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 28/2

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Abbreviation and Acronyms

AEZ	Agro -Ecological Zone
ASA	Association for Social Advancement
BAU	Bangladesh Agricultural University
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BG	Blue Gold
BMD	Bangladesh Metrological Department
BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBO	Community Based Organizations
CDSP	Char Development and Settlement Project
CEGIS	Center for Environmental and Geographic Information Services
CEIP	Coastal Environmental Improvement Project
COD	Chemical Oxygen Demand
COs	Community Organizers
DAE	Department of Agricultural Extension
dBA	DecciBel
DC	District Commissioner
DEM	Digital Elevation Model
DG	Director General
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DPHE	Department of Public Health Engineering
DPP	Development Project Proforma
EA	Environmental Assessment
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment
EKN	Embassy of the Kingdom of Netherlands
EMP	Environmental Management Plan
ERD	Economic Relations Division
FAO	Food and Agriculture Organization of the United Nations
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/ Irrigation
FCBO	Fisheries Community Based Organization
FGD	Focus Group Discussion
FGs	Functional Groups
FMD	Foot and Mouth Disease
FS	Frame Survey
FPCO	Flood Plan Co-ordination Organization
GIS	Geographic Information System
GoB	Government of Bangladesh
GoN	Government of the Netherlands

GPA	Guidelines for Project Assessment
GPWM	Guidelines for Participatory Water Management
GSB	Geological Survey of Bangladesh
GW	Ground Water
Ha	Hectare
HH	Household
HTW	Hand Tube Well
HYV	High Yielding Variety
ICM	Integrated Crop Management
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IRRI	International Rice Research Institute
IPM	Integrated Pest Management
IPSWAM	Integrated Planning for Sustainable Water Management
IS	Institutional Survey
ISC	Important Social Component
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modeling
IWMP	Integrated Water Management Plan
Kg	Kilogram
KII	Key Informant Interview
LCS	Landless Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
Lpc	Litre per capita
MoEF	Ministry of Environment and Forests
MoWR	Ministry of Water Resources
MP	Murate of Potash
MPI	Multidimensional Poverty Index
MSL	Mean Sea Level
MT	Metric Ton
MW	Mega Watt
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NDVI	Normalized Difference Vegetation Index
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NIR	Near- Infrared
NOCs	No Objection Certificates
NWRD	National Water Resources Database
O and M	Operation and Maintenance
OHP	Occupational Health and Safety Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Pestedes Petits Ruminants

PRA	Participatory Rural Appraisal
PSF	Pond Sand Filter
PWD	Public Works Department
RL	Reduced Level
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SAAO	Sub Assistant Agriculture Officer
SIA	Social Impact Assessment
SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SW	Surface Water
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
SWAT	Soil and Water Assessment Tools
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UAO	Upazila Agriculture Officer
UFO	Upazila Fisheries Officer
UNDP	United Nations Development Programme
UNO	Upazila Nirbhahi Officer
WARPO	Water Resources Planning Organization
WMA	Water Management Association
WMC	Water Management Committee
WMF	Water Management Federation
WMGs	Water Management Groups
WMIP	Water Management Improvement Project
WMO	Water Management Organization

Glossary

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

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

Fact Sheet and Conversion Units

Fact Sheet

Polder No.	:	28/2
District	:	Khulna
Upazila	:	Khulna City Corporation and Batiaghata
Union	:	Jalma
O&M Division of BWDB	:	Khulna O&M Divison-1
Gross Area (ha)	:	2590.00
Cultivable Area (ha)	:	2000.00
River	:	The polder is surrounded by the Shoilmari (south), Kazibacha (south-east), Upper Shoilmari (south-west) and Alutola/Moyuri river at the east part.

Major Water Management Infrastructure

Embankment (km)	:	30.00
Regulator (no.)	:	07
Khal (km)	:	88.00

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 710 km of coast line along the Bay of Bengal. Nearly 38.5 millions of people live in the coastal area. About 38% of the population in the coastal region lives below the poverty line and faces high vulnerabilities in terms of access to food, employment, income, water and health service. Integrated and participatory water resources management has the potential to contribute significantly to food security, safety, income level, health and economic growth. In this context, the Government of the Netherlands (GoN) as a development partner of Bangladesh has been supporting water resources management projects in Bangladeshsince1975. These projects are mostly operated by the Bangladesh Water Development Board (BWDB). The Blue Gold Program (BGP) is one of such initiative that will cover 22 polders in four coastal districts of Bangladesh. This program, initiated in January 2013 and expected to end in December 2020, is built on the results and lessons learnt in managing water resources from previous programs and projects. The explicit objective of Blue Gold Program is to reduce poverty and increase people's income through value chain development in an integrated approach. Initially, all water control structures of the selected polders of the coastal districts will be rehabilitated and fine tuned in line with project objectives. However, to proceed with implementation, the BGP needs environmental clearance from the Department of Environment. This is due to the fact that under the Environment Conservation Rules (ECR, 1997), construction/reconstruction/expansion of flood control embankments, polders, dikes, etc. are classified as **'red'** category projects, and are subject to mandatory for Environmental Impact Assessment (EIA) study. This document is the Final EIA study report of Polder 28/2

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Objective of the study

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

Approach and Methodology

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

Project Description

Polder 28/2 covers only the Jalma union under Batiaghata upazila of Khulna district and part Khulna city corporation.The polder was constructed in in 1973-75 by the Bangladesh Water Development Board (BWDB) and later on was rehabilitated under the KJDRP project from 1996 to 2002. The polder is located in the South-West hydrological region of Bangladesh, with administrative jurisdiction under the Khulna O&M Division -1, BWDB, Khulna. The polder is directly surrounded by the by the Shoilmari (west and south), Moury (south-east) and Khulna Satkhira road in the north.

Existing Problems and the Proposed Interventions

A number of problems and issues are hindering the development potential of Polder 28/2 at the moment. Drainage congestion is one of the major problems inside the polder area. Southern part of the polder is mostly waterlogged due to less drainage facilities and becomes worst when there is additional flooding due to heavy rainfall in the upland area. Especially in Joykhali, Bashbaria, Shoilmari, Ghola, and Sachibunia some crop fields (beels) are waterlogged for 3-4 months. Most of the sluice gates are of poor condition. A number of the sluice gates can not be operated 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. Mismanagement issues regarding the water control structures also prevail.

The polder is enriched with embankment having a length of about 23.52 km with top width 4.27 m. The crest level is at 4.27 m above Mean Sea Level (MSL). A significant portion of the peripheral

embankment is paved, which allow heavy vehicular movements during all seasons. But in wet seasons the top surface of unpaved portion of the embankment surface becomes slippery and unsuitable for vehicular movements.

Sometimes tidal floods occur from Rupsha/Kazibacha river and Upper Shoilmari river, but not that frequent and severe. In some cases, upstream water flow and heavy rainfall cause flooding in the polder area. The duration of inundation is about 3 to 4 months. Sometime dirty water comes from town and it is very harmful for the crop field as well as for fish culture.
Rapidly growing the urban area is now big challenge for improvement of the internal water management; Influential people already occupied khals and are fully controlling the sluice gates.
Considering the existing problems and needs of the local residents, the Blue Gold program has considered the following interventions for rehabilitation of Polder 28/2:

- **Re-sectioning along the existing embankment:**
  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 4.27m, 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 4.27 m +PWD (above Mean Sea Level). A total of 3.00 km of embankment will be re-sectioned.
- **Repairing of Water Control Structures:**
  A 7 numbers of sluices among all existing sluices of BWDB within the polder will be repaired with improved type gate and hoisting system. Some sluices would require new shafts and wheels, whereas some sluices would require.
- **Re-excavation of khals:**
  A total number of 21 nos khal in Polder 28/2 are considered in the re-excavation plan of Blue Gold program. The total length to be re-excavated is around 35.500 km.

Environmental and Social Baseline

Meteorology and Physical Resources

The project area experiences tropical climate. The average maximum temperature ranges from 19.3°C (January) to around 30.4°C (April) while average minimum temperatures varies from 15.37°C (January) to 25.2°C (August). The maximum rainfall ever recorded in the area is 343 millimeter (mm) in the month of July and lowest in the month of December which is 7 mm. The monthly average relative humidity of the Khulna BMD station varies from 72 to 87%. The monthly average relative humidity of the Khulna BMD station rises above 85% in monsoon (June to September), and starts decreasing from post monsoon season following the monsoon rainfall. Daily average sunshine hours are higher than 7 hours, but due to increased extent of cloud cover in monsoon (June to September) the values drop below 5.
The water quality of different water bodies has been measured. The pH values in these locations are found higher than neutral scale (pH=7) which means the water in these locations was alkaline in nature. The highest value of TDS were found (above 1900 ppm) in the peripheral rivers. Values of DO were mostly found close to the standard values set by DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). Almost all the surface water samples were found having moderate salinity concentrations. Salinity levels from outside the polder were found similar to those inside the polder as most of the sluice gates are poorly functioned.
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 28/2 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.

About 78% of the land in the area has elevation within 1.22 to 1.52 m, PWD, whereas 17% areas have elevations higher than 1.52 m, PWD. Polder 28/2-part falls under Zone-I, which is considered as a seismically quiet zone, with Seismic Zone coefficient of 0.075, comprising the southwest portion of Bangladesh.

Water Resources

Polder 28/2 is at a distance of 75 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is directly surrounded by the the Shoilmari (south), Kazibacha (south-east), Upper Shoilmari (south-west) and Alutola/ Moyuri river at the east part.

The surface water levels of the BWDB station at Chalna (Passur River) 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. The study found that around 285 m^3 of water is consumed daily by the total number of 9,399 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements.

Land and Agriculture Resources

The polder 28/2 area lies under the Ganges Tidal Flood Plain (AEZ-13). Agriculture is the mainstay of livelihood in this polder. The net cultable area (NCA) of the polder is 1,813 ha which 70% of the total polder area is. The most prominent cropping patterns of the polder area are Sesame – LT.aman - Fallow 36%, Fallow - LT. Aman – Fallow and Vegetable - Lt. aman - Fallow 19% of the NCA respectively. Total cropped area is about 3,600 ha of which the coverage of rice is 61% and non rice is 39%. The single, double and triple cropped areas are 31%, 43% and 26 % of the NCA respectively. Cropping intensity of the polder is about 195%. The annual total crop production stands to about 14,620 tons of which rice is 6,936 tons and non-rice is 7,684 tons. The contribution of rice crops is 48% and non-rice is 52% of total crop production. Total loss of rice production is about 230 tons and loss of non-rice production is about 43 tons due to drainage congestion, siltation of khals and drainage channels, effect of salinity and natural calamities.

Fisheries Resources

Fisheries habitat in Polder 28/2 is about 978 ha which is characterized by both fresh and brackish water fish habitat. The peripheral rivers, tidal and inter tidal floodplains and internal khals are important fish habitat for capture fisheries where internal khals play important role in fish migration. Culture fishery of the polder area is dominated by *gher* (both *golda* and *bagda*) followed by culturable and cultured pond. Although the water quality is good for fisheries, fisheries biodiversity shows a declining trend as most of the water bodies are seasonal in nature. The terrestrial flora and fauna are very rich here although the density of vegetation is not uniform throughout the polder. There are about 67 ha of wetland inside the polder which is very rich in aquatic flora and fauna.

Socio-economic Condition

The populations of Polder 28/2 are about 40,640 of which 20,540 are male and 21,140 are female. The average literacy rate in the study area is 51% which is nearly than that of national level (52%). Out of total population, 25.6% are economically active which include 33.7% employed, 0.4% are looking for job and 65% engaged in household works.

Most of the population in the polder area is engaged in agriculture sector (92%) followed by service and day labors etc. Sources of drinking water in the area are satisfactory. On an average, 86% people can collect drinking water from tube-wells while 14% collects drinking water from other sources such as water bodies, Pond sand filter (PSF); rain water etc.

About 15.4% households have access to non-sanitary latrines, 46.6% non water-sealed sanitary latrines and 6.6% with no latrines facilities in the polder. About 48% of the households in average are in the 'deficit' category, 8% are surplus and rests 44% households are in balance situation. The common property resources and/or community facilities in the area are different social amenities e.g. mosques, graveyards, temples, cremation grounds, playgrounds, open water bodies and *Eidgahs* (place for offering Eid prayers). These are used by the local people for the purposes of religious, social and cultural gathering.

Prediction and Evaluation of Impacts

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

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

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

Furthermore, the cumulative and induced effects of the proposed interventions in Polder 30 have been investigated based on qualitative assessments. The study infers positive long-term cumulative effects in Polder 28/2 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 28/2 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 28/2 has also been found to have been enhanced due to the installation of many capacity development initiatives.

Environmental Management Plan

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

- Construction works near dense settlements are to be carried out using manual labour
- Repaired sluice gates are to be operated and maintained properly to protect saltwater intrusion
- Formation of WMGs (GPWM-2002) and involvement of WMGs in project related different activities
- Strengthening of WMGs through imparting training on proper management of structure and utilization of Re-excavatd earth materials which will be generated from re-excavation.
- The WMGs should be given orientation to protect their standing crops from implementation of the intervention and development on farm water management etc.
- Training may be provided to WMGs on “integrated water management” which will be stored or available in the khals/ cannels for different use
- Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.
- Irrigation should be provided in optimum level with minimum conveyance loss.
- Organic manure should be applied for the restoration of soil fertility
- The repair of flushing sluice, repair of drainage Outlet and irrigation Inlet would help to reduce crop damage situation.
- Re-excavation activity should be done segment wise
- Excavated khal should keep free from encroachment
- Re-excavatd earth should be dumped at a setback distance of the khal
- To protect the indigenous fishes and other aquatic creators, re-excavation should be carried out in segment wise and one after another.
- Fish sanctuary should be constructed in the deep pool of perennial khals.

- Implement plantation along the slopes of embankment after completing the earth works.
- Avoid construction activities in the early morning and night to evade disturbance to wild fauna.
- Plant mixed species of native trees along the slopes of the embankment as and where possible to enhance green coverage.
- According to the project work, the LCS entail 60% male and 40% female, all of them to be engaged from the local area. Thus, ensure more gender promotion activities for female in future.

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

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

1. Introduction

1.1 Background

Bangladesh, the largest river delta in the world has about 710 km of coast line along the Bay of Bengal (DoE, 2001).The three major river systems of the country mark its physiography and the lives of its people. Effective management of this immense natural resource remains a continuing challenge and at the same time offers tremendous opportunities. 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 (ii) of the Blue Gold Program includes rehabilitation of water resources management infrastructure in selected polders. Polder 28/2 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.

1.3 Study Area

The study area of this EIA study is Polder 28/2 was constructed in 1973-75 by the Bangladesh Water Development Board (BWDB) and later on was rehabilitated under the KJDRP project from 1996 to 2002. The polder falls at Jalma union under Batiaghata upazila of Khulna district. It is surrounded by the Shoilmari (west and south), Moury (east) and Stakhira Khulna Road in the north. Map 1.1 shows the base map of the Polder with respect to Upazilla and Union headquarters.

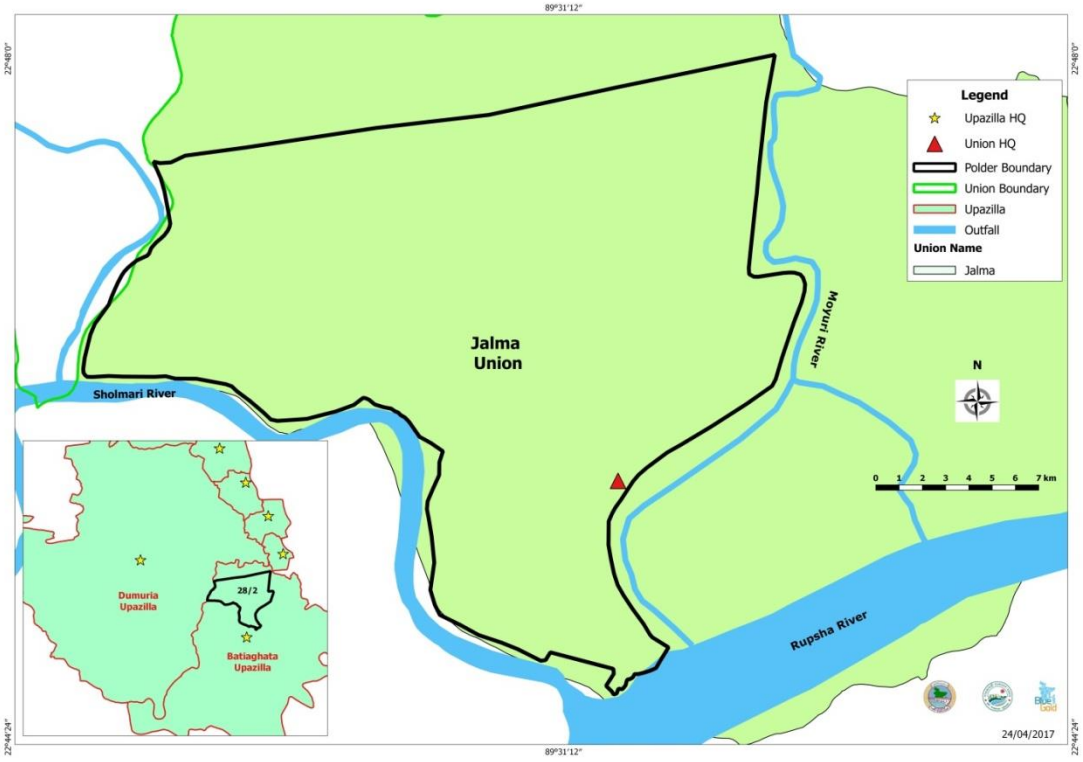
1.4 Objectives of the Study

The limited time assigned for conducting the EIA studies of 7 (seven) project was a major concern and has 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.

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.



Map 1.1 Base map of Polder 28/2 in Batiaghata Upazila under Khulna District

1.5 Scope of Work

The scopes of works of the assignment are to:

i. Carry out detailed field investigation for establishing the environmental and social baseline, especially on critical issues such as tidal flooding and associated impact on crop and fish production, land loss, and socio-economic condition of affected persons.
ii. Identify the Important Environmental and Social Components (IESCs) which may be impacted by the proposed interventions.
iii. Assess environmental quality and conduct laboratory tests (soil and water quality) of the polder area.
iv. Determine the potential impacts from the project through identification, analysis and evaluation on sensitive areas.
v. Identify the specific reciprocal impact of climate change and polder infrastructures.

vi. Prepare a landuse map and ground truthing.
vii. Conduct landuse and land cover classification as well as damage assessment including flood and erosion mapping using remote sensing technologies.
viii. A small section of the EIA (EMP) will indicate occupational health and safety measures to be undertaken for implementation of the work, but a not detailed occupational health plan (OHP).
ix. Investigate the existing institutional contexts (local institutions, NGOs, government policies and regulations etc.) for polder management.
x. Prepare a detailed Environmental Management Plan (mitigation and enhancement plan, compensation and contingency plan as well as monitoring plans).

1.6 Limitations

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

1.7 EIA Study Team

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.

1.8 Report Format

This EIA report has 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

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)

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)

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)

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)

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)

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)

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)

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)

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

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)

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)

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)

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)

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)

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)

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)

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)

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)

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)

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:

a. Feasibility Report for the Project (where applicable)
b. Environmental Impact Assessment (EIA) Report
c. Environmental Management Plan (EMP)
d. No Objection Certificate from relevant Local Authority (where applicable)
e. Other necessary information, (where applicable)

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 are few positions of environment, forestry and fisheries professionals as "Research Officer" all of whom are posted in in BWDB head office in Dhaka. There is no such professional position in Zone/Circle/ Division office at local level, who can implement and monitor the 'Environmental Management Plan (EMP)' of any project. In current practice of BWDB, there is no provision for keeping such professional or forming any unit for implementing EMP while implementing any project. Nevertheless, there are many junior to senior level officers who have training on environmental management of water resources development projects. These officers can contribute towards implementation of EMP and monitor the

environmental concerns of the projects. Since BWDB has large institutional set up and human resources from national to local level, it will be very much convenient to mobilize required resources for implementing EMP.

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

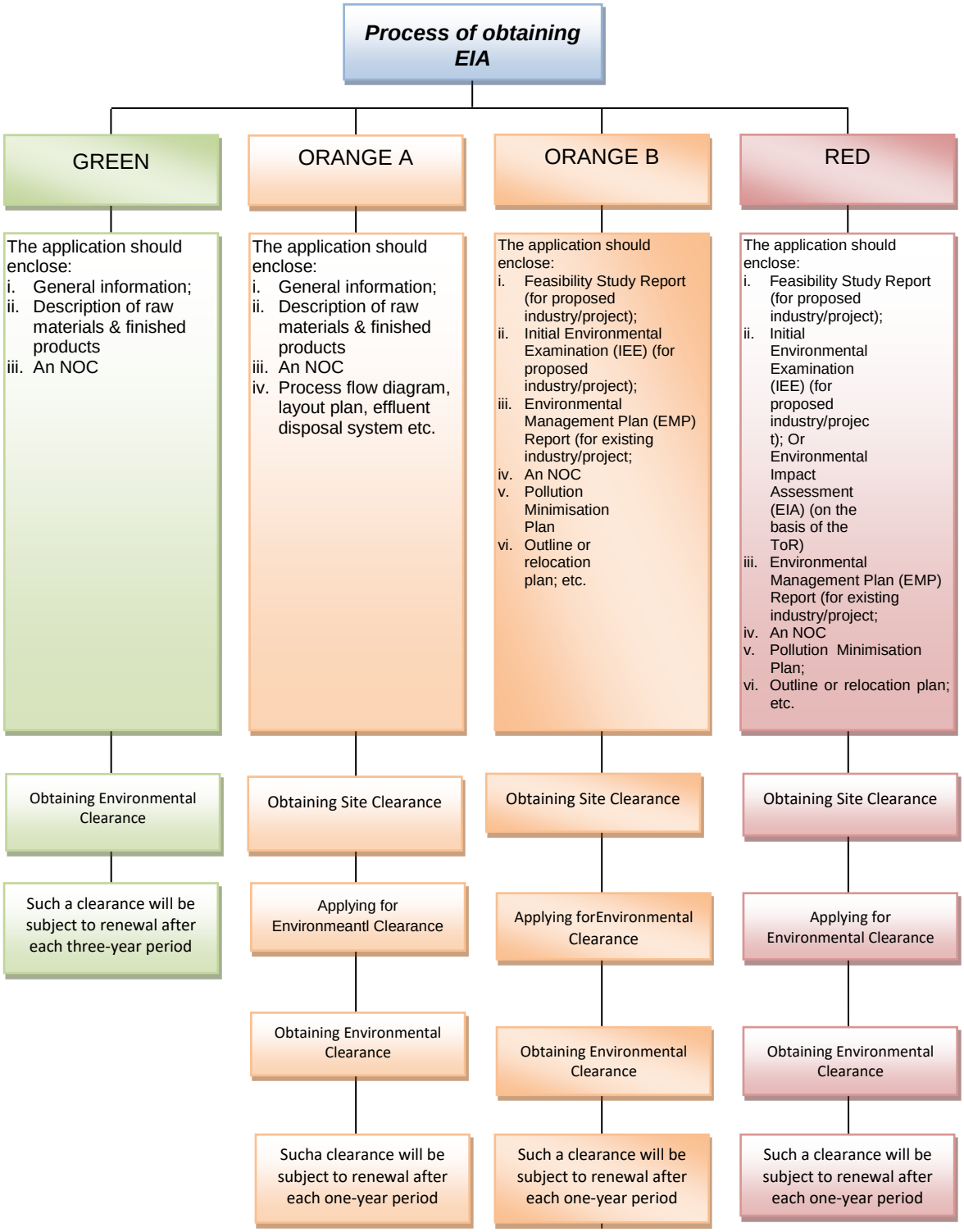


Figure 2.1 Steps Involved in Environmental Clearence folllowing DoE Clearence

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 Planning 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. As such, the EIA guideline of WARPO has been preferred and used in this study.

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 Blue Gold Program were identified. The area of influence (project area for short) 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 Blue Gold officials. Afterwards, a field investigation was carried out by the EIA study team, which helped in the verification of locations and rationale of proposed interventions, and identified the existing water management and other small scale problems. The existing situation of the available water management infrastructures have been inspected during field investigation. An Operation and Maintenance plan for the rehabilitation works has been developed. Furthermore, the potential benefits of the project have also been assessed.

3.3 Environmental and Social Baseline

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 28/2, 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 28/2' 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 Benarpota (Betna River) and Chapra (Morichap 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.

3.3.4 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 were collected from Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of Soil Resources Development Institute (SRDI). Secondary data of these parameters were verified at field during field visit through physical observations as well as in consultation with the local people and officials of the Department of Agricultural Extension (DAE).

3.3.5 Agricultural Resources

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 using a questionnaire and in consultation with local people and concerned agricultural officials. Agricultural resources data were also collected from secondary sources from the upazila DAE office. Crop production was determined 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 the last three years.

3.3.6 Livestock Resources

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

3.3.7 Environmental Quality

Under the environmental quality component, noise and water quality were measured at different selected locations in Polder 28/2. One suitable site was selected at Kamirbeel er gate to measure sound levels and compare with standard values. The location was selected from the polder periphery, where embankment rehabilitation works would be carried out. During field inspection, sound levels were collected near construction site with 10 minute sampling periods. L_{50} (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L_{50} is assumed to be equal to Leq, which is the Equivalent Noise Level. The computed Leq was then compared with the standard noise level suggested in Environmental Conservation Rules 1997 of Department of Environment, Bangladesh.

For collecting information on water quality, major water quality parameters (pH, TDS, Temp., DO and Salinity) were measured on site in March 2015, from different sampling locations of the polder.

3.3.8 Fisheries Resources

- **Data collection methods:**

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

- **Sampling site selection:**

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

- **Data Collection:**

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

- **Habitat Identification:**

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

- **Capture and Culture Fish Habitats:**

Capture fish habitats assessment were assessed through Fishing Effort Survey (FES), habitat based species diversity and composition, identification of species of conservation significance, identification of potential fish habitat prescribing to restore fish conservation, fish migration survey, and habitat identification for fish conservation. Culture fish habitats assessment were assessed 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 (UFO) from their annual reports and from various literatures/studies.

- **Data Analysis and Output:**

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

3.3.9 Ecological Resources

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

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

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

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

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

3.3.10 Socio-economic Condition

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

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

a) Data collated from BBS;
b) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;
c) PRA /RRA, FGDs, KII for primary data collection; and
d) Institutional Survey (IS) for primary data collection from upazila level offices like Local Government Engineering Department (LGED) office, DAE Office, DLS Office, Fosheries Office, AE Civil Surgeon's office, Social Services office and NGO working with BGP etc.

3.4 Scoping

A scoping process was followed for selecting IESCs which are likely to be impacted by the proposed interventions of 'rehabilitation of 28/2'. Scoping was performed in two stages. Individual professionals of the EIA study team made preliminary lists of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgments of the EIA team members as well as the stakeholders opinions obtained in the scoping sessions are considered in selecting the IESCs.

3.5 Bounding

The area likely to be impacted for 'rehabilitation of Polder 28/2' was delineated in consultation with the experts of Blue Gold Program and feedback received from the local people during baseline consultation. In addition, processed Remote Sensing (RS) tools were also used for this purpose.

3.6 Major Field Investigation

The EIA study team members collected intensive data on possible impact of the project after obtaining the detailed rehabilitation plan from the project authority. The study team carried out a number of comprehensive field investigations during 10 to 25 May, 2019 in order to collect primary data and solicit feedback from local people. Intensive data on IESCs were collected from the field during this stage. 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 consultations with the local people were conducted for their feedback on their key parameters. This process helped the multidisciplinary EIA study team to qualify their professional observations. In such exercise attention was given to understand on the historical status of the IESCs and the possible condition of the same against the proposed interventions.

3.7 Environmental and Social Impact Assessment

Environmental and social impacts on the IESCs for the proposed interventions i.e. for Rehabilitation of Polder 28/2' have been assessed through several sets of activities. Impacts are generated for the interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of the difference between the future-without-project (FWOP) conditions and the future-with-project (FWIP) conditions. FWOP conditions are generated through trend analysis and consultation with the local people. This reflected the conditions of IESCs in absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions are assessed to generate the FWIP conditions. Comparison and projection methods are used for impact prediction. This included both positive and negative impacts which are considered in preparation of the environmental management plan.

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

i) Changes in the status of the IESCs pertaining to water resources;
ii) Changes in the status of the IESCs pertaining to land resources, agriculture, livestock and poultry;
iii) Changes in the status of the IESCs pertaining to fisheries;
iv) Changes in the status of the IESCs pertaining to ecological resources; and
v) Changes in the status of the IESCs pertaining to socio-economic conditions.

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

3.7.1 Impact Quantification and Evaluation

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

3.7.2 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 are largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative and positive (beneficial), and the methodology defined below has been applied to define both beneficial and adverse potential impacts.

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

Magnitude

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

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

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

Table 3.1 Parameters for determining magnitude

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

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. The criteria for determining receptor sensitivity of the project's potential impacts are outlined in Table 3.2.

Table 3.2: Criteria for determining sensitivity

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

Assessment of Residual Impacts

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

3.8 Environmental Management Plan

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

3.9 EIA Report Preparation

At the end of the process, the present report on "Environmental Impact Assessment of Rehabilitation of Polder 28/2" is prepared incorporating all findings of the study.

4. Project Description

4.1 Background

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

4.2 Objective

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 strengthen livelihood through improved productivity.

The objective of Blue Gold Program in Polder 28/2 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 28/2 was constructed in 1973-75 by the Bangladesh Water Development Board (BWDB) and later on was rehabilitated under the KJDRP project from 1996 to 2002. The polder falls at Jalma union under Batiaghata upazila of Khulna district. It is surrounded by the Shoilmari (south), Kazibacha (south-east), Upper Shoilmari (south-west) and Alutola/ Moyuri river at the east part.

4.4 Present Status of 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 28/2. Based on field investigation the study team gathered the following information regarding the status of existing infrastructures.

Embankments

The length of Embankment is 23.52 km with top width 4.27 m. The crest level is at 4.27 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 Kochubunia area. The embankment remains dry and various modes of transports 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 of unpaved portion of the embankment surface becomes slippery and unsuitable for vehicular movements.

Water Control Structures

There are 7 numbers of drainage sluices constructed by BWDB within the polder. Some of these structures need repairing. A number of the gates can not be operated 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. Mismanagement issues regarding the water control structures also prevail.

Photo 4.1 Existing Status of Embankments

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. Ramdia Sluice, Gholar sluice, Shindurtola sluice and Choighoria sluice is in vulnerable condition and repair is needed. Construction of bandhakhali sluice (2v-2.00mx1.50m) is also needed.

Photo 4.2 Existing Status of Sachibunia & Gholar Sluice at Polder 28/2

4.5 Present Status of Drainage Khals and Rivers

The present condition of most of the internal drainage khals is completely undesirable. 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 Bashbaria khal, Barui Khal, Guptomari khal, pramanik branch khal are badly silted up and hence, create drainage congestion in the adjacent area which needs re-excavation.

4.6 Problems and Issues in the Polder

A number of problems and issues are hindering the development potential of Polder 28/2 at the moment. Drainage congestion is one of the major problems inside the polder area. Southern part of the polder is mostly waterlogged due to less drainage facilities and becomes worst when there is additional flooding due to heavy rainfall in the upland area. Especially in Joykhali, Bashbaria, Shoilmari, Ghola, and Sachibunia some crop fields (beels) are waterlogged for 3-4 months. Most of the sluice gates are of poor condition.

Sometimes tidal floods occur from Rupsha/Kazibacha river and Upper Shoilmari river, but not that frequent and severe. In some cases, upstream water flow and heavy rainfall cause flooding in the

polder area. The duration of inundation is about 3 to 4 months. Sometime dirty water comes from town and it is very harmful for the crop field as well as for fish culture.
Rapidly growing the urban area is now big challenge for improvement of the internal water management; Influential people already occupied khals and are fully controlling the sluice gates. Another problem is silted khals and inactive sluice gates.

*[(**a**) Hogladanga khal, (**b**) Bashbaria khal, (**c**) Khal leading to Sindurtala Sluice, (**d**) Pramanik khal*

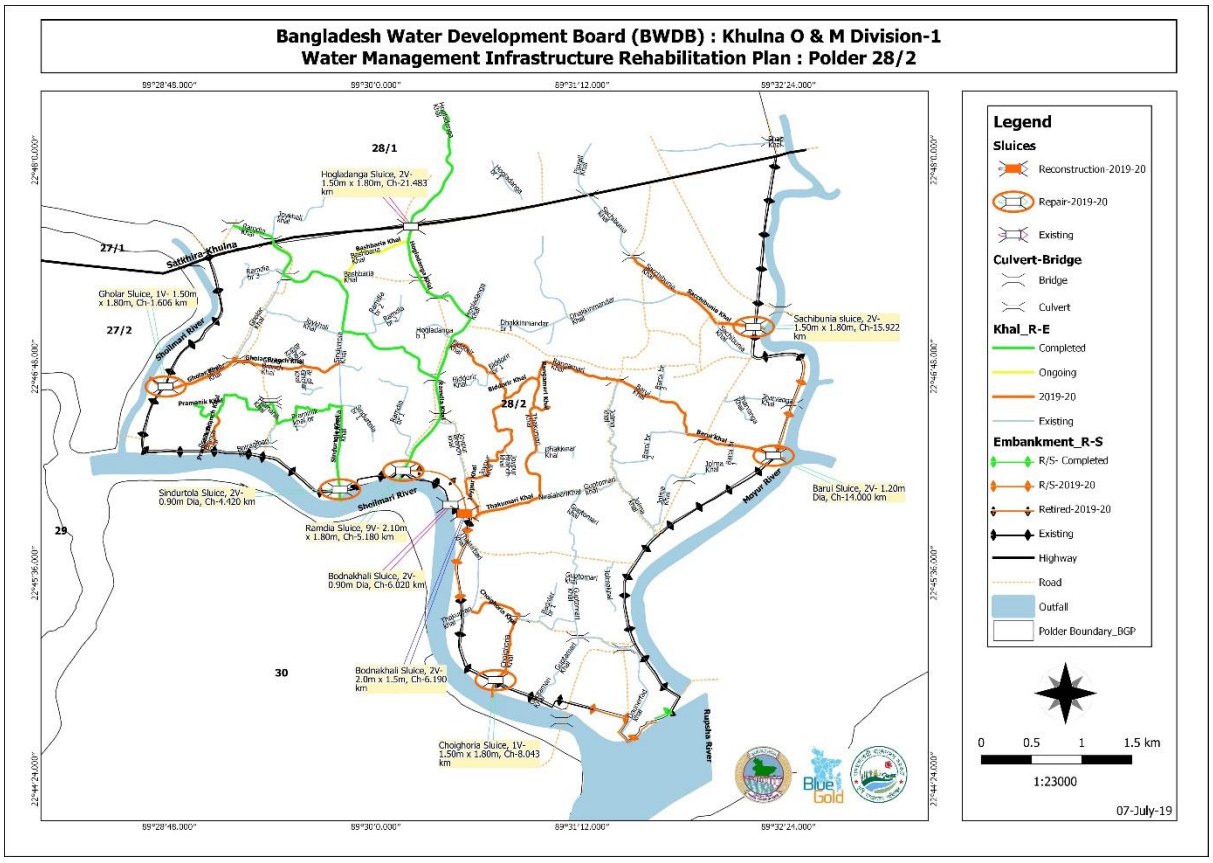
Photo 4.3 Drainage Khals within the polder

4.7 Proposed Interventions in Polder 28/2

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 28/2. The locations of interventions have been shown in Map 4.1.

4.7.1 Re-sectioning of Embankment

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 4.27m, 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 4.27 m +PWD (above Mean Sea Level). A total of 3.00 km of embankment will be re-sectioned.



Map 4.1 Location of the proposed interventions of Polder 28/2

4.7.2 Repairing of Water Control Structures

Some sluices among all existing sluices of BWDB within the polder will be repaired with IPSWAM type gate and hoisting system. 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 Detail information on proposed repairing of Drainage Sluices

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)
1	Ghola Sluice (S-1)	1	1.50 m X 1.80 m	1.606
2	Sindurtola Pipe Sluice (S-2)	2	0.90 m dia	4.420
3	Ramdia Sluice (S-3)	9	2.10 m X 1.80 m	5.180
4	Badnakhali Pipe Sluice (S-4)	2	0.90 m dia	6.020
5	Chhaighoria Sluice (S-5)	1	1.50 m X 1.80 m	8.043
6	Barui khal/Santinagar Sluice	2	1.20 m dia	14.000
7	Sachibunia Sluice (S-6)	2	1.50 m X 1.80 m	15.922

Source: Blue Gold Program Office 2019

4.7.3 Khal Re-excavation

A total number of 16 nos khal in Polder 28/2 are considered in the re-excavation plan of Blue Gold Program. The total length to be re-excavated is around 35.500 km. The names of the khals and lengths to be re-excavated are shown in Table 4.2. Total length of about 28.8km and tentative re-excavated earth volume about 469,336.27 cu-m.

Table 4.2 Detail information on proposed re-excavation of Khals of Polder 28/2

Sl. No	Name of Khal	Length (Km)	Tentetive volume (cum)
1	Re excavation of Sindurtala Khal	1.00	14,668.24
2	Re excavation of Ramdia Khal	4.50	172,209.18
3	Re excavation of Hogladanga Khal	3.60	54,270.58
4	Re excavation of Pramanik Khal	2.30	28,288.85
5	Re excavation of Bashbaria Khal	0.90	6,091.22
6	Re excavation of Guptomari khal	2.21	25,903.00
7	Re excavation of Barui Khal	2.01	13,216.66
8	Re excavation of Branch Pramanik khal	0.50	4,688.55
9	Re excavation of Thakumari khal	1.98	48,362.45
10	Re excavation of Choiguria Khal Khal	1.60	34,234.91
11	Re excavation of Gholar Khal	1.00	17,352.68
12	Re excavation of Branch of Gholar Khal	1.10	10,718.03
13	Re excavation of Rangamarir Khal	1.50	19,595.85
14	Re excavation of Sachibunia Khal	1.60	19,736.07
15	Re excavation of Sindurtala Khal	1.00	14,668.24
16	Re excavation of Ramdia Khal	4.50	172,209.18

4.8 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.

4.8.1 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.

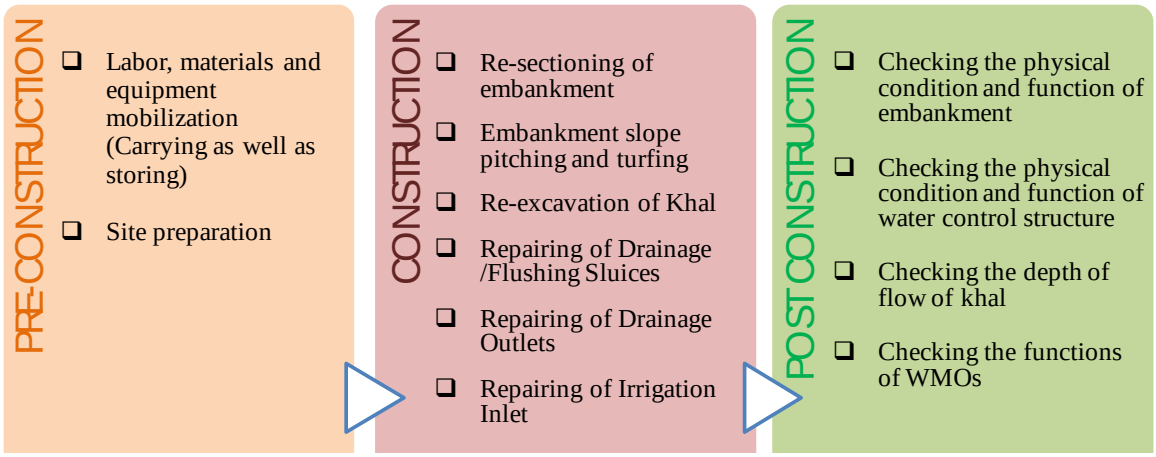


Figure 4.1 Phase wise list of activities in Polder 28/2

4.8.2 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 28/2 are likely to be completed by June 2020.

Table 4.3 Construction Schedule in Polder 28/2

Key Activities	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)					■	■	■	■				
Community mobilization for Water Management Planning					■	■	■					
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs						■	■	■	■	■		
Assessment of WMO Functionality						■	■	■	■			
Strengthening/ capacity building of WMO based on outcome of Assessment						■	■	■	■			
Community Mobilization for Village Development Plan (VDP) and Polder Development Plan (PDP) Firm-up water management development options Firm-up Sustainable Environmental Management Plan (SEMP)							■	■	■	■		
Implementation of Water Management fine tuning works with active participation of the WMOs/ WMA through the Quality Control/ Block Committee								■	■	■		

4.8.3 Materials Requirement

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

Table 4.4 Construction Materials Requirement in Polder 28/2

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Earthwork	53,000 m^3	From the set back location and other khas lands
Repairing of sluices and flushing inlets			
6	Barrel	4 (1.5 m x 1.8 m)	To be procured
7	Pipe	3(dia: 0.90 m)	To be procured
8	Wheel and Shaft	3 sets	To be procured
9	Materials for Plastering, Slope Filling, Railing and other repairing works	As per requirement	To be procured

4.8.4 Manpower Requirement

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.

4.9 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 28/2 are discussed in the following sections.

4.9.1 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.

Methodology: Inclusion of Stakeholders from all class and groups is in focus in every steps of the activities in BGP, from planning, implementation, operation and maintenance.

Preliminary Reconnaissance: The 1st step under Blue Gold Program (BGP) is to form Water Management Organisations (WMOs) as per Participatory Water Management Rule-2014. Water Management Groups (WMG) and Water Management Associations (WMA) are formed. Preparation

of repair or rehabilitation activities initiated with reconnaissance survey of selected Polders, jointly carried out by BWDB, Technical Assistance Team (TA Team) and WMOs through extensive field visit, considering the necessary documents, literature and discussion with community. Polder selection is done through Multi-Criteria Analysis (MCA) based on real field scenario or condition, collected information and data following the approved project documents.

Need Assessment: After selection of a Polder, need assessment for integrated water management of that area is worked out jointly through a local consultation meeting. This meeting is conducted at respective Union or Upzilla Parisad involving all WMGs, WMAs and other partners of BGP the DAE, DoF and DLS is essential part of this step. Participation of LGI (Local Government Institutions) members including elected representatives of the area, the UP Chairman, UP Members and Upzilla Chairman. Presence of all group and class of the community of the area including women representatives, crop and fish farmers, land less population, school teacher, trader etc is considered. In local consultation meeting all demands or requirements of that area are identified through open discussions to solve the problems or to improve the water resources management. A complete list of activities or interventions (like repair or construction of new structures, embankment repair or retired, irrigation or drainage requirement, khal re-excavations etc.) is made. In the need assessment meeting the water resources, ponds, water bodies, complete list of crops of the area also recorded. After identification of the probable interventions needed for the area to solve or improve the water resources management of that area, a priority list is prepared in consultation with the stakeholders.
"Water for All", theme of this seminar is considered in the need assessment meeting through discussion with community of the area.

Need Assessment Validation: After documentation of the need assessment for the Polder field validation is carried out jointly with the stakeholders. At this stage, field visit and discussion with the local people and stakeholders is done.

Survey/ Design data collection: After validation, the survey/ engineering survey is being carried out for design data collection for the identified and listed interventions/ structures jointly by BWDB field Offices & TA Team.

Design: Collected Design data is forwarded from BWDB field Offices to concerned design offices for designing of structures/interventions. After completing the designs, design offices forward those designs to fields Offices for preparing estimates. At designing stage if any queries/ questions arise regarding data or field visit is required, PCD office coordinates to resolve.

Estimate: BWDB field Offices prepare estimates with assistance of TA Team following approved Designs and Rate Schedule of the respective areas. BWDB field divisions then forward the estimates to TA Team for vetting through PCD office. Those estimates are verified and vetted by TA team. The vetted estimates then forwarded to BWDB field divisions also through PCD office. After receiving the vetted estimates, BWDB field divisions forward these vetted estimates to Superintending Engineers (SE) of concerned area. The SE offices verify the vetted estimates of TA Team and finalize.

Reach Selection: As per approved DPP of BGP, part of earth work (embankment repair, retirement, re-sectioning, khal re-excavation etc) is to be done by LCS through WMG. So the reach is selected by BWDB field divisions & TA Team jointly to be allocated in favour of LCS/WMG or contractor through Open Tender. The reach selected for LCS/WMG, is sub-divided into parts/groups/package to allocate to a particular WMG/LCS.

Tendering: Tendering works is done by BWDB field divisions. The Executive Engineers of concerned divisions floats tenders through e-GP with the concurrence of PCD. After receiving and evaluation of tender documents, work orders are issued to successful bidder following guidelines of project documents and Govt. Rule (PPR).

Implementation: Implementation or rehabilitation or re-construction works is done by WMG/LCSs and contractors with joint supervision of BWDB field offices, TA Team to ensure quantity and quality and progress. The respective of WMA is also having role to ensure progress and quality of works during implementation. Thus the BGP activities have been under tri-partite supervision engaging the local stakeholders through WMAs.

Bill preparation: Bills are prepared by BWDB field Offices and TA team, then forwarded to concerned Accounts section for payment. The contractors receive payments from Accounts section.

WMO certification: The concurrence of WMA is required on quantity and quality of completed works. After certification of bills by WMA, WMG is a mandatory steps for bill payment.

Reimbursement: The paid bills by the field Offices for the completed works are then forwarded to PCD and TA Team Office for re-imbursement from EKN (GoN part). After checking and verification those send to Embassy of the Kingdom of the Netherlands (EKN), Dhaka for re-imbursement.

Agreement on Operation & Maintenance (O&M): Agreement has been signed between the BWDB (Executive Engineers Office) and WMA on O&M. The Operation of structures, the Sluice, Regulator, Outlet, Inlet, Khals is done by the community under WMG. Out of three categories of Maintenance, the Routine or Minor Maintenance is the responsibility of the respective MWG/WMA. Periodic and Emergency Maintenance is the responsibility of BWDB. This is important step towards empowering of the Community through water management, the center point of the BGP Objective.

4.10 Operation and Maintenance Plan

Since construction, Polder 28/2 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.

Operation & Maintenance Plan has been prepared, finalized and signed for some Polders in Khulna & Patuakhali between BWDB and WMAs. The Operation & Maintenance will be done following the role and responsibility described in the agreement.

4.10.1 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 28/2. Therefore, maintaining the polder system with embankments and structural elements built and rehabilitated over there has become a permanently important task.

Regulation of Gates: 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.

4.10.2 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 28/2, only those work which directly serve water management should be regularly maintained. The preventive maintenance works can be implemented through community-based functional groups. 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.

4.11 Project Cost

As per the approved Development Project Proforma (DPP) of the Blue Gold Program, the project cost for carrying out rehabilitation works in Polder 28/2 has been estimated as 300.00€ per ha of area (**Appendix 5**). According to the rate, the total project cost is 1,49,9988 € i.e. BDT 12.75 crore (1€=Tk. 85.00, on October, 2016)

4.12 Expected Benefits and Outcome

The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 28/2 are listed in Table 4.6 below.

Table 4.5 Expected benefits and outcome of proposed interventions

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

4.13 No Objection Certificate

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 the existing structures. The No Objection Certificates (NOCs) from the union chairmen have been obtained and are attached in **Appendix- 2**.

5. Environmental Baseline

5.1 Physical Environment

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

5.1.1 Meteorology

This section provides an analysis on meteorological parameters (temperature, rainfall, wind speed and humidity) of Polder 28/2-part area. It is to be mentioned here that data and information for different analyses have been collected for different time intervals, depending on data availability, data variation and significance in connection with the study.

Rainfall

The average monthly rainfall variation at Khulna (from 1978 to 2013) 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 (about 7 mm) respectively.

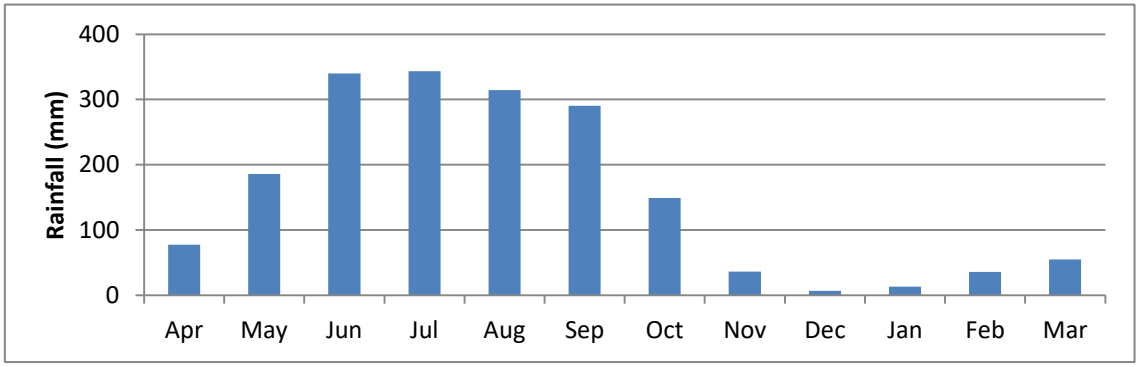


Figure 5.1 Average Monthly Rainfall at Khulna BMD

Furthermore, for better representation of the real world situation, values on rainfall from 1978 to 2013 have also been collected from the BWDB rainfall station at Chalna. Before that, Theissen's Polygons were delineated around all the BWDB's rainfall stations (Subramanya, 1994), which have been shown in **Map 5.5**. The Theissen's Polygons show that the entire polder is located inside the polygon delineated around the BWDB station of Chalna. The monthly variation of rainfall observed in Chalna has a similar trend to that observed for the Khulna BMD station, however, almost all values of monthly rainfall were found higher than the ones observed at Khulna BMD stations. The figure shows that the maximum and minimum monthly rainfall values observed at Chalna were 541 mm (June) and 7 mm (December) respectively.

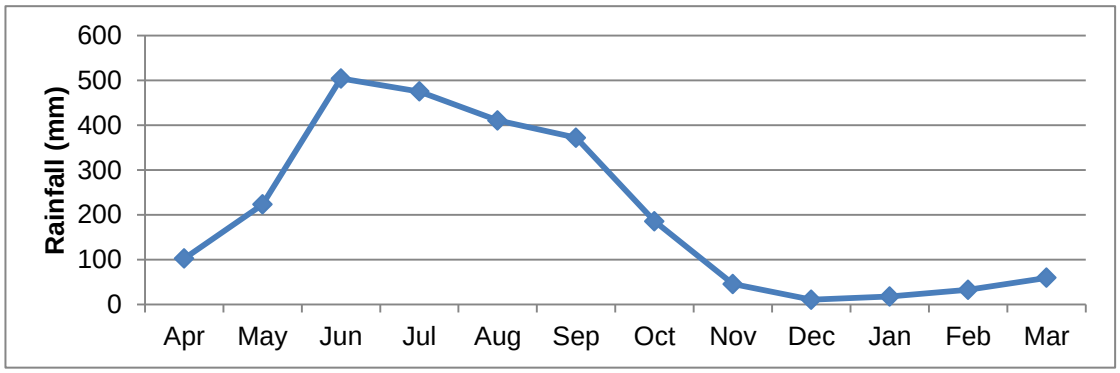


Figure 5.2: Average Monthly Rainfall in Polder 28/2 (using Theissen Polygon Method)

Temperature

Mean maximum temperature stays between 23.48°C (January) to 32.99°C (May) 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 (January) to 25.99°C (August). 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 5.2.**

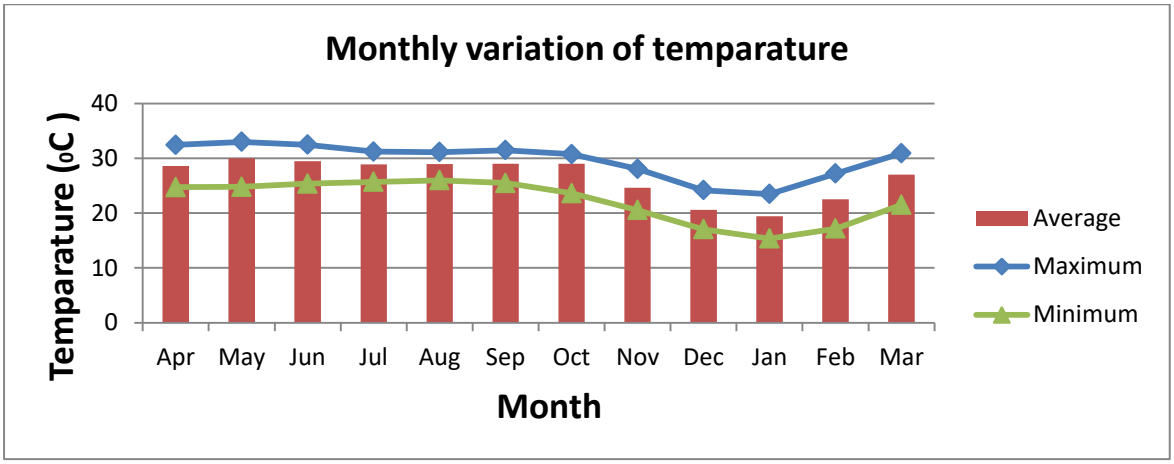


Figure 5.3 Average of Maximum and Minimum Temperatures at Khulna BMD Station

Relative Humidity

Figure 5.3 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. In the coastal areas, relative humidity values are usually higher than the other parts of the country. This is because of having a greater extent of water bodies, leading to increased evaporation.

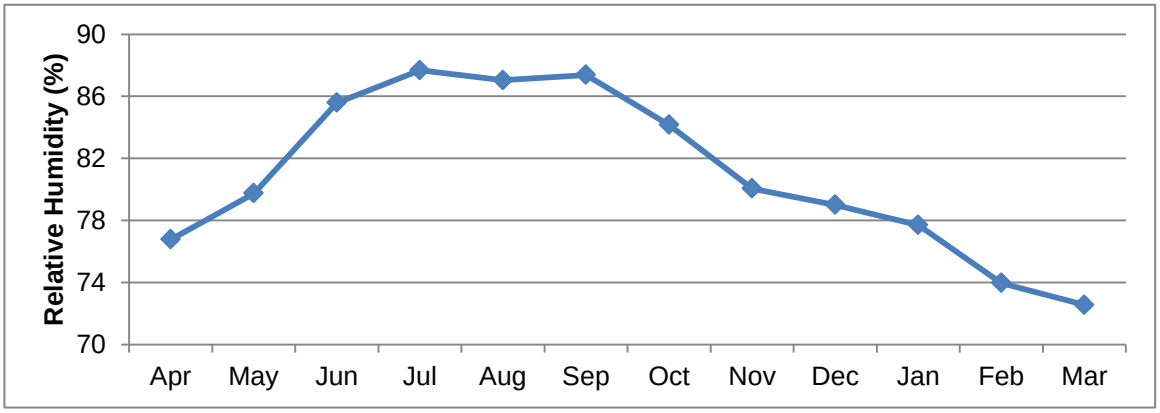


Figure 5.4 Average Relative Humidity at Khulna BMD station

Evaporation

Figure 5.4 below provides the monthly variations of evaporation, actual ET and reference ET (ETo). Evapo-transpiration is maximum during monsoon (June to September); and except dry season, all the other months experience significant evapo-transpiration values. ET is actually an indicator that defines crop and plant health, and observed results in Polder 28/2-part therefore implies for better plant health (especially in Kharif-I and Kharif-II).

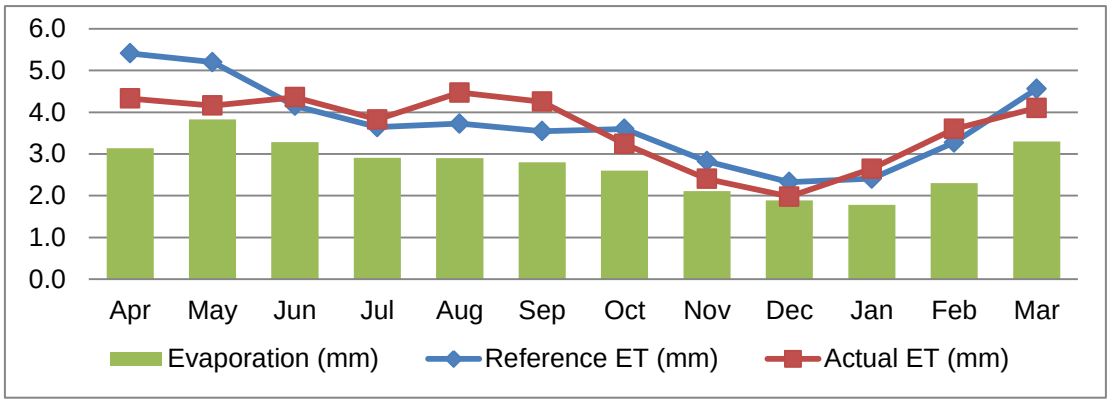


Figure 5.5 Monthly Variation of Evaporation, Reference ET and Actual ET for Khulna BMD Station

*Wind **Speed***

Figure 5.5 below shows the distribution of average monthly wind speeds, at Khulna BMD station (from 1978 to 2012). Wind speed is the highest in April (around 160 kph) and the lowest in November (around 40 kph). During cyclone Sidr (2007) and Aila (2009), 1 minute sustained wind speeds were recorded as 260 kph and 120 kph respectively, the former one created devastating impacts due to the high wind speed whereas the later one is more related to the increased storm surge.

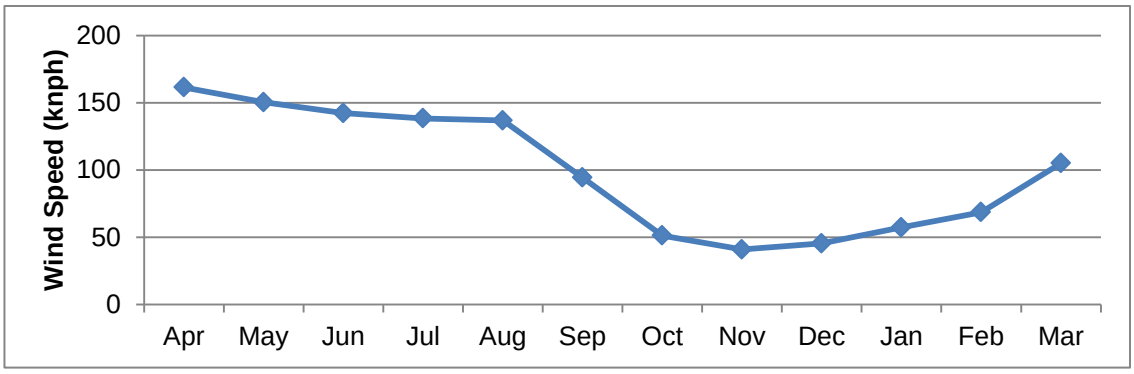
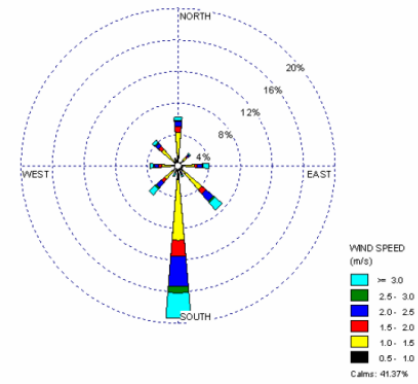


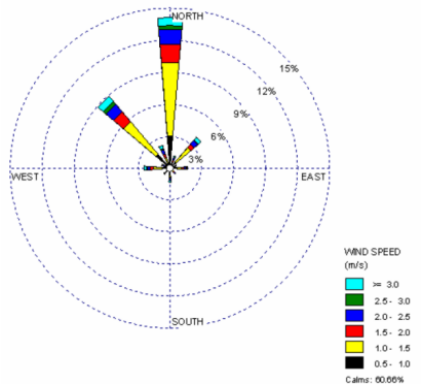
Figure 5.6 Variation of Average Wind Speed at Khulna BMD station

As per Bangladesh National building Code (BNBC), the basic wind speeds[1] for Khulna is 238 kph.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 5.6 a). During November to February, maximum prevailing wind flows from north and northwest to south and southeast direction and for the rest of the period it flows from south (Figure 5.6 b). During March to April wind mostly flows from south and southwest to north and northeast (Figure 5.6 c), and for May to October it flows from south and southeast to north and northwest direction (Figure 5.6 d).

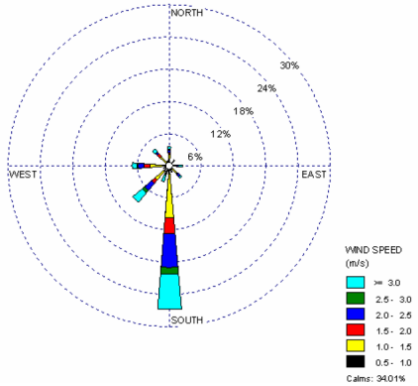
[1]Basic wind speeds of BNBC refer to the speeds above 10m from ground surface, with terrain exposure B (open



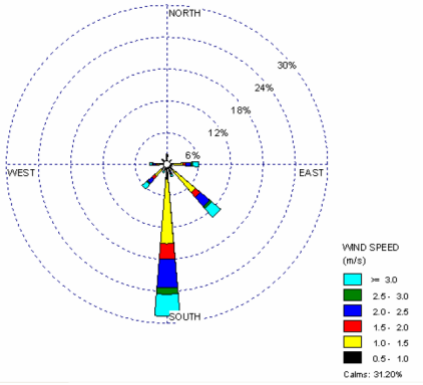
(a): for Khulna for a Full Year



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



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



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

Figure 5.7 Wind Rose

Sun-Shine Hour

The average sunshine hour data has also been collected from Khulna BMD station (1990-2010). **Figure 5.7** 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 5hrs.

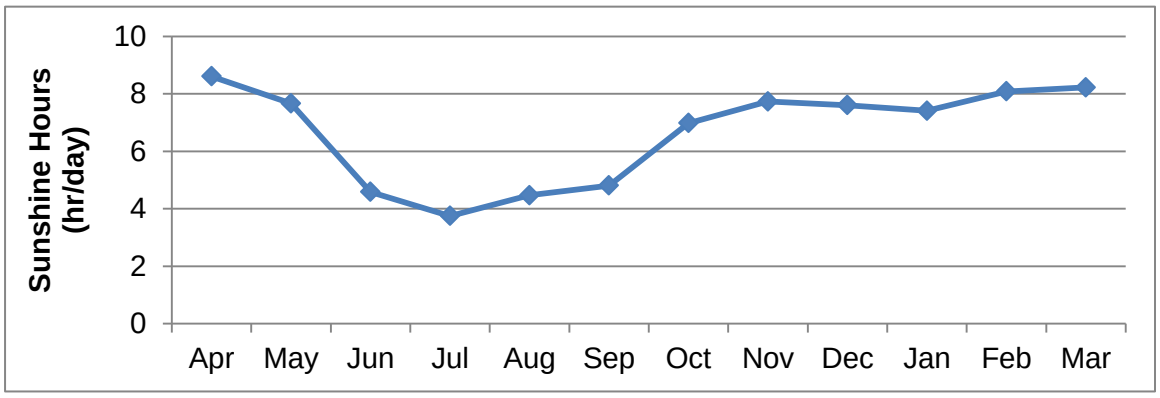
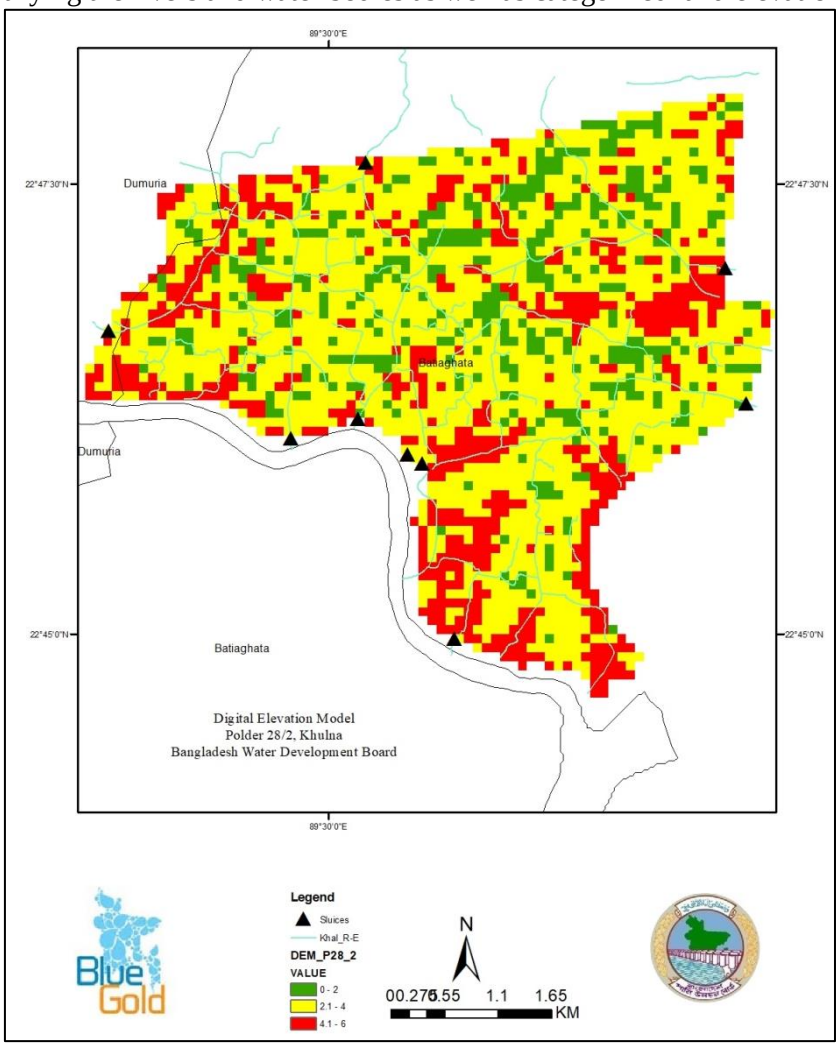


Figure 5.7 Monthly Variation of Average Sunshine Hours at Khulna BMD Station

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



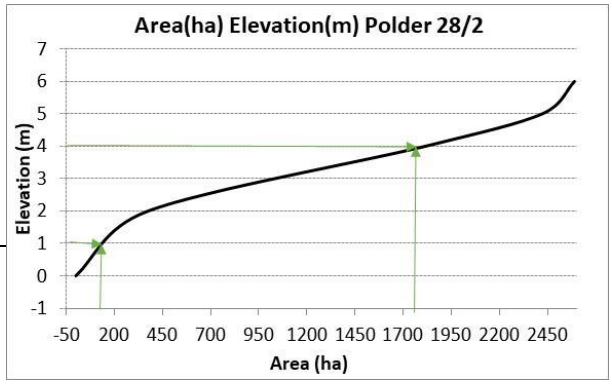
Map 5.1 Digital Elevation Model (DEM) 28/2

Spot levels were interpolated into a continuous surface called Digital Elevation Model (DEM). DEM analysis infers that the reduced levels inside the Polder vary from -1 to + 6 m PWD, with average RL of around +1.65 m +PWD. The average land level of Polder 28/2 is lower than the highest tidal water levels observed in the surrunding Rivers, and higher than the lowest tidal water levels.

Elevation Range (m)	Area (ha)	% of Total Area
-1 - 0	58	2.2
0 - 2	317	12.2
2 - 4	1441	55.6
4 - 5	607	23.5
5 - 6	167	6.6

Percent area as per elevation of Pol 28/2

From the DEM it is found that 55.6% land of the areas have elevation between +2 to +4 m above MSL, and 14.4% have elevations are is below +2mPWDD. 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



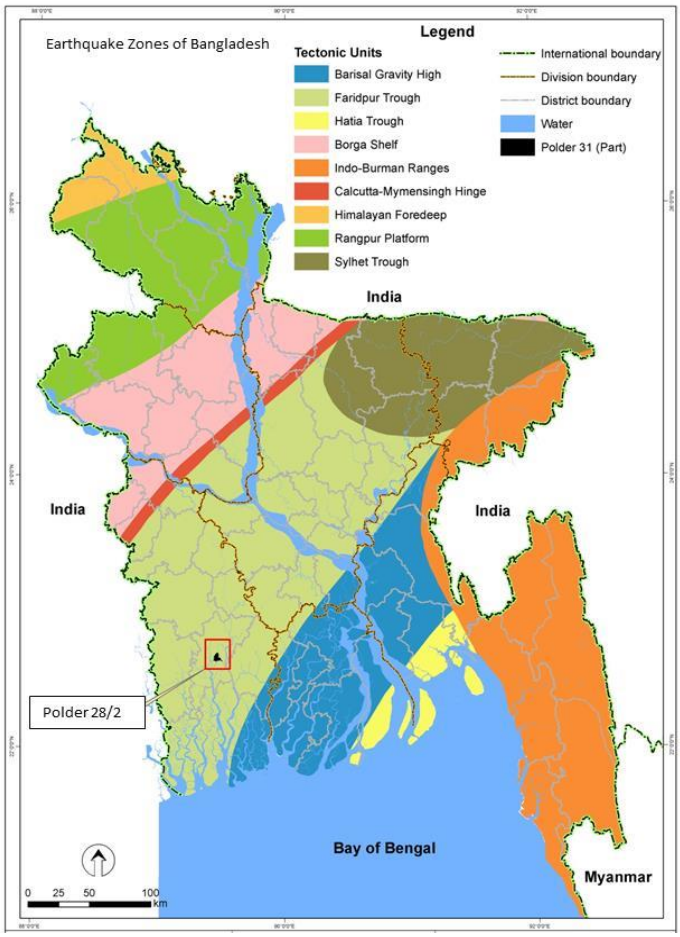
the Rupsha-Pasur River through the peripheral rivers (Sholmari, Salta, Jhopjhopia and Kazi Bacha). **Map 5.1** below shows the topography of the study area, identifying the rivers and water bodies as well as categorizing land elevations.

5.1.3 Seismicity

Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes in the past 200 years. As per the updated seismic design provisions of Bangladesh National Building Code, 1993, Polder 28/2-part falls under Zone-I, which is considered as a seismically quiet zone, with *Seismic Zone coefficient*[2] of 0.075, comprising the southwest portion of Bangladesh. **Map 5.2** below shows the seismic location of Polder 28/2-part.

Moreover, Polder 28/2-part is located inside the Faridpur Trough, which 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 the polder (within the Faridpur Trough).

It can therefore be inferred that both in consideration of seismicity and stratigraphy, Polder 28/2-part falls on a relatively safer (seismically quiet and tectonically stable) side.



Map 5.2 Earthquake Zones of Bangladesh and location of Polder 28/2

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. The polder 28/2 area is in the Ganges Tidal Flood Plain (AEZ-13). These layers are:

[2]Seismic Zone coefficient is a dimensionless number which represents the (maximum) earthquake acceleration as a fraction of the acceleration due to gravity.

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

Agro-ecological zones and sub-zones are very broad units. The fertility status of these zones varies greatly. Individual farmers have fragmented the land into small pieces causing wide variation in the management of each and every piece of land. This leads to large variation in the fertility levels even between adjacent plots. The difficulties of agro-ecological zones are given here which serve as a ground for AEZ based fertilizer recommendations for cropping patterns (FAO/UNDP, 1988). For detailed information about physical and chemical properties of soils, respective Upazila Nirdeshikas may be consulted.

AEZ-13: Ganges tidal floodplain

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. The area is general pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, non-calcareous, heavy silty clays in the extensive basins. Non-calcareous grey floodplain soil is the major component of general soil types. Acid sulphate soils also occupy significant part of the area where it is very strongly acidic during dry season.

5.1.5 Physico- chemical properties of soil

In general, most of the top soils are acidic and sub-soils are neutral to slightly alkaline. General fertility level is moderate to high with low organic matter content and very high CEC and rich 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. Detailed distribution of physico chemical properties of soil of the polder area is presented in the Table 5.1.

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

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

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

Source: Fertilizer Recommendation Guide - 2012, BARC.

5.1.6 Soil fertility Status

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. 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

Polder	Location	Depth (cm)	EC	pH	OM	K	N	P	S
28/2	Hatbati	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)	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)	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	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

5.1.7 Soil Salinity

Estimation from SOLARIS-SRDI, 2006, reveals that over the period soil salinity of the area inside the polder increased gradually. Local farmers reported that most of the water control structures are not functioning properly and cannot restrict intrusion of saline water inside the polder. This is reported to be the salinity increase inside the polder. In the field, top soil was tested by tongue and seems to me salt effected. Some Sub-assistant agriculture officers (SAAO) and Upazila Agriculture Officer (UAO) of DAE and local people of the polder area reported that the soil and water salinity gradually increases with dryness from January and reaches maximum level in the month of March-April and then decreases due to onset of monsoon rainfall. Detailed soil salinity of 1973, 2000 and 2009 of the polder area are presented in Table 5.3

Table 5.3 Detailed soil salinity in the polder area

Soil Salinity Class	EC (dS/m)	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
Slightly saline with some moderately saline (S3)	8.1 - 12.0	1,813	100	1,197	66	1,450	80
Moderately saline with some strongly saline (S4)	12.1 - 16.0			471	26	363	20
Strongly saline with some very strongly saline (S5)	> 16.0			145	8		
Total		**1,813**	**100**	**1,813**	**100**	**1,813**	**100**

Source: SRDI, SRMAF Project, Ministry of Agriculture, 2010

5.1.8 Drainage Characteristics

Drainage plays a vital role in the management of soil productivity in the polder area. The drainage characteristics have been divided into six classes by SRDI for agricultural uses. These are excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and very poorly drained. About 7% of the net cultivable area (NCA) is under imperfectly drained i.e water drains from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land for more than 15 days at a stretch.

During the rainy season, groundwater stands within 1 meter depth and 93% of the NCA is poorly drained. The soil remains under water for 15 days to few months. Water is drained from the soil slowly. Timely removal of water in rainy/monsoon season is crucial for growing Rabi / dry land crops in the polder area. Detailed drainage characteristics of the polder area are presented in Table 5.4 and Map 5.3.

Table 5.4 Detailed distribution of available drainage characteristics in the polder area

Drainage	Area(ha)	% of NCA
Imperfectly Drained	127	7
Poorly Drained	1,686	93
Total	**1,813**	**100**

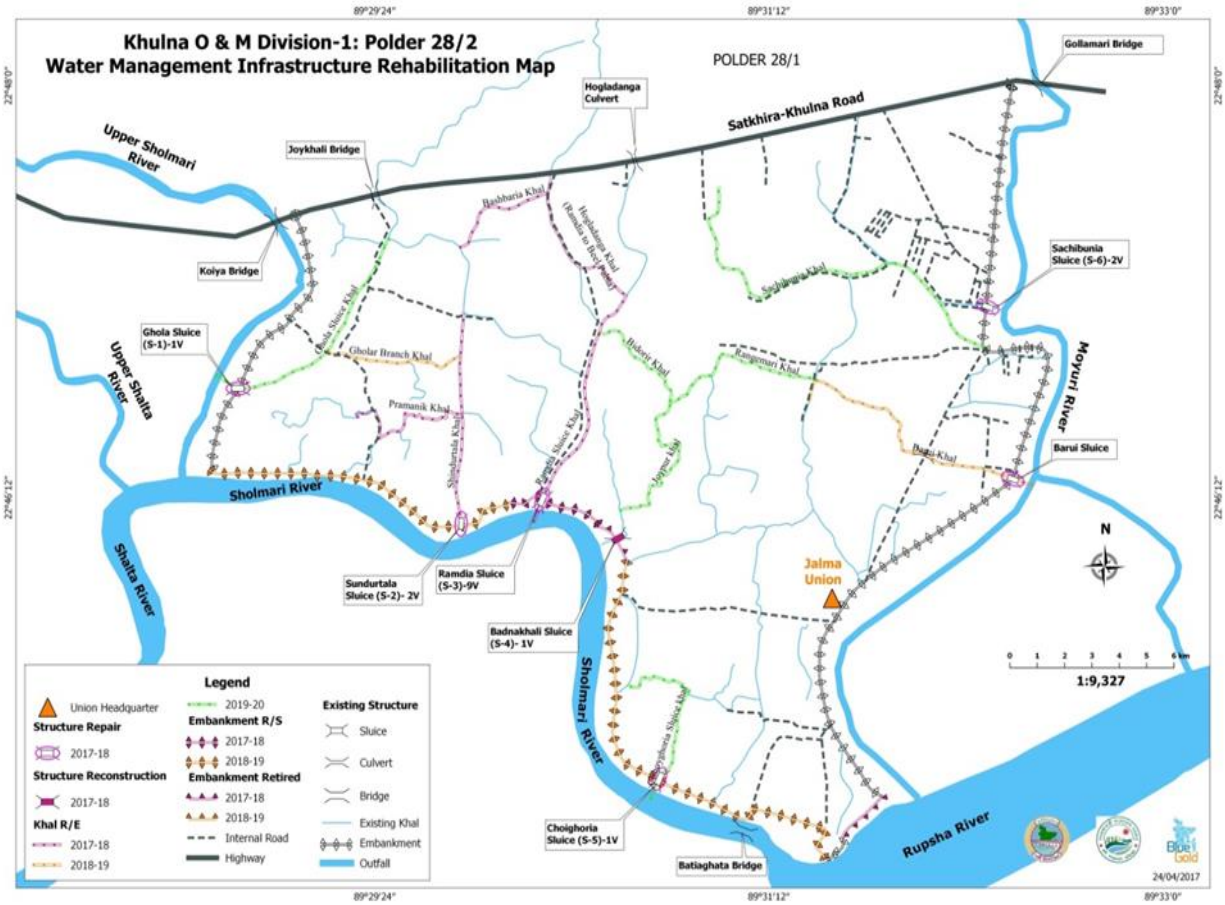
Source: Estimation from SOLARIS-SRDI, 2006

5.1.9 Water Resources System

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 28/2 is 75 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder falls at Jalma union under Batiaghata upazila of Khulna district. It is surrounded by the Shoilmari (south), Kazibacha (south-east), Upper Shoilmari (south-west) and Alutola/Moyuri river at the east part. The river system of the area is shown in **Map 5.3**



Map 5.3: Water Resources System of the Polder Area

During high tide, tidal water flows into the peripheral rivers through the Sibsa-Ghengrail and Rupsa-Passur river systems. The Upper Bhadra River carries water from the Sibsa-Ghengrail River system whereas the Jhapjhapia and Manga rivers carry water from the Passur River. The Jhapjhapia River connects the Upper Bhadra and Manga rivers along the eastern periphery of the polder. However, the hydrological connectivity between these two rivers has been lost due to the gradual siltation of Mora Bhadra River along the south-west portion of the polder. Sometimes tidal floods occur from Rupsha/Kazibacha river and Upper Shoilmari river, but not that frequent and severe. In some cases upstream water flow and heavy rainfall cause flooding in the polder area. The duration of inundation is about 3 to 4 months. There are a number of internal water courses which contribute to the tidal flow circulation within the polder. There are around 67 km lengths of internal water courses which contribute to the tidal flow circulation within the polder. The khals provide water for the internal water courses (Ghola khal, Sindurtala khal, Joykhali khal etc.). There are other important water courses inside the polder namely, Ramdia khal, Joypur khal, Thakrunbari khal, Badaler khal, Guptamari khal etc. Almost 30% of Khals inside the polder are *perennial*[3]. The khals of Polder 28/2 are also shown in **Map 5.3**

Surface Water Level

The surface water levels of the BWDB station at Chalna (Passur River) has been analyzed (**Figure 5.8**). 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.

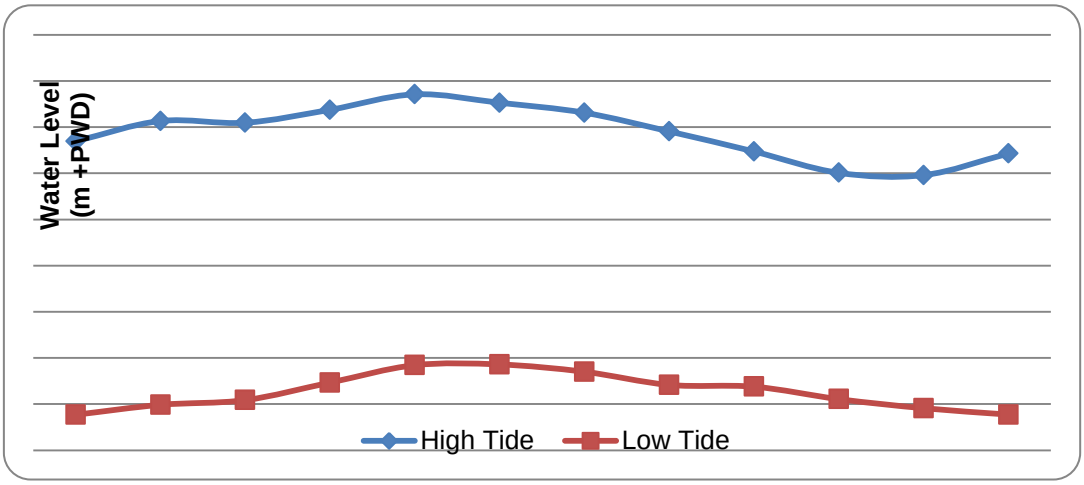


Figure 5.8 Surface Water Level at Chalna (Pasur River)

Ground Water

Monthly variations in ground water levels for the years 2000-2013 have been plotted in **Figure 5.9** for the ground water observation well at Chalna (named as KHU003).The variation pattern shows that the Ground Water Table (GWT) is the lowest in March and the highest in September.

[3] Perennial water courses are those which carry water throughout the year.

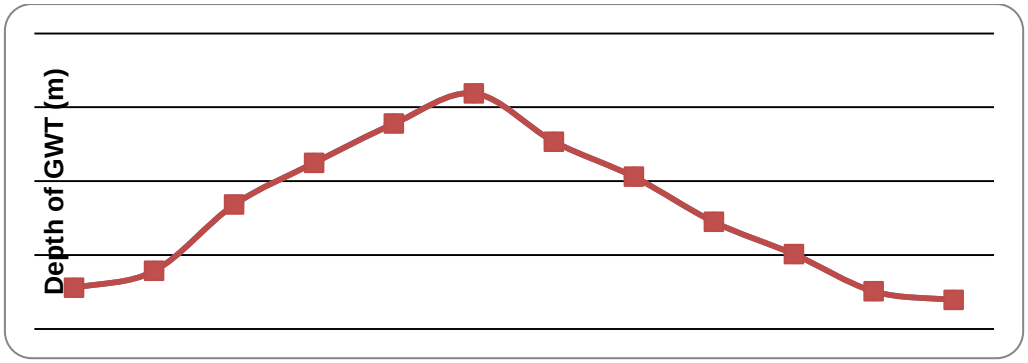


Figure 5.9 Average Monthly Variations of Ground Water Table

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 5.10 and 5.11).

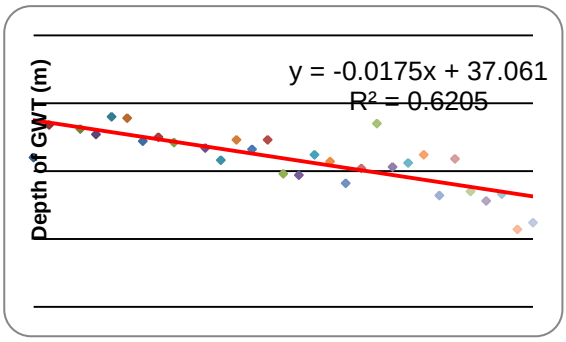


Figure 5.10 Variation of GWT at KHU003 in March (1980 – 2013)

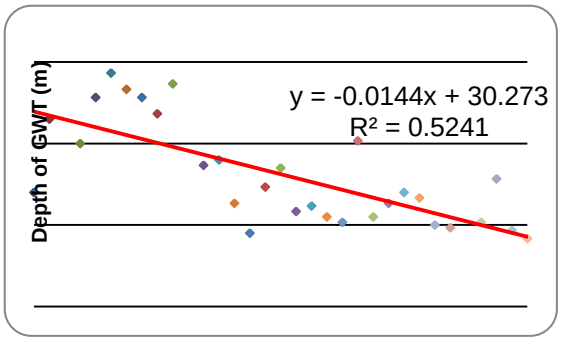


Figure 5.11 Variation of GWT at KHU003 in September (1980 – 2013)

5.1.10 Water Use

Domestic Use

The standard value of average daily demand of water for domestic and drinking purposes in rural areas is considered as 50 lpc (Ahmed and Rahman, 2010). However, the actual status of drinking water in some of the coastal polders is very poor. During the field survey in Polder 28/2, it was found that the average daily domestic use of water was around 30 lpc, which is slightly better than the other adjacent coastal polders studied in the first phase of the Blue Gold Program. The study found that around 285 m^3 of water is consumed daily by the total number of 40,680 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. For other domestic uses, surface water sources are used. Overall, water availability in Polder 28/2 is not a major concern as local people claimed that they have sufficient surface as well as groundwater sources to meet up their daily need of drinking and domestic purposes.

Irrigation Use

The local farmers in Polder 28/2 practice Sesame and Vegetables in Kharif-I (March-June) season, HYV T Aman and LT. Aman in Kharif-II season (July-October) and HYV Boro and Vegetables in Rabi (November-February) season. No irrigation is required in Kharif-I season. During Kharif-II season a very minor portion of water from the surface water sources is used for providing irrigation to HYV T Aman in the booting stages. Irrigation is also required for around 30 ha vegetables during Rabi season. Based on the expert opinions, it has been assumed that around 300 mm of water is usually required for each ha of land for Aman, Vegetable and Sesame cultivation; whereas around 1500 mm water is required for each ha of Boro cultivation. Using these pragmatic standards of water

requirements, the study infers that approximately 13.08 Mm^3 of water would be required for irrigation purposes throughout the year. The brief on irrigation water requirement is provided in **Table 5.5**.

Table 5.5 Irrigation water requirements in Polder 28/2 (Estimation, May 2019)

Season	HYV Boro	Lt. Aman (ha)	HYV T Aman (ha)	Sesame (ha)	Vegetables (ha)	Water requirement (mm/ ha)	Water Used (Mm3)	Type of irrigation
Kharif-I (March -June)	-	-	-	788	-	300	2.36	No irrigation is required
Kharif-II (July - October)	-	1,500	313	-	-	300	5.56	Surface water irrigation is provided in 50 ha areas (0.78 Mm^3 water)
Rabi (November – February)	273	-	-	-	-	1500	4.10	80% irrigation provided with groundwater and 20% irrigation provided with surface water (LLPs)
	-	-	-	-	353	300	1.06	Surface and ground waterr irrigation provided for 100 ha vegetables (0.30 Mm^3 water)

5.1.11 Water Resources Problems and Functions

The following sections describe the different water resources functions and problems in the polder. The water resources functions and problems were identified by the study team during their field investigation in May 2019.

Tidal and Storm Surge Flooding

Local people of Polder 28/2 opined that the peripheral embankment effectively offers protection from regular tidal flooding in the area. Some of the sluice gates located along the periphery of the polder are kept open by local water users, whereas minor flow leakage is going on in some other gates. However, such situations do not cause tidal flooding incidents in the polder, as the flows entering the polder through these khals are only confined within the internal water courses. Local people also alleged that there were no major storm surge flooding in during Aila (2009) and Sidr (2007).

Drainage Congestion and Water Logging

The polder suffers from drainage congestion issues. Almost 65% of the khals within the polder are affected by regular drainage congestion problems. This affects the seasonal water habitat inside the polder, which often gets inundated following any major rainfall events. Local people opined that the gradual siltation along some of the radially aligned water courses of the polder is the main reason of drainage congestion inside the polder. Furthermore, the peripheral of River is also heavily silted up and cannot drain out its portion of water properly. This adds to the drainage congestion phenomenon of the polder. On an average, rainwater requires more than 5 days to be drained out from the polder, which used to take a maximum duration of 1~2 days, almost a decade ago. No long term water logging was observed inside the polder.

Navigation

The peripheral rivers (Shoilmari, Upper Shoilmari, Rupsha/Kazibacha and Alutola/Moyuri River) 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.

5.2 Biological Environment

5.2.1 Farming practices

Farming practices largely depend on the land types, length of growing seasons and other environmental as well as socio–economic factors. In the polder area, there are three cropping seasons in a year. They are kharif-I, kharif-II and Rabi seasons. The kharif-I starts from March and ends in June. This season is characterized by the uncertainty of alternating dry and wet spells. Vegetables, jute and sesame crops are grown in this season in the area. The kharif–II starts from July and ends in October. The kharif-II season comprises wet and cloudy environment and heavy rainfall but uneven distribution, low solar radiation, high temperature and humidity. According to local farmers T aman rice both local and HYV and some vegetables are grown in this season under rainfed condition. Farmers also provide supplementary irrigation to HYV T aman crops under water stressed situation.
The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield. Wide ranges of crops are grown in this season. In this polder area, irrigated HYV Boro rice, sesame and vegetables are grown. Irrigation is given by Shallow Tube Wells (STW) and Low Lift Pumps (LLPs). There are occasional overlaps of growing seasons because of varying length of crop duration. T. Aman becomes late prolonging to Rabi season. Sometimes Rabi crops are also delayed and extend to Kharif-1.

5.2.2 Cropping pattern by land type

The most prominent cropping patterns of the polder area are Sesame – LT.aman - Fallow 36%, Fallow - LT. Aman – Fallow and Vegetable - Lt. aman - Fallow 19%. of the NCA respectively. Detailed cropping patterns by land type are presented in below Table 5.6.

Table 5.6 Detailed existing major cropping pattern by land type

Land Type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Area (ha)	% of NCA
Medium High Land (F_1)	Fallow	HYV T aman	Fallow	200	11
	Fallow	LT aman	Fallow	344	19
	Sesame	LT aman	Fallow	653	36
	Vegetables	LT aman	Vegetables	344	19
	Fallow	HYV T aman	HYV Boro	145	8
	Sesame	LT aman	HYV Boro	127	7
Total				1,813	100
Cropping Intensity (%)				**195**	

Source: field survey, 2019 and secondary data from SAAO, DAE

In the polder area farmers are using different crops varieties (local and HYV). Details of the crop varieties are given in the Table 5.7.

Table 5.7 Varieties rice cultivated in the polder area

Sl. No.	Aman		Boro		Sesame		Vegetables	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV
1	Muri shail, Kachra, Sadamota, Chinikura Banapuri. Jotirai	BRRI dhan23, BRRI dhan39	nil	BRRI -28, Hera 2,	nil	BARI Sesame-2 and BARI Sesame-3	Lal sak	BARI Brinjal-3, BARI Brinjal-4, BARI Cabbage-2, BARI Red

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

5.2.3 Cropping intensity

Total cropped area is about 3,600 ha of which the coverage of rice is 61% and non rice is 39%. The single, double and triple cropped area is 31%, 43% and 26 % of the NCA respectively. Therefore, cropping intensity of the polder is about 195%.

5.2.4 Crop production

In the polder area, the annual total crop production stands at about 14,620 tons of which rice is 6,936 tons and non-rice is 7,684 tons. The contribution of rice crops is 48% and non-rice is 52% of total crop production. Among the rice crops, the contribution of HYV T.aman, LT aman and Boro rice are 13%, 49% and 38% respectively.

According to local farmers and the SAAO's some crops are damaged by drainage congestion and heavy rainfall. Normally, HYV T.aman 10%, LT. aman 8% and sesame10% are damaged. Main causes of the damage's are heavy rainfall and drainage congestion. Total loss of rice production is about 230 tons in 157 ha and loss of non-rice production is about 43 tons in 57 ha due to drainage congestion, siltation of khals and drainage channels and natural calamities. Detailed crop production and crop production loss with percentage are presented in Table 5.8.

Table 5.8 Existing Crop Production and Crop Production Loss of the Polder Area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)	Production (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)			
HYV T aman	325	297	3.1	28	1.5	904	42	13
Lt aman	1,200	1,084	2.8	116	1.0	3298	148	49
HYV Boro	673	660	4.1	13	2.9	2734	40	38
Total rice	**2,198**	**2,041**		**157**		**6,936**	**230**	**100**
Sesame	700	650	1.1	50	0.75	697	38	10
Summer Vegetable	350	343	9	7	0	2,998	5	39
Winter Vegetables	352	352	12	0	0	3,989	0	51
Total non-rice	**1,402**	**1,345**		**57**		**7,684**	**43**	**100**
Total	**3,600**	**3,386**		**214**		**14,620**	**273**	**-**

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

5.2.5 Local price of the crops

In the polder area there are five markets. According to local people the price of the different crops were collected as Tk. /kg. Later it was calculated as Tk./ton, which is presented in the Table 5.9.

Sources: Farmers interviewed, May, 2019

Table 5.9 Local market price of different crops

Sl. No.	Name of the crops	Local price (Tk/ton)
1	HYV T aman	5,000
2	Lt aman	5,300
3	HYV Boro	5,000
4	Sesame	18,500
5	Summer Vegetables	10,000
6	Winter Vegetables	9,500

5.2.6 Inputs use

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

Seed

The seed rate used by the farmers in the polder area is presented in Table 5.10. In case of rice, farmers are using more seed than recommended as they normally use more seedlings per hill. Most of the cases, seedlings are affected by monsoon flood. Some SAAO's and farmers reported that last year, they were bound to re-transplant seedlings due to damage by heavy rainfall during monsoon season. The seed rate of vegetables generally depends on the size and viability of the seed. In the local market seeds are available in good condition.

Table 5.10 Seed used in the polder area

Name of crops	Seed used (kg/ha)	
	Farmers used	Recommended rate by BRRI & BARI
Lt Aman	55	40
HYV Aman	50	40
HYV Boro rice	50	40
Sesame	5	7
S. Vegetables	4.0-5.0	5-8
W. Vegetables	3.5-4.0	5-7

Source: Based on field information, May, 2019, SAAO, DAE.

Labor

In the polder area, almost 45% of the cultural practices for crop production are being done manually. So, agricultural labor (seed sowing, intercultural operations, harvesting and post harvest technologies) 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 and wages rate in the polder area are presented in Table 5.11. Locally labors are available for intercultural operations.

Table 5.11 Labor used in the polder area

Crop name	No. Labor used/ha	Labor wages / day (Tk)	
		Male	Female
HYV Aman	140	300-350	200-250
Lt Aman	85	250-300	150-200
HYV Boro	150	300-350	225-250
Sesame	60	200-250	100-150
S. Vegetables	185	250-300	150-200
W. Vegetables	180	250-300	150-200

Source: Based on field information; 2019, SAAO, DAE.; ***Note:*** *In addition to wages, labors are taking three times meal per day.*

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 Urea, TSP/SSP/DAP, MP and Gypsum. Farmer and SAAOs reported that they are using TSP or DAP. In many cases farmers are use fertilizers in unbalanced way. Organic manures are not used by the farmers in the field crops. Local women, farmers and SAAO of DAE reported that cowdung is used mainly for fuel purpose and partially in the homestead garden. According to local farmers and four SAAO's all most every local market there is fertilizer dealers. Dealers got training from UAO's office. Local farmers also reported that they don't have enough money to buy all types of fertilizer at a time. Detailed information of chemical fertilizer and cowdung use are presented in Table 5.12.

Table 5.12 Fertilizers used in the polder area

Farmers practice(Kg/ha)									Recommended doze(Kg/ha)							
Crop name	Compost	Urea	TSP	SSP	DAP	MP	Gypsum	Zn	Compost	Urea	TSP	SSP	DAP	MP	Gypsum	Zn
HYV Aman	0	120	60	0	0	30	0	0	0	163	35	0	0	30	0	0
Lt Aman	0	35	0	0	0	0	0	0	0	97	14	0	0	17	0	0
HYV Boro	0	140	95	0	0	70	5	0	2,000	270	58	0	0	58	0	4
Sesame	0	15	10	0	0	0	0	0	0	170	60	0	0	31	0	1.3
S. Vegetables	200	225	150	0	0	100	0	0	5,000	217	80	0	0	50	14	S
W. Vegetables	200	190	150	0	0	100	0	0	5,000	217	80	0	0	50	14	3

Sources: Farmers interviewed and SAAO, DAE, May, 2019;

Pesticides

The use of pesticides depends on the degree of pest infestation. According to local SAAO's and farmers, the major insects are stem borer, green leaf hopper, and rice bug. Local farmer reported that they are using different types of pesticides such as Korjan and Bilakto. Both liquid and granular pesticides are being used to prevent pest infestation in the rice cultivation. Local people visit farmers house to house for pesticide application in different fruit trees and rice and vegetable crops. Detailed information of pesticides used is presented in Table 5.13.

Table 5.13 Pesticides used in the polder area

Crop name	Pesticide using by farmers	
	No. of application	Liq. (ml/ha) apx.
HYV Boro rice	1-2	800-1000
HYV T. Aman	1	600-700
S. Vegetables	2-3	1000-1500
W. Vegetables	3-5	1000-1500

Sources: Farmers interviewed and SAAO, DAE, May, 2019;

5.2.7 Integrated Crop Management (ICM)

Recently, Integrated Crop Management (ICM) is practiced in many places of the polder area. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo etc to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. There are two ICM schools in the polder area. DAE is providing training from 4.00 pm to 6.00 pm. In ICM process, about 30% of the crops are protected without applying pesticides. Trap is another technique for controlling pests in the agriculture fields especially on watermelon and vegetables for attracting insects. Thus, it is possible to control the harmful insects without the application of pesticides. ICM technique is mainly applied on rice and vegetables crops. Field information (Farmers and SAAOs of DAE) indicates that ICM is being practiced in the fields in about 30-45% of the cultivated areas and the impact has been found very encouraging.

5.2.8 Irrigation

Some of the SAAOs of DAE and local farmers reported that both surface and ground water are the sources of irrigation. Khals and in few cases ponds are the source of surface water for very limited time. Irrigation is providing mainly in boro rice. Occasionally, Low Lift Pumps (LLPs) and Shallow Tube Wells (STWs) are being used for surface water and ground water irrigation. There are two deep tube wells running by BADC, these are used only boro rice cultivation. Some of the SAAO's and farmers reported that present irrigated area is 423 ha. They also reported that if the khals are re-

excavated then rabi crops area will increase. They also reported that if the project is not implemented irrigated area will be reduced. Some of the SAAO's and farmers reported that the cost of irrigation (surface water) per hectors is about tk. 4,500 to 5,000 and ground water cost is about tk. 8,000 to 9,000. Detailed information on irrigation is presented in Table 5.14.

Table 5.14 Irrigated area by crop

Crop name	Irrigation (Ground water)			Irrigation(Surface water)		
	Irrigated area (ha)	% NCA	Charge (tk/ha)	Irrigated area (ha)	% NCA	Charge (tk/ha)
Boro rice	218	12	8,000-9,000	54	3	4,500-5,000
T aman in booting stage (few area)	0	0	8,000-9,000	54	3	3,500-4,000
W. Vegetables	36	2	6,500	72	4	3,500-4,500

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

Photo 5.1 Irrigation by LLP

Photo 5.2 *Irrigation by STD*

5.2.9 Crop production constraints

According to local farmers and four SAAO's of DAE in four agriculture blocks, the main constraints in the polder area are:

- Salinity
- Drainage congestion.
- Pests
- Lack of irrigation water in rabi season

Photo 5.3 dentified farmers problems for crop production in the polder area through FGD.

5.2.10 Livestock and Poultry Resources

A large number of populations of the polder area earn their livelihood from raising livestock / poultry. About 40% farmers are rearing cows for milk purpose but health of cows is very poor. Women are rearing pigeon. Detailed status of livestock and poultry in the household level is presented in Table 5.15.

Table 5.15 Status of Livestock/Poultry in the Polder Area

Live Stock/Poultry	% of Household	No. Livestock/Poultry in the Polder Area
Cattle/cow/bullock	65	4421
Buffalo	5	340
Goat	4	272
Sheep	6	408
Chicken	90	6121
Duck	35	2380
Pigeon	4	272
Pig	2	136

5.2.11 Commercial livestock/poultry production

According to Local poultry farms owner, farmers and DLS there are about 50-60 poultry farmers. Details are presented below Table 5.16.

Table 5.16 Status of commercial livestock/poultry production

Livestock/poultry farms	Number of farms	Average nos/farms	Production (Nos)	Management		
				H	M	L
Chicken	50-60	600-1500	1.25-2.5 kg/chicken		M	

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

5.2.12 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 only 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 5.4 poultry farms in the polder area

Photo 5.5 Rice straw for cattle feed

5.2.13 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. July to October (rainy season) months are periods of spreading diseases to livestock and poultry population in large scale. There are many deaths of animal and birds every year within in the polder areas because of outbreaks of diseases due to poor drainage conditions.

5.2.14 Loss of open water fish habitat

The open water fish habitat i.e. khal habitat is losing gradually due to siltation, top soil erosion etc. Local people reported that high rate of siltation are main reason for losing of khal habitat. During field visit, it observed that around 70% of depth and 50% of width of khals have been lost due to aforementioned reasons. It is assumed that 60% areas of khals have been lost. Currently, many silted up khals are being used for gher practice (**photo 5.6**). Local people expressed that 15 years back, these khals was perennial and water retain round the year. However, spawning ground of the resident fish species is being damaged and thus capture fishery is declining day by day.

Perennial khal

Silted up khal

Photo 5.6 Open water fish habitat in the polder area

Silted up khal

Prawn practice in Polder

Photo 5.7 Present condition of fish habitat

5.2.15 Fish Habitat Quality

Surface water quality parameters that are related to fish habitat suitability measured in the different location of the khal and periphery river. Table **5.17** presents the measured water quality of fish habitats. From the analyzed data, the pH value is slightly higher which means water is alkaline and it is bad for fisheries. The value of water temperature in khal fish habitat is found within the standard values for fish. Because the water quality was measured during pre monsoon. Dissolved Oxygen (DO) content is found within the limit of Bangladesh standard (>5.0 mg/l) for fish culture. The presence of salinity in river and khal's water is found during field test. The salinity in the river water is high which is not suitable for prawn. However, mostly water quality parameters are within the permissible limit for fisheries resources. Local people opined that the water quality of gher has been declined due to continuous gher practice. During dry season they feel bad odor in the water.

Table 5.17 Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	Temp (ºC)	pH	DO (mg/l)	TDS (ppm)	Salinity (ppt)
Internal Khal		8.2	5.1	410	2
Periphery river (Shoilmari)		7.8	5.2	560	12
Standard values for fish	(28-34)**	(6.5 – 8.5)	4.0-6.0*	1000	(0-4) for prawn and (5 -35) for shrimp**

*Source; Field test, March 2017 (*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). Due to salinity, less aquatic plants such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows is found in the water bodies. Some free floating plants especially duck weed are common and their abundance is high in the closure. The presence of duck weed has created congenial environment for habitation of snake head (*Taki, shol, Magur* etc.) and benthic fishes (mud eels). However, some types of aquatic plants with leafs is using as habitat and spawning ground of fisheries as well as other insects and crustaceans in the polder area.

5.2.16 Fish Productivity and Production

Fish productivity in the polder has been assessed through fish catch survey and consultation with local fishermen. The fish productivity of the polder area is presented in Table (5.18).The open water fish productivity i.e. khal productivity rate is 75 kg/ha which lower than national productivity (172 kg/ha). As field investigation, major reason to low productivity of khal are siltation, low water during dry season, saline water intrusion through regulators for shrimp culture, encroachment of khal for gher practice, indiscriminate fishing by illegal gears etc . In case of culture fishery, the production rate is also lower than the national productivity. The main reason of low production of culture fishery in the study for gradual increasing of gher practice, short duration of water, lack of seed and feed, and lack of training of modern fish culture etc.

Table 5.18 Fish productivity of the Polder area

Fishery Category	Habitat Types	Productivity (kg/ha)	Remarks
Capture	Khal	75	Catch Assessment Survey
Culture	Golda &white fish gher	600	Consultation with fish farmer
	Rice cum golda &white fish gher	900	Consultation with fish farmer
	Culturable pond	1,200	Consultation with fish farmer
	Cultured pond	1,800	Consultation with fish farmer

Source: Catch Assessment Survey and Consultation with Fish farmer, 2017

The estimated total fish production of the polder area is about 181 tons. Bulk of the fish production (about 96%) is coming from culture fisheries and only 4% is come from the capture fishery. Fish production of capture fishery is downward in the polder area. Among the culture fisheries production, rice cum golda gher contribute major share of the fish production. Fish production in the polder area is shown in Table **5.19**

Table 5.19 Fish Production from Different Habitats of the Polder Area

Sl.	Category	Habitat Types	Fish Production (Ton)
1	Capture	Khal	8
		Sub-total	**8**
2	Culture	Golda &white fish gher	54
		Rice cum golda &white fish gher	28
		Culturable pond	42
		Cultured pond	49
		Sub-total	**173**
		Total	**181**

Source: Field survey, 2017

5.2.17 Fishing Effort

Fishermen Number

Local people reported that there are about 120 (4% of the total households) fisher households in the polder area. The fisher's household includes commercial, subsistence and part-time fishers. Among the fisher households, only 5% are engaged as professional/commercial fishers and they spend around 8-10 hours in a day in fishing activities throughout the year while 95% in subsistence level fishing. Local people opined that 70% people are concerned in fishing activities i.e. gher & pond fish culture, fish trading, PL collecting and trading etc. Most of the commercial fishers are in the polder are Hindu community (90% of the total fishers' community). There are no fishers Palli in the polder area. The economic conditions of the commercial fishers are poor and fishing is the only source to maintain their family. They usually catch fish in the nearby rivers and internal khals. The local fishers reported that about 70% of commercial fishers have changed their occupation due to lack of open water fisheries for siltation in near by Shoilmari and Moyuri rivers, encroachment of khals and open water bodies for gher practices etc. In addition, a number of fish traders and fish farmer etc are reported in this area. The seasonal vulnerability of the fishers starts from late October to January of the year.

During this period, fish catch is hardly recorded in this area. In this period, most of the fishers go to Sundarbans and sea to catch fish. Some fishers are involved in fish catch in the pond/gher for remuneration and also involved in fish trading. During this period they involved alternative profession like *golpata* collection from Sundarbans.

Fishing Season

Fishing season in the polder area starts from April/May and continues up to December. Most of the fish catch by different gears is occurred during late June to Mid November. The seasonality of major fishery is furnished in the **Table 5.20**.

Table 5.20 Fishing Seasonality of the Polder Area

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

Source: Field Survey, 2017

5.2.18 Fish Migration

The riverine fish species migrate through regulated khals in the polder to some extent during the period of June to August. Perennial khals along with other seasonal internal khals are used as feeding and nursing ground of the fishes. Fish species such as *Chingri, Puti, Boal, Pairsa, Tengra, Gulsha, Baila* migrate through these regulators to these water bodies as part of their life cycle. Fish migration status in the polder area is found as poor due to successive siltation and mal-function of water control structures, silted up of peripheral rivers, inactive of the Water Management Organizations (WMOs) for operation of sluice and regulators. The improper management of regulators hinder the migration of fish hatchling especially carp fry migration during pre-monsoon and other fishes.

Fishing Crafts and Location

Local fishers use both mechanized and traditional boats including Jala Nouka and Kusha and Dingi boats to catch fish in the peripheral rivers and internal khals. Fishing boat in the polder area is shown in the following **photo 5.9**.

Fishing Gear

Different types of fishing nets/gear are used in the polder area. Table 5.21 presents the fishing gears and targeted fish species. As per consultation with local fishers, around 15% of fishermen have fishing boats and 80% of fishermen have fishing gears/nets. Jhaki jal (cast net) and Dhela jal are common traditional fishing gears which are found all over the polder area (**photo 5.10)**.

Photo 5.8 A traditional fishing boat of the polder area

Photo 5.9 Common fishing gear (Jhaki jal)

Table 5.21 Fishing gear and trap used at Polder area

Category	Nameof gears/Trap	Shapes	Targeted fish species
Gill net	Current jal	Rectangular	Poa, chingri, tengra, gulsha, and koi fish
	Tana jal	Rectangular	Poa, chingri, tengra, gulsha, and koi and small fishes
Cast net	Jhaki jal	Conical	Small fishes (puti, chingri, tengara , Bele etc)
Push net	Dhela jal	Triangular	Small fishes (chingri, puti, chanda, mola etc)
Lining	Borshi	line	Big and small fishes
Trap	Chai/Unta	Rectangular	Small fishes (puti, chingri, tengara , Bele etc)

Source: Field Survey, 2017

5.2.19 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 60 numbers of fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (photo below). List of fishes of different habitat in the study area are presented in Table 5.22.

Fish species like *Taki, Shol, Cheng, Puti, Koi, Shing, Chingri, Baim (guchi)* etc are reported as common in the khal. These species contribute 70% of total fresh water fish production in the polder area. Moreover, some brackish water fish species e.g. *Bhetki, Pairsa* are found in the khal but their abundance is very low.

Photo 5.10 Composition of Fish Catch of the Polder Area

Table 5.22 Status of Indicative Fish Species Diversity of Different Fish Habitats in the Study Area

Scientific Name	Local Name	Habitat type		
		Periphery River	Khal/	Fish pond/Gher
Brackish Fish Species				

Scientific Name	Local Name	Habitat type		
		Periphery River	Khal/	Fish pond/Gher
Lates calcarifer	Koral/Bhetki	M	L	NA
Liza parsia	Pairsa	M	L	L
Liza tade	Bata mach	M	L	L
Rhinomugil corsula	Khorsula	H	L	L
Tenualosa ilisha	Ilish	L	NA	NA
Otolithes argentatus	Sada Poa	L	NA	NA
Terapon jarbua	Barguni/Rekha	M	NA	NA
Mystus gulio	Tengra	M	M	L
Pangasius pangasius	Pangas	L	NA	M
Polynemous paradiseus	Tapasi / Muni	L	L	NA
Sillaginopsis panijus	Tolar dandi	H	L	NA
Scylla serrata	Kankra	H	H	NA
Macrobrachium rosenbergii	Golda chingri	L	L	H (gher)
Metapenaeus monoceros	Horina chingri	M	L	NA
Penaeus monodon	Bagda chingri	H	L	NA
Fresh Water Fish Species				
Channa punctatus	Taki	NA	H	NA
Channa orientalis	Cheng taki	NA	H	NA
Channa striatus	Shol	NA	H	L
Clarius batrachus	Magur	NA	M	NA
Mystus vittatus	Tengra	M	M	NA
Macrognathus pancalus	Chirka baim	M	H	NA
Lepidocephalus guntea	Gutum	L	L	NA
Puntius chola	Chola puti	L	M	L
Wallago attu	Boal	L	NA	NA
Aorichthyes seenghala	Ayre	L	NA	NA
Puntius sophore	Jat puti	L	L	L
Glossogobius giuris	Baila	M	L	L
Eutropiichthyes vacha	Bacha	M	L	NA
Culture Fish Species				
Telapia nilotica	Telapia	NA	L	H
Hypophthalmichthys molitrix	Silver Carp	NA	NA	H
Puntius suchi	Sharputi	NA	NA	L
Cyprinus carpio	Miror Carp	NA	NA	L
Ctenopharyngodon idellus	Grass Carp	NA	NA	L
Catla catla	Catla	L	L	M
Labeo rohita	Rui	L	L	H

Source: Field Survey, 2017; Note: Abundance Code: H= High; M= Medium; L= Low; NA= Not available

Local people reported that 90% of carp production has been decreased in the polder area. Moreover, abundance of Golda *Chingri, Kathali Chingri Goda Chingri* has also declined in the polder area. This may be due to reduce depth of khal, low water flow, indiscriminate fishing by illegal gears. The dominant cultured fish species include tilapia, minor carp, Silver carp, Rui, Catla etc are found in pond and gher. Among these species, rui, catla and telapia are commonly cultured in rice cum golda gher in the polder area. Local people reported that tilapia and are cultured in 85% pond in the polder.

5.2.20 Presence of SIS in the Polder

The availability of SIS and their role in fish production in the polder is very negligible. According to field visit, and consultation with local people, some SIS like *Puti, Koi, Taki, Magur, Khalisa, Bele, Shing, Guchi Baim, Tengra, Tit Puti* etc are found in the polder area. Among them, *Tit puti, Taki, shing, Koi, Baila* are still common and available in different habitats like khal, golda gher, ditch etc in the Polder area. Currently, their existence in all water bodies is at stake. Currently, SIS to high level

of risk to extinction due to shrinkage of khal for siltation, saline water intrusion through regulators, indiscriminate exploitation of brood and juvenile SIS by using destructive gears, saline water intrusion in the khal. Local people reported that about 80% of SIS production has been declined in the polder from the 15-20 years back due to aforementioned reasons.

5.2.21 Threatened fish species

As per field investigation and consultation with elderly local people, threatened fish species those are locally rare and unavailable for last (10-15) years are given in Table 5.23. Among the threatened fish species *Boal, Kain, Sarputi, Ayre, Pabda, Kain* and Gojar etc are reported as extinct in the polder area. Brackish water fish species like *Golda Chingri, Kathali Chingri, Goda Chingri, Pairsa, Koral* has found vulnerable due to lack of water availability, saline water intrusion through sluices and regulators; loss of flow and water depth because of siltation , increasing of gher practices; and obstruction of fish hatchling due to improper and irregular operation of water control structures.

Table 5.23 List of threatened fish species

Local Name	Scientific Name	Polder Status	IUCN Status
Boal	*Wallago attu (*Bloch)	Extinct	C
Boro baim	*Mastacembelus armatus*	Extinct	En
Ayre	*Mystus aor*	Extinct	Vu
Kian	*Plototus canius*	Extinct	Vu
Shorputi	*Puntius sarana*	Extinct	Cr
Mola	*Amblyphyrngodon mola*	Vu	En
Pabda	*Ompok bimaculatus*	Extinct	En
Lal chanda	*Chanda ranga*	En	C
Magur	*Clarius Batrachus*	En	C
Gutum	*Lepidocephalus guntea*	Extinct	C
Gojar	*Channa marulius*	Extinct	En
Chanda Nama	*Chanda nama*	En	Vu
Meni	*Nandus nandus*	En	Vu
Lal Kholisha	*Colisa lalia*	Cr	C
Chuna Kholisha	*Colisa chuna*	Cr	C
Baro baim	*Mastacembelus armatus*	Cr	En
Foli	*Notopterus notopterus*	Cr	Vu
Koral	*Lates calcarifer*	Vu	-
Pairsa	*Liza parsia*	Vu	-
Golda Chingri	*Macrobrachium rosenbergii*	Vu	-
Kathali Chingri	*Macrobrachium villosimanus*	En	-
Goda Chingri	*Macrobrachium dolichodactylus*	Vu	-

Source: Field Survey, 2017; Here- C-common, Vu- Vulnerable, En- Endangered, Cr- Critically endangered

5.2.22 Fish Marketing and Post Harvest Facilities

Fish edible quality is in good condition for human intake. But local people reported that pesticides coming from agriculture field, polluted water from shrimp gher are causing deterioration of habitat quality as well as fish diseases. Sometime, this causes unsuitable for consumption.

Local fishermen sale bulk of their catch either directly to the local fish market at Budhahata, Machlona bazaar, Dulihar bazaar, Satkhira Sadar and Assasuni bazaar or to the fish traders. The fish traders or buyers (Bepari) come from Satkhira Sadar and Assasuni to purchase fishes. There are three *Matshya Arot* within the polder. A large amount of fish is sold from this Arot twice a day. Structured fish-landing centers are not found in the polder area. There are four ice factories inside the polder area which mainly located at Satkhira Sadar. Transportation facility at root level is moderately developed. Local fishers and fish traders use van, pickup van and Motorcycle to carry fish. There is no private hatchery inside the polder area. Availability of fish feeds for culture ponds and gher are insufficient. Fish seeds for culture fishery are collected from the hatcheries and nurseries which are situated at

Khulna, Jessore and Bageraht. But Post Larvae (PL) of Bagda is collected from the Satkhira Sadar which collected from Cox's Bazar directly by fish traders. Fish fry (white fish) are also collected from mobile buyer who comes from Satkhira, Jessore and Khulna districts. Wild fish fry like Vetki, Pairsa, and Korsola which are cultured in the gher are collected from the local fishers. PL ofGolda is collected from the local PL collector in directly or collected from PL traders. The PL is caught from Periphery Rivers and to the Sundarbans area. But it has negative impact on the fish fry of both

5.2.23 Fisheries Management

There is no community based fisherman association in the polder area. The fishermen have partial access in fishing to existing fish habitats in the polder area. There is no leased water body in the polder. Department of Fisheries (DoF) has limited activity for fisheries resource conservation and management in this area. Some NGOs i.e. BRAC, ASA, Grameen Bank are working, but they are very much limited in micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation is weak in and outside the Polder area.

5.2.24 Bio-Ecological Zones

IUCN-The World Conservation Union has identified 25 bio-ecological zones (2002) in Bangladesh. The aspects on which these zones are primarily centered on physiography, climate, soil type, flooding depth and biodiversities. These bio-ecological zones can be classified as major ecosystems of the country. The 28/2 polder area encompasses one of these bio-ecological zones, namely the Saline Tidal Floodplain. The polder is situated at Jalma union under Batiaghata upazila of Khulna district. A brief ecological description of the bio-ecological zone is presented below.

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)* are two common palm of this area. The mango *(Mangifera indica),* Sirish *(Albizia saman),* Babla *(Acacia Arabica),* Khai Babla *(Pithocelobium dulci),* Taal *(Borassus flabeliffer),* Gab *(Diospyros perigrina)* 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 in the polder are: 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.

5.2.25 Terrestrial Ecosystem

- **Terrestrial Flora**

Settlement/Homestead vegetation

Homestead vegetation is dominant with plant in terms of diversity and population. Most of the homestead vegetation is man-made those are usually planted for the household benefits. Rest of vegetation is considered as self propagating. Settlement vegetation is dominated by Sirish, Babla, Khai Babla, Tal, Narikel, Bot, etc. The same species occupy top canopy of the vegetation layers. Among the other species, Aam, jam, kola, bash etc. are common. Akashmoni *(Acacia auriculiformes)* are the other exotic species. Table 5.24 provides a list of major tree species within the homestead vegetation in the polder area. Settlement vegetation is also providing shelter for various terrestrial fauna.

Photo 5.11 Homestead vegetation

Photo 5.12 Showing grazing field in Polder 28/2

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

Table 5.24 Major trees species within the homestead area

Tree species name	Family name	Local Status	Saline susceptibility	Habit	Utilization	Ecological Value
Supari *(Areca catechu)*	Palmae	VC	2	Monocot	Fruit and Thatching	3
Narikel *(Cocos nucifera)*	Palmae	VC	3	Tall monocot	Fruit and Thatching	1,2
Safeda*(Manilkara zapota)*	Zapotaceae	VC	2	T	Fruit	1
Tulshi*(Ocimum americanum)*	Labiatae	VC	1	H	Medicine	3
Babla *(Acacia nilotica)*	Fabaceae	VC	3	T	Timber, fuel wood and fruit	1,2,3
Khai Babla *(Pithecolobium dulce)*	Mimosaceae	VC	2	T	Timber, fuel wood and fruit	1,2,3
Khejur *(Phoneix sylvestirs)*	Palmae	VC	3	Monocot	Fruit	1,2
Tetul*(Temarindus indica)*	Leguminosae	VC	2	T	Timber and Fruit	2
Nim *(Azadirachta indica)*	Meliaceae	VC	2	T	Timber and fuel wood	2
Sirish(Albizia lebbeck)	Leguminosae	VC	2		Timber and fuel wood	2
Tal *(Boassus flabelifer)*	Palmae	VC	2	Tall monocot	Fruit and thatching	1,2
Payra*(Psitium guajava)*	Myrtaceae	VC	2	T	Fruit	2
Sezi *(Euphorbia antiquoram)*	Euphorbiaceae	VC	3	S	Fencing and Medicine	1,2,3
Jiga *(Lennea coromandelica)*	Anacardiaceae	VC	2	S	Fencing	2,3
Aam*(Mangifera indica)*	Anacardiaceae	C	1	T	Fruit and timber	1,2
Jam *(Syzygium sp)*	Myrtaceae	C	1	T	Fruit and timber	1,2
Kola (*Musa sp)*	Musaceae	C	2	H	Fruit	1,2,3
Bot*(Ficus benghalensis)*	Moraceae	C	1	T	Timber	1,2,3
Gab*(Diospyros perigrina)*	Ebenaceae	C	2	T	Fruit and fuel wood	1,2
Boroi *(Zizyphus sp)*	Rhamnaceae	C	2	T	Fruit and fuel wood	2
Bash (*Bamboosa* sp.)	Gramineae	C	1	CL	Thatching	1,2,3
Ipil ipil *(Leucauna laucocephalata)*	Mimisaceae	C	2	T	Timber	2
Jambura(*Citrus fistula)*	Rutaceae	C	1	T	Fruit	2
Dumur*(Ficus religiosa)*	Moraceae	C	2	S	Fruit , Fuel wood	2,3
Mahogany (*Swietenia mahagoni)*	Meliaceae	C	2	T	Timber and medicine	2
Akashmoni *(Acacia auriculiformis)*	Mimosaceae	O	2	T	Timber and fuel wood	3
Bel*(Aglemarmelos)*	Rutaceae	R	1	T	Fruit and Medicine	2
Kathal*(Artocarpus heterophyllus)*	Moraceae	O	1	T	Timber and fruit	1,2
Eucalyptus(*Eucalyptus* spp)						

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

Crop field vegetation

The net cultivated area in the polder area is 1853 ha. Verities of crops and cropping patterns have been discussed in the agricultural section of this report. Crop field vegetation is also a good shelter for different types of terrestrial fauna.

A part of crop fields remain seasonal (March-June) fallow for 3-4 months of a year. During this period, the land contains grassy vegetation with some other wild herbs. Durba (*Cynodon* sp.*)* is prevalent with *Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus* and *Paspalum* sp. The seasonal fallow lands have important roles in ecosystem functioning as support grazing for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna.

Embankment /Roadside vegetation

Riverside embankment is dominated by Babla (*Acacia Arabica*) and 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 5.13 Rows of Babla tree along the embankment sides at the polder

Major species found along the village road are: Sirish (*Albizia odoratissima),* Babla *(Acacia nilotica),* Tal *(Boassus flabelifer),* Narikel (*Coccos nucifera*), Suparee (Areca catechu), Khejur (*Phoenix sylvestris*) etc. The roads which have passed between two homesteads mostly followed Jiga *(Lennea coromandelica)* and Khejur as these have been planted for fencing as well as peripheral plants. Akand (Calotropis procera), Vaant (Clerodendron viscossum), sech/ sezi *(Euphorbia grandialata)* are common wild shrubs and herbs sighted along most of the roadsides.

- **Terrestrial fauna**

There are diversified terrestrial fauna with different species in the polder area. The major terrestrial fauna are different types of mammals, birds, reptiles and amphibians.

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.

Reptiles

The terrestrial reptiles are large in numbers in any given area of the polder compared to aquatic. The current findings are 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 field visit to the polder.

Mammals

Population and diversity of mammalian wildlife are comparatively low of 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.

Avifauna

Species richness of terrestrial fauna is mainly concentrated in homesteads forest and birds are higher 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).*

5.2.26 Aquatic Ecosystem

There are about 67 ha of wetland inside the polder. Wetland contains medium 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.

The seasonal wetlands are 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.

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

- **Aquatic flora**

Aquatic floras are mainly concentrated in internal canals and homesteads ponds, due to having continuous tidal water flow in the channels of the river. It does not support any aquatic macrophyte to grow and develop inside or along the bank line. Within the polder area the ponds and khal 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 polder 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.).

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 Gewa (*Excoecaria agallocha*), Golpata (*Nypa fruticans*), Choila/Ora *(Sonneratia caseolaris),* kankra (*Bruguiera gymnorrhiza*) and etc

- **Aquatic fauna**

The life cycle of aquatic fauna is dependent on seasonal variation as well as inundation depth and availability of water in all types of wetlands. Naturally, wetlands provide food and shelter to the aquatic fauna. Considering other polders, this polder contains lower population and diversity of

aquatic fauna. Siltation of internal canals, compartmentalization of intertidal area and application of pesticides are the major causes of poor faunal diversity. A brief description of aquatic fauna is presented below.

Table 5.25 List of aquatic fauna of the polder area

Types	Name (generic name)	Habitat
Birds	Little Egret *(Egretta garzetta),* Great Egret *(Casmerodious albus),* Common Kingfisher *(Alcedo atthis),* Little Cormorant *(Phalacrocorax niger*), Grey Heron *(Ardea cinerea)*	Mudflats, canal systems and seasonal wetlands.
Reptiles	checkered keelback *(Xenocrophis piscator),* smooth water snake *(Enhydris enhydris),* Rat snake *(Ptyas mucosus),* Common wolf snake *(Lycodon aulicus)*	All types of wetlands.
Amphibians	skipper frog *(Euphlyctis cyanophlyctis),* Bullfrogs *(Hoplobactruchus tigerinus)*	All type of wetland areas area.

Source: Local people interviewed, May, 2019

5.2.27 Ecosystem Services

Ecosystem services are the benefits which people obtain from ecosystems. These include provisioning both goods (tangible benefits) and services (intangible benefits).

Here, goods refer to items given monetary value, whereas the services from ecosystems are valued, but are rarely bought or sold. Ecosystem "goods" includes foods, construction materials, medicinal plants and tourism.

Homestead vegetation is very important for fruit production in the polder area. Banana (*Musa* Spp), Mango (*Mangifera indica*), Payara (*Psidium guajava),* Narikel (*Cocos nucifera*), Supari (*Areca catechu*), etc and various types of fruit species are also a big output from homestead vegetation. Timber for house and furniture are provided from homestead's timber trees. Homestead vegetation also provide important habitat of wildlife like bamboo grove, scrub jungle etc. are habitats for birds, reptiles and small mammals. Total amount of fish production are included in fisheries section of this report. Aquatic plants and micro organisms are important for fishes and also having role to keep balance ecosystem of a wetland.

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

Table 5.26 below represents few tangible ecosystem goods (but not limited to) from different common plants of the polder areas.

Table 5.26 The ecosystem product and its services within the polder area

Goods/Services/Purpose	Source	Plants Parts used
Food	Supari *(Areca catechu),* Narikel *(Cocos nucifera),* Aam *(Mangifera indica),* Jam *(Syzygium sp),* Kola (*Musa sp),* Safeda *(Manilkara zapota),* Payara (*Psidium guajava),* etc	Fruit
	Ghechu (*Aponogeton spp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana, (*Eichhornia crassipe*), Phutku (*Hygroryza aristata*) etc.	Leaf and stem
Wood, timber	Aam*(Mangifera indica),*Jam *(Syzygium sp),* 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	Thatching and fencing for huts and

Goods/Services/Purpose	Source	Plants Parts used
	(Boassus flabelifer)	as protective screen in homestead.
Fuel	Babla *(Acacia nilotica),* Akashmoni *(Acacia auriculiformis,)*Boroi *(Zizyphus sp),*Gab*(Diospyros perigrina),Thespicia populina* and etc.	Brunches, Leaf
Biofertilizer/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

5.2.28 Present Threats on Ecosystem

Soil salinity and internal canal bed siltation are the main threats on ecosystems of this polder. Intrusion of saline water creates stress for vegetation and its succession. Reduction of water conveyance capacity deemed soil moisture that hampers natural succession at canal side. 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.

Pests and diseases attack, improper homestead space utilization planning is also a problem. Nevertheless, hunting of birds and resident wildlife is also a threat and resulting disappears of wildlife day by day. Consequently, faunal population and diversity is also decreasing due to flood, cyclone and various human activities.

Local farmers reported that Mammals' population is very low in the polder area. Big mammals have already disappeared, because of change of land use and different human activities. According to the farmers it is reducing during last 6-10 years, because jungle area is reducing.

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

In the existing land use system, a huge numbers of ghers are found in the polder area which is also a part of aquatic/wetland ecosystem. Hence, there has been increase in soil salinity due to gher farming practices. For this reason, fresh water vegetation is reducing day by day.

Several species are listed in the IUCN *Red Data Book* occurs within the polder area are given below.

Table 5.27 List of several species in the IUCN *Red Data Book* occurs within the polder area

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

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

5.3 Environmental Quality

5.3.1 Sound Quality

During field inspection, sound levels were measured at Kulotir mor bazaar point (22º48'12.15''N and 89º28'08.35''E), with a 10 minute sampling period. The L_{50} (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L_{50} is assumed equal to Leq, which is the Equivalent Noise Level. In the study area, the L_{50} value was found as 46 dB, which is lower than the standard Leq value for residential zone set by ECA 1997 (50 dB). As the project implementation works are to be carried out manually i.e. without the use of any typical heavy loaded vehicle, it can be assumed that the sound levels generated from the construction sites due to project implementation works would have very minor contributions in the equivalent noise levels of the polder. *N.B: All values were collected during daytime.*

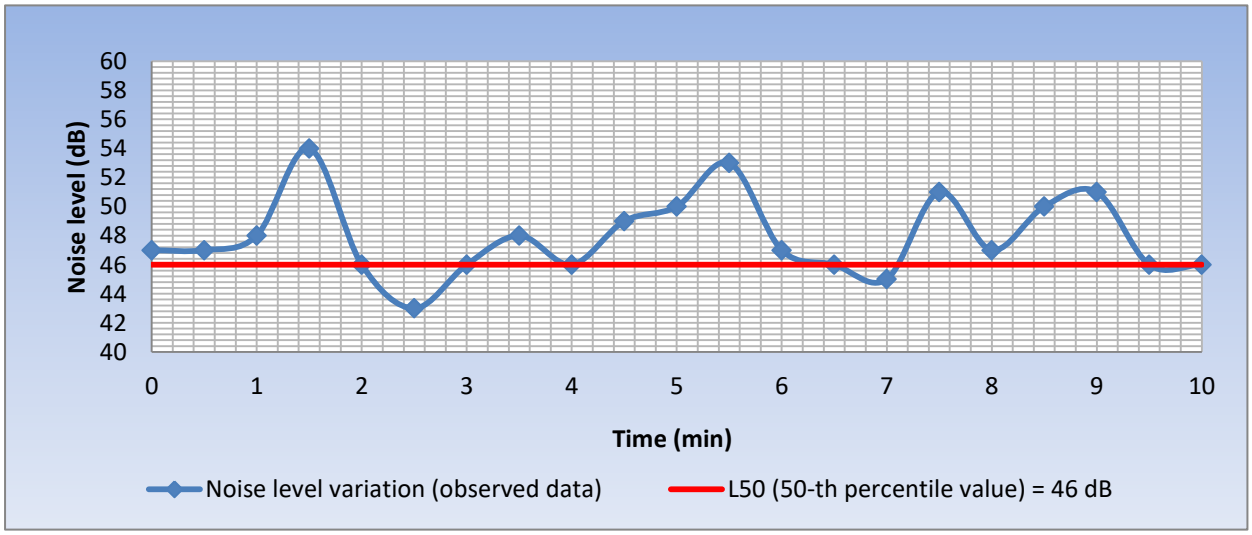


Figure 5.12 Variation of sound levels for 10 minute sampling period at Kulotir mor bazaar (22º48'12.15''N and 89º28'08.35''E)

5.3.2 Water Quality

Four major water quality parameters (pH, TDS, DO and salinity) have been measured during the field investigation in July 2019, from different locations of the study area (**Table 5.28**). The pH values in the inspected surface water sources were higher than neutral scale (pH=7), which means the water in these locations was alkaline. This may be because the typical pre-monsoon rainfall did not start by then (as opined by local people during field visits). Values of TDS were found very low inside the polder, but found high in the Moyur river samples. This is because of the increased sediment load carried by the peripheral rivers, which, to some extent, is prevented by the water control structures from entering the polder. Values of DO were mostly found close to the standards set by DoE for both irrigation (3.5 to 4.5 mg/l) and fishing (5 mg/l).

Almost all the surface water samples were found having moderate salinity concentrations. One deep tube well was also tested and found saline (with 0.04 ppt) at the Kuloti govt. primary school. Salinity values at Paskhali khal and Moyur river samples were found as 0-20 and 0-18 ppt respectively. There are no tidal flooding occurs in the polder. There are 11 khals where salinity concentrations almost similar to the feeding rivers. On the other hand, some khals are somewhat protected by water control structures. Local people opined that they prefer using deep tube well water to meet up their drinking water demand. Salinity levels from outside the polder were found similar to those inside the polder as most of the sluice gates are poorly functioned. In the month of May, highest salinity was observed as 20 ppt at Pashkhali khal in the polder.

Table 5.28 Water Quality Parameters

Location	pH	TDS (ppm)	DO (mg/l)	Salinity (ppt)	Remarks
Paskhali khal	7.5- 8.5	210- 320	3.5-4.5	0-20	Inside polder
Moyur river	7.15- 8.8	250.2- 1185	2.8-4.2	0-18	Outside polder
Kazi Bacha River	7.9	>1960	4.8	0-20	Outside polder
DTW at Kuloti govt. primary school	7.1-7.8	50-70	3.8-4.7	0.04	Deep Tube well inside the polder
Pond at Kuloti village	7.15- 8.2	150-200	4-5	0-0.5	Pond inside the polder

Source: BGP field survey, July 2019

5.4 Climate Change

5.4.1 Climate Science

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. Upstream cross boundary interventions has reduced freshwater 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 average maximum monsoon temperature and the average minimum dry season temperature at Khulna are both rising at 0.037°C and 0.047°C per year respectively. The temperature of extremely cold nights is less than 10°C, whereas extremely hot days having temperature greater than 37°C is not found to be significantly changing (Mondal, 2012).

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 winter is about 0.6 hours a day per decade, whereas the post-monsoon sunshine hours have a decreasing trend of 0.4 hours a day per decade. In a monthly scale, the sunshine duration has 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).

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 in the monsoon season is significant at a lower level of confidence (90%). The trend of the pre- monsoon season is not significant (Mondal, 2012).

The rainfalls at Khulna BMD have experienced 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. Among the monsoon months, June has an 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, and September has a positive trend of 7 mm a decade. Thus, the monsoon is found to be strengthening towards the end of the season. 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. Furthermore, the maximum number of consecutive rainy days in a year is found to be increasing (Mondal, 2012).

Moreover, the annual maximum high tidal water levels, as observed in Chalna (Pasur River) 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.

5.4.2 Climate Change Scenario

1. Two greenhouse gas emission scenarios, *A2 Scenario*[4] and *B1 Scenario*[5], from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC-IV) were used as they represent the high and low brackets of the estimated global temperature increases under the report story lines. The summary features of these scenarios, in relevance to Polder 28/2 has been discussed in **Table 5.28** below.

Table 5.28 Summary Features of Climate Projections for Khulna

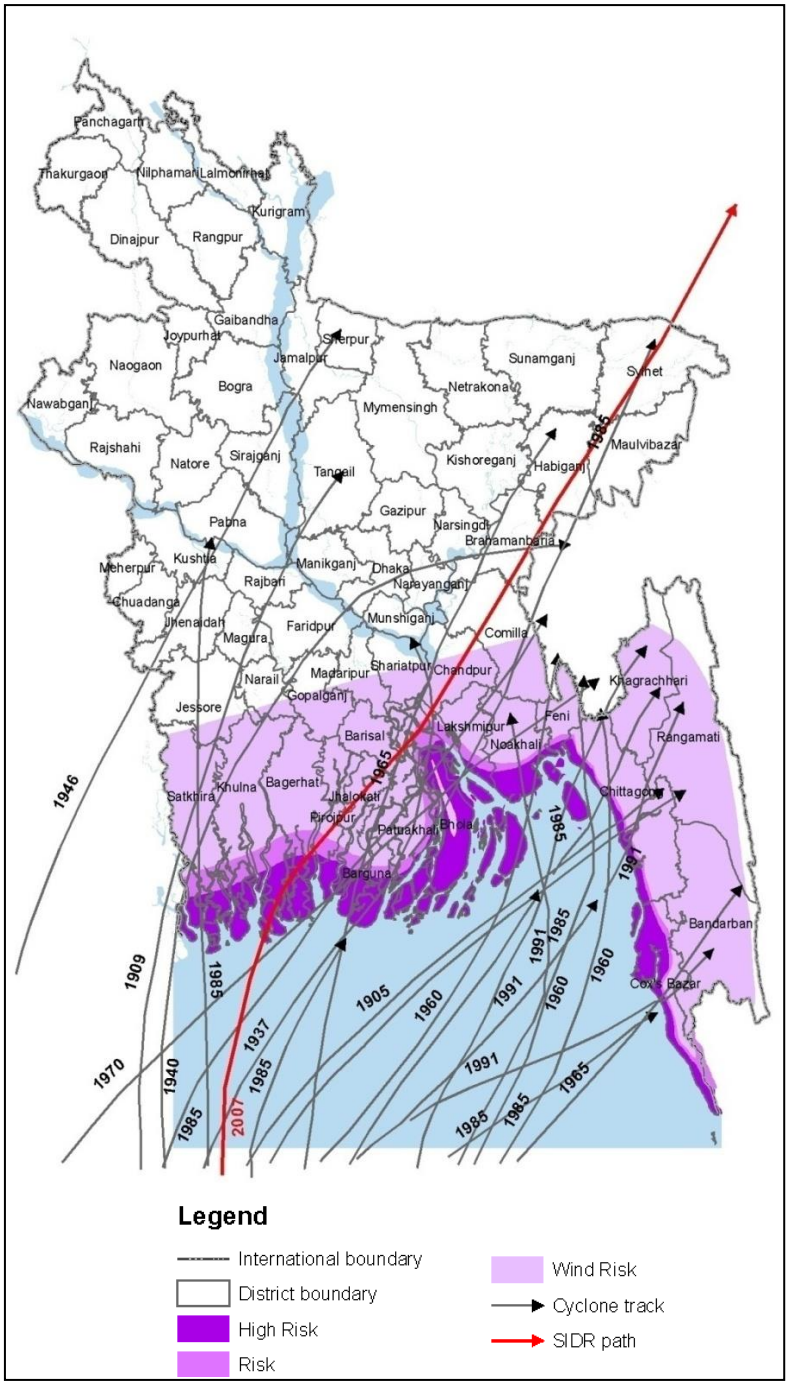
Scenario	A2	B1
Temperature	The average monthly temperature rise by 2050 varies from $+0.5^0$C in October to $+1.7^0$C in January and February.	The average monthly temperature rise by 2050 varies from $+0.5^0$C in June, July, and August to $+1.5^0$C in February and April.
Rainfall	The annual rainfall 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 28/2

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. By observing the tracks of different cyclones affecting the country in the last decade, the country's southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (**Map 5.4**). Polder 28/2 falls in the wind risk zone which possesses some vulnerability due to the strong winds, and surge heights associated with cyclones. However, from field observations, no major damage is found in the polder during the recent cyclonic events such as SIDR (2007), AILA (2009) and MOHASEN (2013).

[4] A2 Scenario is the business-as-usual scenario, a very heterogeneous, market-led world, with high population growth slow economic development, and slow technological change.

[5] B1 Scenario 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



Map 5.4 Cyclone Tracks in Bangladesh and Risk Areas

6. Socio-economic Condition

The socio-economic condition of the people living in 'Polder 28/2 EIA' (i.e. the study area) is captured in this chapter. In doing so, primary data were collected using a range of RRA techniques including Key Informant Interview (KII), Focus Group Discussion (FGD), observation and public consultation. Moreover, relevant secondary information was compiled from the community series of the Population Census 2011 published by Bangladesh Bureau of Statistics (BBS).
The study area is fully situated at Jalma union under Batiaghata upazila of Khulna district. The socio-economic baseline situation of the study area is described in the following sections.

6.1 The people

6.1.1 Demography

The 7,628 households living in the polder area have a total population of 40,680 of which 20,540 are male and 20,140 are female. The male population is higher than the female population. The average male-female sex ratio is 102 of which is higher than the national figure of 100.3 (HIES) 2010[6]]. The average density of population is 1,640 persons per sq. km which is more to the national density of 1,015 persons per sq. km. The inhabitants of this Polder belong to three religious group; i.e. the Islam, Hinduism and Buddhism. About 66% of total populations are Muslim and 34% are Hindus. The demographic data of this Polder is presented in **Table 6.1**.

Table 6.1 Distribution of population and household of polder

District	Upazila	Union	Total HHs	Total Populations			Population density [sq. km]	Sex ratio
				Both	Male	Female		
Khulna	Batiaghata	Jalma	7,628	40,680	20,540	20,140	1,640	102

Source: Housing and Population Census, BBS, 2011

In the overall study area, households distribution by number of persons it is found that the highest percentage (28%) of household comprises of 4 persons in each (**Figure 6.1**). Although average household size is 4.1, a substantial percentage (23%) of households comprises of 3 and over persons in each.

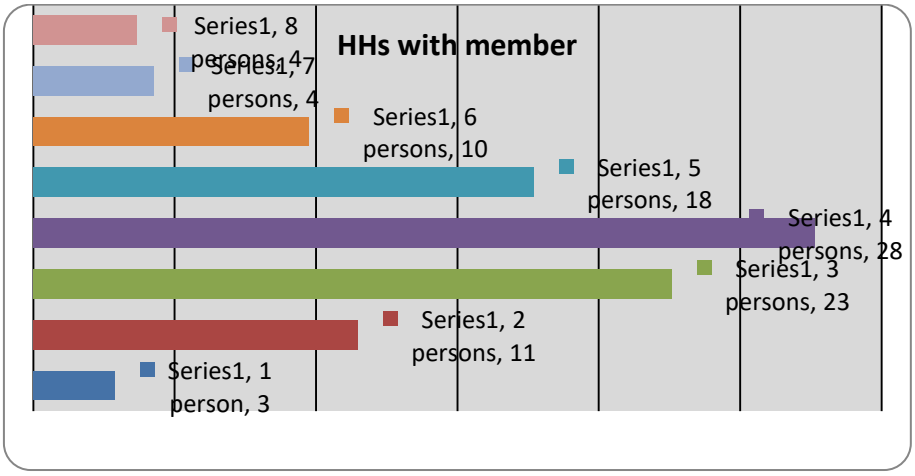


Figure 6.1 Distribution of households comprising member in each

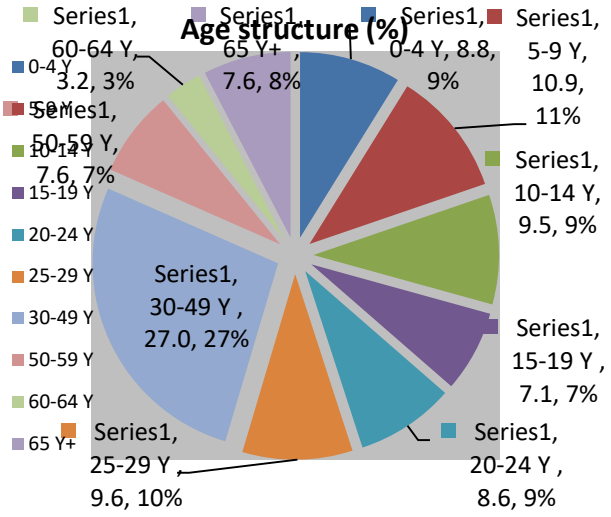
Source: Housing and Population Census, BBS, 2011

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

6.1.2 Age Structure

In the study area the highest number of population (27%) belongs to age category of 30 to 49 years old. Only 3% people are in 60 to 64 years category. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-54 years as prime working age, 55-64 years as mature working age and 65 years and over as elderly people (source: World Fact Book, CIA[7]). This classification is important as the size of young population (under age 15) would need more investment in schools, while size of older populations (ages 65 and over) would call for more invest in health sector.

The population data when analyzed to ascertain the size of (potentially) active working population then it appears that 63% percent population who are in the age bracket of 15-64 can be classified under this category. A small percentage (8%) is of 65 years above. The categorization is made on the basis of ILO reference for opting out potential labour force and dependent population. Population of 15 to 64 years category is considered as labour force whereas, populations below 14 years and above 65 years are considered as dependent. Thus, the total dependency ratio[8] is 59 in which child dependency ratio is 50 and aged dependency ratio is 13. It illustrates that total 59 persons are dependent on 100 labour forces in which 50 are children and 13 are elderly people.



Source: Housing and Population Census, BBS, 2011

Figure 6.2 Age structure of the studied population

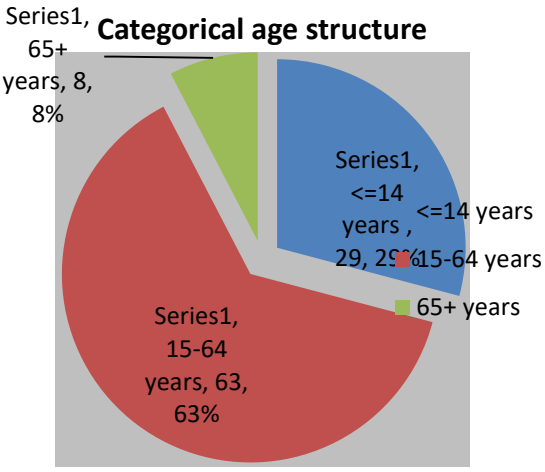


Figure 6.3 Categorical distribution of studied population

6.2 Education

Literacy rate, based on a definition "ability to write a letter in any language" is 51%, where for male it accounts to 56.9% and female 45.4%. The rate of literacy reported above is for population of 7 years and over ages (Figure 6.4). Data confirms that like the national picture of Bangladesh (Male 54.1%

[7] Retrieved on 09/04/2015 from https://www.cia.gov/library/publications/the-world-factbook/docs/notesanddefs.html

[8] Total dependency ratio=$\frac{number\ of\ people\ aged\ 0-14\ \&\ those\ 65\ and\ above}{number\ of\ people\ aged\ 15-64} \times 100$

Child dependency ratio= $\frac{number\ of\ people\ aged\ 0-14}{number\ of\ people\ aged\ 15-64} \times 100$

Aged dependency ratio= $\frac{number\ of\ people\ aged\ 65\ and\ above}{number\ of\ people\ aged\ 15-64} \times 100$

and Female 49.4%), in the study area the male populations are more educated than the female counterpart.

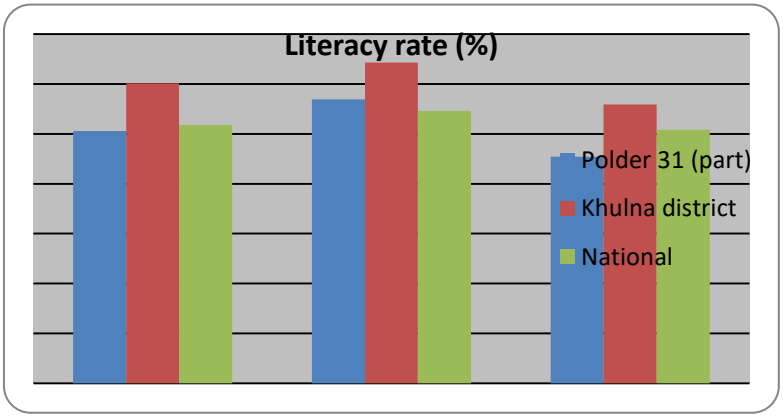


Figure 6.4 Literacy rate among the studied population

Field findings shows there are 16 primary schools, 02 high schools and 04 Ebtedaye/ Dakhil Madrashas in the polder area. There is only one Degree college which name as Goriar Danga College situated within the polder area. *(Source: Field work, 2019).*

6.3 Public Health

6.3.1 Access to health service

Access to health services and facilities refer to availability and adequacy of supply, affordability, physical accessibility and socio-cultural acceptability. Field data shows that there are 4 community clinics and 1 union complex at union level. People stated that the existing services are almost inaccessible to rural poor people. Therefore, a substantial pattern tends to receive services from local chemist and or village trained physicians. They stated that most of the community clinics are located at preferable location of local political leaders therefore; remote villagers have limited access than that of these adjacent villagers.

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

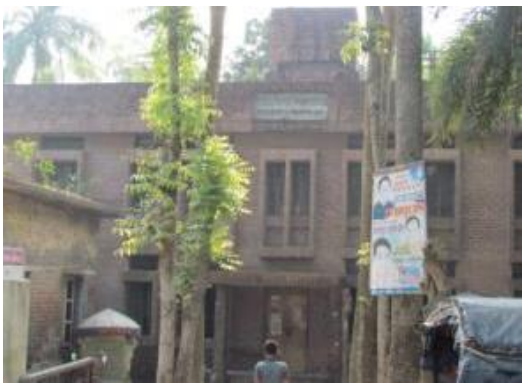


Photo 6.1 Surkhali Union health Complex

The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the respective area. It is found that the study area comprises 3.2% of all types of disabilities and 0.7% people reported that they are physically challenged. 0.6% mentioned speech and mental disorder. Local people opined that 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.

6.3.2 Ownership and utilization of land

The Census of Agriculture, 2008 by BBS classified land holdings into two broad categories- one is farm-holdings and another is non-farm holdings. A farm holding is defined as being an agricultural production unit having cultivated land equal to or more than 0.05 acre. Conversely, non-farm holding includes landless households and households having lands up to 0.04 acre. The study area shows that out of total holdings 60% is farm and the rest 40% is non-farm.
Therefore, the land holdings in the study area show that 0.09% households are absolute landless i.e. they have no lands either homesteads or cultivated. 41.64% households belong to functional landless category that comprises households those have only homestead lands (35.45%) and those have homestead with 0.01 to 0.04 acre cultivated lands (6.19%). Here, cultivated lands include mainly kitchen gardening produced predominantly by housewives mainly for household consumption.

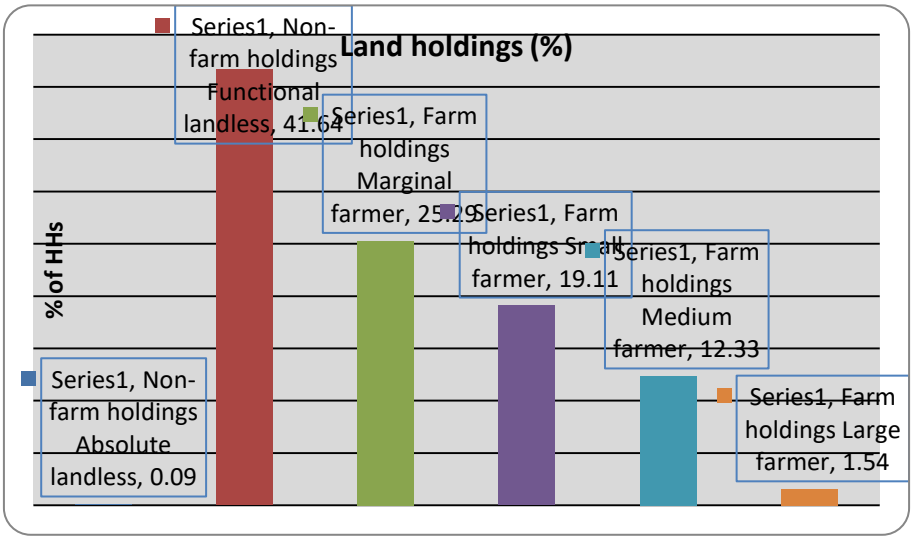


Figure 6.5 Households by land holdings

Source: The Census of Agriculture, 2008, BBS

On the other hand, farm holding distribution shows that 25.29% households belong to marginal farmer (0.05 to 0.99 acre), 19.11% belong to small farmer (1.00 to 2.49 acre), 12.33% belong to medium farmer (2.5 to 7.49 acre) and 1.54% belong to large farmer (7.5+ acre) categories. It is evidential that land fragmentation decreases the holding size therefore; large and medium farmers are gradually being converted to marginal farmers.

Field data proved that this large numbers of landless populations usually adopt alternative livelihood options, for instances; farm and non-farm laboring, driving, earth work, working for shrimp farm and other manual works.

6.3.3 Occupations and livelihoods

Out of total 40,680 population, 10,414 (25.6%) are economically active which include 3,510 (33.7 %) employed, 42 (0.4%) are looking for work, and 6,769 (65%) engaged in are household work. The economically active population includes those who are aged 7 and over and not attending school at reference period of Housing and Population Census, 2011. Therefore, the definition include employed, looking for work and household work categories and exclude children below 7 years, attending school population, physically impaired and elderly people who are not engaged in income generation works at reference period. Here household work particularly for women participation is accounted in terms of household activities as well as alternative income generation such as livestock rearing, poultry farming etc.

Women participation in direct income generating activities (employed category) is trivial as education status confirms that whereas not attending males are engaged in employment, females are getting married and in turn, contributed to the highest participation in household work (43.5%). The employed category also includes child labour as it was accounted from 7 years old population.

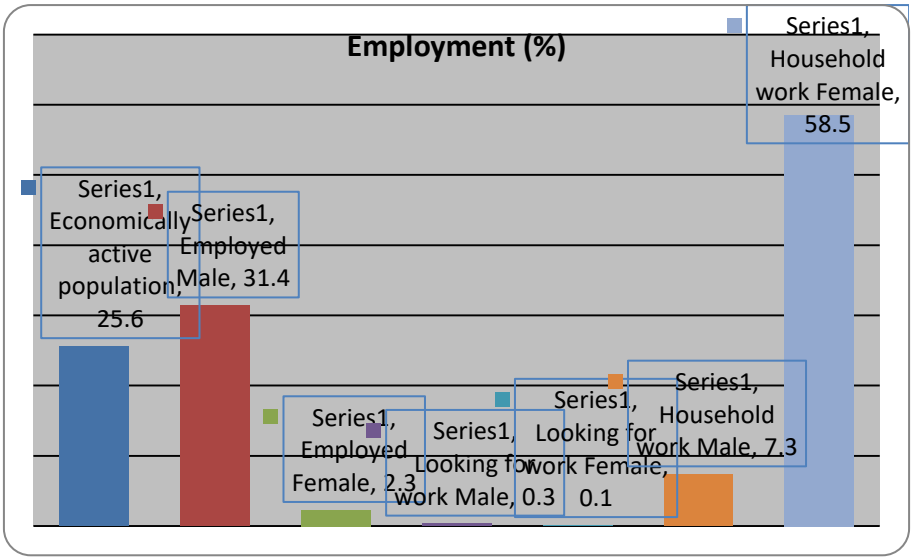


Figure 6.6 Employment status among the studied population

Source: Housing and Population Census, BBS, 2011

Distributing employed population at reference period of census it is found that 92% are engaged in agricultural activities, 4% in industry and 4% in service. Agricultural activities includes broadly crop farming, fishery and livestock and poultry farming. Scope of employment in agricultural sectors is gradually decreasing due to lack of sweet water tending to convert the lands into fellow land or shrimp farm. Field findings suggest that land use for settlements is increasing and water bodies are decreasing. It is evident that once upon a time this area is known as fully saline prone area and now this characteristic is now changing for last 10 years. People are now realizing the curse of salinity and they interested for either crop farming or sweet water shrimp cultivation. In the People stated that this contribution shall be increased if favorable assistances (infrastructure, power and re-excavation of khals) are ensured.

Photo 6.2 Different modes livelihood activities at polder 28/2

6.3.4 Labor market

The employment rate[9] in the study area is 33.7 whereas the unemployment rate[10] is 66.3. It is evident that more than 65% of the total economically active population is still unemployed. Most of the unemployment populations are females who are solely involved in household work, and only 0.25% populations are looking for work (see paragraph….of occupations and livelihood section).
Data confirms that agriculture, industry and service are the sole sectors to generate employment for the local people (see paragraph….of occupations and livelihood section). Field findings documented that peoples who are not permanently employed tend to engage themselves in those sectors in the forms of agricultural labourers, fishers, brick field worker, earth workers, and cleaners. In agricultural sectors most of the labourers are supplied from the local villages.

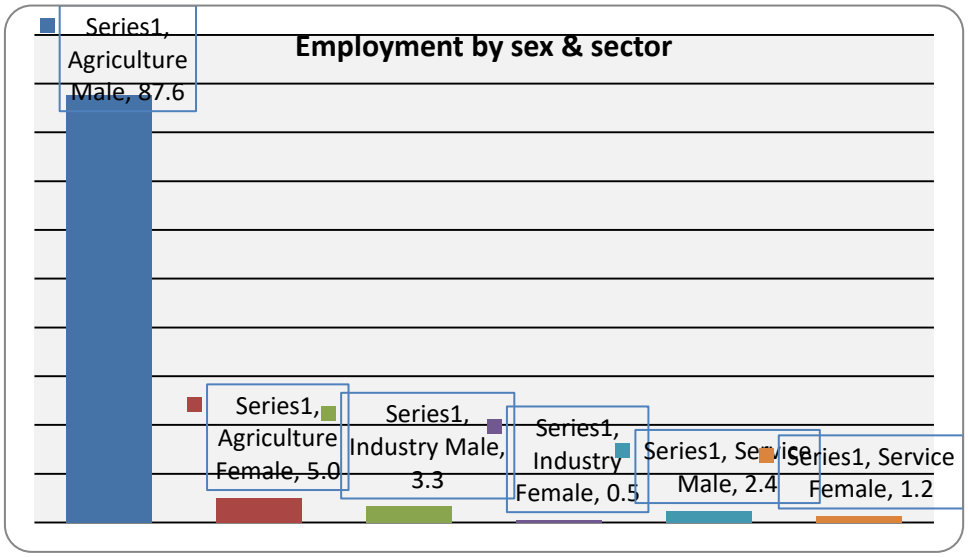


Figure 6.7 Distribution of population by sex and field of activity

Source: Housing and Population Census, BBS, 201

The above figure implies that female participation in agriculture sectors is higher than that of industry and service. Field findings documented that 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. 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.
During field visit, people stated that out migration of labourers is slightly found (2%) in the study area whereas in-migration is almost absent. These out-migrants are mainly agricultural labourer usually go to neighboring upazilas (Gopalganj, Khulna, Dhaka) during May to September for better livelihood and lack of employment opportunity over the polder from April to June. Additionally, there is trivial international out migrants (1%) who tend to go to Middle East for searching better livelihood options.

6.3.5 Standard of living

Standard of living indicates the level of wealth, comfort, material goods and necessities available to the studied population. This section defines it narrowly and necessarily includes people' access to electricity, sanitation facilities, safe drinking water availability, housing condition and fuel consumption.

[9] Employment Rate = $\frac{i\ Population}{bour\ force} X\ 100$

[10] Unemployment Rate= 100-Employment Rate

Electricity facility is very poor in whole union. Data shows that Surkhali Union comprises lowest (29%) coverage among other unions of the Batighata upazila even there is no electricity connection at Surkhali union parishad. Moreover, about 45% households are now use solar electricity in the polder area (Fieldwork, 2019).

The overall housing condition is not satisfactory. The study area shows the predominance of kutcha houses (88.8%) over other three types. Semi-pucka household is 3.9%, pucka is 4.8% and 2.5% is still jhupri houses. (**Figure 6.8**).

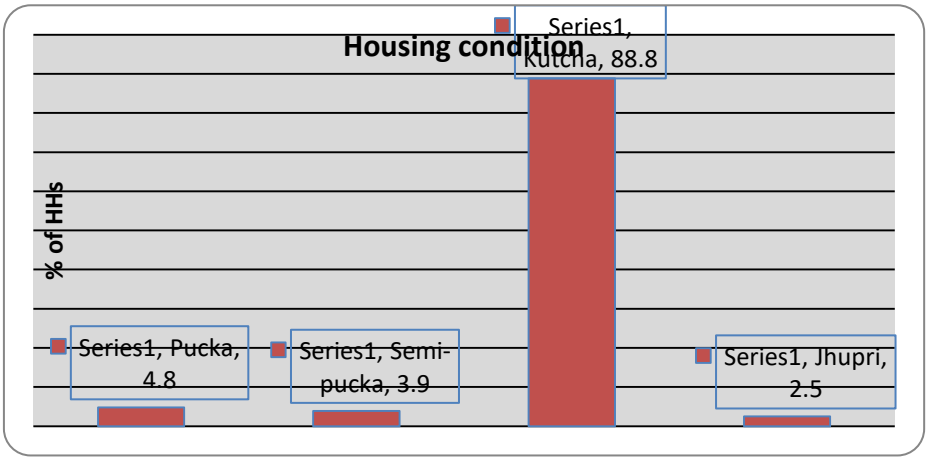
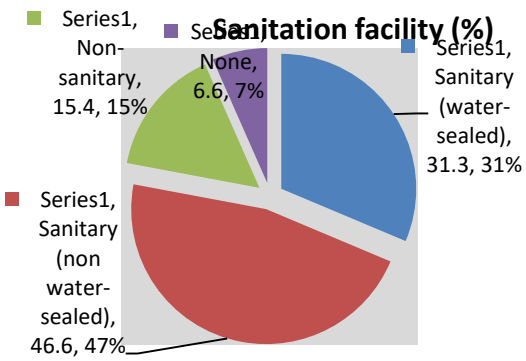


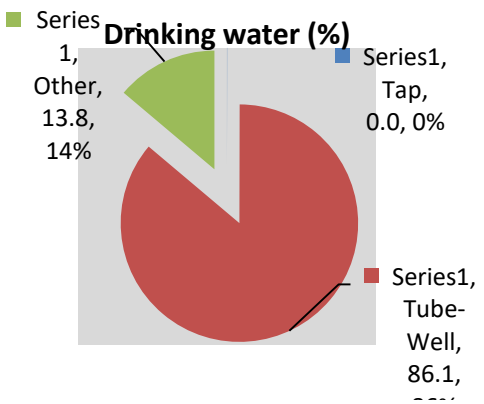
Figure 6.8 Housing condition in the study area

Source: Housing and Population Census, BBS, 2011

Photo 6.2 Housing structure at polder area

Sanitation facilities in the study area show that about 15.4% households use non-sanitary latrines, 46.6% use non water-sealed sanitary latrines and 6.6% use none latrines. Field findings confirm that non-sanitary latrines are predominant among kutcha houses. As water-sealed sanitary latrines are used by kutcha, semi-pucka and pucka households, it contains (31.3%). Water-sealed sanitary latrines are available predominantly in pucka houses. However, there are 4% houses, which have no sanitation facilities but tend to use on shared basis and in some cases uses open spaces (**Figure 6.9**).





Source: Housing and Population Census, BBS, 2011

Figure 6.9 Distribution of households by sanitation facilities

Figure 6.10 Distribution of households by sources of drinking water facilities

Status of drinking water in the polder area is deplorable. BBS data shows, collecting drinking water from tube-well is predominant (86%) throughout the study area. There is no use of tap water in whole polder area. However, 14% households are still depending on unorthodox sources of drinking water such as waterbodies; they are from poor classes and living in the rural areas having no access to tube-wells. On the other hand, Salinity is the main problems for drinking water especially during dry season. Besides, they also mentioned arsenic problem which is observed for last 2 to 3 years. They are depends on inadequate number of ponds and pond sand filter (PSF) for drinking water. Local people express that drinking water crisis is very severe especially during from November to May at Kallansri, Surkhali, Chatrabila, Chakimari, Faissamari, Songkhamari, Monorabad, Barobuiya and Roypur. During this period, the villagers collect drinking water from the neighboring village where sweet water is available in ground water. Even they also buy water from Gaoghera bazar at a cost of 20tk for every 30 litre jar. During monsoon i.e. June to October, they collect rain water and preserve it to meet their drinking water demand. Major sources of drinking water in Polder 28/2 are shown in **Photo 6.4-6.5 & Figure 6.10.**

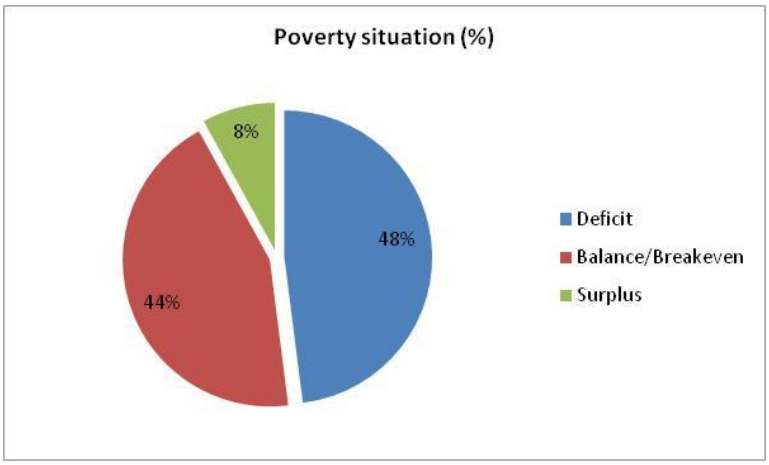
Photo 6.3 Installation of deep tube well at Vabagatipur

Photo 6.4 Collection of drinking water from Gaoghera bazar

Fuel consumption shows that all households located within the polder area have no gas supply. Some of the elite people are using cylinder gas for cooking purpose. However, households in rural area usually use firewood, cow dung, chips for fuel etc.

6.3.6 Poverty situation

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 6.11**). 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.



Source: CEGIS fieldwork, 2014

Figure 6.11 Self-assessment of Poverty Status

Photo 6.5 Road networks within the polder

6.3.7 Extension services

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

to some extent. **Table 6.2** shows the current social services and facilities for alleviating poverty in the study area.

Table 6.2 Households served by different social safety nets programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	4
Food/Taka For Work (F/TFW) of PIO	2
Food for Education/Cash for Education	6
Rural Maintenance Programme (RMP)	4
Old Age Allowance	3
Freedom Fighter Allowance	1
Integrated Poverty Reduction Program of BRDB	3

Source: Fieldwork, 2019

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. These NGOs are serving with micro credit while BRAC working for non-formal education, Health, 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.

Common property resources and its utilization

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

7. Stakeholder Consultation

7.1 Introduction

Public/stakeholder consultation is a regulatory process by which the public's input on matters affecting the local population is sought. It is a part of the EIA process aimed at involving the project stakeholders into the project development and implementation process. A formal meeting comprising of local people who are likely to be impacted was held at the polder 28/2 project location. During consultation meeting the proposed project interventions and their associated impacts were discussed following a comprehensive checklist. Such consolations are organized to solicit people's opinion and feed on the project activities and make the project socially acceptable and environmentally sustainable based on their feedbacks. The participants expressed their opinion spontaneously and shared their experiences.

7.2 Objectives of stakeholder consultations

Keeping in view the following key objectives the consolation process was design and implemented:

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

7.3 Identification of stakeholders

Stakeholders include all those who are affecting and/or perceive to be affected by the 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. In the context of this study stakeholders are those who are and/or could be affected by the project interventions.

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 28/2, 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. From the perspective, NGOs, concerned government departments, line agencies, Blue Gold program officials fall under this category.

7.4 Approach and Methodology

Participatory approach was followed in conducting the public consultation meeting (PCM). The study team first had meeting with BWDB officials responsible for the polder to share with them the feasibility and EIA process of the Blue Gold program. The local government officials/representatives were consulted to identify the potential stakeholders at the polder level. With available support from the Blue Gold program officials and UP Chairman, the union level public representatives as well as the key persons were contacted over telephone and they were informed about the specific consultation meeting and requested them to be present in the meeting. Accordingly, the venue, date and time of the consultation meetings were fixed. Later, the study team organized the meetings at the local level. Names, occupations and addresses of the meeting participants were noted during the meeting.

A number of focus group discussions (FGDs) and several informal discussions were also arranged during the public consultation process. In order to conduct the FGD and informal discussions five checklists were prepared covering various aspects including an overview of the proposed Blue Gold program, information on the ongoing EIA process, and seeking information on the problems of the area with their potential solutions. The local needs and demands have been discussed by providing equal opportunity to all participants attending the meeting. During consultation meeting all relevant issues pertaining to water resources, land resources, socio-economic resources, and disaster aspects were discussed in detail.

During FGDs and PCM, the EIA team displayed maps of the project area, shared the initial concepts on proposed interventions and facilitated the discussions to solicit responses from the participants. The stakeholders of the polder 28/2 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 through these discussions.

7.4.1 Consultation Process

The study team conducted the meeting. During consultation meeting, the following process was followed with sequences.

Greetings:

At the outset, the team spelled greetings to all participants. Welcomed them for attending and stated the entire design of the meeting.

Introduction:

The team members introduced themselves to the participants and gave detail description of the project, spelled out about the objectives and anticipated outcome of the meeting.

Respect to the participants:

The study team showed respect to all participants. They respected not only to the individuals but also to their values, cultural practices and social structures.

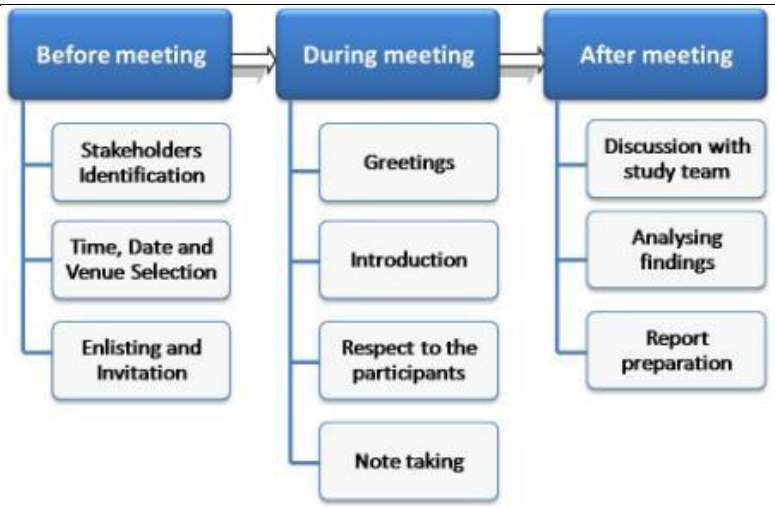


Figure 7.1 Overall consultation process

Ensuring peoples' voice:
Generally, all participants cannot participate equally. In fact, a substantial number of participants tended to remain silent in any meeting. However, the study team encouraged all to participate willingly through explaining the ethics of the study.

Note taking:
Discussed issues and opinions were written in notebook carefully. All issues were given equal importance.

Recapitulation and closing the session:
At the end the study team recapitulated the session and responded to the quarries. Finally, the facilitator closed the session thanking the participants.

7.5 Consultation meetings and FDGs

7.5.1 Consultation Process

One PCM and a number of FGDs were conducted at different locations of the Polder 28/2. The details of these FGDs and PCM are presented in **Table 7.1** and some photographs of the meetings are given in **Photo 7.1**.

Table 7.1 Consultation Details

Sl#	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Khulna	Khulna	Khulna	Blue Gold office	Consultation	23/05/2019	10:00
1	Khulna	Batiaghata	Jalma	Jalma union auditorium	PCM	23/05/2019	10:00
2	Khulna	Batiaghata	Jalma	Shailmari village	FGD	23/05/2019	14:00

Photo 7.1 Knowledge sharing consultation meeting with Blue Gold Program officials, at Khulna

7.5.2 Consultation Participants

The participants of these consultation meetings included Blue Gold program officials, local representatives, farmers, and traders, members of WMO and daily wage laborers of the Polder 28/2-part and nearby areas. A total of 102 participants attended these consultations. The details of the participant are provided in **Table 7.2** and **Photo 7.2 to Photo 7.3** below.

Table 7.2 Participant details

Sl#	Meeting venue	Type of consultation	Type of Participants	No. of participants
1	Blue Gold Prog office	Consultation	Secondary stakeholders	15
2	Jalma union auditorium	PCM	Secondary and primary stakeholders	38
3	Shailmari village	FGD	„	20
4	Raja Khar Beel	„	„	12
5	Vabagati Pur	„	„	10
6	Bunarabad village	„	„	16

Photo 7.2 PCM at Shoilmari, Batiaghata, Khulna

Photo 7.3 FGD at Batiaghata, Khulna

7.6 Issues discussed in FGDs and meetings

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

❖ Water resources:
- surface water (tidal flooding, drainage, salinity, siltation)
- water management (flood control, drainage, irrigation)

❖ Land resources:
- cropping practice,
- production and yield,
- water logging and drainage congestion
- crop damage.

❖ Socio-economic aspects:
- Occupation and Employment (unemployment/joblessness)
- Migration (temporary/permanent out-migration)
- Poverty (food and income poverty)
- Education (literacy rate, school enrolment, female education, drop out etc)
- Health and nutrition (illness, diseases, nutrition)
- Quality of life (housing and sanitation facilities, status of drinking water, fuel and fodder)

❖ Disasters:
- Cyclones
- River erosion
- Associated damages

❖ The sustainable and integrated solutions of the main problems being faced in the Polder:
- Water resource management
- Agriculture and fisheries management
- Land resource management
- Disaster management.

❖ Community involvement

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

7.7 Community concerns and suggested solutions

The name of the participants of different FGDs, their age, occupation and address including cell phone number are provided in **Table 7.3**. Similarly, an inventory of the participants of PCM was maintained in attendance sheet containing their contact numbers. Scanned list of participants is attached in **Appendix-4.**

Table 7.3 Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	Salinity intrusion, drainage congestion, water borne diseases and cyclone are the main community concerns in the polder area.	- Comprehensive rehabilitation of the polder should be taken up at the earliest possible time 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	- Damaged part of the embankment as stated from the local people Borovia to Roypur and Gaoghora bazar to Chardanga bazar should be re-sectioned as early as possible and slope of embankment must include protection with forestation. - Repairing of Gozalia, Goriadanga, Safar, Roypur, Gaoghora, Barobhuiya sluice gates - A new sluice gate is to be built at Chorerkhola - At the beginning point of every sluice gates are should be taken under re excavation activities - Bank protection measures should be taken in the critical river bank erosion prone areas. - Re-excavation of proposed khals
Agriculture	- Soil salinity is the problems for crop production;	- Sluice gates repair

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
resources	- Drainage congestion during transplanting period in Aman season; - The level of sea water increases due to impact of climate change which is responsible for natural calamities such as tidal surge, cyclone etc. - 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. - Lack of amalgamation between the local people and the project authority	- Providing DTW facility to the farmers - Khal re-excavation - Training for WMOs - Raising incorporation between the farmers and project authority
Fishery resources	- Deteriorate 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-excavated the silted up khals - Apply 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 and natural disaster is also another threat that destroys homestead and riverside vegetation. - Loss of vegetation density and succession ultimately impact on wildlife habitats.	- Removing siltation by re-excavation of khal. - Embankment re-sectioning and repairing water control structure along the embankment to protect settlement, road, inter tidal area and crop fields from existing problem.
Socio-economic resources	- Drainage congestion has a significant impact for the loss of agricultural production in polder 28/2 area which also affect to the economic condition of agricultural based households. - During dry season, scarcity of drinking water is another problem in the polder area. Due to malfunctioning of water control structures, lack of reserve sweet fresh 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. - Arsenic creates health problem to the local people - Local people are not satisfied with the activities of contractors - Lack of synthesis between the local project authority and the UP officials	- Strengthening of WMGs so that mass people can access to open water bodies easily. - They opined to re-excavate the inter-connected khals for solving the drainage congestion 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 needed to ensure sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also manage properly water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc and growing of consciousness among the community in the polder. - The Government should rehabilitate the affected farmers who are affected by salinity intrusion; - Need awareness building about water management among the communities; - Let the local UP officials be engaged with the development ativities.

7.8 Participant list

The name of the participants attending different consultations, FGDs, their age, occupation and address including cell phone number (if any) are provided in **Table 7.4.** Besides participants list of the PCM are shown in the Appendix-3.

Table 7.4: Name of participants

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

Place: Shoilmari Mondir, Paiker-2&2, Khulna Date: 23.05.19

Sl. No.	Name	Address/Designation	Mobile No.	Signature
1.	Bhaskar Kumar Roy	Chairman Shoilmari WMG	01715352305	
2.	Moni Poula Mallick	Secretary	01794443165	
3.	নিখিল মল্লিক	সদস্য		
4.	আশীষ কুমার রায়	কার্যকরী সদস্য	01719262032	
5.	নিপা মন্ডল	সদস্য	-	নিপা
6.	রীনা মন্ডল	সদস্য	01794435098	রীনা
7.	ঝিপ্রা মন্ডল	সদস্য	01930688933	ঝিপ্রা
8.	উৎপলা বিশ্বাস	"	-	উৎপলা
9.	কবিতা রানী রায়	দুঃস্থ মহিলা প্রতিনিধি	-	কবিতা
10.	মিতা রায়	সদস্য	01642720831	মিতা রায়
11.	বিপন বৈরাগী	"	01941152891	বিপন
12.	ঝিপ্রা রায়	"	01941951653	ঝিপ্রা
13.	রীনা বৈরাগী	সদস্য	01719392003	রীনা
14.	বিজলী বালা বৈদ্য	কার্যকরী সদস্য	01719392003	বিজলী
15.	জহুরুল আবেদীন	সদস্য	01914198858	
16.	সুকান্তি বৈরাগী	"	01931265834	
17.	[illegible]	কার্যকরী সদস্য	01851-434868	
18.	নারায়ণ মহালদার	NGO প্রতিনিধি	01706-136184	
19.	[illegible]	[illegible]	01719367950	
20.	[illegible]	কোষাধ্যক্ষ	02868626	
21.	রবীন্দ্রনাথ বিশ্বাস	সদস্য	01882535026	রবীন্দ্রনাথ
22.	রুমা কবিরাজ	মুখ্য সমাজসেবা	01912900	রুমা
23.	[illegible]	[illegible]	01716099367	
24.	উর্মিলা বিশ্বাস	"	01842864 30	উর্মিলা
25.	[illegible]	[illegible]	[illegible]	

8. Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification of IESCs and Rationale

The proposed interventions will not affect all environmental and social components. Some environmental and social components will be impacted while others will be independent of the interventions. Environmental and social components likely to be impacted by the project interventions are termed as Important Environmental and Social Components (IESCs). The IESCs under different resources likely to be impacted by the interventions along with the rationale of their selection are presented in Table 8.1 below.

Table 8.1 Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Ambient Noise Level	The construction works, in particular, the collection and placement of earthen materials and eventual compaction along the polder periphery would require heavy excavators to move over the polder alignment. This may create temporary noise pollution, which might be considered as objectionable by adjacent community. As such, Ambient Noise Level is considered as an IEC.
Saltwater Intrusion	At the moment the polder is severely affected by surface water salinity intrusion. Some of the interventions proposed in Polder 28/2, i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, saltwater intrusion has been considered as an IEC.
Water Security	Due to khal re-excavation works, the availability as well as access of surface water in Polder 28/2 may be increased and this might facilitate the multi-purpose use of water. Therefore, water security has been selected 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 (construction of retired embankment and re-excavation of khals) 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.
Agriculture land use	It is expected that the present land use might be changed due to implementation of the polder for the change of hydrologic regime inside the polder area. Farmers of the polder area are expected to feel encouraged to cultivate more crops in changing situation. Because of this reason, land use has been considered as one of the IEC.
Agriculture Resources	
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside polder 28/2, which may encourage the farmers to change their cropping patterns and may use for more HYV. This may increase the cropping intensity in consideration of cropping pattern and intensity has been selected as an IEC.
Crop production	Agricultural crop production is expected to be increased for the improvement of drainage system due to the re-sectioning of embankment, re-excavation of khals, repairing of drainage/flushing sluices and irrigation inlets. The re-excavation of khals would help to drained out excess water from the crop fields. The excess rain water inside the polder area would be drained out through drainage/flushing sluices that might help to cultivate the HYVs rice and other crops. Moreover, the surface water might be available in the re-excavated khals which would be used as irrigation purpose. This situation would be favorable for enhanced crop production. As such crop production has been selected as an IEC.
Crop damage	Crops are presently damaged in the polder area due to drainage congestion in the pre-monsoon and rainy season, drainage congestion, partial salinity, drought, etc. which are expected to be checked due to implementations 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 than 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	
Open water fish habitat	The proposed interventions of the polder are likely to alter the fish habitat as well as habitat quality in the polder area. Increased water depth due to re-excavation of khals may restore the open water fish habitat (silted up khal) and change the water quality which may support different types of fish species. In this context, open water fish habitat has been considered as an IEC of the study.
Golda culture habitat	Aquaculture practice e.g. rice cum prawn (golda), shrimp along with prawn is mostly cultivated in the polder area. Mixture of prawn and white fish culture is a common practice in the polder area. It is expected that the proposed intervention especially re-excavation of khal and repairing of regulators may further increase the rice cum fish culture practice in this area. Thus, gher habitat has been considered as an IEC.
Fish movement and migration	Internal fish movement and migration through khal is still the driving force for capture fisheries of the polder area. A few numbers of internal khals are found perinial. Many khals are silted up and covered with water hyacinth particularly, specially inth northern part. Therefore, fish movement and migration is being obstructed partially or fully in the dry season. Proposed interventions especially khal re-excavation may increase water flow and depth of water in turn facilitates the lateral fish migration. Thus, fish movement and migration has been considered as an IEC.
Fish species diversity	Fresh water fish species are declining in the polder area due to the loss of open water fish habitat for siltation, intrusion of salinity through mal-functioning of regulators etc. Currently, fresh water fish species are under serious threat of disappearing from the polder area fish habitats. A significant number of indigenous fresh water fish species are either endangered or threatened due to said causes. It is expected to change through implementation of the proposed interventions. As such, fish species diversity has been taken as an IEC.
Capture fish production	Fish production from open water sources has been declining over the years due to habitat loss, aggravated khal beds, and unfavorable environment due to increased water temperature during dry season and disrupted migratory routes. The proposed interventions are expected to take care of these problems in consideration of which capture fish production has been considered as an IEC.
Culture fish production	Culture based fish production from both brackish and sweet water fish habitats (gher and pond) contribute major shares of the fish production in the polder area. Production from these habitats has the increasing trends especially gher production. Implementation of the proposed interventions may protect these fish habitats. Thus, culture fish production has been considered as an IEC.
Ecological Resources	
Terrestrial vegetation	Terrestrial vegetation is an important component of the existing ecosystem. This type of vegetation provides habitat for wildlife and also provides various elements to human. Any change of physical environment causes different intensity of vegetation damage. The proposed interventions may cause impacts to vegetation during construction and post construction phases. Therefore, Terrestrial vegetation has been identified as an IEC.
Aquatic flora and fauna	Aquatic flora and fauna status relies on wetland water salinity, quality and depth which play an important role in the existing wetland ecosystem. Proposed intervention especially khal re-excavation is expecting to change water quality as well as fresh water flow which may impact on aquatic flora and fauna. Impacts can be positive and/or negative in long run. Hence, aquatic flora and fauna is considering as an IEC.
Socio-economic Condition	
Social Use of Water	There are various use of surface water i.e. taking shower, domestic usages and other social uses. Deep /Shallow and Hand tube well is the main source drinking water. Water from shallow tube well, ponds and khals use for domestic purpose. During the summer, most of the open water bodies i.e. khals, ponds are being dry

IESCs	Rationale
	up and seen scarcity of water. The proposed 10 nos of khals re-excavation with about 16km will improve the situation significantly, will ensure the various social usages of water.
Drinking Water problem	There is no severe crisis of drinking water in the polder are. There are about 260 nos of deep tube-well and 150nos of shallow tube-well are in operation, which provide drinking water supply in the polder. In addition there are few number of hand-tubewells with deep pipe facility for drinking water. The people are suffering from different kinds of water borne diseases such as diarrhoea, arsenic etc during dry season. Thus, villages of the polder i.e. Kuloti, Line Beel Pabla, Uttor Beel Pabla and Khamarbati collect drinking water from the neighboring villages.
Employment Generation	The repair and rehabilitation work will generate a significant amount of employment over its implementation period for the local people. People will also be involved to carry out the operation and maintenance related jobs to operate the hydraulic structures. It is expected that the agriculture production would increase while salinity problem would decrease. Hence, project which will create opportunities indirectly, for agricultural, business and commercial services. Thus, employment generation can be considered as an ISC.
Gender Promotion	In polder area, people are living not in a very good condition. Specially, the females are mostly vulnerable to distressed and widow who are dependent on others and do not have any definite sources of income. It is proposed that about 40% of labour under lebour constructing society (LCS) will be females. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.

8.2 Prediction and Evaluation of Potential Impacts

8.2.1 Preamble

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

- RRA survey to assess loss of vegetation, occupation, income and poverty levels of the affected households, etc.
- Environmental quality baseline monitoring of noise, surface water, groundwater and soil.
- Ecological surveys comprising vegetation, wildlife and fisheries covering both terrestrial and aquatic ecosystem.
- Land use surveys in Polder 28/2 comprising socio-economic status and environmental settings.
- Expert consultations, focus group discussions, and public consultations.

8.2.2 Impact Screening

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

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

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

Table 8.2 Screening Matrix of Potential Environmental Impacts

Project Phases and Activities	Water Resources				Land & Agriculture						Fisheries						Ecological		Socio-economic		
	Ambient Noise Level	Saltwater Intrusion	Water Security	Drainage Congestion and Water Logging	Soil Salinity	Agriculture land use	Cropping pattern and intensity	Crop production	Crop damage	Irrigated area	Open water fish habitat	Golda/Bagda culture habitat	Fish movement and migration	Fish species diversity	Capture fish production	Culture fish production	Terrestrial Vegetation	Aquatic flora and fauna	Social Use of Water	Employment opportunities	Gender Promotion
Pre-construction Phase																					
Labor, materials and equipment mobilization	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-		I	-	-	I	-
Site preparation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	I	-
Construction Phase																					
Re-sectioning of embankment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MN	-	-	HP	-
Embankment slope pitching and turfing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	-	MP	-
Re-excavation of khal	-	-	-	-	-	-	-	-	-	-	-	-	MN	-	I	-	I	MN	-	MP	-
Repairing of Drainage sluices/Flushing sluices	-	-	-	-	-	-	-	-	-	-	-	-	MN	-	I	-	-	-	-	I	-
Repairing of drainage outlet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-
Construction of Drainage Outlet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-
Repairing of Irrigation inlets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-
Operation Phase																					
Checking the physical condition and function of the embankment		HP	MP	MP	MP	MP	MP	MP	MP	MP	HP	I	I	HP	HP	MP	MP	I	HP	HP	MP
Checking physical condition and function of water control structures		HP	MP	MP	MP	MP	MP	MP	MP	MP	HP	I	I	HP	HP	MP	I	MP	HP	HP	MP
Checking the functions of WMOs		HP	MP	MP	MP	MP	MP	MP	MP	MP	HP	I	I	HP	HP	MP	I	MP	HP	HP	MP

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

8.3 Impact during Pre-construction Phase

There will be no impact during the pre-construction phase on IECs of water resources, agriculture, fisheries, and ecological resources. But some activities like materials and equipment mobilization (carrying as well as storing and land acquisition) would be carried out during this phase which may impacts on IESCs of Socio-economic condition is presented in the following Table 8.3

Table 8.3 Impact Assessment Matrix for the Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Socio-economic Condition				
Activity: (i) Labor, materials and equipment mobilization (carrying and storing (ii) Site preparation				
Employment generation	Periphery and inside of the Polder 28/2 where different activities will be initiated.	Out of total 40,680 population, 10,577 (26%) are economically active which include 4,231 (40 %) employed, 53 (0.5%) are looking for work, and 6,293 (59.5%) engaged in are household work.	Local unemployed labours will be recruited for carrying and storing of materials, site preparation. Thus, the income of labor will increase temporality	2

8.4 Impact during Construction Phase

There will be no impact during the construction phase on IECs of water resources, Land and Agriculture resources. But some activities in this phase may impact on IESCs of physical environment; fisheries; ecological resources and socio-economic condition are presented in the following Table 8.4.

Table 8.4 Impact Assessment Matrix for the Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Physical Environment				
Activity: *Re-sectioning of embankment*				
Ambient Noise Level	Along the polder periphery	The 50-th percentile Noise level observed inside the polder are 47 dB	The excavator and associated heavy machineries will create noise disturbance along the polder alignment, and are likely to increase the noise levels by around 5~10 dB	-2
Fisheries Resources				
Activity: *Re-excavation of khal (22.5 km)*				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Fish habitat and Fish migration and movement	• Sindurtala Khal • Ramdia Khal • Hogladanga Khal • Pramanik Khal • Bashbaria Khal • Barui Khal • Guptomari khal • Thakumari khal • Gholar Khal • Raingamarir Khal	Tidal in nature, Silted up, shallow water or water less during dry season	• Feeding and breeding ground of the bottom dweller fishes will be lost. But after 1-2 year the habitat quality will be improved. • Turbidity of water will be increased. Increased turbidity will inhibit to light penetration in water resulted photosynthesis of aquatic flora and fauna will be reduced. • Movement of some particular fish species like Cheng, *Taki, Puti, Koi, Shing* etc would be impacted.	-2
Activity: *Repairing and construction of Water Control Structures*				
Fish movement and migration	• Repairing of (8 nos) drainage Sluices and two Drainage Outlet (location of the sluices and outlet has already been mentioned in the water resources section) • Repair of Inlet (Gazalia inlet) • Construction of Sluice (Nandon khali) • Construction of Outlet (Barobhuyan Charar khal) • Construction of Inlet (Goriadanga)	• Fish hatchling and some brackish water fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra and boal etc. move through the mal-function of regulator on regular basis during high tide.	• Movement and migration of fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, bele etc will be obstructed during repairing of structures. • Fish hatchling movement will also be hampered, if the repairing works is implemented during hatchling period (May-June).	-1
Ecological Resources				
Activity: *Repairing of embankment*				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Terrestrial vegetation	Both sides of the embankment at repairing points	• Embankment side vegetation is the main type. • Embankment side vegetation is dominated by medium sized trees, shrubs and herbs e.g. Shirish, Babla, Khai Babla, Akand, Bhat, and etc. • This vegetation provides feeding ground for mammals, birds, reptiles and amphibians. • Vegetation is facing risk due to natural disaster and human activities	• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for repairing work.; • Relocation of wildlife due to habitat loss temporarily.	-2
Activity: *Re-excavation of khal*				
Aquatic flora and fauna	All the khals which are proposed to be re-excavated	• Most of the khals are shallow and silted up • Within the polder area the ponds and khal contain different types of aquatic floras such as Kochuripana, Kutipana, etc which support habitat for fishes and Kingfisher, Egret, Snake, etc. • Durba Gash, Biskantali, Dholekolmi, Kasorti, etc. are dominant along the both side of the khal. • Different types of local avifauna roam here for their feeding.	• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	-3
Socio-economic Condition				
Activity: *(i) Repairing of embankment (ii) Embankment slope pitching and turfing (iii) Re-excavation khals (iv) Repairing of drainage/ flushing sluices (v) Repairing of drainage outlet (vi) Repairing of irrigation inlet*				
Employment generation	Periphery and inside of the Polder 28/2 where different activities will be initiated.	About 10,577 (26%) are economically active which include 4,231 (40 %) employed, 53 (0.5%) are looking for work, and 6,293 (59.5%) engaged in are household work.	A significant number of local labour will be recruited for earth work, repairing of embankment and afforestation, soil dumping and compaction of earth.	2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Gender Promotion	Periphery and inside of the Polder 28/2 where different activities will be initiated.	Females are mainly involved in household work and very few of them are working as a day labor or earth worker	According to the project plan, the LCS entails 60% male and 40% female all of them would be engaged from the local area. Thus, employment access to females in the construction works and during operation /maintenance phase will be promoted significantly and they can also take part in different decision making processes.	3

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

8.5 Impact during Operation 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 tabular form.

8.5.1 Water Resources

a. Saltwater intrusion

Future-without-Project

If the sluice gates are not repaired, in future saltwater concentration in the surface water system of the polder would further increase. Most of the water control structures of the polder are not functioning up to the desired level. At present, saltwater enters into the polder during dry season through some of the structural leakages and opened gates. Salinity concentrations found at around 200 m water courses located inside the polder within 50-m buffer distance from Upper Bhadra River are around 15 ppt. For Mora Bhadra and Manga Rivers' 50-m buffer zone inside the polder, around 500 m of khals are contaminated with more than 5 ppt salinity concentrations. If the existing water control structures are not repaired in future, than around 2 km tributaries of Upper Bhadra River (from the upstream of Chardanga khal and Raypura khal etc.) khals would contain upto 15 ppt salinity concentrations. At the same time, almost 2 km khals connected with the Mora Bhadra and Manga Rivers (Keshorabad khal, Churar khal, Suna khal and Nandankhaki khal) may contain more than 10 ppt salinity concentrations.

Future-with-Project

The existing sluice gates, flushing inlets and drainage outlets, if repaired, the salt water leakage into the polder may be permanently prevented. In future, the existing salinity contours inside the polder would be diminished and values of salinity concentrations in the inner surface water system would drop to 'nil'.

Impact

Significant impacts would be achieved regarding the prevention of salt water intrusion inside the polder. Salinity values will drop from a foreseeable maximum of 15 ppts inside the polder to 'zero'. Almost 4 km water courses inside the polder will be improved from potential saltwater intrusion. This will also foster other sectoral benefits within the polder.

b. Water security

Future-without-Project

People living in Polder 28/2 are suffering from concerns in connection with freshwater availability. They cannot meet up their domestic and drinking water requirements up to the desired level. From the spatial distribution of surface water sources and settlements, it has been estimated that around 15% people inside the polder suffer from *water stress*[11]. If the khal re-excavation works are not carried out, the entire polder would suffer from more freshwater scarcities for different uses. With increased siltation and saltwater intrusion, it is projected that around 30% people inside the polder may suffer from water stress. This will ultimately impact their water security, and continue to degrade the status of community level water-food-energy nexus.

Future-with-Project

The project if implemented, additional volumes of around 84,000 m^3 in the re-excavated khals would be available, which can carry water in all seasons and serve the domestic water demands of a significant number of people. However, around 5% people in polder may still remain in water stress, especially drinking water stress.

Impact

Around 25% people inside Polder 28/2 would be ensured sufficient freshwater availability and access, which would result in immense benefits in domestic water use. Besides, water for irrigation would also substantially be available.

c. Drainage congestion and water logging

Future-without-Project

Presently, around 65% of the khals having radial alignments inside the polder (Nandankhali Khal, Surkhali Khal, Churar Khal, Boromoter Khal etc.) are affected by regular drainage congestion which affect the seasonal water habitat inside the polder. On an average, rainwater requires more than 5 days to be drained out from the polder. If the re-excavation works under the project is not implemented, the drainage congestion situation may further deteriorate and additional 10% of khals may be subjected to drainage congestion. However, no prolonged water logging situation has been foreseen.

[11] In this study, water stress refers to a situation when people have domestic and drinking water availability lower than 25 lpcd.

Future-with-Project

The proposed khals, if re-excavated, the drainage congestion in the upstream portions of the khals would diminish, and rainwater would be drained out properly from the area. However, the downstream portions of the affected khals may still be subjected to siltation and drainage congestion might prevail along those reaches. Almost 45% of the khals may still be affected from drainage congestion.

Impact

Considering the 'future without project' and the 'future with project' scenarios, it can be inferred that around 30% of the khals adjacent to the periphery of the polder would be improved from drainage congestion. This would facilitate improved drainage and other associated hydrological functions.

8.5.2 Land Resources

a. Agriculture land use

Future-without-Project

Presently, NCA is about 70% of the gross area. Of the net cultivable area single, double and triple cropped area is about 31%, 43% and 26% respectively. If the project is not implemented single, double and triple cropping would be practiced in about 36%, 44 % and 20% of the NCA respectively (Table 8.5).

Table 8.5 Detailed agriculture land use of the polder area

Land use	Baseline	FWOP	FWIP	% Change
Cropped area	**% NCA**	**% NCA**	**% NCA**	
Single cropped area	31	36	27	-9
Double cropped area	43	44	45	+1
Triple cropped area	26	20	28	+8
Total	**100**	**100**	**100**	**0**

Source: Estimation based on field information, May 2019

Future-with-Project

The interventions would increase land use in the polder areas. Drainage congestion is expected to be removed due to implementation of different interventions of the project. The area under different land types would improve which would create scope of enhanced land use. It is expected that re-sectioning of embankment, repairing of drainage / flushing sluices, repair of irrigation Inlets and re-excavation of khals etc. would enhance land utilization. However, the land utilization for single, double and triple cropped area would be around 27%, 45% and 28% of NCA respectively in future with polder condition. Detailed land use has been presented in **Table 8.5**.

Impact

The overall impact of different options on land use would be very positive. Single cropped area would decreased by about 9% but double and triple cropped area would increased by about 1%, 8% of the NCA respectively under FWIP condition. Detailed land use has been presented in **Table 8.5**.

b. Soil salinity

Future-without-Project

Most of the areas are affected due to capillary raise of saline ground water which is unfavorable for crop production during dry season and remains fallow. If the intervention would not implement in the polder, intrusion of saline tidal water in the agriculture land would be a regular phenomena. The situation would be aggravated in future without project condition. Besides, the salinity developed by capillary rise due to inadequate and non-functioning of structures, would not be drained out properly in

monsoon season. Hence practices of different rice crops such as LT.Aman, HYV T.Aman, and HYV Boro as well as non-rice crops such as Sesame, S. Vegetables and W. Vegetables would suffer from salt stress in the polder area. Most of the structures would be non-functional due to siltation surrounding the structures. There would be negative impact on crop production due to salinity under future without project condition.

Future-with-Project

The construction of re-tired embankments would prevent the intrusion of saline water into the agriculture fields and are expected to decrease in soil salinity which might enhance crop production and would reduce crop damage. Excess rain water would be removed from the polder area through the sluice gates. The embankments and structures would also restrict the intrusion of saline surface water during high tide or tidal surge. In addition, soil salinity would be removed through flashing from project area during monsoon season due to onset of rainfall. The crop damage due to salinity might be reduced.

Impact

The structures would have positive impact on reducing soil salinity. It is expected that the implementation of proposed interventions and its proper management would protect the undesirable entry of saline water and would allow draining out the dissolved salts from agriculture land.

8.5.3 Agricultural Resources

a. Cropping pattern and intensity\

Future-without-Project

Presently, cropping intensity of the polder area is about 195%. If the proposed interventions in the project is not been implemented, the land type as well as land use would be degraded in failure of embankment, non -repairing of existing drainage/flushing sluices and irrigation inlets and siltation of river and drainage channels. Under this condition, there would be negative impact. The cropping intensity is expected to change to about 184% (Table 8.6).

Future-with-Project

The future with polder condition would help to change the hydrologic regime inside the polder area which might encourage the farmers to change their cropping patterns (Table 8.6). Under FWIP condition, the structures would function properly and would drain the excess water during rainy season from the cultivable land as a result land type might be improved. The improved land type would influence the farmers to practices multiple cropping in the polder area. After completion of the interventions, the cropping intensity is expected to increase to around 201%.

Impact

After completion of the interventions, the cropping intensity is expected to increase to around 17%.

Table 8.6 Major cropping patterns under FWOP and FWIP condition in the polder area

Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	% of NCA	% of NCA	% of NCA	% Change
Fallow	HYV T aman	Fallow	11	9	12	3
Fallow	LT aman	Fallow	19	27	15	-12
Sesame	LT aman	Fallow	36	38	33	-5
Vegetables	LT aman	Vegetables	19	16	20	4
Fallow	HYV T aman	Boro	8	6	12	6
Sesame	LT aman	Boro	7	4	8	4
		Total	**100**	**100**	**100**	**0**
		Cropping Intensity (%)	**195**	**184**	**201**	**17**

Source: Estimation based on field information, May 2019.

b. Crop production

Future-without-Project

Presently, total crop production is 14,620 tons of which rice is about 6,936 tons (47%) and non rice is about 7,684 tons (53%). Adverse effect might occur due to siltation of river and drainage channels. The production would be decreased from the base situation. The farmers would be desperate to produce more crops for their increased demand under FWOP condition. Total rice production is expected to be declined to 6,436 tons and total non-rice would also be declined to 6,895 tons in the polder areas (Table 8.7).

Future-with-Project

The crop production would be boosted up significantly under the FWIP condition. The total crop production would be about 16,276 tons of which rice would be about 7,816 tons and non-rice would be about 8,460 tons respectively. Both the rice and non-rice production would be higher in FWIP than that of baseline situation. Rice production would be increased due to expansion of HYV T. Aman, HYV Boro and both of vegetables cultivation area (Table 8.7).

Impact

Additional 1,380 tons (20% higher) of rice and 1,565 tons (23% higher) of non-rice would be produced in FWIP over FWOP (Table 8.7).

Table 8.7 Impact on crop production in the polder area

Crop Name	Production(Ton)			Impact (FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
HYV T aman	904	807	1208	401	50
Lt aman	3,298	3228	3312	84	3
HYV Boro	2,734	2401	3296	895	37
Total rice	**6,936**	**6,436**	**7,816**	**1,380**	21
Sesame	697	642	708	66	10
Summer Vegetables	2,998	2686	3254	568	21
Winter Vegetables	3,989	3567	4498	931	26
Total non-rice	**7,684**	**6,895**	**8,460**	**1,565**	23
Total	**14,620**	**13,331**	**16,276**	**2,945**	22

Source: Estimation from field information, May 2019

c. Crop damage

Future-without-Project

Presently, total crop production loss is about 273 tons of which rice is 230 tons and non-rice is 43 tons due to drainage congestion, salinity and scarcity of irrigation water etc. The situation would be aggravating more under FWOP condition. Total 254 tons of rice and 51 tons of non-rice crops production would be lost under FWOP situation (Table 8.8).

Future-with-Project

In FWIP condition, crop damage would be reduced about by 56% for the implementation of interventions and their proper management. The interventions would have positive impact in reducing crop damage area as well as crop production loss. The total rice and non-rice production loss would be about 166 tons and 19 tons respectively.

Impact

It is expected that loss of crop production would be reduced by 120 tons which would be about 39% less in FWIP over FWOP Table 8.8.

Table 8.8 Impact on crop production loss in the polder area

Crop Name	Production loss(Ton)			Impact(FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
HYV T aman	42	50	29	-21	-42
Lt aman	148	162	112	-50	-31
HYV Boro	40	42	25	-17	-40
Total rice	**230**	**254**	**166**	**-88**	**-35**
Sesame	38	45	17	-28	-62
S. vegetable	5	6	2	-4	-66
W. vegetable	0	0	0	0	0
Total non-rice	**43**	**51**	**19**	**-32**	**-63**
Total	**273**	**305**	**185**	**-120**	**-39**

Source: Estimation from field information, May 2019

d. Irrigated area

Future-without-Project

Presently, irrigated area is about 359 ha. The interventions if not implemented the availability of surface water in the river and khals would decrease due to siltation of river and khals in the area. The irrigated area would decrease about 297 ha in FWOP.

Future-with-Project

After implementation of the proposed interventions in the polder, water will be available in the khals and retainable capacity will be increased in these khals. The irrigated area would increase to about 463 ha in FWIP. The irrigated area would be increased to 104 ha in FWIP over present situation

Impact

The irrigated area would be increased by 166 ha in FWIP over FWOP.

8.5.4 Fisheries Resources

a. Open water Fish habitat

Future without Project

The fish habitat of the polder area mainly includes internal khal and fish pond. Whereas, major portion of a khal is silted up and sallow water or water less during dry season. Due to continuous siltation, water flow as well as water availability in the internal khal would be reduced specially in the dry season many khal may be totally dried up.In future, perennial khals which presently slight contributes to fish production in the polder area will be converted to seasonal khal would be unsuitable for fish habitation. It is assumed that 25% area of a perennial khal would be seasonal khal while all seasonal khal may be fully seasonal khal and land used would be changed to gher as well as agriculture land. Moreover, the presence of water hyacinth would be increased more in the remaining area of a khal. Due to increasing of water hyacinth, the light penetration depending photosynthesis of aquatic vegetation will be reduced. Other hand, decomposition of water hyacinth will pollute the water quality which would impact the fisheries resources and aquatic biota directly.

Future with Project

Water flow as well as water depth of khal will be increased due to re-excavation of khal. Silted up and seasonal khals namely *Andhar Manik khal, Haji Khali khal, Ahmed Khali khal, Baradanga / Gopinathpur khal, Him Khali khal, Swetpur khal, Baula Beeler khal* etc will be perennial khal as well as their habitat quality will be improved. The improved habitat quality will support different types of fishes and aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota. It is mentionable that turbidity of khal's water will be increased after re-excavation activity. Increased turbidity may cause temporary impact on aquatic flora and fauna of the khal. But after one or two year, the turbidity will be reduced naturally.

Impact

All silted up and seasonal khals will be perennial again and habitat quality will be improved. The improved habitat quality would support different types of fishes as well as aquatic vegetation.

(a) Golda culture habitat

Future-without-Project

Two types of gher i.e. Golda gher, rice cum golda gher are found in the polder area. Among them, Golda gher is dominant which comprise 65% of total gher area. Moreover, a few number of gloda with white fish gher is found in the polder area. In future without project, Golda area will remain same or slight increase. As per consultation with local people have interest to cultivate Golda instead of crop production. They opined that this practice is more profitable than agricultural activity. It is mentionable here that, 85% of agriculture land at the southern part of the polder has been occupied by Golda gher.

Future-with-Project

In future with project situation, It is expected that Golda gher area will slightly (1%) decrease in the middle-eastern part of the polder area. Rice cum golda will be increased by 8% from the base condition after rehabilitation of the project interventions. In FWIP situation, golda gher area would be 122 ha.

Impact

Golda gher area would be increased by 1 ha.

(b) Fish movement and migration

Future-without-Project

Fish species both fresh and brackish water as well as hatchling move from river to khal through sluice gate at some stage of their life cycle for nursing and feeding purposes. In FWOP condition, hatchling and fish movement would be facilitated round the year due to existing malfunction of water control structures. Moreover, substantially progressing of khal bed due to siltation will lead to reduce the water depth. Thus, fish movement would be hampered from river to khal and vice-versa.

Future-with-Project

The movement of hatchling and brackish and fresh water fish from river to polder area would be obstructed / regulated due to repairing of sluices and drainage inlets and outlets. Movement of brackish water fish species like *Puti, Chingri, Tengra, Baila* and *Pairsa,* etc which moves on the regular basis during high tide would be impacted. But internal fish migration re-excavation of khal would be facilitated significantly after re-excavation of khals.

Impact

Fish as well as hatchling movement would slightly be hampered. Internal fish migration would be facilitated significantly.

(c) Capture fisheries productivity

Future-without-Project

The catch per unit area (CPUA) would reduce from the current CPUA due to ongoing process of siltation in the khal as well as raising of bed level of khal would cause less suitable for fish habitation. Many fish species would be disappeared from this habitat and would lead to decrease the fish biodiversity in the polder area. For this reasons, capture fisheries productivity would be decreased by 20% from the base condition under FWOP condition. The capture fisheries productivity would be 60 kg/ha.

Future-with-Project

Implementation of proposed activities i.e. re-excavation of khal will increase the water depth, water availability as well as water quality which will increase catch per unit area (CPUA) in the polder area. It is assumed that capture fisheries productivity will be increased to 40% from the baseline situation. The capture fisheries productivity will be105 kg/ha compare to baseline situation (75 kg/ha) due to aforementioned reasons.

Impact

Capture fisheries productivity in the khal will be increased by 30 kg/ha.The increased fish productivity will enhance income of the fishers in the polder area

(d) Culture fish production (bagda/golda gher)

Future-without-Project

In future without project situation, itis expected that shrimp production would increase to 2.0 tons due to increasing of salt water intrusion in the polder. Production of rice cum golda would remain same or slightly increased.

Future-with-Project

The bagda production in the polder area would be decreased. Rice cum golda production would be increased to 30 tons.

Impact

Bagda production would be decreased whereas rice cum golda production would be increased by 2 tons.

8.5.5 Ecological Resources

a. Terrestrial vegetation

Future-without-Project

Terrestrial vegetation including climbers, herbs, shrubs, trees will be further deteriorated due to soil salinity, natural disaster and human activities. Malfunctioning of embankment and water control structures like regulators, outlet causes insufficient drainage and flashing capacity of the polder area, which causes vegetation damage. Damages of vegetation are impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

Future-with-Project

Existing trend of vegetation loss due to natural disaster will be reduced for flood protection by repairing of embankment. Hence, improvement of vegetation including fruit trees will support resident wildlife throughout the year.

Impact

Terrestrial vegetation will be improved. The improved vegetation will support wildlife.

b. Aquatic flora and fauna

Future-without-Project

Aquatic flora and fauna condition will also be degraded day by day due to continuous siltation of khals. Existing floral and faunal species composition will goes under further degradation due to in sufficient water in the khals especially in the dry season.

Future-with-Project

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

Impact

In future the aquatic habitat quality will improve for sure. Moreover after implementation of the interventions, settlement areas soil and water salinity will be reduced salinity due to fresh water flow from nearest khals.

8.5.6 Socio-economic condition

a. Social Use of Water

Future-without-Project

People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their necessity for water through tube well. At present 25% families have poor access and 75% families have medium access to social use of water and without project situation this number will be 35% for poor and 65% medium access..

Future-with-Project

With the 22% families would be good, 7% families would be poor and 71% families would be medium access to social use of water and benefited through this project.

Impact

The standard of life for 1,600 numbers of HHs would be good and 5,000 numbers of HHs would be medium access to social use of water. Around 13% people inside Polder 28/2 would be guaranteed sufficient freshwater availability and access, which would result in benefits in domestic water use. Besides, water for irrigation would also substantially be improved.

b. Crisis of Drinking Water

Future-without-Project

There is a dearth of safe drinking water in polder area. Currently 17% of the settlement are facing severe drinking water crisis where approximately 1,297 no of people live and the remaining 83% people are also facing drinking water crisis at anyhow. Without project situation; this misery would gradually increase and may reach into intolerable stage (some people may be forced to migrate to cities).

Future-with-Project

The reservoir would be highly beneficial for resolving the drinking water crisis to the neighboring areas. In future, 26 % of the settlement will have better access to drinking water facility and an additional 76%

will have better access to domestic water facility. The impacts of proposed interventions, especially reservoir and canal re-excavation, on both drinking water and domestic water are shown in **Map 8.4**.

Impact

About 10,000 (26%) number of people directly benefited from these proposed reservoirs and it can ensure fresh water during dry period. And, in addition, 25,000 number of people will have better access to domestic water facility in future.

c. Gender Promotion

Future-without-Project

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

Future-with-Project

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

Impact

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

d. Employment generation

Future-without-Project

Employment opportunities is still not good as they are living under poor economic condition and have very few options to develop or adapt this condition. In without project situation, their sufferings may increase or in same condition.

Future-with-Project

Proposed intervention can ensure improved quality of life. More income opportunities and possibilities of employment in different interventions can ensure better life and livelihood of the people of the polder.

Impact

Creating new employment opportunities are increasing the means for generating more income for the people of the polder. This ensures improvement of the standard of life and well-being of the people here. Additional income, augments brings solvency, steady of the family.

Table 8.9 Matrix on Impact Assessment with regard to Operation Phase

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
Water Resources				
Saltwater Intrusion	Salinity concentrations found at 200 m tributaries of Upper Bhadra River (Chardanga khal and Raypura khal) are around 15 ppt; while the Mora Bhadra and Manga Rivers' 500 m tributaries Keshorabad khal, Churar khal, Suna khal and Nandankhaki khal) contain 5 ppt salinity concentrations.	Around 2 km tributaries of Upper Bhadra River (upstream of Chardanga khal and Raypura khal) would contain upto 15 ppt salinity concentrations; and almost 2 km khals connected with Mora Bhadra and Manga Rivers (Keshorabad khal, Churar khal, Suna khal and Nandankhaki khal) may contain more than 10 ppt salinity concentrations.	Existing salinity contours inside the polder would be diminished and values of salinity concentrations in the inner surface water system would drop to 'zero'.	+5
Water Security	People of Polder 28/2 cannot fully meet up their domestic, drinking and irrigation water requirements and around 15% people within the polder remain under water stress	Water security may further deteriorate with increased siltation and saltwater intrusion, and around 30% people may remain under water stress	Domestic water security may improve, but around 5% people may still be subjected to drinking water stress	+4
Drainage congestion and water logging	Around 65% of khals inside the polder (Nandankhali Khal, Surkhali Khal, Churar Khal, Boromoter Khal etc.) suffer from drainage. No water logging situation prevails.	Around 75% of khals inside the polder (Nandankhali Khal, Surkhali Khal, Churar Khal, Boromoter Khal etc.) would suffer from severe drainage congestion. No water logging would generate.	Drainage congestion in the upstream portions of the khals would be diminished but around 45% khals' in the downstream portion will face drainage congestion.	+4
Land Resources				
Agriculture land use	Presently, NCA is about 70% of the gross area. Of this net cultivable area single, double and triple cropped area is about 31%, 43%, 26% respectively.	Utilization of land for single, double and triple cropped area would be 36%, 44%, 20% of the NCA respectively under FWOP condition	Utilization of land for single, double and triple cropped area would be 27%, 45%, 28% of the NCA respectively under FWIP condition	+2
Soil salinity	The polder area is suffered by soil salinity of which about 80% of the NCA is suffered by slightly saline with some moderately saline and about 20% of the NCA is suffered by moderately saline with some strongly saline.	Salinity would be increased.	The successful implementation of the project and its proper management would reduce the salinity of the polder area.	+3
Agricultural Resources				
Cropping pattern and intensity	Presently, cropping intensity of the polder area is about 195%.	Cropping intensity would be reduced about 184%.	Cropping increased would be about 201%.	+2
Crop production	Total crop production is 14,620 tons of which	The total crop production is expected to decrease	The total production is expected to increase about	+4

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
	rice is about 6,936 tons and non rice is about 7,684 tons.	about 13,331 tons of which rice would be about 6,436 tons and non-rice would be about 6,895 tons.	16,276 tons of which rice would be about 7,816 tons and non-rice would be about 8,460 tons.	
Crop damage	Total crop loss is about 273 tons, of which rice is about 230 tons and non-rice is about 43 tons.	Total crop loss is expected to damage about 305 tons of which rice crops is about 254 tons and non-rice is about 51 tons.	Crop production loss would be decreased to rice 166 tons and non-rice 19 tons.	+4
Irrigated area	Irrigated area is about 359 ha.	Irrigated area is expected to decrease to about 297 ha.	Irrigated area would be increased by about 166 ha in FWIP over FWOP	+5
Fisheries Resources				
Fish habitat	• In the polder area, fish habitat include internal khal and fish pond • Siltation and excessive duck weed are major problems of the khals which are causing unsuitable for fish habitation.	• The ongoing siltation process, khals bed will be raised, thus reduce the water retention capacity in dry season. • Perennial khal will be converted to seasonal khal	• Habitat quality will be improved. This habitat will support to grow different types of aquatic vegetation which will be used for fish feeding and habitation.	+2
Golda culture habitat	• Golda gher 121 ha	• Golda gher would remain same or slightly increase	• Golda gher area will increased 122 ha	+2
Fish movement and migration	• Some fish species move and migrate through water control structures on regular basis during high tide	• Same as base condition or will be improved	• Fish and hatchling movement will be hampered slightly but internal fish migration will be improved	+2
Capture fisheries productivity	Capture fisheries production in Khal is 75 kg/ha	Production decreased to 60 kg/ha	Production increased to 105 kg/ha	+4
Culture fish production (golda)	Golda production is 82 tons	Golda production will remain same (82 tons)	Golda production increased to 83 tons	+2
Ecological Resources				
Terrestrial vegetation	Moderate	• Increase threats on surrounding vegetation due to natural disaster and human activities. • Most of the terrestrial faunal species are displaced due to vegetation damaged by existing problem.	• Vegetation loss will be reduced and floral species will be increased due to protect area from existing problem.	+3
Aquatic flora and fauna	Moderate	• Reduced depth for continuous siltation caused internal khals habitat deterioration	• Improvement of aquatic habitat as well as khal depth and velocity due to khal re-excavated.	+2
Socio-economic Condition				
Social Use of Water	People cannot use water for taking	At present 25% families have poor access and	With the intervention, 22% families would be	+2

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
	shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their needs for water through tube well.	75% families have medium access to social use of water and without project situation this number will be 35% for poor and 65% medium access	good, 7% families would be poor and 71% families would be medium access to social use of water and benefited through this project. Moreover, it enhances social bonding and cohesion among them.	
Safe Drinking Water	Drinking water crisis is very severe especially during from November to May in the villages of Kallansri, Surkhali, Chatrabila, Chakimari, Faissamari, Songkhamari, Monorabad, Barobuiya and Roypur.	In without project situation, this misery would gradually increase and may reach an intolerable stage (forcing some people to migrate to cities)	In future, 26 % of the settlement will have better access to drinking water facility and an additional 76% will have better access to domestic water facility.	+2
Gender Promotion	In the polder area only 2 % female members are working whereas 98 male members are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, women are mostly vulnerable and widows who are dependent on others and do not have any definite sources of income. Therefore, in without project situation, this opportunity may not be ensured for gender promotion	The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.	+3
Employment generation	Employment opportunities are still not good in the polder. Because they are living under poor economic condition and they have very few options to develop or adapt this condition.	In without project situation, these sufferings may be same or will be deteriorated in future.	Proposed intervention can ensure improvement in the quality of life. More income opportunity and employment in different interventions can ensure better life and livelihood of people.	+2

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

9. Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

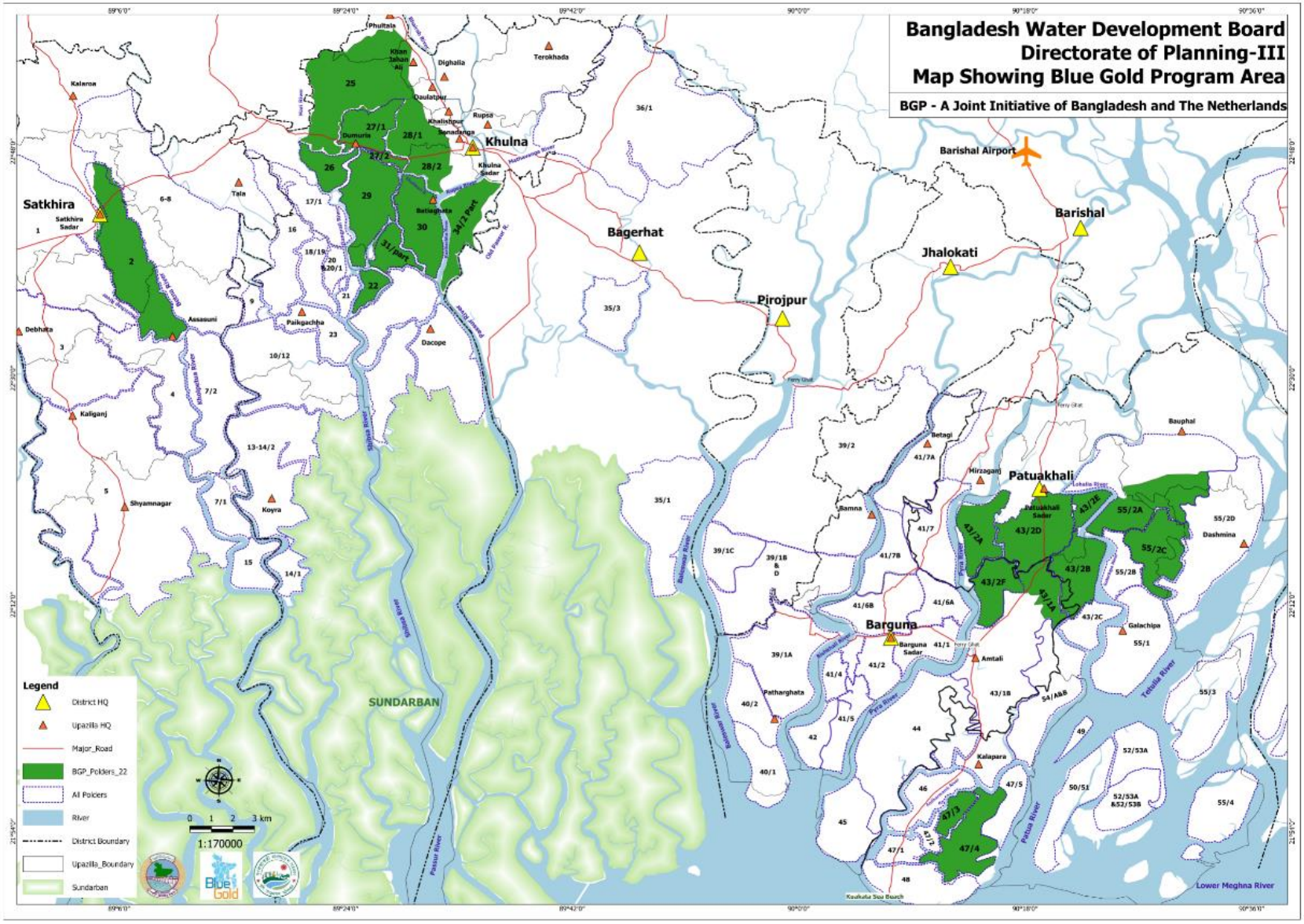
Cumulative impacts entail the total of all impacts to a particular resource that have occurred, or occurring, or may occur as a result of any action or influence in the surrounding area. Apart from the Blue Gold polders, a number of other projects also exist in the vicinity of Polder 28/2. Such projects 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 28/2

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**. Among these, three polders (Polders 28/1, 27/2, and 30) are very adjacent to Polder 28/2 and therefore may generate some impacts in future. The existing crest levels of Polders 22, 29 and 30 are 3.45m, 3.50~3.60m and 3. 20~3.50m respectively above Mean Sea Level. If re-sectioning of embankment are executed along the periphery of these polders up to the design elevation of 4.27 m, which is same as Polder 28/2; then there would be more floodplain sedimentation adjacent to the upstream polders. This may result in increased sedimentation along the Upper Bhadra, Jhapjhapia and Manga 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 28/2. Furthermore, repairing of existing water control structures of Polders 22, 29 and 30 under Blue Gold program would ensure reduction of dry season flow towards the polders (22, 29 and 30). As such, surface water salinity, surrounding the Uper Bhadra, Jhapjhapia and Manga rivers may increase, which might affect the existing river ecosystem, as well as the multifaceted surface water use of Polder 28/2-part. Moreover, if any permanent bank protection works are carried out in future in the aforementioned polders (22, 29 and 30), the morphological behavior of UperBhadra, Jhapjhapiaand Mangarivers may be changed. This might increase risk of river erosion in Polder 28/2.

9.2.1 Synopsis of projects around Polder 28/2

Apart from Blue Gold interventions, there are some other development projects nearby Polder 28/2, 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 28/2, undertaken by different line agencies in Khulna.



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

Table 9.1 List of water management projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
MoWR, BWDB	Construction of Ganges Barrage	To be implemented	Pangsha, Ganges River	High	
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 adjacent WMIP schemes
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008- ongoing	Coastal Zone	Negligible	ECRRP polders are far from Polder 28/2-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 andSatkhira	Negligible	
	Union Infrastructure Development Project	2010-ongoing	Khulna, BagerhatandSathkhira	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	

Source: Integrated Coastal Resources Database, developed and maintained by WARPO and CEGIS

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 28/2 are briefly discussed in the following sections.

9.2.2 Cumulative impacts of the proposed Ganges Barrage

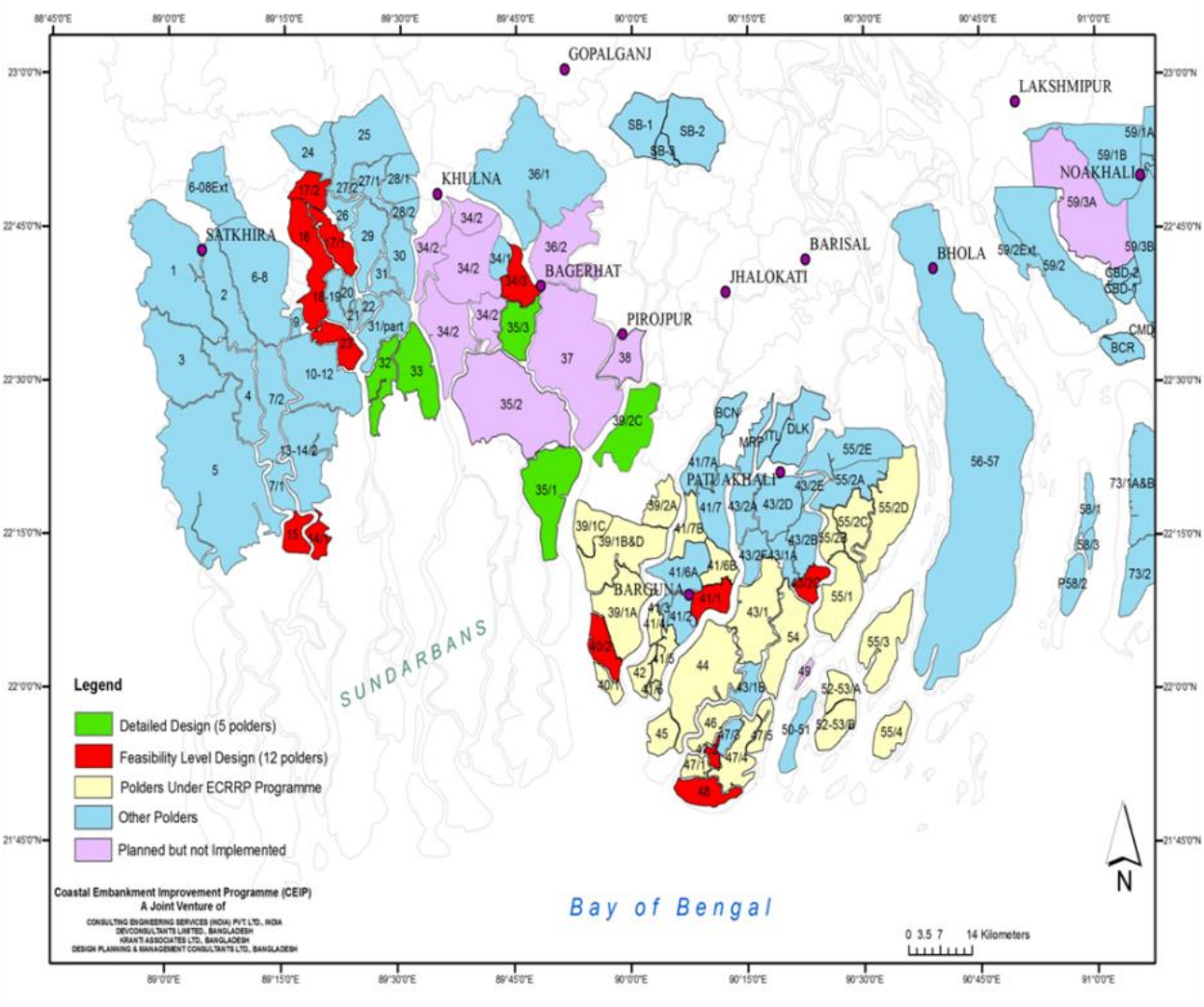
The Ganges Barrage Project is perhaps the most significant project for the downstream region (coastal zone) of Bangladesh. The project is planned to manage the water resources system, promoting inclusive socio-economic development and to recover the existing environmental degradation. The Government of Bangladesh (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 remarkable 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 the 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 28/2bis located within the GDA, and bears high sensitivity towards the proposed Ganges Barrage. The most significant impact of the Barrage on Polder 28/2 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 social context, the effects may be significant as more livelihoods 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 as a whole may be highly benefited.

9.2.3 Cumulative impacts of the Coastal Embankment Improvement Project (CEIP)

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



Map 9.2 Location of CEIP polders

Polders 32 and 33 are located within at distance of 6 km downstream of Polder 28/2-part along the Passur River. Polders 32 and 33 are included in the first phase of CEIP. The existing crest levels of these polders range between 3.4 to 3.8 m above MSL. Re-sectioning is 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 28/2-part.

9.2.4 Cumulative impacts of Other Projects

A number of other projects as shown in **Table 9.1** are functioning near Polder 28/2 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located away from Polder 28/2. A synopsis of the indirect effects of these projects with **low sensitivity** on Polder 28/2 is discussed below:

(a) 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. Till now Environmental Impact Assessment (EIA) studies 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 CCTF projects, the geographic extent of one scheme (rehabilitation works in Polder 28/2) lies within the vicinity of Polder 28/2-part. 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 28/2 would have negligible influence in Polder 28/2.

(b) 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 28/2. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 28/2. 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 28/2 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 28/2 may be further benefited.

9.3 Induced Impacts of Polder 28/2

The interventions in Polder 28/2 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 28/2 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.

9.3.1 River Sedimentation

The proposed interventions in Polder 28/2 will safeguard the polder against direct intrusion of tidal water. Therefore, water from Uper Bhadra, Jhapjhapiaand Manga 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 thus be developed along the peripheral 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 28/2 (i.e. waste generation, increased fertilizers etc.).

9.3.2 Tidal and Storm Surge Flooding

Polders 28/1, 27/2, and 30, are adjacent to Polder 28/2. As per design, the crest level of Polder 28/2 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 28/2 during these events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned adjacent polders. **Table 9.2** below shows the existing average crest levels in Polders 28/1, 27/2, and 30. Therefore, re-sectioning works in Polder 28/2 would create higher flooding and storm surge risks in the polder.

Table 9.2 Existing Average Crest levels of Polders adjacent to Polder 28/2

Polder	Existing crest level (m +PWD)
Polder 27/2	4.27
Polder 28/1	4.
Polder 30	4.27

9.3.3 Changes in aquatic habitat, species migration and biodiversity

The increased floodplain sedimentation outside the polder may slightly affect the aquatic habitat. Flow cross sections may decrease considerably causing change in spacing for aquatic habitat. 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 may 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 UperBhadra, Jhapjhapiaand Manga river system.

9.3.4 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 28/2, 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.

9.3.5 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 28/2 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

(a) Digital Elevation Model (DEM)

The point elevation, existing river network and water body data have been utilized for the generation of a 50 m resolution DEM using ArcGIS for the Polder area. The 50 m resolution is effective enough for identification of internal rivers and regulator locations.

(b) 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.

(c) 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 navigation routes. The discharge and water level data has been collected from BWDB and BIWTA.

(d) Land Use Data

The land use data for the study area was 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.

(e) Soil Data

Information on soil data was obtained from the Soil Research Development Institute (SRDI) of the Bangladesh Government. 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).

(f) 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

(g) 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 9.3**. The results infer that the monthly rainfall will increase for the period of April to October and decrease for November to March. Around 20% of the monthly rainfall will be decreased by 2050s for December and January though the amount of rainfall is very low during that period. The monthly rainfall will increase by 1.3-3.6% during July to September by 2050s. The monthly temperature will increase by 1.6 to 2.0 ^{0}C with an average of 1.8 ^{0}C by 2050s for the study area.

Table 9.3 Change in monthly temperature and rainfall under climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for Polder 28/2.

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

(h) 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, the range of sea level rise is 0.21 to 0.48 m.

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

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

Source: IPCC AR4

9.4.1 Model Schematization

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

SWAT model Setup

Five sequential steps were followed to schematize the SWAT model: watershed delineation, hydrological response unit (HRU) definition, weather data definition, assembling and editing SWAT inputs, and the actual simulation run. The watershed delineation was performed with the automatic delineation tool of SWAT 2012 using the DEM and the river network. All the watershed delineation steps such as filling sink, defining flow direction and accumulation have been done automatically through the user interface. The watershed delineation results 55 watersheds for the entire polder area. The delineated watershed for polder 28/2 is given in **Map 9.3**. After the delineation of watershed, the next step of model setup is the definition of HRU. HRU is the unique combination of land use, soil and slope class. Four land classes, four soil classes and 55 watersheds results 207 numbers of HRUs. The daily precipitation, maximum and minimum air temperature data have been used as weather input for the period of 1981 to 2012. The model has been simulated for the period of 1981 to 2012 based on data availability.

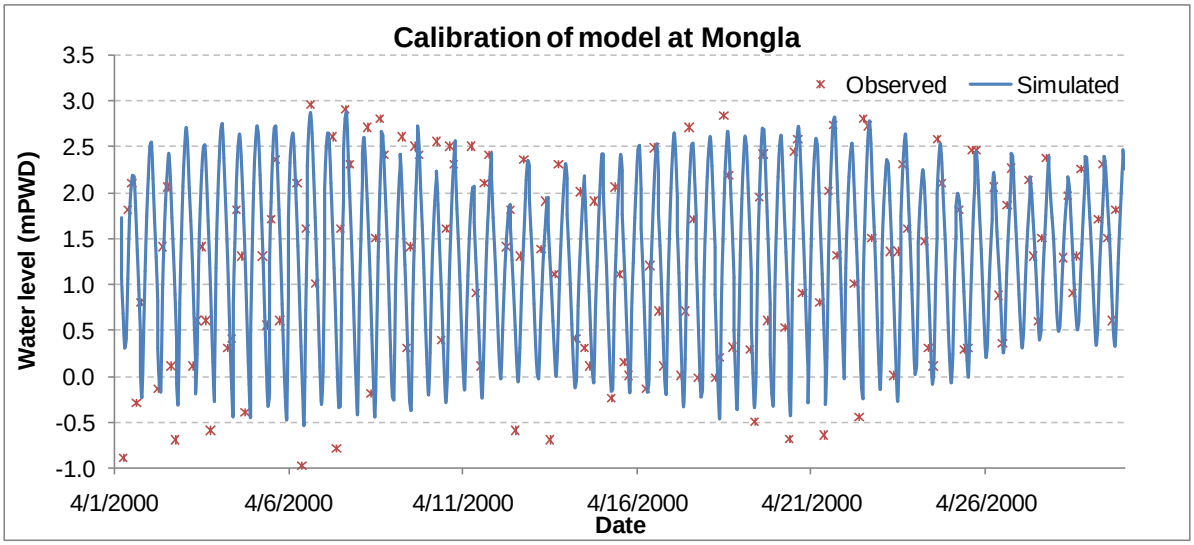


Figure 9.1 Calibration of model results at Mongla for April, 2000

9.4.2 Climate Change Impact on Water Availability

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

The climate change impact on annual water balance in the Polder 28/2 is given in **Table 9.5** for climate change scenario A1B by 2050s. The annual average rainfall for the polder area will be 1865 mm which is about 3% more than the base condition. The surface runoff will also increase as there will be an increase in annual rainfall. There will be slight increase in annual evapotranpiration (3 mm/year) which is mainly due to the increase of temperature. There will also be a minor increase in annual perculation 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	1865
Surface Runoff	848	891
Evapotranspiration	542	545
Percolation	422	428
Baseflow	371	375

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 9.2**.

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 6 to14 mm and decrease is around 2 mm per month.

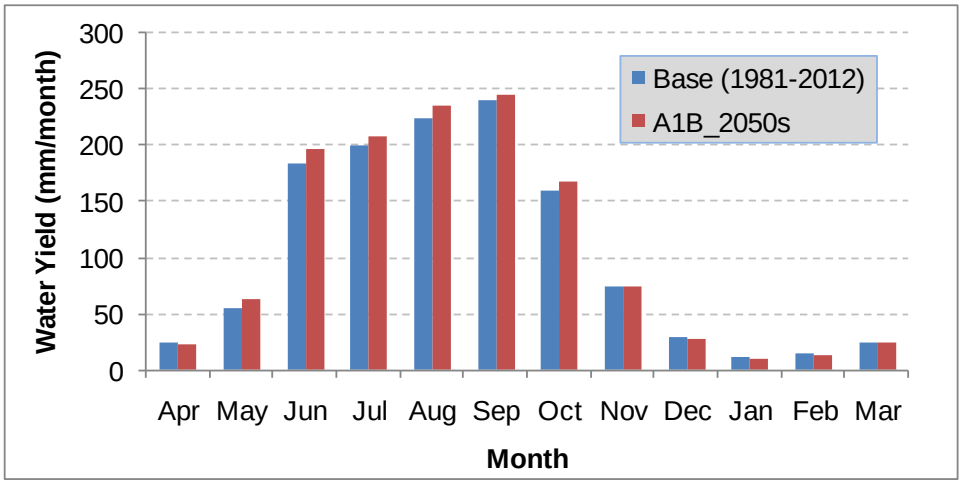


Figure 9.2 Climate change impact on monthly water yield for climate scenario A1B by 2050s

Table 9.6 below shows 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 (4.5 %) and decrease during dry season (5.8%). 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)	80	7.0
Monsoon (Jun-Sep)	848	4.5
Post-monsoon (Oct-Nov)	234	3.9
Dry (Dec-Feb)	78	-5.8

9.4.3 Climate Change Impact on Water Level

The sea level is expected to rise 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 high due to climate change which will result in an increase of extreme flow during monsoon which ultimately results to increase in flood water level. CEGIS recently 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 the above two scenarios and the simulated maximum water level during monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

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-31-part. The increase in flood water level might be a threat for the embankment and it may also interrupt the drainage from the inner side of the 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. Sea level rise may lead to increase salinity in the estuaries, and may affect the 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 28/2-part will increase by 1.0 ppt during the dry period. The increase in river salinity may cause increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.5 Climate Change Resilience Developed in Polder 28/2

During field investigations carried out by the study team, it become evident from peoples' response that they are aware of the climate change consequences and events. In recent years they are 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. The initiatives already undertaken through different software interventions by programs other than Blue Gold, the insight of climate resilience has been developed within the polder habitants. Through the community mobilization in Blue Gold program, local people have become more active towards building a climate resilient society. They are now driven by the concept of climate smart village. 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-excavatd 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 and take part in the knowledge development and capacity building programs organized by Blue Gold, which they believe have enhanced their understanding and preparedness on flood and disaster management.

10. Environmental Management Plan

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

10.1 Physical Environment and Water Resources

10.1.1 Pre-construction and Construction phases

No significant positive or negative impacts on water resources have been foreseen during both pre-construction and construction phases for implementation of the proposed interventions in Polder 28/2. As such, no activities under the proposed EMP have been recommended for these phases.

10.1.2 Operation phase

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

Table 10.1 EMP Matrix for Operation Phase on Physical Environment and Water Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
IESC: Ambient Noise Level				
The excavator and associated heavy machineries will create noise disturbance along the polder alignment, and are likely to increase the noise levels by around 5~10 dB	Construction works near dense settlements (i.e. Gaoghara) are to be carried out using manual labour	Not required	-1	Blue Gold Program, Contractors and LCS
IESC: Saltwater Intrusion				
Almost 4 km water courses inside the polder will be protected from saltwater intrusion.	Not required	Repaired sluice gates are to be operated and maintained properly to protect saltwater intrusion	+6	WMC, BWDB
IESC: Water Security				
Around 25% people inside the polder would be guaranteed having sufficient freshwater and access, which would result in immense benefits in domestic water use.	Not required	Not required	-	-
IESC: Drainage Congestion and Water Logging				
Around 30% of khals adjacent to the periphery of the polder would be improved from drainage congestion.	Not required	Not required	-	-

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

10.2 Land Resources

10.2.1 Pre-construction and Construction phases

No significant positive or negative impacts on land resources have been foreseen during both pre-construction and construction phases for implementation of the proposed interventions in Polder 28/2. As such, no activities under the proposed EMP have been recommended for these phase.

10.2.2 Operation phase

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

Table 10.2 EMP Matrix for Operation Phase on Land Resources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Single cropped area would decrease by about 9% but double and triple cropped area would increase to about 1%, 8% of the NCA respectively under FWIP condition.	-	• Formation of WMGs (GPWM-2002). • Strengthening of WMGs through imparting training on proper management of structure and utilization of Re-excavatd Earth earth materials which will be generated from re-excavation. • Involve the WMGs in project related activities which would enhance crop production.	+3	BWDB, DAE and WMGs
It is expected that the implementation of options and its proper management would protect the undesirable entry of saline water and would allow draining out the dissolved salts from agriculture land. The structures would positive impact on reducing soil salinity.	Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bundh.	-	+4	BWDB and Contractors

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

10.3 Agricultural Resources

10.3.1 Pre-construction and Construction phases

No significant positive or negative impacts on agriculture resources have been foreseen during both pre-construction and construction phases for implementation of the proposed interventions in Polder 28/2. As such, no activities under the proposed EMP have been recommended for these two phases.

10.3.2 Operation phase

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

Table 10.3 EMP Matrix for Operation Phase on Agricultural Resources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Expected to cropping intensity would increased by about 17%.	-	• Involvement of WMGs in polder activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+3	BWDB, DAE and WMGs
Additional 1,380 tons (21% higher) of rice and 1,565 tons (23% higher) of non-rice would be produced in FWIP over FWOP.	-	• Organic manure should be applied for the restoration of soil fertility. • Farmers group should have close contact with SAAO of DAE for adaptation of various measures on ICM. • Irrigation should be provided in optimum level with minimum conveyance loss. • Involvement of WMGs in polder activities would enhance crop production. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs
It is expected that loss of crop production would be reduced 185 tons which would be about 39% less in FWIP over FWOP.	-	• The repair of flushing sluice, repair of drainage Outlet and irrigation Inlet would help to reduce crop damage situation. • The WMGs should be given orientation to protect their standing crops from implementation of the intervention and development on farm water management etc.	+4	BWDB, DAE and WMGs
The irrigated area would be increased about 166 ha in FWIP over FWOP.	-	• Training may be provided to WMGs on "integrated water management" which will be stored or available in the khals/ cannels for different use. • The WMGs should be involved in the integrated water management through proper maintenance of khals, irrigation inlets and drainage/flushing outlets for the expansion of irrigated area.	+5	BWDB, BADC, DAE and WMGs

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

10.4 Fisheries Resources

10.4.1 Pre-construction phase

No significant positive or negative impacts on fisheries resources have been foreseen during pre-construction phase for implementation of the proposed interventions in Polder 28/2. As such, no activities under the proposed EMP have been recommended in this phase.

10.4.2 Construction phase

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

Table 10.4 EMP Matrix for Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
• Feeding and breeding ground and unavailability of fish feed for bottom dweller will be lost. But after 1 year the habitat quality of fish will be improved. • Movement and migration of fisheries species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, bele etc will be obstructed during repairing of structures. Moreover, fish hatchling movement will also be hampered, if the repairing works is implemented during hatchling period (May-June). • Turbidity of water may be increased. • Movement of some particular fish species like Cheng, Taki, Koi, Shing etc will be impacted	• Re-excavation activity should be done segment wise • Avoid construction activities during fish migration period e.g. month of May to August • Earth Re-excavatd Earth should be dumped at setback distance of the khal • To protect the indigenous fishes and other aquatic creators, re-excavation should be implemented segment wise and one after another.	N/A	0	Contractor, BWDB, Department of Fisheries (DoF)

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

10.4.3 Post-construction phase

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

Table 10.5 EMP Matrix for Operation Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Seasonal khal will be perennial again. The improved habitat quality will support different types of fishes as well as aquatic vegetation which will be helpful for fish feeding and habitation.	NA	□ Excavated khal should keep free from encroachment	+3	Department of Fisheries in coordination with WMC
		□ 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.		
Golda gher area would be increased by 1 ha while Bagda gher area would be decreased	• Rice cum gher with white fish area would be increased		+3	Local people with the help of DoE

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Movement of both brackish and fresh water fish species as well as hatchling movement through water control structures will be hampered slightly. But internal fish migration will be facilitated significantly.	NA	Properly and timely gate will be opened 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.	+3	Department of Fisheries in coordination with Water Management Committee
Capture fisheries productivity in the khal will be increased by 30 kg/ha.	NA	• Re-excavated khal should be kept free from encroachment. • Construct deep pool in the perennial khals	+5	Department of Fisheries in coordination with pond owners.
Bagda production would be lost whereas rice cum golda production would be increased by 2 tons.	• Golda and white fish production would be increased		+2	

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

10.5 Ecological Resources

10.5.1 Pre-construction

No significant positive or negative impacts on ecological resources have been foreseen during the both pre-construction phase for implementation of the proposed interventions in Polder 28/2. As such, no activities under the proposed EMP have been recommended in this phase.

10.5.2 Construction phases

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

Table 10.6 EMP Matrix for Construction Phase on Ecological Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Activity: Repairing of embankment				
• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for repairing work. • Relocation of wildlife due to habitat loss temporarily	• Implement plantation along the slopes of embankment after completing the earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: Re-excavation of khal				
• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to	• 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.	N/A	-2	Contractor and BWDB

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
dumping of soil along both sides of the khal				

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

10.5.3 Operation phase

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

Table 10.7 EMP Matrix Operation Phase on Ecological Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Improve terrestrial Vegetation.	N/A	• Plant mixed species of native trees along the embankment slopes wherever possible to enhance green coverage.	+4	BWDB, FD and local stakeholder.
improvement of aquatic plant diversity as well as khal depth and velocity	N/A	• Ensure regular maintenance/re-excavation of all khals when needed • Ensure proper maintenance of all water control structures	+2	BWDB and local stakeholder.

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

10.6 Socio-economic Condition

10.6.1 Pre-Construction Phase

The implementation of proposed interventions may generate some temporary impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts, enhancement for positive impacts and compensation or contingency measures for immitgable residual impacts 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 generation	-	Ensuring engagement of local labour with 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 Construction phase

The implementation of proposed interventions may generate some temporary impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts, enhancement for positive impacts and compensation or contingency measures for immitgable residual impacts 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 generation	-	Ensure employment for local people for both technical and non-technical works. If possible, maximum labor should be recruited locally.	+2	Blue gold and BWDB
Gender Promotion	-	According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for female in future.	+3	Blue gold and BWDB

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

10.6.3 Operation phase

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

Table 10.10 EMP Matrix for Operation Phase on Socio-economic Condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Social Use of Water	-	- re-excavate rest of Khals for more social use of water (taking shower, washing chores and others purposes)	+4	Blue gold and BWDB
Safe Drinking Water	-	- Install rain water harvesting system (PSF, filter etc.) by Blue gold entrepreneurship.	+3	Blue gold and BWDB
Employment generation	-	- Engage local people in other development activities.	+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-excavatd Earth/ Spoil Management Plan (SMP)

The term 'Re-excavatd Earth' is used for soil or dirt resulting from excavation of earthen canals or khals, and discarded off site. Effective management of Re-excavatd Earth is necessary because its volume usually inflates three times after excavation. The Re-excavatd 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-excavatd Earth dumping. It is therefore, important to transport and dispose the Re-excavatd Earth away from the excavation site in a controlled and systematic manner, taking proper accounts of all the environmental and

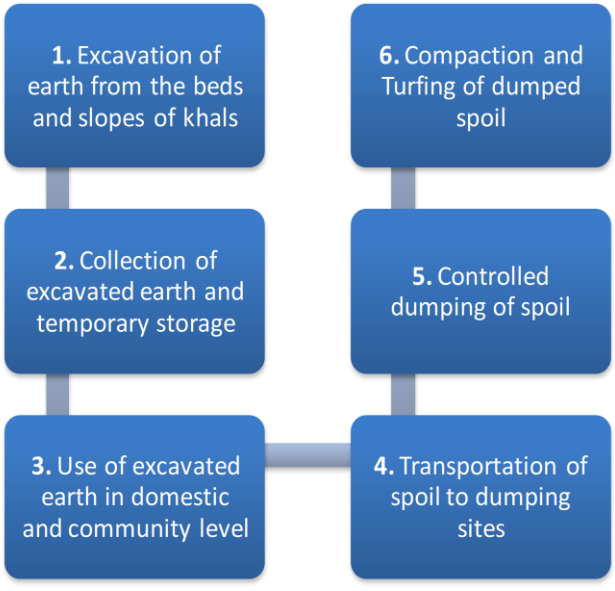


Figure 10.1 Framework for Spoil Management Plan

social issues of the area. Disposal may either be through mechanical equipments, or by manual means.

10.7.1 Framework Proposed for SMP

Polder 28/2 of Blue Gold program entails excavation of a number of khals which would generate a volume of around 2,07,500 m^3 of Re-excavatd 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-excavatd Earth earth for their own household uses.

Figure 10.1 provides a framework which includes the major components of the proposed Re-excavatd Earth Management Plan for rehabilitation of the Polder under Blue Gold Program. The framework entails six basic steps for excavation, collection, use, transportation, dumping and compaction of earth materials in connection with the proposed khal re-excavation works.

Table 10.11 below provides a tentative account of the volume of excavated earth, and its multifaceted uses proposed in the Re-excavatd Earth Management Plan. Around 20% of the excavated earth (40,000 m^3) can be used in embankment re-sectioning works. The rest should then be made available for local people for their multifaceted uses. Local people can collect a portion of the excavated Re-excavatd Earth, and use it to fulfill their domestic requirements. The Re-excavatd Earth may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Re-excavatd 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 schools, mosques, community clinics etc. It is expected that around 41,500 m^3 Re-excavatd Earth would be collected by for different uses. The residual portion (around 1,26,000 m^3) of Re-excavatd Earth may then be disposed on both in a controlled manner.

Table 10.11 Tentative volume calculation and distribution of excavated Re-excavatd Earth

Khals to be Excavated	Excavated Volume (m^3)	Uses of Excavated Soil	Volume (m^3) to be used
Nondonkhali khal	52,000	Embankment Re-sectioning	40,000
Bozrar khal	20,000	Societal uses (uses in household, mosques, schools, clinics or other shelters)	41,500
Bogar khal	32,000		
Charar khal	20,500		
Kechor khal	25,000		
Surkhali khal	40,000		
Roypur kata khal	18,000	Dumping	1,26,000
Total excavation	**2,07,500**	**Total Use**	**2,07,500**

10.7.2 Phase wise activities of Re-excavatd Earth Management

A number of activities are proposed to be carried out during different phases associated with efficient management of re-excavated Re-excavatd Earth (**Figure 10.2**). Before commencement of khal re-excavation, a number of works are to be carried out, which would include both desk works and field level investigations. These activities would finalize the locations of dumping of Re-excavatd 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.

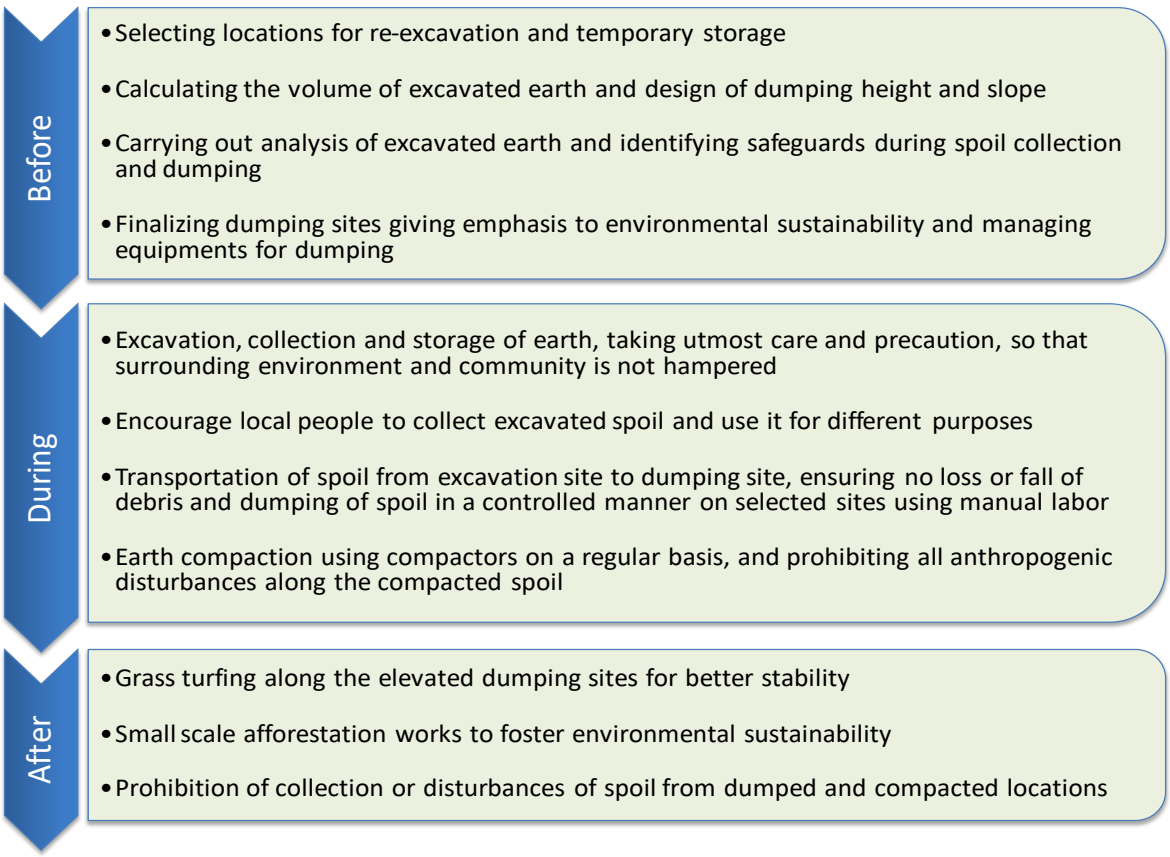


Figure 10.2 Phase wise activities of Re-excavatd Earth Management

10.7.3 Method of Re-excavatd Earth Dumping

The proposed re-excavation works for the Polder would require dumping of a significant amount of Re-excavatd Earth (around 1,26,000 m^3). For a 2.75 meter wide and 1.25 meter thick wedge, this equivalents to around 37 km length of dumped Re-excavatd Earth. Polder 28/2 includes 22.5 km of re-excavation of khals, and if the residual Re-excavatd Earth (1,26,000 m^3) is dumped on both sides of the excavated khals up to a height and width of 1.25 m and 2.75 m respectively, around 18.5 km lengths can be used on both sides. **Figures 10.3** and **10.4** below show the conceptual layouts of proposed dumping technique.

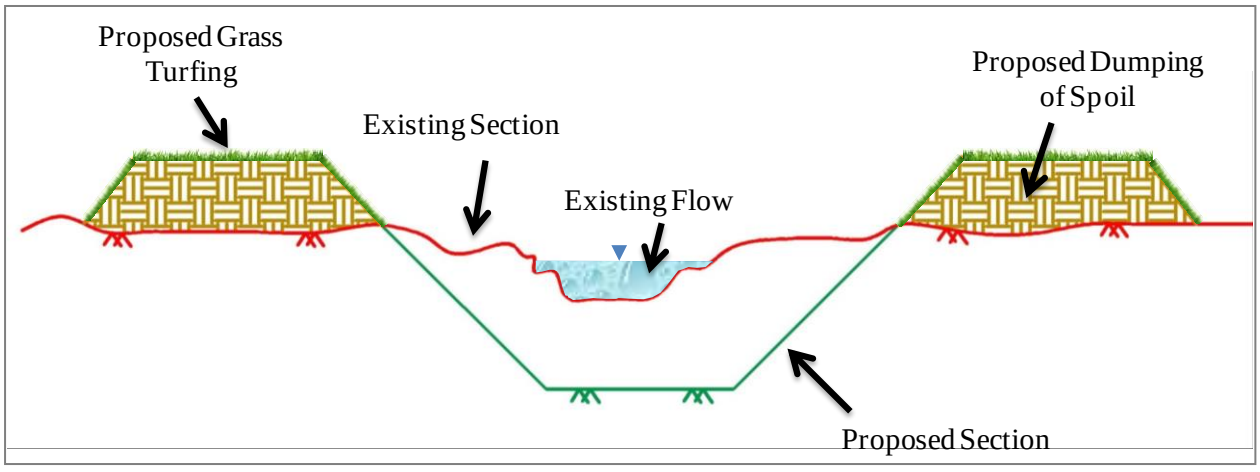


Figure 10.3 Conceptual Cross Section of a typical khal to be re-excavated

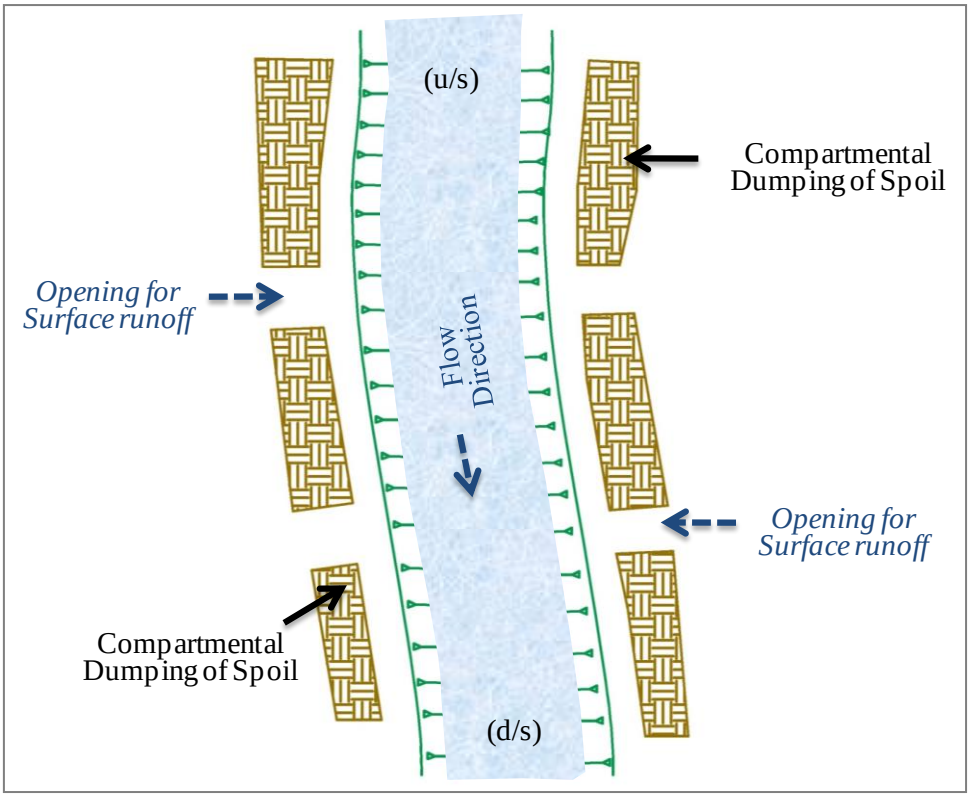


Figure 10.4 Plan form of a typical khal to be re-excavated

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 bank sides of the khals are government owned khas lands which fall within the actual width of the khals. Re-excavatd Earth earth would be dumped on both bank sides of the khal, on these khas lands. This would provide raised level through the bank lines of excavated khals, which may prevent khal siltation in future through erosion of top soil. **Figure 10.4** shows a plan 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 after any rainfall can flow into 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-excavatd 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-excavatd Earth should properly awared about of the health and hygienic aspects
- ✓ Sufficient washing and cleaning arrangements are to be in place for the LCS laborers
- ✓ Dumped Re-excavatd Earth needs to be compacted thoroughly, after the disposal uoto a certain height (e.g. 6~8 inches)
- ✓ The works when are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, which may reduce the strength or stability of the dumped Re-excavatd 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 wastes from the dumped Re-excavatd Earth falls back into the water courses
- ✓ It should also be ensured that the dumped Re-excavatd Earth is not weathered and transported to any privately owned lands or lands of agricultural interests.

10.8 Environmental Monitoring Plan

10.8.1 Monitoring Plan for Pre-Construction Phase

No specific monitoring plan is required to be followed during the pre-construction phase of the environmental and social component of the project in Polder 28/2.

10.8.2 Monitoring Plan for construction phase

A typical monitoring plan has been prepared which will be followed during construction of rehabilitation of Polder 28/2. The Monitoring report will be submitted to the concerned organizations as mentioned in the following checklist.

Blue Gold Program and
Bangladesh Water Development Board

Blue Gold Program: Component II

EMP IMPLEMENTATION

Book No. _____ Monitoring Report No._____

Date:_____ Time:_____

Contract:_____

Contractor:_____

Work Sites (s):_____

A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5	A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5
1	Correct dumping of earth for construction of retired embankment				5	Obstruction of fish migration and hatchling movement			
2	Inconsistencies or mismanagement in embankment re-sectioning works				6	Hamper road communication			
3	Compaction of earth materials on embankment				7	Inconsistencies in water control structures requiring repair works			
4	No pollution from construction site				8	Any threat caused to riverbank area			

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

C.NON COMPLIANCE:

Period Description :

Class

1. Minor: Under One Month (Contractor alerted)

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

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

4.Critical: Over Three Months (Contractor's overall bill withheld by RE and PM***** till compliance)

D.CIRCULATION

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

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

10.8.3 Monitoring Plan for post-construction phase

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
Drainage Congestion and Water Logging	Field observation	Inside the polder	Once in dry season and once in post-monsoon	WMOs and BWDB

Land and Agricultural Resources

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

Fisheries Resources

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

Indicator	Method	Location	Frequency	Responsible Agency
				committee and local fishers.

Ecological Resources

Indicator	Method	Location	Frequency	Responsible agency
Habitat develop	Direct observation	At proposed construction sites	Once before earthworks and half-yearly basis for 5-year monitoring plan	BWDB and DoE
Wildlife occurrence	Direct observation and public discussion	At proposed construction sites	Once before earthworks and half-yearly basis for 5-year monitoring plan	BWDB and DoE

Socio-economic Condition

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

10.9 EMP and Monitoring Cost

10.9.1 Cost of EMP and monitoring of Water Resources

There is no EMP and monitoring cost for water resources.

10.9.2 Cost of EMP and monitoring of land and agricultural resources

Sl. No.	EMP measure	Cost (Lakh Tk.)	Sl. No.	Monitoring item	Cost (Lakh Tk.)
1	• Formation of WMGs/ WMA/ WMF (GPWM-2002), strengthening of WMGs through imparting training on re-excavation of Khals, Embankment management Group (EMG), landless Contacting Society (LCS), on farm water management and development etc. • Involvement of WMGs in polder activities would change positively.	1.50	1	Re-excavation of Khals, disposal of Re-excavatd Earth earth materials for Re-excavatd Earth management and re-sectioning 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 ICM. • Irrigation should be provided in optimum level with minimum conveyance loss. • Involvement of WMGs in polder activities would enhance crop production. • Introduction of HYV crops with crop diversification need to be practiced.	2.50	2	Crop production and damage	1.25
3	• Training of "Integrated water management" and "on farm development" of WMGs	1.00	3	Irrigated area	0.50

Sl. No.	EMP measure	Cost (Lakh Tk.)	Sl. No.	Monitoring item	Cost (Lakh Tk.)
	would help to increase the expansion of irrigated area. • The WMGs should be involved in the integrated water management through proper maintenance of sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.				
	Total	**5.00**			**2.50**

Total cost of EMP and monitoring of land and agriculture resources is **Taka 7.50 lakh**.

10.9.3 Cost of EMP and monitoring of fisheries resources

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
1	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, water Day Rally, Discussion etc. Two year in the polder area.	1.0	1	Fish hatchling movement in 4 khals (Two year).	1.0
2	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring)	2.5 (Training 1.5 Tk and demonstration pond 1.0 Tk) (Number of pond :4 pond area: about 100 decimal)	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	1.5
-	-	-	3	Water quality monitoring (two years)	.50
	EMP Cost	**3.5**		**Monitoring Cost**	**3.0**
	Total cost	**6.5**			

Total Cost for EMP and Monitoring of fisheries resources is **Taka 6.50 Lakh**

10.9.4 Cost of EMP and monitoring of ecological resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
1.	Embankment would facilitate to enhance habitat quality as well habitat size through tree plantation program but the area for re-sectioning has not estimated yet. However here is mentioned the plantation cost for each 8.92 km length of embankment	5.79		Habitat develop	2
				Wildlife diversity	1
	Total	**5.79**		**Total**	**3**

Total cost of EMP and monitoring of ecological resources is **Taka 8.79 lakh**.

10.9.5 Cost of EMP and monitoring of socio-economic condition

There is no EMP and monitoring cost for socio-economic condition.

10.10 Summary of cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost
Water Resources	-	-	-
Land and Agricultural Resources	5.00	2.50	7.50
Fisheries Resources	3.50	3.00	6.50
Ecological Resources	5.79	3.00	8.79
Socio-economic Condition	-	-	-
Grand Total =	**14.29**	**8.50**	**22.79**

Total cost of EMP and monitoring is **BDT 22.79 lakh** (Taka twenty-two lakh and seventy-nine thousand) only.

10.11 EMP Updating

The study infers that EMP has been developed assessing the impacts of interventions on the basis of baseline and prediction information. But monitoring has to be carried out to collect information on the impacts at actuality resulted due to construction of interventions. Furthermore, actual information due to implementation of EMP measures need to be collected for updating the EMP to make the development more environmental friendly as because EMP is not an one time plan rather it is a plan which needs updating continuously.

11. Conclusions and Recommendations

11.1 Conclusions

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 28/2 include re-sectioning of embankment, repair of water control structures, drainage outlets, re-excavation Khals. Drainage congestion, tidal flooding and water logging are very prevalent in Polder 28/2. The proposed interventions will bring about huge beneficial effects for the inhabitants inside the polder e.g. drainage congestion will be removed from 60% 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 28.8km and tentative re-excavated earth volume about 469,336.27 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-excavatd Earth
Location specific Re-excavatd Earth management plan for individual khal

Sl	Name of Khal	Location-dumping of Re-excavatd Earth earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
1						
2						

Sl	Name of Khal	Location-dumping of Re-excavatd Earth earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
3						
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-excavatd 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			
Sali-sation			
Acidification			
Nutrient deficiency			
Pesticide use			
Water logging			
Others			

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

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

Feed and Fodder

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

Diseases

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

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

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

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

Problem/ Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and	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 (+/-) and	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:		Sig-ficant areas	1. 2. 3.						Mrigal				
												Koi				
												Sarputi				
												Large shrimp				
												Small shrimp				
Vertical Migration Pattern	Species: 1. 2. 3.	Season (Months):	Habitats:		Species of Conservation Significance	Rare:						Silver carp				
												Carpio				
												Grass carp				
												Tengera				

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

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

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

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

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

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

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

Ecological Data Collection Form for ESIA Study

Center for Environmental and Geographic Information Services (CEGIS)

Date		Name of the interviewer	
Name of the Project			
District/s		Upazila/s	
Location of the FGD			
Latitude		Longitude	
Gross area:		Net Area:	

Bio-ecological Zone(s):

Terrestrial Ecosystem

Major land use types of terrestrial habitat of the study area (please put Tick where applicable)

Agriculture land		Forest patches including social forestry	
Settlement/Homesteads		Canal and ponds	
Orchard		Grasslands	
Fallow		Reserve forest	
Embankment and roadside vegetation		Others	

Terrestrial Biodiversity

Major Terrestrial Flora

Common Species	Rare Species	Extinct Species	Exotic Species

Major Terrestrial fauna

Species Name	Habitat1	Food Habit2	Breeding Time	Status3	Migration Status4

1 Habitat: 1= Homestead forest, 2= floodplains, 3= wetlands, 4= river
2 Habit: 1=Herbivore, 2= Carnivore, 3= Both

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

Aquatic Ecosystem

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

Name of wetland	Type of Wetland12	Area in ha		Flooding depth (m)	Connectivity with river		Importance13
		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	Utilization14

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			

1=Very common, 2=Common, 3=Occasional, 4=Rare

Present status and negative impacts on flora & fauna

Impacted Species	Existing Status	Cause of impact

[12] 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

[13] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[14] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

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

Victim Species	Anticipated Impact	Cause of impacts

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

☐ Yes ☐ No

How	

Ecosystem Services

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

Presence of Important Ecosystem (If any)

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

Note (If any):

SOCIO-ECONOMIC BASELINE DATA COLLECTION
Checklist for Rapid Rural Appraisal (RRA)

Facilitation Information

Name of Facilitator	
Date of Facilitation	

Project Information

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

Study Area

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

Educational Institution

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

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

Disease Prevalence

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

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

Health Facilities

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

Peripheral Health Facilities (if any)

Number	
Name	
Description/status	

Sources of Treatment Facilities

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

Electricity Coverage

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

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

Income and Expenditure

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

Labor and Wage

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

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

Self Assessed Subsistence Poverty

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

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

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

Disaster and Damage (in last five years)

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

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

Migration Trend

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

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

Professional/occupational Conflict

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

Miscellaneous

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

Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

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

Appendix-2: No Objection Certificate

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
জেলা প্রশাসকের কার্যালয়, খুলনা
এল.এ (ওয়াপদা) শাখা
www.khulna.gov.bd

স্মারক নম্বর ঃ ৩১.৪৪.৪৭০০.০১৩.০৩.০০১.১৭- ১৮ (যুক্ত) তারিখ ঃ ২৯/০২/১৭ খ্রিঃ

বিষয় ঃ বাংলাদেশ ও নেদারল্যান্ড সরকারের আর্থিক সহায়তায় ব্লু গোল্ড প্রোগ্রাম এর আওতায় বিকল্প বাঁধ নির্মাণ, নিষ্কাশন খাল পুনঃখনন ও বিভিন্ন স্থানে খালের মুখে স্লুইস গেট নির্মাণে জমি অধিগ্রহণের বিষয়ে অনাপত্তি পত্র প্রদান প্রসঙ্গে।

সূত্র ঃ নির্বাহী প্রকৌশলী, খুলনা পওর বিভাগ -১ বাপাউবো, খুলনা এর স্মারক নম্বর ৯৫, তারিখ ঃ ১১ জানুয়ারি, ২০১৭ খ্রিঃ

উপর্যুক্ত বিষয় ও সূত্রের আলোকে জানানো যাচ্ছে যে, উপকূলীয় এলাকায় বন্যা, জোঁয়ার ভাটা জনিত প্লাবন ও জোয়ারের লবনাক্ত পানি নিয়ন্ত্রণে রেখে অধিক খাদ্য উৎপাদনের লক্ষ্যে বাংলাদেশ ও নেদারল্যান্ড সরকারের আর্থিক সহায়তায় ব্লু গোল্ড প্রোগ্রাম এর আওতায় বিকল্প বাঁধ নির্মাণ, নিষ্কাশন খাল পুনঃখনন ও বিভিন্ন স্থানে খালের মুখে স্লুইস গেট নির্মাণের পরিকল্পনা বাস্তবায়নের নিমিত্ত স্থাবর সম্পত্তি অধিগ্রহণ ম্যানুয়েল ১৯৯৭ এর আলোকে শোভনা, পাতিবুনিয়া, চাঁদগড়, বারোয়াড়িয়া, রুহিতমারি, সেচবুনিয়া, ও বৃত্তিভুলবাড়িয়া মৌজার জমি অধিগ্রহণে নির্দেশক্রমে অনাপত্তি প্রদান করা হল।

২৯/২/১৭
এস.এম. সাইফুর রহমান
ভূমি অধিগ্রহণ কর্মকর্তা
খুলনা

নির্বাহী প্রকৌশলী
খুলনা পওর বিভাগ -১,
বাপাউবো, খুলনা।

Chief Executive Engineer
Directorate of Planning-III
BWDB, Dhaka

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Appendix-3: Terms of References

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

Memo No: 22.02.0000.18.72.08.19- 30 Date: 30 /01/2019

Subject: Approval of Terms of Reference for EIA of the Proposed Rehabilitation and Improvement of Infrastructure of Five Polder (Polder-27, 28/1, 28/2, 34/2 & 55/2A) under Blue Gold Program.

Ref: Your Application dated 17/12/2018.

With reference to your letter dated 17/12/2018 for the subject mentioned above, the Department of Environment hereby gives Approval of Terms of Reference for EIA of the Proposed Rehabilitation and Improvement of Infrastructure of Five Polder (Polder-27, 28/1, 28/2, 34/2 & 55/2A) under Blue Gold Program subject to fulfilling the following terms and conditions.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein.

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

4a. Project activities:
- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information
Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)
   - Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
   - Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
   - Environment Quality : Air, Water, Soil and Sediment Quality
   - Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:
   - Population: Demographic profile and ethnic composition
   - Settlement and housing
   - Traffic and transport
   - Public utilities: water supply, sanitation and solid waste
   - Economy and employment: employment structure and cultural issues in employment
   - Fisheries: fishing activities, fishing communities, commercial important species, fishing resources,

1

commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).
   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.
8. Management Plan/Procedures:
   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.
   An outline of the Environmental Management Plan shall be developed for the project.
   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).
9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)
   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)
10. Emergency Response Plan & disaster Impact Assessment
11. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the feasibility study report, the applicable Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Head Office of DoE in Dhaka with a copy to the Concerned Divisional office of DoE.

20.01.19

(Syed Nazmul Ahsan)
Director (Environmental Clearance)
Phone # 02-8181673

Director (Planning-III)
Bangladesh Water Development Board
Hasan Court (7th & 8th floor)
23/1, Motijheel C/A, Dhaka-1000.

Copy Forwarded to :

1) PS to the Secretary, Ministry of Environment, Forest and Climate Change, Bangladesh Secretariat, Dhaka.
2) Director, Department of Environment, Barisal Divisional Office, Barisal.
3) Director, Department of Environment, Khulna Divisional Office, Khulna.
4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.