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 28/1

September 2019

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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	Labor Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
Lpc	Litre per capita
MoEF	Ministry of Environment and Forests
MoWR	Ministry of Water Resources
MP	Murate of Potash
MPI	Multidimensional Poverty Index
MSL	Mean Sea Level
MT	Metric Ton
MW	Mega Watt
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NDVI	Normalized Difference Vegetation Index
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NIR	Near- Infrared
NOCs	No Objection Certificates
NWRD	National Water Resources Database
O & M	Operation and Maintenance
OHP	Occupational Health and Safety Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Pestedes Petits Ruminants
PRA	Participatory Rural Appraisal
PSF	Pond Sand Filter
PWD	Public Works Department
RL	Reduced Level
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SAAO	Sub Assistant Agriculture Officer
SIA	Social Impact Assessment
SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SW	Surface Water
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
SWAT	Soil and Water Assessment Tools

T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UAO	Upazila Agriculture Officer
UFO	Upazila Fisheries Officer
UNDP	United Nations Development Programme
UNO	Upazila Nirbhahi Officer
WARPO	Water Resources Planning Organization
WMA	Water Management Association
WMC	Water Management Committee
WMF	Water Management Federation
WMGs	Water Management Groups
WMIP	Water Management Improvement Project
WMO	Water Management Organization

Glossary

Aila	Major Cyclone, which hit Bangladesh coast on May 25, 2009
Aman	A group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-December.
Arat	Generally an office, a store or a warehouse in a market places 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 Unit

Fact Sheet

Polder No.	:	28/1
District	:	Khulna
Upazila	:	Dumuria
Union	:	Rangpur, Ghutudia, Dumuria Sadar, Kharnia
O&M Division of BWDB	:	Khulna O&M Divison-1
Gross Area (ha)	:	5600
Cultivable Area (ha)	:	4500
River	:	The polder is surrounded by the upper Shoilmari (west), lower Shoilmari (south) and Moyuri (east) rivers.

Major Water Management Infrastructure

Embankment (km)	:	32.20
Regulator (no.)	:	07
Khal (km)	:	72.00

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 live below the poverty line and face high vulnerabilities in terms of access to food, employment, income, water and health service. Integrated and participatory water resources management has the potential to contribute significantly to food security, safety, income level, health and economic growth. In this context, the Government of the Netherlands (GoN) as a development partner of Bangladesh has been supporting water resources management projects in Bangladesh since 1975. These projects are mostly operated by the Bangladesh Water Development Board (BWDB).The Blue Gold Program (BGP), is one of such initiative that will cover 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 28/1.

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 is followed to conduct this EIA study.

Project Description

Polder 28/1 is located at Ghutudia and Jalma unions under Dumuria upazilla and Batiaghata upazilla of Khulna district. Polder 28/1 was constructed in 1965-70 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 lying with the Khulna O&M Division-1, BWDB, Khulna. The polder is surrounded by the upper Shoilmari (west), lower Shoilmari (south, via 28/2) and Moyuri (east) rivers.

Existing Problems and Proposed Interventions

The Polder is enriched with embankment having a length of about 29.852 km and providing protection against tidal and storm surges and salinity intrusion. There are 8 numbers of drainage sluices constructed by BWDB within the polder.

A number of problems and issues are hindering the development potential of Polder 28/1 at the moment. Drainage congestion is one of the major problems inside the polder area. During monsoon and post-monsoon periods, most of the khals running through the polder area cannot cope with the increased rainfall occurrences, leading to moderate to severe drainage congestions. Among the sluices some needs repair but Sluice gate at Panchur khal is in vulnerable condition and need re-construction. One outlet is also very much essential to repair at Gollamari.

In addition to all these issues, mismanagement is resulting in various damages in water control structures as well as peripheral embankments. The unpaved portion becomes unusable for heavy vehicles during wet season.

Considering the existing problems and needs of local residents, the Blue Gold program has considered the following interventions for rehabilitation of Polder 28/1:

- **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.

- **Construction of Water Control Structures**
  A total numbers of 8 drainage sluices among all existing sluices of BWDB within the polder will be repaired. A number of 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.

- **Khal Re-excavation**

A total number of 11 khals in Polder 28/1 are considered in the re-excavation plan of Blue Gold program. The total length to be re-excavated is around 18.00 km.

Environmental and Social Baseline

The project area experiences tropical climate. The mean maximum temperature stays between 19.3°C to 30.4°C. The maximum rainfall ever recorded in the area is 343 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 73% to 88%. Daily average sunshine hours are higher than 7 hours which reduces to 5 hours from June to September. Wind speed of the polder area is highest in April (around 160 kph) and lowest in November (around 40 kph). Temperature values varied within a typical range for different locations as samplings were made in different time of the day.

The water quality of different water bodies has been measured. The pH values were higher than the neutral value (pH=7) which means that water in these locations are alkaline in nature. However, the polder areas soil is good for crop production. Values of TDS were found very low inside the polder, but were high in the Ghengrail and Upper Bhadra 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 (5 to 6 mg/l) and fishing (5 mg/l).

From the DEM it is found that 58% land of the areas have elevation between +2 to +4 m above MSL, and 32% have elevations are above 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). Polder 28/1 falls under Zone-III which is considered as a seismically quiet zone with a Seismic Zone coefficient of 0.075, comprising the southwest portion of Bangladesh. Furthermore, almost all the surface water samples were found having objectionable salinity concentrations. In the month of May, highest salinity was observed as 22 ppt in AmtalaKhal outside the polder.

The Polder is within an aerial distance about 75 km away from the Bay of Bengal. The polder is surrounded by the upper Shoilmari (west), lower Shoilmari (south, via 28/2) and Mouri (east) rivers. Water levels during high tide range from 1.5 to 2.26 m +PWD at Dumuria, and 2 to 2.78 m +PWD at Sutarkhali. On the other hand, the low tidal water levels range from 0.8 to 1.39 m below the MSL at Dumuria, and to 0.01 to 0.78 m below MSL at Sutarkhali. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. Average daily use of water is around 30 lpc for domestic use.

Agriculture is the mainstay of livelihood in this polder. The net cultivable area (NCA) of the polder is 5,466ha which 69% of the total polder area.The most prominent cropping patterns of the polder area are Fallow – LT.aman - Fallow (38%), and Sesame - LT. Aman – Fallow (29%). Total cropped area is about 9,075 ha of which 6,451 ha is covered with rice and the rest 2,624 ha is occupied by non-rice crops. The annual total crop production in the polder area stands at about 29,476 tons of which 16,215 tons are rice and 13,261 tons are non-rice . The cropping intensity of this polder is 166%.

The estimated fish habitat in the Polder area is 1105 ha where capture fishery contributes the major share (590 ha) and the culture fish habitat shares the rest. The peripheral rivers, tidal and inter tidal floodplains and internal khals are important fish habitat for capture fisheries where internal khals play an important role in fish migration. The estimated total fish production of the polder area is about 432 tons. Bulk of the fish production (about 88%) is coming from culture fisheries and the rest is from the capture fishery. Among the culture fisheries production, rice cum golda contribute major share of the fish production. The terrestrial flora and fauna are very rich here although the density of vegetation is not uniform throughout the polder.

The populations of Polder are about 58,397 of which **29,023** are male and **29,374** are female. The average literacy rate in the study area is 51%which is slightly lower than national level (52%).Out of total population, 15,915 (27.25%) are economically active which include 6,148 (38.63%) employed, 39 (0.25%) are looking for work, and 9727 (61%) engaged in are household work. Sources of drinking water in the area are satisfactory. About 54% households have access to hygienic sanitation facility (water-sealed), 31 % non-water-sealed sanitation facility and 11% non-sanitary facilities in the polder area.

Prediction and Evaluation of Potential Impacts

The proposed interventions will affect a number of environmental and social components either positively or negatively. It is expected that around 30% of khals adjacent to the periphery of the polder would be improved from drainage congestion in future, due to the overall improvement in drainage capacity of re-excavated khals. Around 35% of people living inside the polder would be ensured sufficient freshwater and access, which would result in immense benefits in domestic water use. Besides, water for irrigation would also substantially be available. After completion of the interventions, the cropping intensity is expected to increase by 15%. It is expected that additional amount of 5,500 tons of rice and 5,950 tons of non-rice would be produced moreover irrigated area would be increased by 652 ha in the polder area. Seasonal khal would be turned into perennial khal again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota. However, the open water fish production would be increased and habitat quality will also be improved. In addition, movement of fishes and hatchling of brackish and fresh water fish like Bhetki, Pairsa, Chingri, and Bele etc. from river to polder area would be hindered due to the repair of regulators/sluices. Culture fish productivity will also be increased due to reduction of flood risk for re-sectioning of the embankment. Terrestrial vegetation will be benefitted due to re-sectioning of embankment and construction of retried embankment which will enhance plant succession at river levees that would ultimately improve their habitat suitability. Embankment re-sectioning will reduce the vulnerability of livelihoods to natural disasters especially to cyclonic storm surge. The road communication will be developed for re-sectioning of embankment. The standard of living of the polder people will be benefitted.

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 :

- Construction works near dense settlements (near Dumuria, Sahas and Sarappur) 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)
- Strengthening of WMGs through imparting training on proper management of structure and utilization of Re-excavated earth earth materials which will be generated from re-excavation.

- Involvement of WMGs in project related different activities
- Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bunch
- Re-excavated earth earth materials and others waste should be managed properly
- Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced
- Organic manure should be applied for the restoration of soil fertility
- Irrigation should be provided in optimum level with minimum conveyance loss.
- 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
- Earth Re-excavated earth should be dumped at setback distance of the khal
- Re-excavation activity should be done segment wise
- Avoid construction activities during fish migration period e.g. month of May to August
- Excavated khal should keep free from encroachment
- 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
- Plant mixed species of native trees along the embankment slopes wherever possible to enhance green coverage.

Furthermore, a conceptual Re-excavated earth Management Plan (SMP) has been proposed by the study team for controlled and sustainable disposal of excavated Re-excavated earth. Follow up of 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 may occur after the construction. The mitigation measures suggested in the EMP would ensure the sustainable development of the project area, and the project management is advised to pay 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.

The total land area of the four districts is 11,463 km² and the total population is 5.6 million. This gives an average population density of 493 people per km² and an average household size of 4.3 persons (BBS, 2011). These districts are chosen considering (i) higher incidence of poverty, (ii) ineffective coordination with the local administration and private sector and (iii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. Total 22 polders from these four districts are included in the Blue Gold Program program, as illustrated in Table 1.1.

Table 1.1 District wise distribution of polders under BGP

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

The main implementing partners of the program are BWDB and the Department of Agriculture Extension (DAE). The program will cooperate closely with the related Ministries, the Local Government institutions, knowledge based institutes and private sector including the NGOs. The

overall approach is innovative and therefore whenever needed, the program will strengthen the technical and strategic capacity of Government officers and their operational capacity in particular at local (Union, Upazila and District) level, concentrating on polder development in the three districts.

The Blue Gold program has four distinct and interlinked components: (i) community mobilization and institutional strengthening, (ii) water resources management, (iii) food security and agricultural production, (iv) business development and private sector involvement. From environmental point of view, activities of two components i.e. the water resources management component (component ii) and the food security and agricultural production component (component iii) need to be taken into special consideration.

1.2 Rationale of the Study

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

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

1.3 Study Area

The study area of this EIA study is Polder 28/1 which was constructed in 1965-70 by the Bangladesh Water Development Board (BWDB) and later on was rehabilitated under the KJDRP project from 1996 to 2002. The polder covers a big portion of Gutudia union under Dumuria upazila and small portion of Jalma union under Batiaghata upazila of Khulna district. The polder is surrounded by the upper Shoilmari (west), lower Shoilmari (south, via 28/2) and Moyuri (east) rivers. Map 1.1 shows the base map of the Polder.

1.4 Objectives of the Study

The secondary data and information used in this study have been collected from existing data sources for different time intervals, which has some influence on the results and remarks included in this study. For such time limitations, more localized primary data on hydrology, meteorology; household status etc. could not be collected for a full hydrological cycle. Furthermore, the inference drawn from implied hydrologic and hydrodynamic models are mostly subjected to the authenticity of used data.
Implementing partners of the program are BWDB and the Department of Agriculture Extension (DAE). The program will cooperate closely with the related Ministries, the Local Government institutions, knowledge based institutes and private sector including the NGOs. The overall approach is innovative and therefore whenever needed, the program will strengthen the technical and strategic capacity of Government officers and their operational capacity in particular at local (Union, Upazila and District) level, concentrating on polder development in the four districts.

The Blue Gold program has four distinct and interlinked components: (i) community mobilization and institutional strengthening, (ii) water resources management, (iii) food security and agricultural production, (iv) business development and private sector involvement. From environmental point of view, activities of two components i.e. the water resources management component (component ii)

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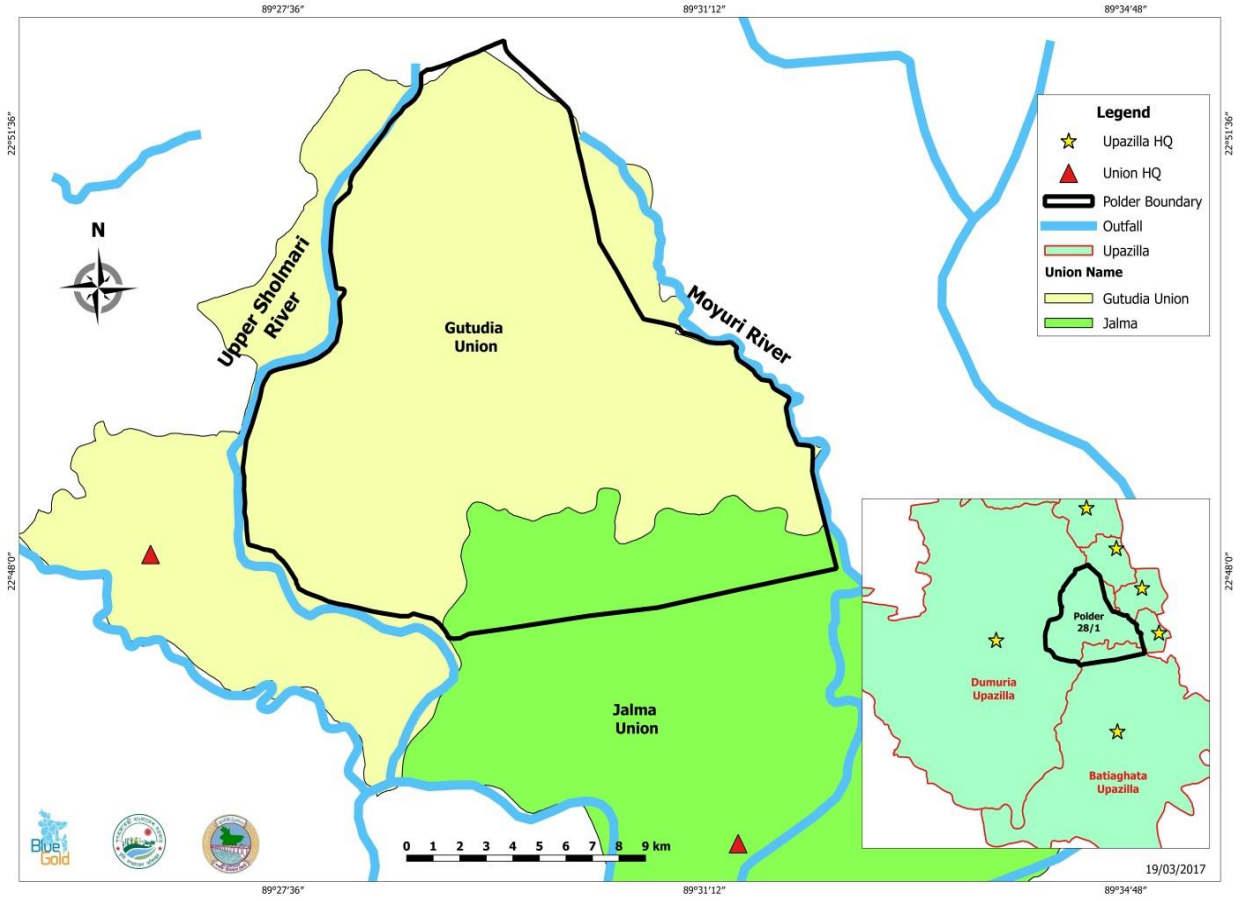


Map 1.1 Map of Polder 28/1

1.5 Scope of Work

The scopes of work 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.
iv. Determine the potential impacts from the project through identification, analysis and evaluation on sensitive areas.
v. Identify the 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 Environmental Management Plan.

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)

- **PanishampadParikalpanaAin (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:

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

2.4 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.

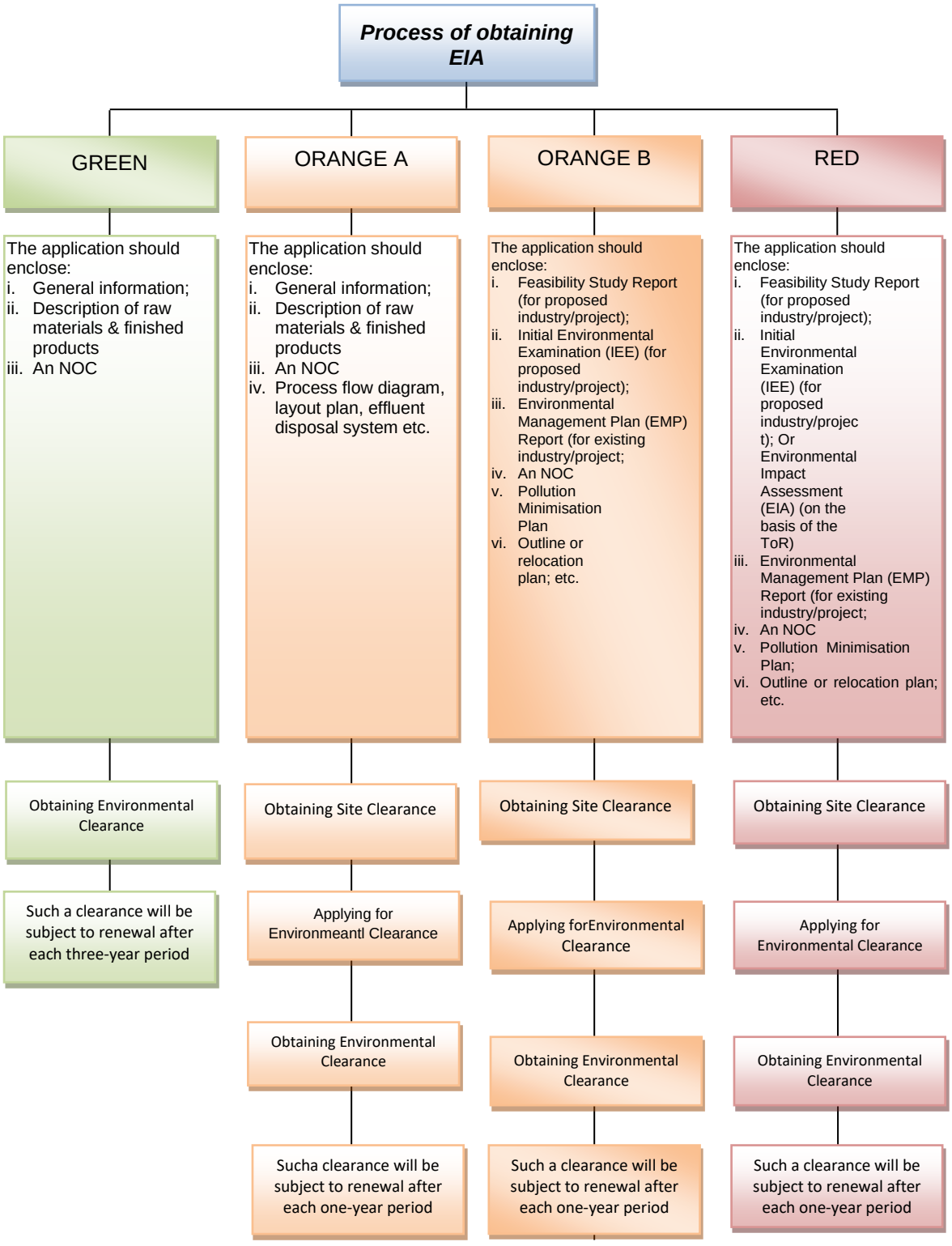


Figure 2.1 Steps Involved in Environmental Clearence folllowing DoE Clearence

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 Plannin Organization (WARPO) in 2003. There is another guideline for EIA, formulated by the Department of Environment (DoE) in 1997, which only includes the industrial projects of the country, and has very limited emphasis on water sector developments.

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

Figure 3.1 The EIA process

3.2 Project Design and Description

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

3.3 Environmental and Social Baseline

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

identification of problems in respect to the proposed project site and adjoining area. The baseline data collection methodology is presented in the following section:

3.3.1 Climate and Meteorology

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

Data on different meteorological parameters such as rainfall, temperature, sunshine hours, humidity and wind speed were used for assessing the existing climate which is directly related to the water resources of the study area. The nearest station of Bangladesh Water Developement Board (BWDB) and Bangladesh Meteorological Department (BMD) at Khulna was selected.

3.3.2 Topography and Seismicity

To understand the topography of the area through visualization of Reduced Levels (elevations) of different locations within the polder, an analysis using Digital Elevation Model (DEM) has been carried out. To establish the DEM, re-sampled 500m×500m grid levels (elevations) were captured from BWDB's one foot contour maps, which were produced in the late sixties. These spot levels were interpolated into a continuous surface known as the DEM produced. The DEM has been downscaled within the processing extent of Polder 28/1 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 28/1 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 Sholmari River and Moyuri 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 has also been collected from secondary sources from upazila livestock office, NGO working with BGP.

3.3.7 Environmental Quality

Under the environmental quality component, noise and water quality were measured at different selected locations in Polder 28/1. 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, can be 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 Polder 28/1'. 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 judgment of the EIA team members as well as the stakeholders opinions obtained in the scoping sessions are considered in selecting the IESCs.

3.5 Bounding

The area likely to be impacted for 'rehabilitation of Polder 28/1' 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 Baseline and IESCs were collected from the field during this stage. Information on the IESCs was collected through a mixed method including RRA, PRA and KII using checklists for water resources, land resources, agriculture, livestock, fisheries, ecosystem and socio-economic components. Intensive consultations with the local people were carried out fort heir feedback on the key parameters. This process helped the multidisciplinary EIA study team to qualify their professional observations. In such exercise attention was given to understand the historical status of the IESCs and the possible condition of the same against the proposed interventions.

3.7 Environmental and Social Impact Assessment

Environmental and social impacts on the IESCs for the proposed interventions i.e. for Rehabilitation of Polder 28/1' 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 sequences 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. 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, impacts were assessed in qualitative terms and scores are assigned with plus (+) sign for positive impacts and minus (-) sign for negative impacts. The magnitude of both positive and negative impacts 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 15 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 28/1" 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 challenges of freshwater scarcity, tidal flooding, food security, climate change etc. Capacity building of stakeholder activity are considered an integral component of the project to ensure participatory water resources development and management involving the community as well as other stakeholders; design and quality implementation; introduction of participatory working concepts and make WMOs as driving forece for water management in the Polder area are the salient features of the project.

4.2 Objective

The objectives of the Blue Gold Program are to

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

The objective of the second component of Blue Gold Program in Polder 28/1 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 28/1 was constructed in 1965-70 by the Bangladesh Water Development Board (BWDB) and later on was rehabilitated under the KJDRP project from 1996 to 2002. The polder covers a big portion of Gutudia union under Dumuria upazila and small portion of Jalma union under Batiaghata upazila of Khulna district. The polder is surrounded by the upper Shoilmari (west), lower Shoilmari (south, via 28/2) and Moyuri (east) rivers.

4.4 Present Status Water Management Infrastructures

Water Management Infrastructures are the physical interventions which ensure sustainable management, optimal use and equitable sharing of water resources. There are some typical water management infrastructures such as peripheral embankments, sluices, drainage outlets, flushing inlets in Polder 28/1. Based on field investigation the study team gathered the following information regarding the status of existing infrastructure.

Embankments

The length of the Embankment is 29.852 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 Pashkhali area. The embankment remains dry and various modes of transportations are found through it in dry season. A significant portion of the peripheral embankment is paved, which allow heavy vehicular movements during all seasons. But in wet seasons the top surface the unpaved portion of the embankment surface becomes slippery and unsuitable for vehicular movements.

Photo 4.1 Existing Status of Embankments

Water Control Structures

There are 8 numbers of drainage sluices constructed by BWDB within the polder. Some of these structures need repairing. A number of the gates do not operate smoothly due to damages of the wheels and shafts used to elevate gates. Siltation of the river bed caused some of the sluice gates to remain non-functional. Severe mismanagement issues regarding the water control structures also prevail.

During the field visit in 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. Sluice gate at Panchur khal is in vulnerable condition and need re-construction. One outlet is also very much essential to repair at Gollamari.

Photo 4.2 Existing Status of Kuloti Sluice and Pashkhali Sluice at Polder 28/1

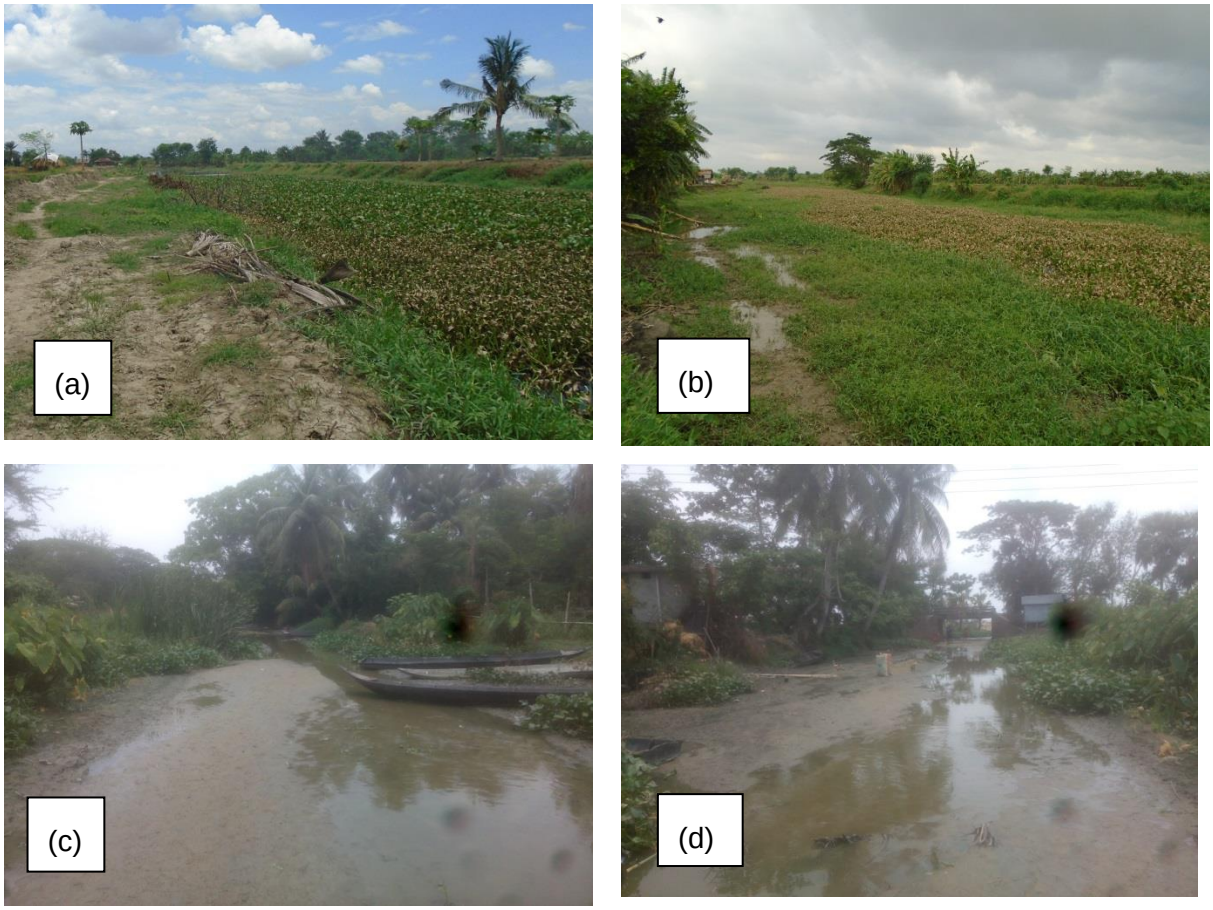
4.5 Present Status of Drainage Khals and Rivers

The present condition of most of the internal khals is in very poor condition in absence of maintenance or re-excavtion. Over the years, siltation, topsoil erosion and other land filling activities have resulted in gradual decrease of water courses within the polder. Among the existing khals the 4 khals namely Badurgacha Khal, Latakumarer khal, Panchkhali khal and Panchur 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 28/1 at the moment. Drainage congestion is one of the major problems inside the polder area. During monsoon and post-monsoon periods, most of the khals running through the polder area cannot cope with the increased rainfall occurrences, leading to moderate to severe drainage congestions.

Among the sluices some needs repair but Sluice gate at Panchur khal is in vulnerable condition and need re-construction. One outlet is also very much essential to repair at Gollamari.



*(**a**)Pashkhali khal, (**b**) Pashkhali khal , (**c**) Puber khal, (**d**) Puber khal*

Photo 4.3 Drainage Khals within the polder

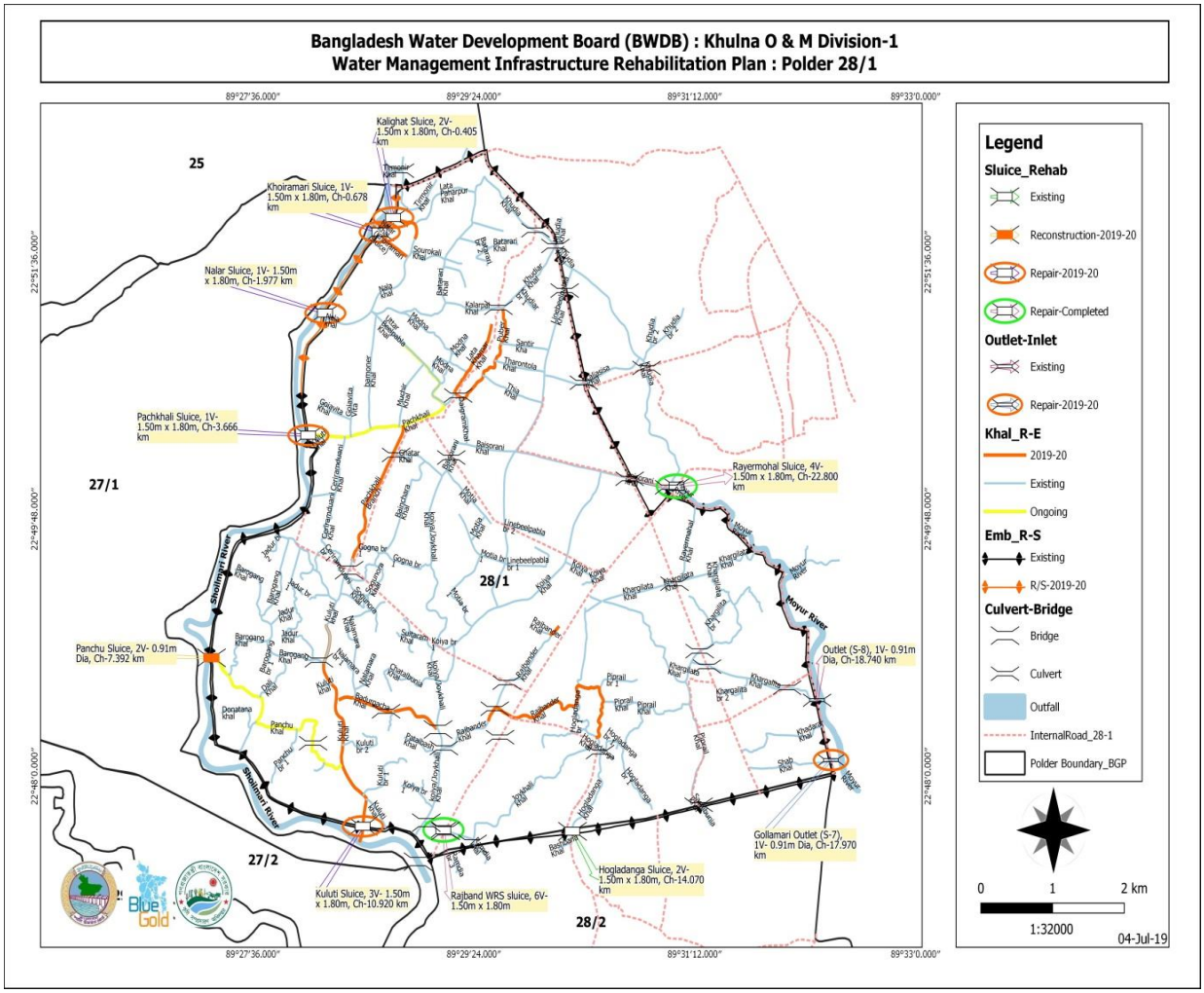
In addition to all these issues, mismanagement is resulting in various damages in water control structures as well as peripheral embankments. The unpaved portion becomes unusable for heavy vehicles during wet season.

4.7 Proposed Interventions in Polder 28/1

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 28/1. The locations of interventions have been shown in Map 4.1.

4.7.1 Repairing of Water Control Structures

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



Map 4.1 Location of the proposed interventions of Polder 28/1

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	Kalighat	2V	1.5m X 1.8m	0.405
2	Khoiramari	1V	1.5m X 1.8m	0.678
3	Nalar	1V	1.5m X 1.8m	**1.977**
4	Pashkhali	1V	1.5m X 1.8m	3.667
5	Panchu	2V	0.90 m dia	7.392
6	Kuloti	3V	2.1m X 1.8m	10.900
7	Rajband (WRS)	6V	1.5m X 1.8m	Near Koya Bazar
8	Rayarmohol	4V	1.5m X 1.8m	23.000

Source: Blue Gold Program Office

4.7.2 Khal Re-excavation

A total number of 11 khals in Polder 28/1 are considered in the re-excavation plan of Blue Gold program. The total length to be re-excavated is around 18.00 km. The names of the khals and lengths to be re-excavated are shown in Table 4.2.

Table 4.2 Detail information on proposed re-excavation of Khals

Sl. No	Name of Khal	Length (Km)	Tentetive volume of Earth (cum)
1	Re excavation of Panchu Khal	3.30	14,946.35
2	Re excavation of Badurgacha Khal	1.50	10,890.54
3	Re excavation of Lata Khamar Khal	1.00	7,615.25
4	Re excavation of Pashkhali Khal	3.15	25,468.23
5	Re excavation of Pashkhali Branch Khal	1.20	5,185.92
6	Re excavation of Puber khal	1.60	9,101.67
7	Re excavation of Rajbander khal	2.80	30,337.61
8	Re excavation of Kalighat khal	0.60	5,933.42
9	Re excavation of Khoiramari khal	0.61	6,022.25
10	Re excavation of Nalar Khal	0.20	5,684.41

Source: Blue Gold Program Office

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.

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 28/1 are likely to be completed by June 2020.

Table 4.3 Construction Schedule in Polder 28/1

Key Activities	2018				2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)												
Community mobilization for Water Management Planning (Fine tuning works)												
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs												
Assessment of WMO Functionality												
Strengthening/ capacity building of WMO based on outcome of Assessment												
Community Mobilization for 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.
- 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 28/1 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.

4.9.2 *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.

4.9.3 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.

4.10 Operation and Maintenance Plan

Since construction, Polder 28/1 has been playing a vital role in safeguarding the polder area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, it is observed that due to inadequate maintenance and mismanagement issues over the years, the polder did not serve as per its potential.

4.10.1 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 28/1.Therefore, maintaining the polder system with embankments and structural elements built and rehabilitated over there has become a permanently important task. In this regard, 'Guidelines for O&M Planning and Budgeting, August 2001; CERP-II' has been studied and an O&M plan for the Blue Gold Program in Polder 28/1 has been proposed.

Regulation of Gate Operation

The gates need to be operated properly so as to retain water in the drainage channels without overtopping their channel banks. Moreover, consultations must be made with beneficiaries of all occupational sectors i.e. farmer, fisher etc. Operation of outlets and inlets should also undergo similar practices with maximum involvements of different beneficiaries' organizations. The WMOs and BWDB O&M staff will assist local stakeholders in effective management of water inside the polder.

Frequent Monitoring of Embankments and Structures

This is a typical monitoring activity, to be carried out by the BWDB O&M staff. It is intended mainly to detect weak sections, gullies, slips at abutments, damage of protective works, wing walls, periodic damage to flap gates, fall boards, sign of squatter settlements, cuts in the embankments to accommodate homesteads, embankment subsidence and erosion, and settlement in protection works. The functional WMOs in the polder will assist in the problem detection process.

Supervision of Preventive Maintenance Works

Preventive maintenance works are done by the community-based functional groups (e.g. LCSs) as and when required throughout the year. The works are usually most simple, cheap and cost effective maintenance works, and are implemented more or less continuously. The field staffs of O&M section of BWDB supervise all preventive maintenance works. Routine monitoring of water management situation and hydrological conditions will supply data which will dictate the needs of adjusting the operational measures.

4.10.2 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 28/1, only those work which directly serve water management should be regularly maintained. The preventive maintenance works can be implemented through community-based functional groups such as LCSs. The works may include:

- All activities related to vegetative covers on embankment and small earthworks on the embankment;
- Cleaning, greasing, and painting of structures ;
- Minor repair of protective works i.e. re-positioning of the displaced blocks, small patching of brick works, replacing rubber seals;
- Major Periodic Maintenance Works i.e. re-sectioning of embankments including turfing;
- Major repair of structures i.e. repair or replacement of metal works / hinges, lifting mechanisms, gates, block works, head / wing walls; and

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

4.11 Project Cost

As per the approved Development Project Proforma (DPP) of the Blue Gold Program, the project cost for implementation of the rehabilitation in Polder 28/1 has been estimated as 300.00 € per hectare of area (**Appendix 5**). According to that rate, the total project cost is 1,03,1176 € i.e. BDT 8.76 crore (1 € = 85.00 Taka, 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 28/1 are listed in Table 4.4 below.

Table 4.4 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

5.1.1 Meteorology

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

Rainfall

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

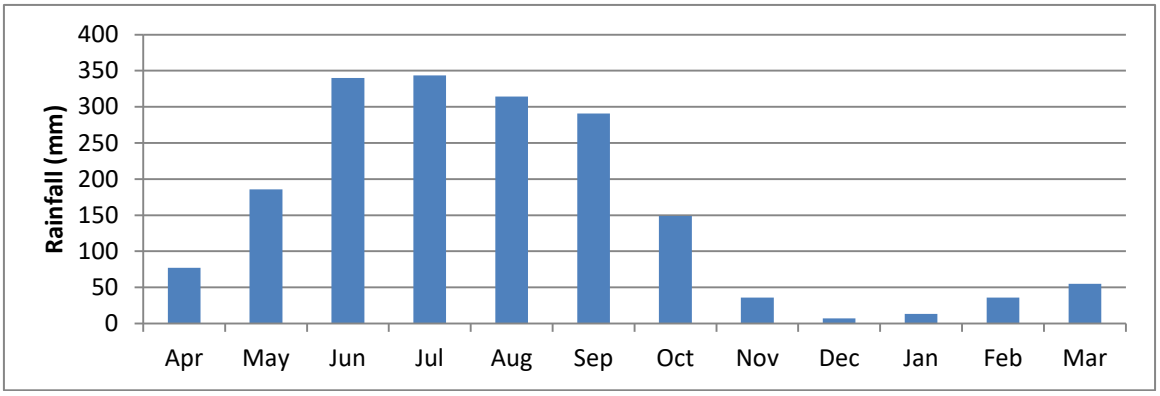


Figure 5.1 AverageMonthly Rainfall at Khulna BMD

For better representation of the real world scenario, values on rainfall from 1978 to 2008 have also been collected from the three BWDB stations located at Dumuria. To take account of the spatial variation of rainfall, Theissen's Polygon have been delineated around these stations (Subramanya, 1994), which have been shown in **Map 5.6**. The area-weighted average values of monthly rainfall in Polder 28/1 has been plotted in **Figure 5.2** and the peak rainfall is observed as 503 mm in June, which is around 1.5 times higher than the same observed in **Figure 5.1**

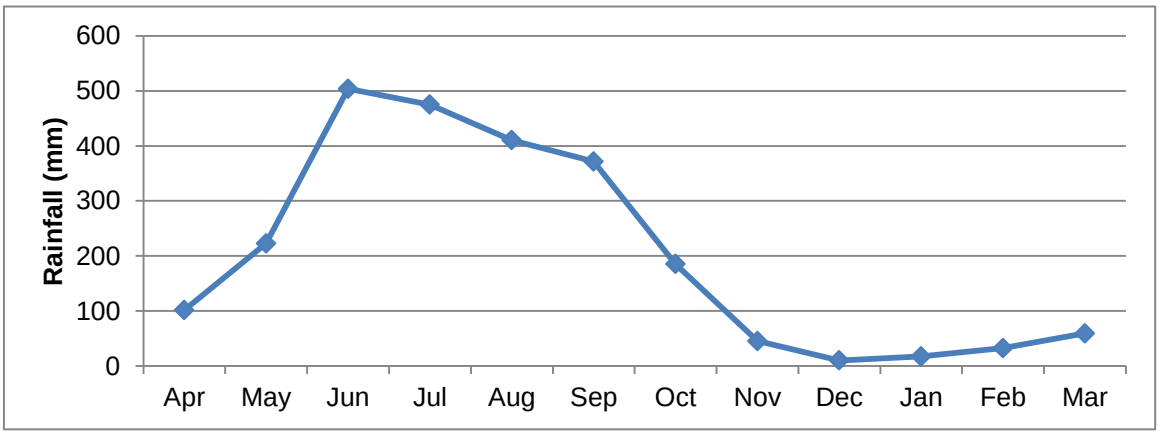


Figure 5.2 Average Monthly Rainfall in Polder 28/1 (using Theissen Polygon Method)

Temperature

Mean maximum temperature stays between 19.3°C to 30.4°C over the year with the highest temperature experienced in the month of May. There is also significant fluctuation in minimum temperature, which varies between 15.37°C to 25.2°C. The lowest temperature is experienced in the

month of January. The results of monthly average, maximum and minimum temperature variations of the polder are shown in **Figure 5.3**

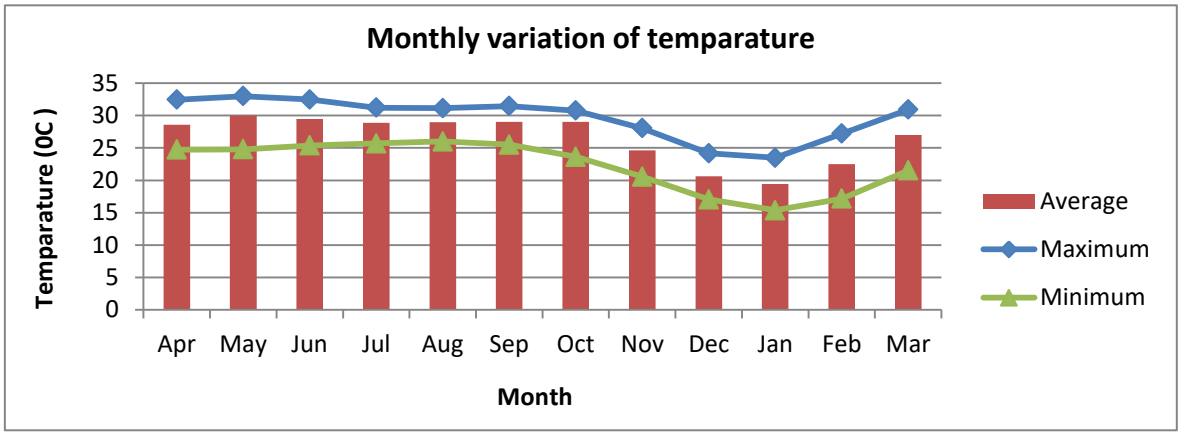


Figure 5.3 Average of Maximum and Minimum Temperatures at Khulna BMD Station

Relative Humidity

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

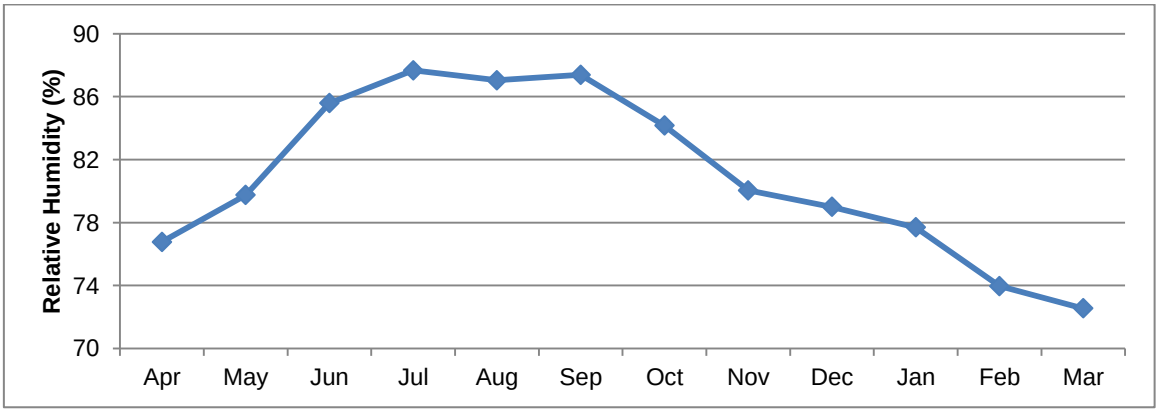


Figure 5.4 Average Relative Humidity at Khulna BMD station

Evaporation

Values of reference evapo-transpiration, ETo (from 1984 to 1998) and pan evaporation (from 1992 to 2011) have been collected from the Khulna BMD station. Later on, pan evaporation values have been multiplied by a co-efficient of 0.8 to compute the actual evaporation values, whereas the ETo values have been multiplied by suitable crop coefficients used in *Bangladesh IWRA supplementary report in May 2014,* to get the actual evapo-transpiration. An understanding of transpiration is then found for all the months (by deducing actual Evaporation from actual Evapo-transpiration). **Figure 5.5** below provides the monthly variations of evaporation, actual ET and reference ET. Evapo-transpiration has

been observed as the maximum during monsoon (June to September) and except dry season all the other months experience significant evapo-transpiration. ET is actually an indicator that defines crop and plant health, and observed results in Polder 28/1 therefore implies for better plant health (especially in Kharif-I and Kharif-II seasons).

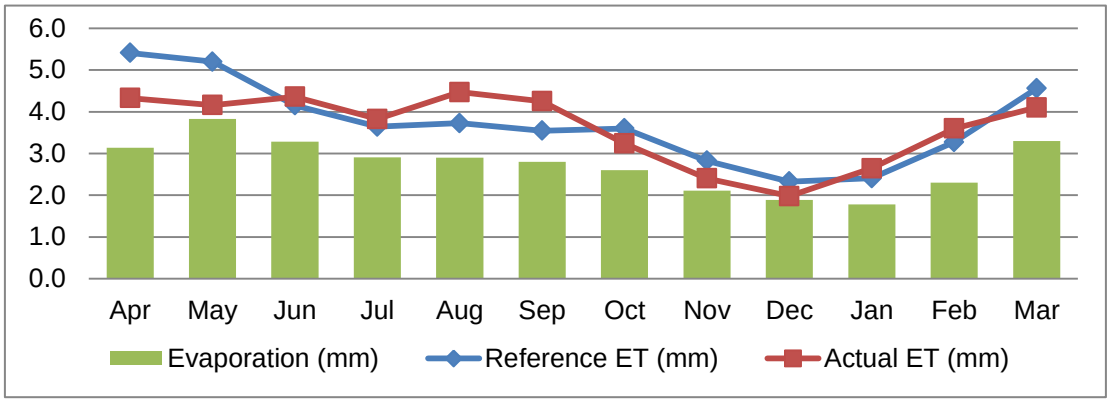


Figure 5.5 Monthly Variation of Evaporation, Reference ET and Actual ET for Khulna BMD Station

Wind Speed

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

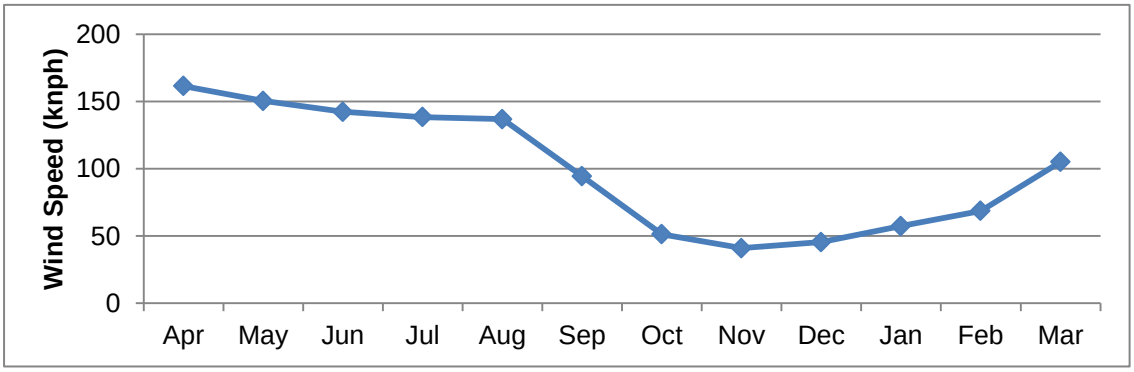
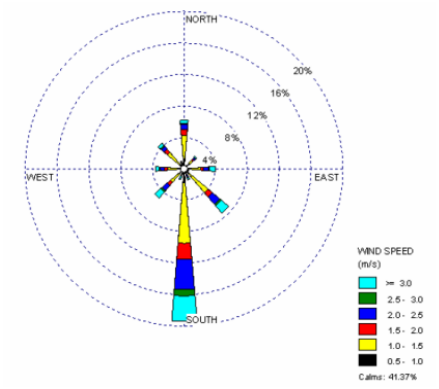


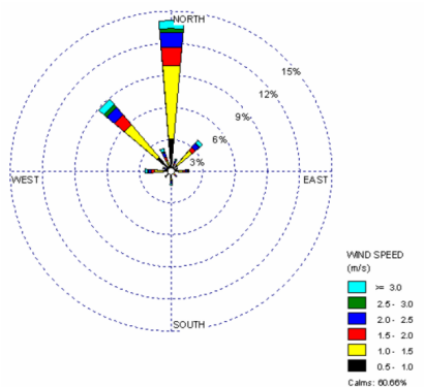
Figure 5.6 Variation of Average Wind Speed at Khulna BMD station

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

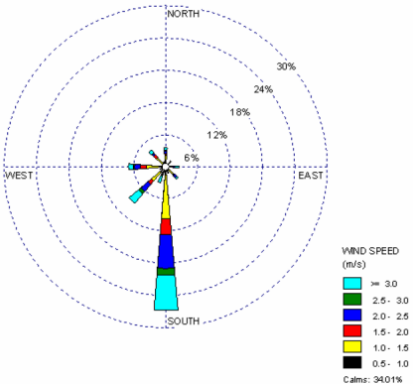
The wind roses generated using observed data at Khulna BMD station (source: SMEC, 2006) show average wind direction and speed for different period of a year. The yearly average wind rose shows that the prevailing wind flows from south to north during most periods of the year (**Figure 5.7a)**. During November to February, maximum prevailing wind flows from north and north-west to south and southwest direction and for the rest of the period it flows from south (**Figure 5.7 b**). During March to April wind mostly flows from south and southwest to north and northeast (**Figure 5.7 c**), and for May to October it flows from south and southeast to north and northwest direction (**Figure 5.7 d**).



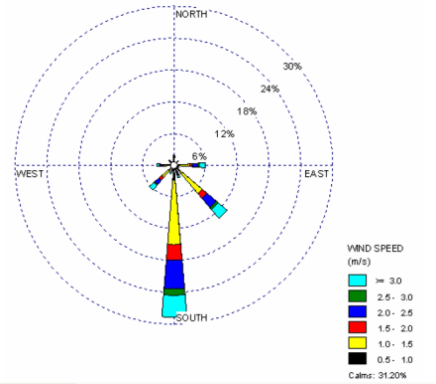
(a):for Khulna for a Full Year



(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 5.8** shows that from October to May, daily average sunshine hours are higher than 7 hours, but due to increased extent of cloud cover in monsoon (June to September) (monsoon) the values drop below 5.

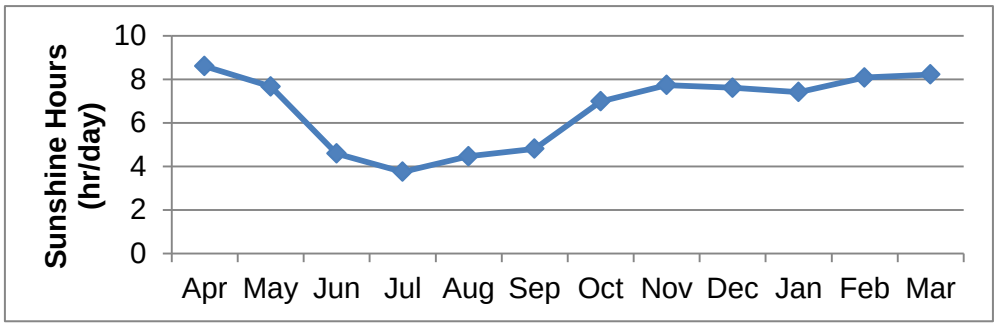


Figure 5.8 Monthly Variation of Average Sunshine Hours at Khulna BMD Station

5.1.2 Topography

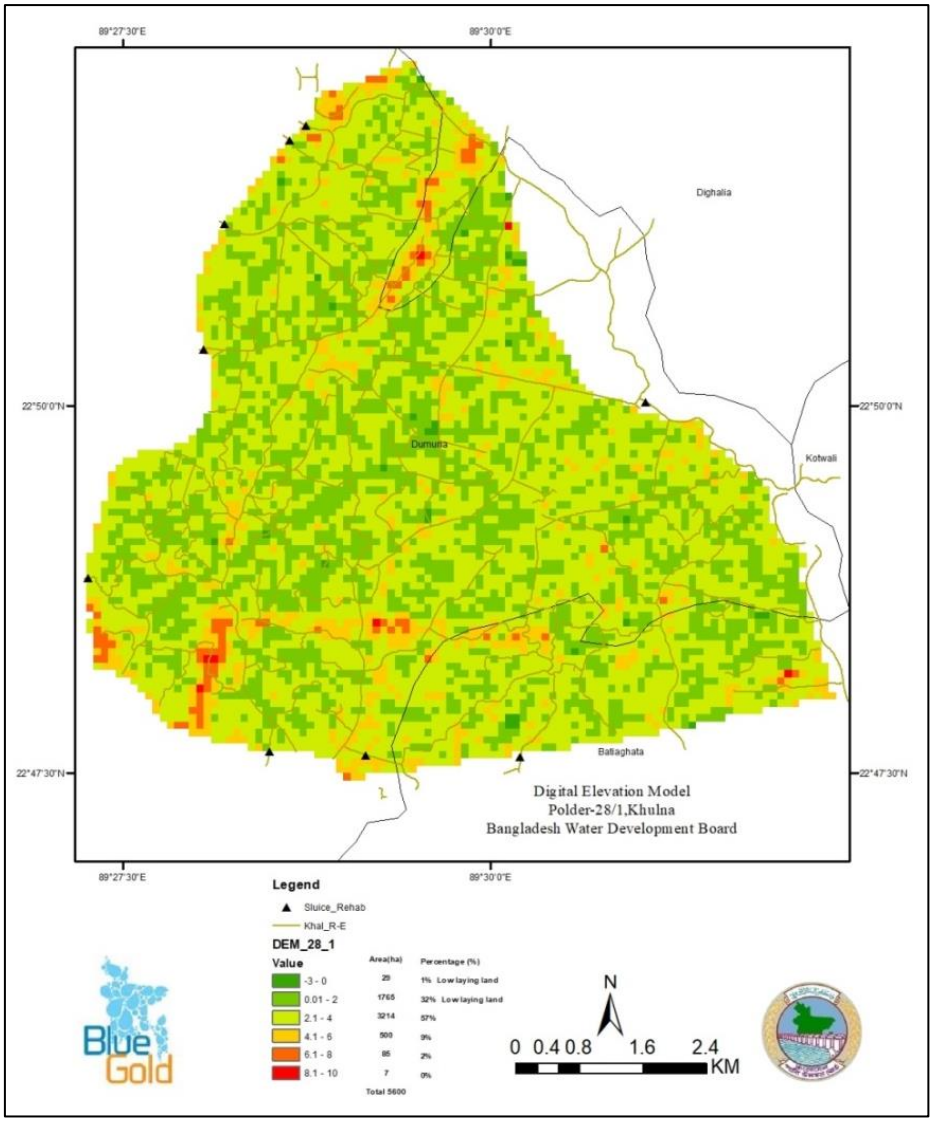
The study area is located in the south western hydrological zone of the country, with low average elevations. Re-sampled 500m×500m grid reduced levels were captured from BWDB's one foot contour maps, which were produced in the late sixties.

These spot levels were interpolated into a continuous surface called Digital Elevation Model (DEM). DEM analysis infers that the reduced levels inside the polder vary from -1.5 to +6 m PWD, with average RL of around +1.55 m +PWD. The average land level of Polder 28/1 is lower than the highest tidal water levels observed in the surrunding Rivers, and higher than the lowest tidal water levels.

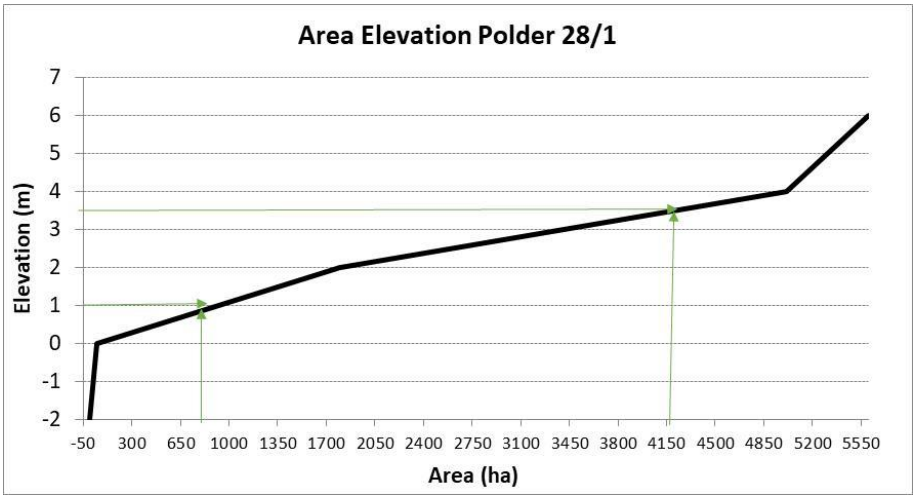
Elevation Range (m)	Area (ha)	% of Total Area
-2 - 0	48.60	0.87
0-2	1745.31	31.17
2-4	3220.84	57.51
4-6	585.26	10.45

Percent area as per elevation of Pol 28/1

From the DEM it is found that 58% land of the areas have elevation between +2 to +4 m above MSL, and 32% 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.



Map 5.1 Digital Elevation Model (DEM) 28/1



5.1.3 Seismicity

Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes in the past 200 years. Major active fault zones of the country have been delineated through geological trenching and dating methods. A seismic zoning map of Bangladesh was proposed in 1979 by Geological Survey of Bangladesh (GSB) dividing the country into three seismic zones: zone-I, zone-II, and zone-III. Later, a new updated seismic zoning map and detailed seismic design provisions have been incorporated in Bangladesh National Building Code (BNBC 1993). **Polder 28/1 falls under Zone-I which is considered as a seismically quiet zone with a Seismic Zone coefficient of 0.075, comprising the southwest portion of Bangladesh.** Seismic Zone coefficient is a dimensionless number which represents the (maximum) earthquake acceleration as a fraction of the acceleration due to gravity. **Map 5.2** below shows the seismic location of Polder 28/1.

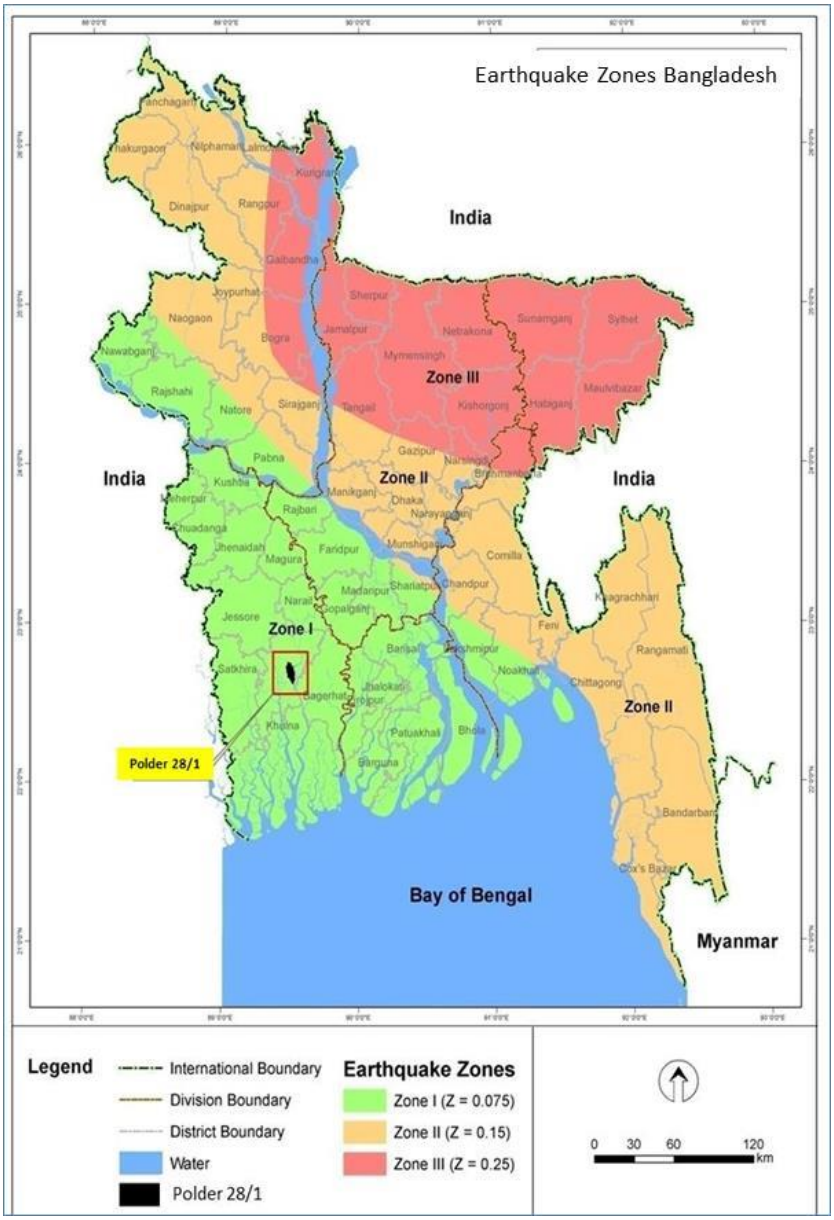
Furthermore, the concept of tectonic frameworks has been studied to provide a comprehensive stratigraphic understanding of the area. Bangladesh is divided into two major tectonic units: i) Stable Pre-Cambrian Platform in the north-west, and ii) Geosynclinal basin in the south-east (and both units are separated by a narrow zone called the hinge zone). Stable Pre-Cambrian Platform refers to the stable shelf of the Bengal basin which can be divided into three major zones i.e. Dinajpur slope, Rangpur Saddle (Indian Platform) and Bogra slope. The tentative boundary of the Rangpur Saddle separates the Bengal Foredeep from the Himalayan Foredeep. Bengal Foredeep plays the most important role in the tectonic history of Bengal Basin and can further be divided into the Western Platform Flank and Eastern Folded Flank. Faridpur Trough is one of the five major troughs within the Western Platform flank. This is where Polder 28/1 is located. The trough is situated adjacent to the Hinge Zone, and is characterized by a general gravity-low with the development of Neogene sequence. It is therefore observed that both in consideration of seismicity and stratigraphy, Polder 28/1 falls on a relatively safer (seismically quiet and tectonically stable) side.

5.1.4 Agro-ecological Regions

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

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

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



Map 5.2 Earthquake Zones of Bangladesh and location of Polder 28/1

The Polder 28/1 area constitutes of one agro-ecological zone, namely Ganges Tidal Flood Plain (AEZ-13). The polder area is situated at Gutudia union under Dumuria upazila and Jalma union under Batiaghata upazila of Khulna district.

Ganges Tidal Floodplain AEZ-13

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 saline land with varying degree of salinity. The area is characterized by 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.

5.1.5 Physico-chemical properties of soil

This region occupies an extensive area of tidal floodplain land in the south-west of the country. The greater part of this region has smooth relief having large area of salinity. There is general pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, non-calcareous, heavy silty clays in the extensive basins. Non-calcareous Grey Floodplain soil is the major component of General Soil Types. Acid Sulphate soils also occupy significant part of the area where it is very strongly acidic during dry season. In general, most of the top soils are acidic and sub-soils are ne10utral to slightly

alkaline. Soils of the Sundarban area are alkaline. General fertility level is high with low to medium organic matter content and very high CEC and K status. There are limitations of high exchangeable Na and low Ca/Mg ratio. The Zn status is low to medium and the B and S status is medium to optimum.

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

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

OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum;
Source: Fertilizer Recommendation Guide-2012, BARC.

5.1.6 Soil Fertility Status of Polder Area

Soil fertility is an important factor for crop production. In general the coastal regions of Bangladesh organic matter content of the soil are pretty low, (Haque, 2006). Thus in addition to salinity, plant nutrients in soils affect plant growth. Farmers reported that the soils are in general poor in organic matter content. Soil sample were collected from four locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month of May, 2014. But in the month of April salinity may be high. The collected soil samples analyzed the Soil Resource Development Institute (SRDI), Dhaka. Analyzing result presented in the Table 5.7.We found from the table, Salinity level is ranges from 3.18-5.27 in top soil in all locations. The pH ranges from 4.5-8.4 in AEZ 13 and we observed that, pH ranges from 6.8-7.6 in all locations of the polder. It indicates that, pH ranges within the limit in the polder area. OM content ranges from 1.0-2.5 in all locations. But OM status in the AEZ is low to medium. It indicates that, soil of the polder area is quite suitable for crop production. K, ranges from 0.22-0.44 in all locations of the soil. But, it was found in the soils of AEZ is ranges from medium to optimum. It is suitable from 0.17-3.30 for crop production. N level is low in the AEZ. We found from the table that, N ranges from 0.08-0.14 in all locations of the polder area and ranges from 0.02-0.50 are good for crop production. P level is very low to low in the over all AEZ area and 0.01-0.20 is suitable for crop production. On the otherhand, it ranges from 3.83-13.52 in locations of the polder. However, the polder areas soil is good for crop production. In case of the quality of S in the soils of AEZ is medium to optimum. But it was observed, in S ranges 13.05-87.78 in all locations of the polder. It was found from the table S level of the polder area. Detailed information of the soil quality of the polder area is presented in the Table 5.2**.**

Table 5.2 Chemical properties of soil on agriculture land

Number of the polder	Location	Depth (cm)	EC	pH	OM	K	N	P	S
28/1	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 texture

Soil texture is an important soil characteristic that determines crop selection, crop production and also field management. It influences many other properties of great significance to land use and management.

Soil texture is the relative proportions of sand, silt and clay, four major textural classes: a) sands, b) silts, c) loams, and d) clays. There are three types of soil texture in the polder area i.e. clay, clay loam and loam. It influences many other properties of great significance to land use and management. Detailed distribution of soil texture is presented in **Table 5.4**

Table 5.3 Detailed soil texture of the surface soil (0-15 cm) in the polder area

Soil texture	Area (ha)	% of NCA
Clay	3,600	90
Clay Loam	360	9
Loam	40	1
Total	**4,000**	**100**

Source: Estimation from SOLARIS-SRDI, 2006

5.1.8 Available soil moisture

The availability of soil moisture varies depending on the soil characteristics. The available soil moisture is very important for the cultivation of rabi/dry season crops. Three type of soils, with high, medium and low moisture are available in the polder area. All three levels of soil moisture with the percentage of the NCA of the polder area is presented in **Table 5.5**.

Table 5.4 Detailed distribution of available soil moisture in the polder area

Classification of Available Soil Moisture	Characteristics	Area (ha)	% of NCA
High	Plant extractable soil moisture remained in field level from two to three months	40	1
Medium	Plant extractable soil moisture remained in field level from one to two months	360	9
Low	Plant extractable soil moisture remained in the field level less than one month	3,600	90
	Total	**4,000**	**100**

Source:Estimation from SOLARIS-SRDI, 2006

5.1.9 Soil salinity

The soils of the polder area become saline in the dry season (Jan-May). The soil and water salinity gradually increases with dryness from January and reached maximum level in the month April-May and then decreases due to onset of monsoon rainfall. From the SRDI soil salinity data, it is found that over the period'\s soil salinity inside the polder increases gradually. For instance, in 1973, 52% of the NCA inside the polder was slightly saline whereas in 2000, there was no slightly saline area but 12% of the NCA becomes strongly saline and in 2009, 19% of the NCA became moderately saline. However, one of the objectives behind polder construction is to protect the area inside the polder from salinity. In this polder, it is found that most of the water control structures are not functioning properly. As a result, this cannot restrict the saline water to intrude inside the polder which is reported as the major cause of the salinity increment inside polder. Soil salinity of the polder area is presented in Table 5.5.

Table 5.5 Detailed Soil Salinity in the Polder Area

Soil Salinity Class (Ec=DS/m)	Desciption	Location (Union/ Mouza)	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
4.1 - 8.0	Very slightly saline with some slightly saline	Batiaghata	1,920	48			20	0
8.1 - 12.0	Slightly saline with some moderately saline		2,080	52	3,520	88	3,240	81
12.1 - 16.0	Moderately saline with some strongly saline						740	19
> 16.0	Strongly saline with some very strongly saline				480	12		
		Total	**4,000**	**100**	**4,000**	**100**	**4,000**	**100**

Sources: Estimation from SOLARIS-SRDI, 2006

5.1.10 Land form

The major portion of the study area is occupied by ridge 3,920 ha (98%) and basin is about 80 ha (2%). These landforms influence the land use related to agricultural crop production. Detailed distribution of land form in the polder area is presented in Table 5.4

Table 5.6 Detailed landform of the polder area

Drainage	Area (ha)	% of the NCA
Basin	80	2
Ridge	3,920	98
Total	**4,000**	**100**

Source: Estimation from SOLARIS-SRDI, 2006

5.1.11 Water Resources

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

River System

Polder 28/1 is around 75 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is situated in the south-west hydrological regions of the country. The polder is surrounded by the upper Shoilmari (west), lower Shoilmari (south, via 28/2) and Moyuri (east) rivers. Both the Shoilmari and Moyuri Rivers are connected together to form the Rupsha-Pasur river.

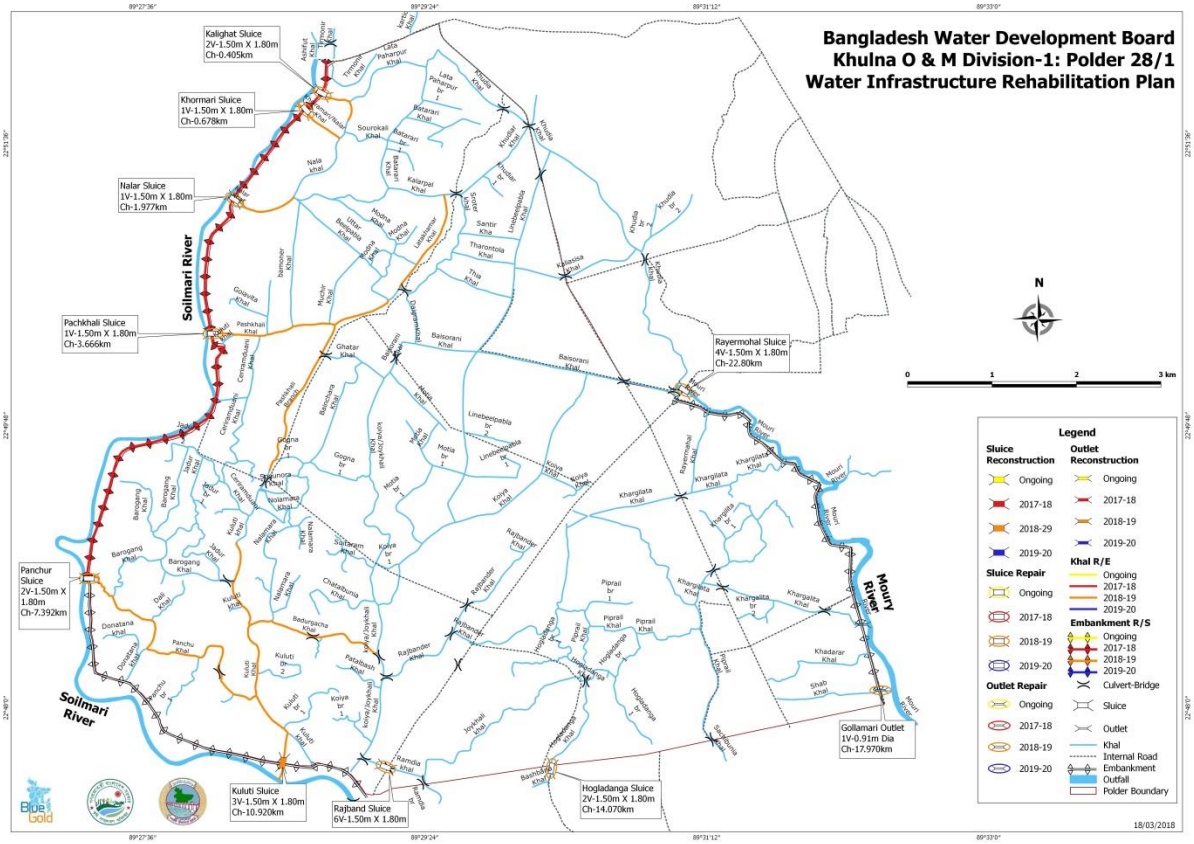
Hydrological Connectivity

During high tide, water flows from Bay of Bengal to the Rupsa-Pasur and other peripheral rivers (Sholmari River, Salta River, Jhopjhopia River and Kazi Bacha River). A number of khals exist within the polder i.e. Hania khal, Hugolbunia khal, Botiaghata-Baraiyabad khal, Amtala khal, Khoria khal etc.). The internal water courses of the polder facilitate the flow circulation inside the polder, when needed. During low tide, tidal water recedes through the peripheral water courses and reaches the Bay of Bengal. During dry season the khals are usually blocked off by the sluice gates so as to prevent the entry of saltwater, whereas in wet season, these khals are used to drain the surplus water out of the polder. However, in recent years, most of the khals have been silted up due to increased siltation. This hampers the flow circulation inside the polder. The khals of Polder 28/1 are also shown in **Map 5.9**.

Surface Water Level

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

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



Map 5.3 Water Resources System of the Polder Area

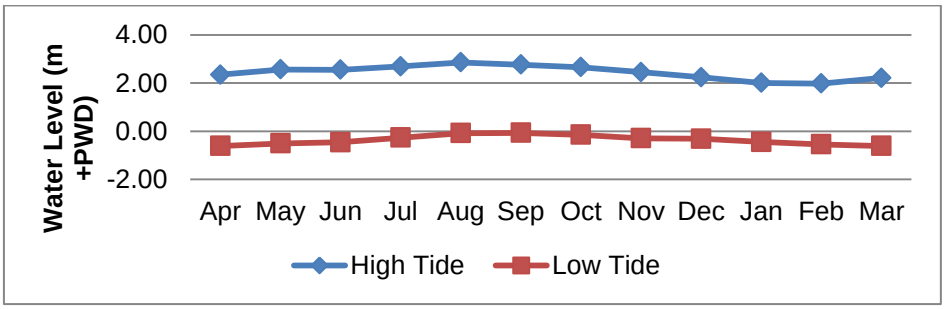


Figure 5.9 Surface Water Level at Chalna (Rupsa-Pasur River)

5.1.12 Water Resources Problems

Tidal and Storm Surge Flooding

Local people in Polder 28/1 opined that the peripheral embankment effectively offers protection from regular tidal flooding in the area. Even though some of the water control structures are subjected to flow leakage, the amount of flow entering the polder for such leakage are minimal. As such, it can be said that, there is no tidal and river flooding effect in polder 28/1. There was no evidence overtopping of the embankment. But there are internal floods due to heavy rainfall in monsoon and upland flow through bridges and culverts in the north and north-eastern boundary. Local people also alleged that there was no major storm surge flooding in Polder 28/1 during Aila (2009) and Sidr (2007).

Ground Water

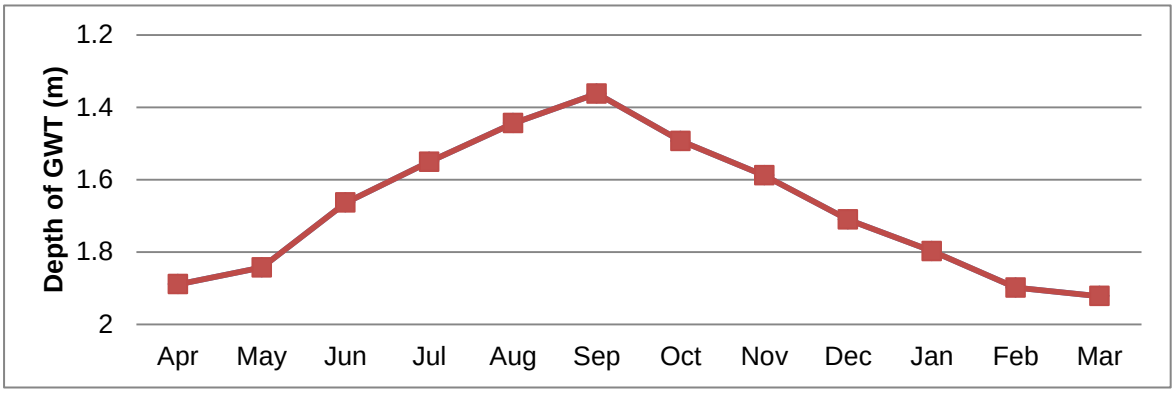


Figure 5.10 Yearl y Variation of GWT at KHU003 in (1980 – 2013)

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

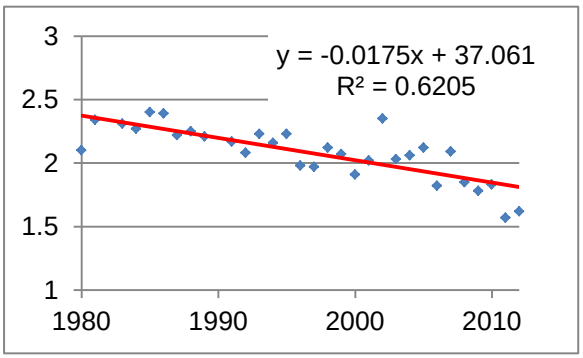


Figure 5.11 Variation of GWT at KHU003 in March (1980 – 2013)

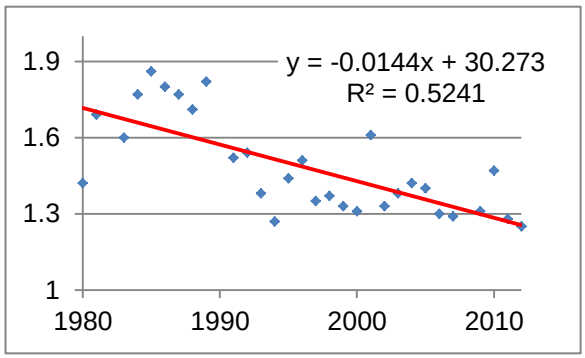


Figure 5.12 Variation of GWT at KHU003 in September (1980 – 2013)

Source: NWRD, 2013

Drainage Congestion and Water Logging

Drainage congestion has been identified as one of the major issues inside the polder. Almost all khals inside the polder suffer from tremendous drainage congestion. Northeast and middle part of this polder (major part Beel Pabla Mouza, Char Kalipur, Shibpur, Chak Ashankhali and Kuloti), are waterlogged due to less drainage facilities, cross dams, private structures, land grabbing etc.. Most of the sluice gates are poorly functioning because of interventions and poor condition of gates. Two sluices are inactive because of private cross dams on the river side channel. However, some of the tributaries of that river have been silted up over the years, leading to drainage congestion in the

western alignment of the polder. The water control structures (sluice gates, outlets etc.) along the openings of these khals are also not functioning properly, which further aggravates the situation. Local people opined that, around 25% khals inside the polder suffer from *severe drainage congestion*[1], whereas almost 30% of khals suffer from *moderate drainage congestion*[2]. The uttor Beel pabla, paschim Beel Pabla and Lata Khamarbari beel are mostly prone to water logging. It suffers people severely for 3-6 months (July-December) particularly for T.Aman and seed bed for Boro. Such drainage congestion problems mostly affect the agriculture and production sector.

5.1.13 Water Resources Functions

Water Use

- **Drinking and 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 field survey in Polder 28/1, it was found that the average daily domestic use of water is around 30 lpc. The study found that around 635 m^3 of water is consumed daily by the total number of 20,862 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. The use of shallow tubewells is only confined within the domestic purposes. This is because the shallow subsurface layers contain minor salinity (upto 2 ppt), making its drinking water use objectionable. There is a 100 year old historical pold near Akra govt. primary school, which is a much preferred freshwater source for the local people. Around 700 people from the nearby villages collect water from the pond and meet up their drinking purpose. Overall, water availability in Polder 28/1 is not a major concern as local people claimed that they have sufficient surface and groundwater sources to meet up their daily need of drinking and domestic purposes.

- **Irrigation Use**

In polder 28/1 approximately 55% lands come under irrigation facilities especially for cultivate Rabi crops (Boro and Robi vegetable). Mainly surface water (cannel, Gher and pond water) and deep water is used for irrigation. Total of 940 irrigation machine with Low Lift Pump, and 800 semi deep tube-wells and manmade agri equipment use for properly managed the irrigation facilities. The local farmers in Polder 28/1 practice LT Aman and HYV Aman during Kharif-II season (July-October) and Watermelon, Seasame and other vegetables during Rabi season (November-February). From field investigations it has been found that around 300 mm water is required for each ha of LT and HYV Aman cultivation whereas 250 mm water should be available for each ha for water melon and vegetables (**Table 5.12**). The local farmers do not need surface water irrigation for practicing Aman as the rain water availability is sufficient enough. For irrigation in watermelon and vegetables, approximately 0.2625 Mm^3 water is used each year.

The Rabi season boro crops require high irrigation, around 80% of which is met up by groundwater sources and the rest is provided with surface water sources using LLPs (Table 5.10).

Based on previous CEGIS studies, it has been assumed that around 300 mm of water is required for each ha of lands for Jute, Mustard, Vegetables, and Aman cultivation. For the HYV Boro crops during Rabi season, around 2000 mm of water is required for each ha of land. Using these standards of water requirements, the study infers that approximately 47.64 Mm^3 of water are used by the crops. Around 50% of this use is provided through surface and groundwater irrigation. The remaining portion is sufficiently met up by rainfall. Local people claimed that the low water availability marked by the reduced water carrying capacity of khals and poor functioning of water control structures are the major reasons for which more areas cannot be irrigated during the Rabi season.

[1]Severe Drainage Congestion has been defined as the water courses which have extremely low conveyance capacity and usually take one week or more to properly drain out rainwater.

[2]Moderate Drainage Congestion has been defined as the water courses which have low conveyance capacity and usually take 2 to 6 days to properly drain out rainwater.

Table 5.7 Irrigation water requirements in Polder 28/1

Season	Lt. Aman (ha)	HYV T Aman (ha)	Boro (ha)	Sesame and Vegetables (ha)	Jute (ha)	Water requirement (mm/ ha)	Water Used (Mm3)	Type of irrigation
Kharif-I (March - June)	-	-	-	2,023	164	300	6.56	No irrigation is required as pre-monsoon rainfall is sufficient
Kharif-II (July - October)	2700	996	-	219	-	300	16.40	Groundwater irrigation is provided in 60 ha HYV T aman crops (0.1% of Kharif-II water requirement) during booting stage, the remaining amount is provided by rainwater
Rabi (November – February)	-	-	1,203	-	-	2000	24.06	Groundwater irrigation is provided in 80% areas, the remaining portion is provided by LLPs
	-	-	-	219	-	300	0.66	No irrigation is required as the moisture content is adequate

Source: Estimation, May 2019

Navigation

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

Map 5.10 below is a reference map, showing the locations of noise quality measurement sites; stations used for collecting secondary data on water resources (both surface and ground water); and the Thiessens polygons used for spatial distribution of rainfall.

Photo 5.1 Navigation corner at Shoilmari river

5.2 Biological Environment

5.2.1 Farming practices

Farming practices largely depend on the land type, 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 start from March and ends in June. This season is characterized by the uncertainty of weather of alternating dry and wet spells. Vegetables, jute and mustard crops are grown in this season in the area. The *Kharif–II* starts from July and ends in October. The *Kharif -II* season is characterized by 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 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* is harvested in Rabi season. Sometimes rabi crops are also delayed and extend to *Kharif-1* season.

5.2.2 Cropping pattern by land type

The most prominent cropping patterns of the polder area are Boro- Fish-Fish (37%) with dike vegetable, Fallow – T.Aman- Fallow (40%), Fallow – HYV.Aman- Boro (20%), Vegetable-Vegetable- Vegetable (3%), During the field visit, Boro rice crop was found in flowering stage, germination started in jute in and vegetables were in harvesting stage. Detailed cropping patterns by land type are presented in **Table 5.11**.

Table 5.8 Detailed existing major cropping pattern by land type

Land Type	Kharif-I (March-June)	Khartif-Ii (July-Oct)	Rabi (Nov-Feb)	Area (Ha)	% of NCA
Medium High Land	Fallow	Lt Aman	Fallow	1,600	40
	Fallow	HYV T Aman	Boro	800	20
	Fish	Fish	HYV Boro rice	1,480	37
	Vegetables	Vegetables	Vegetables	120	3
Total				**4,000**	**100**
Cropping Intensity (%)				***206***	

Sources: 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 5.12.

Table 5.9 Varieties cultivated

Sl No.	Aman		Boro		Sesame		Jute		Vegetables	
	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV
1	Bajramoni, Jotirai, Bashfulbala, Ranisulat and Kalmilota	BRRI dhan23, BRRI dhan39, BRRI dhan41	nil	BRRI dhan28, Hera 2, BINNA dhan-10 and Taj	nil	BARI Sesame-2 and BARI Sesame-3	nil	O-9897	Lal sak	Bari Brinjal-3, Bari Brinjal-4, Bari Cabbage-2, Bari Red Amaranth-2, Bitter Gourd

Sources:Secondary data from local SAAO, DAE.

5.2.3 Cropped area and cropping intensity

Total cropped area is 5600 ha of which the coverage of rice is 71% and non-rice is 29%. The single, double and triple cropped area is 43%, 55% and 2% of the NCA respectively. Therefore, cropping intensity of the polder is about 206%.

Photo 5.2 HYV Boro rice field in the Polder 28/1 area

Photo 5.3: Rice (HYV) cum fish culture field inside the Polder

5.2.4 Crop production

In the polder area, the annual total crop production stands at about 16,154 tons of which about 9,107 tons of rice is produced and 7,047 tons non-rice is produced. The contribution of rice crops about 56% and non-rice is about 44% of total crop production. Among the rice crops, the contribution of HYV Aman, Lt Aman and HYV Boro are about 15%, 23% and 62% respectively. In the polder area, some crops are damaged by drainage congestion and heavy rainfall as reported by local farmers and the Sub-Assistant Agriculture Officer (SAAO). Normally, HYV T.aman (15%), Lt.aman (10%) are damaged. Total loss of rice production is 288 tons and loss of non-rice crop production is 60 tons due to drainage congestion, siltation of khals and drainage channels, natural calamities. Detailed crop production and crop production loss with percentage are presented in **Table 5.13**.

Table 5.10 Existing Crop Production and Losses of the Polder Area

Crop Name	Total Production (Ton)	Production loss(Ton)	Production (%)
HYV Aman	1,000	158	4
Lt.Aman	1,500	130	5
HYV Boro	25,200	-	91
Total rice	**27,700**	**288**	**100**
S. vegetables	4,800	60	29
W. vegetables	12,000	-	71
Total non-rice	**16,800**	**60**	**100**
Total	**44,500**	**348**	**-**

Table 5.11: Local market price of different crops

Sl No.	Name of the crops	Local price (Tk/ton)
1	Lt aus	33,000
2	HYV T aman	29,000
3	Lt aman	34,600
4	HYV Boro	30,000
5	Mustard	55,000
6	Jute	40,500
7	Summer Vegetables	10,000
8	Winter Vegetables	9,500

Sources: Field estimation, 2019, UAO, DAE.

5.3 Local price of the crops

There are five markets in the polder area. According to local people, the prices of the different crops were collected as tk/kg. Later it was calculated as tk/ton, which is presented in the **Table 5.14**. Sources: Farmers interviewed, March, 2019

5.3.1 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 5.15**. 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. According to SAAOs and farmers, before two years, 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 5.12 Seed used in the polder area

Name of crops	Seed rate	
	Farmers used(kg/ha)	Recommended rate(kg/ha)
Lt aus	50	40
HYV T aman	50	40
Lt aman	50	40
HYV Boro	60	40
Mustard	7	10
Jute	7.5	7-9
Summer Vegetables	3.5-4.0	2.5
Winter Vegetables	3.0-4.0	2.5

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

Labor

In the polder area, almost 50% of the cultural practices for crop production are being done manually. So, agricultural labor (seed sowing, intercultural operations, harvest 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 from season to season. The average number of labor (male and female) used per hectare in the polder area is presented in **Table 5.16**.

Table 5.13 Labor used in the polder area

Crop name	No. Labor and rate/ha	Labor wages / day (Tk)	
		Male	Female
Lt aus	150	250-300	200-250
HYV T aman	170	250-300	150-200
Lt aman	160	250-300	150-200
HYV Boro	180	300-350	200-225
Mustard	100	250-300	100-150
Jute	100	250-300	100-150
Summer Vegetables	120	250-300	150-200
Winter Vegetables	150	250-300	150-200

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

Fertilizers

The rate of fertilizer use per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern, financial ability etc. The major fertilizers used in this area are Urea, TSP/SSP, MP and Gypsum. Farmer reported that they are using TSP but in the field visit it was found they applied SSP in watermelon pits. Most of the cases about 65% farmers use unbalanced doses of fertilizers. Organic manures are not used by the farmers in the field crops. Local farmers and SAAO of DAE reported that cowdung is used for watermelon, homestead garden and fuel purpose. According to local farmers and two SAAOs, there are fertilizer dealers in almost every local market. Dealers got training from UAO office. Local farmers also reported that they don't have enough money to buy all types of fertilizer at a time. Detailed information of fertilizer used is presented in **Table 5.17**.

Table 5.14 Fertilizers used in the polder area

Crop name	Farmers practices (Kg/ha)						Recommended dose (kg/ha)					
	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn
Lt Aus	0	40	10	20	0	0	0	97	14	17	0	0
HYV Aman	0	100	40	30	0	0	0	163	35	21	0	0
Lt Aman	0	40	10	20	0	0	0	97	14	17	0	0
HYV Boro	0	200	90	50	5	0	2,000	270	58	58	0	4
Mustard	0	100	40	40	0	0	0	250	150	80	120	5
Jute	0	40	15	10	0	0	0	51	22	70	36	0
S.Vegetables	1000	140	80	50	0	0	8,000	370	150	240	0	0
W. Vegetables	500	180	40	100	0	0	5,000	217	80	50	14	3

Source: Farmers interviewed, 2015

Pesticides

The use of pesticides depends on the degree of pest infestation. The major insects as reported by the farmers are stem borer, green leaf hopper, and Rice bug. Local farmer reported that they are using different types of pesticides such as Basudin, Furatar, Fighter, Rovral, Ridomil gold etc. Both liquid and granular pesticides are being used to prevent pest infestation in the rice, watermelon and groundnut cultivation. Local people visit farmers house to house for pesticide application in different fruit trees and field crops. Detailed information of pesticides used is presented in **Table 5.18**.

Table 5.15 Pesticides used in the polder area

Crop name	Pesticide using by farmers	
	No. of application	Liq. (ml/ha) apx.
Lt Aus	0	0
HYV Aman	1-2	700-800
Lt Aman	1-2	0
HYV Boro	2-3	800-1000
Mustard	0	0
Jute	1	650
Summer Vegetables	2-3	500-700
Winter Vegetables	3-4	700-800

Source: Farmers interviewed, 2015

5.3.2 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. There are five ICM schools in the polder area. The IPM schools start at 4.00 pm and close at 6.00 pm. After getting training, farmers of the ICM areas use branches of trees and bamboo sticks to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. In this process, the crops are protected without applying pesticides. Trap is another technique for controlling pests in the agriculture fields especially vegetables for attracting insects. Thus, it is possible to control the harmful insects without the application of pesticides. ICM technique is mainly applied on boro rice and vegetables crops. Field information (Farmers and SAAOs of DAE) indicated that ICM is being practiced in the fields covering about 20-30% of the cultivated areas and the impact has been found very encouraging.

5.3.3 Irrigation

Surface and ground water are the source of irrigation as reported by local farmers. *Khals* and few cases ponds are the source of surface water for very limited time. Low Lift Pumps (LLPs) are being used for surface water irrigation and Shallow Tube Wells (STD) are used for ground water irrigation. Irrigation is provided mainly in HYV Boro rice, few winter vegetables and HYV T. aman rice in booting or flowering stage. Farmers and SAAOs reported that if the khals are re-excavated then watermelon, groundnut and other winter crops cultivation will be about double and *Rabi* crops area will increase. Farmers also reported that now the cost of irrigation per hectors of land in boro rice is about tk. 5,000 to 5,500. Detailed information on irrigation is presented in **Table 5.19**.

Table 5.16 Irrigated area by crop

Crop name	Coverage area (ha)		Total area (ha)	Total % of NCA	Charge (tk/ha)
	Ground water	Surface water			
HYV Boro	2,699	621	3,320	83	5,000-5,500
Winter vegetables	20	60	80	2	3,500-4000

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

5.3.4 Major crop production constraints

Salinity and drainage congestion are the major constraints of crop production.

5.3.5 Livestock and Poultry Resources

A large number of populations of the polder area earn their livelihood through work associated with raising livestock / poultry. Few farmers started rearing hybrid cattle in the polder area. Because there is good milk market and price per kg milk is tk.60, even in Ramadan it is more. Detailed status of livestock and poultry in the household level is presented in Table 5.20.

Photo 5.4 Discussion with farmers on constraints of crop production in Polder 28/1

Table 5.17 Status of Livestock/Poultry in the Polder Area

Live Stock/Poultry	% of Household	No. Livestock/Poultry in the Polder Area
Cattle/cow/bullock	45	22,968
Buffalo	10	2,552
Goat	15	3,828
Sheep	10	2,552
Chicken	75	38,280
Duck	17	4,338
Pigeon	3	766

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


Photo 5.5 Hybrid and local cattle are rearing in the polder area

5.3.6 Commercial livestock/poultry production

There are about 60 poultry farmers according to local poultry farm owners, farmers and DLS. Details are presented below in Table 5.21

Table 5.18 Status of commercial livestock/poultry production

Livestock/poultry farms	Number of farms	Average nos/poultry farms	Production (Nos)	Management		
				H	M	L
Chicken	150-200	200-1000	1.25-2.5 kg/chicken	-	M	-

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

5.3.7 Feed and Fodder

The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to non-availability of grazing land. During monsoon, aman crops remain in the field, when rice straw is the main source of fodder. In addition, rice husk and oil cakes, are the 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 in the field due to salinity which acts as the main barrier for the grasses to grow. In some high land, farmers started to grow Napier grass for their cattle. Poultry population and duck at family level survives by scavenging and generally no feed supplements are provided.

Photo 5.6 Grass cultivation in the polder area

Photo 5.7 Grass harvesting by the farmers in the polder area

5.3.8 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),Hemorrhagic Septicemia (HS), Diarrhoea and Pest Des Petits Ruminants (PPR). Major poultry diseases are duck plague, Ranikhet (Newcastle), Fowl Pox and Fowl cholera. During monsoon season, the soggy condition of the animal shelter promotes various kinds of diseases to the bullock and cows. Moreover the unhygienic condition of the courtyard during this season increases the diseases of poultry birds. However, the vulnerable period is between July to October (rainy season) months for spreading diseases to livestock and poultry population.

5.3.9 Fish Habitat

Polder 28/1 is located under Dumuria and Batiaghata Upazila of Khulna District. This area is tidal with diversified brackish and fresh water environment. The fish habitats of the polder are primarily classified under two broad categories like capture and culture fishery. Capture fisheries habitats include internal khals, and tidal floodplain near the river side which is flooded during high tide. Internal khals are mainly acting as major arteries of fish migration for open water fisheries into the polder area. These khals are playing vital role in maintaining fisheries productivity of the open water fish habitats. The culture fishery of the polder is dominated by prawn gher and found all over the polder area. There are many culturable and nursery ponds in the polder area. A few numbers of cultured ponds is found in this area.

Capture Fisheries

The estimated fish habitat in the polder area is 807 ha where culture fishery contributes the major share (615 ha) and the cupture fish habitat shares the rest. The open water fish habitat is mainly represented by khal. Different type of fish habitat with area as shown in the following Table **5.22**.In the study, the peripheral rivers and its tidal floodplain habitat has not been considered for fish production estimation of the polder area.

Table 5.19 Fish habitat status in the polder area

Sl.	Fishery Category	Habitat Type	Area (Ha)	Observation
1	**Capture**	khal	191	• Silted up • Khal's is mostly found water less during dry season • Saline water intrusion for shrimp gher • Mouth of khals almost closed • Encroachment for gher and agriculture practice
	Sub-Total=		***191***	
2	**Culture**	Golda & white fish gher	493	• Expanding day by day • Gher is used as nursery pond of white fish
		Rice cum golda &white fish gher	100	• Expanding gradually • Gher wall damaged and fish wash out during heady rainfall
		Culturable pond	12	• Pond are used water reservoir cum fish culture • No supplement feed is applied • Many pond are being used as nursery pond for gher fish culture
		Cultured pond	10	• Decreasing day by day • Short duration of water • Lack of quality seed and feed
	Sub-Total=		***615***	
	Grand Total=		**807**	

Source: Blue Gold Program survey 2017

During field visit, it is observed that khals are silted up and land use change to gher practice in most cases. The depths of these khalsranges from 2-3 ft in dry season and 3-6 ft in monsoon. During dry season, there is no water flow in most of the part of a khal. Moreover, salt water intrusion through mal-functioning or damaged gate or damaged embankment of regulators due to poor O&M and embankment cutting by the local people for bagda gher are deteriorating the congenial environment for fresh water fishes in the khal as well as its adjoining water bodies. Moreover, there are low water flow is found in Shoilmari and Moyuri River during high tide, impacting fish migration from river to khal. But it would also maintain to open water fish productivity in the polder area Photo below 5.10 (a & b) shows the internal khal in the polder area.

Culture Fisheries

Culture fisheries in the polder area include pond and gher. The estimated area under culture fishery is about 615 ha (**Table 5.22**) of which gher 73% and pond occupy 3% respectively because profitable of gher culture, Gher practice is expanding gradually in the polder area. In contrast, pond fish culture is decreasing day by day. During field visit, it is observed that three types of gher i.e. bagda gher, golda white fish gher and rice cum golda gher are found in the polder area. Fish ponds in the polder area are mainly culturable and cultured pond. Most of the fish pond is seasonal, traditional nature and size is very small. The number of cultured pond (3% of total pond) is negligible. Most of the fish pond is used as nursery pond for gher fish culture. Local people indentified the constraints of fish culture in the polder area are lack of quality fish seed and fish feed, lack of training on aquaculture/pond culture practices and high expenditure of fish culture. Nevertheless, various types of fish culture systems are practiced by the local people including mono-, poly, and mix-culture.

5.3.10 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 to 90 %of depth and 50% to 60% of width of khals have been lost due to aforementioned reasons. Significant areas of khals and open water fish habitate have been lost due to silt deposition or illegal encroachment. Currently, many silted up khals are being used for gher practice (**photo 5.12**). 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 5.7 Open water fish habitat in the polder area


Silted up khal | Prawn practice in Polder

Photo 5.8 Present condition of fish habitat

5.3.11 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 5.23 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. 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 5.20 Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	Temp (°C)	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, May 2019 (*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.

5.3.12 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 (5.24).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 5.21 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 2,226 tons. Bulk of the fish production (about 99%) is coming from culture fisheries and only 1% 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 **5.25**

Table 5.22 Fish Production from Different Habitats of the Polder Area

Sl.	Category	Habitat Types	Fish Production (Ton)
1	Capture	Khal	14
		Sub-total	**14**
2	Culture	Golda &white fish gher	296
		Rice cum golda &white fish gher	90
		Culturable pond	14
		Cultured pond	18
		Sub-total	**418**
		Total	**432**

Source: Field survey, 2015

5.3.13 Fishing Effort

Fishermen Number

Local people reported that there are about 221 (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 5.26**.

Table 5.23 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

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 5.13**.

Fishing Gear

Different types of fishing nets/gear are used in the polder area. Table 5.27 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.

Photo 5.9 Fishing boats in the Polder Area

Jhaki jal (cast net) and Dhela jal are common traditional fishing gears which are found all over the polder area (**photo 5.14)**.

Table 5.24 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

The riverine fish species migrate through regulators/sluices/outlets/inlets in the polder to some extent during the period of June to August. Perennial khals along with other seasonal internal khals and Beel area are used as feeding and nursing ground of the fishes. Fish species such as *Chingri, Puti, Boal, Pairsa, Tengra, Gulsha, Baila* etc has been migrating through these regulators to these water bodies as part of their life cycle.

Photo 5.10 Common fishing gear (Jhaki jal)

Fish Migration

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.

5.3.14 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 5.28.

Photo 5.11 Composition of Fish Catch of the Polder Area

Table 5.25 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				
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

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

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. 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 90% pond in the polder.

5.3.15 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 85% of SIS production has been declined in the polder from the 15-20 years back due to aforementioned reasons.

5.3.16 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 5.29. 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 5.26 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

5.3.17 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.

5.3.18 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.

5.3.19 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 are physiography, climate, soil type, flooding depth and biodiversity. These bio-ecological zones can be classified as major ecosystems of the country. The area of Polder 2 encompasses two of these bio-ecological zones, namely the Ganges floodplain and the Saline Tidal Floodplain.The polder is situated at Budhhata,Kulla, Kulia, Brahma Rajpur, Fingiri, Dhulihar, Labsa and Paurasava Union of Debhata and Satkhira Sadar Upazila of Satkhira district. Brief descriptions of the bio-ecological zones are presented below.

The Ganges Floodplain

Ganges Floodplain is the active meandering floodplain of the Ganges River. The floodplain mainly comprises a smooth landscape of ridges, basins and old channels. The Ganges channel is constantly shifting within its active floodplain, and eroding depositing large areas of charlands in each flooding season. Both plants and animals move and adapt with the pattern of flooding (Brammer, 1996). The floodplain is characterized by mixed vegetation and support a habitat of rich bio-diversity to some extent due to presence of a lot of stagnant water bodies and channels, rivers and tributaries. Homesteads forest is prominent with cultivated and wild plant species. In this zone, the dominant floral types are the Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Topapana (*Pistia strateotes*), Chechra (*Schenoplectus articulatus*), Sada Sapla (*Nymphaea nouchali*), Keshordam (*Ludwigia adscendens*), Kolmi (*Ipomoea sp*), Tamarind (*Tamarindus indica*), Panibaj (*Salix tetrasperma*) etc. Moreover, grasses are more abundant in Ganges floodplain and begin to grow as soon as the floodwater begins to recede. *Cyperus rotundus, C. deformis, Eleocharis* sp., *Hemarthria* sp. etc are the notable grass species.

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

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 Sundarbans. The rivers carry fresh water throughout the year to the east and northeast, but saline water penetrates increasingly further inland towards the west mainly in the dry season, and for most or all of the monsoon season in the southwest. In the northeast, there is moderately deep flooding during the monsoon season, mainly due to accumulation of rainwater on the land when water level in the Ganges distributaries and the lower Meghna are high. Elsewhere, there is mainly shallow flooding at high tide, either throughout the year or only in the monsoon season, except where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater (Brammer, 1996).

Several types of palms and bamboo clumps grow in almost all the villages in the polder area. Narikel *(Cocos nucifera)* and Supari *(Areca catechu)* is two commonest palm of this area. The mango *(Mangifera indica),* Sirish *(Albizia saman),*Babla *(Acacia Arabica),* Khai Babla *(Pithocelobium*

*dulci),*Taal *(Borassus flabeliffer),* Gab *(Diospyros perigrina)* etc supply the timber and are used for daily needs. Existence of mangrove patches along riverside or even beside homestead forest indicates presence of water and soil salinity of that zone.
The dominant aquatic floral types are in the polder area: the Kochuripana (*Eicchornia crassipes*), Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Helencha (*Alternanthera philoxeroides*), Topapana (*Pistia strateotes*), Chechra (*Schenoplectus articulatus*), Keshordam (*Ludwigia adscendense*), Kolmi (*Ipomoea aquatica*), Dhol kolmi (*I. fistulosa*) etc. In numerable 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.

Settlement/Homestead vegetation

Homestead vegetation (3775 hectares) is the major type of terrestrial flora of the polder area. It can be divided into two groups considering floral diversity and density derived by soil salinity as well as distance between settlement and the river. The homesteads far from polder peripheries show comparatively high density and diversity of vegetation.

On the other hand, density of homestead trees along polder peripheries is low due to having saline nature of soils. The trees which are successfully adapted in peripheral homesteads are: Sirish *(Albizia saman),*Babla *(Acacia Arabica),* Khai Babla *(Pithocelobium dulci),*Taal *(Borassus flabeliffer)* and Narikel *(Cocos nucifera)*

Most of the homestead cover consists of timber plant species, few medicinal plants, and some vegetables and fruit trees. According to the vegetation survey, the most common plants that are now planted by local people are: Aam, Kola, Boroi, Tatul, Peyara etc. Bamboo bushes are also commonly found in each homestead area. Many species of undergrowth wild plants are found in homestead vegetation and village groves. Among this type, Swetkan *(Euphorbia thymifolia),* Bhui amla *(Phylanthus niruri),* Nata *(Caesalpinia bonduc),* Sezi *(Euphorbia antiquorum)* and Jiga *(Lennea coromandelica)* are common.

Photo 5.12 Homestead vegetation

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

Table 5.30 represents dominant tree species of homestead vegetation according to canopy coverage.

Table 5.27 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

Tree species name	Family name	Local Status	Saline susceptibility	Habit	Utilization	Ecological Value
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
Peyara*(Psitium guajava)*	Myrtaceae	VC	2	T	Fruit	2
Aam*(Mangifera indica)*	Anacardiaceae	C	1	T	Fruit and timber	1,2
Jam *(Syzygiumsp)*	Myrtaceae	C	1	T	Fruit and timber	1,2
Lichu(*Lichi chinensis)*	Sapindaceae	C	1	T	Fruit and timber	1,2
Kola (*Musa sp)*	Musaceae	VC	2	H	Fruit	1,2,3
Boroi *(Zizyphus sp)*	Rhamnaceae	C	2	T	Fruit and fuel wood	2
Bash(*Bamboosa* sp.)	Gramineae	VC	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
Mahogany (*Swietenia mahagoni)*	Meliaceae	C	2	T	Timber and medicine	2
Akashmoni *(Acacia auriculiformis)*	Mimosaceae	R	2	T	Timber and fuel wood	3
Kathal*(Artocarpus heterophyllus)*	Moraceae	C	1	T	Timber and fruit	1,2

Note: Local Stratus: C= Common, VC = Very Common, O = Occasionally, R= Rare; Habit : T= tree, H= Herb, S= Shrub, V=Vine; VC= Very Common, C= common, UC= Uncommon CL=Clump; Saline Susceptibility: 1 = Highly Susceptible, 2 = Moderately Susceptible, 3 = Slightly Susceptible, 4 = Resistant ; Ecological Value: 1 = For Wildlife, 2 = For Avifauna, 3 = For micro-Ecosystems

Crop field vegetation

The net cultivated area in the polder area is 4,000 ha. Rice is the main crop. Different types of vegetables and economic crops are also cultivated in this area.Verities of crops and cropping patterns have been discussed in the agricultural section of this report.

A part of crop fields remain seasonally (March-June) fallow for 3-4 months of a year. During this time the land is covered by grassy vegetation with some other wild herbs. *Croton bonplandianum*, *Echinochloa colonum*, *Chynodon dactylon*, *Panicum repens*, Cheratopteris *sp*, *Heliotropium indicum*, *Amaranthus spinosus*, *Centipeda orbicularis*, *Cyperus sp*., *Chenopodium ambrosoides*, *Ethulia conyzoides* etc. are the major species (weed) which are growing with the crop in this area. The seasonal fallow lands have important roles in ecosystem functioning as they support grazing for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna.

Embankment /Roadside vegetation

Riverside embankment is exclusively 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.

Major species found along the village road are: Sirish (*Albizia odoratissima),*Babla*(Acacia nilotica),*Tal *(Boassus flabelifer),*Narikel(Coccos nucifera), and Suparee(Areca catechu), and Khejur (Phoenix sylvestris) etc. The roads which have passed between two homesteads mostly have 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.

Photo 5.13 Babla trees along the both side of the embankment

Orchards vegetation

The polder area is famous for mango production. The total orchard inside the polder area is about 300 ha. According to the SAAO and local people Mango (*Mangifera indica*), Lichu(*Lichi chinensis)* , Guava (*Psitium guajava*) and Papaya (*Carica papaya*) are existing major orchards vegetation. Farmers are growing nursery for their own plantation and for sailing in the local market. In the polder area maximum family cultivate Mango and Guava for their economic value and annually they earn a large amount which help for their livelihoods.

Photo 5.14 Mango orchard inside the polder

Photo 5.15 Mango Nursery

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. The major fauna of different species with their habitat is shown in the following table.

5.3.20 Aquatic ecosystem

There are about 256 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, Khaland ditches. Homesteads 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.

Table 5.28 List of terrestrial fauna of the polder area

Types of Species	Name (generic name)	Habitat
Mammals	Small mammals, such as Jackal (*Canis aureus*), Grey mask shrew (*Suncus murinus*) and small Indian civet (*Viverricula indica*), Common Mongoose (*Herpestes edwardsii),* Jungle Cat (*Falis chaus*), Bengal Bandicot Rat (*Bandicota bengalensis*), Common House Rat (*Rattus rattus*), Squirrel *(Cllosciurus pygeryhrus)* and bats like Short-nosed Bat (*Cyynopterus sphinx*)	Mostly in bamboo thickets, cropped fields or broken, bushy areas.
Birds	Common bird of prey species found in the polder area are Brahminy Kite (*Heliastur indus*). 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*), Black Drongo (*Dicrurus macrocercus*), Asian Koel (*Eudynamys scolopacea*), Larged-billed crow (*Corvus macrohynchos).*	Terrestrial birds can be divided into two major groups: birds observed in floodplains and wetland, and birds observed in dry habitat such as homestead, open woodland, scrub and grass land.
Reptiles	Common Kukri Snake (*Oligodon arnenesis*), Buffstriped Keelback (*Amphiasma stolata*), Rat Snake *(Ptyas mucosus*), Monocellate Cobra (*Naja kaouthia*) Garden Lizard (*Calotes versicolor*), House Lizard (*Hemidactylus brooki*).	Habitats belongs to these species are homestead, cropland and garden vicinity.
Amphibians	Common toad *(Bufo melanostictus),* Cricket Frog *(Fejervarya limnocharis),* Jerdon's Bull Frog *(Hoplobactruchus crassus)*	Wetland areas and the dried areas

Source: Field visit and Local people interview, March, 2019

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Seasonal wetland

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

Permanent wetland

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

Aquatic flora

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.

Table 5.29 List of aquatic flora of the polder area

Kochuripana (*Eichhornia crassipes*), Kutipana (*Azolla pinnata*) and Khudipana (*Lemna perpusilla*) also common species among the free floating type.
Submerged plants in both perennial and seasonal wetlands are Jhangi (*Hydrilla verticillata*), Ghechu (*Aponogeton natans*), Bicha (*Vallisneria spiralis*) etc. Almost all of these plants belong to closely related families like Aponogetonaceae, Hydrocharitaceae and Potamogetonacea.
Sedges and meadows 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. They include Dhol kolmi (*Ipomoea aquatic*) and, Kochu *(Colocasia* spp.) etc.
Throughout the intertidal plains, some species of brackish grasses likeChaila gash *(Hemarthria protensa)*.are dominated. In addition, patches of Gewa *(Ecocaria agallocha),* Choila/Ora *(Sonneratia caseolaris)* trees are observed sporadically on the torus and along riverside toe of the embankment. Aquaculture in this tidal plain hinders regular tidal fluctuation that decrease succession of natural vegetation and reduced habitat suitability of dweller animals.

Source: Ffield survey, March, 2019

Photo 5.16 Internal canal (Silted up)

Photo 5.17 A homestead pond, contains aquatic plants

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 5.30 List of aquatic fauna of the polder area

Types of Species	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.
Fishes	Verities of fishes and fish habitat have been discussed in the fisheries section of this report.	

Source: Local people interviewed and Group Discussion, May, 2019

5.3.21 Ecosystem services

Output of ecosystem services

UNEP defines an ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment, interacting as a functional unit. Humans are an integral part of ecosystems. Ecosystem services are the tangible and intangible benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control, cultural services such as spiritual, recreational, and cultural benefits, and supporting services, such as nutrient cycling, that maintain the conditions for life on earth.

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

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

Table 5.31 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 *(Syzygiumsp)*, Kola (*Musa sp)*, Safeda *(Manilkara zapota)*, Payara (*Psidium guajava)*, etc	Fruit
	Ghechu (*Aponogeton spp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana, (*Eichhornia crassipe*), Phutku (*Hygroryza aristata*) etc.	Leaf and stem
Wood, timber	Aam *(Mangifera indica)*,Jam *(Syzygiumsp)*, Bot *(Ficus benghalensis)*, Babla *(Acacia nilotica)*, Mahogany (*Swietenia mahagoni)*,	Trunk
Medicine	Mahogany (*Swietenia mahagoni)*, Tulshi*(Ocimum americanum)*,Sezi *(Euphorbia antiquoram)*, ,Nim *(Azadirachta indica)*	Roots, Leaf, Stem
Thatching and mat making	*Cyperus platystylis*, Supari *(Areca catechu)*, Narikel *(Cocos nucifera)*,Bash(*Bamboosa* sp.), Tal *(Boassus flabelifer)*	Thatching and fencing for huts and as protective screen in homestead.
Fuel	Babla *(Acacia nilotica)*, Akashmoni *(Acacia auriculiformis,)* Boroi *(Zizyphus sp)*, Gab *(Diospyros perigrina), Thespicia populina* etc.	Brunches, Leaf
Bio-fertilizer/ Guano	Kochuripana,	As compost,
Hydroponics	Kochuripana to make baira (floating platforms)	to grow seedlings and vegetables
Bio-gas	Kochiripana, Khudipana (*Lemna* and *Spirodelaspp.*) and other aquatic plants.	All parts of the pant

Present threats on ecosystem

Soil salinity and internal canal bed siltation are the main threats on ecosystems of this polder. Specially, some village is near the embankment that's why the soil salinity is higher than other villages. 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, lack off irrigation in *Rabi* season is also a problem.
Local farmers reported that Mammals' population is very low in the polder area. Big mammals have already disappeared, because change of land use and different human activities. 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.
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. 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.
Several species listed in the IUCN *Red Data Book* occurs within the polder area and are given in Table 5.35.

Table 5.32 Threatened fauna in 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: Field survey, 2015 and Red Data Book of IUCN Bangladesh

5.4 Environmental Quality

5.4.1 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.*

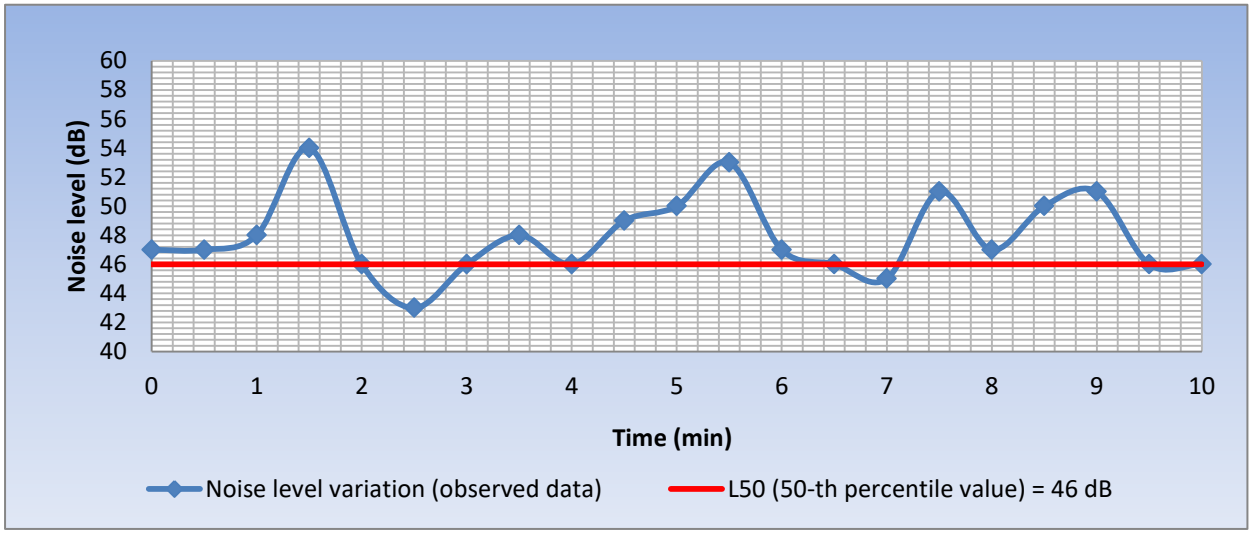


Figure 5.13 Variation of sound levels for 10 minute sampling period at Kulotir mor bazaar (22º48'12.15''N and 89º28'08.35''E)

5.4.2 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 5.37**). 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 5.33 Water Quality Parameters

Location	pH	TDS (ppm)	DO (mg/l)	Salinity (ppt)	Remarks
Soilmari River	7.5- 8.5	210- 320	3.5-4.5	0-20	Inside polder
Moury river	7.15- 8.8	250.2- 1185	2.8-4.2	0-18	Outside polder

5.5 Climatic Trends

Khulna is identified as one of the 15 most climate change vulnerable areas of the world. Cyclone, storm surge induced flooding, riverine coastal flooding, water logging, salinity intrusion and coastal erosion are the main climate and hydrologic hazards in the area. Commissioning of the Farakka Barrage on the Ganges River in India in 1975 has reduced the fresh water inflows to the region, and construction of coastal polder has gradually reduced the flood-plain storage areas for tidal waters from the Bay of Bengal (Mondal, 2012).The following sections provide a comprehensive discussion on the trends in temperature, sunshine hour, humidity, rainfall in Khulna,and trends of variation in annual maximum and minimum tidal water levels at Chalna in Rupsha-Pasur River, a location which is around 2.5 km downstream of Polder 30**.**

5.5.1 Temperature

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

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

5.5.2 Sunshine

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

0.4 hours a day per decade, which is equivalent to a decrease of 4.9% in average sunshine duration in a decade(Mondal, 2012).

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

5.5.3 Humidity

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

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

5.5.4 Rainfall

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

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

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

5.5.5 Tidal Water Level

The annual maximum high tidal water levels at Rupsa-Pasur are increasing at a rate of 18 mm per year and the annual minimum low tidal water levels are decreasing at a rate of 8 mm per year (Figures

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

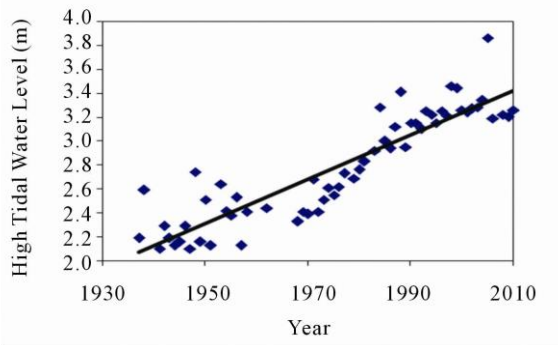


Figure 5.14 Trend in Annual Maximum High Tidal Water Levels at Rupsa-Pasur River (Mondal, 2012)

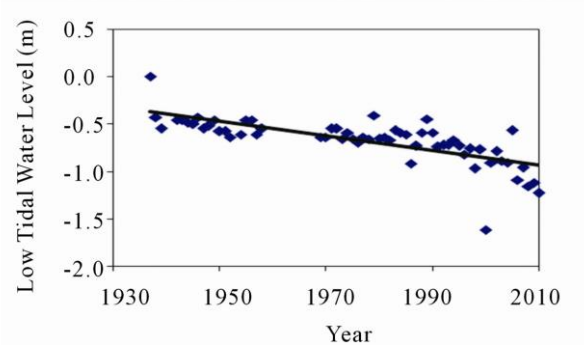


Figure 5.15 Trend in Annual Minimum Low Tidal Water Levels at Rupsa-Pasur River (Mondal, 2012)

5.6 Climate Change Projection

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

Table 5.34 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.

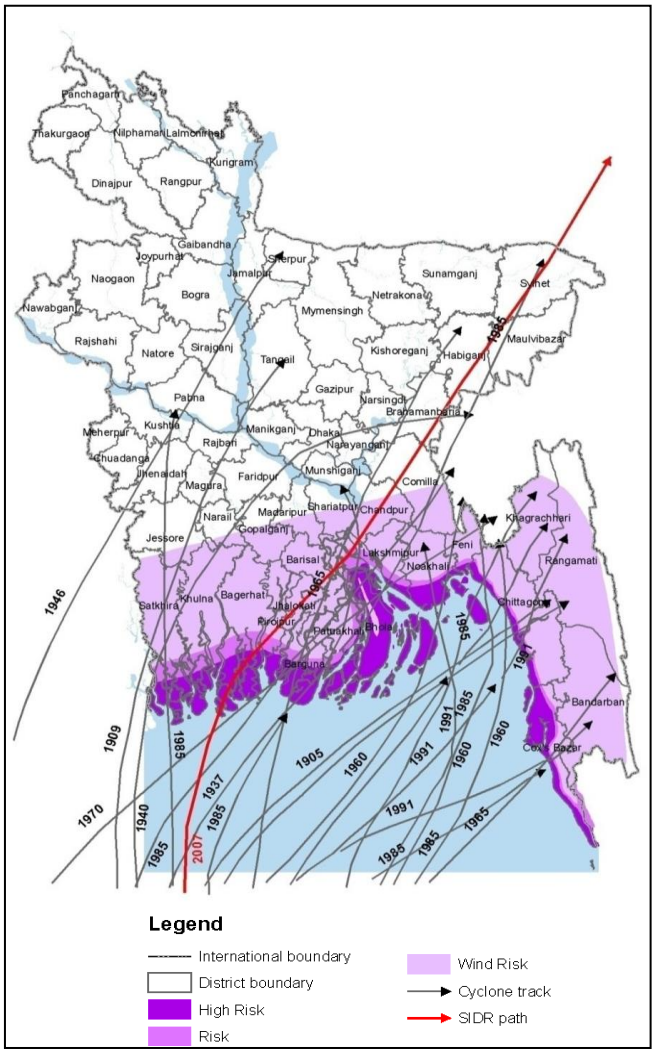
5.7 Cyclones and Storm Surges in Polder 28/1

Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal regions in Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of even more than 9m. For

example, the 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m. observing the tracks of different cyclones affecting the country in the last decade, the countries southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (Map 5.11). Polder 28/1 falls in the wind risk zone which possesses some vulnerability due to the strong winds, and surge heights associated with cyclones. From field observations it was found that the polder did not undergo any major damage during the recent cyclones.

Photo 5.18 Kazi Bacha River at Barun para

Photo 5.19 Salta River at Mailmara



Map 5.4 Cyclone Tracks in Bangladesh and Risk Areas

6 Socio-economic Condition

6.1 Introduction

The socio-economic condition of the people living in 'Polder 28/1 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 were compiled from the community series of the Population Census 2011 published by Bangladesh Bureau of Statistics (BBS).

The study area contains 2 unions under 2 upazilas of Khulna district. The socio-economic baseline situation of the study area is described in f the following sections.

6.1.1 The people

Demography

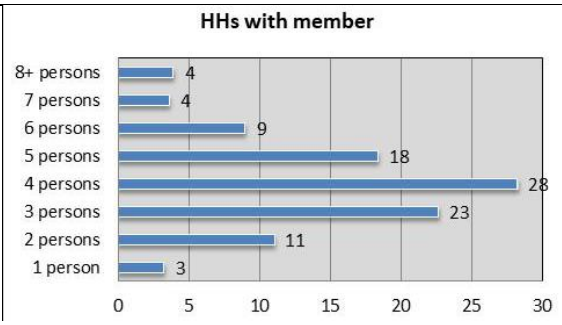
The 5,519 households living in the polder area have a total population of 20,862 of which 10,522 are male and 10,340 are female. The male population is higher than the female population. The average male-female sex ratio is 99 of which there are 99 females per 100 males which is almost equal to national figure of 100.3 (HIES) 2010[3]]. The average density of population is 1013 persons per sq. km which is higher than 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 75% of total populations in the polder area are Hindu while about 25% are Muslim and rests of 20 people are Christian. The demographic data of this Polder is presented in **Table 6.1**.

Table 6.1 Demographic Data of Polder 28/1

Unions	HHS	Total Population					
		Both	Male	Female	Hindu	Muslim	Christian
Ghutudia and Jalma	5,519	20,862	10,522	10,340	15,627	5215	20

Source: Population Census 2011, BBS

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. The highest number of population (28%) in the study area belongs to age category of 30 to 49 years old. Only 3% people are in 60 to 64 years category.



Source: Housing and Population Census, BBS, 201

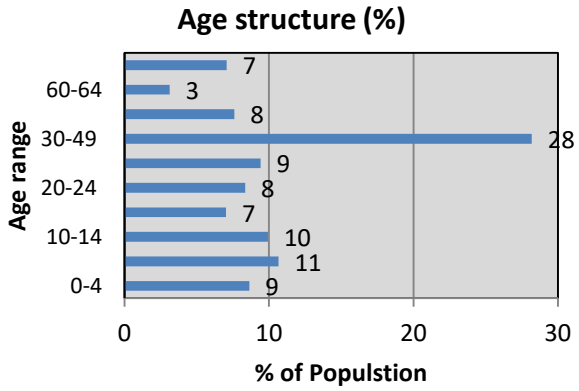
Figure 6.1 Distribution of households comprising member in each

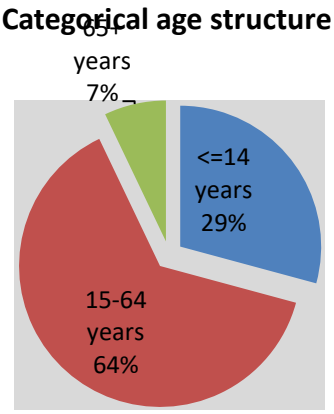
Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-54 years as prime working age, 55-64 years as mature working age and 65 years and over as elderly people (source: World Fact Book, CIA[4]). This classification is important as the size of young population (under age 15) would need more investment in schools, while size of older populations (ages 65 and over) would call for more invest in health sector.

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

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

The population data when analyzed to ascertain the size of (potentially) active working population then it appears that 61% percent population who are in the age bracket of 15-64 can be classified under this category. A small percentage (7%) 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[5] is 56 in which child dependency ratio[6] is 45 and aged dependency ratio[7] is 11. It illustrates that total 56 persons are dependent on 100 labour forces in which 45 are children and 11 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

6.1.2 Sex Composition

Sex ratio when analyzed per upazila appears to be almost similar. According to BBS (2011) data in the study area overall sex ratio is 99, which means males are comparatively higher (100) than that of females (99). Male population is higher in Ghutudia (101), when the lower ratio is in Jalma (99) unions. The data indicates that like national average (100.3), the discrepancy between male-female numbers is gradually decreasing.

6.1.3 Education

The people of the study area have favorable access to education. Accessibility refers to equal opportunities to be enrolled in the educational institutions, pre-school attendance rate, assistive technologies in institutions, adequate health care and nutrition services and communication facilities to the institutions. Accessibility is obviously higher in urban areas such as municipal town, compare to rural areas. Data on male-female attendance ratio confirms that both sexes have equal opportunities in education. There are a few privately owned preschools facilities located mostly in municipal areas. These schools are expensive and largely unaffordable for the poorer classes of people. According to BBS 2011, the total attendance rate age up to 29 years is 41% whereas not attendance rate is 59%. The higher secondary level shows the threshold point from which not attending rate moves upward and attending rate starts sliding. This trend is true for higher as well as advanced level studies.

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

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

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

School attendance rate is measured by BBS from 3 years to 29 years by six clusters of age groups. 3 to 5 years is defined as preschool attendance, 6 to 10 as primary, 11 to 19 years as secondary and higher secondary and finally 20 to 29 years as higher as well advanced level attendance at educational institutions. Comparative picture of attending and not attending rate shows that net attendance rate is the highest (18%) at primary level then the rate starts declining.

Source: Housing and Population Census, BBS, 2011

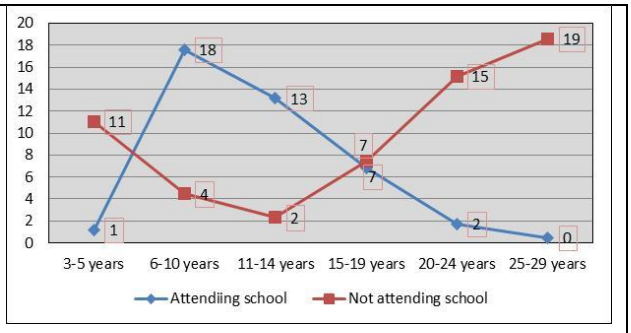


Figure 6.4 Difference between attending and not attending rate

However, as mentioned earlier that male-female attendance ratio is almost equal with a little difference at primary level in which female attendance is comparatively higher than that of males. Field findings confirm that female attendance at this stage is higher because of existing scholarship program, and the parents also consider this basic schooling as an investment for securing a good marriage of their girl child. It has also been observed and our data confirms that after completion of primary education, most of the girls get married and therefore the attendance rate gradually starts decreasing. However, male attendance rate is decreasing due to their involvement in income generating activities.

Literacy rate, based on a definition "ability to write a letter in any language" is 51%, where for male it accounts to 60% and female 56%. The rate of literacy reported above is for population of 7 years and over ages (Figure 0.00). Data confirms that like the national picture of Bangladesh (Male 54.1% and Female 49.4%), the male populations are more educated than the female counterpart in the study area.

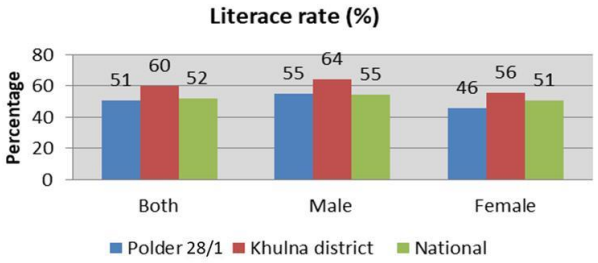


Figure 6.5 Litaracy rate in the study area

6.1.4 Public Health

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 1 upazila Health Complex (UHC) at upazila level. Besides, there are 12 community clinics and 5 union complexes at union level providers also provide health services to the local people. 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, 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 replaced by registered/trained physicians. It is assumed that economic wellbeing may drive them toward receiving treatment facilities from trained physicians whether it is expensive or cost effective

The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the polder area. It is found that the study area comprises 2.8% of all types of disabilities and 1% people reported that they are physically challenged. 0.5% 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.

6.1.5 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 59.32% is farm and the rest 40.38% is non-farm.

On the other hand, farm holding distribution shows that 27.05% households belong to marginal farmer (0.05 to 0.99 acre), 22.25% belong to small farmer (1.00 to 2.49 acre), 13.05% belong to medium farmer (2.5 to 7.49 acre) and 1.41% 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.

Source: The Census of Agriculture, 2008, BBS

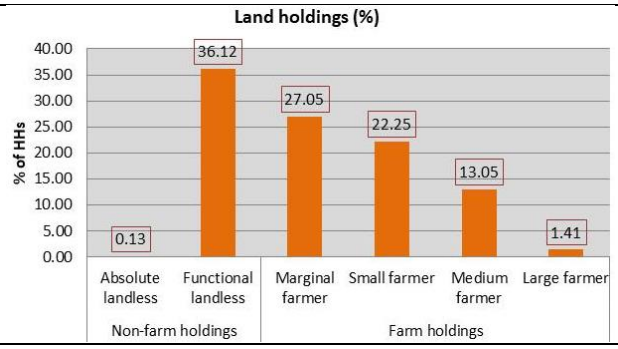


Figure 6.6 Households by land holdings

Therefore, the land holdings in the study area show that 0.13% households are absolute landless i.e. they have no lands either homesteads or cultivated. 36.12% households belong to functional landless category that comprises households those have only homestead lands (30.50%) and those have homestead with 0.01 to 0.04 acre cultivated lands (5.62%). Here, cultivated lands include mainly kitchen gardening produced predominantly by housewives mainly for household consumption.

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.

6.1.6 Occupations and livelihoods

Out of total 20,862 population, 5,685 (27.25%) are economically active which include 2,196 (38.63%) employed, 14 (0.25%) are looking for work, and 3,475 (61.12%) 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.

Source: Housing and Population Census, BBS, 2011

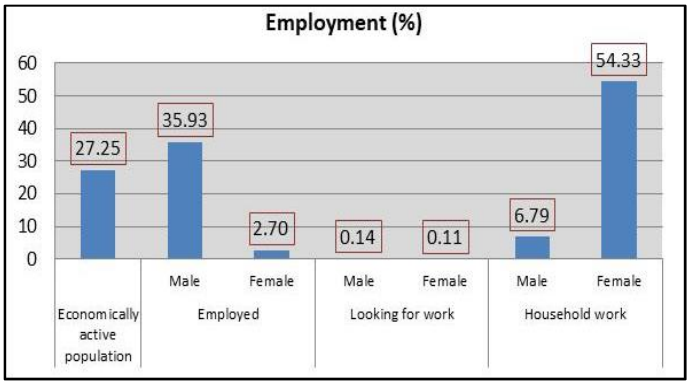


Figure 6.7 Employment status among the studied population

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 (42.6%). The employed category also includes child labour as it was accounted from 7 years old population.

Distributing employed population at reference period of census it is found that 35% are engaged in agricultural activities, 1% in industry and 3% 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. Data confirms that lands used for agriculture is 56%, for settlement is 38% and rest of them for other purposes as water bodies or industrial sector is 6%. 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 6.1 Different modes livelihood activites at polder 28/1

6.1.7 Labor market

The employment rate[8] in the study area is 38.63 whereas the unemployment rate[9]is 61.37. It is evident that more than 60% 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 section 6.2.7).

[8] Employment Rate = $\frac{Employed\ Population}{Total\ labour\ force} X\ 100$

[9] Unemployment Rate= 100-Employment Rate

Data confirms that agriculture, industry and service are the sole sectors to generate employment for the local people (see paragra 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.

Source: Housing and Population Census, BBS, 2011

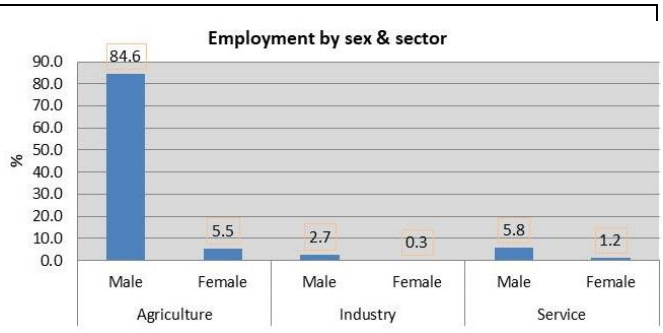


Figure 6.8: Distribution of population by sex and field of activity

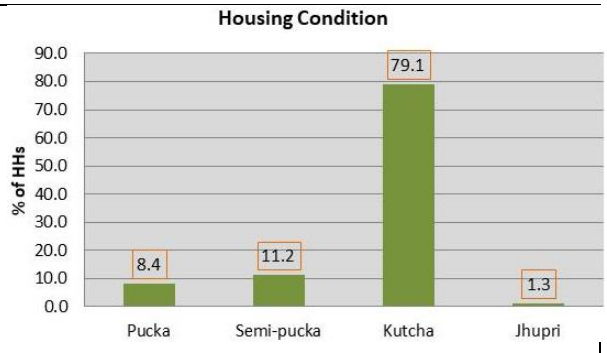
The above figure implies that female participation in agriculture sectors are higher (5.5%) than that of industry and service (1.5%). Field findings documented that during harvesting period, they take part in action with men in same agricultural field. Some of them are also collect fry fish from river, earthwork etc (**Photo 0.00**).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 (Digholia, 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.
.

6.1.8 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. Data shows that about 50.5% households are under grid electricity coverage.

BBS data shows Dumuria Union comprises highest (61.1%) electricity coverage whereas Surkhali Union comprises lowest (29%) coverage among other unions of this polder. Moreover, about 35% households are now use solar electricity in the polder area. (Field survey, 2018).

The study area shows the predominance of kutcha houses (79.1%) over other three types. Semi-pucka household is 11.2% pucka is 8.4% and one percent is still jhupri houses. Most of the pucka houses are located in Dumuria municipal areas, whereas semi-pucka are predominant at the peripheral areas of municipality. Kutcha houses are predominant in the rural area (**Figure 6.9**).



Source: Housing and Population Census, BBS, 2011

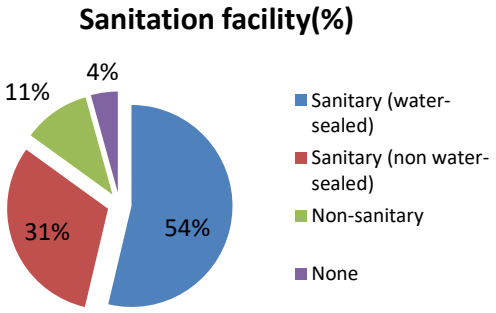
Figure 6.9 Housing condition in the study area

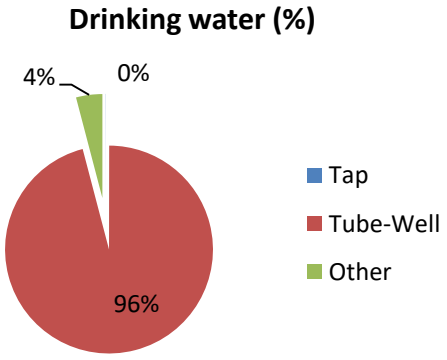
Sanitation facilities in the study area show that about 11% households use non-sanitary latrines, 31% use non water-sealed sanitary latrines and 4% use none latrines. Field findings confirm that non-sanitary latrines are predominant among kutcha houses. As water-sealed sanitary latrines are used by kutcha, semi-pucka and pucka households, it contains the highest coverage (54%). 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 6.11**).

Photo 6.21 Housing structure at polder area

Status of drinking water in the polder area is deplorable. BBS data shows, collecting drinking water from tube-well is predominant (96%) throughout the study area. There is no use of tap water in whole polder area. However, 4.1% households are still depending on unorthodox sources of drinking water such as water bodies; 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 in the villages of Akhra, Bahir Akhra, Chadgarh, Jaliakhali, Ratankhali. During this period, the villagers collect drinking water from the neighboring 100 years old Akhra's pond. Even they also buy water from Dumuria at a cost of 20tk for every 30 litre jar by 25/30 Tk.





Source: Housing and Population Census, BBS, 2011

Figure 6.10 Distribution of households by sanitation facilities

Figure 6.11 Distribution of households by sources of drinking water facilities

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 28/1 are shown in **photo 6.6&** (**Figure 6.12**).

Photo 6.3 Very old Akhra's pond

Photo 6.4 Domestic level PSF

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

6.1.9 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 6.13**). It is observed that about 25% of the households in average are in the 'deficit' category, 30% are surplus and rest of 45% households are in balance situation. These households have been identified in the RRA as the poor households of the Polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals in a day in the lean period since they could not afford three full meals.

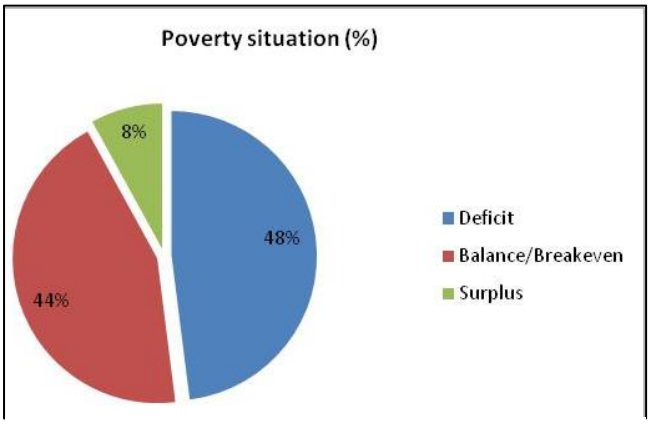


Figure 6.12 Poverty situation

7 Public Consultation

7.1 Introduction

Public 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 in involving the project stakeholders into the project development and implementation process. A formal meeting comprising of local people who are likely to be impacted was arranged at the Polder 28/1 project location. During consultation meeting the proposed project interventions and their associated impacts were discussed following a comprehensive checklist. Such consultations 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 consultation process was design and implemented

- To provide key project information and create awareness among various stakeholders about project intervention;
- To have interaction for primary and secondary data collection with project beneficiaries, affected populations, 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 will be affected and/or perceived 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 28/1, 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, fisher, 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 which could contribute to the study, play a role in implementation at some stage, or affect decision making on project aspects. From this 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 the 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 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. In this process, 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 carried out 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 giving 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 the 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 responsesfrom the participants. The stakeholders of the polder 29 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.

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.

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.

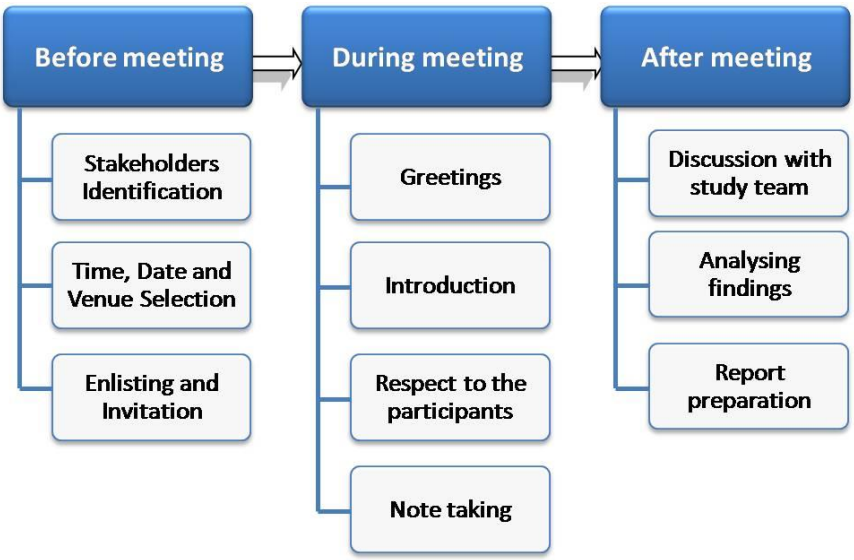


Figure 7.1 Overall consultation process

7.5 Consultation meetings and FDGs

7.5.1 Consultation Process

One PCM and number of FGDs were conducted at different locations in the polder area. The details of these FGDs and PCM are presented in **Table 7.1** and some photographs of these meetings are given in **Photo 7.1** to .**7.2**.

Table 7.1 Consultation Details

Sl	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Khulna	Khulna	Khulna	Blue gold office	consultation	23/05/2019	14:00
1	Khulna	Batiaghata	Rajbandh	WMG	PCM	22/05/2019	10:00

7.5.2 Consultation Participants

The participants of these consultation meetings included Blue gold officials, local representatives, farmers, and traders, members of WMO and daily-wage laborers of the Polder 28/1 and nearby areas. A total number of 95 participants attended these consultations. The details of the participant are provided in **Table 7.2** and **Photo 7.3 to Photo 7.5** below.

Photo 7.1 PCM at Batiakhali




Photo 7.2 FGD at Batiakhali

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

- Disasters:
  - ✓ Cyclones
  - ✓ River erosion
  - ✓ Associated damages

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

- Community involvement

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

7.7 Community Concerns and Suggested Solutions

Concerns and issues raised by the participants and their suggested solutions are provided in **Table7.3**.

Table 7.2 Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	Salinity intrusion, drainage congestion and cyclone are the main community concerns in the polder area.	Comprehensive rehabilitation of the polder should be taken up at the earliest with the active involvement of the local
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 drainage congestion	- Damaged part of the embankment should be re-sectioned as early as possible and slope of embankment must include protection with forestation. - Bank protection measures should be taken in the critical river bank erosion prone areas. - Replace the damaged/non-functional sluice gates and construct new ones where required - Re-excavation of proposed khals
Agriculture resources	- Soil salinity is the problems for crop production; - Drainage congestion during transplanting period in Aman season; - The level of sea water increases due to impact of climate change which is responsible for natural calamities such as tidal surge, cyclone etc. - Severe scarcity of irrigation water in dry season especially for rabi crops cultivation; - The siltation caused raise of bed of different internal drainage khals.	- Sluice gates repair - Khal re-excavation - Training for WMOs
Fishery resources	- Deteriorated habitat quality due to salinity and siltation in the khal - Pond overtopping during heavy rain - Illegal 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 slowly destroy fresh water ecosystem. - Drainage congestion and natural disaster is also another threat that destroys homestead and riverside vegetation. - Loss of vegetation density and succession	- 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.

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	ultimately impact on wildlife habitats.	
Socio-economic resources	- Drainage congestion has a significant impact for the loss of agricultural production in polder 28/1 area which also affect to the economic condition of agricultural based households. - During dry season, scarcity of drinking water and fresh water crisis 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.	- Strengthening of WMGs so that mass people can access to open water bodies easily. . - 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 proper operation of the project infrastructure, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also manage properly water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc and growing of consciousness among the community in the polder. - The Government should rehabilitate the affected farmers who are affected by salinity intrusion; - Need awareness building about water management among the communities;

7.8 Participant list:

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

Table 7.3 Name of participants

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

Place: Rajbandh, Polder-28/1, Batiaghata, Khulna   Date: 22-05-2019

Sl. No.	Name	Address/Designation	Mobile No.	Signature
1.	দেবব্রত মল্লিক	ইউপি সদস্য ২নং জলমা ইউনিয়ন ৯নং ওয়ার্ড।	[illegible]	দেবব্রত মল্লিক
2.	নীরোদ রঞ্জন সিকদার	সভাপতি রাজবাধ	[illegible]	নীরোদ সিকদার
3.	কালিদাস মণ্ডল	কোষাধ্যক্ষ, রাজবাঁধ		[illegible]
4.	রাজপ্রসাদ মল্লিক	সাধারণ সম্পাদক	[illegible]	[signature]
5.	সুমিনু রায়	সদস্য		সুমিনু রায়
6.	প্রতিমা রায়	〃	01756527534	প্রতিমা রায়
7.	আরতি বিশ্বাস	〃	01988481247	আরতি বিশ্বাস
8.	তনু গোলদার	〃	0183741[illegible]	তনু গোলদার
9.	সঞ্জয় গোলদার	〃	01741418559	সঞ্জয়
10.	স্বপন রায়	〃		স্বপন রায়
11.	শীতল মণ্ডল	〃		শীতল মণ্ডল
12.	অঞ্জলী গোলদার	〃	01851479556	অঞ্জলী
13.	রবীন রায়	〃		রবীন রায়
14.	তাপসী রায়	〃	0191-2-157339	তাপসী
15.	শীলা বৈরাগী	〃		শীলা
16.	অপর্না রায়	〃	01856652604	অপর্নারায়
17.	জয়া বেগম	〃	0183393455 09	জয়া বেগম
18.	অঞ্জলী রায়	〃		অঞ্জলী রায়
19.	প্রমিলা রায়	সহ সভাপতি	01876[illegible]5113 33	প্রমিলা রায়
20.	বর্নালী রায়	সদস্য		[signature]
21.	চিত্তরঞ্জন মণ্ডল	সদস্য	01949235767	চিত্তরঞ্জন
22.	সুশান্ত মল্লিক	〃	[illegible]	[signature]
23.	কান্তিলতা মল্লিক	〃	01797516188	কান্তিলতা
24.	প্রমিলা রায়	যুগ্ম সম্পাদক	01777093912	প্রমিলা
25.	অপর্না রায়	সদস্য		অপর্না

8 Identification, Prediction and Evaluation of Potential Impact

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 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.
Salt water Intrusion	At the moment the polder is severely affected by surface water salinity intrusion. Some of the interventions proposed in polder 28/1 i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, salt-water intrusion has been considered as an IEC.
Water Security	Due to khal re-excavation works, the availability as well as access of surface water in polder 28/1 may be increased and this might facilitate the multi-purpose use of water. Therefore, water security has been selected as an IEC.
Erosion Vulnerability	There is no erosion surrounding the polder 28/1.
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.
Tidal Flooding	There is no tidal flooding in polder 28/1.
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 IECs.
Agriculture Resources	
Current cropping pattern	Boro- Fish-Fish (75%) with dike vegetable Boro – Fallow – T.Aman (10%) Vegetable- Vegetable- Vegetable (5%) Potato – Vegetable- Vegetable (5%)

IESCs	Rationale
	Spices – Vegetable – Vegetable (5%)
Crop production	Agricultural crop production is expected to be increased for the improvement of drainage system due to the construction of re-tired embankment and re-excavation of khals. 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 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 water lodging in the pre-monsoon and rainy season, drainage congestion, salinity, drought, etc. which are expected to be checked due to implementation of the proposed interventions. Major challenges to crop damage- 1. Major percentage of land is irrigated but during dry season water scarcity is the big challenge; 2. General lack of knowledge on improved agricultural production technology, in combination with a lack of extension services; 3. Due to poor drainage facilities, some areas created severe water logging condition and as a result, after harvesting T. Aman, field does not come under tillage condition.
Irrigated area	In polder 28/1 approximately 90% lands come under irrigation facilities especially for cultivate Rabi crops (Boro and Robi vegetable). Mainly surface water (cannel, Gher and pond water) and deep water is used for irrigation. A total of 1300 irrigation machines of which shallow tube-well is 100 and low lift pump is 1200 use for properly managed the irrigation facilities.
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 connected with the peripheral rivers. But the major portion of the khals are silted up and covered with water hyacinth particularly in the northern part of the Moyuri River. 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 may facilitate 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 and 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

IESCs	Rationale
	water temperature during dry season and disrupted migratory routes. Therefore, 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 of area provides habitats for local wildlife as well as ecosystem services to the ecological components. Vegetation of the polder area are consequentially damaged by saline water intrusion, natural disaster and erosion in every year. Repairing and construction of retired embankment may protected existing problem and improve the vegetation condition. But all types of proposed construction activities are suspected to change of existing vegetation at construction sites. So terrestrial vegetation is considering an important IEC.
Aquatic flora and fauna	Aquatic flora and faunal status relies on wetland water salinity, quality, depth which plays 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, utensil washing, washing cloths and other social uses. Deep tube well is the main source drining water. Water from shallow tube well, ponds and khals use for for .domestic purpose. During the summer, most of the open water bodies i.e. khals, ponds are being dry up and seen scarcity of water where the proposed canals are to be dug. As a result, people cannot use water for their social needs. Hence, if the eleven proposed canals are made, it will ensure the various social use of water. Therefore, social use of water is considered as an ISC.
Crisis of Drinking Water	There is no severe crisis of drinking water in the polder area. There are a number of 262 well-deep tube and 144 shallow tube-well are present which provide drinking water supply in the polder. The people are suffering from differnt 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. Hence, crisis of drinking water is regarded as an.ISC
Employment Generation	The construction work will generate a significant amount of employment over its construction period for the local people. People will also be involved to carry out the operation and maintenance related jobs to operate the structures. It is expected that the agriculture production would increase which will create opportunities indirectly, for agriculture, business and commercial services. Thus, employment generation can be considered as an ISC.
Gender Promotion	In polder area, people are living under poor condition. Specially, the females are mostly vulnerable to distressed and widow who are dependent on others and do not have any definite sources of income. It is proposed that about 25% of labour under total local constructing society (LCS) will be females. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.

8.2 Prediction and Evaluation of Potential Impacts

8.2.1 Preamble

This section identifies the potential environmental and social impacts that may be caused by various project activities during the three stages of construction works: pre-construction, construction, and operation, on the identified IESCs. Proposed interventions which may cause potential environmental impacts during pre-construction, construction, and post-construction stages have been identified in Chapter 4. The following detailed investigations have been carried out to assess the magnitude of these 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 28/1 comprising socio-economic status and environmental settings.
- Expert consultations focus group discussions, and public consultations.

8.2.2 Impact Screening

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

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

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

Table 8.2 Screening Matrix

Project Phases and Activities	Water Resources						Land & Agriculture						Fisheries			Ecological		Socio-economic			
	Ambient Noise Level	Saltwater Intrusion	Water Security	Erosion Vulnerability	Drainage Congestion and Water Logging	Tidal Flooding	Soil Salinity	Agriculture land use	Cropping pattern and intensity	Crop production	Crop damage	Irrigated area	Open water fish habitat	Golda/Bagda with white fish culture	Fish movement migration	Terrestrial vegetation	Aquatic flora and fauna	Social Use of Water	Crisis of Drinking Water	Employment Generation	Gender Promotion
Pre-construction Phase																					
Labor, materials and equipment mobilization	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MP	-
Site preparation	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MP	-
Construction Phase																					
Re-sectioning of embankment	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MN	-	-	-	HP	-
Construction of Retired Embankment	MN	-	-	-	-	-	-	-	-	I	I	-	-	-	-	MN	-	-	-	HP	-
Embankment slope pitching and turfing	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	HP	-
Re-excavation of khal	MN	-	-	-	-	-	-	-	-	-	-	-	MN	-	MN	-	MN	-	-	HP	-
Repairing of Water Control Structures	MN	-	-	-	-	-	-	-	-	-	-	-	MN	-	MN	-	-	-	-	HP	-
Operation Phase																					
Checking the physical condition and function of the embankment	-	HP	MP	MP	MP	MP	MP	MP	HP	HP	MP	MP	MP	MP	I	HP	MP	MP	MP	MP	MP
Checking physical condition and function of water control structures	-	HP	MP	MP	MP	MP	MP	MP	HP	HP	MP	MP	MP	MP	I	HP	MP	MP	MP	MP	MP
Checking functions of WMOs	-	HP	MP	MP	MP	MP	MP	MP	HP	HP	MP	MP	MP	MP	I	-	-	MP	MP	MP	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 would be no significant impact during the pre-construction phase on IESCs of water resources, agriculture, fisheries and ecological resources because some activities *like* materials and equipment mobilization (carrying as well as storing and land acquisition) would be carried out during this phase. The proposed activities may generate some temporary impacts on social conditions. The descriptions of such impacts as well as their magnitudes have been shown below.

Table 8.3 Impact Assessment Matrix for the pre-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 28/1 where different activities will be initiated.	Out of total 20,862 population, 10,848 (52%) are economically active which include 2,712 (25%) employed and 8,136 (75%) are engaged in household work.	Local unemployed labors 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

Impacts on IESCs during construction phase by the proposed interventions 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
Water Resources				
Activity: *Re sectioning of embankment and Construction of retired embankment*				
Ambient Noise Level	Along the polder periphery	The 50-th percentile Noise level observed inside the polder are 46 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
Land Resources				
There will be no impact during the construction phase.				
Agricultural Resources				
Activity: *Collection and dumping of Re-excavated earth earth materials for construction of re-tired embankment*				
Crop production loss	Ghutudia and Jalma	About 5.0 ha of agricultural land of which about 3.0 ha is under HYV Boro cultivation.	About 12 tons of HYV Boro crop production would be lost.	-1
Fisheries Resources				
Activity: *Re excavation of khal*				
• Fish habitat • Fish migration and movement	Panchu Khal Badurgacha Khal Lata Khamar Khal Pashkhali Khal Pashkhali Branch Khal Puber khal Rajbander khal Kalighat khal Khoiramari khal Nalar 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	<u>Repairing of sluices</u> • Rayarmohol (4-V) • Kuloti (3-V) • Pashkhali (1-V)	• Fish hatchling and some brackish water fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra etc. move through the mal-function of regulator on	• Movement and migration of fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, bele etc would be obstructed during repairing of structures.	-1

IESC	Location	Baseline Condition	Impact	Impact (+/-) / Magnitude
	• Nalar (1-V) • Khoiramari (1-V) • Kalighat (1-V) • Panchu (2-V) • Rajband (WRS) (6-V)	regular basis during high tide.	• Fish hatchling movement would also be hampered, if the repairing works is implemented during hatchling period (May-June).	
Ecological Resources				
Activity: *Repairing of embankment*				
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, Sezi 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 re-sectioning work.; • Relocation of wildlife due to habitat loss temporarily.	-2
Activity: *Construction of retired embankment*				
Terrestrial vegetation	Village at Ghutudia and Jalma	• Embankment/polder side vegetation is dominated by medium sized trees, shrubs and herbs e.g. Babla, Khai Babla, Taal, Narike, Akand, Bhat, Sezi and etc. • This vegetation provides feeding ground for mammals, birds, reptiles and amphibians. • Vegetation is facing risk due to river erosion.	• Permanently damages of herbs, shrubs, various types of grass and bushes due to construction work. • Relocation of wildlife due to habitat loss temporarily.	-3
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 from a long time and being waterless in dry season. • No aquatic vegetation is observed in the river side khals because of tidal flow and salinity.	• Water depended fauna as Skipper frog, Bullfrog, Kingfisher, Egret, common aquatic Snake, etc. will be temporary re-located due to habitat loss in the khal area. • Grasses will be damaged due to storage of soil along the both side of the khal.	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-) / Magnitude
		• Vegetation along internal khal side is low, some grasses are found along the marshy parts of proposed Khals.		
Socio economic Condition				
Activity: *(i) Repairing of embankment (ii) Construction of retired embankment (iii) Embankment slope pitching and turfing (iv) Re-excavation khals (v) Repairing of drainage/ flushing sluices (viii) Repairing of drainage outlet (iv) Repairing of irrigation inlet*				
Employment generation	Periphery and inside of the Polder 28/1 where different activities will be initiated.	About (52%) are economically active which include 2,712 (25%) employed and 8,136 (75%) are engaged in 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
Gender Promotion	Periphery and inside of the Polder 28/1 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, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS. 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

8.5 Impact during Operation Phase

Possible impacts of the proposed interventions on the selected IESCs have been assessed during post-construction phase 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

The proposed sluice gates, if not repaired, may further increase the saltwater concentration in the surface water system of the polder in future. Almost all the water control structures of the polder are not functioning up to the desired level. At present salt water enter into the polder during dry season through some of the structural leakages, and the salinity concentrations found at 20-m buffer zone inside the polder are up to 20 ppt. If the existing water control structures are not repaired and khals are not re-excavated then salinity concentrations may increase to around 15 ppt during the dry season.

Future with Project

If the existing sluice gates, flushing inlets and drainage outlets are repaired, the salt water leakage into the polder may be permanently prevented. In future, the salinity contour line would be diminished and salinity concentrations in the surface water system of the polder would drop to ‘zero’.

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 ppt inside the polder to ‘zero’. This will also foster other sectoral benefits within the polder.

b. Water Security

Future without Project

There is no severe crisis of drinking water in the polder area. There are a number of 262 -deep tube well and 144 shallow tube-well are present which provide drinking water supply in the polder. The people are suffering from differnt 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. On the other hand if the khal re-excavation works are not carried out, around 25% of people inside the polder may suffer from water stress (i.e. irrigation, washing, bathing etc.)

Future-With-Project

An additional 18 km re-excavated khals if implemented would carry water in all seasons and serve the domestic water demands of a significant number of people. However, the drinking water situation may not be improved due to implementation of the project as the project does not directly include any water supply measures.

Impacts

Around 80% of people living inside polder 28/1 would be guaranteed 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. Tidal Flooding

Future without Project

There is no tidal and river flooding effect in polder 28/1. There was no evidence overtopping of the embankment. However, there are internal floods due to heavy rainfall in monsoon and upland flow through bridges and culverts in the north and north-eastern boundary.

Future with Project

After completion of the embankment re-sectioning the crop land and fisheries land within the polder would be protected if overtopping is occurred in future.

Impact

The proposed embankment will be impacted long term from prevention of tidal flooding. This may induce other associated benefits.

d. Erosion Vulnerability

Future without Project

No such erosion area was reported by the local people and/or observed by us during the field investigation.

Future with Project

Sometimes sewage from Khulna city area enters the polder through Khuder khal to Pashkhali khal and pollutes the water in the polder, which badly affects the fish culture and other household activities. The proposed structures and retired embankments and if implemented, the existing condition would be altered.

Impact

The fish culture, homestead vegetable and other household level activities would greatly be secured from probable polluted water.

e. Drainage congestion and water logging

Future without Project

Presently, around 80% of the khals inside the polder (Paskhali khal, Paskhali Branch khal and Lata Khamarbati khal) suffer from *severe drainage congestion*[10], and almost 50% of the khals (Rajbandh khal, Hogladanga khal (partial) and Ramdia khal (partial) suffer from *moderate drainage congestion*[11]. If the re-excavation works under project is not implemented, the drainage congestion will be increased.

Future with Project

The proposed khals if re-excavated, the drainage congestion problems in the upstream portions of the khals would diminish, and rain water 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 30% 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 concluded that around 50% of khals adjacent to the periphery of the polder would be improved from drainage congestion. This would facilitate improved drainage and other associated hydrological functions.

[10] Severe Drainage Congestion has been defined as the water courses which have extremely low conveyance capacity and usually take one week or more to properly drain out rainwater.

[11] Moderate Drainage Congestion has been defined as the water courses which have low conveyance capacity and usually take 2 to 6 days to properly drain out rainwater.

8.5.2 Land Resources

a. Agriculture land use

Future without Project

Presently, NCA is about 75% of the gross area. Of the net cultivable area single, double and triple cropped area is about 10%, 80% and 10% respectively. If the project is not implemented, single, double and triple cropping would be practiced in about 10%, 80% and 10% of the NCA respectively (Table 8.4).

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 polder. The area under different land types would improve which would create scope of enhanced land use. It is expected that construction of re-tired embankment and re-excavation of khals would enhance land utilization. However, the land utilization for single, double and triple cropped area would be around 5%, 75% and 20% of NCA respectively in future with project condition. Detailed land use has been presented in Table 8.4.

Impact

The overall impact of different options on land use would be very positive. Single cropped area and double cropped area would decrease by about 5%, and triple cropped area would increase by 20% of the NCA under FWIP condition. Detailed land use has been presented in Table 8.5.

Table 8.5 Detailed agriculture land use of the polder area

Agriculture land use	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)
	% of NCA	% of NCA	% of NCA	
Single crop	10	10	5	-5
Double crop	80	80	75	-5
Triple	10	10	20	10
Total	**100**	**100**	**100**	

Source: BGP field survey, July 2019

b. Soil salinity

Future without Project

Most of the areas are affected due to capillary raise of saline ground water during dry season which is unfavorable for crop production and as a result the land remains fallow. If the intervention is not implemented, intrusion of saline water in the agriculture land would be regular phenomena. The situation would be aggravated in future without project condition. Besides, the salinity developed by capillary rise would not be drained out properly in monsoon season. Hence practices of different rice crops such as LT.Aman, HYV T.Aman, and Boro as well as non-rice crops such as 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. Water logging would be substantially decreased from the polder area through the sluice gates. The embankments and structures would also restrict the intrusion of saline surface water during tidal surge. In addition, soil salinity would be reduced through flashing from project area during monsoon season due to onset of rainfall. The crop damage due to salinity might be reduced.

Impact

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 of the dissolved salts from agriculture land. The structures would have positive impact on reducing soil salinity.

8.5.3 Agricultural Resources

a.Cropping pattern and intensity

Future without Project

Presently, cropping intensity of the polder area is about **206%.** If the proposed interventions are not implemented, the land type as well as land use would be decreased through degradation of embankment and siltation of river and drainage channels. Under this condition, there would be negative impact. The cropping intensity is expected to decrease to about **190%** (Table 8.5).

Future with Project

Rehabilitation of polder 28/1 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 well and would influence to drain the excess water during rainy season from the cultivable land and 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 250%.

Impact

After completion of the interventions, the cropping intensity is expected to impact by 44%.

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

Land Type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Baseline	FWOP	FWIP	% Change
				% of NCA	% of NCA	% of NCA	
Medium High Land (F_1)	Fallow	HYV T Aman	Boro	x	x	x	x
	Fallow	LT aman	Fallow	10	10	20	10
	Vegetables	LT aman	Fallow	x	x	x	x
	Vegetables	Vegetables	Vegetables	10	10	20	10
Low Land	Fish (Vegetable in Gher)	Fish (Vegetable in Gher)	Boro	80	80	60 (with vegetables)	-20
Total				**100**	**100**	**100**	**0**
Cropping Intensity (%)				**206**	**190**	**250**	**44**

Source: DAE, Dumuria Office and calculated by BGP, July 2019

b.Crop production

Future without Project

Presently, total crop production is 80,900 tons (fish, vegetables and rice) of which rice is 27,700 tons (34%), fish is 36,400 tons (45%), and vegetables 16,800 tons (21%). There is no siltation in this polder due to no flow tidal effects. The whole area mainly used to cultivate fish, vegetables and rice.The production would not be decreased from the baseline situation. Rather total crop production would be increased 6% due to rehabilitation works.

Future with Project

The crop production would be boosted up significantly under the FWIP condition. The total crop production would be increased about 6,100 tons. The rice and vegetables production would be higher about 20% and 12% respectively in FWIP than that of FWOP. Rice production would be increased due to expansion of HYV Aman and HYV Boro.

Impact

Additional 3800 tons of rice and 2300 tons of non-rice would be produced (Table 8.7).

Table 8.7: Impact on crop production in the polder area

Crop Nme	Productin (Ton)			Impact (FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
HYV T.aman	1000	300	2000	1,700	2.00
LT.aman	1500	300	600	300	.40
HYV Boro/Hybrid	25200	25200	27000	1,800	1.07
Total rice	**27,700**	**25,800**	**29,600**	**3,800**	**3.47**
Summer Vegetables	4800	4800	5,500	700	1.14
Winter vegetables	12000	12000	13,600	1,600	1.13
Total non-rice	**16,800**	**16,800**	**19,100**	**2,300**	**2.27**
Total	**44,500**	**42,600**	**48,700**	**6,100**	**5.74**

Source: BGP field survey, July 2019

c.Crop damage

Future without Project

Crops are presently damaged in the polder area due to water lodging in the pre-monsoon and monsoon season and drought in the winter months. Presently, the salinity problem is not the great problems in the polder areas but sometimes problems happen due to drought problem. In the last four years, there was no problems of salinity, however, in last year it was happened crop loss which is about 100 tons. No damage happened for the vegetables production. The situation would be aggravated under FWOP condition. Approximate 100 tons of rice production would be lost under FWOP situation (Table 8.7).

Future with Project

In FWIP condition, crop damage would be reduced by 90% for the implementation of interventions and their proper management. The interventions would have positive impact in reducing crop damage area as well as crop production loss. The total rice production loss would be about 10 tons.

Impact

It is expected that loss of crop production would be reduced by 90 tons which would be about 90 % less in FWIP over FWOP (Table 8.8).

Table 8.7 Impact on crop production loss in the polder area

Crop Nme	Productin loss (Ton)			Impact (FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
HYV T.aman	10	10	5	-5	-50%
LT.aman	20	20	15	-5	-75%
Boro	70	70	20	-50	-29%
Total rice	**100**	**100**	**40**	**-60**	**-154%**
Total non-rice	**No vegetables**				**-**
Total					**-154%**

Source: BGP estimation from field information, July 2017

d.Irrigated area

Future without Project

Presently, irrigated area is about 3500 ha out of total 4000 ha crop land. The availability of surface water in the river and khals would decrease due to siltation of river and khals in the area under the FWOP condition. The irrigated area would decrease about 10% area.

Future with Project

After implementation of the proposed interventions in the polder, water will be available and retained in the rivers and khals. Irrigation would be provided from different rivers and khals in rabi crops by using LLPs up to February. About 500 ha will come under irrigation support in FWIP which thus result to cover whole 4000 ha in FWIP.

Impact

The irrigated area would be increased by 500 ha.

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 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 62% 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 7% from the base condition after rehabilitation of the project interventions. In FWIP situation, golda gher area would be 595 ha.

Impact

Golda gher area would be increased by 2 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 3.0 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 96 tons.

Impact

Bagda production would be decreased whereas rice cum golda production would be increased by 6 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 increase of soil salinity, drainage congestion and riverbank erosion. Currently, there is no high density settlement but moderate. It is also observed that, settlement density is higher in line with the polder embankments and lower near the peripheral settlement of the polder.
In addition, yearly riverbank erosion, natural disaster is also another threat that destroys homestead as well as terrestrial vegetation. Malfunctioning of water control structures like regulators causes insufficient drainage and flashing capacity of the polder area, which causes vegetation damage. Intrusion of saline water will degraded habitat quality, and vegetation loss those disrupt in continuation of ecosystem services.

Future with Project

By controlling saline water inundation through repairing of regulators and construction of retired embankment will reduce saline water intrusion and protect climatic effects through fresh water flow. It will enhance vegetation coverage. Hence, improvement of vegetation including fruit trees will support resident wildlife throughout the year. Improvement of drainage system and water conveyance capacity through re-excavation of khals.

Impact

Terrestrial vegetation density will be high. Moreover after implementation of the interventions settlement areas soil and water salinity will be reduced due to fresh water flow from nearest khals and rivers.

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

People cannot use water for taking shower, washing clothes, washing utensil and others purposes due to unavailability of fresh water bodies. They make up their necessity for water through tube well. At present 20 % families have poor access and 80 % families have medium access to social use of water and without project situation this number will be 30% for poor and 70% medium access.

Future with Project

With the intervention, 30% families would be good, 15% families would be poor and 85 % families would be medium access to social use of water and benefited through this project.

Impact

The standard life for 700 HHs would be good and 1,693 HHs would be medium access to social use of water. Around 30% people inside polder 28/1 would be benefitted with sufficient fresh water availability and access, which would result in benefits in domestic water use. Besides, water for irrigation would also substantially be improved.

a. Gender Promotion

Future without Project

One third of the total labour force will be female who will be mobilized through labor constructing society (LCS). It is expected that they will be directly benefited through for these interventions.

Future with Project

According to the project plan, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS. 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.

Impact

The employment opportunity for women in the construction works and during operation/maintenance phase can create opportunities for the labouring female population for better life and livelihood

b. 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 8.8 Matrix on Impact Assessment with regard to Operation Phase

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
Water Resources				
Water Security	People of polder 28/1 cannot meet up their domestic, drinking and irrigation water requirements and around 10% people within the polder remain under water stress	Water security may further deteriorate with flooding and around 20% people would remain under water stress	Domestic water security may improve, but around 5% people may still be subjected to drinking water stress	+4
Tidal Flooding	Very limited tidal flooding occurs within the polder	An estimated area of 250 ha near Alutola sluice may be subjected to regular tidal flooding	Tidal flooding would be completely prevented	+3
Erosion Vulnerability	There is no areas are susceptible to erosion as reported by the local people and as observed during field visits	-	The embankment expected to be further strengthened and secured due to implementation of embankment re-sectioning works.	+2
Drainage congestion and water logging	Northeast and middle part of this polder (major part Beel Pabla Mouza, Line Beel Pabla Mauza, Purbo Beel Pabla, Khamarbati Mauza, Lata Mauza and Uttor Beel Pabla) are prone to waterlogging due to less drainage facilities, cross dams, private structures, land grabbing etc.. Most of the sluice gates are poorly functioning because of interventions and poor condition of gates. Two sluices are inactive because of private cross dams on the river side channel.	Around 55% of khals inside the polder would suffer from moderate to severe drainage congestion.	Drainage congestion in the upstream portions of the khals would be diminished but around 25% khals' at the downstream portion may face moderate drainage congestion.	+4
Land Resources				
Agriculture land use	Presently, NCA is about 75% of the gross area. Of the net cultivable area single, double and triple cropped area is about 10%, 80% and 10% respectively.	single, double and triple cropped area would be around 5%, 75% and 20% of NCA respectively under FWOP condition	Single cropped area and double cropped area would decrease by about 5%, and triple cropped area would increase by 20% of the NCA under FWIP condition	+3
Soil salinity	About 15% of the NCA is slightly saline with some moderately saline soils.	Salinity would be increased.	The successful implementation of the project and its proper management would reduce the salinity of the polder	+2

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
			area.	
Agricultural Resources				
Cropping pattern and intensity	Presently, cropping intensity of the polder area is about 206%.	Cropping intensity would be reduced to 190%.	Cropping intensity would be increased to about 250%.	+3
Crop production	Presently, total crop production is 80,900 tons (fish, vegetables and rice) of which rice is 27,700 tons (34%), fish is 36,400 tons (45%), and vegetables 16,800 tons (21%)	The total crop production would be increased about 6,100 tons. The rice and vegetables production would be higher about 20% and 12% respectively in FWIP than that of FWOP.	Additional 3800 tons of rice and 2300 tons of non-rice would be produced	+3
Crop damage	Crops are presently damaged in the polder area due to water lodging in the pre-monsoon & monsoon season and drought in the winter months.	The situation would be aggravated under FWOP condition. Approximate 100 tons of rice production would be lost under FWOP situation	In FWIP condition, crop damage would be reduced by 90% for the implementation of interventions and their proper management.	+4
Irrigated area	Presently, irrigated area is about 3500 ha out of total 4000 ha crop land	Irrigated area is expected to decrease about 10% area	Additional 500ha will brought under irrigation in FWIP, (100%)	+4
Fisheries Resources				
Fish habitat	• In the polder area, fish habitat include internal khal and fish pond • Siltation & 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 would be converted to seasonal khal	• Habitat quality would be improved. This habitat would support to grow different types of aquatic vegetation which would be used for fish feeding and habitation.	+2
Golda culture habitat	Golda gher 593 ha	Golda gher would remain same or slightly increase	Golda gher area will increased 595 ha respectively	+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 would be improved	Fish & hatchling movement would be hampered slightly but internal fish migration would be improved	+2
Capture fisheries productivity	Khal (production is 75 kg/ha	Production decreased to 60 kg/ha	Production increased to 105 kg/ha	+4
Culture fish production (Bagda/golda)	Golda production is 386 tons Bagda production is 844 tons	Golda production will remain same (386 tons) Bagda production will remain same (844 tons)	Golda production increased to 410 tons Bagda production decreased to 827 tons	+2
Ecological Resources				
Terrestrialvegeta	Moderate	• Increase threats on surrounding vegetation	• Vegetation loss will be reduced and	+3

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
tion		due to river erosion, increasing salinity, natural disaster & human activities. • Most of the terrestrial faunal species are displaced due to vegetation damaged by existing problem.	floral species will be increased due to protect area from existing problem.	
Aquatic flora and fauna	Moderate	• Aquatic habitat quality might be deteriorat due to death of aquatic plants. • Reduced depth for continuous siltation caused internal khals habitat deterioration	• Improve aquatic habitat due to improvement of plant diversity as well as khal depth and velocity	+2
Socio-economic Condition				
Social Use of Water	People cannot use water for taking shower, washing clothes and others purposes due to polluted water bodies. They make up their needs for water through tube well.	In without situation, 30% of families will have poor access and 70% families will have medium access.	With intervention, 30% families would be good, 15% families would be poor and 85 % families would be medium access to social use of water and benefited through this project.	+2
Gender Promotion	In the polder area only 30 % female members are working whereas 70% 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	According to the project plan, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS. Thus, employment access to females in the construction works and during operation /maintenance phase	+3
Employment generation	Employment opportunities are not good in 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 28/1. 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 28/1

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 26, 27/1, 27/2, and 28/2) are very adjacent to Polder 28/1 and therefore may generate some impacts in future. The existing crest levels of Polders range from 3.20~4.00m and respectively above Mean Sea Level. If re-sectioning works are carried out along the periphery of these polders up to the design elevation of 4.27 m (same as Polder 28/1), there would be more floodplain sedimentation adjacent to the upstream polders. This may result in increase in sedimentation along the Soilmari and Moury 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 28/1. Furthermore, repairing of existing water control structures of Polders 27/1, 27/2, and 28/2 under Blue Gold program would ensure reduction of dry season flow towards the polders 27/1, 27/2, and 28/2. As such, surface water salinity, surrounding the Soilmari and Moury Rivers may increase, which might affect the existing river ecosystem, as well as the multifaceted surface water use of Polder 28/1. Moreover, if any bank protection works are carried out in future in the aforementioned polders 27/1, 27/2, and 28/2, the morphological behavior of Soilmari and Moury Rivers may be changed. This might increase risk of river erosion in Polder 28/1.

9.2.1 Synopsis of projects around Polder 28/1

Apart from Blue Gold interventions, there are some other development projects nearby Polder 28/1, 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 28/1, undertaken by different line agencies in Khulna.

Table 9.1 List of water management projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
BWDB	Projects under Climate Change Trust Fund	2013-ongoing	Entire country	Low	
	Capital Dredging of River system of Bangladesh	2012-ongoing	Entire country	Low	
	Water Management Improvement Project (WMIP)	2010-ongoing	Entire country	Negligible	No WMIP schemes nearby Polder 28/1
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008- ongoing	Coastal Zone	Negligible	ECRRP polders are far from Polder 28/1
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	

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 28/1 are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

Ganges Barrage Project is perhaps the most significant project for the downstream region (coastal zone) of Bangladesh. The project is planned to manage the water resources system, promoting socio-economic development in equitable manner, and to recover the existing environmental degradation. GoB already finalized the feasibility level investigation of the project. The selected site at Pangsha is situated at the lower stretch of the river, at 32 km upstream of the Jamuna-Ganges confluence. The

main function of the 2116.50 m long barrage would be to store water for dry season through flow control.

Sufficient dry season flow may cause 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 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 28/1 is located within the GDA, and bears high sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 28/1 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 livelihood shifting phenomena would take place. Existing shrimp farming practices along the polder floodplain may disappear, and the rural livelihood would shift towards enhanced farming practices. More regional and local developments are foreseen, and the environment of the polder as a whole may highly be benefited.

9.2.3 Cumulative Impacts of Coastal Embankment Improvement Project (CEIP)

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

Polder 32 and 33 are located within a distance of 14 km downstream of Polder 28/1 along the Passur River. Polder 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 works are proposed in these polders under CEIP, which would increase the crest levels up to 5.27 m (Polder 33) and 5.8 m (Polder 32) above MSL. This increase in crest levels would reduce storm surge to enter into the polder, and additional storm surge may be diverted towards Polder 28/1.

The other CEIP polder adjacent to Polder 31/Part is Polder17/1. Polder 17/1 is located in the upstream of Polder 28/1 along the Solmari River. The existing crest level of Polder 17/1 ranges between 3.2 to 3.5 m above MSL. Embankment re-sectioning is proposed in the polder under CEIP, which would increase the crest level up to 4.27 m above MSL. This increase in height of the crest would reduce storm surge to enter into the polder, but additional storm surge may be diverted towards Polder 28/1.

9.2.4 Cumulative Impacts of Other Projects

A number of other projects as shown in **Table 9.1**are functioning near Polder 28/1 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located far away from Polder 28/1. A synopsis of the minor indirect effects of these projects with **low sensitivity** on Polder 28/1 is discussed below.

9.2.5 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 studies have been completed for a total number of 30 projects, 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 31) lies within the vicinity of Polder 28/1. However, the interventions proposed under the project are localized within the polder and no large-scale embankment re-sectioning works are proposed. Therefore the cumulative effects of the CCTF project in Polder 31 would have negligible influence onPolder 28/1.

9.2.6 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. There is also a dredging project being carried out by BIWTA to restore the major navigation routes. Among these dredging projects, Project works along Upper and Lower Meghna Rivers are relevant to Polder 28/1. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 28/1. 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 28/1 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 28/1may be further benefited.

9.3 Induced Impacts of Polder 28/1

The interventions in Polder 28/1 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 28/1 is an existing polder and was further developed under IPSWAM. The proposed rehabilitation works are to cause very minor alteration of the environmental setup outside the polder. Therefore, induced impacts likely to occur are minor and as such discussed qualitatively.

River Sedimentation

The proposed interventions in Polder 28/1 will safeguard the polder against direct intrusion of tidal water. Therefore, water from from Salta, Kazibacha and Jhopjhopia rivers carrying sediments will move further downstream or upstream and may cause induced sedimentation. New morphological changes (i.e. formation of new lands, river course shifting) may be developed as a result along the Rupsa-Passur river system. The river system may be subjected to increased floodplain siltation due to sedimentation in the upstream reaches and other anthropogenic development caused by Polder 28/1 (i.e. waste generation, increased fertilizers etc.).

Tidal and Storm Surge Flooding

Polders 25, 27/1, 27/2, and 28/2 are adjacent to Polder 28/1. As per design, the crest level of all theses Polders is up to 4.27 m above MSL. This may increase the risk of flooding in the aforementioned adjacent polders. **All these Polders having same defence againest** flooding and storm surge risks in.

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 Bhadra, Mora Jaykhaliand Ghengrailsystem.

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 28/1, new employment opportunities would be created. This will encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

The proposed interventions would drive agro-economic development inside the polder. Thus, the area may provide enhanced food security to the surrounding areas. In future, Polder 28/1 would not only be able to resist the damage of cyclonic hazards or flooding, but may also provide safety against food crisis of the nearby areas undergoing probable damage. In greater context, the agro-economic development of the polder would contribute to the regional food security as well.

9.4 Reciprocal Impacts of Climate Change and Polder

In order to investigate the reciprocal impacts of Climate Change and Polder 28/1, both quantitative assessments and qualitative judgments have been carried out. Two separate hydrological and hydrodynamic models have been setup and simulated with data input from climate and hydro-meteorology to assess the impact of climate change on some sensitive issues of the polder namely, water availability, flood security and salinity. On the other hand, resilience towards climate change developed in the polder has been discussed based on field findings.

9.4.1 Development of Models

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

Digital Elevation Model (DEM)

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 better enough for identification of internal rivers and regulator locations.

River Bathymetry Data

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

Discharge and Water level data

BWDB regularly measures the water level and discharge data at the key locations on the major rivers. BIWTA also measures the water level data for the rivers which are used as their navigation route. The discharge and water level data has been collected from BWDB and BIWTA.

Land Use Data

The land use data for the study areas were obtained from the CEGIS database. These land types were linked with SWAT land type classification for use in the SWAT model. There are four land use types classified, i.e., agricultural land, settlement, roads and water bodies. Agricultural land is the predominant land class in both study areas. The settlement areas are mainly concentrated along the rivers.

Soil Data

Information on soil data was obtained from Soil Research Development Institute (SRDI), Bangladesh. For agriculture EC, pH, OM, N, P, K and S. Soil bulk density, available water content and hydraulic

conductivity were estimated from the available soil attributes for each horizontal layer using the Pedo Transfer Function (PTF) developed by Saxton and Rawls.

Weather Data

On the basis of the location of the meteorological stations, Thiessen polygons or sub catchments were generated. Daily precipitation, maximum and minimum air temperature were used for the study area. The data has been collected from the BMD for the period of 1981 to 2012.

Climate Change Data

The 50 percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in **Table 9.3**. 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.

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

Source: Climate Wizard, Washington University

Table 9.2 Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for Polder 28/1.

	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

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

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

Source: IPCC AR4

9.4.2 Climate Change Impact on Water Level

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

level. CEGIS, recently conducted a study on climate change impact on stream flow for the GBM 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 the monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

From the model simulation, it has been found that the flood level adjacent to the polder area will increased by 60 cm for only the increase of sea level and by 7 cm for only the increase of upstream water flow. The combined effect of sea level rise and increase of upstream water results an increase of 70 cm increase of maximum water level of the rivers surrounding polder-28/1. The increase in flood water level might be a threat for the embankment and 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.

9.4.3 Climate Change Impact on Salinity

Sea level rise can cause saline water to migrate upstream to points where freshwater previously existed or can intensify the salinity. Several studies indicated that sea level rise would increase the salinity in estuaries, which would result in changes in stratification and estuarine circulation. Salinity migration could cause shifts in salt-sensitive habitats and could thus affect the distribution of flora and fauna. In addition to sea level rise, the decrease in flow during dry season can increase the salinity of rivers through encroaching seawater that moves upstream during periods of low flow.

To assess the impact of climate change and sea level rise on salinity, the delft 3D model has been utilized. It has been assumed that the dry season flow of the Gorai River will be reduced by 15% and 0.5 m of sea level rise has been considered for the scenario model setup. The model has been simulated for those two assumptions and the result has been compared with the base condition. From the simulation, it has been found that the salinity level of the rivers adjacent to the Polder 28/1 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.

9.4.4 Climate Change Resilience Developed in Polder 28/1

During field investigations it was found that the local people are mostly aware of the climate change consequences and events. In recent years they are the victims 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 are able to afford are now re-building their houses and infrastructures on a relatively higher level. Local people claimed that they would use the excavated Re-excavated earth from the internal khals for their household purpose if available. This will allow them to have their house and other infrastructures on a re-built higher land. The local farmers are now more concerned about climate change issues as well. They regularly follow and take part in the knowledge development and capacity building programs organized by Blue Gold Program, which they believe have enhanced their understanding and preparedness on flood and disaster management.

10 Environmental Management Plan

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

10.1 Water Resources

10.1.1 Pre Construction and Construction Phases

No significant positive or negative impacts on water resources have been foreseen during the both pre-construction and construction phases for implementation of proposed interventions in Polder 28/1. 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 Post Construction Phase on 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	Re-excavation works near dense settlements (near Dumuria, Sahas and Sarappur) are to be carried out using manual labour	Not required	-1	Blue Gold Program, Contractors and LCS
IESC: Saltwater Intrusion				
Significant impacts would be achieved regarding the prevention of saltwater intrusion inside the polder. Salinity values will drop from a foreseeable maximum of 7 ppts inside the polder to 'zero'.	Not required	Repaired sluice gates are to be operated and maintained properly to protect saltwater intrusion	+6	WMC and BWDB
IESC: Water Security				
More than 70% people inside Polder would be benefitted with sufficient freshwater availability and access result in immense benefits in domestic water use, irrigation, cattle, wild lives etc.	Not required	Not required	-	-
IESC: Tidal Flooding				
Almost 4500 ha area (below 3mPWD) protected from tidal flooding in future.	Not required	Not required	-	-
IESC: Erosion Vulnerability				
Vulnerable areas along Shoilmari river would be protected from probable river erosion.	Not required	Not required	-	-
IESC: Drainage Congestion and Water Logging				
Around 50% of khals adjacent to the periphery of the polder would be improved from drainage congestion problems.	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 the both pre-construction and construction phases for the implementation of proposed interventions in Polder 28/1. 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 measures for immitigable residual impacts as discussed in the following Table 10.2.

Table 10.2 EMP Matrix for Post Construction Phase on Land Resources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact / Magnitude (1-10) with EMP	Responsible agency
Single cropped area would decrease by 13% but double and triple cropped area would increase to 11%, 2% of the NCA respectively.	-	• Formation of WMGs (GPWM-2002). • Strengthening of WMGs through imparting training on proper management of structure and utilization of Re-excavated earth earth materials which will be generated from re-excavation. • Involvement of WMGs in project related different activities.	+4	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 have 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 bunch.		+3	BWDB and Contractors

10.3 Agriculture Resources

10.3.1 Pre Construction Phase

There would be no impact during pre-construction phase. So, there would be no EMP required for this phase.

10.3.2 Construction phase

In construction phase, crop production loss would occur due to construction of re-tired embankment. So, measures would be required in this phase (Table 10.3).

Table 10.3 EMP Matrix for Construction Phase on AgricultureResources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
About 12 tons of HYV Boro crop production would be lost.	Re-excavated earth earth materials and others waste should be managed properly.	-	0	BWDB, Contractors and WMGs

10.3.3 Post Construction Phase

There would be impact during post-construction phase. So, there would be measures required for this phase.

Table 10.4 EMP Matrix for Construction Phase on AgricultureResources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Cropping intensity would increase by about 15%.	-	• Involvement of WMGs in project activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs
Additional 5,500tons (43% higher) of rice and 5,950 tons (55% 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 project 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 by 850tons which would be about 68% 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.	+5	BWDB, DAE and WMGs
The irrigated area would be increased about 652 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

10.4 Fisheries Resources

10.4.1 Pre Construction Phase

There would be no impact during pre construction phase. So, there would be no EMP required for this phase.

10.4.2 Construction Phase

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

Table 10.5 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 fisheriesspecies like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, bele etc would be obstructed during repairing of structures. Moreover, fish hatchling movement would also be hampered, if the repairing works is implemented during hatchling period (May-June). • Turbidity of water willbe increased. Increased turbidity will inhibit to light penetration in water resulted photosynthesis of aquatic flora and fauna may be reduced. • Movement of some particular fish species like Cheng, Taki, Koi,Puti, Shing etc would 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-excavated 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)

10.4.3 Post Construction Phase

The implementation of 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 10.6.

Table 10.6 EMP Matrix for Post Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
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.	NA	• Excavated khal should keep free from encroachment • Awareness development on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area. • Apply IPM in agriculture field for protection of capture fish habitat quality.	+2	Department of Fisheries in coordination with WMC
Golda gher area would be increased by 2 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 would be hampered slightly. But internal fish migration would befacilitated 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	DoFisheries in coordination with pond owners.
Bagda production would be lost whereas rice cum golda production would be increased by 6 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 Phase

There would be no impact during pre construction phase. So, there would be no EMP required for this phase.

10.5.2 Construction Phase

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

Table 10.7 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 re-sectioning work.; • Relocation of wildlife due to habitat loss temporarily	• Implement plantation along the slopes of embankment after completing the earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: Construction of retired embankment				
• Permanently damages of herbs, shrubs, various types of grass and bushes due to construction 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	-2	Contractor and BWDB

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Activity: Re-excavation of khal				
• Water depended fauna as Skipper frog, Bullfrog, Kingfisher, Egret, common aquatic Snake, etc. will be temporary re-located due to habitat loss in the khal area. • No large tree only grasses will be damaged due to storage of soil along the both side of the khal.	•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

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

10.5.3 Post Construction Phase

The implementation of proposed interventions may generate some long term impacts on ecological resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts, enhancement for positive impacts and compensation, or contingency measures for immitigable residual impacts as shown in following Table 10.8.

Table 10.8 EMP Matrix for Post Construction 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.
Improve Aquatic flora and fauna due to improvement of plant diversity as well as khal depth and velocity	N/A	• Ensure regular maintenance/re-excavation of all khals when needed • Ensure proper maintenance of all water control structures	+2	BWDB and local stakeholder.

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

10.6 Socio Economic Condition

10.6.1 Pre Construction Phase

The implementation of proposed interventions may generate some long term impacts on social 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 10.9.

Table 10.9 EMP Matrix for the pre Construction Phase on socio economic resources

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

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

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 immitigable residual impacts as shown in following Table 10.10.

Table 10.10 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, about 25% of works will be done by labor contracting society (LCS) of which one third will be done by women LCS. 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

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

10.6.3 Post Construction Phase

The implementation of proposed interventions may generate some long term impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts, enhancement for positive impacts and compensation, or contingency measures for immitigable residual impacts as shown in following Table 10.11.

Table 10.11 EMP Matrix for Post-construction Phase on Socio-economic Condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
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

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

10.7 Re-excavated earth Management Plan (SMP)

The term 'Re-excavated earth' is used for soil or dirt resulting from excavation of earthen canals or khals, and discarded off site. Effective management of Re-excavated earth is necessary because its volume usually inflates three times after excavation. The Re-excavated earth may also cause other problems if not dumped in a planned and controlled manner. The physical quality of nearby water courses may be hampered due to transportation of debris, agricultural lands may be disrupted, and social conflicts may raise regarding site selection for Re-excavated earth dumping. It is therefore, important to transport and dispose the Re-excavated earth away from the excavation site in a

controlled and systematic manner, considering proper accounts of all the environmental and social issues of the area. Disposal may either be through mechanical equipment, or by manual means.

10.7.1 Framework Proposed for SMP

Polder 29 of Blue Gold program entails excavation of a number of khals which would generate a volume of around 73,200 m^3 of Re-excavated earth. This volume should be temporarily stored on the Khal openings to block the entry of flow. The rest should be used for different purposes before commencing the actual dumping process. The public consultation meetings of the EIA study inferred that the local people are willing to collect the excavated Re-excavated earth earth for their own household uses. **Figure 10.1** provides a framework which includes the major components of the proposed Re-excavated earth Management Plan for rehabilitation of 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.

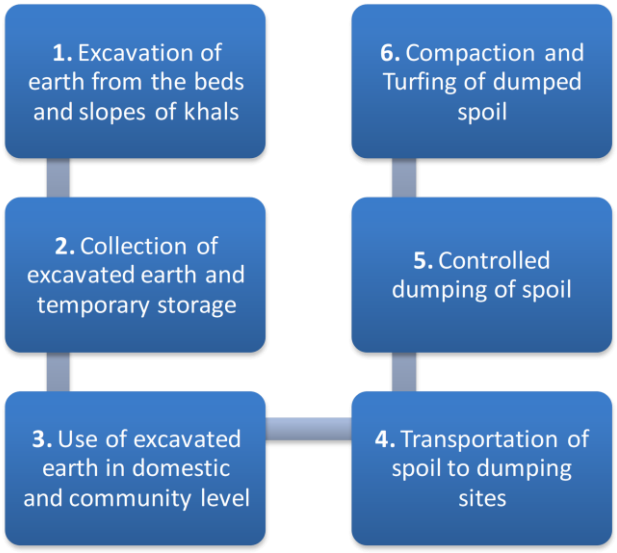


Figure 10.1 Framework for Re-excavate earth

Table 10.12 provides a tentative account of the volume of excavated earth, and its multifaceted uses proposed in the Re-excavated earth Management Plan. Around 40% of the excavated earth (75,000 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-excavated earth, and use it to fulfill their domestic requirements. The Re-excavated earth may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Re-excavated earth may also be collected and used on community basis to strengthen the basements and earthen portions of other rural sheds and shelters such as mosques, schools, community clinics etc. It is expected that around 36,800 m^3 Re-excavated earth would be collected by for different uses. The residual portion (around 1,85,000 m^3) of Re-excavated earth may then be disposed on both in a controlled manner.

Table 10.12 Tentative volume calculation and distribution of excavated Re-excavated earth

Khals to be Excavated	Excavated Volume (m^3)	Uses of Excavated Soil	Volume (m^3) to be used
Kata khal	24,000	Embankment Re-sectioning	75,000
Bakultala Diversion khal	6,100	Societal uses (uses in household, mosques, schools, clinics or other shelters)	36,800
Kanchan Nagar khal	23,700		
Asannagar - Keyakhali khal	36,000		
Ramakhali khal	32,500		
Mora Bhodra khal	20,000		
Telikhali Diversion khal	8,000	Dumping	73,200
Ruhitmari khal	14,000		
Aro khal / Taner khal	20700		
Total excavation	**1,85,000**	**Total Use**	**1,85,000**

10.7.2 Phase wise activities of Re-excavated earth Management

A number of activities are proposed to be carried out during different phases associated with efficient management of re-excavated Re-excavated 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-excavated earth. During implementation of re-excavation works of khals, a number of activities have been recommended as well. These activities would ensure the environmental sustainability and social viability of the excavation works. Moreover, some activities are suggested to be carried out to enhance the stability of dumping spots, and ensure the environmental sustainability of the area.

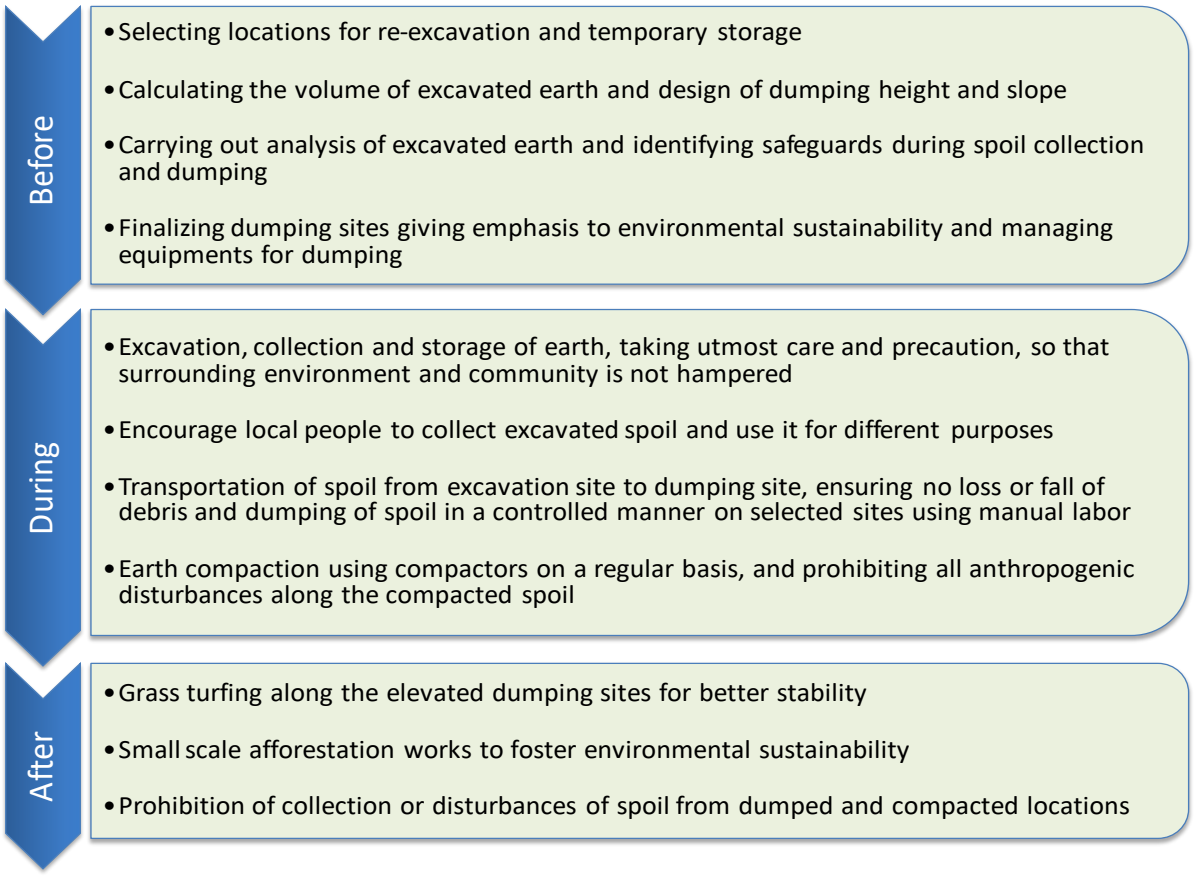


Figure 10.2 Phase wise activities of Re-excavated earth Management

10.7.3 Method of Re-excavated earth Dumping

The proposed re-excavation works for the Polder would require dumping of a significant amount of Re-excavated earth (around 73,200 m^3). For a 2.5 meter wide and 1 meter thick wedge, this equivalents to around 29.28 km length of dumped Re-excavated earth. Polder 28/1 includes about 16 km of re-excavation of khals, and if the re-excavated earth (about 121,200 m^3) is dumped on both sides of the excavated khals up to a height and width of 1 m and 2.5 m respectively, around 15 km lengths can be used on both sides. **Figures 10.3** and **10.4**below show the conceptual layouts of proposed dumping technique.

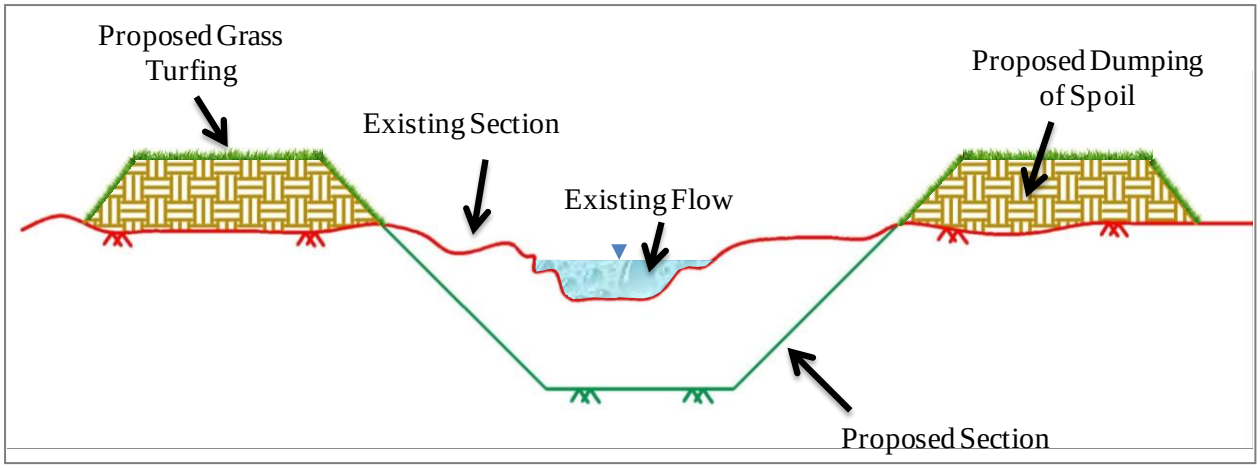


Figure 10.3 Conceptual Cross Section of a typical khal to be re-excavated

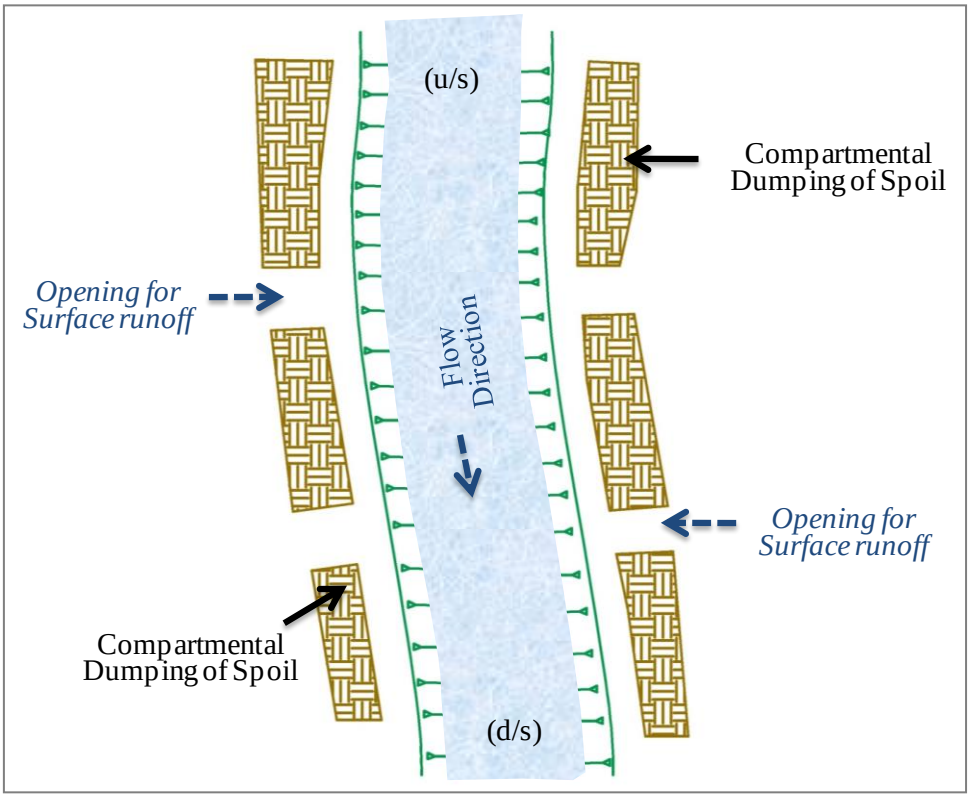


Figure 10.4 Plan form of a typical khal to be re-excavated

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-excavated 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 could be created along the sides of the excavated khals, so that surface runoff following rainfall events can enter the excavated khals and drain out properly.

10.7.4 Safety Measures and Precautions

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

- ✓ The laborers used for collection, carriage and dumping of Re-excavated earth should properly aware about the health and hygienic aspects.
- ✓ Sufficient washing and cleaning arrangements are to be in place for the LCS laborers
- ✓ Dumped Re-excavated earth needs to be compacted thoroughly, after the disposal upto a certain height (e.g. 6~8 inches)
- ✓ The works when are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, which may reduce the strength or stability of the dumped Re-excavated earth
- ✓ Dumping should be made firmly on the selected locations, and barriers or other measures may be provided on sensitive locations to ensure that no wastes from the dumped Re-excavated earth falls back into the water courses
- ✓ It should also be ensured that the dumped Re-excavated earth is not weathered and transported to any privately owned lands or lands 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 environmental and social component of the project in Polder 28/1.

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 28/1. The Monitoring report will be submitted to the concerned organizations as mentioned in the following checklist.

Blue Gold Team and Bangladesh Water Development Board

Blue Gold Program: Component-2

EMP IMPLEMENTATION

Book No. _____ Monitoring Report No._____

Date:_____ Time:_____

Contract:_____

Contractor:_____

Work Sites (s):_____

A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5	A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5
1	Correct dumping of re-excavated Re-excavated earth				4	Inconsistencies in water control structures repairing works			
2	Inconsistencies or mismanagement in embankment re-sectioning and retired embankment construction				5	Avoid the usage of heavy machineries at suggested locations to prevent noise pollution			
3	Proper compaction of earth materials on embankment				6	Any threat caused to river bank 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 Progra 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
Embankment Breaches and River Erosion	Field observation	Throughout the peripheral embankment of Polder 29	Once in a month (during monsoon and post-monsoon)	WMOs and BWDB

Land and Agricultural Resources

Indicator	Method	Location	Frequency	Responsible agency
Re-excavation of Khals, disposal of Re-excavated earth earth materials for Re-excavated earth management and construction of re-tired embankment etc.	Field observation.	Jaliakhali and Bara Aria (Khals and construction of re-tired embankment)	Weekly	Contractors and WMGs
Crop production and damage	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire project area	At harvest time of each cropping season (Will continue two years).	BWDB, DAE and WMGs
Irrigated area	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire project area	During Rabi season (Will continue two years).	BWDB, DAE, BADC and WMGs

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible Agency
Species diversity and	Catch monitoring/ observations and	Perennial khals and adjacent floodplain in	Twice per month in each location and	DoF in cooperation with water

richness of fish	local fish market survey.	inside the polder area.	continue two year.	management committee and local fishers.
Gher water quality	Field and laboratory test	Selective gher in the polder area	Monthly	Gher owner, 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 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 Program
Employment opportunities	RRA and observation	Whole polder area	Twice in a year	Blue Gold Program 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 project related activities would change positively.	1.50	1	Re-excavation of Khals, disposal of Re-excavated earth earth materials for Re-excavated earth management and repairing of embankment etc.	1.0
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 project activities would enhance crop production. • Introduction of HYV crops with crop diversification need to be practiced.	2.50	2	Crop production and damage	1.50
3	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area. • Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bundh. • The WMGs should be involved in the integrated water management through proper maintenance of sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.50	3	Irrigated area	1.50
	Total	**5.50**			**4.00**

Total Cost for EMP and Monitoring of land and agricultural resources is**Taka 9.50 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.	2.5	1	Fish hatchling movement in six khals (Two year).	1.0
2	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring) (Training 1.5 Tk and demonstration pond 0.5 Tk) (Number of pond :4 pond area: about 100 decimal)	2.0	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	2.0
	EMP Cost	**2.5**		**Monitoring Cost**	**3.0**
	Total cost	**5.5**			

Total Cost for EMP and Monitoring of fisheries resources is **Taka 5.50 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 (16.38+27.30=43.68) km length of embankment	28.04	1.	Habitat develop	3
			2.	Wildlife diversity	2
	Total	**28.04**		**Total**	**5**

Total Cost for EMP and Monitoring of ecological resources is **Taka 33.04 Lakh**

10.9.5 Cost of EMP and monitoring of socio-economic condition

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

10.10 Summary of cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost
Water Resources	-	-	-
Land and Agricultural Resources	5.50	4.00	9.50
Fisheries Resources	2.50	3.0	5.50
Ecological Resources	28.04	5.0	33.04
Grand Total =	**36.04**	**12.0**	**48.04**

Total cost of EMP and monitoring is BDT 48.04 lakh (taka forty eight lakh and four 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 Conclusion 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 28/1 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 28/1. The proposed interventions will bring about huge beneficial effects for the inhabitants inside the polder e.g. drainage congestion will be removed from 50% 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. 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,		Salinity:

pH, DO, TDS, BOD, COD)		pH: DO: TDS: BOD: COD:
*Note: It can be extended according to Client demands		
E. Pollution status (people's perception)		
1. Source of pollution		
2. Type of effluent		

F. Water Use

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

G. Historical severe flood:

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

H. People's opinion about the project

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

I. Collect Project description related information from field office:

Name of re-excavation Khals with length
Catchment area of the Khals
Outfall information of Khals
Drainage network of Khals
Drainage pattern of Khals
Cross section of Khals with other design information
Re-excavation length of individual Khal and volume of earth Re-excavated earth
Location specific Re-excavated earth management plan for individual khal

Sl	Name of Khal	Location-dumping of Re-excavated earth earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
1						
2						
5						

Sl	Name of Khal	Location-dumping of Re-excavated earth earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
10						
..						
..						

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

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

Stockyard information during construction time:

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

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

Agro-ecological regions

Name of AEZ	**Area (ha)**	**%**	**Soil characteristics**

Land use

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

Land type

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

Soil Texture

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

Soil Salinity

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

Farming practices

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

Major Cropping Pattern by land type

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

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

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

Inputs Used

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

Irrigation

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

Crop production constraints (including land degradation)

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

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

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

Feed and Fodder

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

Diseases

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

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

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

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

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

Fish Migration					**Fish Biodiversity**		**Species List**					**Species Composition**				
							River	**Khal**	**Beel**	**Pond**	**Other**	**Group**	**River**	**Khal**	**Beel**	**Pond**
Previous Migration Status					Fish diversity status (Poor/Moderate/Rich)/%							Major carp				
												Exotic carp				
												Other carp				
												Catfish				
												Snakehead				
Present Obstacle to fish migration:	1. 2. 3.				Reasons of increase or decrease	1. 2. 3. 4. 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.				Unavailable:						Chapila				
	5.										Others				

Post Harvest Activities		Fishermen Lifestyle	
Fish edible quality:		Socio-economic Status of subsistence level fishermen:	
Source of pollution in each habitat:		Socio-economic Status of Commercial fishermen:	
Seasonal vulnerability:		Other conflict (with muscle men/ agriculture/ other sector/laws):	
Ice factory (Number, location and name):		Fishermen 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			

[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

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

Present status and negative impacts on flora & fauna

Impacted Species	Existing Status	Cause of impact

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

Victim Species	Anticipated Impact	Cause of impacts

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

☐ Yes ☐ No

How	

Ecosystem Services

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

Presence of Important Ecosystem (If any)

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

Note (If any):

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

Facilitation Information

Name of Facilitator	
Date of Facilitation	

Project Information

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

Study Area

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

Educational Institution

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

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

Disease Prevalence

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

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

Health Facilities

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

Peripheral Health Facilities (if any)

Number	
Name	
Description/status	

Sources of Treatment Facilities

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

Electricity Coverage

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

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

Income and Expenditure

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

Labor and Wage

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

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

Self Assessed Subsistence Poverty

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

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

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

Disaster and Damage (in last five years)

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

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

Migration Trend

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

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

Professional/occupational Conflict

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

Miscellaneous

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

Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

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

Appendix-2: No Objection Certificate

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 ঃ ১৯/০২/১৭ 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 বিয়য় 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।

২৩/২/১৭
এস.এম. সাইফুর রহমান
ভূমি অধিগ্রহণ কর্মকর্তা
খুলনা

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

Director of Planning
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,

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- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste
- Economy and employment: employment structure and cultural issues in employment
- Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Conclusion and Recommendations

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

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

V. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the no objection certificates (NOCs) from the local authority, NOCs from forest department (if it is required in case of cutting any forested plants/trees of private or public) and NOC from other relevant agencies for operational activity etc. to the concerned divisional offices of DOE with a copy to the Head Office of DOE in Dhaka.

15.02.2015

(Syed Nazmul Ahsan)
Director (Environmental Clearance)
Phone # 02-8181778

Program Co-ordinating Director
Blue Gold Program
Bangladesh Water Development Board
Planning-III, Hasan Court (7th and 8th Floor)
23/1, Motijheel C/A, Dhaka-1000.

Copy Forwarded to :

1) Director, Department of Environment, Khulna/Barisal Divisional Office, Khulna/Barisal.
2) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

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