-
05	Amena Khatun	F	,,	45	-
06	Md. Sumon	M	Computer operator, Gangarampur UP	30	01916-705822
07	Biplab Mondal	M	Agriculture	32	01915-901380
08	Hadi Solaiman Ripon	M	Agriculture	23	01932-640435
09	Sunil Mondal	M	Agriculture	42	01914-318113
10	Oshima Mondal	F	House wife	45	-
11	Nilima Mondal	F	,,	40	-
12	Jogodish Goldar	M	Agriculture	60	-
13	Narayan Roy	M	,,	60	-
14	Oshim Mondal	M	Business	30	01946-512770
15	Nikhil Mondal	M	Autistic	35	-
16	Ganesh Biswas	M	Agriculture	60	-
17	Bipul Roy	M	Business	40	01719-634392
18	Ananda Mohan Mondal	M	,,	35	-
19	Kali Sankar Mondal	M	Agriculture	45	-
20	Harendranath Ganguly	M	Teacher (Retd.)	70	01915-749689
21	Shekhor Roy	M	Agriculture	30	-
22	Bilwal Hossain	M	Business	32	01911-564616
23	Md. Rasel	M	Carpenter	20	-
24	Mariam Begum	F	House wife	22	-
25	Pir Ali	M	Land surveyor	48	01912-959218
26	Titu Tarafdar	M	Agriculture	40	01925-676564
27	Amar Chandra Tarafdar	M	Teacher	51	01925-323147
28	Shiddarth Sangkar Roy	M	Agriculture	43	01949-867631
29	Md. Ebadul Islam	M	Business	34	01922-489131
30	Banamali Haldar	M	Agriculture	50	01916-794649
31	Omalindu Mondal	M	Ex-member, Gangarampur UP	52	01862-158931
32	Oshim Roy	M	Driver	38	01924-322631
33	Chandan Kumar Sarkar	M	Teacher	43	01915-901677

7.8 Perceptions towards proposed interventions

335. The interventions proposed by the Blue Gold Program for rehabilitation of the polder were discussed with local people by the EIA study team. A list of identified problems and the suggested solutions made by the local people are shown in Table 7.3. The solutions opted by the local people are mostly found similar to these proposed by the Blue Gold Program for this polder. During public consultation meeting conducted by this team, the participants were also requested to provide their overall perception about the proposed interventions. The opinions received were positive, as almost all the local participants spoke in favour of the proposed interventions. The generalized perception was that they believe that the interventions proposed (discussed in Chapter 4) have the outright potential to remove the existing water management problems and concerns in Polder 30.

8 Identification, Prediction, and Evaluation of Potential Impacts

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

8.1 Ientification of IESCs and Rationale

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

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Saltwater Intrusion	At the moment the polder is severely affected by surface water salinity intrusion. Some of the interventions in Polder 30, i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, salt water intrusion has been considered as an Important Environmental Components (IEC).
Saltwater Intrusion	At the moment the polder is severely affected by surface water salinity intrusion. Some of the interventions in Polder 30, i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, salt water intrusion has been considered as an Important Environmental Components (IEC).
Surface Water Availability	Due to khal re-excavation works, the availability of surface water in Polder 30 may be increased and this might facilitate the multi-purpose use of water. As such, surface water availability has been selected as an IEC.
Siltation	The prevention of tidal water entry through the khals would reduce the volume of sediments entering the polder. As a result, the khals might experience benefits regarding low silt transportation. Moreover, the river sediments may get deposited over the flood plain areas outside the polder, which might increase the peripheral river siltation. Considering these, siltation has been considered as an IEC.
Erosion	Temporary bamboo protection works would be provided at four vulnerable points, as per WMOs recommendations in Polder 30. The works may offer protection against seasonal wave actions of the peripheral Sholmari and Kazibacha rivers, and this might temporarily effect the river bank erosion in Polder 30. Therefore, erosion has been considered as an IEC.
Drainage Congestion and Water Logging	The re-excavation works in the khals may improve the drainage status of the area, and diminish the risk of emergence of water logging problems at some portions of the polder. Therefore, drainage congestion and water logging has been considered as another IEC.

IESCs	Rationale
Land Resources	
Soil Salinity	Soil salinity increases with the intrusion of saline water in the polder area. The proposed interventions (repair/re-sectioning of entire embankment, repair of sluices, etc.) are expected to check the intrusion of saline water which in turn would help in the reduction of soil salinity. Soil salinity has, therefore, been selected as an IEC.
Agricultural Resources	
Crop Production	Agricultural crop production is expected to be increased for the improvement of drainage congestion due to excavation, and rainwater harvest in the Khals. The crop damage would be reduced due to repairing of retired/repaired embankments. The embankments might protect the crops from early flooding. The re-excavation of khals would help to drained out excess water from crop field through sluices. Moreover, the surface water of the re-excavated khals would be used as irrigation purpose. As such crop production has been selected as an IEC.
Crop Damage	Crops are presently damaged in the polder area due to water lodging in the pre-monsoon and rainy season, drainage congestion, salinity, drought, etc. which are expected to be checked due to implementation of the proposed interventions. Reduction in crop damage would be reflected in aerial extent as well as increased yield per hectare contributing to increase in crop production in consideration of which crop damage has been selected as an IEC.
Irrigated Area	Surface water is more preferable over ground water for irrigation use because of its low cost and sediment content contributing towards maintaining the soil nutrient status. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.
Fisheries Resources	
Fish Habitat	The proposed interventions of the project likely alter the fish habitat as well as habitat quality in the polder area. Increased water depth may support different fish species for re-excavation of khals. In this context, fish habitat has been considered as an IEC of the study.
Hatchling and Fish Movement	A few numbers of khals are connected with the peripheral rivers. Most of the khals are silted up but till there is a scope of hatchling as well fish movement from river to khal and tidal area especially in monsoon in the polder area. The proposed interventions like repairing of regulators and re-excavation of khals may have considerable change in fish hatchling movement in the polder area. Thus hatchling and fish movement has been considered as an IEC.
Fish Biodiversity	The brackish and fresh water fish species are declining due to habitat losses, obstruction of migration routes, degradation of fish habitat quality etc. Moreover, the proposed intervention may change the fish migration which might change in fish species diversity in the polder area. So, fish diversity has been considered IEC of this study.
Capture Fisheries Productivity	Open water fisheries especially river fisheries still contribute significantly on fish production in the polder area. The proposed interventions may change the fish abundance which ultimate may increase the fish productivity of both capture and culture fisheries in this area. Due to increased depth and improved water quality for re-excavation of khal, it is expected that capture fisheries productivity inside the polder
Ecological Resources	

IESCs	Rationale
Habitat Condition	Proposed intervention is expected to minimize river erosion as well as countryside saline intrusion, increase depth of khals and reduce tidal flood and drainage congestion. In addition, all types of proposed construction activities are suspected to change of existing vegetation at construction sites. So habitat conditionhas been considered as an IEC.
Socio-econimic Condition	
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. Thus, communication regarded as an ISC.
Employment Opportunity	The construction work will generate a significant amount of employment over its construction period to local people and other associated professionals. People will also be involved to carry put operation and maintenance related jobs to operate the hydraulic structures. It is expected that proposed intervention will create employment opportunities for different occupational groups. Hence, employment opportunity considered as an ISC.
Gender issues	Construction work requires various types of skilled and unskilled labors. It is found that in Bangladesh a portion of construction labors are female. These females are vulnerable to mostly distressed and widow who are dependent on others and do not have any definite source of income. Therefore, employment access to them in the construction works and during operation/maintenance phase is desirable. Thus, gender issues regarded as an ISC.
Quality of Life	The project is expected to increase resilience of people within Polder 30. Through the implementation of the project, agriculture production would increase, drainage congestion would be reduced, salinity would be reduced from water and significant income generation is expected to ensure the better quality of life of the stakeholder. Thus, quality of life is considered as an ISC.

8.2 Eavaluation of Potential Impacts

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

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

8.3 Impact Screening

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

- Highly negative (adverse) impact (HN);
- Moderately negative impact (MN);
- Insignificant impact (I);
- Highly positive (beneficial) impact (HP);
- Moderately positive impact (MP).

338. The potential environmental impacts on the IESCs by the proposed interventions during pre-construction, construction as well as Operation and Mentainace (O & M) 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			
	Saltwater Intrusion	Surface Water Availability	Siltation	Erosion	Drainage Congestion & Water Logging	Soil Salinity	Crop Production	Crop Damage	Irrigated Area	Fish Habitat	Hatchling and Fish Movement	Fish Biodiversity	Capture Fisheries Productivity	Habitat Condition	Communication	Employment Opportunity	Gender Promotion	Quality Of Life
a. Pre-construction phase																		
Labor, materials and equipment mobilization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	HP	-	MP
Site preparation	-	-	-	-	-	-	-	-	-	-	-	-	-	MN	-	HP	-	MP
b. Construction phase																		
Re-sectioning of embankment	-	MN	-	MP	-	-	-	-	-	MN	MN	MN	MN	MN	MN	MP	MP	MP
Embankment slope pitching and turfing	-	-	-	-	-	-	-	-	-	-	-	-	-	MN	MN	MP	MP	MP
Re-excavation of Khal	-	HP	-	-	HP	HP	HP	HP	HP	MN	MN	-	-	MN	MN	MP	MP	MP
Spoil dumping and compaction on the banks of khals	-	-	-	MP	-	-	-	-	-	-	-	-		MN	MN	MP	MP	MP
Repairing of Drainage Sluices	HP	HP	-	-	HP	MP	HP	HP	HP	-	MN	-	-	I	MN	MP	MP	MP
Repairing of Drainage Outlets	HP	MP	-	-	HP	MP	MP	MP	- MP	-	MN	-	-	I	MN	MP	MP	MP
Construction of Flushing Inlets	HP	MP	-	-	HP	MP	MP	MP	- MP	-	MN	-	-	MN	MN	MP	MP	MP
Repairing of Flushing Inlets and Culverts	-	MP	-	-	MP	MP	MP	MP	MP	-	MN	-	-	I	MN	MP	MP	MP
Construction of temporary protection works	MP	MN	-	MP	-	-	-	-	-	-	MN	-	-	MN	MN	MP	MP	MP

Project Phases And Activities	Physical & Water					Land & Agriculture				Fisheries				Ecological	Socio-Economic			
	Saltwater Intrusion	Surface Water Availability	Siltation	Erosion	Drainage Congestion & Water Logging	Soil Salinity	Crop Production	Crop Damage	Irrigated Area	Fish Habitat	Hatchling and Fish Movement	Fish Biodiversity	Capture Fisheries Productivity	Habitat Condition	Communication	Employment Opportunity	Gender Promotion	Quality Of Life
c. O & M phase																		
Checking the physical condition of embankment during pre and post monsoon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Checking the physical condition and function of water control structures	HP	HP	HP	-	HP	-	-	-	-	-	-	-	-	-	-	-	-	HP
Checking depth and flow through the khals	-	-	-	-	-	-	-	-	-	HP	HP	HP	HP	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).

8.4 Impact during Pre-construction Phase

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

Table 8.3: Impact Assessment Matrix during Pre-construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Socio-economic Condition				
Activity: (i) Labor, materials and equipment mobilization (carrying as well as storing); (ii) Site preparation				
Quality of life (income generation)	Periphery and inside of the polder 30 where different activities will be initiated.	Most of the HHs income comes mainly from two sectors i.e. agriculture (45%) and fishing (32%). Both male and female are working here simultaneosly	Local unemployed labors will be recruited in pre-construction of intervention work i.e. carrying and storing of materials, site preparation. Thus, the income of labor will increase temporarily	+2

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

8.5 Impact during Construction Phase

340. The proposed activities may generate some temporary impacts on environmental social components. The descriptions of such impacts as well as their magnitudes have been shown in Table 8.4 below

Table 8.4: 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-agriculture land.				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Fisheries Resources				
Activity: Re-excavation of khal				
1. Fish Habitat 2. Hatchling and fish movement	1. Amtola Khal 2. Botiaghata - Baraiyabad Khal 3. Hania Khal 4. Hugolbunia Khal 5. Khoria Khal 6. Kolatola -Narikeltola Khal 7. Uzukhali Khal	• Most of the khal are seasonal. Average depths of these khals are (0.7-1.7) m is suitable for fish habitation. But habitat quality is degrading day by day. • About 100 fish species (both brackish and fresh water fish) are present.	• Loss of habitat quality and temporary loss of feeding ground and unavailability of fish feed for bottom dweller (e.g. eel fish, baila, crabs etc). • Decrease of fish habitat quality for time being. But after one (01) year the habitat quality will improve. • Fish production would loss temporally about 2 tons per year.	-2
Activity: Repairing of Water Control Structures				
Hatchling and fish movement	All sluice and regulators.	• Fish hatchling and some brackish water fish species move through the mal-function of regulator during high tide.	• Fish hatchling and fish species like *Bhetki / Koral, Pairsa, Chingri, Baila, Tengra* etc movement would be obstructed because of implementation of proposed intervention.	-1
Activity: Re-sectioning of Embankment and Bank Protection				
There would be no impact on fisheries resources for these activities.				
Ecological Resources				
Activity: Re-sectioning of embankment				
Habitat Condition	Both sides of the embankment at re-sectioning points	• Habitat created by few medium sized trees, shrubs and herbs e.g. Babla, Shirish, Akand, Bhat and Sech/Sezi. • Feeding ground for mammals, birds, reptiles and amphibians.	• Herbs, shrubs, various type of grass and bushes will be temporarily damaged due to soil dumping for re- sectioning work.; • Temporary relocation of wildlife due to habitat loss.	-1
Activity: Construction of flushing inlets				
Habitat Condition	Dakkhin Sholmari	• Habitat consist with medium-sized trees along with marginal vegetations;	• Babla 22 trees along with different shrubs and herbs needs to be cut	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
		• Feeding habitat for wildlife species.	during construction activities.	
Activity: Temporary bank protection				
Habitat Condition	Dakkhin Sholmari, Kismat Fultola, near to UZ HQ and Hogalbunia	• Species diversity and density of vegetation are poor in the terrestrial part. A few trees, herbs and shrubs are there; • Existing vegetation favors frogs, snakes, birds, mongooses and mice; • Crabs and mudskippers exist in aquatic habitat.	• Minor damages to the vegetation of embankment slopes during earthwork activities; • Deterioration of aquatic habitat condition due to placement of geo-bags.	-2
Activity: Re-excavation of Khal				
Habitat Condition	a. Ojukhali Khal b. Batighata Khal c. Kolatola Khal d. Amtola Khal e. Karia Khal f. Hogalbunia Khal g. Hania Khal h. Perbataiaghata Simanar Khal	• Kochuripana (*Eichhornia crassipes*), Kutipana (*Azolla pinnata*), Dhol Kolmi (*Ipomoea aquatic*), etc are the most common vegetation which support habitat for fishes and kingfisher, egret, snake, etc. • The major species Durba Gash (*Cynodon dactylon*), Biskantali (*Polygonum Sp*.) and Different types of marginal herbs like Dholekolmi (Ipomoea aquatic), Kasorti (*Eclipta Sp*.),etc. are dominant vegetations to both sides of the khal; • Different types of local avifauna roam here as feeding habitat	• Disturbance to existing aquatic habitat would have negative impacts on wildlife e.g. Egret; • Damages of existing bank line vegetations due to dumping of soil along sides of the khal	-3
Socio-economic Condition				
Employment Opportunity	Periphery and inside of the polder 30 where different activities will be initiated.	About 30% of total population is employed, 48% is engaged in household work, only one percent is looking for work and about 21% 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

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Quality of Life (income generation)	Do	Most of the HHs income comes mainly from two sectors i.e. agriculture (45%) and fishing (32%). Both male and female are working here simultaneously	Local unemployed labours will be recruited during construction of intervention work. Thus, the income of labor will increase temporality	+2
Gender Promotion	Periphery and inside of the polder 30 where different activities will be initiated.	About 52% of female are working only 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 them 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
Communication	Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ, and Hogalbunia of polder 30 area	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

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

8.6 Impact during O & M Phase

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 Table (Table 8.7).

8.6.1 Water Resources

a. Saltwater Intrusion

Future Without Project

341. Almost all the water control structures of the polder are not functioning up to the desired level at the moment. As such saltwater would enter into the polder during dry season through the structural leakages even if the gates are closed. If the sluice gates are not repaired, and tidal water keeps entering the polder on a regular basis, in future saltwater concentration in the surface water system would further increase. Existing saltwater concentrations of 7 ppt at around 18 km primary khals would increase upto 10 ppt in future, whereas further 18 km secondary and tertiary khals carrying freshwater at present would be subjected to a salinity level of up to 5 ppt in future. The situation might aggravate if the existing water control structures experience accidental failure, which would increase the chances of similar dry season salinity levels of both sides of the polder.

Future with Project

342. The salt water leakage into the polder could permanently be prevented if the existing sluice gates, flushing inlets and drainage outlets are repaired, and are properly operated. However in Polder 30 the case is different as severe social issues were observed regarding the management of water control structures during the field investigations. Local people at present are willingly allowing tidal water to enter the polder through the sluice gates. They claimed that such activities are in place to prevent the growth of fresh water aquatic flora (water hyacinths) which impedes their water access and uses. If such situation continues, the salinity status of the polder would not be improved at all by the proposed interventions. Moreover, the study infers that an additional amount of 24 km newly re-excavated khals would be contaminated with salinity levels of around 7 ppt in future, if the water control structures are improperly maintained as they are now.

Impacts

343. In spite of having immense potential of saltwater prevention impacts, the proposed interventions would not be able to cure the existing saltwater intrusion problems because of the improper management of water control structures. Minor negative impacts are foreseen at around 60% of the existing khals in future. Salinity values might reach a level of 10 ppt in 18% primary khals, 5 ppt in 18% secondary and tertiary khals and 7 ppt in around 24% re-excavated khals if the sluice gates are kept open

b. Surface Water Availability

Future Without Project

344. At present, people from Polder 30 are suffering from water availability concerns. They cannot serve their domestic and drinking water requirements and at the same time, irrigation for potential Aus crops during Kharif-I season cannot be provided. If the khal re-excavation

works are not carried out, the entire polder area would suffer from water scarcity for different uses. The top-soil erosion will cause further siltation in the khals, and the water carrying capacity would tremendously deteriorate. Water availability would be restricted and use of water could be severely constrained.

Future With Project

345. An additional volumes of around 193,500 m^3 water would be available in the re-excavated khals if the project is implemented, which can carry water in all seasons and serve a significant number of people. From the spatial distribution of settlements it is observed that around 46% population inside Polder 30 are directly dependent on Hugolbunia, Hania, Botiaghata, Uzukhali, Kalatola, Khoria and Amtola khals. This eventually leads that around 40 thousand people from Polder 30 are likely to be benefited by the additional volume of water available in the re-excavated khals.

Impacts

346. Around 10% population inside Polder 30 would be guaranteed sufficient surface water availability, and this would result in immense benefits in water use. Domestic purposes of water would be served, and water for irrigation would also be available substantially.

c. Siltation

Future Without Project

347. The internal khals of Polder 30 are subjected to siltation due to both top soil erosion and silt transportation. Silts from the peripheral rivers enter into the polder through the water control structures. At present around 24 km lengths of the Amtala, Batiaghata, Hania, Hogulbunia, Kalatala-Narikeltala, and KhoriaKhals outfall ends are silted up. If the water control structures are not repaired, in future the siltation situation might be further aggravated. The study infers that 7km of the aforementioned khals would further be subjected to siltation problems.

Future With Project

348. The entry of tidal water would be prevented effectively during most parts of the year if the water control structures are repaired.. As such, the entry of silts from the peripheral rivers would largely be limited. This will result in having significant water depths inside the khals of Polder 30. Almost the entire 24 km of silted up khal openings would be deeper, and this will ensure sufficient flow and drainage through the khals.

Impacts

349. The sedimentation situation inside the polder would be reduced by repairing the sluice gates, and re-excavation of khals. If tidal water is not allowed to enter the polder during the dry, and pre-monsoon seasons, there will be no silt transportation inwards Polder 30 during these periods. This may ensure sufficient depth of water courses inside the Polder and about 33 km khal will be free from siltation problem.

d. Erosion

Future Without Project

350. There are four erosion hotspots in Polder 30 namely, Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ and Hogalbunia, which are vulnerable to erosion due to the morphological shift of peripheral rivers. If erosion prevention measures are not carried out

immediately, the risk remains that a significant portion of lands in the aforementioned areas might be eroded. This will eventually cause damages in other sectors as well.

Future With Project

351. Given that the four identified hot-spots are dealt with temporary erosion prevention measures, river erosion would temporarily be prevented. The placement of geo-bags would make the river banks more stable, whereas the bamboo erection works would reduce pressure on the embankments. Moreover, risk of erosion would considerably decrease.

Impacts

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

e. Drainage Congestion and Water Logging

Future Without Project

353. The khals proposed for re-excavation need to drain out a large volume of water after any major rainfall events. Jhopjhopia, the outfall river of some of the southern khals has been silted up heavily over the years and as such drainage congestion problems emerge at a significant portion of the khals after rainfall. At present, around 10 km of the khals suffer from high drainage congestion problems and 14 km khals face low drainage congestion. If the re-excavation works are not carried out, the 14 km khals with low drainage congestion problems would be facing medium drainage congestion problems. In addition around 9 km khals would newly be subjected to low drainage congestion problems. Even though there is no water logging inside the polder but in future, water logged areas may appear in the upstream region of the khals if no re-excavation works are carried out. Field observations and topographic studies in Polder 30 have inferred that around 132 ha areas at Katamari, Ketenangla, Kayemkholar Hula, Debitala, Hantalbunia etc. Mauzas may undergo water logging problems in next 10 years.

Future With Project

354. The re-excavation of existing khalswould reduce the drainage congestion problems in the upstream portions of the khals up to a considerable extent. Rain water would be drained out properly from the area into the outfall river if adequate supplementary measures (i.e. pumping water into the outfall river) are taken accordingly.

Impacts

Considering the ‘future without project’ and the ‘future with project’ scenarios, it can be said that around 33 km lengths of the existing khals would be benefited from reduced drainage congestion. Furthermore, 132 ha areas within polder 30 would be saved from probable water logging problems, due to the overall improvement in drainage capacity of khals.

8.6.2 Land Resources

a. Soil Salinity

Future Without Project

355. The polder areas are affected by salinity, of them 81% of NCA of the polder area is slightly saline. If the intervention (repair/re-sectioning, embankment, sluices gates, khals re-

excavation and drainage congestion) would not be implemented in the polder, then saline tidal water in the agriculture land would be regular practices. As such salinity would continue to increase under the FWOP condition.

Future With Project

356. The repair/ re-sectioning of embankment, repair of sluice gate, khals re-excavation would prevent the intrusion of saline water into the agriculture fields and are expected to decrease in soil salinity which may enhance crop production and may reduce crop damage. It is expected that WMG/WMA/WMF can help for implementation of options and its proper management that may protect the undesirable entry of saline water and would allow draining out of rain water and reducing of salt from agriculture land. The above work will have positive impact on reducing soil salinity.

Impacts

357. The intervention would change the hydrologic regime of the project in future with project (FWIP). The entire project area would be benefited (Table 8.5).

8.6.3 Agricultural Resources

a. Crop Production

Future Without Project

358. Presently, total crop production is 17,134 tons of which, rice production is about 8,268 tons and non-rice crops production is about 8,866 tons. The contribution of rice production is about 48% and non-rice is about 51% of the total crop production. Under the FWOP condition, the crop production would be 15,548 tons due to increase of salinity, siltation of khals, drainage congestion etc.

Future With Project

359. The successful implementation of the interventions would have positive impact on crop production. The crop production would be boosted up significantly under the FWIP condition. The total rice production would be 9,365 ton which would be about 30% higher than the production of FWOP. About 9,688 tons of non-rice crops would also be produced under the FWIP condition which would be about 16% higher than that of future without project (FWOP). The production of rice would be increased due to increase of HYV Aman rice area. Additional 2,157 tons rice and 1,348 tons of non-rice would be produced under FWIP as compared with future without project (FWOP).

Impacts

360. Additional 2,157 tons rice and 1,348 tons of non-rice would be produced under future with project (FWIP) as compared with future without project (FWOP) (Table 8.5 and Table 8.6).

Table 8.5: Impact on Crop Production under FWOP and FWIP Condition in the Study Area

Sl. No.	Crop Name	Production (Ton)				% of Change
		Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	
1	HYV Aman	3,638	2,536	4,534	1,998	79

Sl. No.	Crop Name	Production (Ton)				% of Change
		Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	
2	LT Aman	4,630	4,672	4,831	159	3
Total rice		**8,268**	**7,208**	**9,365**	**2,157**	**30**
3	Sesame	2,955	2,279	2682	402	18
4	Vegetables	3,060	2,550	3,570	1,020	40
5	Watermelon	1,900	2,420	2,061	-359	-15
6	Mungbean	840	1,060	1,272	212	20
7	Sunflower	113	30	103	73	240
Total non-rice		**8,866**	**8,340**	**9,688**	**1,348**	**16**
Total crop production		**17,134**	**15,548**	**19,053**	**3,505**	**23**

Source: Field information, 2014

b. Crop Damage

Future Without Project

361. Presently, total rice crop production loss is 751 tons and non-rice production loss is 491 tons due to drainage congestion/water logging etc. The situation would be aggravated under FWOP condition. The crop production would be about 1,323 tons of which rice production is 763 tons and non-rice is about 560 tons.

Future With Project

362. 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 rice crop production loss would be 256 tons of rice and 186 tons non-rice under the future with project (FWIP) condition.

Impacts

363. It is expected that loss of crop production would be reduced 506 tons rice and 374 tons non-rice crops under FWIP over FWOP (Table 8.6).

Table 8.6: Impact on Crop production loss in the Study Area

Sl. No.	Crop Name	Production loss (ton)				% of change
		Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	
1	HYV Aman	420	551	173	-379	-69
2	LT Aman	331	212	83	-129	-61
Total rice		**751**	**763**	**256**	**-507**	**-66**
3	Sesame	263	434	117	-318	-73
4	Water melon	220	120	64	-56	-47
5	Sun flower	8	5	5	0	0
Total non-rice		**491**	**560**	**186**	**-374**	**-67**
Total crop production		**1242**	**1,323**	**442**	**-881**	**-67**

Source: Field information, 2014

c. Irrigated Area

Future Without Project

364. Presently, irrigated area is about 105 ha. The situation would be aggravated under FWOP condition i.e., irrigated area would be about 50 ha. This is happened due to siltation of existing khlas.

Future With Project

365. Irrigated area would be increased due to implementation of interventions (Re-excavation of khals-Ojukhali khal, Batiaghata khal and branches, Kolakola khal, Amtola khal,Kharia khal, Hogolbunia khal, Hania khal andPerbataiaghata Simanar khal) and its proper management. It is expected that, irrigated area would be about 225 ha in FWIP (Map 8.5).

Impacts

366. It is expected that, irrigated area would increase about 175 ha under FWIP over FWOP (Table 8.6).

8.6.4 Fisheries Resources

a. Fish Habitat

Future Without Project

367. Most of the internal khals of Polder 30 are seasonal and silted up. The bed level of these khals are being raised gradually resulting in reduced water depth and causes less suitability of fish habitation. During high tide, saline water intrudes regularly through the mal-functioning of water control structures which is causing the deterioration of the habitat quality. Moreover, the perennial khal including Amtola Khal, Hugolbunia Khal, Khoria Khal, and Botiaghata - Baraiyabad Khal are already encroached by local musclemen for shrimp culture. They are allowing saline water in these khals illegally during dry season which are also causing deterioration of water quality further. Due to such activities, the concentration of salinity in that water bodies would be increased. Khals as well as dependant floodplain habitat would be converted into brackish or saline water prone fish habitat in future. The habitat suitability for fresh water fisheries would be lost. As a result, local people would be interested to practice rice cum prawn/shrimp culture inside the polder instead of agriculture practice. Moreover, the existing eroded embankment near the Garampara village may breach by continuous river erosion caused by wave action. For this reason, overtopping chances and damage to pond dyke of cultured ponds may be increased by tidal flooding. This tidal flood may also cause sand carpeting on the fish pond and thus will make it less suitable for fish habitation. Almost every year, the cultured pond at the Debitola and Amtola area is inundated and the fish are washed out due to heavy rainfalls associated water logging. In FWOP, the vulnerability of cultured pond may be increased. The culture fisheries practice in this area may be declined while floodplain fish habitat would be expanded. It is assumed that the floodplain fish haibitat would be 156 ha (Map 8.4).The further are included Katamari, Ketenangla, Kayemkholar Hula, Debitala, Hantalbunia etc.

Future With Project

368. In FWIP, water depth and surface water availability round the year would be increased for re-excavation of khals. The increased water depth as well as improved water quality would create congenial environment for habitation of different type of fish species at the

excavated khals. Besides, repairing of water control structures would prevent saline water intrusion inside the polder area. Due to prevention of saline water intrusion, fresh water habitat for capture fisheries would be restored. The improved water quality will not only support to grow aquatic vegetation both micro and macrophytes in the internal khals but also will support to habitation and feeding for fisheries resources. Moreover, aquatic plants or vegetation could play an important role in the structure and function of the aquatic ecosystem. The rice cum prawn culture may be increased by 10% in the low land of the polder from the base condition. The further area may include Baruirabad, Hantalbunia, Mathabanga, Hutbunia, Khalisebunia, Aushkhali, Bagildanga and Britti Khalisebunia etc along western part of the polder (Map 8.4). Culture fisheries practiceswould be increased significantly due to reduction of flood risk and salinity. Many culturable pond would be converted into cultured pond.

Impacts

369. Water depth as well as habitat quality will be improved. Saline water prone habitat would be converted into brackish to fresh water fish habitat. The improved habitat will support different types of aquatic vegetation which would be helpful for fish feeding and habitation. Rice-cum prawn culture would be increased slightly.

b. Hatching and Fish Movement

Future Without Project

370. Some particular brackish and freshwater fish species move from river to khal through mal-functioning sluice gate or regulators at some stage for their life cycle to access spawning, nursery and feeding grounds. In FWOP condition, hatchling and fish movement would be facilitated round the year. The driving factors for intensifying the disruption of those movement routes include substantially progressing khal bed siltation leading to reduced water depth, fixing more in-stream barriers like cross fish pata and encroachment in terms of fish culture.

Future With Project

371. Due to repairing of regulators/sluices, the movement of hatchling and brackish and fresh water fish from river to polder area would be obstructed. Movement of brackish water fish species like *Vetki, Pairsa, Chingri, and Bele* etc. which move s on the regular basis during high tidewould be impacted. But internal fish migration would be facilitated for the re-excavation of khals. Beside these, construction of three new inlets (at Deuatola, Dakhin Sholmari and Fultola) will facilitate the fish movement inside the polder area.

Impacts

372. Hatchling movement from river to polder area through water control structures would be obstructed. Some brackish water fish species like *Vetki, Pairsa, Chingri, and Bele* etc. migrate on regular basis during high tide would be impacted. But construction of new inlets would allow the movement of a number of SIS inside the polder area.

c. Fish Bio-diversity

Future Without Project

373. Fish biodiversity in the polder area is moderate. Due to continue siltation in the khals and saline water intrusion through water control structures, brood stock at perennial khals would be depleted in FWOP condition. Some fish species like *Tengra, Koi, Shol, Taki , Puti,*

Shing, Baim would become rare or disappearance from this area due to salinity. Besides, some rare and unavailable fish species like *Ayre, Boal, Roina, Datine, Shing, Magur* may be disappear from the polder area. The fish species composition would be dominated by brackish water fish species.

Future With Project

374. The fish habitat both khal and floodplain would become suitable for fresh water fish species. Thus capture fish species richness would be increased by the small indigenous species (SIS) of fish. It is expected that fish SIS like *Koi, Shol, Taki , Puti, Shing, Baim* would be available in the polder area. Moreover, locally rare and unavailable fish species like *Ayre, Boal, Roina, Datine, Shing, Magur* would be increase along with their abundance. In contrast, brackish water fish species like *Bhetki, Pairsa, Chingri, and Baila* etc are commonly found in the internal khal might be disappeared from the polder area. Due to protection of flood water, culturable fish pond would be converted into cultured pond. Rice-cum-prawn habitat would be dominated by the major and other carps instead of naturally recruited white fish.

Impacts

375. Richness of capture fish species would be increased including small indigenous species (SIS). Brackish water or saline tolerant fish species which are merely found in the polder area would be reduced due to controlling of saline water intrusion round the year.

d. Capture Fisheries Productivity

Future Without Project

376. In the polder area, at present capture fisheries productivity is 165 kg/ha from khals. Due to the ongoing process of siltation in the khal as well as saline water intrusion would cause less suitable for fish habitation in future. The fresh water fish species would disappear from the habitat simultaneously. Due to this reasons, capture fisheries productivity from the internal khal would be reduced about 10% from the base condition under the FWOP condition.

Future With Project

377. Due to re-excavation of khal and repairing of regulators, the capture fisheries productivity would reduce. On the other hand, improved drainage channel would reduce the flood duration in the polder area but water will exist around the year. For this reason fish production would be increase significantly. It is expected that the capture fisheries productivity from khal would be increased about 10 to 15% from the base scenario.

Impacts

378. Habitat quality and productivity will improve. It is expected about (10–15) % of fish production would increase in compare with base condition.

8.6.5 Ecological Resources

a. Habitat Condition

Future Without Project

379. Terrestrial habitat condition will further deteriorate due to intrusion of saline water and riverbank erosion. Aquatic habitat condition will also be worse for continued siltation to khal**s**. In addition to riverbank erosion, natural disaster is also another threat to homestead

vegetation. Malfunctioning of water control structures like regulators causes insufficient drainage and fl*u*shing capacity in this polder area causes vegetation damage. Intrusions of saline water which will deteriorate habitat quality as well as vegetation loss by disrupt continuation of ecosystem services. It is expected that low density vegetation will be enriched while medium density vegetation will be declined slightly (Map 8.5).

Future With Project

380. By controlling saline water intrusion through re-sectioning of embankment and repairing of regulators and flush inlets will reduce salinity in soil. It will enhance vegetation coverage that ultimate improve habitat suitability for species diversity both flora and fauna for viable population to continue ecosystem services. Improvements of drainage system and water conveyance through re-excavation of khals will impacts positively on aquatic habitat. But there may have a negative impact due to illegal intrusion of saline water for improving drainage system and deterioration of freshwater habitat in re-excavated khal area. In future with Project (FWIP) condition, high density vegetation will be increased significantly (Map 8.5).

Impacts

381. Project interventions would improve overall habitat condition in terms of habitat improvement as well as species diversity both flora and fauna in the long run. But there is risk risk of deterioration of freshwater aquatic habitat in re-excavated khals.

8.6.6 Socio-economic Condition

a. Access to Open Water Bodies

Future Without Project

382. Mass people cannot use open water bodies i.e. khals for bathing, washing chores and other purposes due to monopolization of these khals by local power elite. They often use these khals for shrimp cultivation. Without project situation, salinity condition may increase to severe condition like Polder 22 and people's suffering may increase.

Future With Project

383. With the intervention, numbers of families will be benefited. They can use water in different social aspects. Moreover, this would enhance social bonding and cohesion among them.

Impacts

384. The standard of life for 1700 HHs 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. Gender Promotion

Future Without Project

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

Future With Project

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

Impacts

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

c. Quality of Life (Income generation, employment opportunity etc.)

Future Without Project

388. The quality of life regarding income generation, employment opportunities, housing condition and sanitation are still not good. Because they are living under poor economic condition and they have very few options to develop or adapt this condition. Under the future without project situation, these sufferings may remain same or will be deteriorated in future.

Future With Project

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

Impacts

390. Creating new employment opportunities would increase income generation of the people which would ensure betterment and wellbeing that would improve the standard of life. Additional income would bring solvency, steady of the family.

Table 8.7: Impact Assessment Matrix during O & M Phase

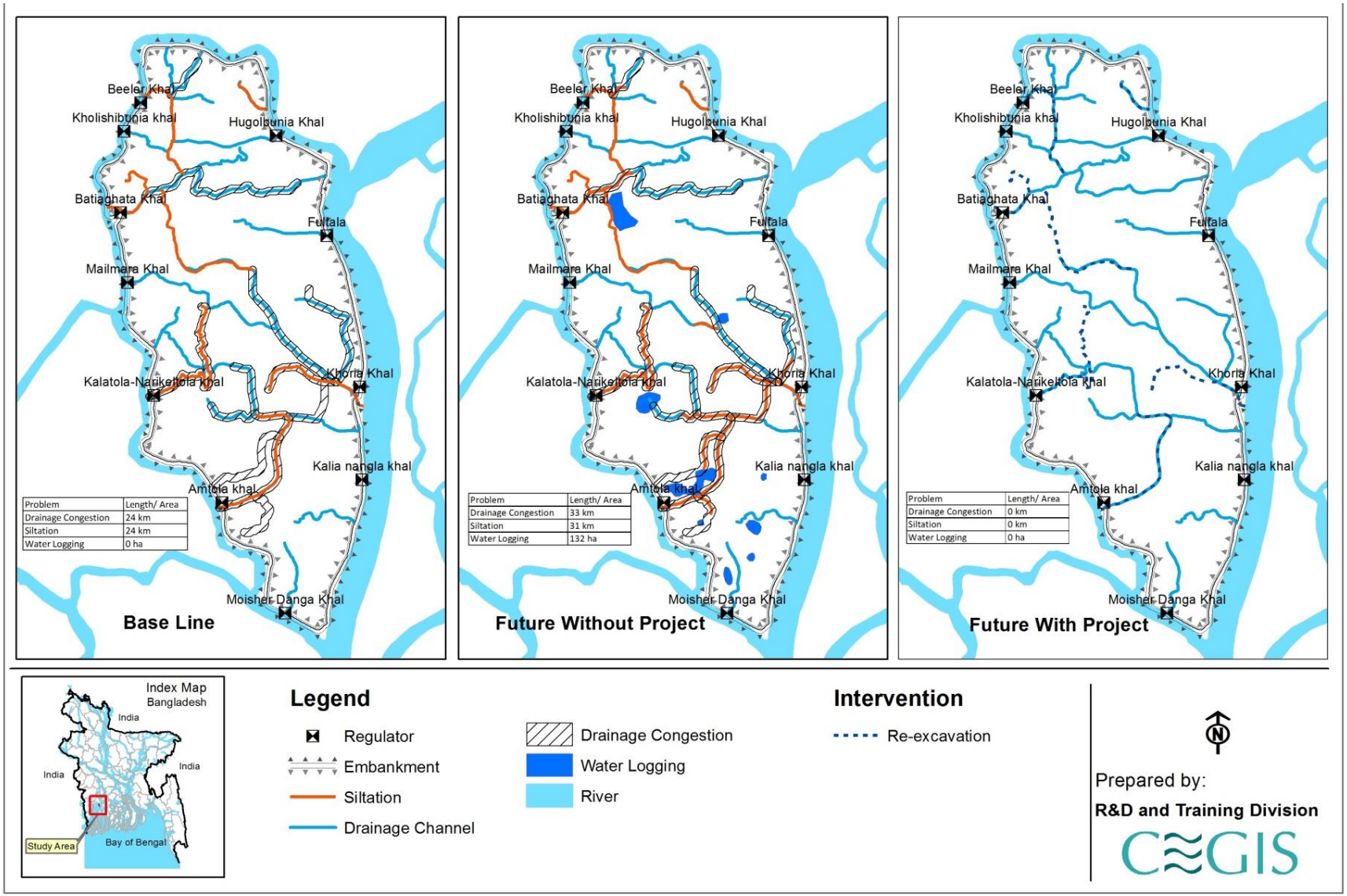
IESC	Baseline	FWOP	FWIP	Impact (+/)/ Magnitude (1-10)
Water Resources				
Saltwater Intrusion	7 ppt salinity levels at 18% primary khals	10 ppt salinity levels at 18% primary khal, and 5 ppt salinity levels at 19% secondary and tertiary khals	If the gates are not properly managed, 10 ppt salinity levels would still arise at 18% primary khals, and 5 ppt salinity levels would emerge at 19% secondary and tertiary khals, and an additional 24% newly re-excavated khals would be subjected to 7 ppt salinity levels	-1
Surface Water Availability	People from Polder 30 cannot serve their multifaceted water requirements and at the same time irrigation during Kharif-I season cannot be provided.	Water availability would be restricted and use of water could be severely constrained.	Around 10% would be benefited from the increased water availability in re-excavated khals	+4
Sedimentation	The internal khal openings are subjected to siltation by both top soil erosion as well as sediment transportation from peripheral rivers.	Sedimentation situation might be further aggravated.	Significant water depths inside the khals of Polder 30.	+2
Erosion	Four erosion hotspots at DakkhinSholmari, KismatFultola, BatiaghataUpazila HQ and Hogalbunia are vulnerable to erosion due to the morphological shift of peripheral rivers	A significant portion of lands might be eroded.	Risk of erosion at the four locations would considerably decrease.	+2
Drainage congestion and	Drainage congestion at 23 km water courses inside the polder,	Around 32 km khals would face more drainage	Drainage congestion in the upstream portions of the khals	+3

IESC	Baseline	FWOP	FWIP	Impact (+/)/ Magnitude (1-10)
water logging	but no water logging.	congestion and 132 ha areas may face water logging problems	would diminish	
Land Resources				
Soil salinity	About 81% of NCA are slightly saline with some moderately saline, 19% of NCA is Moderately saline with some strongly saline in 2009.	It will be the same as base condition or may be deteriorated in the polders if the polder is not implemented.	i. Salinity situation would be decreased due to prevention of intrusion of saline water in the polder area.	+2
Agricultural Resources				
Crop production	Total crop production is 17,134 tons of which rice crop is 8,268 tons and non-rice is t 8,866 tons.	Total crop production would be 15,548 tons of which rice crop would be 9,365 tons and non-rice would be about 9,688 tons.	Crop production would Increase about 23% in FWIP over FWOP.	+4
Crop damage	Rice production loss is about 751 tons and non-rice production loss is 491 tons.	Rice production loss would be about 763 tons and non-rice production loss would be about 560 tons.	Loss of crop production would decrease as follows: Rice: 66% Non-rice: 67% in FWIP over FWOP.	+2
Irrigated area	Irrigated area is about 105 ha.	Irrigated area would be about 50 ha.	Irrigated area would be about 225 ha	+4
Crop production	Total crop production is 17,134 tons of which rice crop is 8,268 tons and non-rice is t 8,866 tons.	Total crop production would be 15,548 tons of which rice crop would be 9,365 tons and non-rice would be about 9,688 tons.	Crop production would Increase about 23% in FWIP over FWOP.	+4
Fisheries Resources				
Fish habitat	Habitat quality is comparatively	• The ongoing siltation	Habitat quality would be improved.	+3

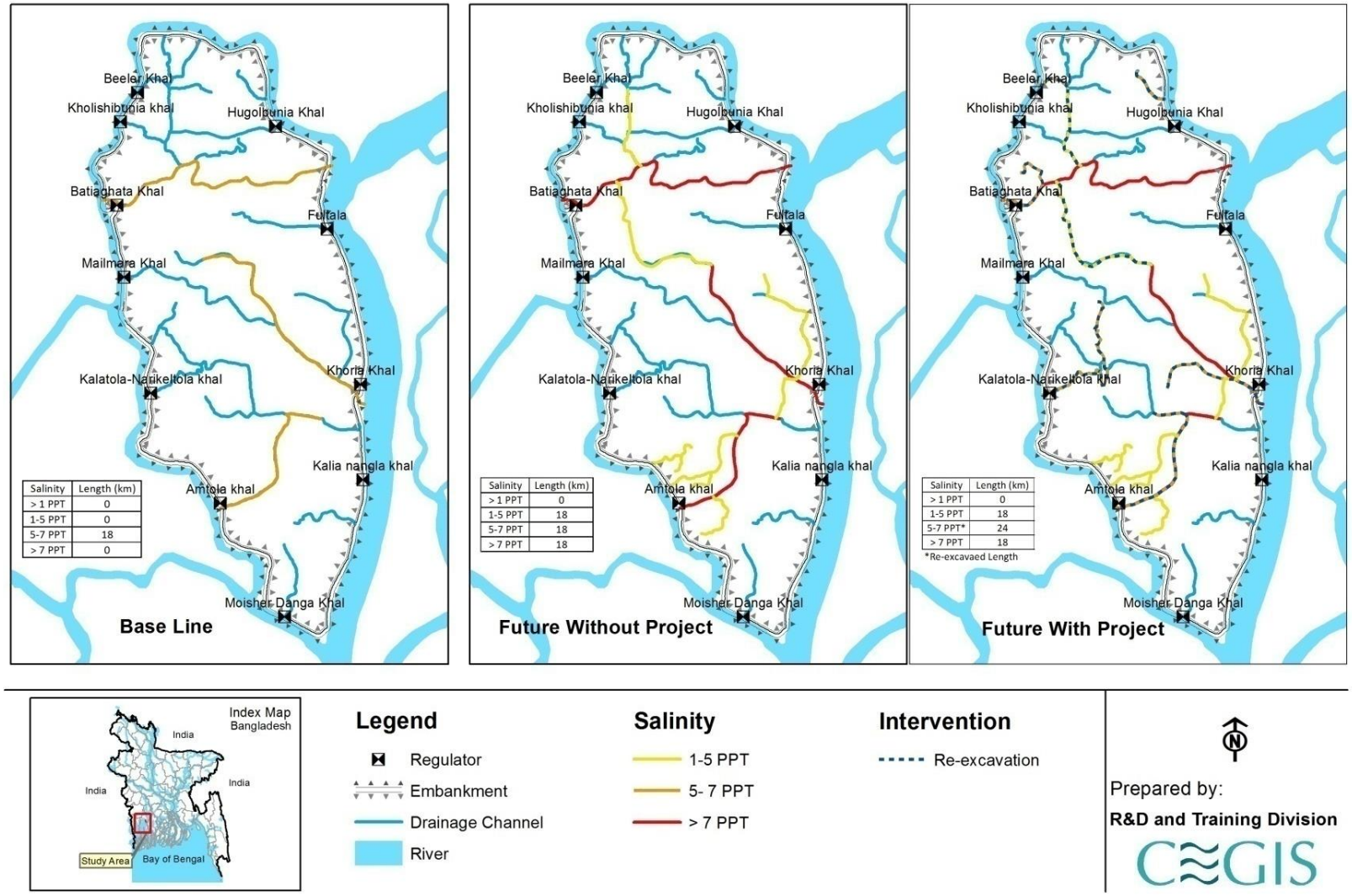
IESC	Baseline	FWOP	FWIP	Impact (+/)/ Magnitude (1-10)
quality	good in the polder area though some pollutants are released from crop fields and are substantially causing damage to fish. Siltation is found one of the major problems of the khals to make the habitat unsuitable for larger fishes.	process, khals bed will be raised, thus reduce the water retention capacity in dry season. • Salinity in the water bodies would be increased. Fresh water fish habitat would be converted into brackish habitat.	That would support different types of aquatic vegetation which would be helpful for fish feeding and habitation.	
Hatchling and fish movement	Medium	Same as base condition	Hatchling migration hampered but increase the fish movement.	+1
Fish Biodiversity	Moderate and 100 nos. of fish species is present.	Decline from the base situation.	Richness of fish species will improve.	+2
Capture Fisheries Productivity	Khal (kg/ha): 165	Khal (kg/ha): 150	Khal (kg/ha): 170	+1
Ecological Resources				
Habitat condition	Moderate	Will deteriorate habitat condition persisting with existing problems in the polder area.	Habitat improvement through proposed interventions.	+2
Socio-economic Condition				
Access to open water bodies	People cannot use water for bathing, washing chores and others purposes due to monopolization of khals by local power elite. They often use these khals for shrimp cultivation.	Under the FWOP situation, shrimp cultivation may increase which would eventually create more salinity in water and agricultural land. As a result people's quality of life will be deteriorated.	With the intervention, numbers of families would be benefited. They would be able to use water in different social aspects. Moreover, this would enhance social bonding and cohesion among them.	+2

IESC	Baseline	FWOP	FWIP	Impact (+/)/ Magnitude (1-10)
Gender promotion	In the polder area only 3 percent female members are working whereas 97 male members are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, the females are mostly vulnerable to distressed and widow who are dependent on others and do not have any definite sources of income. Therefore, under the FWOP situation they will be more vulnerable and become burden to society.	The employment opportunity for women in the construction works and during operation/ maintenance phase can promote them into better life and livelihood.	+3
Quality of life	The quality of life regarding income generation, employment opportunities, housing condition and sanitation are still not good. Because they are living under poor economic condition and they have very few options to develop or adapt this condition.	Under the FWOP situation, these sufferings may be same condition or will be deteriorated in future.	Proposed intervention would improve quality of life. More income opportunity and employment in different interventions would ensure better life and livelihood for stakeholder of the polder.	+2

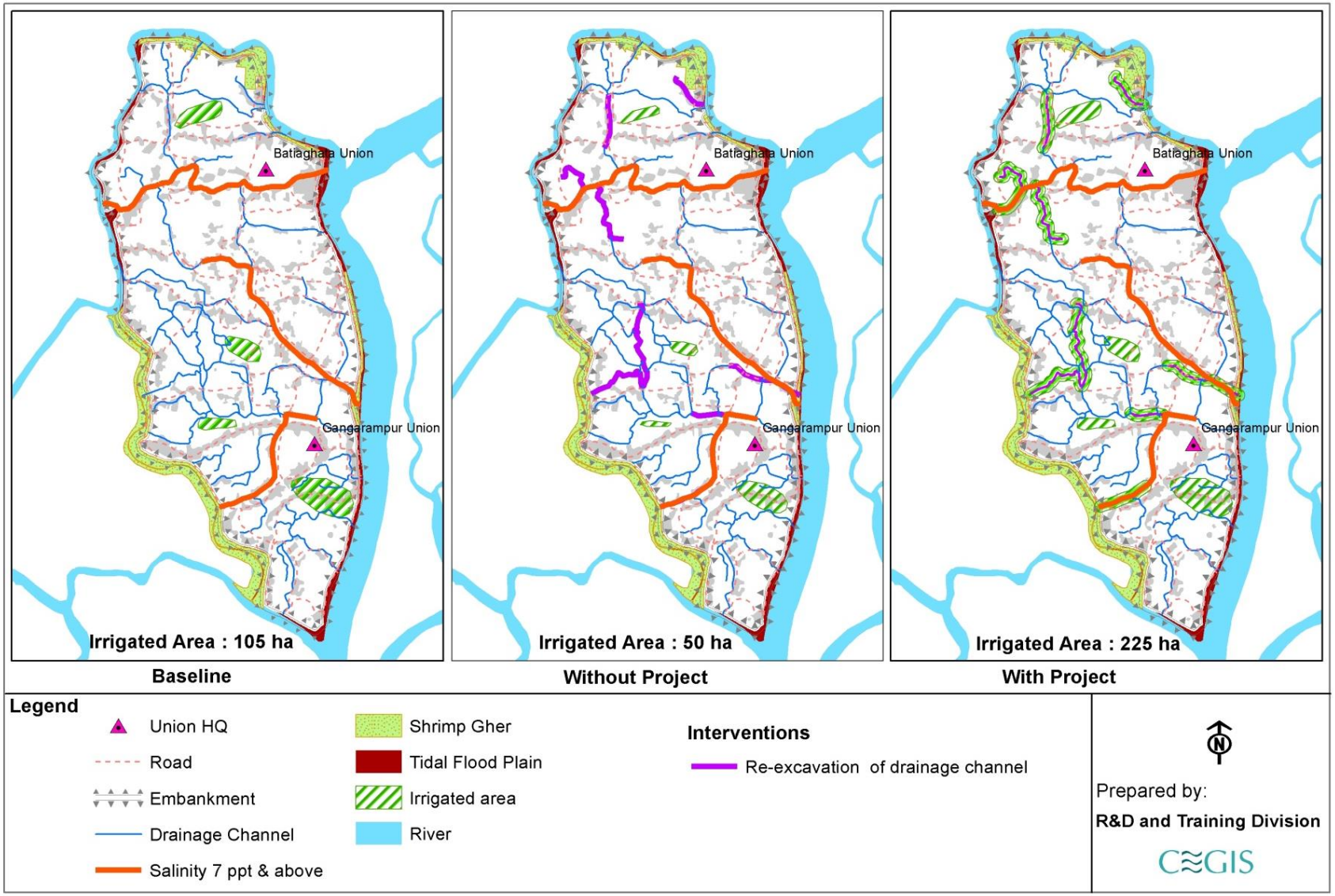
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



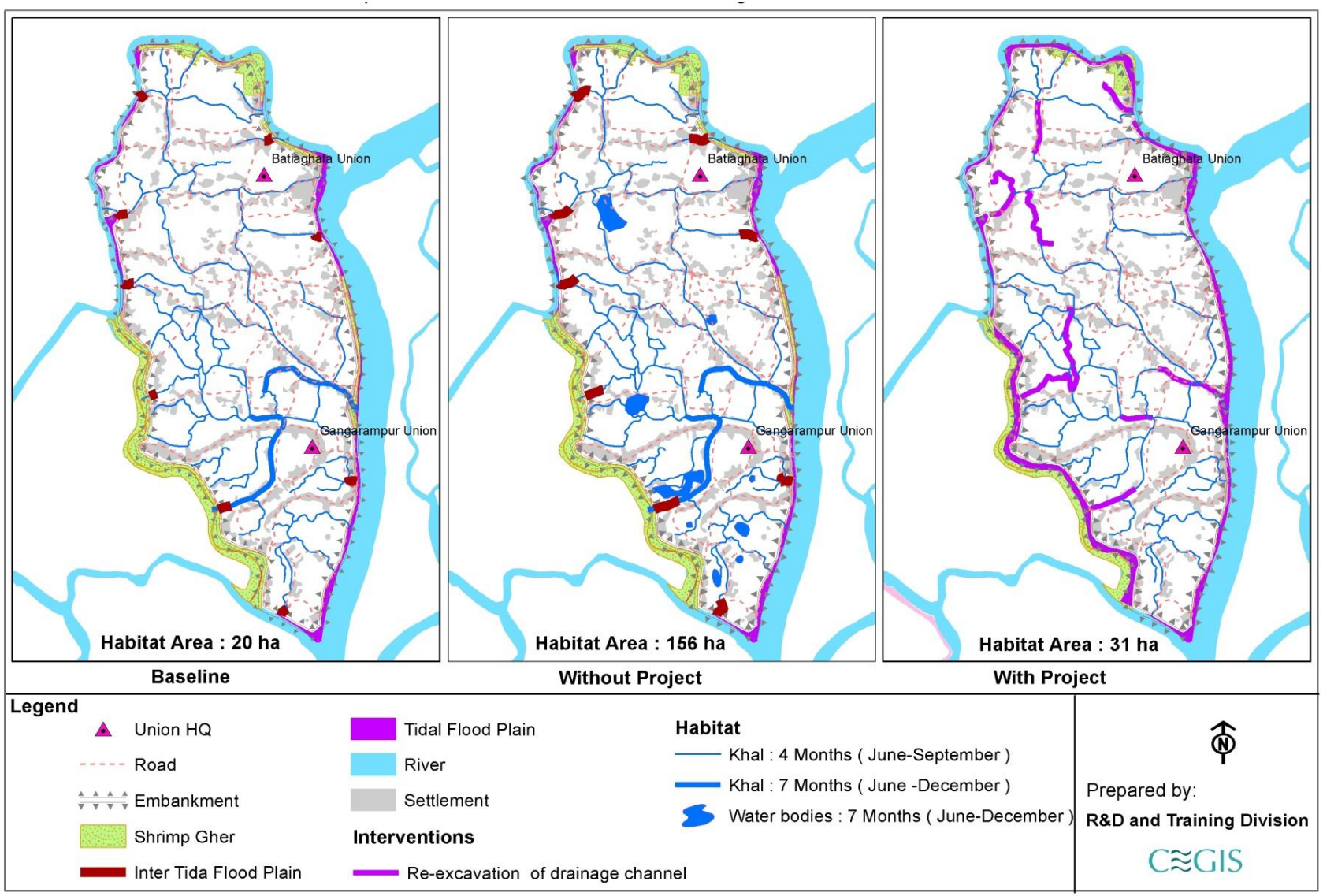
Map 8.1: Impact map of Water Resources in FWOP and FWIP Condition



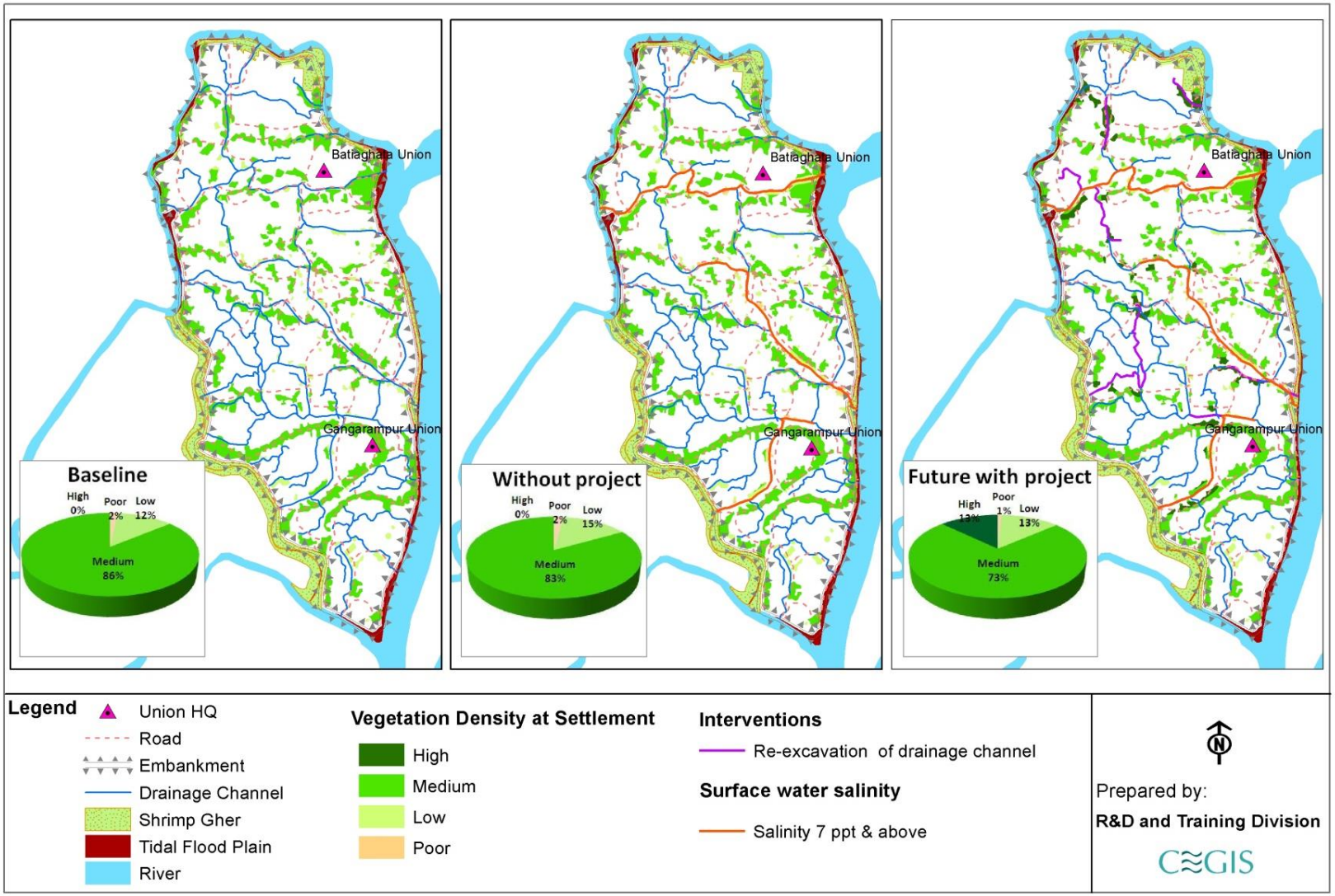
Map 8.2: Impacts on Water Resources in FWOP and FWIP Condition



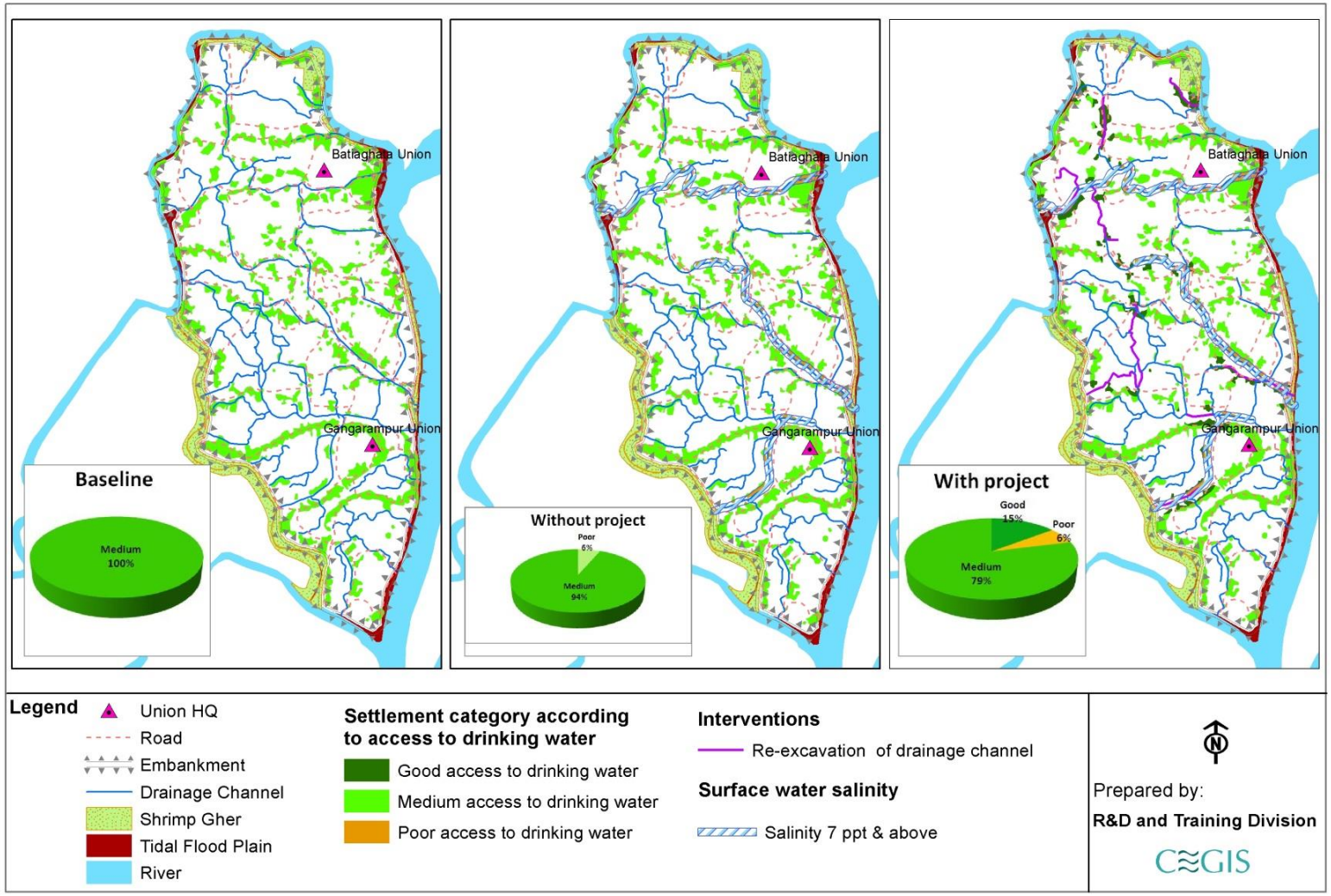
Map 8.3: Impacts on Showing Changes in Irrigated Area



Map 8.4: Impacts on Fisheries Resources showing Changes in Fish Habitat



Map 8.5: Impacs on Ecological Resources showing Changes in Habitat Condition (Terrestrial Vegetation)



Map 8.6: Impacts on Socio-economic Condition showing Changes in Drinking Water Facility

9 Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

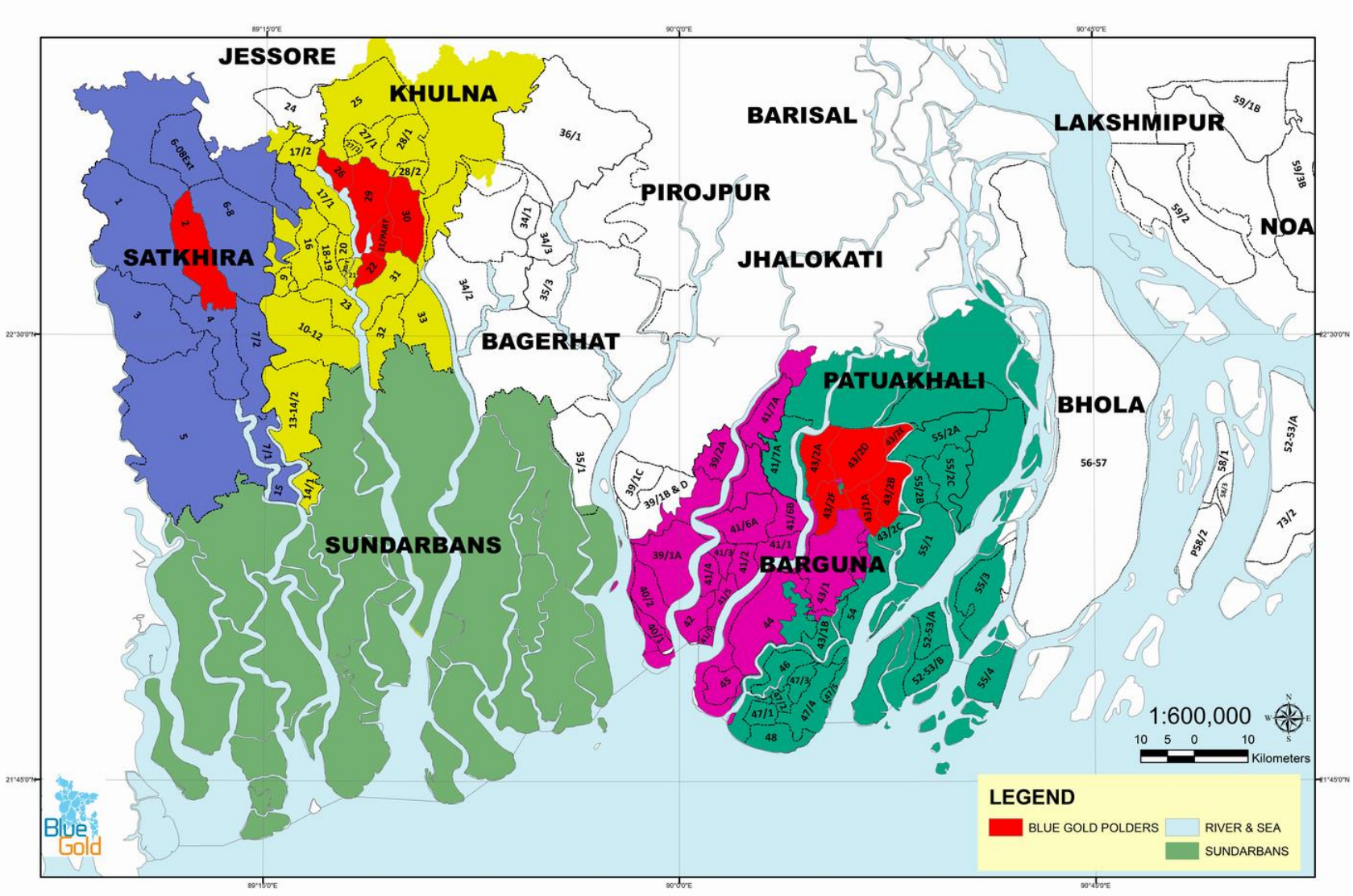
391. This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 30. These effects include cumulative and induced impacts of Polder 30, and the reciprocal impacts of climate change and polder. Cumulative 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 30, 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 30

392. 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, four polders (Polders 29 and 31/part) are located adjacent to Polder 30 and therefore may generate some impacts in future. The existing crest levels of these polders range from 3.50 m to 3.75 m above Mean Sea Level. If re-sectioning works are carried out along the periphery of these polders up to the design elevation of 4.27 m (same as Polder 30), there would be more floodplain sedimentation adjacent to the upstream polders. This may result in increase sedimentation along the Salta-Jhapjhapia river system. With reduced river sections along the upstream, tidal flow velocity might increase in the downstream which would create more pressure along the peripheral embankment of Polder 30. Furthermore, repairing of existing water control structures of Polders 29 and 31/part under Blue Gold program would ensure reduction of dry season flow towards the polders (29 and 31/part). As such, surface water salinity, surrounding the Salta and Jhopjhopia rivers may increase, which might affect the existing river ecosystem, as well as the multifaceted surface water use of Polder 30. Moreover, if any permanent bank protection works are carried out in future in the aforementioned polders (29 and 31/part) under, the morphological behavior Jhopjhopia river may be changed. This might increase risk of river erosion in Polder 30.

9.2.1 Synopsis of projects around Polder 30

393. Apart from Blue Gold interventions, there are some other development projects nearby Polder 30, 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 30, undertaken by different line agencies in Khulna.



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

Table 9.1: List of water management projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
MoWR, BWDB	Construction of Ganges Barrage	To be implemented	Pangsha, Ganges River	High	
MoDMR	Comprehensive Disaster Management Program (CDMP), Phase II	2010-ongoing	Entire country (40 districts with direct interventions)	Low	
BWDB	Projects under Climate Change Trust Fund	2013-ongoing	Entire country	Low	
	Capital Dredging of River system of Bangladesh	2012-ongoing	Entire country	Low	
	Water Management Improvement Project (WMIP)	2010-ongoing	Entire country	Negligible	No WMIP schemes nearby Polder 30
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008-ongoing	Coastal Zone	Negligible	ECRRP polders are far from Polder 30
BWDB	Coastal Embankment Improvement Project (CEIP)	2012-ongoing	Coastal zone	Moderate	
Local					
LGED	Flood Rehabilitation Project in the Area of Rural Development Project-18 (Greater Khulna, Jessore and Kushtia District)	2000-2003	Khulna, Satkhira, Bagerhat	Negligible	
	Greater Khulna District Infrastructure Development Project	2000-2004	Khulna, Satkhira, Bagerhat	Negligible	
	Biodiversity Conservation in Sundarban Reserve Forest.	1999-2005	Satkhira, Khulna, Bagerhat	Negligible	
	Rural Infrastructure Development Project	2008-ongoing	Khulna, Bagerhat and Satkhira	Negligible	
	Union Infrastructure Development Project	2010-ongoing	Khulna, Bagerhat andSathkhira	Negligible	
DoF	Extension of Culture Technology of Marine Shrimp	1997-2004	Khulna, Bagerhat, Satkhira and Cox's Bazar	Negligible	
KCC	Solid Waste Disposal and Environmental Improvement in Khulna City Corporation	1996-2004	Khulna	Negligible	

394. 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 30 are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

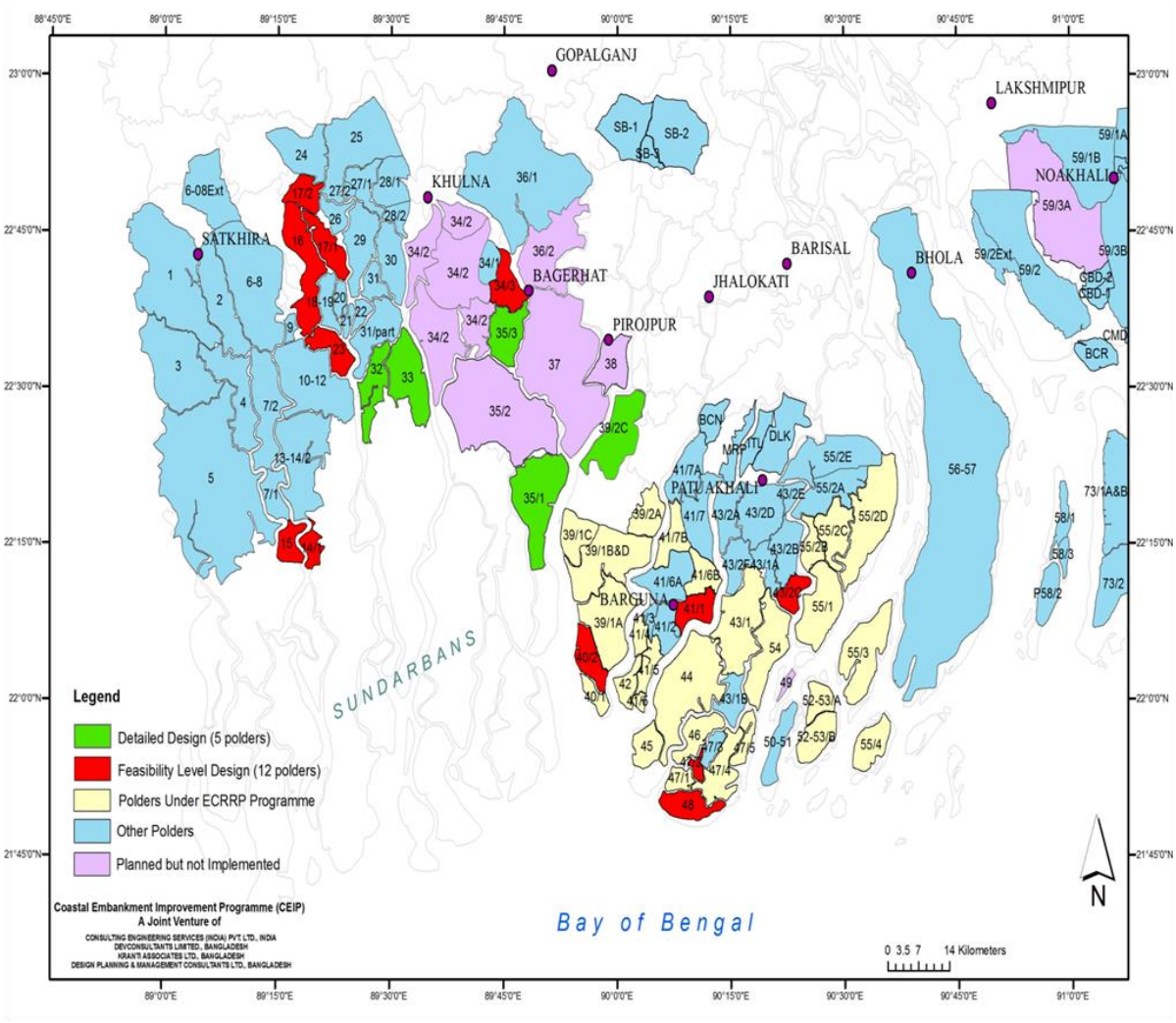
395. Ganges Barrage Project is perhaps the most significant project for the downstream region (coastal zone) of Bangladesh. The project is planned to manage the water resources system, promoting socio-economic development in equitable fashion, and to recover the existing environmental degradation. GoB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

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

397. Polder 30 is located within the GDA, and bears high sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 30 would be the reduction of surface water salinity in its adjoining river system. Dry season water use may be benefited tremendously and more surface water irrigation is expected to increase inside the polder. This would eventually enhance the production and food security of the area. Several saltwater species may face extinction in the long run, creating scopes for new ecological diversities of freshwater tolerant species. On a social context, the effects may be significant as more livelihood shifting phenomena would take place. Existing shrimp farming practices along the polder floodplain may disappear, and the rural livelihood would shift towards enhanced farming practices. More regional and local developments are foreseen, and the environment of the polder may be highly benefited as a whole.

9.2.3 Cumulative Impacts of Coastal Embankment Improvement Project (CEIP)

398. 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

399. Polder 32 and 33 are located within 4 km downstream of Polder 30 along the Passur River. The existing crest levels of these polders range between 3.4 to 3.8 m above MSL. Re-sectioning works are proposed in these polders under CEIP, which would increase crest levels up to 5.27 m (Polder 33) and 5.8 m (Polder 32) above MSL. This increase would reduce storm surge to enter into the polder, and additional storm surge may be diverted towards Polder 30.

9.2.4 Cumulative Impacts of Other Projects

400. As shown in **Table 10.1**, a number of other projects are functioning near Polder 30 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located far away from Polder 30. A synopsis of the minor indirect effects of these projects with **low sensitivity** on Polder 30 is discussed below.

Projects under Climate Change Trust Fund (CCTF)

401. Considering Bangladesh's vulnerability to climate change, GoB decided to finance climate change adaptation initiatives from its own revenue budget as Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation. Up until now feasibility level investigations have been completed for a total number of 30 projects of BWDB, some of which are being implemented throughout the country. The second phase of CCTF is in the pipeline for implementation, with a number of newly

proposed projects. Among all the CCTF projects, the geographic extent of one scheme (rehabilitation works in Polder 31) lies within the vicinity of Polder 30. However, the interventions proposed under the project are localized within the polder and no large-scale embankment re-sectioning works are proposed. Therefore the cumulative effects of the CCTF project in Polder 31 would have negligible influence in Polder 30.

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

402. CDMP was launched by GoB in 2003 as a key strategy to advance combined risk reduction efforts. CDMP ensures established and fully operational Disaster Management Regulatory Framework, strengthened capacities and integration of line agencies and ministries, improved functioning of Disaster Management Committees, effective early warning communication and response in all coastal districts, reduced risks through structural and non-structural interventions etc. There are 16 schemes under CDMP-II in the Dacope and Dumuria upazilas of Khulna district. The schemes are maintained from the Local Disaster Risk Reduction Fund (LDRRF) of CDMP, and are mostly software initiatives which include local level capacity strengthening on Climate Change and Disaster Management. Two of the aforementioned schemes, located in Chalna and Shorafpur unions, are adjacent to Polder 30. Implementation of CDMP has contributed in the overall disaster management preparedness of local people, which in turn have indirectly facilitated their interest and credibility towards implementation of the Blue Gold program.

Capital Dredging of River system

403. 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 30. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 30. But 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 30 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 30 may be further benefited.

9.3 Induced Impacts of Polder 30

404. The interventions in Polder 30 may cause some spatial and temporal effects to a number of environmental and social components near the polder. The following sections entail detail discussions on such components which are to be indirectly impacted. It is to be mentioned here that Polder 30 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

405. The proposed interventions in Polder 30 will safeguard the polder against direct intrusion of tidal water. Therefore, water from Salta, Kazibacha and Jhopjhopia rivers carrying sediments will move further downstream or upstream and may cause induced sedimentation. New morphological changes (i.e. formation of new lands, river course shifting) may be developed as a result along the Rupsa-Passur river system. The river system may be subjected to increased floodplain siltation due to sedimentation in the

upstream reaches and other anthropogenic development caused by Polder 30 (i.e. waste generation, increased fertilizers etc.).

Tidal and Storm Surge Flooding

406. Polders 28/2, 29, 31 and 34/2 are adjacent to Polder 30. As per design, the crest level of Polder 30 would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 28/2, 29, 31 and 34/2) during extreme events. Tidal water may not be able to enter Polder 30 during these events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders. **Table 9.2** below shows the existing average existing crest levels in Polders 28/2, 29, 31 and 34/2. Polder 34/2 is still not developed, therefore, re-sectioning works in Polder 30 would create higher flooding and storm surge risks in the polder.

Table 9.2: Existing Average Crest levels of Polders adjacent to Polder 30

Polder	Existing crest level (m +PWD)
Polder 28/2	3.3~4.1
Polder 29	3.5~3.6
Polder 31	3.5~3.8
Polder 34/2	Not yet implemented

Affect on water quality

407. The interventions in Polder 30 would lead to infrastructural developments, increased settlements and other human induced output. This would generate debris/ waste which may reach the peripheral rivers. Pollution phenomena might increase in the peripheral Rupsa-Passur and Sholmari 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

408. Due to increased floodplain sedimentation outside the polder, aquatic habitat may slightly be affected. Flow cross sections may decrease considerably and spacing for aquatic habitat might change. With the increased flow velocity along the upstream and downstream of the polder, new options for species migration and biodiversities may be opened up. Salinity concentration might increase in the peripheral rivers in future, and the salinity tolerant aquatic species may dominate while fresh water aquatic species may decrease. Biodiversity of aquatic life may also decrease in the Rupsa-Passur River system.

Employment opportunities and Livelihood improvement

409. 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 30, new employment opportunities would be created. This will encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

410. 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 30 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

411. In order to investigate the reciprocal impacts of Climate Change and Polder 30, 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

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

Digital Elevation Model (DEM)

413. 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

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

Discharge and Water level data

415. 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

416. 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

417. 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.

418.

Weather Data

419. 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

420. The 50 percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in **Table 9.3**. The results infer that the monthly rainfall will increase for the period of April to October and decrease for November to March. Around 20% of the monthly rainfall will be decreased by 2050s for December and January though the amount of rainfall is very low during that period. The monthly rainfall will increase by 1.3-3.6% during July to September by 2050s. The monthly temperature will increase by 1.6 to 2.0 ^{0}C with an average of 1.8 ^{0}C by 2050s for the study 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 30.

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (^{0}C)
Jan	-17.1	1.9
Feb	-6.8	1.9
Mar	-2.2	2.0
Apr	5.3	1.9
May	5.4	1.8
Jun	0.8	1.6
Jul	1.5	1.7
Aug	3.6	1.8
Sep	1.3	1.7
Oct	4.1	1.7
Nov	-3.8	1.7
Dec	-19.4	1.7

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

Source: Climate Wizard, Washington University

Sea Level Rise

421. 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

Scenarios	Sea Level Rise (m)
A1FI	0.26 – 0.59

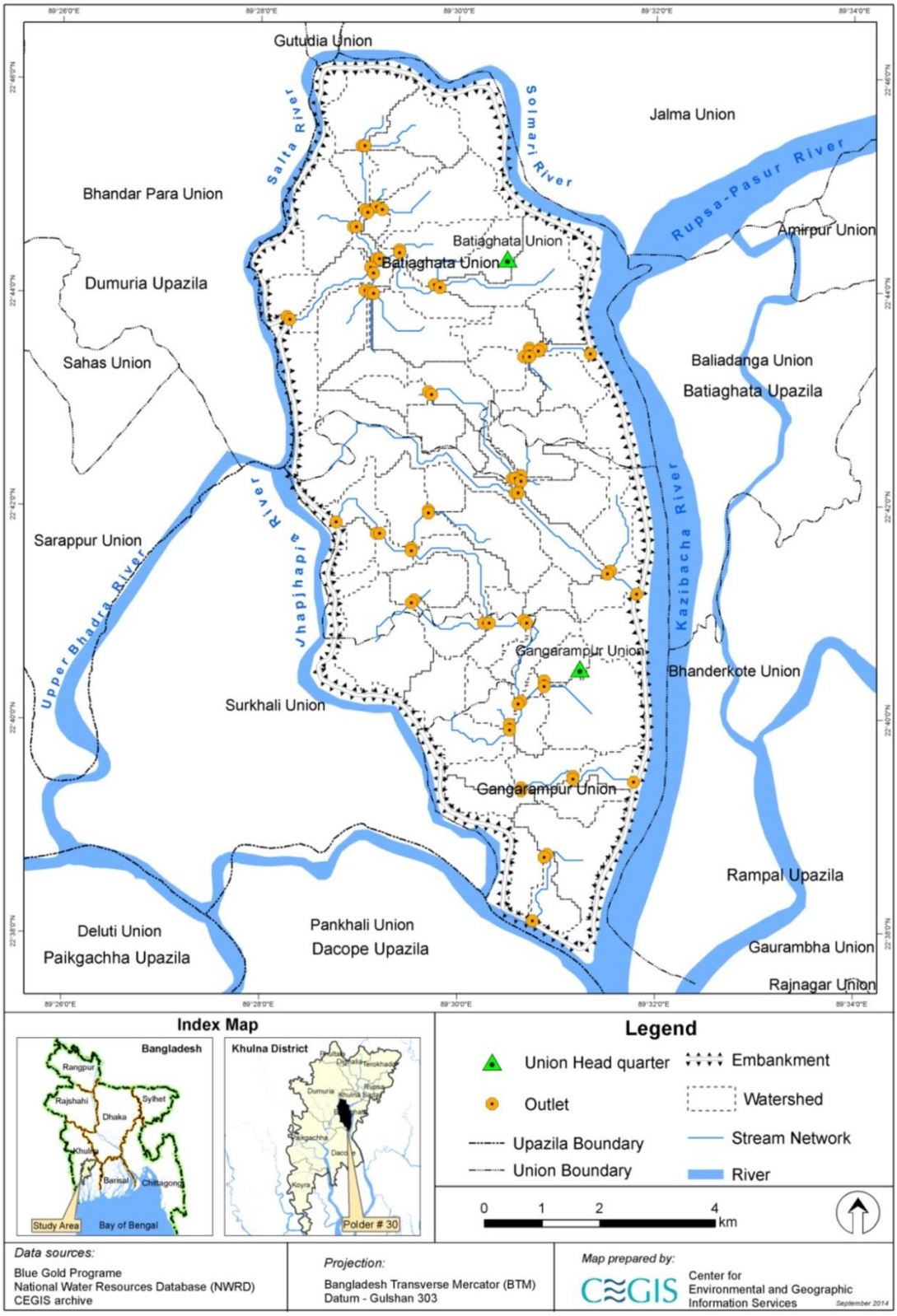
Source: IPCC AR4

9.4.2 Model Schematization

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

SWAT model Setup

423. 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 67 watersheds for the entire polder area. The delineated watershed for polder 30 is given in **Map 9.3**. After the delineation of watershed, the next step of model setup is the definition of HRU. HRU is the unique combination of land use, soil and slope class. Three land classes, five soil classes and 67 watersheds results 302 numbers of HRUs. The daily precipitation, maximum and minimum air temperature data have been used as weather input for the period of 1981 to 2012. The model has been simulated for the period of 1981 to 2012 based on data availability.



Map 9.3: Delineated watershed during model schematization using SWAT for polder-30

Delft 3D model Setup and Calibration

424. A 2-D hydrodynamic model was setup for the Gorai-Passur and Sibsa river system. The schematization of the model is shown in **Figure 9.1**. The model starts from Gorai to the Bay of Bangal. The bathymetry of the river has been generated from the interpolation of available cross-sections at a distance of 100 m using the HEC-RAS model. Daily discharge data of BWDB at Gorai Rail Bridge has been utilized as upstream flow boundary and hourly water level data of BIWTA at Hiron point has been utilized as downstream boundary condition. The model has been simulated with a time step of 10 min for the year 2000 and 2001. It has been simulated for water level, discharge and salinity.

425. The model has been calibrated using Manning's n values for the rivers, against the water level data at Mongla as shown in **Figure 9.2**. The model shows good agreement with the observed water level. It can simulate both high and low water level during the calibration period.

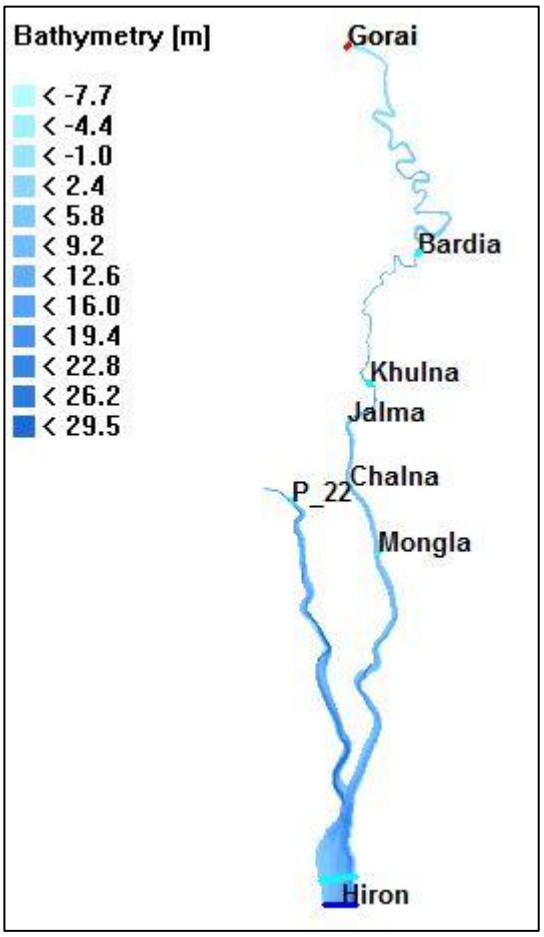


Figure 9.1: Schematization of hydrodynamic model using Delft 3D

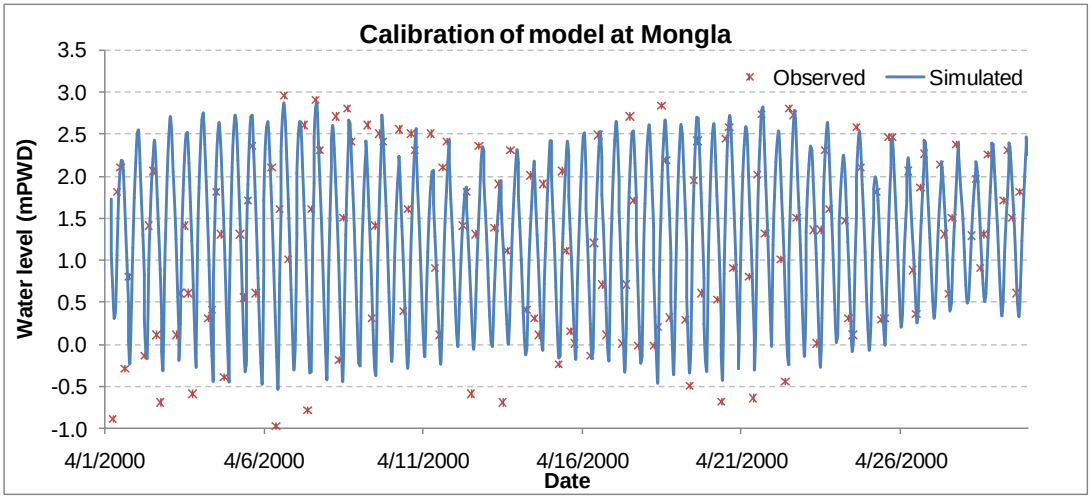
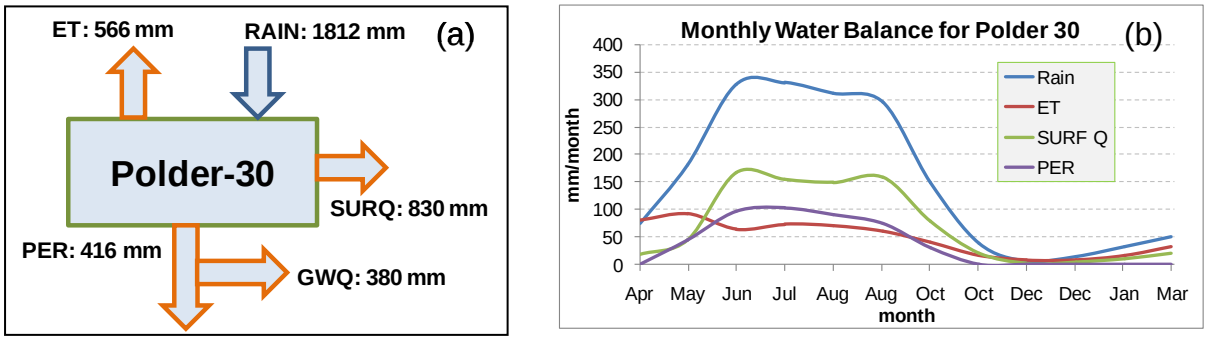


Figure 9.2: Calibration of model results at Mongla for April, 2000

Water Balance of the Study Area

426. 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 30 is shown in **Figure 9.3.**



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

Figure 9.3: Water balance for polder 30, (a) average annual, (b) average monthly during the period of 1981 to 2012

427. The simulation results of the annual water for the polder 30 are shown in Figure for the simulation period of 1981 to 2012. The average annual rainfall of polder 30 is 1812 mm. The monsoon starts from the month of May and reaches its peak in June. There is a decreasing trend of rainfall during the month of July and a tendency of secondary peak during September. The maximum monthly rainfall is about 350 mm for the polder 30.

428. 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 566 mm which is 31 % of annual rainfall. The evapotranspiration is maximum during April and May and which is about 95 mm per month. The evapotranspiration rate is minimum during December to January. The percolation rate for the polder area is 416 mm per year which is 23% of annual rainfall. The percolation rate follows the similar trend like rainfall and the maximum rate is 100 mm per month. After the losses of water through evapotranspiration and percolation, the remaining water contributes to stream flow as overland flow and lateral (subsurface) flow. Around 46% (830 mm) of rainfall contributes to stream flow through surface runoff while the lateral flow is negligible.

9.4.3 Climate Change Impact on Water Availability

429. 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.

430. The climate change impact on annual water balance for the Polder 30 is given in **Table 9.5** for climate change scenario A1B by 2050s. The annual average rainfall for the polder area will be 1846 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 (2 mm/year) which is mainly due to the increase of temperature. There is also a small amount of increase in annual percolation due to climate change.

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

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC 2050s
Rainfall	1812	1846
Surface Runoff	830	860
Evapotranspiration	566	568
Percolation	416	419
Baseflow	380	382

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

432. 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-Apr), the water availability will decrease due to climate change by 2050s. The increase in around 3-10 mm and decrease is around 2 mm per month.

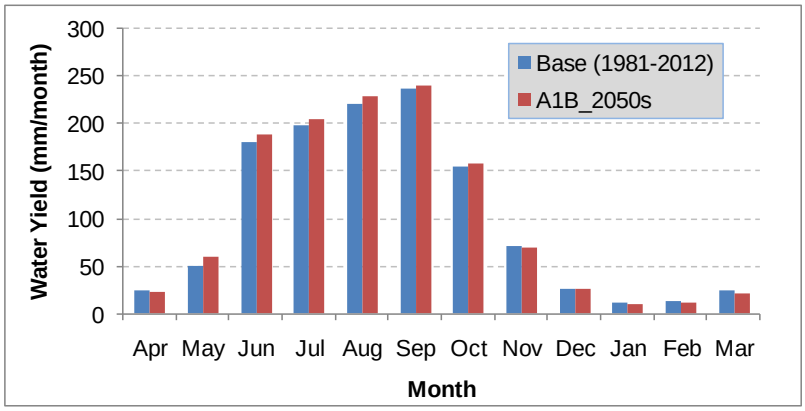


Figure 9.4: Climate change impact on monthly water yield for climate scenario A1B by 2050s

433. **Table 9.6** below show the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows considerable increase in seasonal water yield during monsoon (38.8 %). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

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

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Mar-May)	74	7.9
Monsoon (Jun-Sep)	836	26.6
Post-monsoon (Oct-Nov)	225	3.3
Dry (Dec-Feb)	75	-6.5

9.4.4 Climate Change Impact on Water Level

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

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

436. From the model simulation, it has been found that the flood level adjacent to the polder area will increased by 60 cm for only the increase of sea level and by 7 cm for only the increase of upstream water flow. The combined effect of sea level rise and increase of upstream water results an increase of 70 cm increase of maximum water level of the rivers surrounding polder-30. The increase in flood water level might be a threat for the embankment and it also interrupt the drainage from the inside polder area. The climate change and sea level rise may increase the drainage congestion and flood risk for the polder.

9.4.5 Climate Change Impact on Salinity

437. 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.

438. To assess the impact of climate change and sea level rise on salinity, the delft 3D model has been utilized. It has been assumed that the dry season flow of the Gorai River will be reduced by 15% and 0.5 m of sea level rise has been considered for the scenario model setup. The model has been simulated for those two assumptions and the result has been compared with the base condition. From the simulation, it has been found that the salinity

level of the rivers adjacent to the Polder 30 will increase by 1.0 ppt during the dry period. The increase in river salinity may cause the increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.6 Climate Change Resilience Developed in Polder 30

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

10 Environmental Management Plan

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

10.1 Water Resources

10.1.1 During Pre-Construction Phase

441. There is no water resources impact in the phase.

10.1.2 During Construction Phase

442. There is no waterresources impact in the phase.

10.1.3 During O & M Phase

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

Table 10.1: EMP Matrix for O & M Phase on Water Resources

Impact	Mitigation Measure	Enhancement/Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
IESC: Saltwater Intrusion				
Sluice gates are intentionally kept open during dry season which would cause minor negative impacts at around 60% of the existing khals,as salinity values might reach a level of 10 ppt in 18% primary khals, 5 ppt in 19% secondary and tertiary khals and 7 ppt in around 23% re-excavated khals.	Closing the repaired sluice gates during dry season, to prevent tidal water	Not required	+6	WMC
IESC: Surface Water Availability				
Around 10% people inside Polder 30 would be guaranteed sufficient surface water availability, and this would result in immense benefits in water use for both domestic and pre monsoon irrigation purposes	Not required	Not required	-	-
IESC: Sedimentation				
Increased depth of khals and minimal sediment transportation inwards Polder 30 during these periods	Not required	Closing the repaired sluice gates during dry season, to prevent tidal water	+4	-
IESC: Erosion				
The four locations at Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ and Hogalbunia would be temporarily protected from erosion.	Not required	Not required	-	-
IESC: Drainage Congestion and Water Logging				
Around 32 km lengths of the existing khals would be benefited from reduced drainage congestion and 132 ha areas would be protected from probable water logging problems.	Not required	Re-excavation of Jhopjhopia river along the polder	+6	-

**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 During Pre-Construction Phase

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

10.2.2 During Construction Phase

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

10.2.3 During O & M Phase

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

Table 10.2: EMP Matrix for O & M Phase on Land Resources

Impact	Mitigation Measure	Enhancement/ \Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Salinity situation would be decreased due to prevention of intrusion of saline water in the polder area.		• Intrusion of saline water need to be stopped through smoothing functioning of regulators and strengthening of embankment with the involvement of WMGs/WMA/WMF • Dissolved salts have to be washed-out by rain water from the surface soil through sluice gate during monsoon season. • Drainage system should be strengthening for proper functioning with the involvement of WMGs/ WMA/ WMF	+4	BWDB, DAE, WMGs/WMA /WMF
a. Hydrologic regime will improve if the interventions are implemented according to		• Formation of WMGs/WMA/WMF strengthening through imparting training need to be done. Involvement of WMGs in project	+3	BWDB, DAE and WMGs

Impact	Mitigation Measure	Enhancement/ \Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
the design (re-excavation of Khal, earth work in repair/re-sectioning/protection of embankments and repair of sluice/irrigation inlet/drainage outlet).		activities (maintenance of embankment, functioning of regulators, etc) would improve the climate change induce impact. • Crop rotation with leguminous crops, application of more organic materials, organic manure, and green manuring and soil management should be practiced to improve soil fertility in the project area. • Crop diversification with 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 During Pre-Construction Phase

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

10.3.2 During Construction Phase

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

10.3.3 During O & M Phase

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

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

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
It is expected that crop production would increase by rice 30% and non-rice 16% 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 project activities would enhance crop production. • Introduction of HYV crops cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE, BADC and WMGs/WMA /WMF
It is expected that crop production loss would decrease as follows: Rice: 66% 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 crops from re-excavation of Khal and re-sectioning/ repair of embankment works/protection work of embankment and development on farm water management etc.	+4	BWDB, DAE, BADC and WMGs/WMA/ WMF
It is expected that irrigated area would be expanded about 225 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 During Pre-Construction Phase

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

10.4.2 During Construction Phase

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

Table 10.4: EMP Matrix for Construction phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
• Temporary loss of feeding ground and unavailability of fish feed for bottom dweller. Turbidity of water would be increased. But after one (1) year the habitat quality of fish will be improved. • Intertidal floodplain fish habitat would be decreased. • Fish habitat especially for Cuchia, baim, Chingri, Baila would be impacted significantly due to re-excavation.	• 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 be more depth about 0.5 m than the normal design to protect the fish brood.	N/A	-2	Contractor, BWDB, Department of Fisheries (DoF)

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

10.4.3 During O & M Phase

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

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

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Water depth increase and habitat quality would be improved. Saline water pronehabitat would be converted into brackish to fresh water fish habitat. The improved habitat quality would support different types of aquatic vegetation which would be helpful for fish feeding and habitation.	NA	• Awareness development on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area. • Apply IPM in agriculture field for protection of capture fish habitat quality.	+2	Department of Fisheries in coordination with WMC
Hatchling movement from river to polder area through regulators /sluice gates would be obstructed. Some brackish water fish species include Bhetki, Pairsa, Bagda Chingri, Baila etc migrates in regular basis during high tide that would be impacted.	NA	• 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.	+2	Department of Fisheries in coordination with Water Management Committee
Richness of capture fish species would be increased fish species composition would be changed.		• Avoid fish culture in different khals. • Release native rare and unavailable fish species in excavated khals • Awareness development on natural resources, camping against	+2	Department of Fisheries in co-ordination with Management Committee

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
		indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area.		
Capture and culture fish production from khals would increase about 10 % from the base condition.		• 100 m (Deep area) of each re-excavated khal should be kept as non fishing zone for brood fish protection. • Training on fish culture should be provided and pond demonstration and monitoring activities should be implemented in the polder area. • Ensure pure strain and native fish species for aquaculture in pond culture.	+3	Department of Fisheries in co-ordination with pond owners.

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

10.5 Ecological Resources

10.5.1 During Pre-Construction Phase

453. There will be no impacts in this phase.

10.5.2 During Construction Phase

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

Table 10.6: EMP Matrix for Construction Phase on Ecological Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Activity: Re-sectioning of embankment				
• Herbs, shrubs, various type of grass, bushes will be temporary damaged due to soil dumping for re- sectioning work;. • Relocation of wild fauna due to habitat loss temporary	N/A	N/A	-1	Contractor and BWDB
Activity: Construction of flashing inlet				
Babla (22) trees, shrubs and herbs will need to be cut due to construction of water control structures ;	• Plant trees along the slopes of embankment after earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-2	Contractor and BWDB
Activity: Temporary bank protection				
• Minor damages to the vegetation of embankment slopes during earthwork activities; • Deterioration of aquatic habitat condition due to placement of geo-bags	N/A	N/A	-1	Contractor and BWDB
Activity: Re-excavation of Khal				
• Disturbance to existing aquatic habitat which would impacts negatively to wildlife e.g. Egret;	• Keep untouched the deepest points of the khal as much as possible;	N/A	-3	Contractor and BWDB

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
• Damage of existing bank-line vegetations due to dumping of soil	• Create new habitat adjacent to the existing habitat before going to re-excavation of khal; • The works should be completed in scheduled time to minimize habitat disturbance to wildlife			

**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

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

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

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Terrestrial and aquatic habitats improvement	N/A	• Plant native mixed trees along the embankment slopes wherever possible to enhance green coverage • Adequate and proper maintainanceshould done to the proposed interventions after implement ion by local people.	+3	BWDB and DoE

10.6 Socio-economic Condition

10.6.1 During Pre-Construction Phase

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

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

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Employment opportunities	-	- Ensure employment opportunities that all local skilled manpower get chance in work before construction period	+3	Blue gold and BWDB
Quality of life (income generation)	-	- Ensuring Engagement of local labor and paying proper wages.	+2	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).*

10.6.2 During Construction Phase

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

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

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Employment opportunities	-	- Local labor should be recruited for the construction work of the project area.	+4	Blue gold and BWDB
Quality of life	-	- 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
Quality of life (income generation)	-	- Ensuring Engagement of local labour and	+2	Blue gold and

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
		paying proper wages.		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

**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 During Post-Construction Phase

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

Table 10.10: EMP Matrix for O & M Phase on Socio-Economic Condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Employment opportunities	-	- Ensure/arrange training from DAE and DOF for local people.	+3	Blue gold and BWDB
Access to open water bodies	-	- About 1700 no of HHs will be benefited from current intervention i.e. they can use sweet water in different social sectors. - Concentration should be paid to re-excavate rest of Khals for ensuring equity and share of open water bodies.	+4	Blue gold and BWDB
Communication	-	- Existing rural road requires repair and carpeting the new embankment as well as properly maintained.	+3	Blue gold and BWDB
Gender promotion	-	- At least 40% of total labor should be recruited for these interventions work and ensure more gender promotion in different	+3	Blue gold and BWDB

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
		sectors of present interventions of the polder.		
Quality of life	-	- It is expected that income generation and employment opportunity would ensure better quality of life of the polder. - Initiate different income generating activities for better life and livelihood of the people.	+2	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)

459. 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

460. Polder 30 of Blue Gold program entails excavation of a number of khals which would generate a volume of around 1,77,000 m^3 of spoil. This volume should be temporarily stored on the Khal openings to block the entry of flow. The rest should be used for different purposes before commencing the actual dumping process. The public consultation meetings of the EIA study inferred that the local people are willing to collect the excavated spoil earth for their own household uses. **Figure 10.1** provides a framework which includes the major components of the proposed Spoil Management Plan for rehabilitation of Polder 30 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.

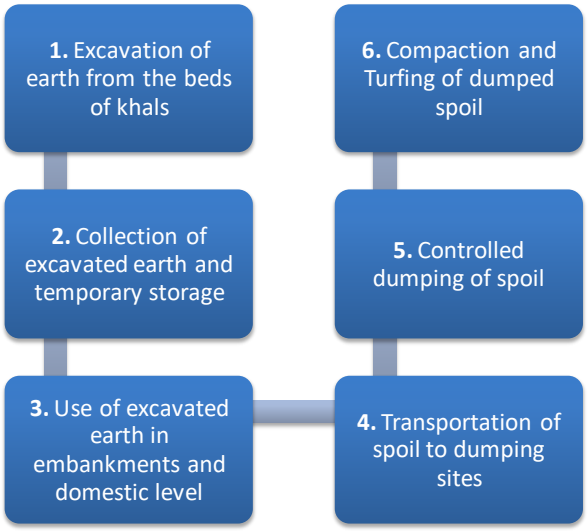


Figure 10.1: Framework for Spoil Management Plan

461. **Table 10.11** below provides a tentative account of the voluPme of excavated earth, and its multifaceted uses proposed in the Spoil Management Plan. Around 45% of the excavated earth (80,500 m^3) can be used in embankment re-sectioning works. The rest should then be made available for local people for their multifaceted uses. Local people can collect a portion of the excavated spoil, and use it to fulfill their domestic requirements. The spoil may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Spoil may also be collected and used on community basis to strengthen the basements and earthen portions of other rural sheds and shelters such as mosques, community clinics etc. It is expected that around 9,500 m^3 spoil would be collected by for different uses. The residual portion (around 87 thousand m^3) of spoil may then be disposed on both in a controlled manner.

Table 10.11: Tentative volume calculation and distribution of excavated spoil

Khals to be Excavated	Volume (m^3)	Uses of Excavated Soil	Volume (m^3)
Amtola Khal	33,800	Embankment Re-sectioning	80,500
Botiaghat-Simana Khal	36,930	Societal uses (uses in household, mosques, clinics or other shelters requiring earth materials)	9,500
Hania Khal	18,400		
Hugolbunia Khal	10,410		
Khoria	41,200		
Kolatola-Narikeltola Khal	21,000		
Uzukhali Khal	15,260	Dumping	87,000
Total Excavation	**1,77,000**	**Total Use**	**1,77,000**

10.7.2 Phase wise activities of Spoil Management

462. 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.

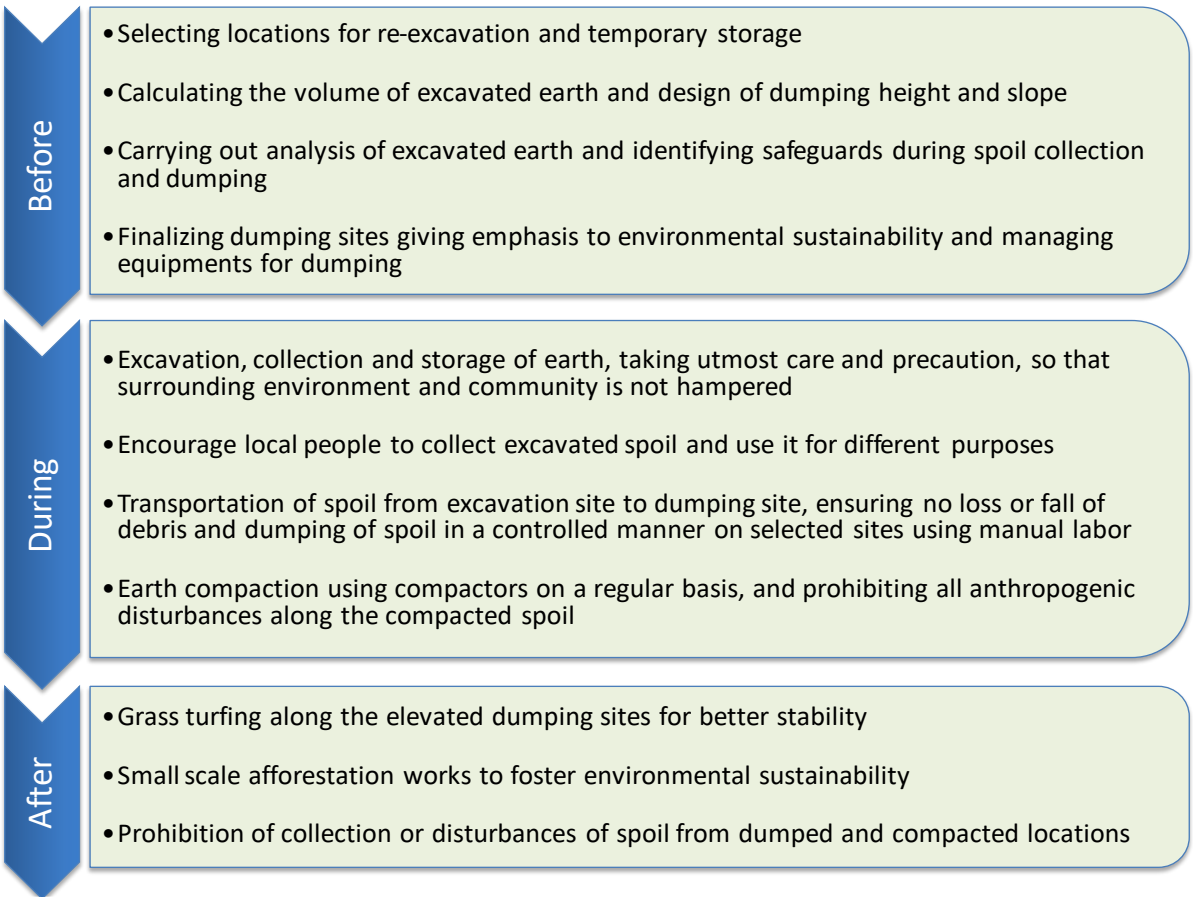


Figure 10.2: Phase wise activities of Spoil Management

10.7.3 Method of Spoil Dumping

463. The proposed re-excavation works for Polder 22 would require dumping of a significant amount of spoil (around 87 thousand m^3). For a 3 meter wide and 1 meter thick wedge, this equivalents to around 29 km length of dumped spoil. Polder 30 includes 18.05 km of re-excavation of khals, and if the residual spoil (87 thousand m^3) is dumped on both sides of the excavated khals up to a height and width of 1 m and 3 m respectively, around 14.5 km lengths can be used on both sides. **Figures 10.3** and **10.4** below show the conceptual layouts of proposed dumping technique.

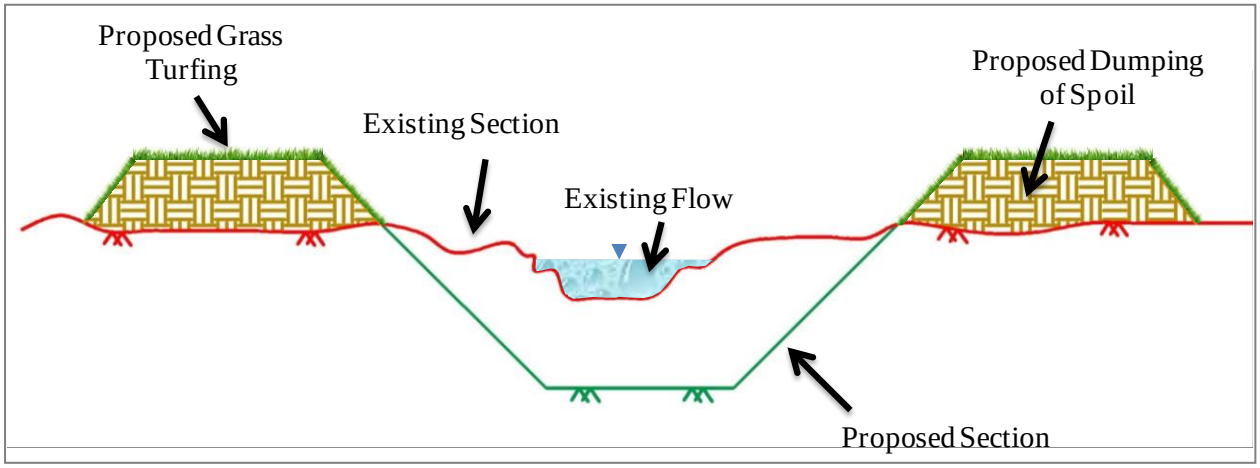


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

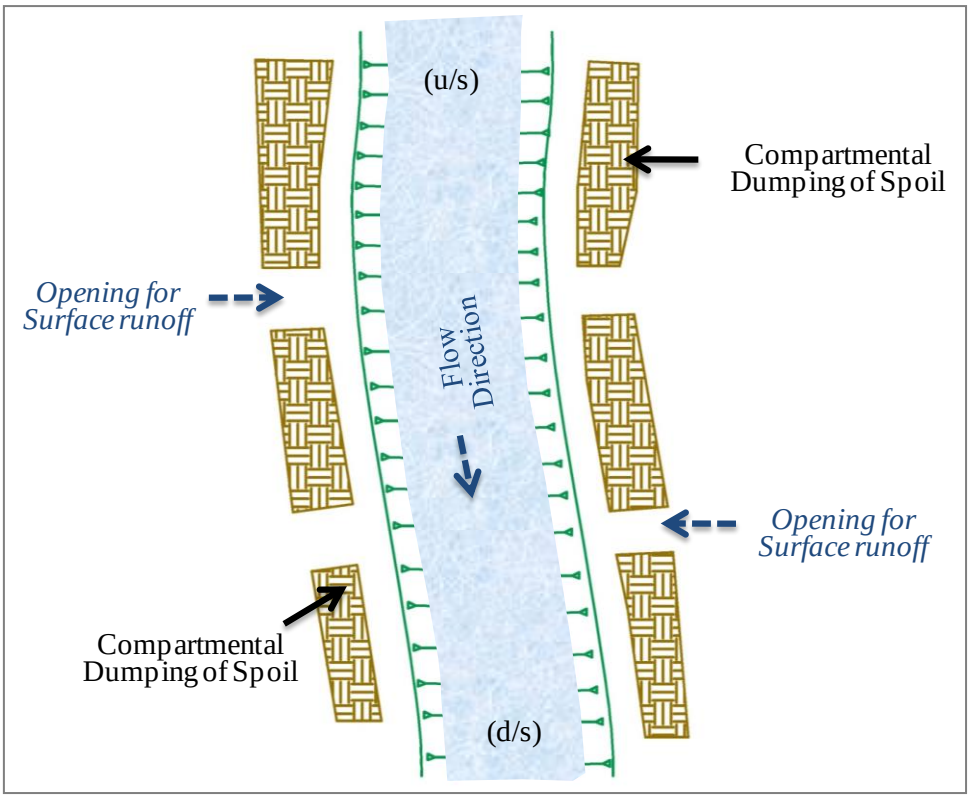


Figure 10.4: Plan Form of a Typical Khal to be Re-excavated

464. **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

465. 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

466. 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 30.

10.8.2 Monitoring Plan for Construction Phase

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				8	Disrupt road communication			
2	Inconsistencies or mismanagement in embankment re-sectioning works				9	No earth spoil collection from crop land			
3	Compaction of earth materials on embankment				10	Top-soil protection system from borrow pit area			
4	No pollution from construction site				11	Ensure participation of women labour			
5	Inconsistencies in water control structures repairing works				12	Presence of child labour			
6	Any threat caused to river bank area				13	Safety dress, helmet and field boots used			
7	Obstruction of fish migration route				14	Social conflict between local and outside labour			

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

C.NON COMPLIANCE:

Period Description : **Class**

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

D.CIRCULATION

1)Concerned official designation**, Donor name** 2) **DG**, DoE 3) Concerned official designation, Client 4) **Concerned official designation**, Local Office

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

Land and Agricultural Resources

Indicator	Method	Location	Frequency	Responsible Agency
Re-excavation of Khals and dumping of spoil earth materials on the existing embankment and re-sectioning/ repair of embankment works/ protection work of embankment	Field observation	Entire project area	7 days interval during constructionperiod	Contractor, WMGs and BWDB

10.8.3 Monitoring Plan for O & M Phase

467. In the post-construction phase, monitoring plan of each sectors constitutes of some indicators. The following tables showing the indicators of each sectors along with methods to be followed, location where necessary, probable frequency and responsible agency who would monitor those indicators.

Water Resources

Indicator	Method	Location	Frequency	Responsible Agency
Surface water salinity	In-situ testing	All the khals inside the polder	Once in a month (from December to May)	BWDB
Depth of khals	Field survey (e.g. boat and led method)	All the khals inside the polder	Once in a dry season and once in a wet season	WMOs and BWDB

Indicator	Method	Location	Frequency	Responsible Agency
Water Logging	Field observation	Inside the polder	Once in dry season and once in post-monsoon	WMOs and BWDB
Erosion	Field observation	Throughout the peripheral embankment of Polder 22	Once in a week (during monsoon and post-monsoon)	WMOs and BWDB
Operation of Sluice Gates	Field observation	All sluice gates in Polder 30	Once in a week (dry and pre-monsoon seasons)	WMOs and BWDB
Method of Pumping for draining out water from Polder	Field observation	All sluice gates in Polder 30	Frequently during monsoon season (following any major rainfall events)	WMOs and BWDB

Land and Agricultural Resources

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

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible Agency
Species diversity and richness of fish	Catch monitoring/ observations and local fish market survey.	Three 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	BWDBand DoE
Wildlife occurrence	Direct observation and public discussion	At proposed construction sites	Once before earthworks and half-yearly basis for 5-year monitoring plan	BWDBand DoE

Socio-economic Condition

Indicator	Method	Location	Frequency	Responsible Agency
Employment opportunities	RRA and observation	Whole polder area	Twice in a year	Blue gold and BWDB
Quality of life	Union wise Public consultation/RRA during post project phase	villages within the polder area	Once in a year	Independent social monitoring institute along with Blue gold and BWDB contractors
Gender Promotion	Village wise RRA/ FGD	Periphery within the polder	Every year	Blue gold
Social use of water	Village wise RRA/ FGD	Whole polder	Every year	Blue gold
Communication	Observation	Dakkhin Sholmari, Kismat Fultola, Batiaghata Upazila HQ, and Hogalbunia of polder 30 area	Once in a year	LGED, BWDB and Blue gold

10.9 EMP and Monitoring Cost

468. The following sections will provide the detail cost of environmental management plan and also monitoring cost.

10.9.1 Water Resources Monitoring Cost

469. To cinduct water resources environmental monitoring plan, an amount of taka two lakh (BDT 2.00 lakh) would be needed.

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	1.50	1	Re-excavation of Khals and disposal of spoil	0.75

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
	through imparting training on re-excavation of Khals. • Embankment management Group (EMG), landless Contacting Society (LCS), on farm water management and development etc. • Involvement of WMGs in project activities would change positively.			earth materials for spoil management and re-sectioning/ repair/ protection work of embankment etc	
2	• Organic manure should be applied for the restoration of soil fertility; • Farmers group should have close contact with DAE for adaptation of various measures on IPM/ICM; • Irrigation should be provided in optimum level with minimum conveyance loss; • Involvement of WMGs in project activities would enhance crop production. • Introduction of HYV crops with crop diversification need to be practiced.	2.00	2	Crop production	0.75
3	• The constructing materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land as far as possible. • Dumping of spoil earth materials on non-agricultural land. • WMGs/WMA/WMF should be involved in the construction and post construction phase which might reduce crop damage.	1.00	3	Crop damage	0.50
4	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area • The WMGs/WMAs/WMFs should be involved in the	1.00	4	Irrigated area	0.50

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
	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.				
	Total	**5.50**			**2.50**

470. Total Cost for EMP and Monitoring = 8.0 Lakh Taka

10.9.3 EMP and Monitoring Cost for Fisheries Resources

Sl. No.	EMP Measure	Cost (Lakh Tk)	Sl. No.	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.	1.5	1	Fish hatchling movement in three khals (Two year).	0.5
2	Transfer of improved fish culture technology to the pond owner and demonstration of pond on improved fish culture in the polder area. 4 or 5 pond about 100 decimal areas. First year demonstration and next year monitoring.	1.5 (Training 1.0 Tk and demonstration pond 0.5 Tk)	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	1.5
EMP Cost		**3.0**	**Monitoring Cost**		**2.0**
Total cost		**5.0**			

471. Total Cost for EMP and Monitoring = 5.0 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.	5.00 (Gross amount)	1	Habitat suitability	3.00
			2	Wildlife diversity	4..00
	Total	**5:00**		**Total**	**7.00**

472. Total Cost for EMP and Monitoring = 12.0 Lakh Taka

10.9.5 EMP and Monitoring Cost for Socio-economic Condition

	Pre-Construction	Construction	Post Construction	Total/ Lakh Tk.
Total Monitoring cost	-	-	4.90	4.90
			Total	**4.90**

473. Total Cost for Monitoring = 4.90 Lakh Taka

10.10 Summary of Cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost
Water Resources	2.00	-	2.00
Land and Agricultural Resources	5.50	2.50	8.00
Fisheries Resources	3.00	2.00	5.00
Ecological Resources	5.00	7.00	12.00
Socio-Economic Condition	-	4.90	4.90
Grand Total	**15.50**	**16.40**	**31.90**

474. Total EMP and monitoring cost is BDT 31.90 (Taka Thirty One Lakh and Ninety Thousand) only.

11 Conclusion and Recommendations

11.1 Conclusion

475. The gross area of Polder 30 is 6,455 ha, with a Net Cultivable Area (NCA) of 4,240 ha (66%). The proposed intervention works include re-excavation of khals, repair of water control structures and culverts, and temporary bank protection works.

476. Implementation of the proposed work plan will partially prevent salt water intrusion in the polder area, surface water would be available for domestic and irrigation purposes, sedimentation transport would be reduced and overall drainage congestion would be improved. Besides, temporary bank protection works would protect the polder area from further erosion.

477. After implementation of the proposed intervention, crop production would increase by 23%. Loss of rice crop production would decrease by 66% and loss of non-rice crop production would decrease by 67%. Total irrigated area would be about 225 ha. Overall fish habitat quality would be improved which would support different types of aquatic vegetation. Capture fisheries productivity would increase to 170 kg/ha. Overall habitat condition would be improved through the proposed interventions.

478. The proposed intervention would improve the quality of life. More income opportunity and employment in different interventions would ensure better lives and livelihoods for the stakeholders of the polder. The employment opportunity for women in the construction works and during the operation/ maintenance phase would also ensure better lives and livelihoods for them.

479. The following EMP measures will minimize the negative impacts and enhance the positive impacts which will be generated by the proposed interventions:

EMP Measures for Negative Impacts

- Re-excavation should be avoided during fish migration period e.g. from May to August.
- Spoil should be dumped outside the khal area.
- Re-excavation should be implemented segment-wise and one after another to protect indigenous fishes and other aquatic creatures.
- At least 100 m of each khal should be deeper by 0.5 m than the normal design to protect fish brood.
- Trees should be planted along the slopes of embankments after earth works.
- Construction activities should not be run in early morning and night to avoid disturbance to wild fauna;
- The works should be completed in scheduled time to minimize habitat disturbance to wildlife;
- The deepest points of the khals should be kept untouched to the extent possible;
- New habitat should be created adjacent to the existing habitat before re-excavation of khals.

EMP Measures for Positive Impacts

- Repaired sluice gates should be closed during dry season to prevent tidal water from entering the area.
- Dissolved salts must be washed-out by rain water from the surface soil through sluice gate during monsoon season.
- Crop rotation with leguminous crops, application of more organic materials, organic manure, and green manuring and soil management should be practiced to improve soil fertility in the project area.
- Crop diversification with multiple-crops might improve soil fertility.
- Organic manure should be applied for the restoration of soil fertility.
- Irrigation should be provided at optimum level with minimum conveyance loss from khals.
- Awareness should be developed on natural resources along with campaign against indiscriminate fishing and reinforcement of fisheries laws and regulations in the polder area.

11.2 Recommendations

- Local communities should be made involved in operation and maintenance of the structure for ensuring sustainability of the interventions.
- Gate operation rule should strictly follow to ensure that sufficient water is retained in the internal khals.
- Monsoon period should be avoided for implementation of the proposed interventions, especially from May to July which is very crucial for fish migration.

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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)	Labour (No/ha)	Pesticide (No. of spray)	Land preparation (Tk/ha)
Note: Name of pests and pesticides:								

Irrigation

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

Crop production constraints (including land degradation)

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

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

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

Feed and Fodder

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

Diseases

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

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

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

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

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

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

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

Fish Migration				Fish Biodiversity		Species List					Species Composition				
						River	Khal	Beel	Pond	Other	Group	River	Khal	Beel	Pond
Pattern	2.			Significance							Grass carp				
	3.										Tengera				
	4.				Unavailable:						Chapila				
	5.										Others				

Post Harvest Activities		Fishermen Lifestyle	
Fish edible quality:		Socio-economic Status of subsistence level fishermen:	
Source of pollution in each habitat:		Socio-economic Status of Commercial fishermen:	
Seasonal vulnerability:		Other conflict (with muscle men/ agriculture/ other sector/laws):	
Ice factory (Number, location and name):		Fishermen community structure (Traditional/Caste/Religion)	
Landing center, whole sale market, other district markets, etc.:		Traditional fishermen vulnerability (Occupation change/others):	
Storage facility (number, location and name):		Existing Fisheries Management	
Fish market (Number, location and name):		Fishermen Community Based Organizations (FCBOs):	

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

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

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

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

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

Ecological Data Collection Form

Environmental Studies for Blue Gold Program

EDate		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**

Common Species	Rare Species	Extinct Species	Exotic Species

Major Terrestrial fauna

Species Name	Habitat1	Food Habit2	Breeding Time	Status3	Migration Status4

1 Habitat: 1= Homestead forest, 2= floodplains, 3= wetlands, 4= river

2 Habit: 1=Herbivore, 2= Carnivore, 3= Both

3Status: 1= Very common, 2=Common, 3= Rare, 4= Very Rare

4 Migration Status: 1= Local, 2= Local Migratory, 3= Migratory

Aquatic Ecosystem

Wetlands and types of aquatic habitat (specify, area per type, flooding depth etc)

Name of wetland	Type of Wetland7	Area in ha		Flooding depth (m)	Connectivity with river		Importance8
		Seasonal	Perennial		from	to	

1= Open water wetlands, 2= Rivers, 3= Estuarine and mangrove forest, 4= Beels and haors, 5= Floodplains, 6= Closed water wetlands,

7= Ponds, 8= Baors (oxbow lake), 9= Brackish water farms

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

Aquatic flora

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

Species name	Type1	Abundance2	Growing period	Utilization9

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

[8] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[9] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

Species name	Type1	Abundance2	Growing period	Utilization9

1 1=Submerged, 2=Free floating, 3=Rooted floating, 4=Sedges, 5=Marginal

2 1= High, 2= Moderate, 3= Low

31=food; 2=fuel; 3=medicinal; 4=fiber/thatching; 5=Bio-fertilizer 6=others (specify if any)

Aquatic Fauna

Species name	Status1	Species name	Status1
Amphibians			
Reptiles			
Birds			

Species name	Status1	Species name	Status1
Mammals			
1=Very common, 2=Common, 3=Occasional, 4=Rare			

Present status and negative impacts on flora & fauna

Impacted Species	Existing Status	Cause of impact

Anticipated impacts on flora and fauna due to project activity (according to people opinion)

Victim Species	Anticipated Impact	Cause of impacts

Necessity of wildlife management practices (According to people's opinion):

☐ Yes ☐ No

How	

Ecosystem Services

Type of Service	Estimated Cost/House	Total Cost in project Area	Grand Total Cost
Fuelwood			
Timber			
Fruit production			
Thatching			
Fodder			
Bio-fertilizer			
Other			

Presence of Important Ecosystem (If any)

Important Ecosystem	Name	GPS Coordinate/waypoint
Ecologically Critical Area		
Important Bird Area		
Reserve Forest		
Natural Forest		
National Park		
RAMSAR Site		
Wildlife Sanctuary		
Game Reserve		
Eco-park		

Note (If any):

SOCIO-ECONOMIC BASELINE DATA COLLECTION

Checklist for Rapid Rural Appraisal (RRA)

Environmental Studies for Blue Gold Program

Facilitation Information

Name of Facilitator	
Date of Facilitation	

Project Information

Name of Project	
Gross Area (ha.)	
Net Area (ha.)	

Study Area

Mauza	
Union/Ward	
Municipality (if any)	
Upazila/Thana	
District	

Educational Institution

Sl. No.	Type of facility	Nos. of Institution	Type of facility	Nos. of Institution
1	Primary School		Ebtedayee Madrasha	
2	High School		Dakhil Madrasha	
3	College		Alim/Fazil Madrasha	

Note: The category “Primary School” includes only Government Primary School (GPS) and Registered Non-government Primary School (RNGPS)

Disease Prevalence

Ranking by Incidence	Name of Disease	Ranking by Incidence	Name of Disease
1		6	
2		7	
3		8	
4		9	
5		10	

Note: If the facilitator can collect disease profile from the Upazila Health Complex then this question could be skipped

Health Facilities

Sl. No.	Type of Facility	Number of Facilities
1	District/Sadar Hospital	
2	Upazila Health Complex	
3	Union Sub-Center	
4	Union Family Welfare Center	
5	Community Clinic	
6	Private Health Clinics/hospitals	
7	Other (if any)	

Peripheral Health Facilities (if any)

Number	
Name	
Description/status	

Sources of Treatment Facilities

Sl. No.	Source of treatment facilities	Percentage of Households Received
1	Trained physician	
2	Paramedic/diploma physician	
3	Quack doctor & informal treatments	
4	No treatment facilities at all	

Electricity Coverage

Sl. No.	Type of facility	Percentage of Households
1	Grid	
2	Solar	
3	Biogas	
4	Other (if any)	

Note: Percentage of households covered by grid electricity will be cross-checked with the data given in the Population and Housing Census 2011 of Bangladesh Bureau of Statistics

Income and Expenditure

Range (Tk./month)	Percentage of Households	
	Expenditure	Income
Less than 1,000		
1,000 - 2,000		
2,000 – 5,000		
5,000 - 9,000		
9,000 - 20,000		
More than 20,000		

Labor and Wage

Type of Activity	Male Labor		Female Labor	
	Availability (put √)	Daily Wage (Tk.)	Availability (put √)	Daily Wage (Tk.)
Farming	H M L		H M L	
Non-Farming	H M L		H M L	

Note: H=High; M=Medium; L=Low. Farming activities include agricultural activity and Non-farming activities include earthwork, brickfield work, construction work etc)

Self Assessed Subsistence Poverty

Sl. No.	Poverty Status	Percentage of Households
1	Deficit	
2	Balance/Breakeven	
3	Surplus	

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

Sl. No.	Lands Type	Sale Value (Tk./per acre)
1	Homesteads land	
2	Agricultural land	
3	Commercial Land	
4	Others (if any)	

Disaster and Damage (in last five years)

Most Prevalent Disasters	
Ranking by Incidence	1) 2) 3) 4) 5)
Tangible loss due to Disasters	
Intangible loss due to Disasters	
Impacts on Households	
Impacts on Livelihood	
Proposed Mitigation	

Note: These data will be cross-checked with the multidisciplinary information

Migration Trend

Type of Migration	Out Migration		In Migration	
	Place of destination	Number/ Percentage*	Place of origin	Number/ Percentage*
Seasonal Labor migration				
Permanent Household migration				

*Percentage of migration will be applicable in case of seasonal labor migration; whereas number will be applicable in case of permanent migration of households

Professional/occupational Conflict

Type of Conflict	
Reasons of Conflict	
Area	
Groups engaged in conflict	
Proposed solutions	

Miscellaneous

Particulars	Number	Name	Brief Description
Ethnic Community			
Vulnerable Community			
Cultural Heritage Site			

Particulars	Number	Name	Brief Description
Common Property Resources			

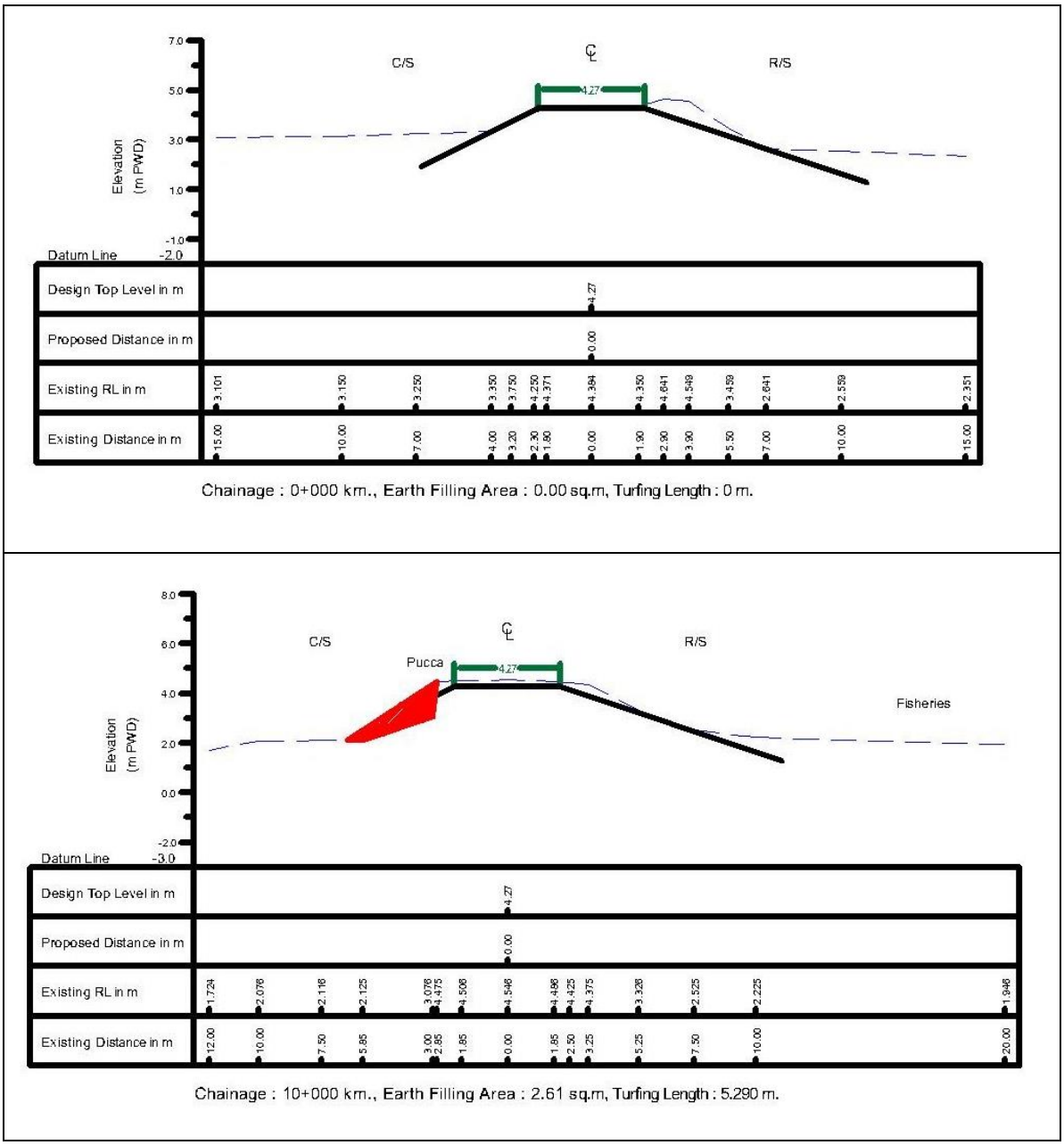
Profile of RRA Participants

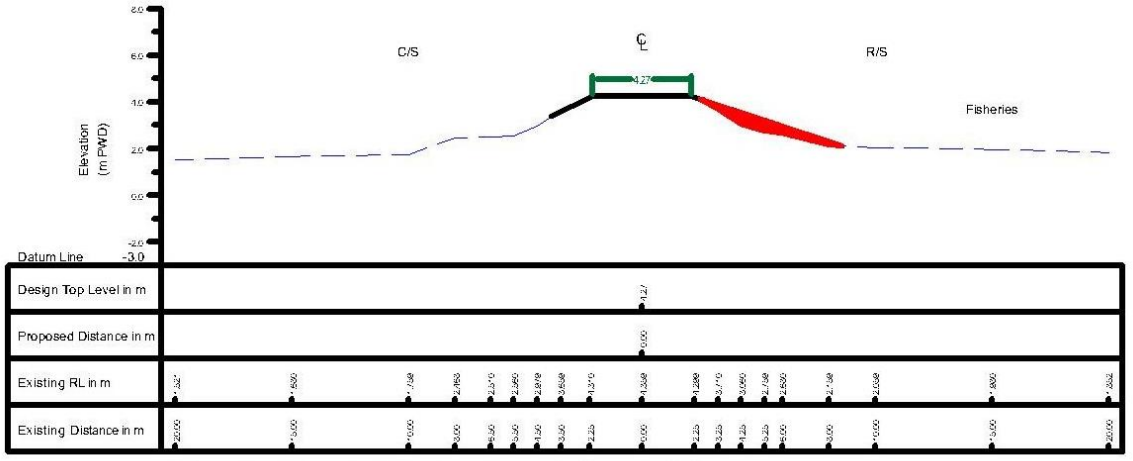
Name	Age	Occupation	Address/ Mobile no.

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

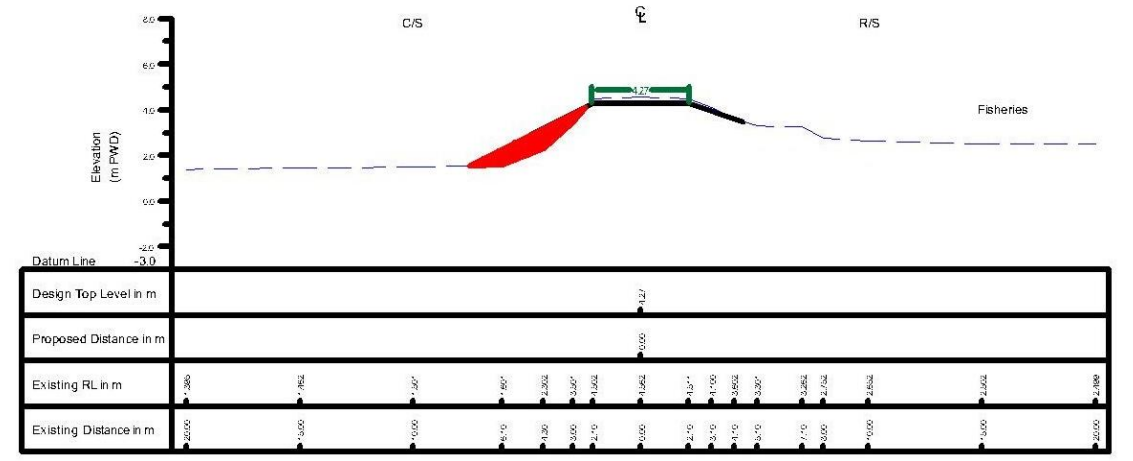
Appendix -2: Cross Section of Emabankment and Khal Re-excavtion

(a) Selected Cross-sections of Embankment Works

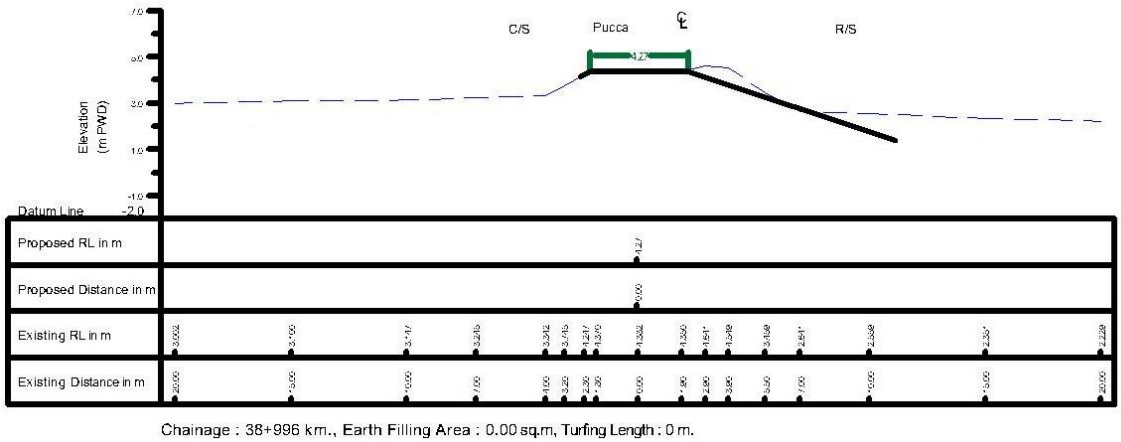




Chainage : 20+000 km., Earth Filling Area : 1.70 sq.m, Turfing Length : 6.360 m.

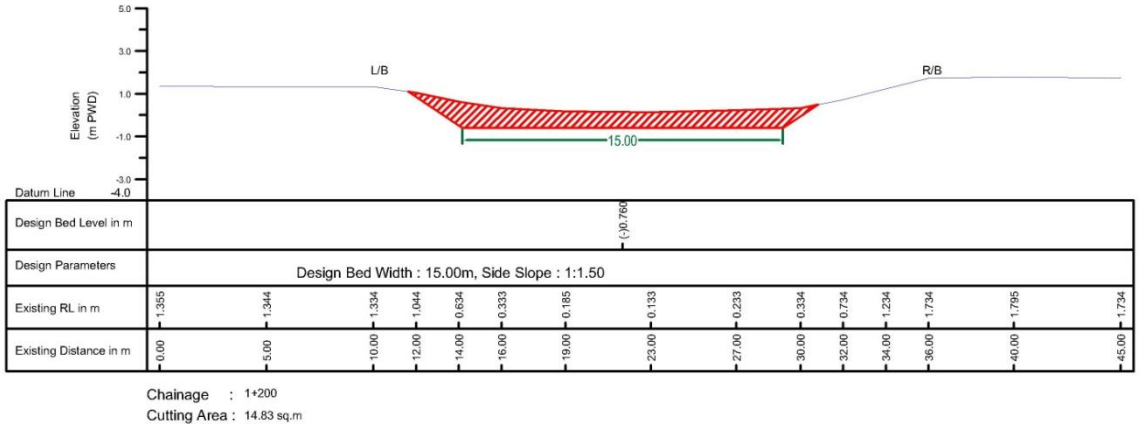


Chainage : 30+000 km., Earth Filling Area : 2.80 sq.m, Turfing Length : 5.700 m.

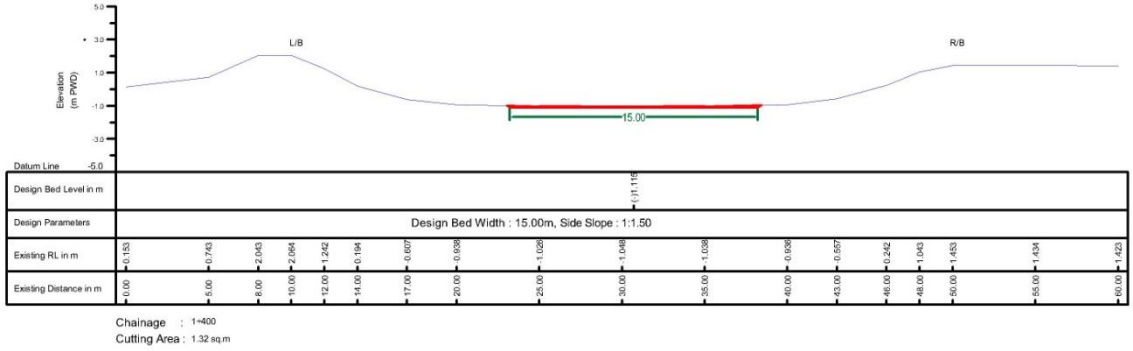


Chainage : 38+996 km., Earth Filling Area : 0.00 sq.m, Turfing Length : 0 m.

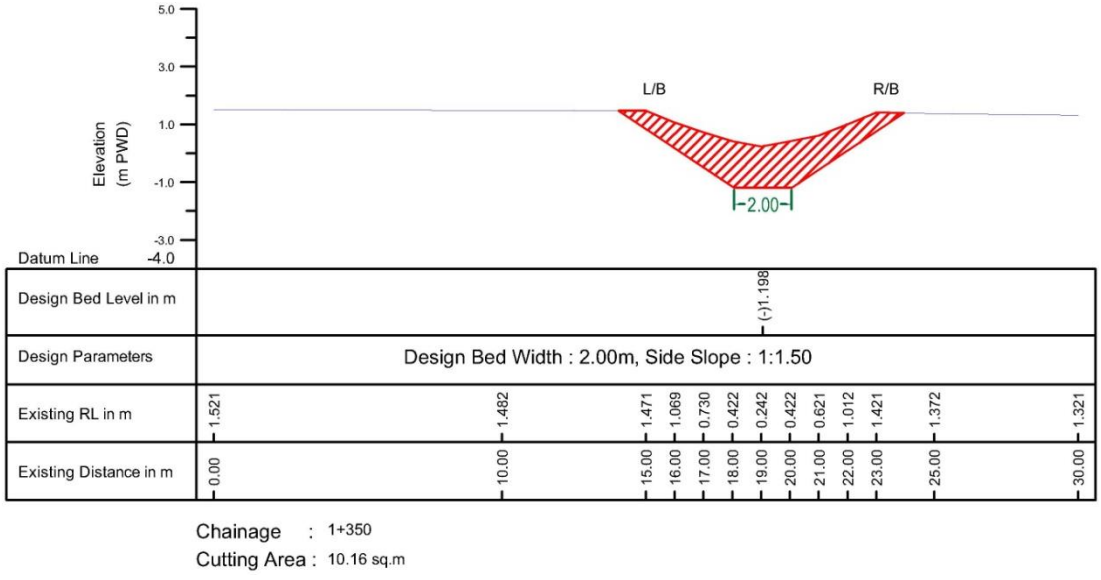
(b) Selected Cross-sections of Khal Re-excavation Works



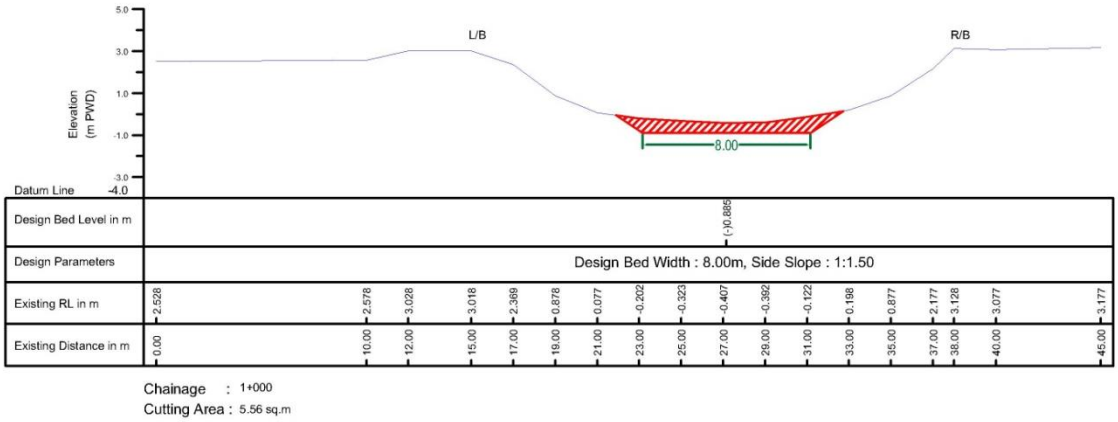
Amtola Khal



Botiaghata Khal

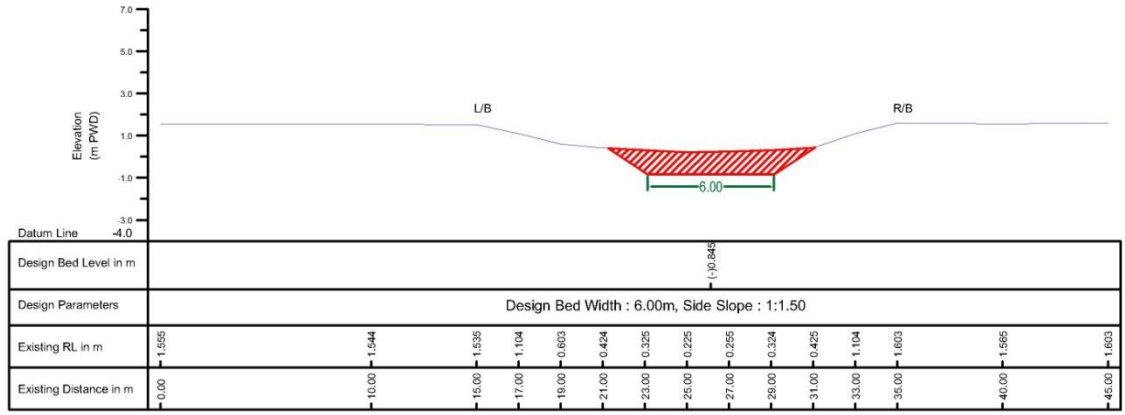


Hania Khal



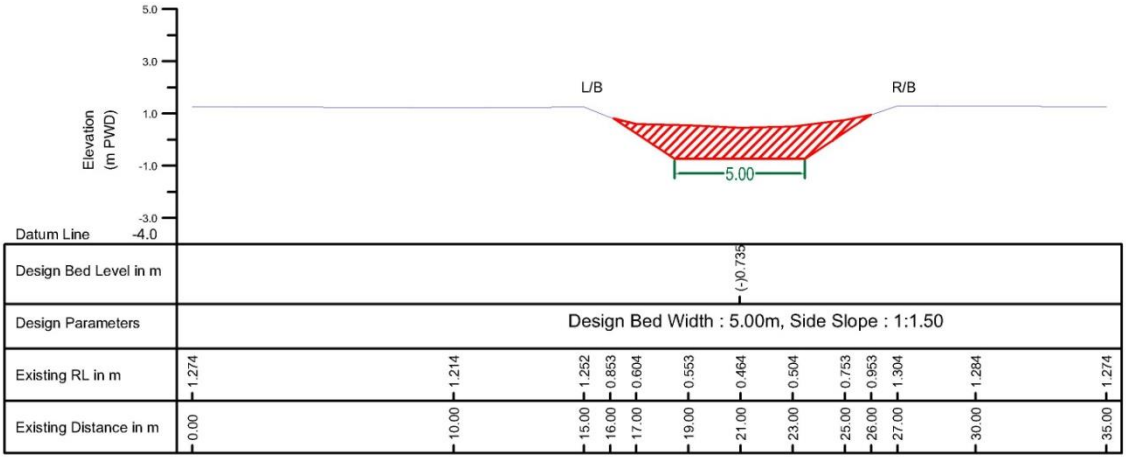
Chainage : 1+000
Cutting Area : 5.56 sq.m

Hugolbunia khal



Chainage : 1+400
Cutting Area : 8.90 sq.m

Khornia khal



Chainage : 2+000
Cutting Area : 9.17 sq.m

Uzukhali Khal

Appendix-3: No Objection Certificate

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

চেয়ারম্যানের কার্যালয়

৩নং গঙ্গারামপুর ইউনিয়ন পরিষদ

ডাকঘর-কাতিয়ানাংলা, থানা-বটিয়াঘাটা,খুলনা।

স্মারক নং-

তারিখঃ ২৮-০১-২০১৫ইং

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্রের ছক

১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড ।

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা) ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা-১০০০।

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ পোল্ডার ৩০ খুলনা জেলার বটিয়াঘাটা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
খুলনা	বটিয়াঘাটা				মাঝারি উচু ভূমি	৬৪৫৫ হেক্টর

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

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৩০ পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্ণিত অনাপত্তি প্রদান করা হলো।

শর্তাবলী ঃ

১। প্রকল্প স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।

২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।

৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তার নিশ্চিত করতে হবে।

৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে। এবং অগ্নিকান্ড কিংবা অন্য কোন দূর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।

৫। বায়ু ও শব্দ দূষন করা যাবে না।

৬। প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

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

তারিখ ঃ

২৯-১-১৫

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীলঃ

আঃ গনি বিশ্বাস

চেয়ারম্যান

৩নং গঙ্গারামপুর ইউনিয়ন পরিষদ

উপজেলা-বটিয়াঘাটা, খুলনা

কার্যালয়
২নং বটিয়াঘাটা ইউনিয়ন পরিষদ
উপজেলা- বটিয়াঘাটা, জেলা- খুলনা।

স্মারক নং-...২৬২/২৫..... তারিখ-২৭.০২.২০২৫

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্রের ছক

১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড ।

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা) ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা-১০০০।

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ পোল্ডার ৩০ খুলনা জেলার বটিয়াঘাটা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
খুলনা	বটিয়াঘাটা				মাঝারি উচু ভূমি	৬৪৫৫ হেক্টর

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

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৩০ পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্ণিত অনাপত্তি প্রদান করা হলো।

শর্তাবলী ঃ

১। প্রকল্প স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।

২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।

৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তার নিশ্চিত করতে হবে।

৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে। এবং অগ্নিকান্ড কিংবা অন্য কোন দূর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।

৫। বায়ু ও শব্দ দূষন করা যাবে না।

৬। প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

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

তারিখ ঃ ২৭.০২.২৫

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীলঃ
মনোরঞ্জন মন্ডল
চেয়ারম্যান
২নং বটিয়াঘাটা ইউনিয়ন পরিষদ
বটিয়াঘাটা, খুলনা।

Appendix-4: List of PCM participants

1. Participant list of PCM of Gangrampur Union

Environmental Study for Blue Gold Program

EIA and SIA study conducted by CEGIS

Participant list of PCM

Venue: Gangarampur UP hallroom Date: 02.09.2014

SL	Name	Occupation	Age	Address	Mobile No.
1	NIRANGON	P. chairman	55yr	ANDHARIA	019253646[illegible]
2	Md. [illegible]uddin	[illegible] Blue Gold [illegible]	64yr	362, [illegible] Road, Khulna	01720[illegible]35
3.	Md. [illegible]	[illegible]	52yr	[illegible] BWDB, Khulna	01711-45[illegible]35
4	Md Moshiur Rahman	ACE Blue gold	40	Bluegold	0171145023[illegible]
5	Md zahidul Islam	[illegible] Assistant	25	BWDB khulna	01712-309014
6.	[illegible]	[illegible]	29	[illegible]	
7.	[illegible]	[illegible]	80	[illegible]	[illegible]
8	[illegible]	[illegible]	68	"	01942[illegible]
9	[illegible]	[illegible]	40	"	01925367[illegible]
10	[illegible]	[illegible]	[illegible]	"	01937097[illegible]
11.	Dr. Kabil Hossain	Env. Expert	45	BGP, Khulna	01715[illegible]
12	Nirangan Sikdar	P. chairman	55yr	ANDharia	01925364601

CEGIS Center for Environmental and Geographic Information Services
(A Public Trust under The Ministry of Water Resources)
House No. 6, Road No. 23/C, Gulshan-1, Dhaka-1212, Bangladesh

Environmental Study for Blue Gold Program

EIA and SIA study conducted by CEGIS

Participant list of PCM

Venue: Gangyarampur up hall room Date: 02.09.2014

SL.	Name	Occupation	Age	Address	Mobile No.
১।	[illegible]	কৃষি	৪৫	[illegible]	[illegible]
২।	[illegible]	ব্যবসা	৪৪	[illegible]	01912-167317
৩।	[illegible]	[illegible]	৪২	[illegible]	01913-892172
৪	[illegible]	কৃষি	৭২	[illegible]	01921 22602
৫	গাজী আহজাহুনআলী	চাকুরী -	৫৫	কাউয়া নাংলা	০২১১৪২২২৬
৬	মোঃ পীর মোহাম্মদ	সমাজসেবক	৪৬	[illegible]	01912-359218
৭	[illegible]	গৃহিনী	৪৯	[illegible]	01840480427
৮	মাবিতানা সুলতানা	চাকুরি [illegible]	৩২	[illegible]	01588022967
৯	মোঃ আতিকুর রহমান	"	৪২	"	01724-177674
১০	[illegible]	গৃহিনী	৪০	কাউয়া নাংলা	01735-229[illegible]
১১	মোঃ মিকানুর রহমান	চাকুরি	২৯	[illegible]	8918782526
১২	[illegible]	কৃষি	৫৪	[illegible]	01920834514
১৩	[illegible]	কৃষি	৪৫	[illegible]	01925301776
১৪	[illegible]	গৃহিনী	৫৮	[illegible]	01925-219121
১৫	[illegible]	[illegible]	৬২	[illegible]	01731980494

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Appendix-5: Terms of Reference

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

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

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

Ref: Your Application dated 20/04/2014.

With reference to the above, the undersigned is directed to convey the approval of the Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of the proposed Rehabilitation and Improvement of Infrastructure of five coastal Polders under Blue Gold Program.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of each polder in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein..

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)

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

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- 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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