Government of the People's Republic of Bangladesh

Ministry of Water Resources

Bangladesh Water Development Board

Blue Gold Program

Final Report

on

Environmental Impact Assessment (EIA) on

Rehabilitation of Polder 34/2

September 2019

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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.

Fact Sheet and Conversion Unit

Fact Sheet

Polder No.	:	34/2 Part
District	:	Khulna
Upazila	:	Batiaghata
Union	:	Ameerpur, Vandarkot and Baliadanga
O&M Division of BWDB	:	Khulna O&M Divison-2
Gross Area (ha)	:	4900
River	:	Kazibacha river (on the West), Passure river (dead or Mora Passure) (on east and North).

Major Water Management Infrastructure

Embankment (km)	:	40km
Regulator/Sluics (nos.)	:	21nos
Outlet		1 no
Khal (km)	:	About 30 Khals recognized with 50km lenth

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.

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 34/2 part 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 4,900 ha, with a Net Cultivable Area (NCA) of 3,528 ha (72%).

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 34/2 part 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 34/2 part 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 34/2 part 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 6,845 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 34/2 part have been investigated based on qualitative assessments. The study infers positive long-term cumulative effects in Polder 34/2 part 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 34/2 part 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 34/2 part 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.
- Re-excavated earth 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 Re-excavated earth Management Plan (SMP) has been proposed by the study team for controlled and sustainable disposal of excavated Re-excavated earth. 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

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

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

Blue Gold Program builds on the results and lessons learned in managing water resources from previous programs and projects in Bangladesh. The explicit objective of the Blue Gold Program is to reduce poverty in the coastal areas by enhancing productivity of crops, fisheries and livestock in an integrated way and increase people's income by creating opportunities for improved processing and marketing of agricultural commodities with value chain development. The project started in January 2013 and will end in December 2020. Its operations are limited to selected polders of four coastal districts: Satkhira, Khulna, Barguna and Patuakhali which are a part of the South-west and South-central hydrological zones.

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The total land area of the four 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 considering (i) higher incidence of poverty, (ii) ineffective coordination with the local administration and private sector and (iii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. Total 22 polders from these four districts are included in the Blue Gold Program program, as illustrated in Table 1.1.

Table 1.1: District wise distribution of polders under BGP

District	No. of Polders
Patuakhali	8
Barguna	2
Khulna	11
Satkhira	1
Total	**22**

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.

The Blue Gold program has four 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. From environmental point of view, activities of two components i.e. the water resources management component (component ii) and the food security and agricultural production component (component iii) need to be taken into special consideration.

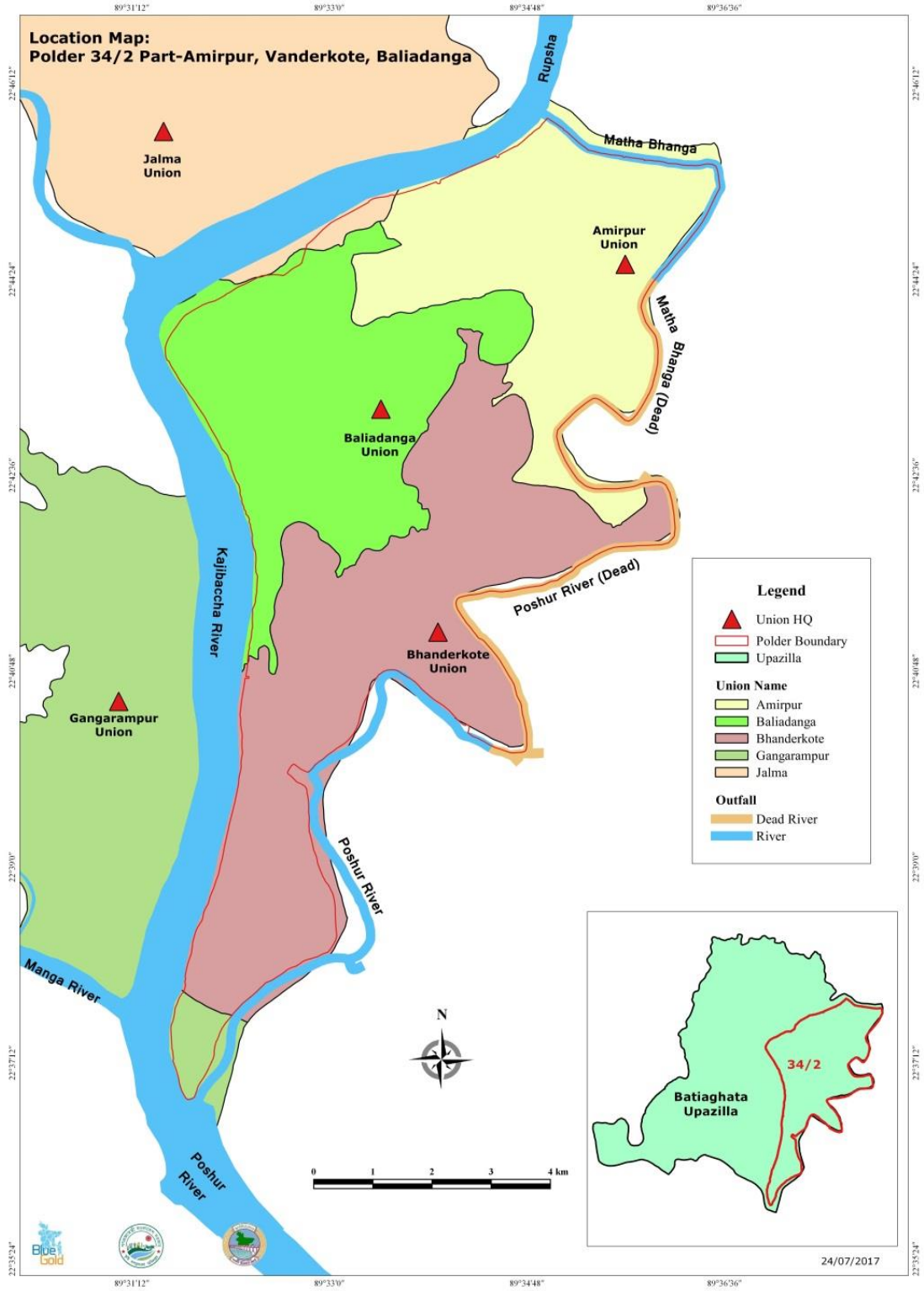
1.2 Rationale of the Study

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

Component of the Blue Gold Program includes rehabilitation of water resources management infrastructure in selected polders. Polder 34/2 part is one of them. The rehabilitation works of the polder includes re-sectioning of embankments, repair and/or improvement of drainage outlets and irrigation inlets, re-excavation of internal canals and improvement of on-farm water management. To proceed with these interventions, the Blue Gold Program needs environmental clearance from the DoE.

Study Area

Polder 34/2 Part is managed by the Bangladesh Water Development Board (BWDB) and was constructed during 1998-2005. It is located in Amirpur union (part), Vanderkote union (part) and Baliadanga union under Batiaghata upazila, Khulna district. The Polder area is surrounded by Mathabhanga river in the north, Rupsha river in the northwest, Kazibacha in the west, Poshur in the south and dead Poshur & dead Mathabhanga in the east (shown in the map). The characteristics of the polder can be found in Table 1 and the location map of the polder with respect to Upazilla and Union headquarters is shown in Map 1.1.



1.1:Location of Polder 34/2 Part in Batiaghata Upazila under Khulna District

Objectives of the Study

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

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 four districts.

The Blue Gold program has four 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. From environmental point of view, activities of two components i.e. the water resources management component (component ii) and the food security and agricultural production component (component iii) need to be taken into special consideration.

1.3 Scope of Work

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 Environmental Management Plan.

1.4 Limitations

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

1.5 EIA Study Team

The multi-disciplinary EIA study team included the following professionals:

1. Mr. Md. Amirul Hossain, Superintending Engineer/Director, Planning-III & Progaram Coordinating Director, BGP, BWDB, Dhaka.
2. Mr. Md. Rahmat Ali, Deputy Chief (Fisheries), Planning-III & BGP, BWDB, Dhaka.
3. Ms. Nasrin Akter Khan, Executive Engineer, Planning-III & BGP, BWDB, Dhaka.
4. Mr. Shafiqul Islam, Assistant Chief (Sociology), Planning-III & BGP, BWDB, Dhaka.

5. Ms. Shahnaz Akter, Assistant Chief (Economics), Planning-III & BGP, BWDB, Dhaka.
6. Mr. Md. Shariful Alam, Sub-Divisional Engineer, Planning-III & BGP, BWDB, Dhaka.
7. Mr. Tanvir Islam, Value Chain/Fisheries Expert/Joint Manager Innovation Fund, Technical Assistant Team, BGP, Dhaka.
8. Dr. Munir Ahmed, Livestock Expert, Technical Assistant Team, BGP, Dhaka.
9. Mr. Md. Joynal Abedin, Environmental Expert, Technical Assistant Team, BGP, Dhaka.

1.6 Report Format

This report contains the following 11 (Eleven) chapters as per ToR:

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

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

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

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

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

Chapter 6: ***Socio-economic Condition:*** This chapter discusses demography, livelihood, quality of livelihood, social safety net etc of the project area.

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

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

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

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

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

2 Policy, Legal and Administrative Framework

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

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

The National Environment Policy was adopted by the Government of Bangladesh in 1992, with the aim to maintain ecological balance and overall development through protection and improvement of the environment and to protect the country against any natural disaster. (website: http://www.doe.gov.bd)

2.1.2 National Environmental Management Action Plan (NEMAP) 1995

The National Environmental Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends the statements set out in the National Environmental Policy. (website: (http://documents.worldbank.org/ curated/en/ 329001468741610744/Bangladesh-National-environment-management-action-plan-NEMAP)

2.1.3 The National Water Policy, 1999

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. (website: http://warpo.gov.bd)

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

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. (website: http://warpo.gov.bd)

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

The Bangladesh Climate Change Strategy and Action Plan 2009 is built for the wellbeing of the environment of Bangladesh. (website: https://moef.gov.bd)

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

The National Water Management Plan (NWMP) 2001, approved by the National Water Resources Council in 2004, envisions establishing an integrated development, management and use of water resources in Bangladesh over a period of 25 years. (website: http://warpo.gov.bd)

2.1.7 Coastal Zone Policy, 2005

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

2.1.8 Coastal Development Strategy, 2006

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

2.1.9 National Conservation Strategy (NCS) 1992

The National Conservation Strategy was drafted in late 1991 and submitted to the government in early 1992. This was approved in principle. However, the final approval of the document is yet to be made by the government. (website: http:// bforest.portal.gov.bd)

2.2 Legislation, Act and Rules

2.2.1 National Water Act, 2013

The Water Act 2013 is based on the National Water Policy, and provides the legal framework for integrated development, management, abstraction, distribution, usage, protection and conservation of water resources in Bangladesh. (website: warpo.gov.bd/acts)

2.2.2 The Embankment and Drainage Act 1952

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

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

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. (website: bdlaws.minlaw.gov.bd)

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

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. (website: bdlaws.minlaw.gov.bd)

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

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

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

This is an Ordinance to manage ground water resources for agricultural production. (website: bdlaws.minlaw.gov.bd)

2.2.7 The Protection and Conservation of Fish Rules (1985)

These are a set of rules in line with the overall objectives of the Fish Act. (website: http://www.fisheries.gov.bd)

2.2.8 Panishampad ParikalpanaAin (Water Resource Planning Act, 1992)

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. (website: http://warpo.gov.bd)

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

The Bangladesh Wild Life Preservation (Amendment) Act 1974 provides the power to the government to declare areas as game reserves, wild life sanctuaries and national parks to protect the country's wild life. (website: http://bdlaws.minlaw.gov.bd)

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

The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation in relation to environment protection in Bangladesh. (website: www.doe.gov.bd)

2.2.11 The Environment Conservation Rules, 1997

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).

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. (website: https://www.elaw.org)

2.3 Procedure for environmental clearance

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

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.

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)

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

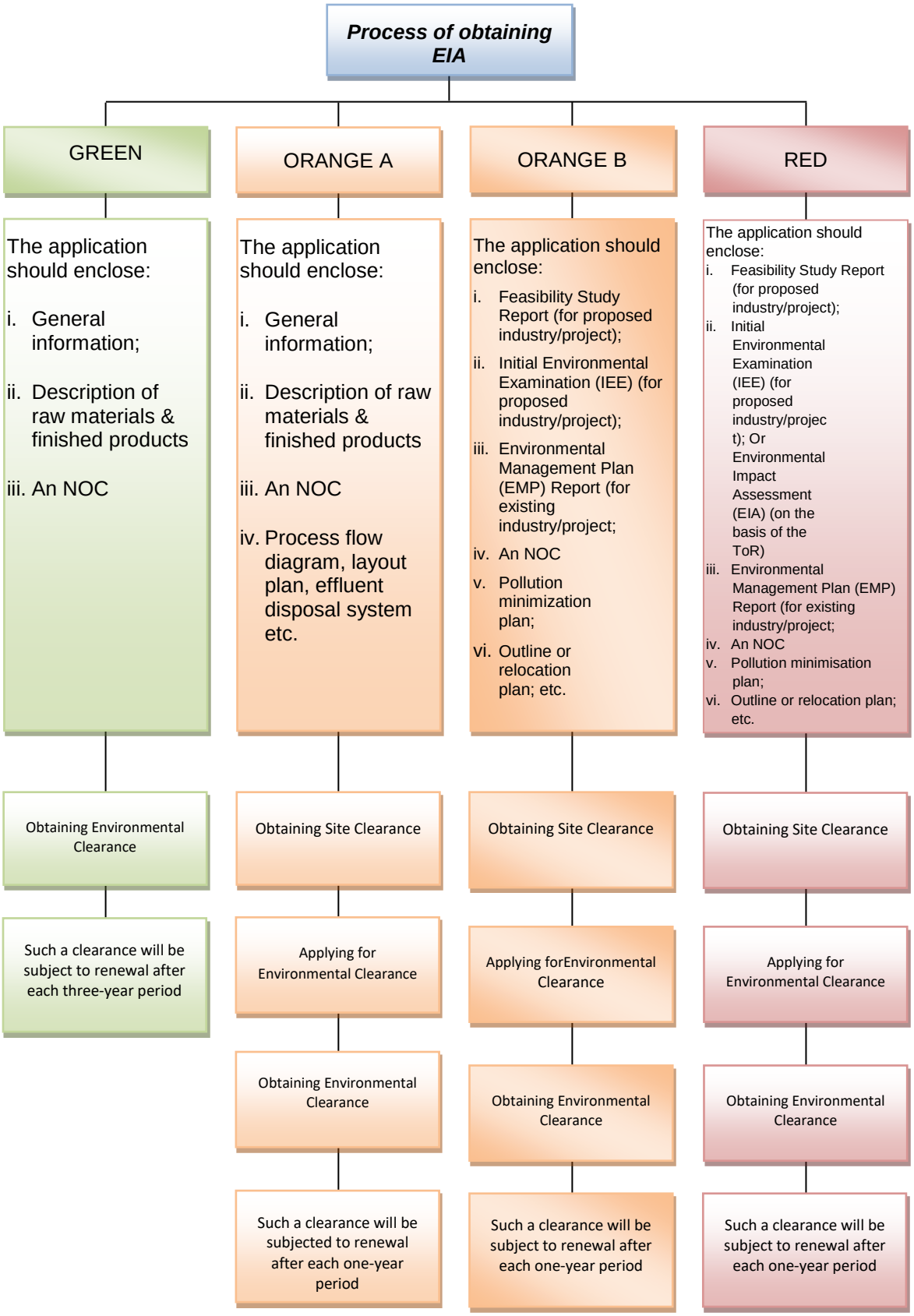


Figure 2.1: Steps Involved in Environmental Clearence following DoE Clearence

Environmental Quality Standards

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.

2.4 Administrative Framework

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.

Within organizational structure of BWDB, there has few positions of environment, economics, sociology, forestry and fisheries professionals are 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

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

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

Figure 3.1: The EIA process

3.2 Project Design and Description

The rehabilitation activities i.e. interventions which are to be implemented under the BGP were identified. The area of influence (project area) was demarcated. This included the area inside the polder where most of the Project interventions would implemented, and the area immediately outside the polder embankments (area to be used for staging of construction works, material stockpiling, and/or earth borrowing). A detailed description of the proposed works to be carried out has been provided. Supplementary information on design and implementation of the project interventions were collected from the BGP 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

Baseline data collection was conducted as a pre-requisite for this EIA study. The baseline condition of the project area was drawn according to the information collected from secondary and primary data sources through literature review, field investigations and consultation with different stakeholders. 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 methodology is presented in the following section:

3.3.1 Climate and Meteorology

A discussion has been provided on climate change, based on secondary literature review has been made. The issue was discussed on a regional scale, with respect to the different hydrological regions and administrative divisions of Bangladesh. Long term impacts of climate change have been investigated following literature review. In addition, field level information on the recently occurred natural disasters and their impacts was investigated.

Data on different meteorological parameters such as rainfall, 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 Water Developement Board (BWDB) and Bangladesh Meteorological Department (BMD) at Khulna was selected.

3.3.2 Topography and Seismicity

To understand the topography of the area through visualization of Reduced Levels (elevations) of different locations within the polder, an analysis using Digital Elevation Model (DEM) has been carried out. To establish the DEM, re-sampled 500m×500m grid levels (elevations) were captured from BWDB's one foot contour maps, which were produced in the late sixties. These spot levels were interpolated into a continuous surface known as the DEM produced. The DEM has been downscaled within the processing extent of Polder 34/2 to develop an understanding of the topographic features inside the polder.

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

3.3.3 Water Resources

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

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 34/2 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.

The specific data on different components of water resources were collected from different sources. The monthly average water levels were collected from two BWDB stations at Rupsha River and Kazibacha River. Values on monthly average groundwater levels and annual variation of Ground Water Table (GWT) were collected from the two BWDB observation wells named as SAT001 and SAT005. Data on water quality were used from Hydrology, BWDB data base. Surface water salinity was measured 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

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

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:

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

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

Livestock Resources

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

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:

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.

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.

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.

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.

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.

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

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

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.

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.

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:

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

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

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.

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

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 34/2'. 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

Area likely to be impacted by "Rehabilitation of Polder 34/2" 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

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

Environmental and social impacts of the proposed interventions for "Rehabilitation of Polder 34/2" 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.

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 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

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

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.

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

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.

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	Meets minimum national standard limits or international guidelines	Not applicable

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

3.8.3 Sensitivity

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

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

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

At the end of the process, the present report on "Environmental Impact Assessment of rehabilitation of Polder 34/2" is prepared incorporating all findings of the EIA study.

4 Project Description

4.1 General

The Blue Gold Program seeks to offer innovative and effective solutions to increase infrastructure sustainability and stability, and to make the polder effective against challenges of freshwater scarcity, tidal flooding, food security, climate change etc. Capacity building of stakeholder activity are considered an integral component of the project to ensure participatory water resources development and management involving the community as well as other stakeholders; design and quality implementation; introduction of participatory working concepts and make WMOs as driving forece for water management in the Polder area are the salient features of the project.

4.2 Objective

The objectives of the Blue Gold Program are to

- Increase sustainability of the development of the polders through effective community participation.
- Protect flood and use water resources effectively
- Increase farmers' income and strength livelihood through improved productivity.

The objective of the second component of Blue Gold Program in Polder 34/2 is to improve the existing status of water management, through rehabilitation of infrastructures. In short, the specific objectives of the program are:

- Repairing of water control structures such as sluice gate and outlet to allow better control on drainage and flushing, and thus improve the agricultural production.
- Re-sectioning of embankment to increase embankment stability and peripheral communication.
- Re-excavation of khals to primarily drain out the peak flow and provide rainwater storage to meet up the increasing water demand for irrigation.

4.3 Polder Overview

Polder 34/2 Part is managed by the Bangladesh Water Development Board (BWDB) and was constructed during 1998-2005. It is located in Amirpur union (part), Vanderkote union (part) and Baliadanga union under Batiaghata upazila, Khulna district. It is surrounded by Mathabhanga river in the north, Rupsha river in the northwest, Kazibacha in the west, Poshur in the south and dead Poshur & dead Mathabhanga in the east.

4.4 Present Status Water Management Infrastructures

Water Management Infrastructures are the physical interventions which ensure sustainable management, optimal use and equitable sharing of water resources. There are some typical water management infrastructures such as peripheral embankments, sluices, drainage outlets, flushing inlets in Polder 34/2. Based on field investigation the study team gathered the following information regarding the status of existing infrastructure.

Embankments

The length of the Embankment is 34.70 km with top width 4.30 m. The crest level is at 4.50 m above Mean Sea Level (MSL). Existing side slopes are 1:3 in riverside and 1:2 in countryside. The existing condition of the embankment is good in most portions excepting the embankments in Shialidanga, west halia area. The embankment remains dry and various modes of transportations are found through it in dry season. A significant portion of the peripheral embankment is paved, which allow heavy vehicular movements during all seasons. But in wet seasons the top surface the unpaved portion of the embankment surface becomes slippery and unsuitable for vehicular movements.


Photo 4.1: Existing Status of Embankments

Water Control Structures

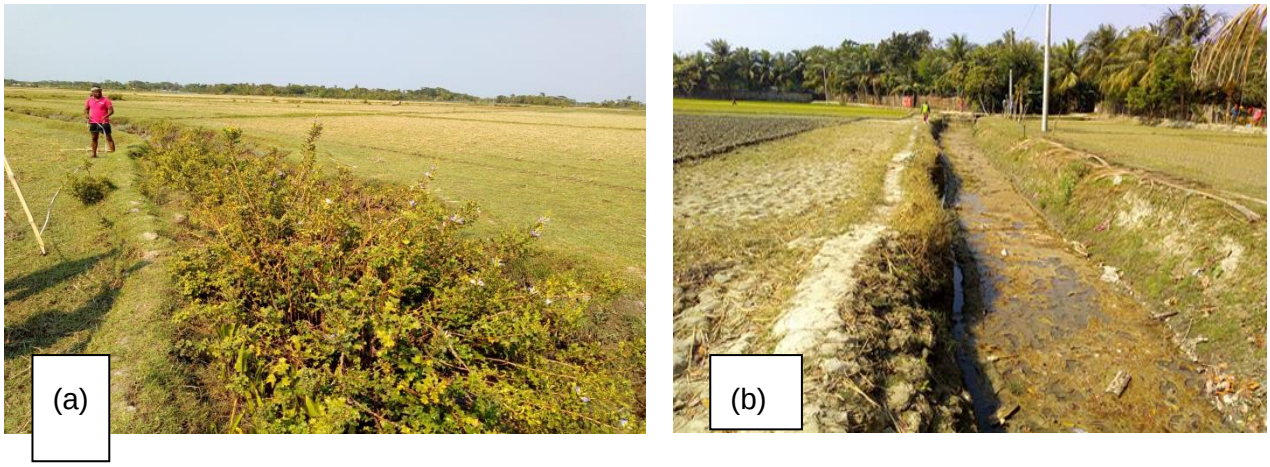
There are 31 numbers of drainage and flushing sluices constructed by BWDB within the polder. Some of these structures need repairing. A number of the gates do not operate smoothly due to damages of the wheels and shafts used to elevate gates. Siltation of the river bed caused some of the sluice gates to remain non-functional. Severe mismanagement issues regarding the water control structures also prevail.

During the field visit the study team found that some of existing sluice gates have been subjected to structural damage in recent years and are not maintained properly by local community. The conditions of the gates are not satisfactory at all. East Halia Drainage cum Flushing Regulator and Thakrunbari Drainage cum Flushing Regulator is in vulnerable condition and need re-construction.


Photo 4.2: Existing Status of Narayankhali Sluice and Shialidanga Sluice at Polder 34/2

4.5 Present Status of Drainage Khals and Rivers

The present condition of most of the internal khals is in very poor condition in absence of maintenance or re-excavtion. Over the years, siltation, topsoil erosion and other land filling activities have resulted in gradual decrease of water courses within the polder. Among the existing khals the Nagladoho Khal, Noapakhia khal, Betbunia khal and Doani/Pramanik Khal and Baroi katakhali are badly silted up and hence, create drainage congestion in the adjacent area which needs re-excavation.



*(**a**) Broi kata khali khal, (**b**) Nastakhali khal*

Photo 4.3: Drainage Khals within the polder

4.6 Problems and Issues in the Polder

Geo-physically, the south-west part of the polder is depressed. In adjacent to Poshur river there are huge number of saline water shrimp firms which are basically managed by some influential. As reported by the UP members, due to the saline water intrusion the rice cultivation, homestead vegetables and vegetation are greatly affecting;

The Bhatgatir beel under Vanderkote union, Nagladoha beel under Amirpur union and Dhaduar beel under Baliadanga union are prone to water logging which effects the people for 3-4 months usually start from July and end in October. As claimed by the local farmers the T.Aman is mostly affecting by the water logging;

From the secretary of Union Parishads we got that peoples in this polder mostly depends on tube-well water. In the western part deep tube-well is feasible while at eastern part shallow tube-well is feasible. The shallow tube-well mostly contaminated with arsenic;

The over and indiscriminate use of fertilizer and pesticides (Dimocrone, Vittako, Seven powder etc.) in agriculture and horticultural crops are the major problems affect to the human health and environment health;

There are three major erosion points in this polders i) Koria under Amirpur union (river Rupsha) ii) Bujbunia under Baliadanga union (river Kazibacha) and iii) Shealidanga under Vanderkote (river Kajibacha). T. Aman cultivation and people living adjacent to these erosions are at risks.

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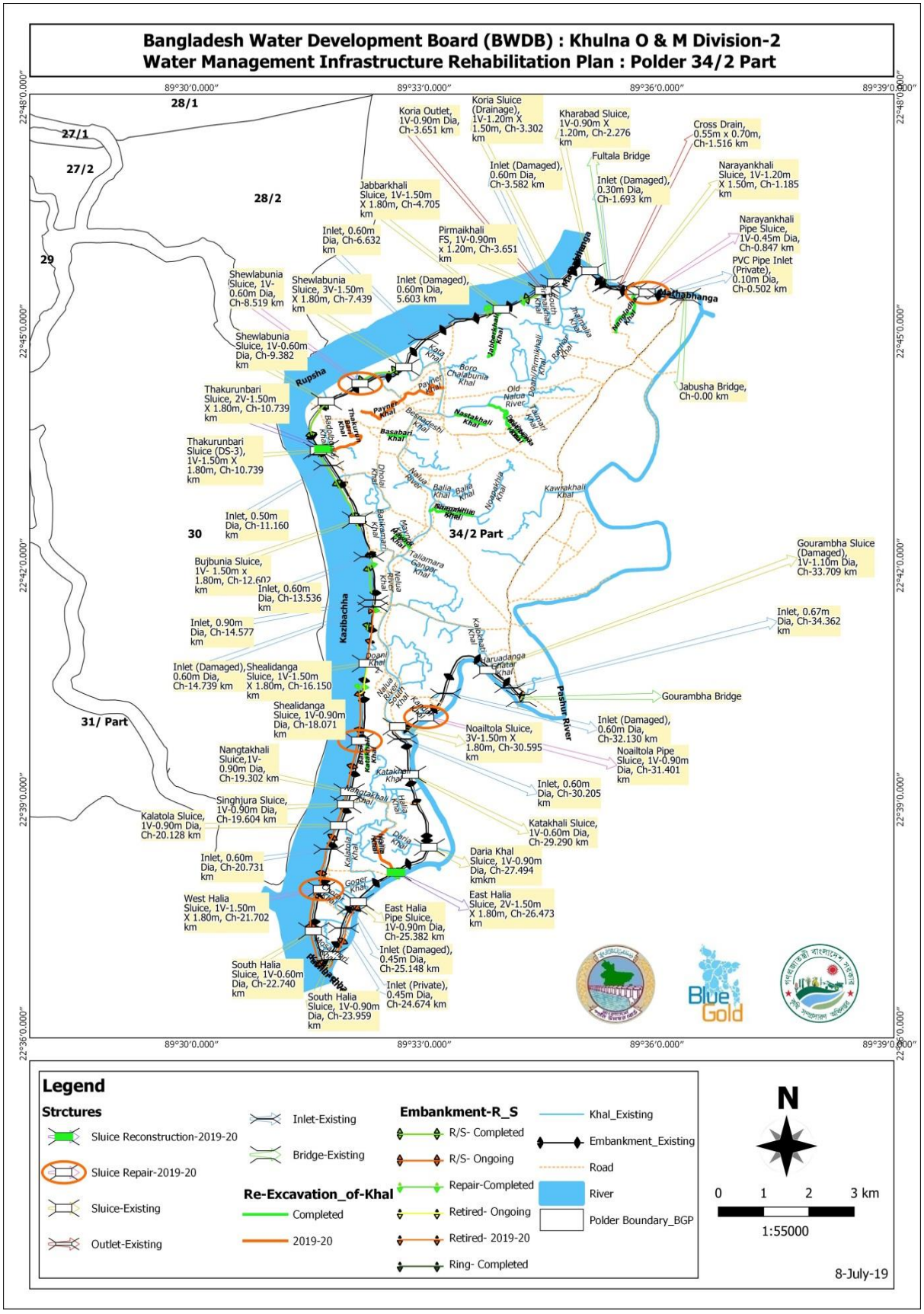
4.7 Proposed Interventions in Polder 34/2

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 34/2. The locations of interventions have been shown in Map 4.1.



Map 4.1: Location of the proposed interventions of Polder 34/2

4.5.1 Repairing of Water Control Structures

Re-sectioning works along the peripheral embankment is proposed to be carried out in the selected locations which are found damaged. The proposed crest width is 4.30m, with side slopes of 1(V): 3(H) on river side and 1(V): 2(H) on country side. The design elevation of the crest of the embankment is at 4.50 m +PWD (above Mean Sea Level). **A total of 3.00 km of embankment will be re-sectioned.**

4.7.2 Repairing of Water Control Structures

Some sluices among all existing sluices of BWDB within the polder will be repaired. Some sluices would require new shafts and wheels, whereas some sluices would require Details of all interventions to be undertaken are presented below from **Table 4.1.**

Table 4.1 (a) : Detail information on proposed repairing of Drainage Sluices

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)
1	Noailtola pipe sluice	1	0.90 m dia	31.401
2	Narayankhali pipe sluice	1	0.45 m dia	0.847
3	West Halia pipe sluice	1	1.50mX1.80m	21.702
4	Shaulabunia pipe sluice	1	0.60 m dia	8.519
5	Shealidanga FS	1	0.90 m dia	18.071

Source: Blue Gold Program Office

Table 4.1 (b): Detail information on proposed Construction of Drainage Sluices

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)
1	East Halia Drainage cum Flushing Regulator	2	2.00mX1.80m	24.765
2	Thakrunbari Drainage cum Flushing Regulator	2	2.00mX1.80m	8.440

Source: Blue Gold Program Office

4.7.3 Khal Re-excavation

A total number of 14 khals in Polder 34/2 are considered in the re-excavation plan of Blue Gold program. The total length to be re-excavated is around 17 km with volume of 262,000 cu-m. The names of the khals and lengths to be re-excavated are shown in Table 4.2.

Table 4.2: Detail information on proposed re-excavation of Khals

Sl. No	Name of Khal	Length (Km)	Tentetive volume of Earth (cu-m)
1	Re-excavation of Nagladaho khal	1.336	17,089
2	Re-excavation of Jatamari/Donia khal	1.850	23,262
3	Re-excavation of Jabbarkhali khal	1.380	30,463
4	Re-excavation of Noapakhia khal	1.095	13,591
5	Re-excavation of Baroi Katakhali Khal	1.000	11,930
6	Re-excavation of Betibunia Khal	1.620	24,791
7	Re-excavation of Mayndii Khal	0.430	10,436
8	Re-excavation of Basabari Khal	0.600	3,566
9	Re-excavation of Nastakhali Khal	0.900	6,960
10	Re-excavation of Doani/Pirmaikhali Khal	0.850	16,458
11	Re-excavation of Halia khal	1.400	23,690
12	Re-excavation of Thakurunbari khal	1.760	44,217
13	Re-excavation of Payaner/ Ranajiter Hular khlal	2.662	35,854.14

Source: Blue Gold Program Office

- **Construction Details**

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.

Description of Activities

Re-sectioning of Embankment

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

Repairing of Water Control Structures

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

Re-excavation of khals

First of all, 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.

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

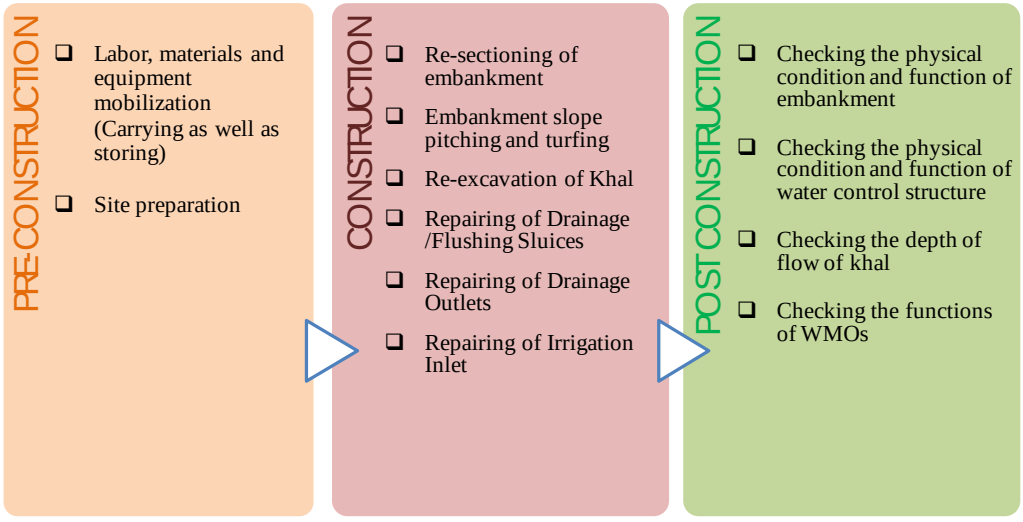


Figure 4.1: Phase wise list of activities in Polder 34/2

Construction Schedule

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 34/2 are likely to be completed by June 2020.

Table 4.3: Construction Schedule in Polder 34/2

Key Activities	2017				2018				2019			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)												
Community mobilization for Water Management Planning (Fine tuning works)												
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs												
Assessment of WMO Functionality												
Strengthening/ capacity building of WMO based on outcome of Assessment												
Community Mobilization for Polder Development Plan (PDP). Firm-up water management development options. Firm-up Sustainable Environmental Management Plan (SEMP)												
Implementation of Water Management fine tuning works with active participation of the WMOs/ WMA through the Quality Control/ Block Committee												

Materials Requirement

i) The construction materials required for re-sectioning and retired embankment, water regulators and flushing inlets, and bank protection work will include soil, cement, steel, and sand.

Manpower Requirement

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

- **Project Management and Implementation**

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 34/2 are discussed in the following sections.

Community Participation through WMO/ CBO

Participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) is 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. The Following CBOs have been recommended for this polder under Blue Gold Program.

Water Management Committee (WMC)

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

Landless Contracting Society (LCS)

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 LCSs women participation in all groups will have to be ensured.

- **Operation and Maintenance Plan**

Since construction, Polder 34/2 has been playing a vital role in safeguarding the polder area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, it is observed that due to inadequate maintenance and mismanagement issues over the years, the polder did not serve as per its potential.

4.7.4 Operational Plan

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 34/2.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 34/2 has been proposed.

Regulation of Gate Operation

The gates need to be operated properly so as to retain water in the drainage channels without overtopping their channel banks. Moreover, consultations must be made 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 WMOs and BWDB O&M staff will assist local stakeholders in effective management of water inside the polder.

Frequent Monitoring of Embankments and Structures

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 in protection works. The functional WMOs in the polder will assist in the problem detection process.

Supervision of Preventive Maintenance Works

Preventive maintenance works are done by the community-based functional groups (e.g. LCSs) as and when required throughout the year. The works are usually 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. Routine monitoring of water management situation and hydrological conditions will supply data which will dictate the needs of adjusting the operational measures.

4.7.5 Maintenance Plan

Maintenance of embankments and structures is necessary because it helps in keeping the infrastructures in good and functional condition so as to protect investments, and prevent high rehabilitation costs. Under 'component II' of Blue Gold program in Polder 34/2, only those work which directly serve water management should be regularly maintained. The preventive maintenance works can be implemented through community-based functional groups such as LCSs. The works may include:

All activities related to vegetative covers on embankment and small earthworks on the embankment;
Cleaning, greasing, and painting of structures ;
Minor repair of protective works i.e. re-positioning of the displaced blocks, small patching of brick works, replacing rubber seals;
Major Periodic Maintenance Works i.e. re-sectioning of embankments including turfing;
Major repair of structures i.e. repair or replacement of metal works / hinges, lifting mechanisms, gates, block works, head / wing walls; and
Some emergency maintenance works to protect the polder from the adverse effects of flooding or uncontrolled saline water intrusion i.e. construction of cross dams over canals if structure fails.

4.8 Expected Benefits and Outcome

The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 34/2 are listed in Table 4.5 below.

Table 4.8: 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
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.

4.9 No Objection Certificate

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

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

Rainfall

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.

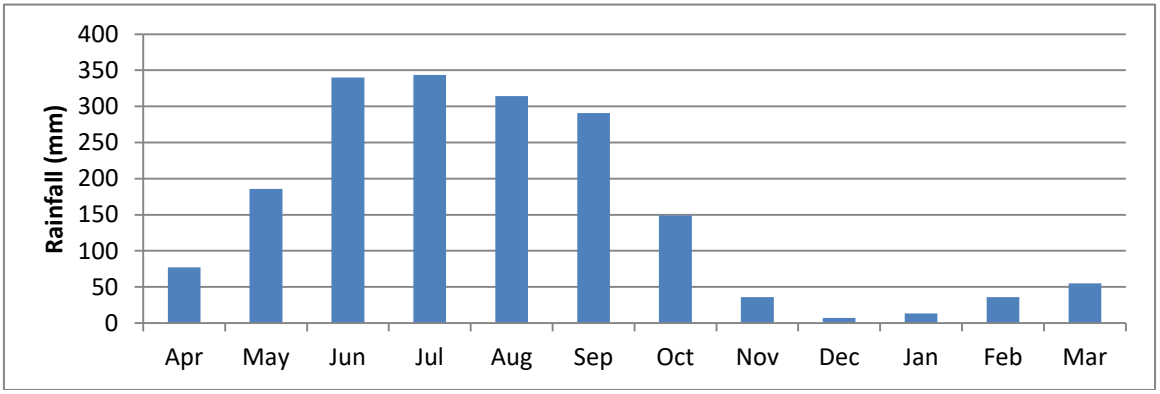


Figure 5.1:AverageMonthly Rainfall at Khulna BMD

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 34/2 part 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**

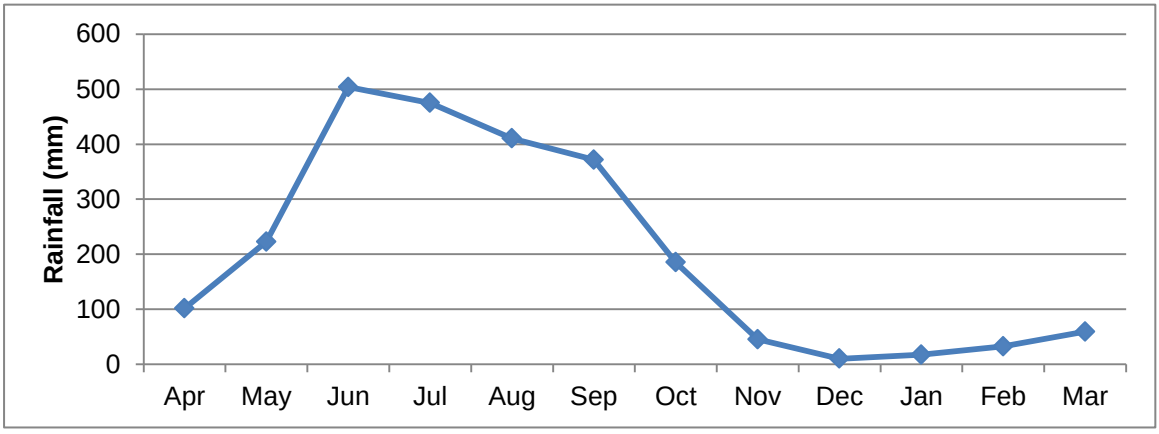


Figure 5.2: Average Monthly Rainfall in Polder 34/2 part (using Theissen Polygon Method)

Temperature

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**

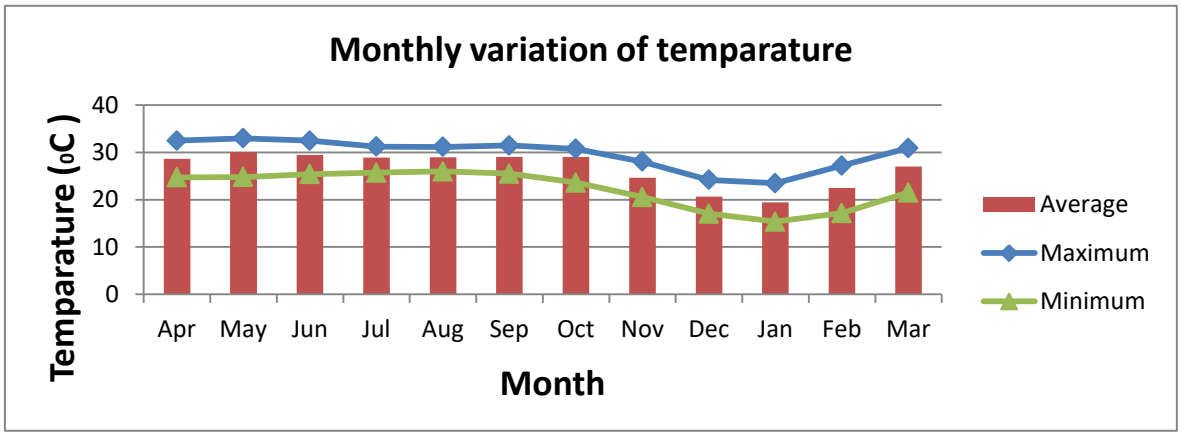


Figure 5.3: Average of Maximum and Minimum Temperatures at Khulna BMD Station

Relative Humidity

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.

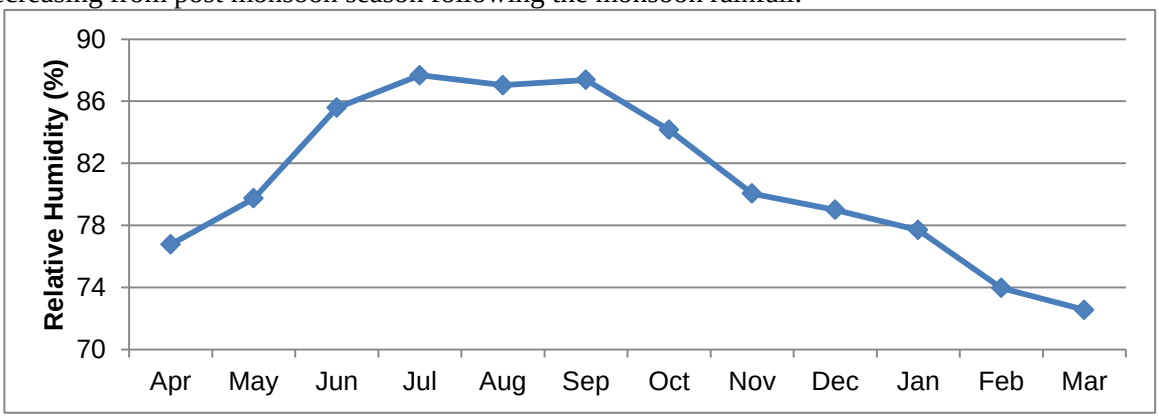


Figure 5.4: Average Relative Humidity at Khulna BMD station

Evaporation

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 34/2 part therefore implies for better plant health (especially in Kharif-I and Kharif-II seasons).

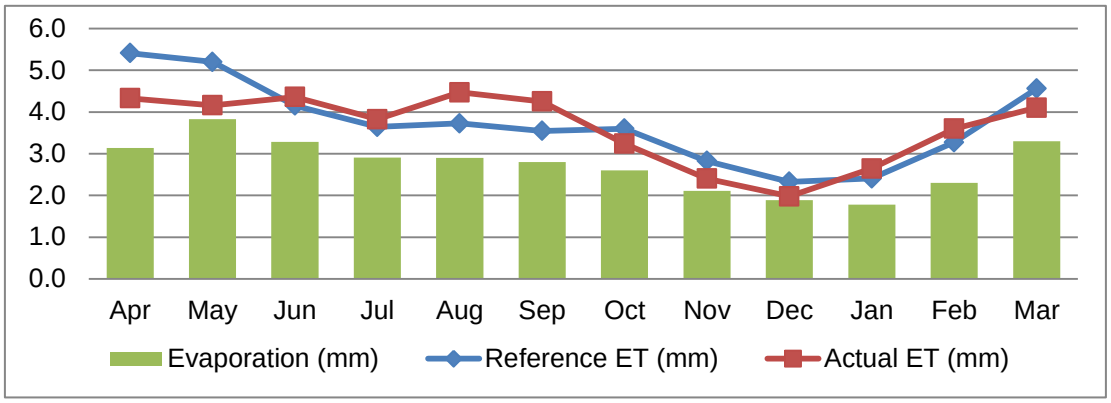


Figure 5.5: Monthly Variation of Evaporation, Reference ET and Actual ET for Khulna BMD Station

Wind Speed

Figure 5.6below 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.

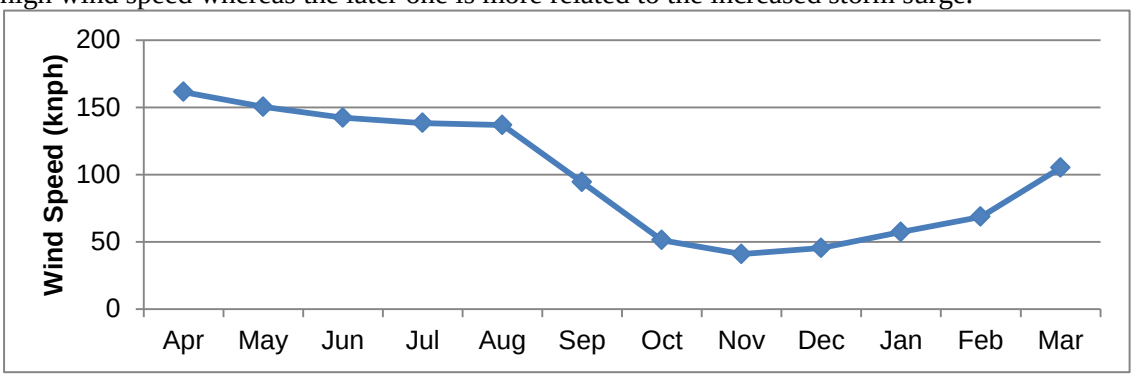


Figure 5.6: Variation of Average Wind Speed at Khulna BMD station

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).

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**).

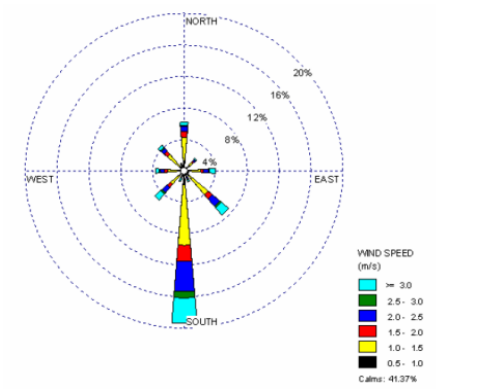


Figure 5.7(a): Wind Rose for Khulna for a Full Year

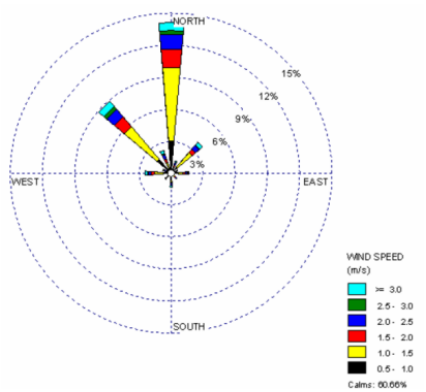


Figure 5.7(b): Wind Rose for Khulna from November to February

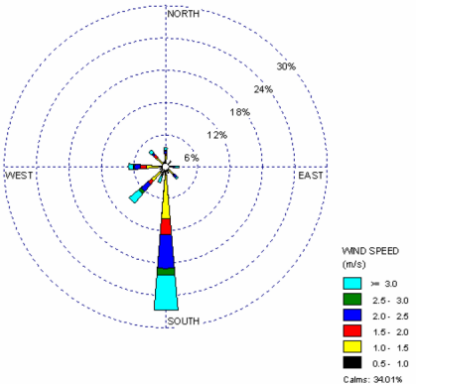


Figure 5.7(c): Wind Rose for Khulna from March to April

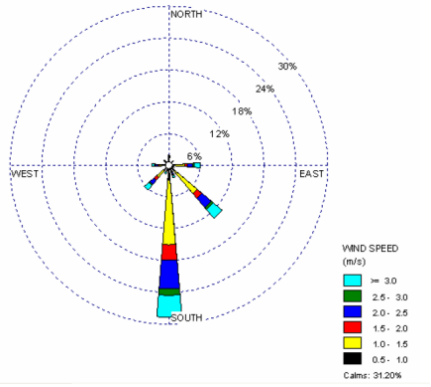


Figure 5.7(d): Wind Rose for Khulna from May to October

Sun-Shine Hour

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.

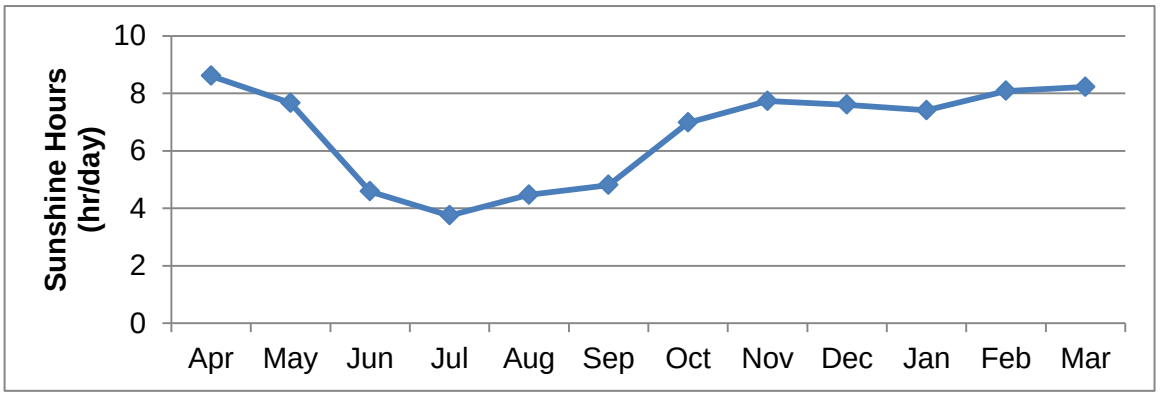
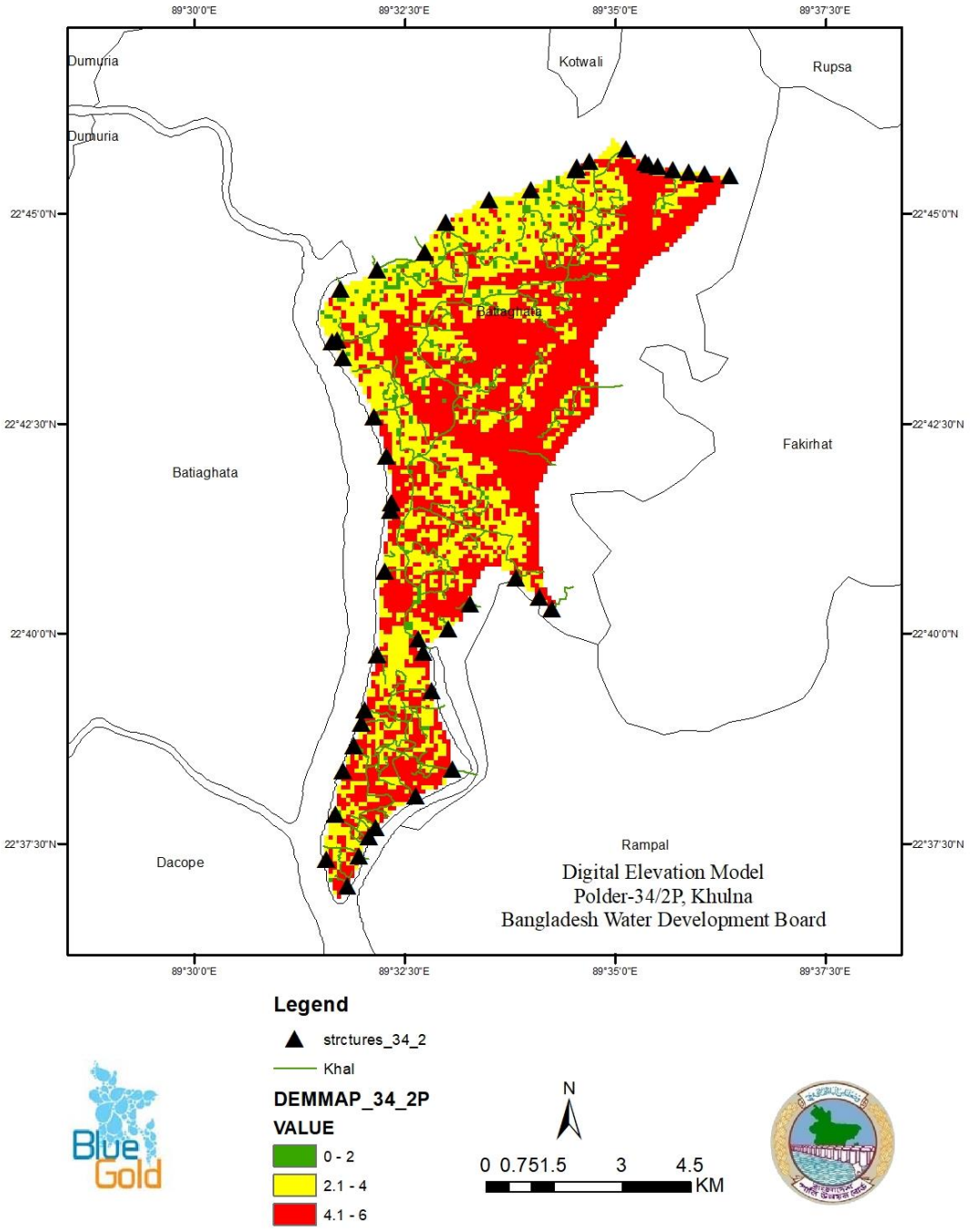


Figure 5.8: Monthly Variation of Average Sunshine Hours at Khulna BMD Station

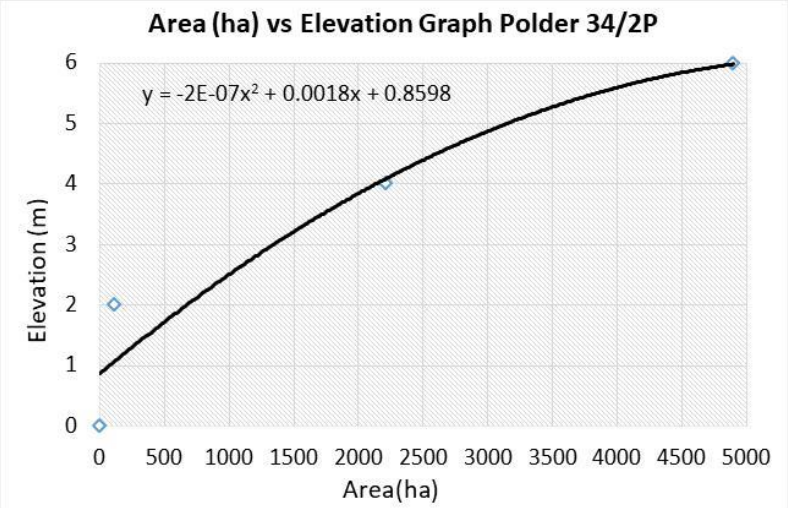
5.1.2 Topography

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 34/2 part 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.

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 34/2 part

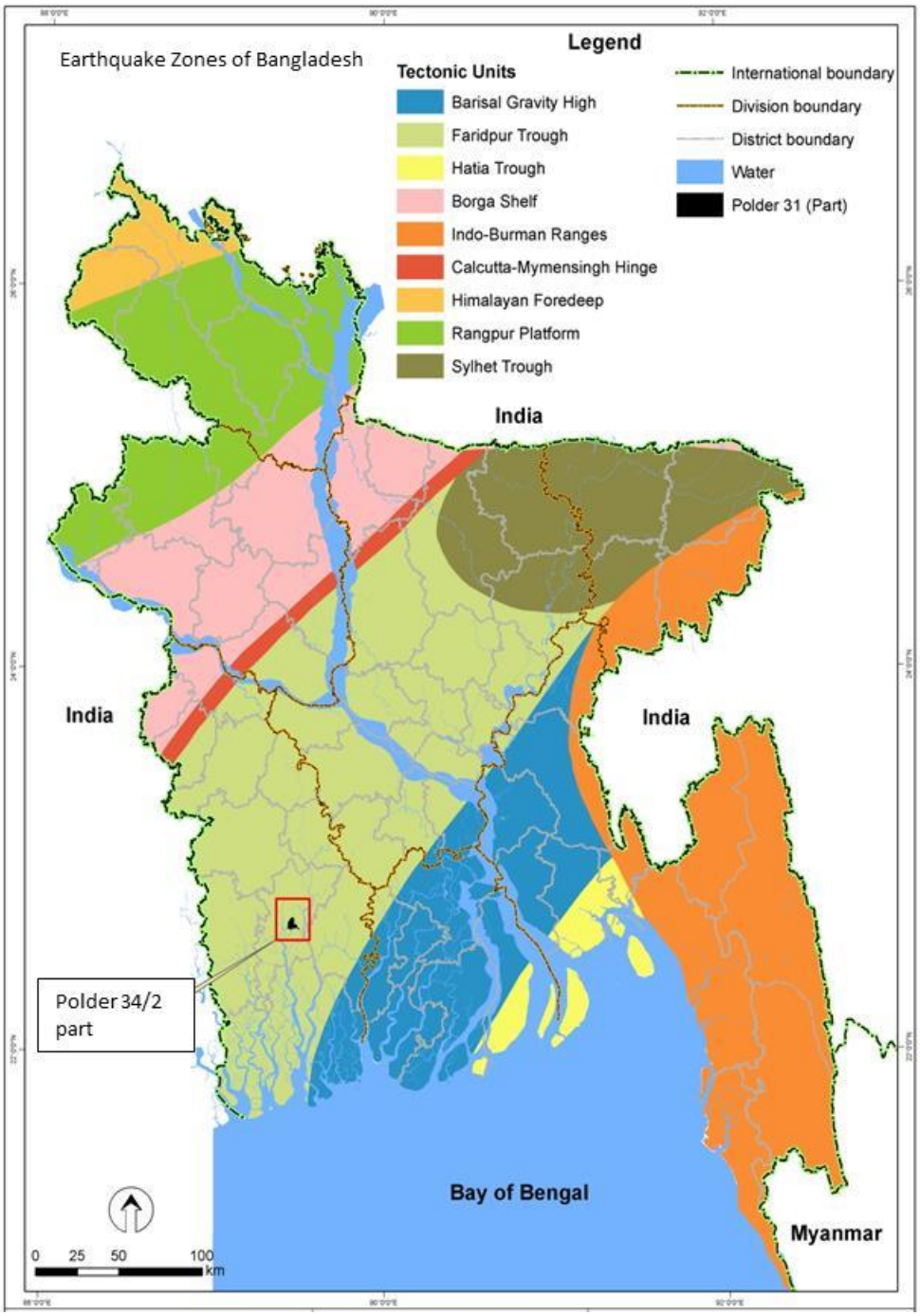


5.1.3 Seismicity

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 34/2 part 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 34/2 part.

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 34/2 part 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 34/2 part (within the Faridpur Trough).

It is therefore observed that both in consideration of seismicity and stratigraphy, Polder 34/2 part falls on a relatively safer (seismically quiet and tectonically stable) side.



Map 5.2: Earthquake Zones of Bangladesh and location of Polder 34/2 part

5.1.4 Agro-ecological Zone

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)].

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).

The polder 34/2 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.

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

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
34/2	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

The total polder area is about 4,900 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.

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

Land Use	Area (ha)	Percent of total area
Net Cultivable Area (NCA)	3,234	66
Settlements	1,421	29
Water bodies (khals)	196	4
Road	49	1
Total Area	4,900	**100**

Land Type

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.

5.1.7 Soil Texture

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.

Source: Eestimation from SOLARIS-SRDI, 2014

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

Texture	Area(ha)	% of NCA
Clay	3,137	97
Clay Loam	97	3
Total	**3,234**	**100**

5.1.8 Soil Salinity

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	1,552	48			20	0
8.1 - 12.0	Slightly saline with some moderately saline		1,682	52	2,846	88	2,620	81
12.1 - 16.0	Moderately saline with some strongly saline						614	19
> 16.0	Strongly saline with some very strongly saline				388	12		
		Total	**3,234**	**100**	**3,234**	**100**	**3,234**	**100**

Sources: Estimation from SOLARIS-SRDI, 2006

5.1.9 Available Soil Moisture

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).

5.1.10 Drainage Characteristics

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.

5.1.11 Farming Practices

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.

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.
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.

5.1.12 Crop Production Constraints

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.

Above situations are unfavorable for crop production.

5.1.13 Cropping Pattern by Land Type

Total land in the polder area is medium highland (F_1). The most prominent cropping pattern is Fallow-Lt Aman- HYV Boro which is occupied about 40% of the Net Cultivable Area (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.

Photo 5.1: View of Sesame Field in the Polder Area

Photo 5.2: View of Rice Demonstration in the Polder Area

Detailed cropping patterns along with land type are presented in Table 5.6. Department of Agriculture Extension (DAE) started demonstration in Rabi season with rice BR28. 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	Khartif-II	Rabi	Area (Ha)	% of NCA
	(March-June)	(July-Oct)	(Nov-Feb)		
Medium High Land	Fallow	HYV T aman	HYV Boro	1,294	40
	T. Aus (LIV)	HYV T aman	HYV Boro	873	27
	Fallow	HYV Aman	Sesame	582	18
	Fallow	Lt Aman	Mungbean	194	6
	Fallow	Lt Aman	Sesame	97	3
	Fallow	Lt Aman	Watermelon	65	2
	Fallow	Lt Aman	Sunflower	64	2
	Vegetables	Vegetables	Vegetables	65	2
			Total	**3,234**	**100**

Source: Field survey, 2019 and secondary data from UAU and SAAO, DAE, Batiaghata

5.1.14 Cropped Area and Cropping Intensity

Total cropped area is about 6,890 ha of which the coverage of rice is 51% and non rice is 49%. The single, double and triple cropped area about 10%, 80% and 10% respectively. Therefore, cropping intensity of the polder is about 206%.

5.1.15 Crop Damage

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; 2019, SAAO, DAE and UAO, DAE.

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

Soil fertility is an important factor for crop production. Local people reported that in general the polder area is quite low in soil fertility. The organic matter content of the top soils ranges from less than 1% to 1.5%. The low organic content in soils indicates poor physical condition of the polder soils. 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

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

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

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

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*

5.1.17 Integrated Crop Management (ICM)

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

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	65	2	4,500
Vegetables	32	1	5,000

*Source: Estimation on field information; 2019 * Supplementary irrigation*

Crop Yield Level (Normal and Damaged) and Production

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*
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

In the polder area, the annual total crop production stands at about 16,337 tons of which about 8, 717 tons of rice is produced and 7,620 tons non-rice crop is produced. The contribution of rice crops about 53% and non-rice crop is about 47% of total crop production. Among the rice crops, the contribution of HYV Boro, HYV Aman and Lt Aman and T. Aus (LIV) are about 36%, 43%, 19% and 2% respectively. Detailed crop production and crop production loss 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 (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)	(ton)	loss(ton)	
HYV Boro	758	758	3.9	-	-	3,134	-	
HYV Aman	1,499	1,289	2.9	210	0.9	3,738	420	
LT.Aman	946	879	1.8	67	0.6	1,658	47	
T. Aus (LIV)	104	98	1.7	6		187	11	
Total rice	**3,307**	**3,024**		**283**		**8,717**	**478**	**53**
Sesame	2,578	2,467	1.1	111	0.2	3,010	50	
Vegetables	186	186	12	-	-	2,432	-	
Watermelon	45	37	25	8	12	1,225	108	
Mungbean	680	680	1.1	-	-	840	-	
Sunflower	94	81	0.95	13	0.3	113	8	
Total non-rice	**3,583**	**3,451**		**132**		**7,620**	**166**	**46**
Total	**6.890**	**6,475**		**415**		**16,337**	**644**	**100**

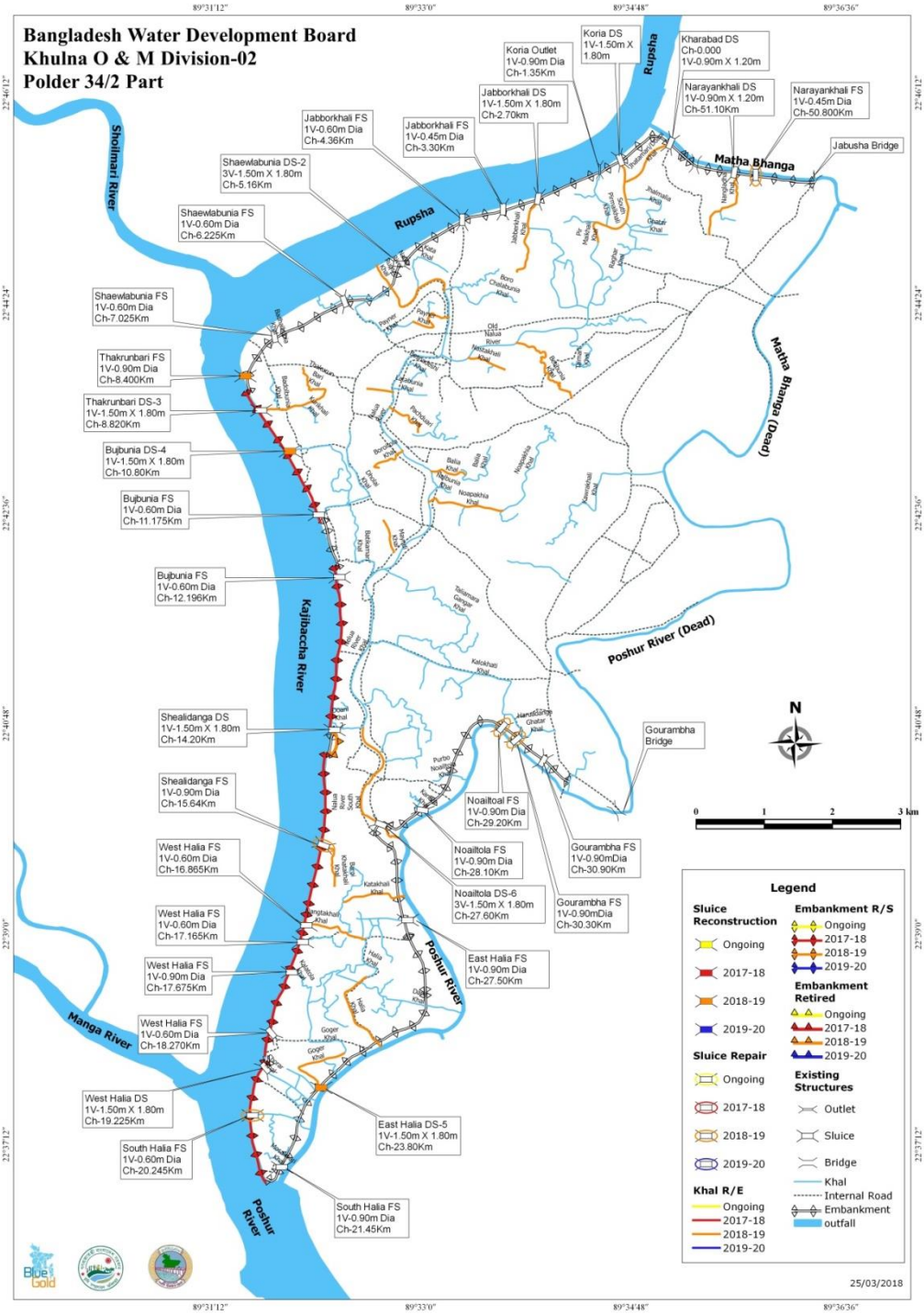
Source: Field estimation, 2019, UAO, DAE. Clean rice*

5.1.18 Water Resources

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

Polder 34/2 is 80 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is directly surrounded by surrounded by Mathabhanga river in the north, Rupsha River in the northwest, Kazibacha in the west, Poshur in the south and dead Poshur & dead Mathabhanga in the east (shown in the map). The river system of the area is shown in **Map 5.7**.



Map 5.7: Water Resources System of the Polder Area

Hydrological Connectivity

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 34/2 are also shown in **Map 5.7**.

Surface Water Level

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.

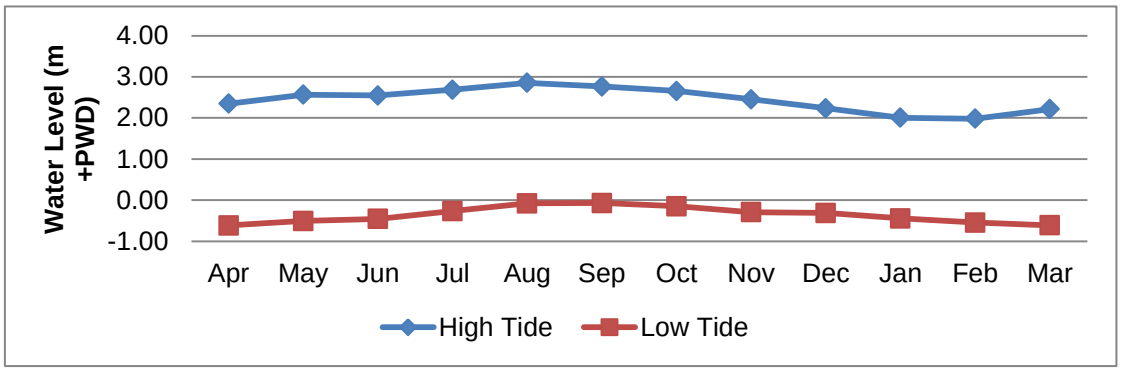


Figure 5.9: Surface Water Level at Chalna (Rupsa-Pasur River)

Ground Water

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.

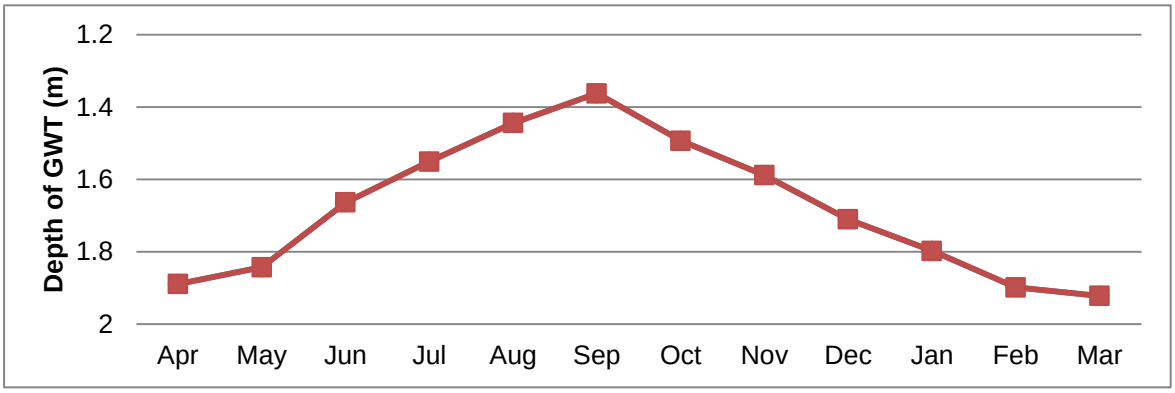


Figure 5.10: Average Monthly Variations of Ground Water Table

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)

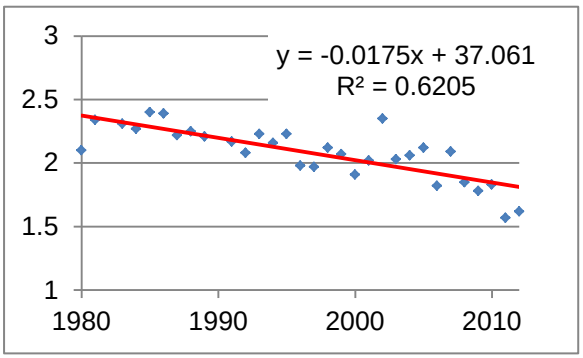


Figure 5.11: Variation of GWT at KHU003 in March (1980 – 2013)

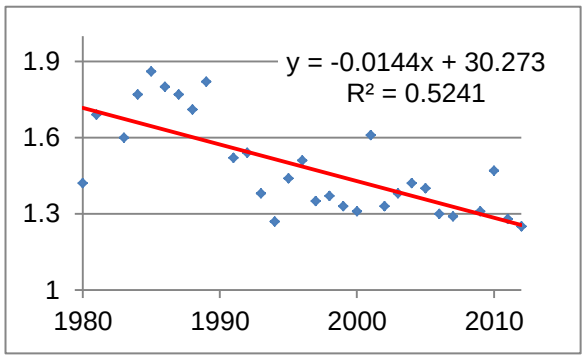


Figure 5.12: Variation of GWT at KHU003 in September (1980 – 2013)

Source: NWRD, 2013

5.1.19 Water Resources Problems

Tidal and Storm Surge Flooding

Local people in polder 34/2 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 34/2. Local people also alleged that there was very minor storm surge flooding in Polder 34/2 during Aila (2009) and Sidr (2007).

Water Logging and Drainage Congestion

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 34/2.

Erosion

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 2019, 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.

5.1.20 Water Resources Functions

Water Use

a. Domestic Use

The average daily demands of water for domestic and drinking purposes in rural areas are considered as 50 lpc [19]. However in Polder 34/2, 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

The local farmers in Polder 34/2 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 34/2

Season	Aman (ha)	Watermelon, Vegetables(ha)	Water Required (Mm Per ha)	Water Used (Mm^3)	Source of Irrigation
Kharif-II	3,234	-	300	12.72	Rain Water
Rabi	-	105	250	0.2625	Surface Water

Source: CEGIS Estimation

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 34/2 under Aus cultivation.

Navigation

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.

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.

5.2 Biological Environment

5.2.1 Fish Habitat

The polder area is surrounded by the Mathabhanga river in the north, Rupsha river in the northwest, Kazibacha in the west, Poshur in the south and dead Poshur & dead Mathabhanga in the east (shown in the map). 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.

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

Capture Fisheries

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	90
		Floodplain/Borrow Pit	50
		Sub-total	**140**
2	Culture	Gher (Rice-cum-golda/Bagda)	*82*
		Fish pond	64
		Sub-total	***150***
		Total	**290**

Source: Field survey data 2017

Among the khals, Nalua (River) khal, Halia khal, Thakrunbari 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. Halia khal **(Encroached for Fish Culture)**

b. Baroikatakhali 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 34/2 part

Sl. No.	Name of Khal	Wide (m)	Depth (m)	Length (km)	Type of Water Bodies
1	Nalua (River) khal	20.0	1.7	4.41	Perennial
2	Halia khal	15.6	1.7	2.57	Perennial
3	Thakrunbari khal	10.1	0.7	3.16	Perennial
4	Goger khal	13.4	2.3	1.13	Perennial
5	Zabberkhali khal	20.6	1.7	3.28	Seasonal
6	Baroikatakhali khal	7.2	1.7	4.78	Seasonal
7	Peermaikhali khal	9.7	1.2	4.35	Seasonal

Sources: Field survey data 2017

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

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

Aquatic environmental quality is overall satisfactory in the study area. 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 (°C)**	**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

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.

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

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	15
		Floodplain/Borrow Pit	13
		Sub-total	**28**
2	Culture	Gher (Golda/Bagda with white fish)	57
		Culturable pond	45
		Sub-total	**102**
		Total	**130**

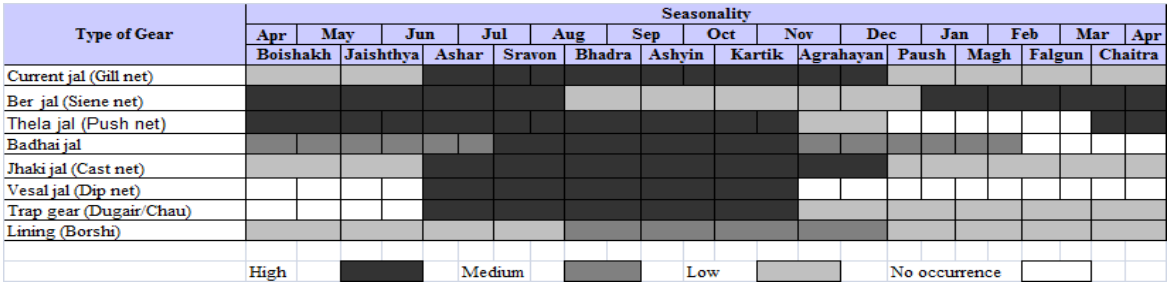
Source: Field data and FRSS, 2011-12

5.2.4 Fishing Effort

Fishing Seasonality

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, 2017

Fishing Crafts and Location

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.

Fishing Gears

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 5.6: Fishing Boat in the Polder Area

Photo 5.7: Fishing Gear

5.2.5 Fish Migration

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 Nalua (River) khal, Halia khal, Thakrunbari khal 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

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

The dominant cultured fish species (both pond and gher) are *Rui*, *Catla*, *Tilapia*, *Pangas*, *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

Scientific Name	Local Name	Habitat Type			
		Periphery Rivers	Khal	Gher	Pond
Wallago attu	Boal	M	NA	NA	NA
Sperata seenghala	Guijja Ayre	L	NA	NA	NA
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, 2017, Here, Abundance H= High; M=Medium; L= Low; and NA= Not Available

5.2.7 Species of Conservation Significance

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, 2017

5.2.8 Area of Conservation Significance

Nalua (River) khal and Halia 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

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

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 Amirpur union (part), Vanderkote union (part) and Baliadanga union under Batiaghata upazila of Khulna district. The polder area encompasses two of these bio-ecological zones; namely The Ganges Tidal Floodplain and Saline tidal floodplain. A brief ecological description of the bio-ecological zone is presented below.

Ganges Tidal Floodplain

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.

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.
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.

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

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).

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.

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.

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 Biological Zone	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

5.2.11 Terrestrial Ecosystem

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

a. Homesteads
b. Field Crops
c. Roads and embankment

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

a. Terrestrial Flora

Settlement/Homestead Vegetation

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

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

Crop Field Vegetation

Crop field vegetation extends over 3, 234 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 HYV Boro, sesame, watermelon, mungbean, sunflower and very little vegetables. Different crop plants and cropping patterns are discussed in the agricultural section of this report.

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.

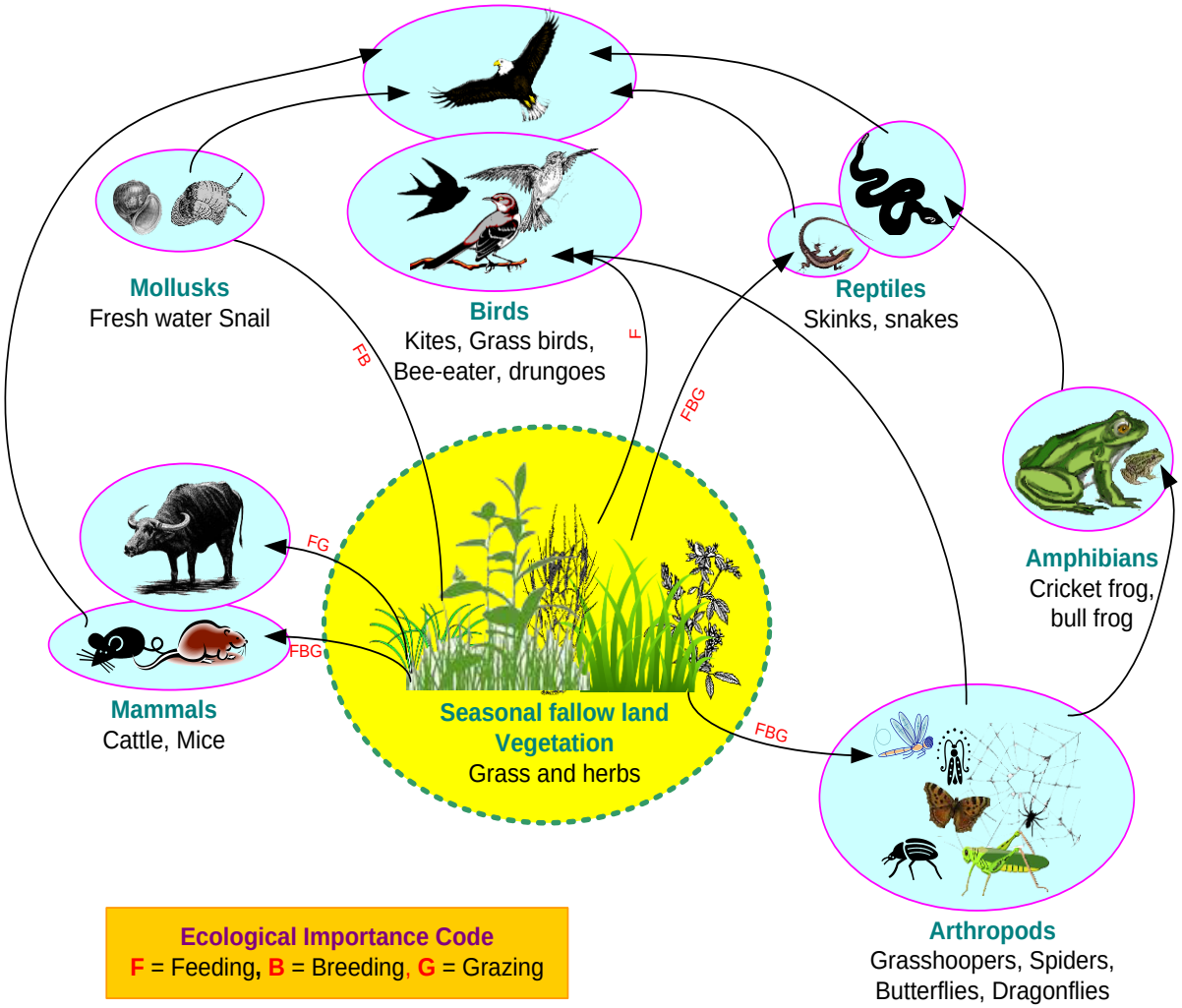


Figure 5.13: Ecological Importance of Seasonal Fallow Land's Vegetation for Different Faunal Commodities along with Partial Food Web

Photo 5.10: View of Sesame Field in the Polder 34/2 Area

Embankment /Roadside Vegetation

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.**

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

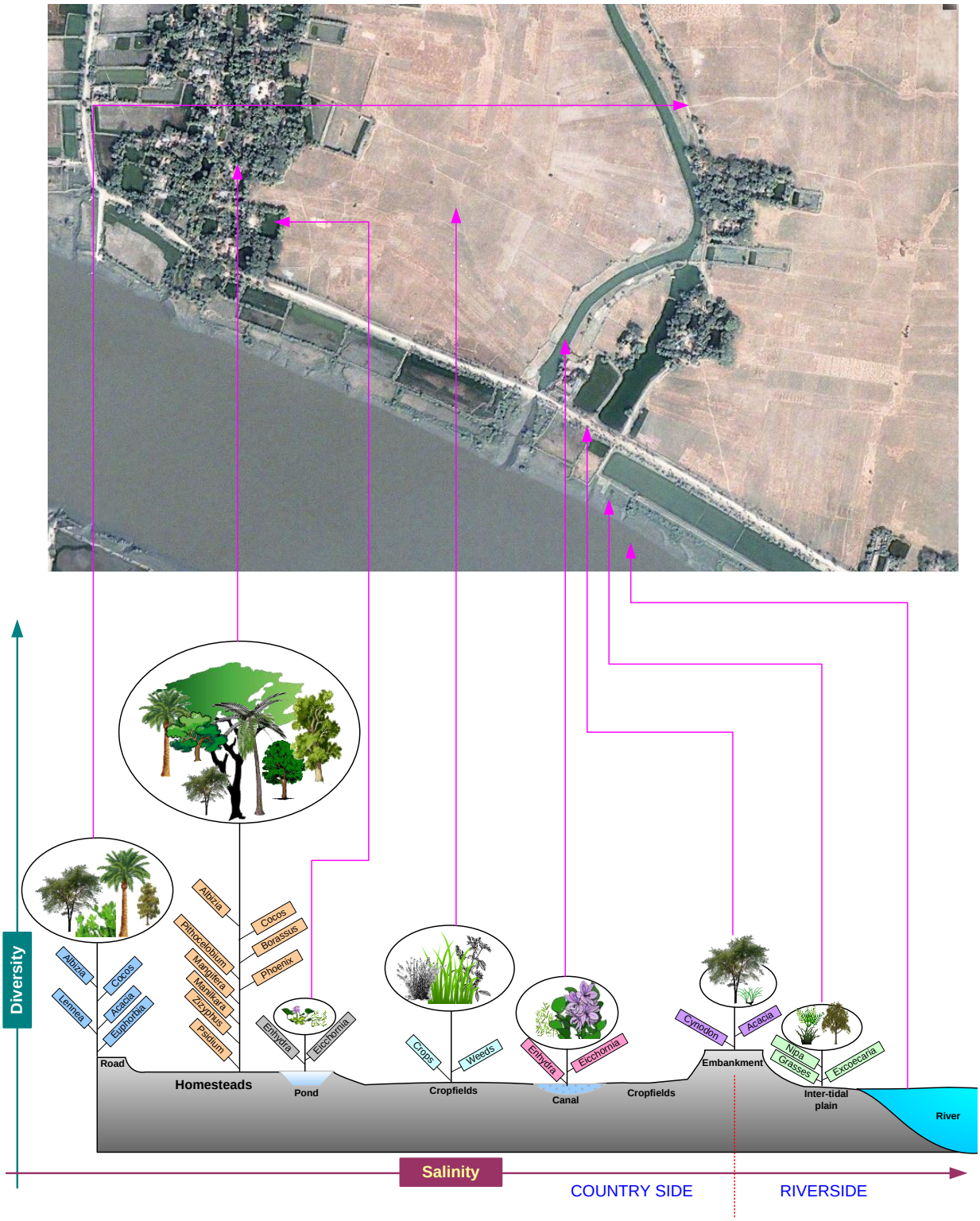


Figure 5.14: Different Types of Ecosystems and Vegetation Composition of Polder 34/2

b. Terrestrial Fauna

i. Amphibians

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

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

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

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 scolopacea*), and Large-billed crow (*Corvus macrohynchos).*

5.2.12 Aquatic Ecosystem

Wetlands

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.

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

Seasonal Wetland

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

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

c. Aquatic Flora

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.

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.

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.
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.).

Mangrove Vegetation
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.

d. Aquatic Fauna

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

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

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

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

e. Output of Ecosystem Services

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*	Leaf and stem

Item	Source	Goods/Services
	aquatica)	
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

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

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	3,456
Goat	40	1,967
Sheep	20	1,212
Chicken	75	9,945
Duck	40	5,278
Pigeon	4	899
Pigs	25	1290

Source: Based on field information, 2019 and Upazila Livestock Office.

Feed and Fodder

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.

Photo 5.16: View of Duck in the Polder Area

Photo 5.17: View of Poultry Firm in the Polder Area

Livestock and Poultry Diseases

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

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.

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%
Gongarampur Union Parishad	22º40'47.8" 89º30'39.2''	50		Up to 20%

Source: CEGIS field survey, May 2014

5.3.2 Water Quality

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).

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
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: field survey, May 2014

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: field survey, May 2014, Note: SW: Surface water and GW: groundwater.

5.4 Climate Change

5.4.1 Climatic Trends

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 34/2.

Temperature

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).

The number of extremely cold nights having temperature less than or equal to 9.7°C, which corresponds to the 10^{th}percentile 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 90^{th}percentile 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

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).

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

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).

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

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).

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).

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

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.

5.4.2 Climate Change Projection

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**).

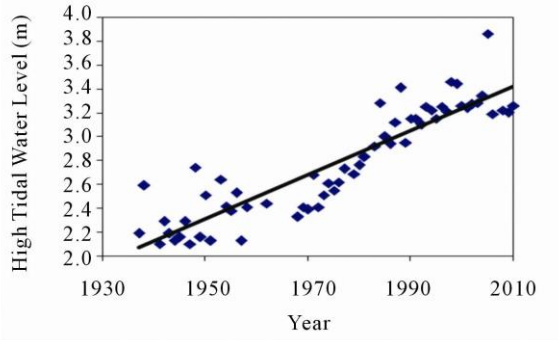


Figure 5.15: Trend in Annual Maximum High Tidal Water Levels at Rupsa-Pasur River (Mondal, 2012)

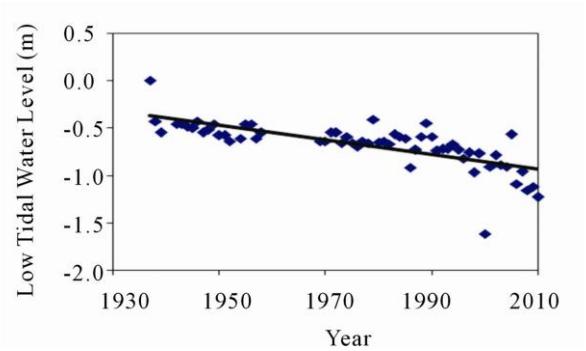


Figure 5.16: Trend in Annual Minimum Low Tidal Water Levels at Rupsa-Pasur River (Mondal, 2012)

Table 5.26: Summary Features of Climate Projections for Khulna

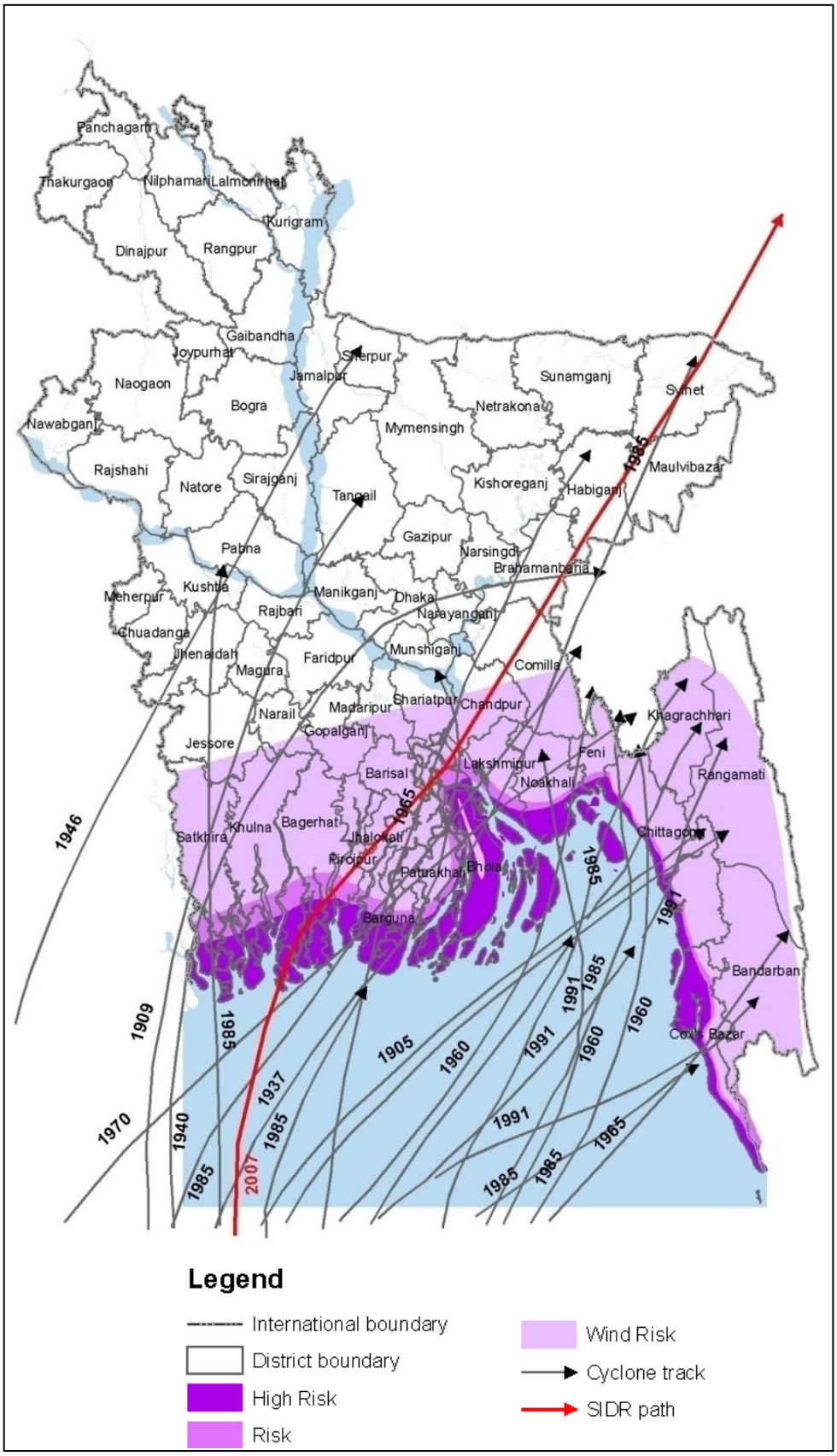
Scenario	A2	B1
Temperature	The average monthly temperature rise by 2050 varies from $+0.5^0$C in October to $+1.7^0$C in January and February.	The average monthly temperature rise by 2050 varies from $+0.5^0$C in June, July, and August to $+1.5^0$C in February and April.
Rainfall	The annual rainfall 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 34/2

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 34/2 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



Map 5.11: Cyclone Tracks in Bangladesh and Risk Areas

6 Socio-Economic Condition

6.1 Demography

The 4,427 households in the polder area have a total population of 18,292 of which 9,064 are male and 9,226 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	2946	11
Percentage (%)	-	**100%**	**49.55%**	**50.44%**	**74.91%**	**25.03**	**0.06**

Source: Population Census 2011, BBS

6.1.1 Age Composition

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).

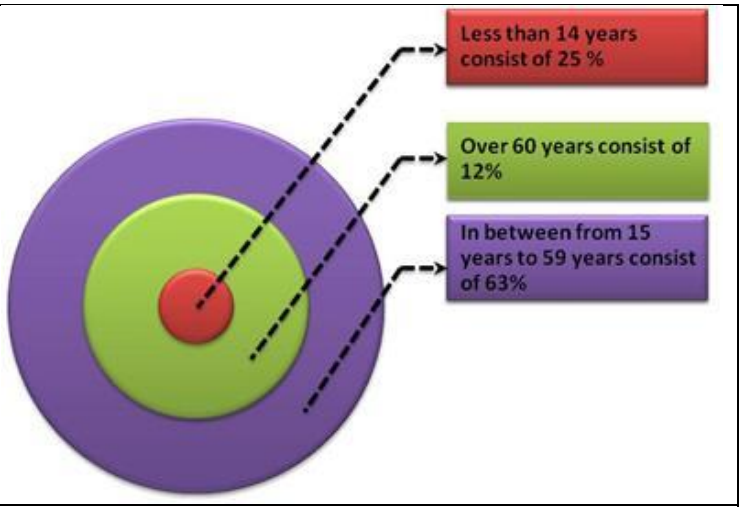


Figure 6.1: Age Composition at Polder Area

Source: Population Census 2011, BBS

Table 6.2: Age Distribution at Polder 34/2

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

Source: Population Census 2011, BBS

6.1.2 Dependency Ratio

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 35% of the population depends on the 65% of the earning members of their households. Hence, the dependency ratio is 54 which are smaller than national rate 56.

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

Source: Population Census 2011, BBS

6.1.3 Marital Status

According to BBS, around 66% 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

Source: Population Census 2011, BBS

6.2 Household Size and Types of Family

The average household size is 4.02, which is smaller than the national household size of 4.50 (HIES 2010[1]). 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

Source: Population Census 2011, BBS

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.

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

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

6.3 Livelihood Status

6.3.1 Employment and Occupation

In the polder area, about 28% of total population is employed, 49% is engaged in household work, only 0.02 percent is looking for work and about 23% 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.

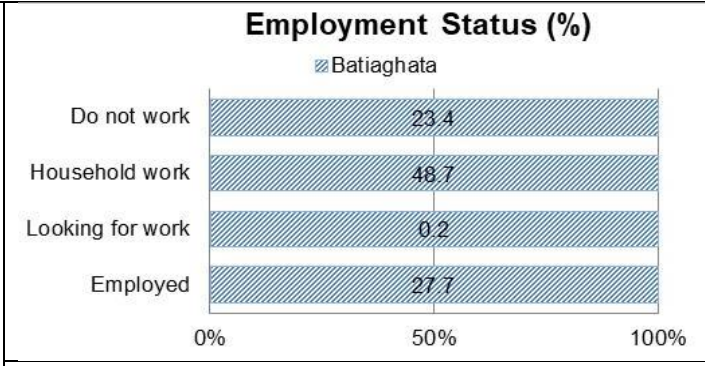


Figure 6.4: Distribution of Employment Status by Polder Area

Source: Population Census 2011, BBS

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.

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.

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.

6.3.2 Availability of Labor and Wage Rate

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

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

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

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: Fieldwork 2019

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

The average literacy rate in the study area is 55.9% which is slightly better that national level (51%). 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.

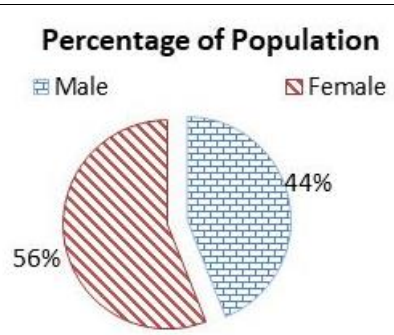


Figure 6.7: Percentage of Population (%) Aged 7+ years not Attending School

Source: Population Census 2011, BBS

6.5.1 Educational Institutions

According to the field findings there are 18 primary schools, 3 high schools and 3 ebtedaye/ Dakhil Madrashas in the polder area (Table 6.7 and Photo 6.2). 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

Source: Field work, 2019

6.6 Health Condition

6.6.1 Disease Prevalence

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: Fieldwork, 2019

6.6.2 Health Services and Facilities

Field findings show that there are one upazila health complex, 1 union health complexes and 4 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

Source: Feldwork, 2019

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

Landownership pattern[4] can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 73% smallholders, 22% medium and only 5% large landholders. In the study area, arable land is mainly used for crop production. Generally small and medium holders cultivate variety of crops at those lands. They cannot produce 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.

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.

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

Table 6.10: Sell Value of Land at Polder 34/2

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: Fieldwork, 2019

6.8 Household Income and Expenditure

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.

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: Fieldwork, 2019

6.9 Sectors of Income and Expenditure

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).

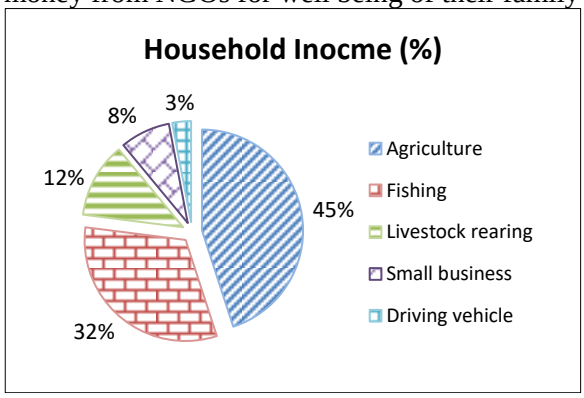


Figure 6.9: Proportionate Distribution of Household Income

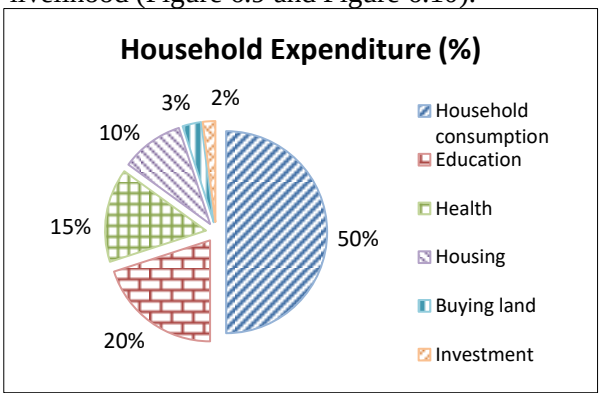


Figure 6.10: Proportionate Distribution of Household Expenditure

Source: Fieldwork, 2019

6.10 Susceptibility to Disasters

The local inhabitants of Polder 34/2 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: Fieldwork, 2019

6.11 Quality of life

Housing Tenancy and Housing Condition

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 90% people possessed own household within the polder area whereas around 6% people are living without rent free and rest of 4% are living in rented house (Source: Population Census 2011, BBS)

In the polder area, overall housing condition[5] is not satisfactory. On an average only 9.5% of houses are Pucka, 12.7% houses are semi-pucka and 1.3% houses are as like Jhupri whereas 76.5% 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.

[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 6.3: Jhupri House

Photo 6.4: Kutcha House

Table 6.13: Types of Housing Structure by Union at Polder 34/2

Union	Type of Structure (%)			
	Pucka	Semi-Pucka	Kutcha	Jhupri
Batiaghata	9.5	12.7	76.5	1.3

Source: Population Census 2011, BBS

Photo 6.5: Semi-pucka Hhouse

6.11.1 Sanitation

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 82 %households have hygienic sanitation facility (water-sealed), 13 % have not water-sealed sanitation facility, 3% have non-sanitary sanitation facility and 2%have no sanitation facility. Local people face the worst situation regarding the sanitation facility.

[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.

Table 6.14: Sanitation Facilities by Union at Polder 34/2 part

Union	Toilet Facility (%)			
	Sanitary (Water-Sealed)	Sanitary (Non Water-Sealed)	Non-Sanitary	None
Batiaghata	81.8	13.4	3.3	1.6

Source: Population Census 2011, BBS

Photo 6.7: Sanitation Facility in the Polder Area

6.11.2 Drinking Water

Overall status of drinking water in the area is satisfactory. Almost 100% people can collect drinking water from tube well, salinity is the main problems in the polder area but not severe condition. 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 significant.

Table 6.15: Sources of Drinking Water in Polder by Union

Union	Source of Drinking Water (%)		
	Tap	Tube-Well	Other
Batiaghata	-	100.0	-

Source: Population Census 2011, BBS

6.11.3 Electricity and Fuel Consumption

Electrification as reported in the Population Census is moderate in the polder area. On an average, only 44% households are under electricity coverage for Polder 34/2. Moreover, almost 35% households are now use solar electricity in the polder area (Fieldwork, 2019). 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.

6.12 Social Amenities

Roadways

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 34/2 part

Road Type	Length (Km)	Width (m)	Area under road (Ha)
District Road	11	9	10.10
Upazila Road	23	8	17.35
Union Road	16	5	7.92
Rural Road	79	4	29.03
Total	129	-	64.4


Photo 6.11: Paved and Soling Roads in the Polder Area

Markets and Growth Centres

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 34/2 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

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). 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: Ffieldwork, 2019

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.

6.13.2 Common Property Resources

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).

There are 16 mosques, 26 temples, 8 Eidgah, 10 graveyards and 16 crematoriums in the polder area. Besides there are 5 cyclone shelters among them 2 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 34/2

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

Source: Union website, 2014

6.13.3 Conflict of Interest

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

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.

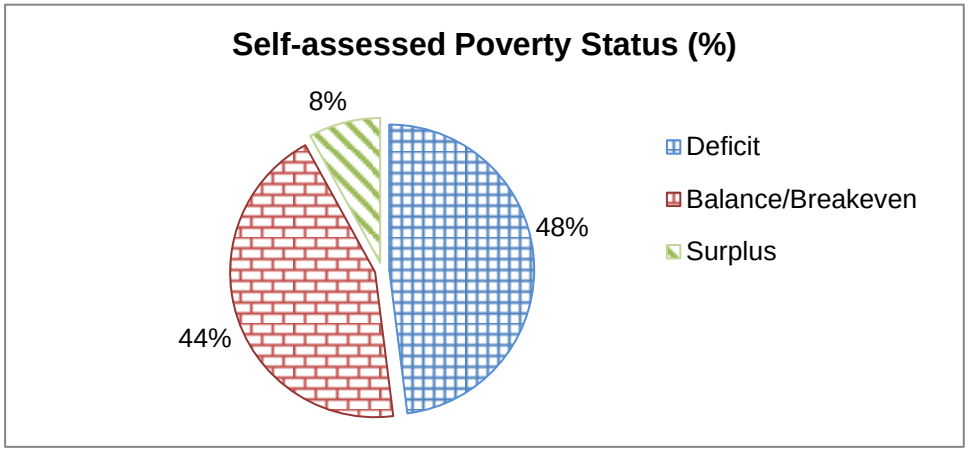


Figure 6.13: Self-assessment of Poverty Status

Source: Fieldwork, 2019

6.15 Gender Issue

Education Enrolment

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).

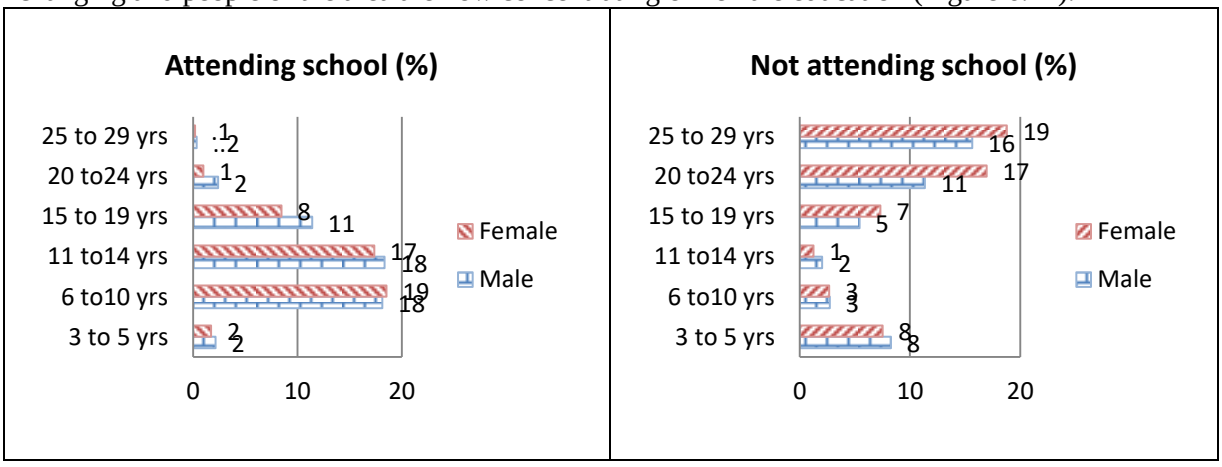


Figure 6.14: Male-Female Education Enrolment at Polder Area

Health

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

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

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.

Vulnerable Communities

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

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

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.

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

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

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

Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed Project in Polder 34/2, 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

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.

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

Participatory approach was followed in conducting the public consultation meetings in the Polder 34/2. 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.

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.

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 34/2 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

One PCMs and number of discussions were conducted at different locations of the Polder 34/2. 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	24/05/2019	09:00
2	„	„	Sadar	Fulbari WMG, Batiaghata Bazar	FGD	24/05/2019	11:00
3	„	„	Batiaghata UP	Batiaghata UP	PCM	24/05/2019	14:00

Photo 7.4: PCM and Group discussions meeting at Batiaghata upazila, Khulna

7.4.2 Consultation Participants

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 34/2 and nearby areas. A total of 120 participants attended these consultations.

7.5 Issues Discussed in FGDs and Meetings

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

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 7.2: 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 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

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Fishery resources	• Deterioration of habitat quality due to salinity and siltation in the khal • Pond overtopping during heavy rain • Illegally fish culture in the internal khal through pata jal by the local musclemen	• Repairing the water control structure • Re-excavation of the silted up khals • Application of fisheries rules and 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 & 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

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

Table 7.4: Name of Participants

Environmental Study for Blue Gold Program
Participants List of Public Consultation Meeting (MCM)

Place: Fulbari, Polder- 34/2, Baliaghata, Khulna Date: 24-05-2019

Sl. No.	Name	Address/Designation	Mobile No.	Signature
1.	পারভীন বেগম	সদস্য, WMG	01913213507	পারভিন
2.	তানিয়া বেগম	〃	01831994727	তানিয়া
3.	ওমেনুর বেগম	〃		[illegible]
4.	নাজমা বেগম	〃	01868-196958	নাজমা
5.	মাফুজা বেগম	〃	01883498196	মাফুজা
6.	নাদিরা বেগম	〃	01650099528	নাদিরা
7.	হাজিনা বেগম	〃	01735505789	Hagina
8.	খাদিজা বেগম	〃	018714706[8/4]	খাদিজা
9.	গোলাম মোস্তফা	সভাপতি, WMG	01768199107	[illegible]
10.	সিরাজ গাজী	সদস্য. WMG	01827974530	সিরাজ
11.	আঃ রব মিনা	〃	01871811423	রব
12.	মোশারফ শেখ	〃	01727-739352	মোশারফ
13.	আতিকুল সরদার	〃		আতিকুল
14.	খায়রুল আলম	〃	01839148651	[illegible]
15.	আবুবর গাজী	〃	01872819155	আবুবর
16.	তরিকুল শেখ	〃	01884439127	তরিক
17.	মুজাহিদ মোল্লা	〃		[illegible]
18.	সচিন মল্লিক	〃	01726943435	সচিন মল্লিক
19.	হেনারা বেগম	〃	01863698550	হেনারা
20.	শওকত আলী	〃	01726	[illegible]
21.	মেরাজুল আলম	সম্পাদক, WMG	01758687601	[illegible]
22.	হাবিবু শেখ	সদস্য, WMG	01735371284	[illegible]
23.	মিকাইল সরদার	〃	01729903667	মিকাইল
24.	জাকির হোসেন	〃	01857849084	জাকির
25.	হাসনা হেনা	〃	0597098600	[illegible]

7.8 Perceptions towards proposed interventions

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 34/2.

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 34/2, 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 34/2, 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 34/2 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 protection works would be provided at four vulnerable points, as per WMOs recommendations in Polder 34/2. 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 34/2. 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.
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	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 damage observed 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.

IESCs	Rationale
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	
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 34/2 part. 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

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

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).

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
Re-excavated earth dumping and compaction on the banks of khals	-	-	-	MP	-	-	-	-	-	-	-	-		MN	MN	MP	MP	MP
Repairing	HP	HP	-	-	HP	MP	HP	HP	HP	-	MN	-	-	I	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**
of Drainage Sluices																		
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
c. O & M phase																		
Checking the physical condition of embankment during pre & post monsoon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Checking the physical	HP	HP	HP	-	HP	-	-	-	-	-	-	-	-	-	-	-	-	HP

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**
condition and function of water control structures																		
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

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 34/2 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

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 Re-excavated earth materials would be used on existing embankment and non-agriculture land.				
Fisheries Resources				
Activity: Re-excavation of khal				
1. Fish Habitat 2. Hatchling and fish movement	1. Nagladaho khal 2. Jatamari/Donia khal 3. Jabbarkhali khal 4. Noapakhia khal 5. Baroi Katakhali Khal 6. Betibunia Khal 7. Mayndii Khal 8. Basabari 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, after one (01) year the habitat quality will improve.	-2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
	9. Nastakhali Khal 10. Doani/Pirmaikhali Khal 11. Halia khal 12. Thakurunbari khal 13. Payaner/ Ranajiter Hular khlal		• Fish production would loss temporally about 2 tons per year.	
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.	-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; • Feeding habitat for wildlife species.	• Babla trees along with different shrubs and herbs needs to be cut during construction activities.	-3
Activity: Temporary bank protection				
Habitat Condition	Dakkhin Sholmari, Kismat Fultola, near to UZ HQ and Hogalbunia	• Species diversity & 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. Nalua (River) khal b. Halia khal	• Kochuripana (*Eichhornia crassipes*), Kutipana (*Azolla pinnata*), Dhol Kolmi	• Disturbance to existing aquatic habitat would have negative	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
	c. Thakrunbari khal d. Goger khal e. Zabberkhali khal f. Baroikatakhali khal g. Peermaikhali khal	(*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	impacts on wildlife e.g. Egret; • Damages of existing bank line vegetations due to dumping of soil along sides of the khal	
Socio-economic Condition				
Employment Opportunity	Periphery and inside of the polder 34/2 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
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 34/2 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	The LCS entail 50% male and 50% female, all of them would be engaged from the local area. Thus, employment access to female in earth 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 34/2 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

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

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 34/2 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

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

At present, people from Polder 34/2 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

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 34/2 part are directly dependent on Hugolbunia, Hania, Botiaghata, Uzukhali, Kalatola, Khoria and Amtola khals. This eventually leads that around 40 thousand people from Polder 34/2 are likely to be benefited by the additional volume of water available in the re-excavated khals.

Impacts
Around 10% population inside Polder 34/2 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
The internal khals of Polder 34/2 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
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 34/2. 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
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 34/2 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
There are four erosion hotspots in Polder 34/2 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
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
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
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 34/2 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

The re-excavation of existing khalswould reduces 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 34/2 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

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

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

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

Presently, total crop production is about 16,337 tons of which, rice production is about 8,717 tons and non-rice crops production is about 7,620 tons. The contribution of rice production is about 53% and non-rice crop is about 47% of the total crop production. Under the FWOP condition, the crop production would be 14,356 tons due to increase of salinity, siltation of khals, drainage congestion etc.

Future With Project

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 9,433 ton which would be about 34% higher than the production of FWOP. About 8,725 tons of non-rice crops would also be produced under the FWIP condition which would be about 19% higher than that of future without project (FWOP). The production of rice would be increased due to increase of HYV Aman and Boro rice area. Additional 2,413 tons rice and 1,389 tons of non-rice would be produced under FWIP as compared with future without project (FWOP).

Impacts

Additional 2,413 tons rice and 1,389 tons of non-rice crop 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 Boro	3134	2836	3350	514	18
2	HYV Aman	3738	2467	4135	1668	68
3	LT Aman	1658	1547	1768	221`	14
4	T. Aus	187	170	180	10	5
Total rice		**8,717**	**7020**	**9433**	**2413**	**34**
5	Sesame	3010	2856	3278	422	15
6	Vegetables	2432	2045	2997	952	47
7	Watermelon	1225	1423	1345	-78	-5
8	Mungbean	840	982	1002	20	2
9	Sunflower	113	30	103	73	243
Total non-rice		**7620**	**7336**	**8725**	**1389**	**19**
Total crop production		**16337**	**14356**	**18158**	**3802**	**26**

Source: Field information, 2019

b. Crop Damage

Future Without Project

Presently, total rice crop production loss is 283 tons and non-rice crop production loss is 132 tons due to drainage congestion/water logging etc. The situation would be aggravated under FWOP condition. The crop production loss would be about 766 tons of which rice production is 407 tons and non-rice is about 359 tons.

Future With Project

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 184 tons of rice and 186 tons non-rice under the future with project (FWIP) condition.

Impacts

It is expected that loss of crop production would be reduced 223 tons rice and 173 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	210	320	134	-186	-58
2	LT Aman	67	79	46	-33	-42
3	T. Aus	6	8	4	-4	-50
Total rice		**283**	**407**	**184**	**-223**	**-55**
4	Sesame	111	234	117	-117	-50
5	Water melon	8	120	64	-56	-47
6	Sun flower	13	5	5	0	0
Total non-rice		**132**	**359**	**186**	**-173**	**-48**
Total crop production		**415**	**766**	**370**	**-396**	**-52**

Source: Field information, 2019

c. Irrigated Area

Future without Project

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

Irrigated area would be increased due to implementation of interventions (Re-excavation of khals) and its proper management. It is expected that, irrigated area would be about 225 ha in FWIP.

Impacts

It is expected that, irrigated area would increase about 175 ha under FWIP over FWOP.

8.6.4 Fisheries Resources

a. Fish Habitat

Future Without Project

1. Most of the internal khals of Polder 34/2 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 Nalua (River) khal, Halia khal, Thakrunbari 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 in the Baliadanga Union 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 in the Amirpur Union 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 12ha (Map 8.4).

Future With Project

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. Culture fisheries practices would be increased significantly due to reduction of flood risk and salinity. Many culturable pond would be converted into cultured pond.

Impacts

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

2. 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

3. 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 Thankrunbari, Bujbunia and Shealidanga) will facilitate the fish movement inside the polder area.

Impacts

4. 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

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

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

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

In the polder area, at present capture fisheries productivity is 172 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

5. 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

6. 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

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

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

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

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

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

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

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

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

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

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

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

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 34/2 part 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 34/2 part.	+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 water logging	Drainage congestion at 23 km water courses inside the polder, but no water logging.	Around 32 km khals would face more drainage congestion and 132 ha areas may face water logging problems	Drainage congestion in the upstream portions of the khals would diminish	+3
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.	h. Salinity situation would be decreased due to prevention of intrusion of saline water in the polder area.	+2
Agricultural Resources				

IESC	Baseline	FWOP	FWIP	Impact (+/)/ Magnitude (1-10)
Crop production	Total crop production is 16,337 tons of which rice crop is 8,717 tons and non-rice is t 7,620 tons.	Total crop production would be 14,356 tons of which rice crop would be 7,020 tons and non-rice would be about 7,336 tons.	Crop production would Increase about 26% in FWIP over FWOP.	+4
Crop damage	Rice production loss is about 283 tons and non-rice production loss is 132 tons.	Rice production loss would be about 407 tons and non-rice production loss would be about 359 tons.	Loss of crop production would decrease as follows: Rice: 55% Non-rice: 48% 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
Fisheries Resources				
Fish habitat quality	Habitat quality is comparatively 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.	• The ongoing siltation 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.	Habitat quality would be improved. That would support different types of aquatic vegetation which would be helpful for fish feeding and habitation.	+3
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): 172	Khal (kg/ha): 160	Khal (kg/ha): 190	+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	Under the FWOP situation, shrimp cultivation may increase	With the intervention, numbers of families would be benefited. They	+2

IESC	Baseline	FWOP	FWIP	Impact (+/)/ Magnitude (1-10)
	to monopolization of khals by local power elite. They often use these khals for shrimp cultivation.	which would eventually create more salinity in water and agricultural land. As a result people's quality of life will be deteriorated.	would be able to use water in different social aspects. Moreover, this would enhance social bonding and cohesion among them.	
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)*

9 Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

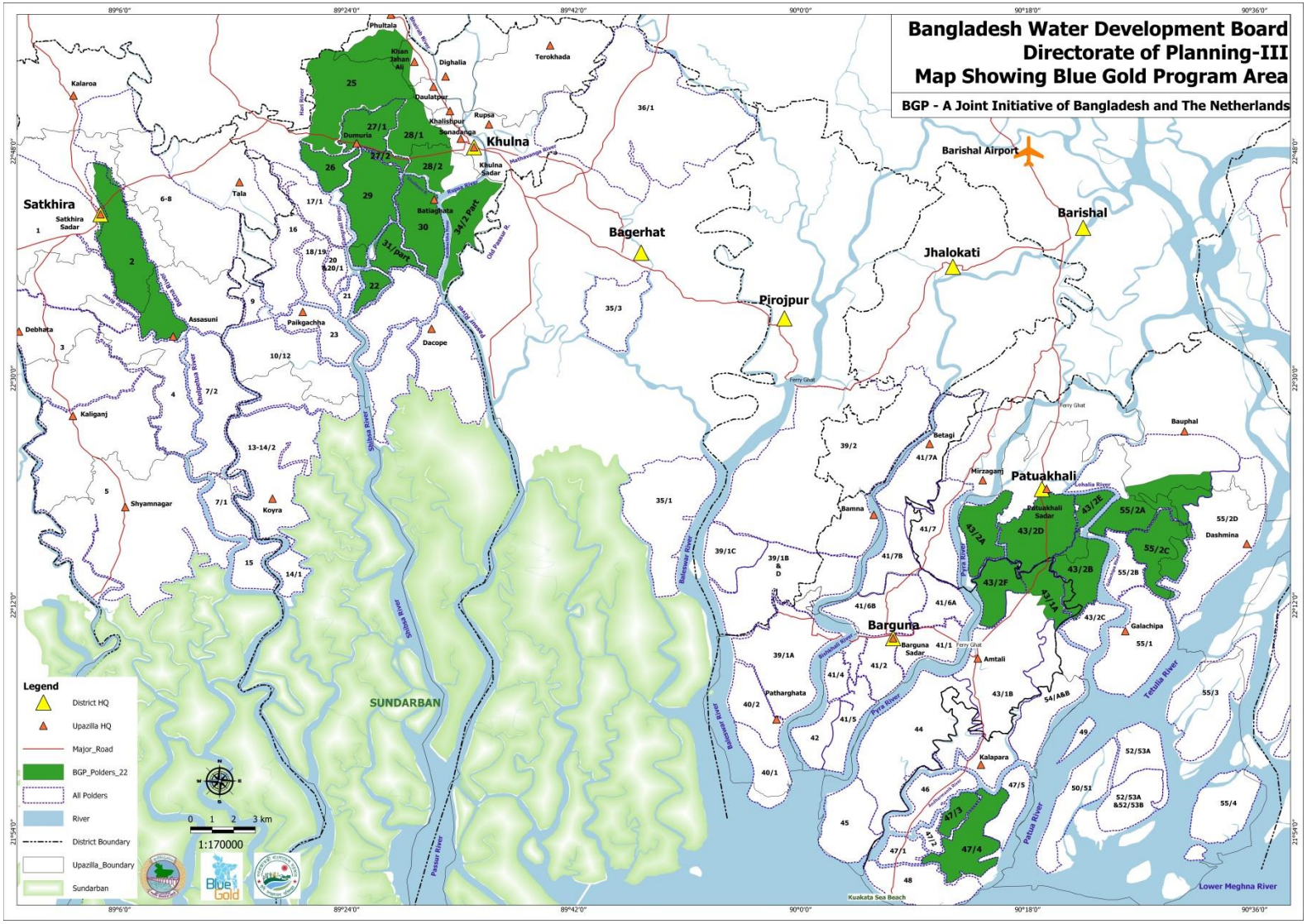
This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 34/2. These effects include cumulative and induced impacts of Polder 34/2, and the reciprocal impacts of climate change and polder. Cumulative impacts 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 34/2, 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 34/2

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, Polders 30 are located adjacent to Polder 34/2 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 34/2), 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 34/2. Furthermore, repairing of existing water control structures of Polders 30 under Blue Gold program would ensure reduction of dry season flow towards the polders. 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 34/2. Moreover, if any permanent bank protection works are carried out in future in the aforementioned polders under, the morphological behavior Jhopjhopia river may be changed. This might increase risk of river erosion in Polder 34/2.

9.2.1 Synopsis of projects around Polder 34/2

Apart from Blue Gold interventions, there are some other development projects nearby Polder 34/2, 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 34/2, undertaken by different line agencies in Khulna.



Map 9.1: Location of Polders selected for Blue Gold Program

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 34/2 part
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008- ongoing	Coastal Zone	Negligible	ECRRP polders are far from Polder 34/2 part
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	

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 34/2 are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

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.

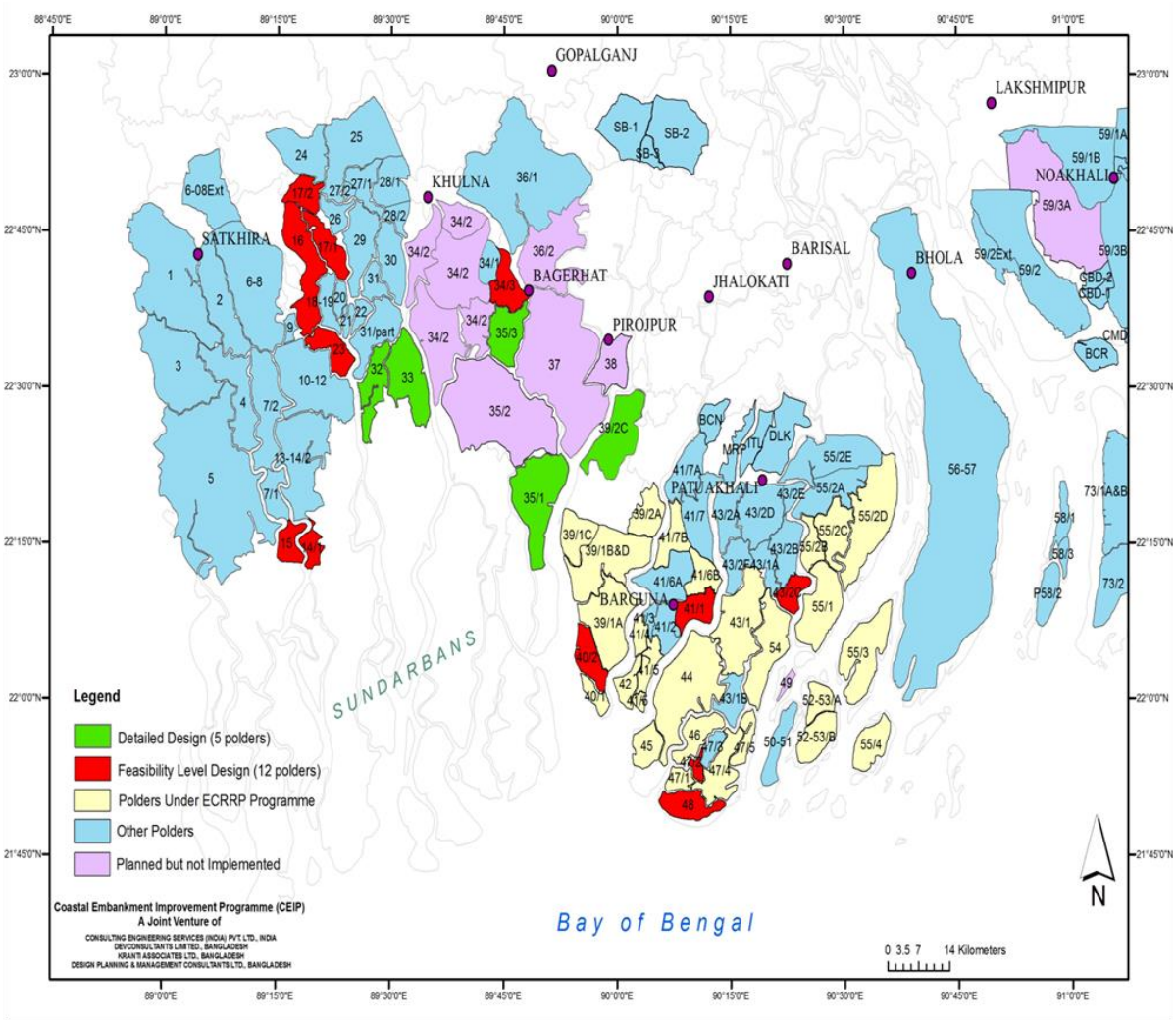
Sufficient dry season flow may cause great hydrological changes in the Ganges and adjacent river systems. The Barrage will meet up the demand of utilizing Ganges water of different sectors, leading to sustainable development of the Ganges Dependent Area (GDA). Diversion of Ganges water from the upstream 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.

Polder 34/2 is located within the GDA, and bears high sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 34/2 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)

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.

Polder 32 and 33 are located within 4 km downstream of Polder 34/2 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 34/2.



Map 9.2: Location of CEIP polders

9.2.4 Cumulative Impacts of Other Projects

As shown in **Table 10.1**, a number of other projects are functioning near Polder 34/2 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located far away from Polder 34/2. A synopsis of the minor indirect effects of these projects with **low sensitivity** on Polder 34/2 is discussed below.

Projects under Climate Change Trust Fund (CCTF)

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 34/2. 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 34/2.

Capital Dredging of River system

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 34/2. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 34/2. 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 34/2 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 34/2 may be further benefited.

9.3 Induced Impacts of Polder 34/2

The interventions in Polder 34/2 part 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 34/2 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

The proposed interventions in Polder 34/2 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 34/2 (i.e. waste generation, increased fertilizers etc.).

Tidal and Storm Surge Flooding

Polder 28, Polder 29 and Polders 30 is adjacent to Polder 34/2. As per design, the crest level of Polder 34/2 would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders during extreme events. Tidal water may not be able to enter Polder 34/2 during these events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders.

Affect on water quality

The interventions in Polder 34/2 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

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

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 34/2, 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

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 34/2 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

In order to investigate the reciprocal impacts of Climate Change and Polder 34/2, 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

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)

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

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

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

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

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

Weather Data

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

The 50 percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in **Table 9.2**. The results infer that the monthly rainfall 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. 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 9.2: Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for Polder 34/2.

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

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, 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
Source: IPCC AR4

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

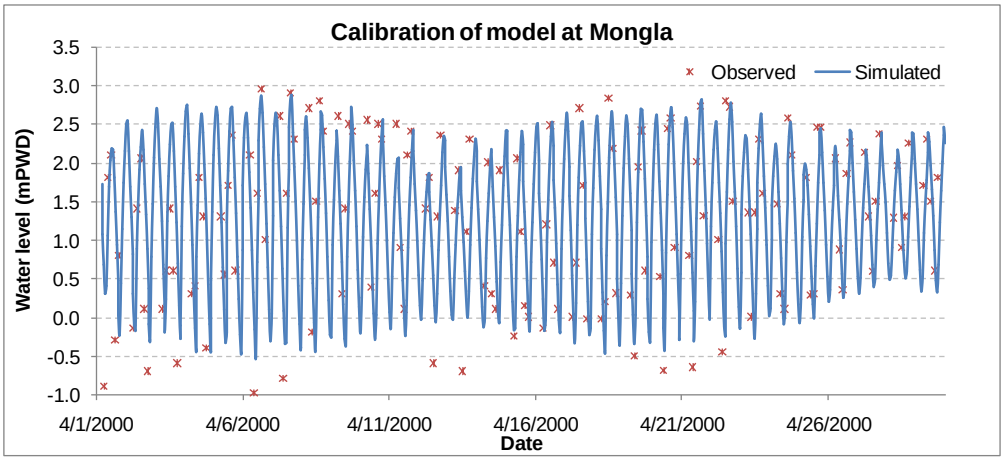


Figure 9.2: Calibration of model results at Mongla for April, 2000

9.4.2 Climate Change Impact on Water Availability

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.

The climate change impact on annual water balance for the Polder 34/2 part 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

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**.

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.

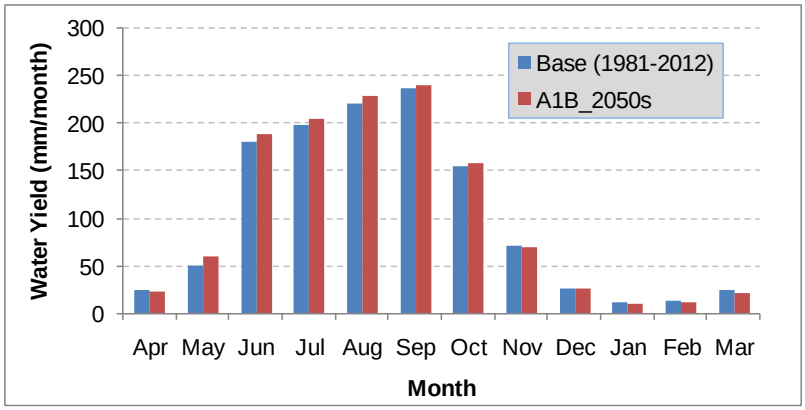


Figure 9.4: Climate change impact on monthly water yield for climate scenario A1B by 2050s

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

9.4.3 Climate Change Impact on Water Level

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.

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.

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 34/2. 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.

9.4.4 Climate Change Impact on Salinity

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.

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 34/2 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.

9.4.5 Climate Change Resilience Developed in Polder 34/2

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 Re-excavated earth 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(EMP)

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

There is no water resources impact in the phase.

10.1.2 During Construction Phase

There is no waterresources impact in the phase.

10.1.3 During O & M Phase

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 34/2 part 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 34/2 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

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

10.2.2 During Construction Phase

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

10.2.3 During O & M Phase

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 the design (re-excavation of Khal, earth work in repair/re-sectioning/protection of embankments and repair of sluice/irrigation inlet/drainage outlet).		• Formation of WMGs/WMA/WMF strengthening through imparting training need to be done. Involvement of WMGs in project 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.	+3	BWDB, DAE and WMGs

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

10.3 Agricultural Resources

10.3.1 During Pre-Construction Phase

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

10.3.2 During Construction Phase

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

10.3.3 During O & M Phase

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 34% and non-rice 19% 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: 55% Non-rice: 48% 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

There would be no impact during pre-construction phase.

10.4.2 During Construction Phase

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 Re-excavated earths 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

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 indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area.	+2	Department of Fisheries in co-ordination with Management Committee
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

There will be no impacts in this phase.

10.5.2 During Construction Phase

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

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Activity: Re-excavation of Khal				
• Disturbance to existing aquatic habitat which would impacts negatively to wildlife e.g. Egret; • Damage of existing bank-line vegetations due to dumping of soil	• Keep untouched the deepest points of the khal as much as possible; • 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	N/A	-3	Contractor and BWDB

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

10.5.3 Post-Construction Phase

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

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

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 paying proper wages.	+2	Blue gold and BWDB
Gender promotion	-	According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for female in future.	+3	Blue gold and BWDB

**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

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 sectors of present interventions of the polder.	+3	Blue gold and BWDB
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 Re-excavated earth Management Plan (SMP)

The term 'Re-excavated earth' is used for soil or dirt resulting from excavation of earthen canals or khals, and discarded off site. Effective management of Re-excavated earth is necessary because its volume usually inflates three times after excavation. The Re-excavated earth 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 Re-excavated earth dumping. It is therefore, important to transport and dispose the Re-excavated earth 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

Polder 34/2 of Blue Gold program entails excavation of a number of khals which would generate a volume of around 1,77,000 m^3 of Re-excavated earth. 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 Re-excavated earth earth for their own household uses. **Figure 10.1** provides a framework which includes the major components of the proposed Re-excavated earth Management Plan for rehabilitation of Polder 34/2 part 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.

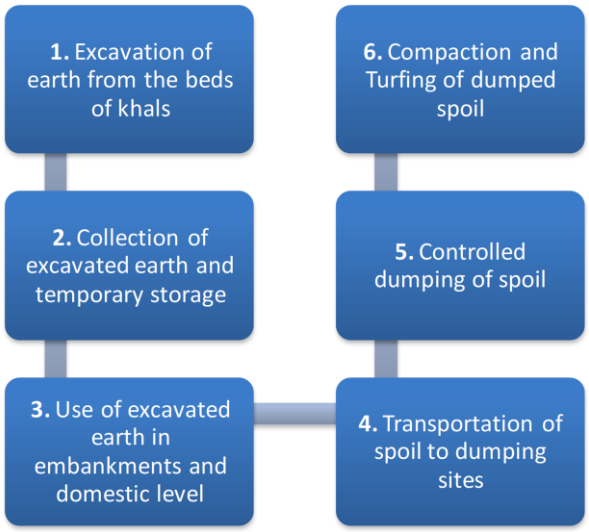


Figure 10.1: Framework for Re-excavated earth Management Plan

Table 10.11 below provides a tentative account of the voluPme of excavated earth, and its multifaceted uses proposed in the Re-excavated earth 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 Re-excavated earth, and use it to fulfill their domestic requirements. The Re-excavated earth may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Re-excavated earth 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 Re-excavated earth would be collected by for different uses. The residual portion (around 87 thousand m^3) of Re-excavated earth may then be disposed on both in a controlled manner.

Table 10.11: Tentative volume calculation and distribution of excavated Re-excavated earth

Khals to be Excavated	Volume (m^3)	Uses of Excavated Soil	Volume (m^3)
Nagladaho khal	17,089	Societal uses (uses in household, mosques, clinics or other shelters requiring earth materials)	80,000
Jatamari/Donia khal	23,262		
Jabbarkhali khal	30,463		
Noapakhia khal	13,591		
Baroi Katakhali Khal	11,930		

Khals to be Excavated	Volume (m^3)	Uses of Excavated Soil	Volume (m^3)
Betibunia Khal	24,791		
Mayndii Khal	10,436		
Basabari Khal	3,566		
Nastakhali Khal	6,960		
Doani/Pirmaikhali Khal	16,458		
Halia khal	23,690	Dumping	121,000
Thakurunbari khal	44,217	Loss during carrying	25,000
Payaner/ Ranajiter Hular khlal	17,089		
Total Excavation	**2,26,000**	**Total Use**	**1,26,000**

10.7.2 Phase wise activities of Re-excavated earth Management

A number of activities are proposed to be carried out during different phases associated with the efficient management of re-excavated Re-excavated earth (**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 Re-excavated earth. 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.

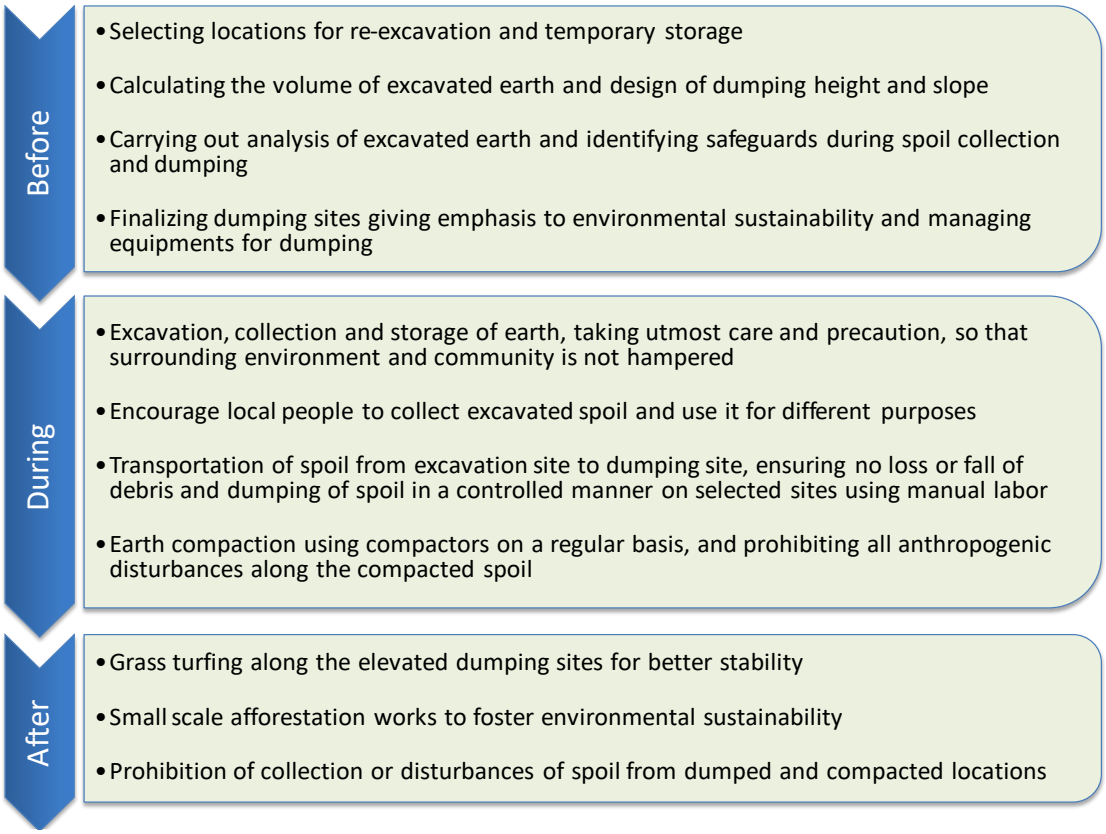


Figure 10.2: Phase wise activities of Re-excavated earth Management

10.7.3 Method of Re-excavated earth Dumping

The proposed re-excavation works for Polder 34/2 would require dumping of a significant amount of Re-excavated earth (around 87 thousand m^3). For a 3 meter wide and 1 meter thick wedge, this equivalents to around 29 km length of dumped Re-excavated earth. Polder 34/2 includes 18.05 km of re-excavation of khals, and if the residual Re-excavated earth (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.

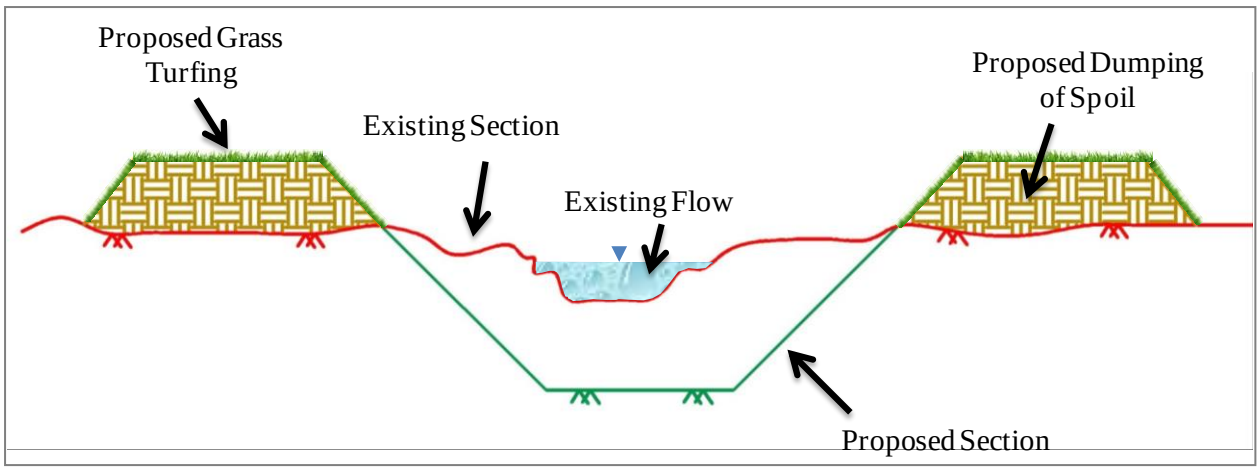


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

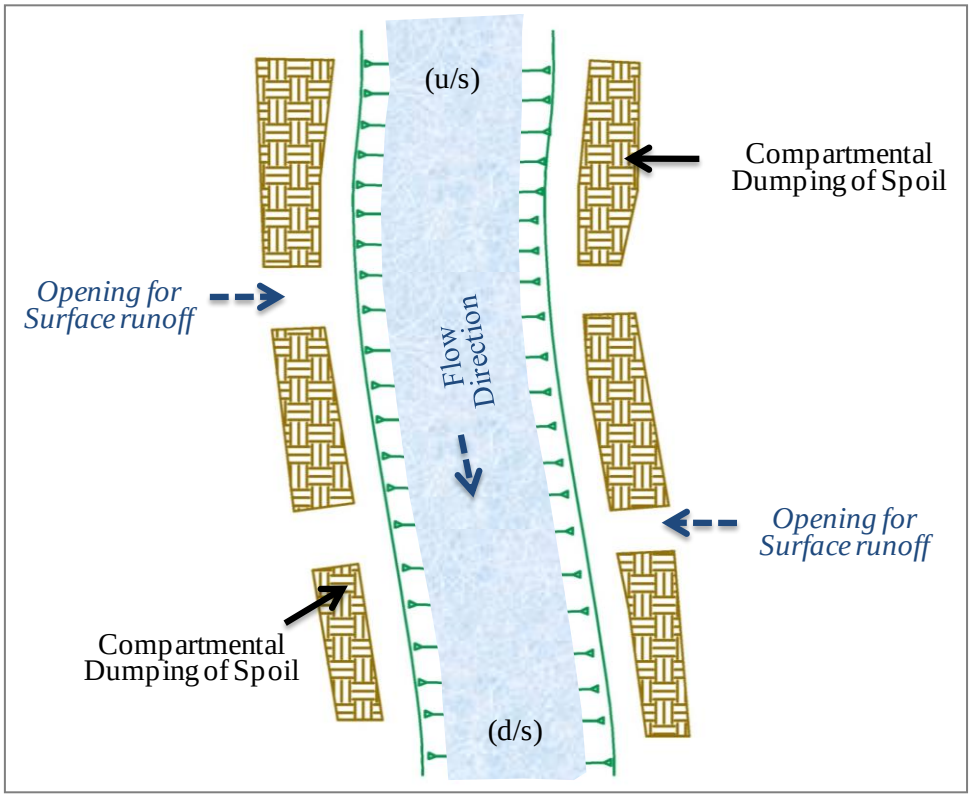


Figure 10.4: Plan Form of a Typical Khal to be Re-excavated

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 Re-excavated earth dumping. These are government owned khas lands which fall within the actual width of the khals. Re-excavated earth 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

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 Re-excavated earth 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 Re-excavated earth 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 Re-excavated earth needs to be compacted thoroughly, following the disposal of a certain height of Re-excavated earth (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 Re-excavated earth.
- ✓ 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 Re-excavated earth falls back into the water courses.
- ✓ It should also be ensured that the dumped Re-excavated earth 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

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 34/2.

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 Re-excavated earth				8	Disrupt road communication			
2	Inconsistencies or mismanagement in embankment re-sectioning works				9	No earth Re-excavated earth 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 Re-excavated earth 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

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
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 34/2	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 34/2	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	Amirpur union (part), Vanderkote union (part) and Baliadanga union Batiaghata Upazila HQ of Polder 34/2 area	Once in a year	LGED, BWDB and Blue gold

10.9 EMP and Monitoring Cost

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

10.9.1 Water Resources Monitoring Cost

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 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.	1.50	1	Re-excavation of Khals and disposal of Re-excavated earth earth materials for Re-excavated earth management and re-sectioning/ repair/ protection work of embankment etc	0.75
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

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
3	• The constructing materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land as far as possible. • Dumping of Re-excavated earth 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 integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.00	4	Irrigated area	0.50
	Total	**5.50**			**2.50**

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**			

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**

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**

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**

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

11 Conclusion and Recommendations

11.1 Conclusion

This project aims to improve water management and productivity through rehabilitation or repair of the existing embankment and other water control infrastructures like sluices, regulators, outlets etc. The water management interventions proposed for Polder 34/2-part include repair of water control structures, drainage outlets repair/re-sectioning of Embankment, re-excavation Khals and rehabilitation or re-costruction of Sluices/regulators. Drainage congestion, tidal flooding and water logging are very prevalent in Polder 34/2-part. The proposed interventions will bring about huge beneficial effects for the inhabitants inside the polder e.g. drainage congestion will be removed from 75% of the congested khals; repair of sluices/regulators/ outlets, repair/re-sectioning of Embankment, re-excavation of khals will increase surface water availability and facilitate drainage; re-sectioning of embankment will provide more flood protection from tide and storm surge; repairing of existing sluice gates, flushing inlets and drainage outlets will prevent salt water intrusion and retain post monsoon rainwater and salinity concentrations in the surface water system of the polder would drop to 'zero'; after implementation of above interventions agriculture resources will be significantly changed such as crop production and irrigated area will be increased with decrease of crop damage. Total length of about 17km and tentative re-excavated earth volume about 262,300 cu-m. More usable water will be available for domestic usages and for the cattle and wild lives. However during construction phase, there will be some negative impacts on agriculture, terrestrial vegetation and fisheries. During re-sectioning of the embankment, slope pitching and turfing, loss of vegetation like herbs and shrubs will occur i.e. there will be a temporary loss of habitat for some small reptiles and mammals such as rats, frogs etc. Moreover, movement of fresh and brackish water fisheslike *Puti, Chingri, Tengra, Baila* and *vetki* etc. from the river to the polder area would be obstructed due to the repair of water control structures. The embankment also plays an important role in maintaining communication which will be improved. Moreover, proposed intervention will improve the quality of life and better livelihood.

11.2 Recommendations

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

- The proposed implementation will ensure good water management for proper utilization of surface water for agricultural, domestic and oterh usages in the Polder area.
- Monsoon period should be avoided for implementation of the proposed interventions, especially from May to August which is very crucial for fish migration.
- Re-excavation activity should be done segment wise to protect the indigenous fishes and aquatic fauna.
- Crop rotation with leguminous crops, application of more organic materials and green manure to improve soil fertility in the project area.
- Introducing crop diversification with multi-crops for improving condition of the soil.
- Native mixed trees should be planted along the embankment slopes and toes wherever possible to enhance green coverage.
- Water Management Organization (WMO) should be strengthened.
- WMOs will be made involved in minor maintenance and operation of the structure, embankment and khals wghere applicable for ensuring sustainability of the interventions.
- WMOs would encouraged to follow and maintain the EMP.

The long-term impact of the Project is reduction in scarcity of surface water availability, and lack of irrigation facility, which will increase crop production leading to poverty reduction. There are some negative impacts as swell, some of which may be overcome through appropriate mitigation measures and timely monitoring. As such, the Project may be granted necessary clearance for implementation.

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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 Re-excavated earth
Location specific Re-excavated earth management plan for individual khal

Sl	Name of Khal	Location-dumping of Re-excavated earth 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 Re-excavated earth 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: Culture Fisheries: Indiscriminate Fishing Activities:	a. Total No. of fisher HHs: b. %/No. of CFHHs: c. %/No. of SFHHS: d. No. of Days spend annually in fishing by CFHHs: SFHHs: e. Hrs/Day spend in fishing by CFHHs:	River Beel (Leased/non leased)																

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):	
Marketing problems:		WMOs activity:	

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

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

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

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

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

Ecological Data Collection Form

Environmental Studies for Blue Gold Program

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**

Major Terrestrial fauna

Species Name	**Habitat1**	**Food Habit2**	**Breeding Time**	**Status3**	**Migration Status4**
1 Habitat: 1= Homestead forest, 2= floodplains, 3= wetlands, 4= river 2 Habit: 1=Herbivore, 2= Carnivore, 3= Both			3Status: 1= Very common, 2=Common, 3= Rare, 4= Very Rare 4 Migration Status: 1= Local, 2= Local Migratory, 3= Migratory		

Aquatic Ecosystem

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

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

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

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

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

Aquatic flora

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

Species name	**Type1**	**Abundance2**	**Growing period**	**Utilization9**

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

Aquatic Fauna

Species name	**Status1**	**Species name**	**Status1**
Amphibians			
Reptiles			
Birds			
Mammals			

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

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

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

Species name	Status1	Species name	Status1
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	

Sl. No.	Type of facility	Percentage of Households
4	Other (if any)	

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

Income and Expenditure

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

Labor and Wage

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

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

Self Assessed Subsistence Poverty

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

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

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

Disaster and Damage (in last five years)

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

Note: These data will be cross-checked with the multidisciplinary information

Migration Trend

Type of Migration	Out Migration		In Migration	
	Place of destination	Number/ Percentage*	Place of origin	Number/ Percentage*
Seasonal Labor migration				
Permanent Household migration				

*Percentage of migration will be applicable in case of seasonal labor migration; whereas number will be applicable in case of permanent migration of households

Professional/occupational Conflict

Type of Conflict	
Reasons of Conflict	
Area	
Groups engaged in conflict	
Proposed solutions	

Miscellaneous

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

Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

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

Appendix-3: No Objection Certificate

Appendix-4: List of PCM participants

1. Participant list of PCM of Gangrampur Union

Appendix-5: Terms of Reference