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 27

January 2020

Table of Contents

List of Tables

List of Figures

List of Photographs

List of Maps

Abbreviation and Acronyms

ADB	Asian Development Bank
AEZ	Agro -ecological Zone
ASA	Association for Social Advancement
AWD	Alternate Wetting and Drying system
BANCID	Bangladesh National Committee of ICID
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BG	Blue Gold
BMD	Bangladesh Metrological Department
BNBC	Bangladesh National Building Code
BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBO	Community Based Organizations
CDSP	Char Development and Settlement 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	Dissolve 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
FES	Fishing Effort Survey
FGD	Focus Group Discussion
FGs	Functional Groups
FMD	Foot and Mouth Disease
FS	Frame Survey
FPCO	Flood Plan Co-ordination Organization
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 Forest
MoWR	Ministry of Water Resources
MP	Murate of Potash
MSL	Mean Sea Level
MT	Metric Ton
MW	Mega Watt
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NDVI	Normalized Difference Vegetation Index
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NIR	Near- Infrared
NOCs	No Objection Certificates
NWRD	National Water Resources Database
O and M	Operation and Maintenance
OHP	Occupational Health and Safety Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Peste des 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 Organizations

Glossary

Aila Major Cyclone, which hit Bangladesh coast on May 25, 2009

Aman A group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-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, common in the rural areas.

Khal A drainage channel usually small, sometimes man-made, 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 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.	:	27 (Consisted of two sub-polders 27/1 & 27/2), Khulna Satkgira road run through these two coomponents
District	:	Khulna
Upazila	:	Dumuria
Union	:	Rangpur, Ghutudia, Dumuria Sadar and Kharnia
O&M Division of BWDB	:	Khulna O&M Divison-1
Gross Area (ha)	:	4260 ha (Polder 27/1, 3765 ha + Polder 27/2, 495ha)
River	:	The polder is surrounded by the upper Shoilmari (east), Upper Shalta (south) and Hamkura (north and west) rivers.

Major Water Management Infrastructure

Embankment (km)	:	45.71 (Polder 27/1, 30.42 km + Polder 27/2, 15.29km)
Regulator/Sluics (nos.)	:	11nos (Polder 27/1, 08nos + Polder 27/2, 03nos)
Khal (km)	:	72km

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 ar per revised RDPP(1st Revision) compliion target is 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 27.

Objective

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

Approach and Methodology

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

Project Description

Polder 27 covers Rangpur(P), Ghutudia(P), Dumuria Sadar(P), Kharnia(P) of Dumuria Sadar upazila, Khulna district. The polder was constructed in 1967 – 68 by the Bangladesh Water Development Board (BWDB) and was recently rehabilitated under the IPSWAM project from 2003 – 2011. The polder is located in the South-West hydrological region of Bangladesh, with administrative jurisdiction lying within the Khulna O&M Division - 1, BWDB, Khulna. This polder is surrounded by the Upper Shoilmari, Hamkura and Upper Shalta River. Khulna-Satkhira Road is run through this Polder along east-west divided into two sub-polders.

Existing Problems and the Proposed Interventions

The Polder is encircled with embankment having length of about 20 km of and providing protection against tidal and storm surges and salinity intrusion. There are three drainage sluices and a few number of drainage khals. The existing condition of the embankment is good in most of the portion; only 5% of the peripheral embankment is paved, which allow vehicular movements in dry season. Drainage sluices of this polder became redundant as the surrounding rivers have nearly been silted up. Out of the three drainage sluices, one is now under-construction and another one needs repairing. As a result, these cannot fulfill the public needs. Unauthorized public cut of embankment is injurious and threat to the polder area. The overall condition of the internal drainage channels of Polder 27 is pretty good except siltation problem of the khals namely; Baorer khal, Dangar khal etc.

Considering the existing problems and needs of local residents, the Blue Gold program has considered the following interventions for rehabilitation of Polder 27:

- **Re-sectioning of the existing embankment** with crest width of 4.27m, with side slopes of 1(V): 3(H) in the river sides and 1(V):2(H) in the country sides, with an exception of 1(V): 2(H) on both river and country side. A total length of 6.20 km will be re-sectioned.
- **Repairing of eight numbers of drainage sluices**;
- **Re-excavation of 10 nos of khals** inside the polder for a length of 33.22 km.

Environmental and Social Baseline

The project area experiences tropical climate. The average temperature ranges from 19°C (January) to around 29°C (April). The maximum rainfall ever recorded in the area is 343 mm in the month of July and lowest 7 mm in the month of December. The monthly average relative humidity of the Khulna BMD station varies from 73% to 88%. Daily average sunshine hours are more than 7 hours which reduces to 5 hours from June to September. Wind speed of the polder area is highest in April (around 160kph) and lowest in November (around 40 kph).

Elevation of about 48% of the land inside the polder is in between 1.26 and 1.73 m +PWD, while 43% lands below 1.26 m, PWD. The study area falls under Zone-I, which is a low earthquake prone site. In consideration with the seismicity and stratigraphy, Polder 27 falls under a relatively safer (seismically quiet and tectonically stable) site.

The polder is covered by two AEZ i.e. High Ganges River Floodplain (AEZ-11) and Ganges Tidal Flood Plain (AEZ-13). The gross area of the polder is about 2,664 ha of which net cultivable area (NCA) is about 1,993 ha. About 67% of NCA exists in "Non saline with very slightly saline (S1)" soil salinity class and 94% NCA characterized in poorly drainage. Most prominent cropping pattern of this polder is "Fallow –HYV T Aman – Boro", which is practiced in 40% of the NCA and cropping intensity is about 143%. Annual total crop production stands at about 9,637 tons of which 8,552 tons are rice and 1,085 tons are non-rice.

The Polder is within an aerial distance about 85 km from the coast of the Bay of Bengal. The polder is surrounded by tidal rivers by the upper Shoilmari (east), Upper Shalta (south) and Hamkura (north and west) rivers. Water levels during high tide ranges from 1.7 to 2.3 m +PWD, during the low tide water levels range from 0.7 to 1.2 m below the MSL.

The polder area is diversified with brackish and fresh water environment containing about 245 ha. of fish habitat. Rice cum golda are mainly is cultured in the polder area. Total fish production is about 103 M. Ton, half of which comes from rice cum golda cultivation. One of the Bio-ecological zone namely the Saline Tidal Floodplain falls inside the polder. Homestead and Crop field vegetation are the main floral pattern of the polder which performs major ecosystem services. Soil salinity and internal canal bed siltation are the main threats on ecosystems of this polder. More than 60% households of the polder are rearing cattle and chicken and having 50-70 poultry farmers inside the polder.

The surface water quality of both Periphery Rivers and internal khals has been measured. The pH values at different locations are higher than neutral scale and measured highest in Barobeeler Khal inside the polder. Average Salinity of the river systems in dry season about 8 ppt.
A total of 15,175 people are living in this polder. Average literacy rate is 60%. About 100% household drink tube well water and about 40% of household use water sealed sanitary latrine. It is reported that about 55% of households are in the balance or breakeven poverty status.

Prediction and Evaluation of Potential Impacts

The proposed interventions considered for rehabilitation will affect a number of environmental and social components either positively or negatively. It is expected that water quality of the distributaries will be improved from possible saltwater intrusion and salinity concentrations in the surface water system would drop to 'nil'. As such, 15% of the people would have sufficient freshwater. With proposed improvement/development works, around 80% of the khals adjacent to the Hamkura River, Upper Shoilmari river and upper Salta river would be improved from drainage congestion.

After completion of the interventions, the cropping intensity is expected to be increased by 9% and additional 2,330 tons (32% higher) of rice and 725 tons (101% higher) of non-rice would be produced. Again, the damage of rice crop would be reduced by about 750 M. ton. Irrigated area would be increased by about 155 ha for increase of water conveyance capacity of the proposed re-excavated khals. For ensured fresh water in the internal khals, rice cum prawn (golda) culture is expected to expand by more than 15%. Overall, floral and faunal habitat will be improved and increased. Finally, the income of the local people will increase and promote the income level.

Environmental Management Plan

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

- Prepare and implement well adaptive water management plan and strengthen the water management groups for proper utilization of surface water for agriculture
- Ensure regular O&M of all water control structures and avoid encroachment of the drainage khals
- Implementation of the proposed interventions should be avoided in monsoon, especially from May to July which is very crucial for fish migration.
- Re-excavation activities should be carried out in segment wise to protect the indigenous fishes and aquatic fauna
- Introduce crop rotation with leguminous crops and IPM, application of organic and green manure in crop production to improve soil fertility of the project area
- HYV boro cum golda practice should be practiced
- Ensure engagement of local labor and the payment of proper wages in all construction and O&M activities

In addition, 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 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 because of having (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. 22 polders from these three districts are included in the program, as illustrated in Table 1.1.

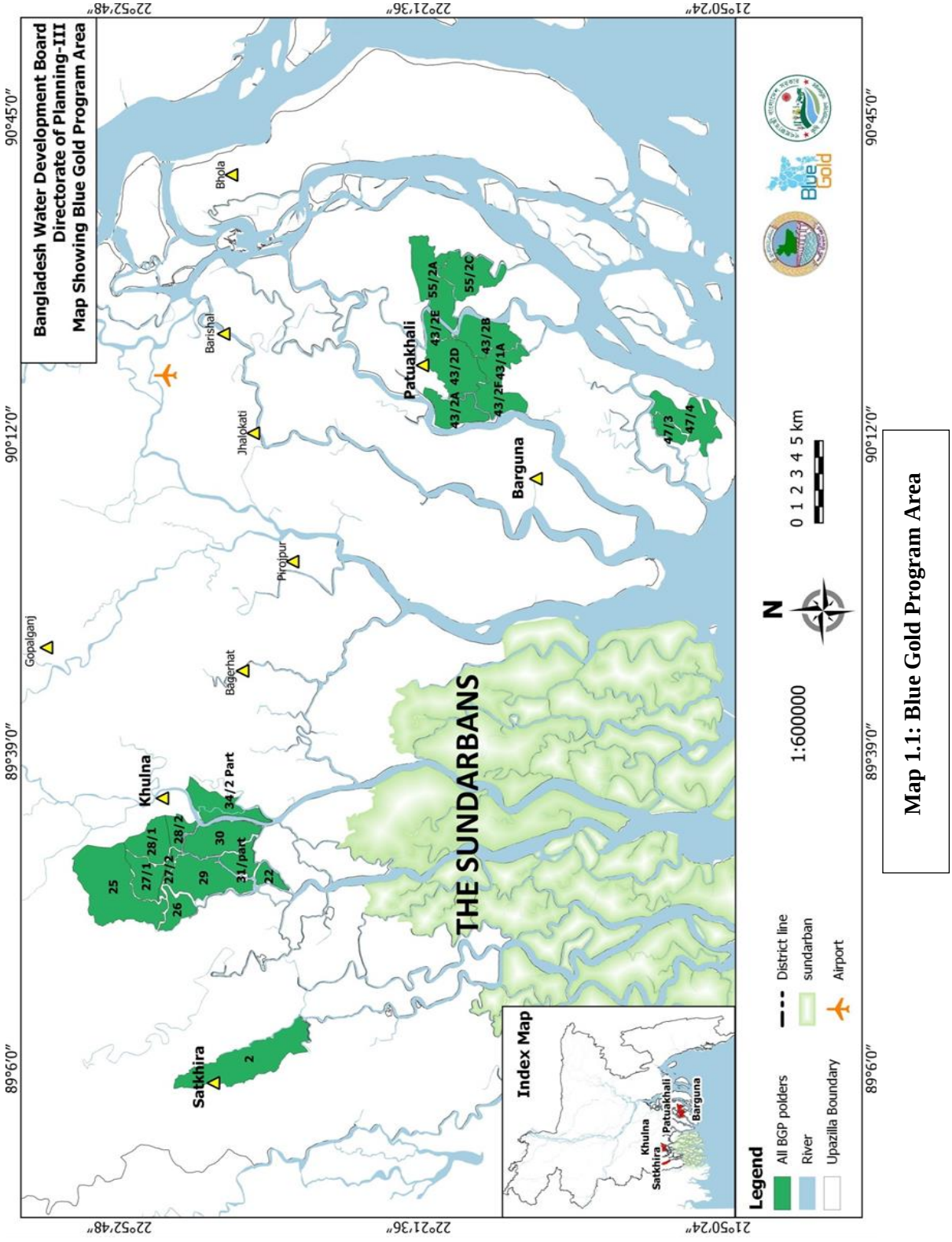
Table 1.1: District wise distribution of polders under BGP

Districts	Number of Polder
Patuakhali and Barguna	10
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.



Map 1.1: Blue Gold Program Area

1.2 Rationale of the Study

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

Component (ii) of the Blue Gold Program includes rehabilitation of water resources management infrastructure in selected polders. Polder 27 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

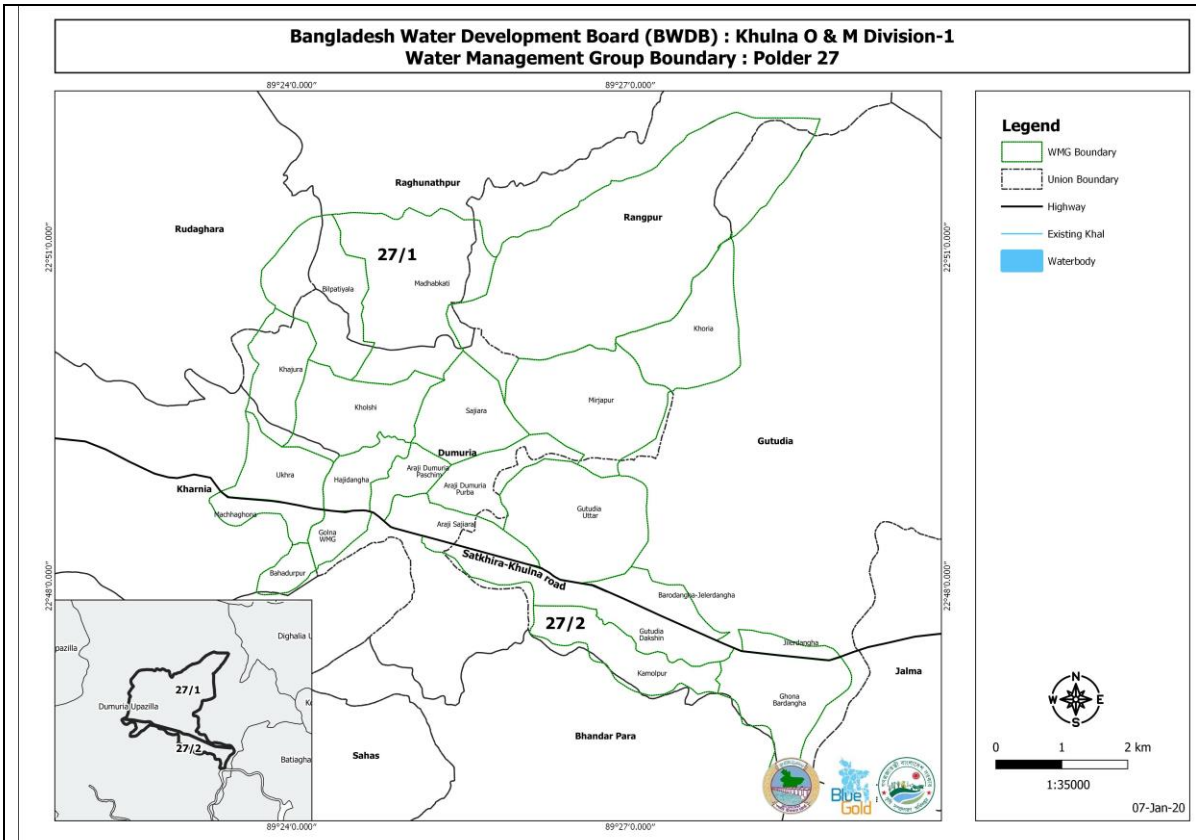
Polder 27 (with gross area of 4260ha) constituted with two units or sub-polders, Polder 27/1 (with area of 3765ha) and Polder 27/2 (with area of 495ha), divided by the Satkhira- Khulna road(Map 1.2). Polder Polder 27 is managed by the Bangladesh Water Development Board (BWDB) and was constructed during 1963-65 and later was rehabilitated under the KJDRP project from 1996 to 2002. It is located mostly in Dumuria, Rangpur and Gutudia unions of Dumuria upazila under Khulna district. It is surrounded by Shalta River in its South, upper Shoilmari River in the East and Vodra River in the Western part. Polder 27/2 is also managed by the Bangladesh Water Development Board (BWDB) and was constructed during 1974-76 and later on was rehabilitated under the KJDRP project from 1996 to 2002. It is located in Gutudia union (part), Dumuria Sadar union (part) and Kharnia union (part) under Dumuria upazila, Khulna district. It is surrounded by Upper Shalta river in the south, Upper Shoilmari River in the east and Mora Bhadra and Hamkura river (dead) in the west.

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) and the food security and agricultural production component (component iii) need to be taken into special consideration.



Map 1.2: Map of Polder 27

1.5 Scope of Work

The scope of works of the assignment is summarized below.

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

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

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

iv. Determine the potential impacts from the project through identification, analysis and evaluation on sensitive areas.

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

vi. Prepare a landuse map and ground truthing.

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

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

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

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

1.6 Limitations

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

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.
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1.8 Report Format

This EIA report consists of the following 11 (eleven) chapters:

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

Chapter 2: ***Policy, Legal and Administrative Framework*****:** This chapter 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: ***Public Consultation and Disclosure:*** This chapter gives an overview of the public consultations held in the project sites as well as disclosure and results including methodology, public 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 before making specific recommendations for implementation of the EMP.

2 Policy, Legal and Administrative Framework

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

2.1 National Policies and Legislations

The National Environment Policy, 1992

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

National Environmental Management Action Plan (NEMAP) 1995

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

The National Water Policy, 1999

The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. (website: http://warpo.gov.bd)

The National Biodiversity Conservation Strategy and Action Plan for Bangladesh 2004

The Biodiversity Conservation Strategy and Action Plan 2004 (BCSAP) is a wide ranging and multi-faceted plan, which is also closely related to the statements set out in the National Environment Policy. (website: http://warpo.gov.bd)

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

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

National Water Management Plan, 2001 (Approved in 2004)

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

Coastal Zone Policy, 2005

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

Coastal Development Strategy, 2006

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

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

2.2 Legislation, Act and Rules

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

The Embankment and Drainage Act 1952
This is an Act that consolidate the laws relating to embankment and drainage and make better provisions for the construction, maintenance, management, removal and control of embankments and watercourses or better drainage of lands and for their protection from floods, erosion or other damage by water. (website: bdlaws.minlaw.gov.bd)

The Inland Water Transport Authority Ordinance, 1958 (E.P. Ordinance No.LxxvOf 1958)
This is an Ordinance to set up an Authority for the development, maintenance and control of inland water transport and certain inland navigable waterways in Bangladesh. The Authority is mandated to perform any other function such as, carrying out river conservancy work, including river training for navigation purposes and aiding navigation; drawing up programs on dredging requirements and priorities for the efficient maintenance of existing navigable waterways; and reviving dead or dying rivers, channels, or canals, including developing new channels and canals for navigation. (website: bdlaws.minlaw.gov.bd)

The Government Fisheries (Protection) Ordinance, 1959 (Ordinance No. Xxiv Of 1959)
This Ordinance provides power to the government to declare any area as "Khas managed fishery" to bring it under the management and control of the government. No person shall fish in such an area without a valid fishing license issued by such authority as may be prescribed under the Act. (website: bdlaws.minlaw.gov.bd)

The Bangladesh Irrigation Water Rate Ordinance, 1983 (Ordinance No. XXXI of 1983)
An Ordinance to consolidate and amend the law related to the imposition of a water rate for the supply, regulation or storage of water for irrigation or drainage purposes. Water rate can be imposed, whenever the government is of the opinion that lands within any area is benefited or is likely to be benefited by water supplied or regulated by the government or the Board or the Corporation through any canal during any financial year. The Government may, by notification, declare its intention to impose in such area, hereinafter referred to as the notified area, a water rate for such financial year provided that the water rate so specified for a crop season shall not exceed such rate as may be prescribed and provided further that the water rate intended to be imposed may vary from one notified area to another. (website: bdlaws.minlaw.gov.bd)

The Ground Water Management Ordinance, 1985 (Ordinance No.XxvitOf 1985)
This is an Ordinance to manage ground water resources for agricultural production. (website: bdlaws.minlaw.gov.bd)

The Protection and Conservation of Fish Rules (1985)
These are a set of rules in line with the overall objectives of the Fish Act. (website: http://www.fisheries.gov.bd)

Panishampad ParikalpanaAin (Water Resource Planning Act, 1992)
Under this Act, the government is authorized to set up a Water Resource Planning Organization (WARPO), which would prepare a master plan for the development of water resources and through a technical committee, advice all other agencies related to the issue of water resource development use. (website: http://warpo.gov.bd)

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

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

The Wildlife (Preservation and Security) Act, 2012

An Act to provide for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. Bangladesh after her liberation took initiatives to combat wildlife crime and secure and preserve wildlife population along with many other development challenges. In 1973 President promulgated an Order, namely, Bangladesh Wild Life (Preservation) Order, 1973 (President's Order No. 23 of 1973). To accommodate new provisions in law for coping with changed situations, in 2012 parliament passed another Act, namely, The Wildlife (Preservation and Security) Act, 2012. The Act of 2012 has enabled the government to form a "Wild life Advisory Board" comprised of experts. The Board will assess present condition and give direction from time to time in relation to development and management of biodiversity, wildlife and forest. On the contrary Chief Warden, Additional Chief Warden and Warden have been assigned to look after overall development and management of them. Chief Conservator of Forest, Conservator of Forest and Divisional Forest Officers will carry out the duties of Chief Warden, Additional Chief Warden and Warden respectively by dint of their official capacity (https://bforest.portal.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)

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

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.

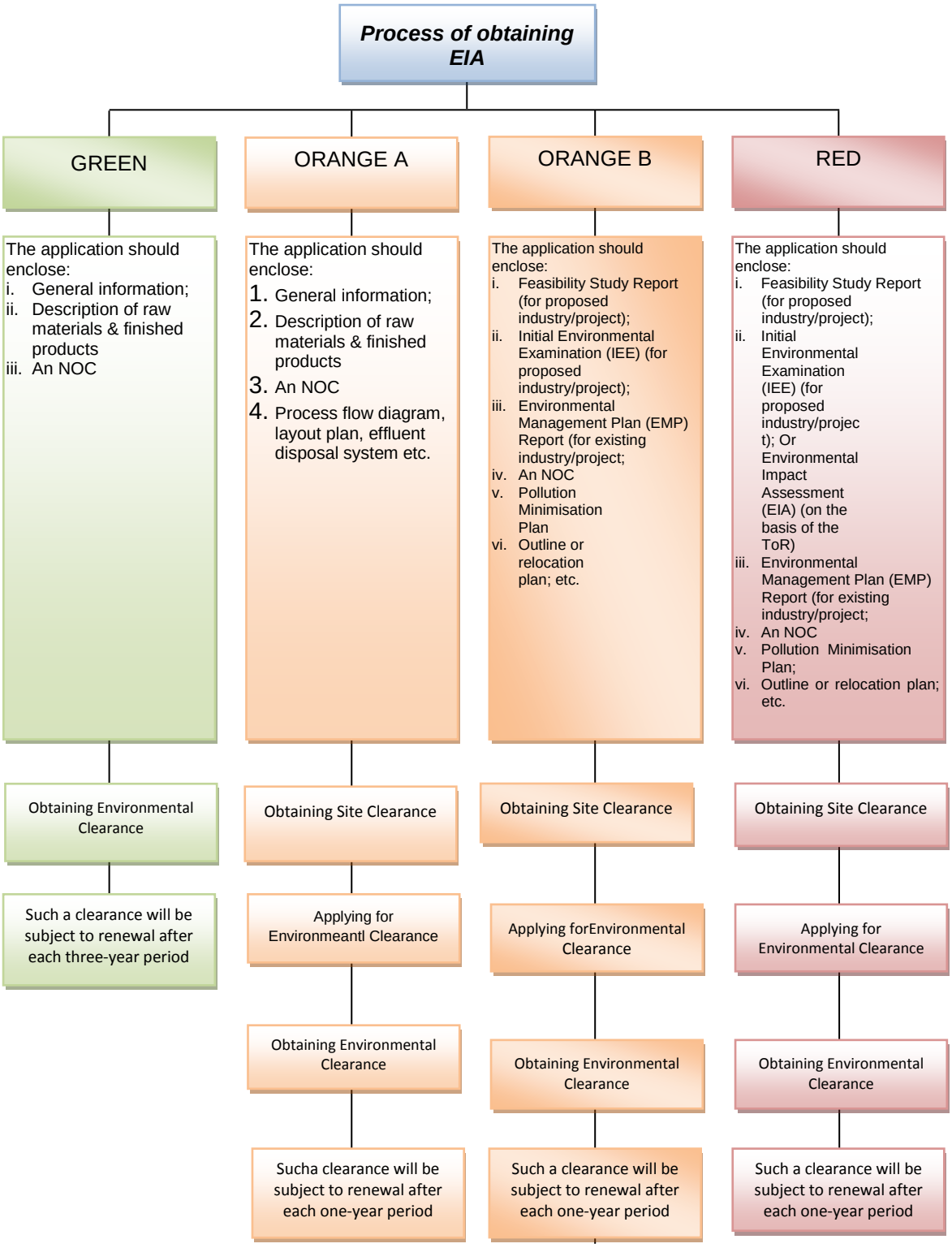


Figure 2.1 Steps Involved in Environmental Clearence folllowing DoE Clearence

3 Approach and Methodology

3.1 EIA Process

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

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

Figure 3.1: The EIA process

3.2 Project Design and Description

The rehabilitation activities i.e. interventions which are to be implemented under the 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 27 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 27 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 Upper Shoilmari River and Upper Sholta 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 and Soil 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 level 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 last three years.

3.3.6 Livestock Resources

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

3.3.7 Environmental Quality

Under the environmental quality component, noise and water quality were measured at different selected locations in Polder 27. One suitable site was selected at Sovna Union Parishad to measure sound levels and compare the standard levels and in-situ values. The location was also 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 were collected in multiple ways which can be broadly classified into two classes, for instance, (i) primary data and (ii) secondary data. Primary data were collected from the fisher community, fisher households and local key informants 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 categorized into capture & 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 habitat assessment was made 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 habitat assessment was performed 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. 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 has been collected from the publication of International Union for Conservation of Nature (IUCN). For ecological baseline, data on terrestrial and riverine ecology including flora, birds, reptiles, amphibians, mammals, and migratory birds were collected. The field activities included collection of ecosystem and habitat information, 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. was collected form secondary sources, i.e. the 2011 publication of Bangladesh Bureau of Statistics (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 was 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, 2011;

b) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;
c) PRA /RRA, FGDs, KII for primary data collection; and
d) Institutional Survey (IS) for primary data collection from upazila level offices like Local Government Engineering Department (LGED) office, Civil Surgeon's office, Social Services office 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 27'. Scoping was done 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 27' 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 the 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 13 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. I 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 for their 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 27' have been assessed through several sets of activities. Impacts are generated for the interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of the difference between the future-without-project (FWOP) conditions and the future-with-project (FWIP) conditions. FWOP conditions are generated through trend analysis and consultation with the local people. This reflected the conditions of IESCs in absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions are assessed to generate the FWIP conditions. Comparison and projection methods are used for impact prediction. This included both positive and negative impacts which are considered in preparation of the environmental management plan.

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

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

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

data, river network, cross-section, water level, discharge and salinity data have been used for modelling exercise.

3.8 Impact Quantification and Evaluation

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

3.9 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.

3.10 Magnitude

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

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

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

Table 3.1: Parameters for determining magnitude

Parameter	Major	Moderate	Minor	Negligible/Nil
Duration of potential impact	Long term (more than 35 years)	Medium term lifespan of the project (5 to 15 years)	Less than project life span	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and	Breaches national standards and or	Complies with limits given in national	Meets minimum national standard	Not applicable

Parameter	Major	Moderate	Minor	Negligible/Nil
established professional criteria	international guidelines/obligations	standards but breaches international lender guidelines in one or more parameters	limits or international guidelines	
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

3.11 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

3.12 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.

3.13 Environmental Management Plan

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

3.14 EIA Report Preparation

At the end of the process, the present report on "Environmental Impact Assessment of Rehabilitation of Polder 27" 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 27 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 27/1 is managed by the Bangladesh Water Development Board (BWDB) and was constructed during 1963-65 and later was rehabilitated under the KJDRP project from 1996 to 2002. It is located mostly in Dumuria, Rangpur and Gutudia unions of Dumuria upazila under Khulna district. It is surrounded by Shalta river in its South, upper Shoilmari river in the East and Vodra River in the Western part. Polder 27/2 is also managed by the Bangladesh Water Development Board (BWDB) and was constructed during 1974-76 and later on was rehabilitated under the KJDRP project from 1996 to 2002. It is located in Gutudia union (part), Dumuria Sadar union (part) and Kharnia union (part) under Dumuria upazila, Khulna district. It is surrounded by Upper Shalta river in the south, Upper Shoilmari River in the east and Mora Bhadra and Hamkura river (dead) in the west.

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 27. Based on field investigation the study team gathered the following information regarding the status of existing infrastructure.

Embankments

The length of the Embankment of Polder 27 is 45.71 km (Polder; 27/1 30.42km + Polder 27/2; 15.29km) with top width 4.27 m. The crest level is 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 Khajuria 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 of polder 27

Water Control Structures

There are 11 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 Tiabunia, Komolpur and sostitola is in vulnerable condition.

Photo 4.2: Existing Status of (a) Magurkhali Sluice and (b) Tiabunia Sluice at Polder 27

4.5 Present Status of Drainage Khals and Rivers

There are total 23km of Khals reconised. 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 few khals namely shostitola Khal, Magurkhali khal, Khoria khal, Tiabunia khal, Komolpur khal, Dowania branch khal are badly silted up and hence, create drainage congestion in the adjacent area which needs re-excavation.

4.6 Problems and Issues in the Polder

Major Khals are blocked by cross dams. Hamkura River is fully silted that totally blocks the drainage from the western part of the polder. Two sluices, Khajura and Boloikhali, on this river are totally blocked and inactive. Water flow from Beel Dakatia and Thukra areas come down through Ghonerdara khal and inundates this polder, especially Rangpur mouza, because of damaged internal dikes on both side of this khal.

60% of Jilerdanga, Bordanga, Tiabunia and South Kata Khali beel are water logged from July to September/October. The Upper Shalta is the main outfall but it is partially silted up.

*(**a**) Shostitola khal, (**b**) Khoria khal , (**c**) Magurkhali khal, (**d**) Tiabunia khal*

Photo 4.3: Drainage Khals within the polder 27

4.7 Proposed Interventions in Polder 27

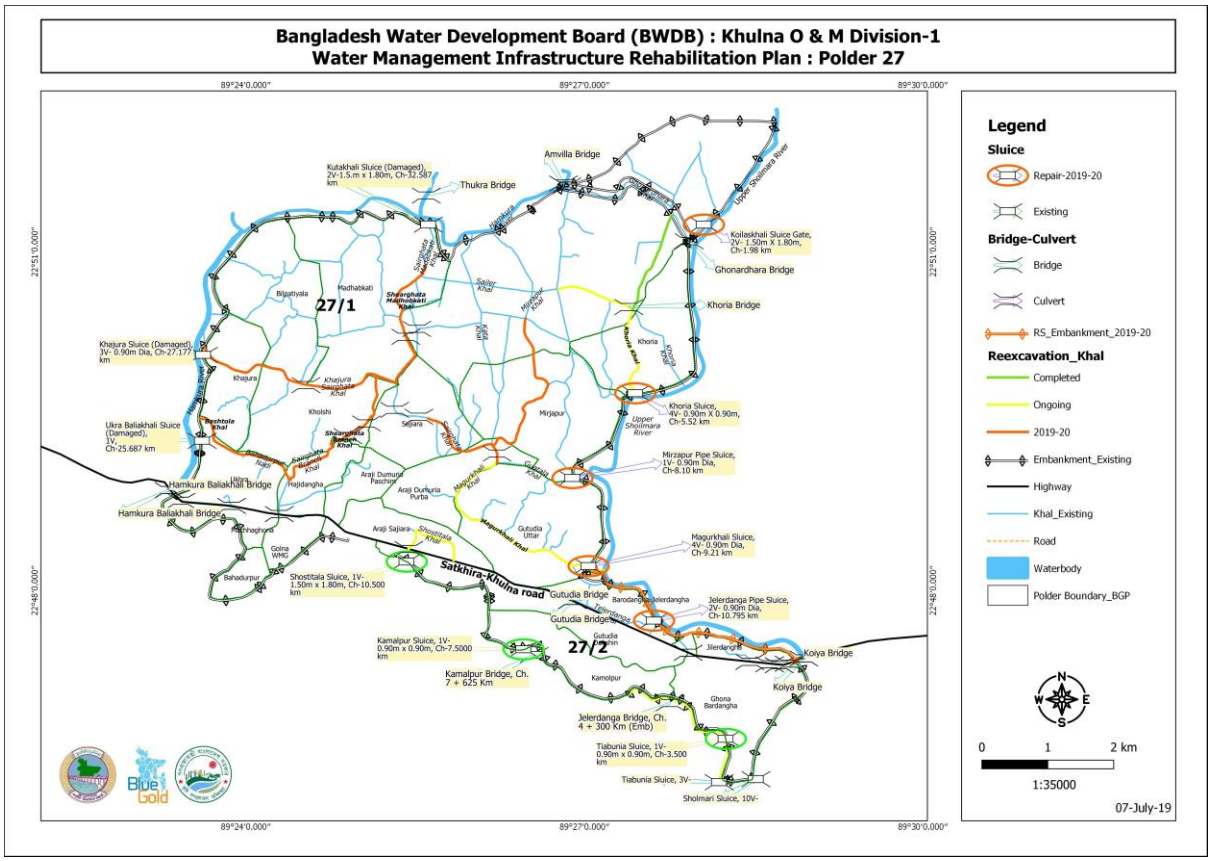
Taking the status of existing infrastructures into account, and the problems resulting from their damaged state, the Blue Gold Program has the following category of interventions in Polder 27. The locations of interventions have been shown in Map 4.1.

4.8 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 above Mean Sea Level. A total of 6.20 km of embankment will be re-sectioned.

4.9 Repairing of Water Control Structures

Some sluices among all existing sluices of BWDB within the polder 27 will be repaired. Some sluices would require new shafts and wheels. Details of all interventions to be undertaken are presented below from **Table 4.1.**



Map 4.1: Location of the proposed interventions of Polder

Table 4.1: Detail information on proposed repairing of Drainage Regulator/Sluices

Sl. No.	Name	Number of Vent	Vent Size (m)	Chainage (km)
1	Magurkhali pipe Regulator/sluice.	4	0.90 m dia	9.210
2	Koilashkhali Regulator/sluice.	2	1.90mx2.10m	1.980
3	Jelardanga pipe Regulator/sluice	2	0.90 m dia	10.795
4	Khoria pipe Regulator/sluice	4	0.90 m dia	5.520
5	Mirzapur pipe Regulator/sluice	2	0.90 m dia	8.100
6	Tiabunia Regulator/sluice	1	0.90mX1.20m	3.400
7	Kamalpur Regulator/sluice	1	1.50mX1.80m	7.500
8	Shoshthitala Regulator/sluice	1	1.20mX1.50m	10.240

Source: Blue Gold Program;
Note – all the Regulator/sluice are for reapir only, no change in size or number of vents

4.10 Khal Re-excavation

Total 10nos of khals in Polder 27 are considered in the re-excavation plan of Blue Gold program. The total length to be re-excavated is around 23 km with tentative volume of erth to be re-excavated 224,000 cu-m. The names of the khals and lengths to be re-excavated are shown in Table 4.2.

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

Sl. No	Name of Khal	Length (Km)	Tetetive Volume (cu-m)
1	Gonardara Khal	1.584	29030
2	Shostitola khal	3.550	8225
3	Magurkhali khal	1.400	29535
4	Khoria khal	2.692	27986
5	Shairghati Branch Khal	2.608	8265
6	Shairghati -Madabkati Khal	2.292	15795
7	Khajura-shairghata khal	3.275	52000
8	Tiabunia Khal	1.580	25332

9	Komolpur-Dowania Khal	1.019	24985
10	Arru-Dowania Branch Khal	5.000	2900

Source: Blue Gold Program Office

4.11 Repair and maintenance 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.

Descripiton 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 Stuctures

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.

Schedule of works

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 27 are likely to be completed by June 2020.

Table 4.3: Construction Schedule in Polder 27

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				▬	▬	▬	▬					
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						▬	▬	▬	▬	▬		

Key Activities	2018				2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Community Mobilization for Polder Development Plan (PDP). Firm-up water management development options. Sustainable Environmental Management Plan (SEMP)												
Implementation of Water Management works with active participation of the WMOs/ WMA through the Quality Control/ Block Committee												

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.

Manpower Requirement

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

4.12 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.

4.12.1 Community Participation through WMO

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.

4.12.2 Water Management Groups (WMGs)

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

4.12.3 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.

4.13 Operation and Maintenance Plan

Since construction, Polder 27 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.

4.13.1 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 27. 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 27 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.

4.13.2 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 27, 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.

4.14 Project cost

As per the approved Development Project Proforma (DPP) of the Blue Gold Program, the project cost for carrying out fine-tuning works in Polder 27 has been estimated as 300.00 € per ha of area (**Appendix-5**). Accordingly, the project cost is 130,36,6000 € i.e. BDT 11.10 crore (1€ = 85 BDT, on 6 October, 2016).

4.15 Expected Benefits and Outcome

The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 27 are listed in Table 4.7 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.
Construction of an Outlet	✓ Drainage situation out 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.

4.16 No Objection Certificate

There are no archeological sites or any cultural heritage in the polder area that might affect the normal activities of the polder after rehabilitation. There will be no problem of land acquisition or displacement of people since rehabilitation will be made on existing structures. The No Objection Certificates (NOCs) from the union chairmen have been obtained and are attached in **Appendix 2.**

5 Environmental Baseline

5.1 Physical Environment

5.1.1 Meteorology

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

Rainfall

The average monthly rainfall variation at Khulna (from 1978 to 2013) has been shown in Figure 5.1. The hyetograph shows that the highest and lowest values of rainfall are usually observed during the months of July (343 mm) and December (7 mm) respectively. Furthermore, for better representation of the real world situation, values on rainfall from 1978 to 2013 have also been collected from the BWDB rainfall station at Dumuria. Prior to that, Theissen's Polygons were delineated around all the BWDB's rainfall stations (Subramanya, 1994), which have been shown in Map 5.1. The Theissen's Polygons show that the entire polder is located inside the polygon delineated around the BWDB station of Dumuria. The monthly variation of rainfall observed in Dumuria was almost similar to that observed for the Khulna BMD station, with the maximum and minimum values of monthly rainfall found as 344 mm (July) and 7 mm (December) respectively.

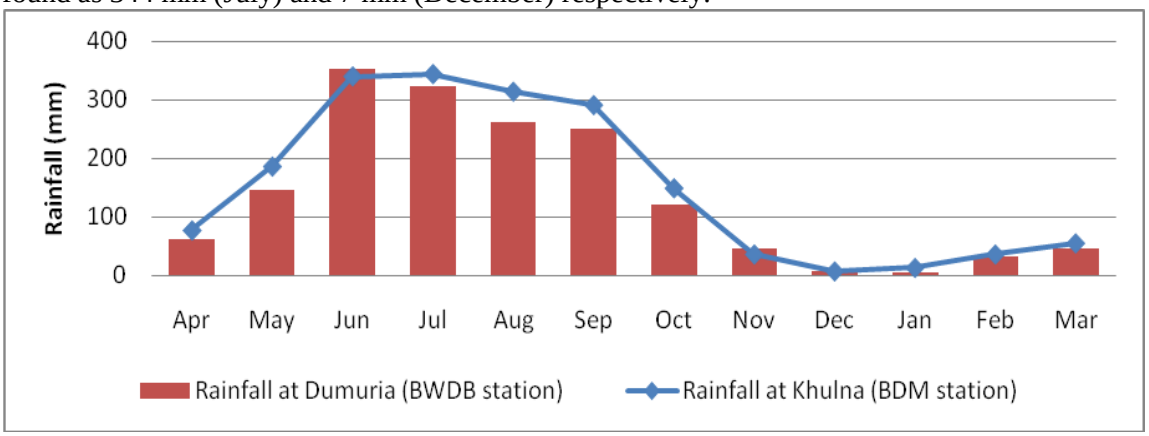


Figure 5.1: Average Monthly Rainfall at Khulna BMD

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 5.2

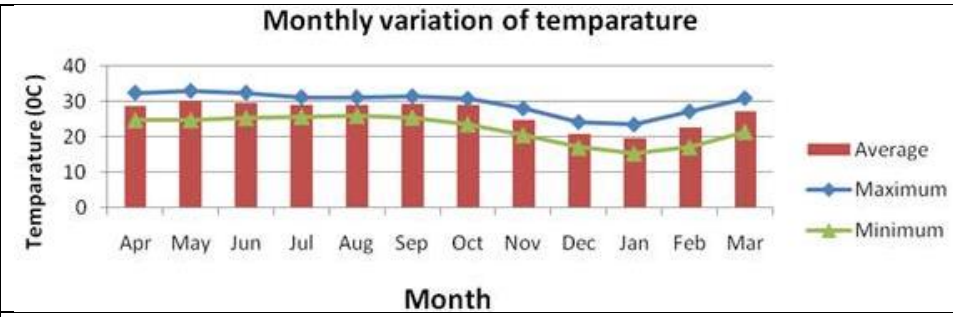


Figure 5.2: Average of Maximum and Minimum Temperatures at Khulna BMD Station

Relative Humidity

Figure 5.3 below shows the variation of monthly relative humidity, as recorded by the Khulna BMD station (1978~2011). A significant fluctuation has been observed as relative humidity values start to increase from April (start of summer) due to the increase in atmospheric water vapors coupled with temperature rise. Relative humidity rises above 85% in monsoon (June to September), and starts decreasing from post monsoon season following the monsoon rainfall. In the coastal areas, relative

humadity values are usually higher than the other parts of the country. This is because of having a greater extent of water bodies, leading to increased evaporation.

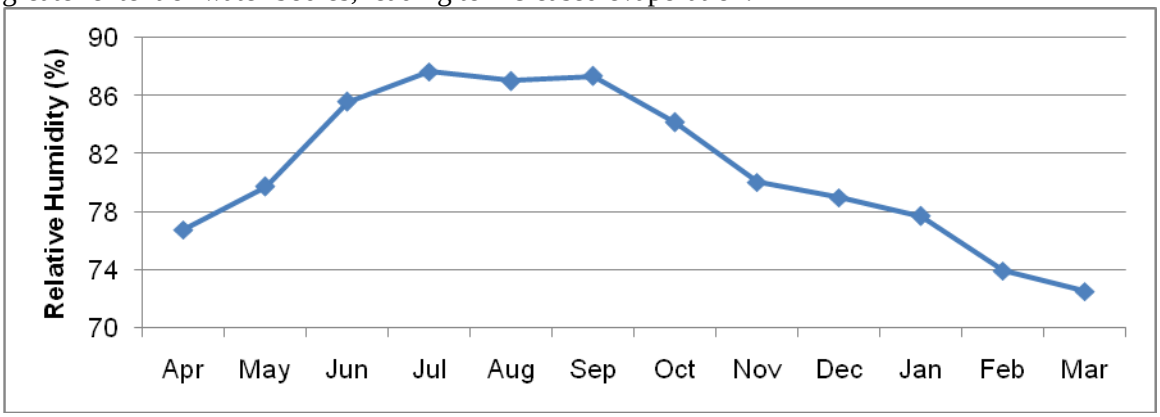


Figure 5.3: Average Relative Humidity at Khulna BMD station

Evaporation

Figure 5.4 below provides the monthly variations of evaporation, actual ET and reference ET (ETo). Evapo-transpiration is maximum during monsoon (June to September); and except dry season, all the other months experience significant evapo-transpiration values. ET is actually an indicator that defines crop and plant health, and observed results in Polder 27 therefore implies for better plant health (especially in Kharif-I and Kharif-II).

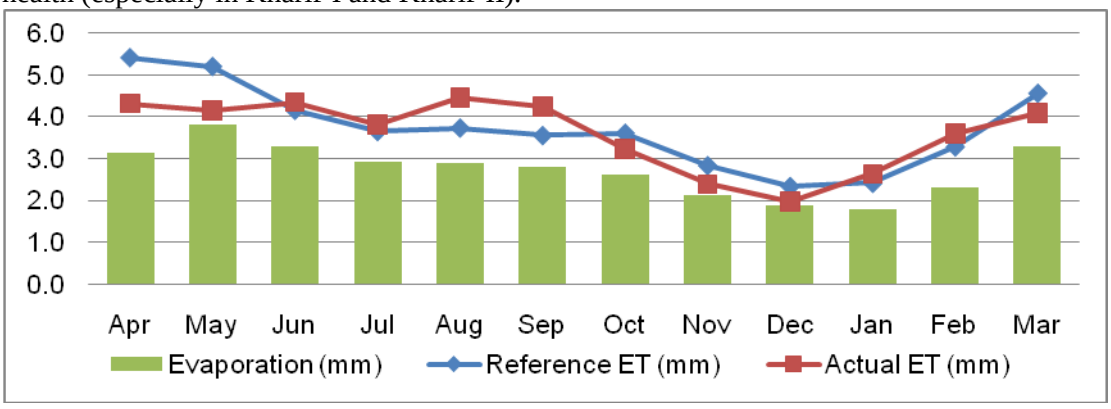


Figure 5.4: Monthly Variation of Evaporation, Reference ET and Actual ET at Khulna

Wind Speed

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

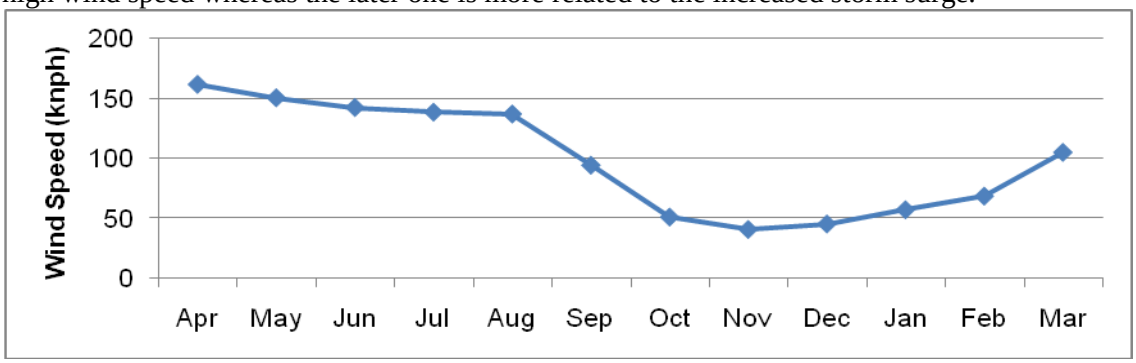
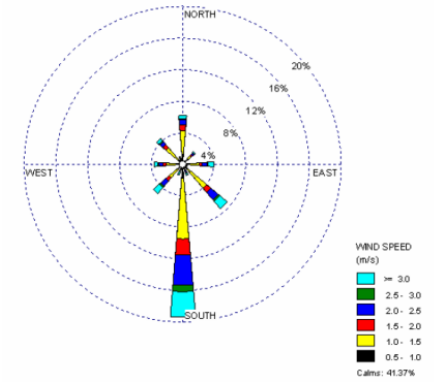
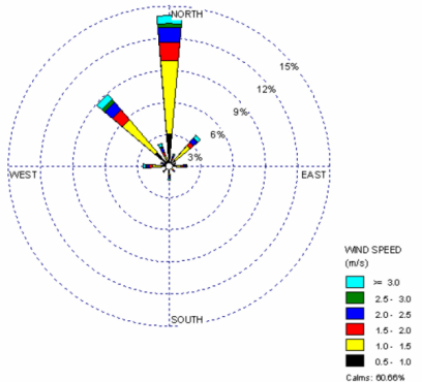


Figure 5.5: Variation of Average Wind Speed at Khulna BMD station

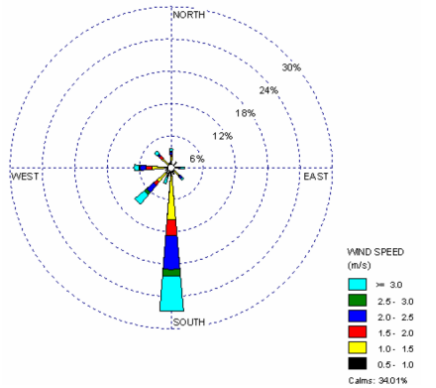
As per Bangladesh National building Code (BNBC), the *basic wind speeds*[1]for Khulna is 238 kph.The wind roses generated using observed data at Khulna BMD station (*source: SMEC, 2006*) show average wind direction and speed for different period of a year. The yearly average wind rose shows that the prevailing wind flows from south to north during most periods of the year (Figure 5.6 a). During November to February, maximum prevailing wind flows from north and northwest to south and southeast direction and for the rest of the period it flows from south (Figure 5.6 b). During March to April wind mostly flows from south and southwest to north and northeast (Figure 5.6 c), and for May to October it flows from south and southeast to north and northwest direction (Figure 5.6 d).



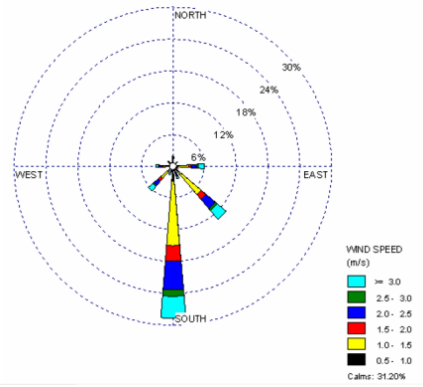
(a): Wind Rose for Khulna for a Full Year



(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 5.6 :Wind Rose for Khulna

Sun-Shine Hour

The average sunshine hour data has also been collected from Khulna BMD station (1990-2010). Figure 5.7 shows that from October to May, daily average sunshine hours are higher than 7 hours, but due to increased extent of cloud cover in monsoon (June to September) (monsoon) the values drop below 5.

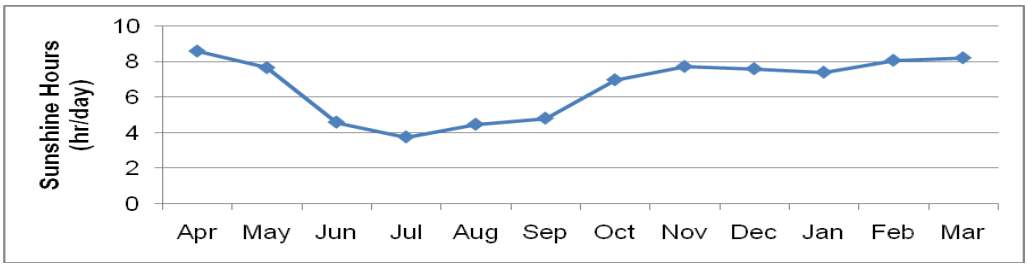
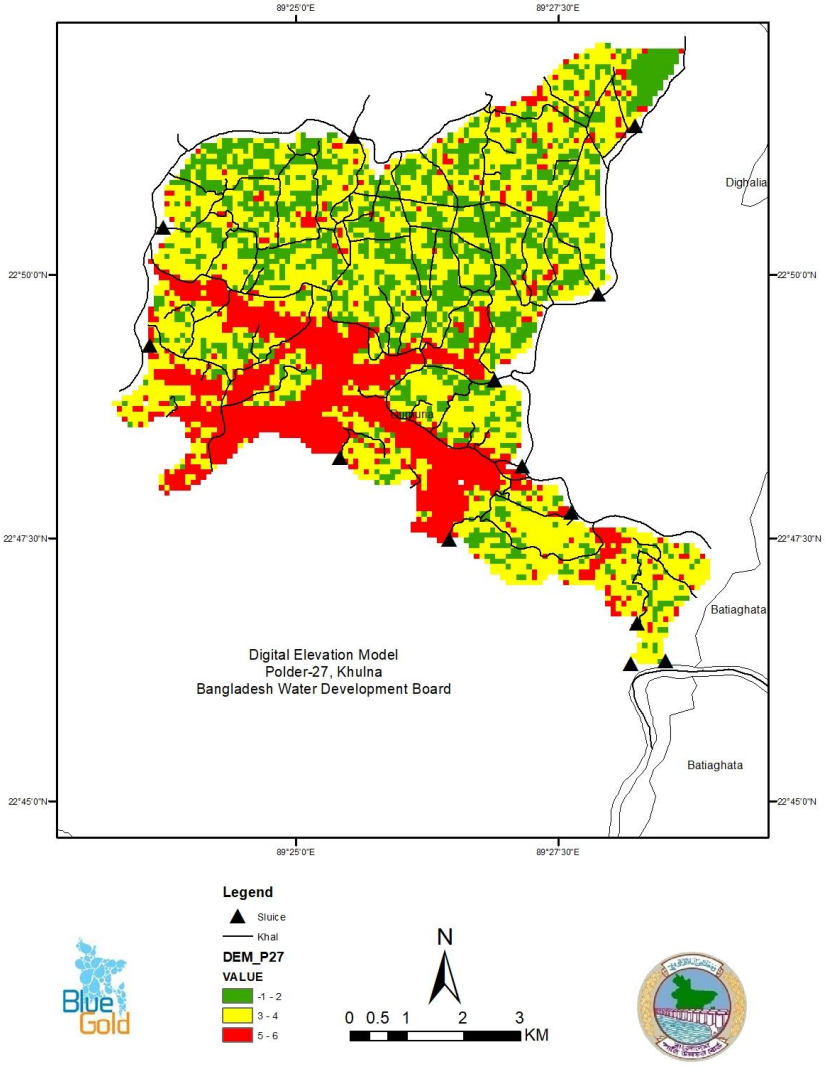


Figure 5.7: Monthly Variation of Average Sunshine Hours at Khulna BMD Station

[1]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)

5.1.2 Topography

The study area is located in the southern hydrological zone of the country, with very low average elevations. Re-sampled 500m×500m grid reduced levels were captured from BWDB's one foot contour maps, which were produced in the late sixties. These spot levels were interpolated into a continuous surface called Digital Elevation Model (DEM), produced by CEGIS in 1997 (Map 5.1). DEM analysis infers that the reduced levels inside the polder vary from 0.77 to 2.80 m, PWD (from Mean Sea Level), with average *Reduced Levels*[2] (RLs) of around 1.33 m +PWD. From the DEM it is found that around 43% lands inside the polder are below 1.26 m, PWD. Around 48% lands of the polder have elevations within 1.26 to 1.73 m, PWD; whereas only around 9% areas have elevations higher than 1.73 m, PWD. The topographic features are normally distributed throughout the polder. Due to several natural and anthropogenic processes along the upstream areas of the polder, the Mora Bhadra River, located along the northern periphery has been heavily silted up in the last couple of decades. For almost the last 8/9 years, the river has completely been silted up and has been converted into an agricultural land. This phenomenon has lead to the gradual increase in RLs along the northern portions of the polder, which is reflected in the DEM shown in Map 5.2. The elevations in the southern areas are lower that the northern portions. This has led to a topographic gradient along the south and southwest portions of the polder, which creates temporary drainage congestion problems inside the connected water courses. Map 5.1 below shows the topography of the study area, identifying the rivers and water bodies as well as categorized land elevations.



Map 5.1: Digital Elevation Model (DEM) of Polder 27

[2]Reduced Level is defined as the elevation from Mean Sea Level, and is measured as meter, PWD.

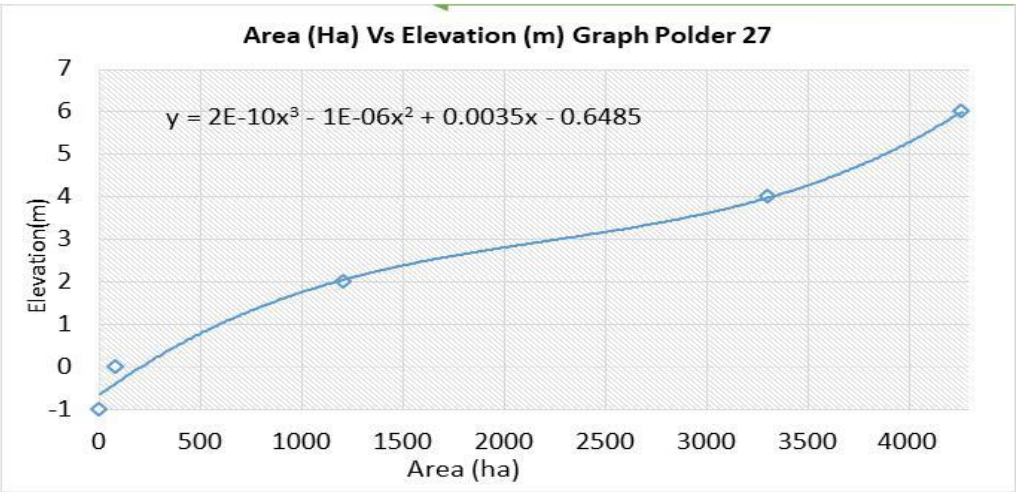


Figure 5.8 Area vs Elevation Graph for Polder 27

5.1.3 Seismicity

Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes in the past 200 years.As per the updated seismic design provisions of Bangladesh National Building Code, 1993, Polder 27 falls under Zone-I, which is considered as a seismically quiet zone, with *Seismic Zone coefficient* [3] of 0.075, comprising the southwest portion of Bangladesh. Map 5.2 below shows the seismic location of Polder 27. Moreover, Polder 27 is located inside the Faridpur Trough, which is situated adjacent to the Hinge Zone, and is characterized by a general gravity-low with the development of Neogene sequence. Map 5.4 below represents the tectonic units available in Bangladesh and the location of the polder (within the Faridpur Trough).

It can therefore be inferred that both in consideration of seismicity and stratigraphy, Polder 27 falls on a relatively safer (seismically quiet and tectonically stable) side.

Map 5.2: Earthquake Zones of Bangladesh and location of Polder 27

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. The Polder 27 area is covered by two AEZ i.e High Ganges River Floodplain (AEZ-11) and Ganges Tidal Flood Plain (AEZ-13).

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

High Ganges River Floodplain (AEZ-11)
In general most areas have a complex relief of broad and narrow ridges and inter-ridge depressions, separated by areas with smooth broad ridges . There is an overall pattern of olive-brown silt loams to silty clay loams on the upper parts of the floodplain ridges and dark grey mottled brown, mainly clay soils on ridge sites and in basins. Most ridge soils are mostly calcareous throughout the profile. General Soil Types predominately include Calcareous Dark Grey Floodplain soils and Calcareous Brown Floodplain soils. Organic matter content in brown ridge soils is low, but higher in dark grey soils.
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

In general, most of the top soils are acidic and sub-soils are neutral to slightly alkaline. General fertility level is moderate to high with low organic matter content and very high CEC and rich K status. There are limitations of high exchangeable Na and low Ca / Mg ratio. The Zn status is low to medium and the B and S status is medium to optimum. Detailed distribution of physico chemical properties of soil of the polder area is presented in the Table 5.1.

Table 5.1: Some Physic-Chemical Properties of Soils of AEZ-11 and AEZ-13

Major Land Type	Soil pH	Soil OM	Nutrients Status								
			N	P	K	S	Ca	Mg	Zn	B	Mo
High land (43%)	4.5-7.9	L-M	VL-L	VL-L	L-M	VL-L	M-H	M-H	L-M	VL-L	M
Medium highland(32%)	5.6-8.1	L-M	VL-L	VL-L	L-M	VL-L	M-H	M-H	L-M	L-M	M
Medium lowland (12%)	6.5-8.3	L-M	VL-L	VL-L	L-M	VL-L	M-H	M-H	L-M	L-M	M

VL=Very low; L=Low; M=Medium; H=High
Source: Fertilizer Recommendation Guide - 2012, BARC

5.1.6 Soil fertility analytical data of analytical samples

Soil sample were collected from twor locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area on 18th, March, 2015. Collected soil samples were analyzed by Soil Resource Development Institute (SRDI), Dhaka. Results of the analysis are presented in the Table 5.2.

Table 5.2: Chemical properties of soil on agriculture land

Number of the polder	Location / Mouza / Village	GPS reading	Depth (cm)	EC ds/m	pH	OM	N	K	P	S
						%		Meq/100 g	µg/gm	
27	Subha. M. para	22°47'43.73"N 89°21'15.44"E	0-10	0.98	8.3	1.07	0.06	0.33	9.58	95.21
			10-20	0.89	8.5	0.53	0.03	0.17	4.45	106.70
			20-30	0.85	8.6	0.53	0.03	0.27	5.05	88.31
	Jialtola	22°45'50.05"N 89°22'39.29"E	0-10	23.85	7.9	2.36	0.13	0.26	6.75	399.40
			10-20	6.55	8.0	1.93	0.11	0.55	7.76	370.50
			20-30	2.63	7.7	1.93	0.11	0.42	4.04	285.80

Source: SRDI laboratory analysis, 2015

5.1.7 Land form

The total of the study area is occupied by ridge which is 1,993 ha (100%). These landforms influence the land use related to agricultural crop production.

5.1.8 Land type

Land type is a system of classifying cultivated land based on the seasonal inundation depth of normal flooding. According to Soil Resource Development Institute (SRDI, 1988), five land types (High land, Medium Highland, Medium Lowland, Lowland and Very Lowland) have been classified in terms of depth of flooding on agriculture land. The entire polder area is under medium highland (F1) which is normally flooded between 0-90 cm depth of water continuously for more than two weeks to few months during the monsoon season.

Photo 5.1: SAAO helped in soil sample collection

5.1.9 Land use

The gross area of the polder is about 4,260 ha of which net cultivable area (NCA) is about 3,195 ha. The NCA is about 75% of the gross area.

The coverage of settlements 20%, road 1% and water bodies area about 4% of the gross area. Fishers expert reported that 192 ha (6% of NCA) is under rice cum fish culture. Detailed land use of the polder area is presented in Table 5.3 and Map 5.5.

Table 5.3: Detailed land use of the polder area

Land use	Area (ha)	% of Gross Area
Net Cultivated Area (Agriculture)	3,195	75
Settlements	852	20
Road	43	1
Water bodies(river/khal)	170	4
Gross area	4,260	100

Source: Estimation from SOLARIS-SRDI, 2006

5.1.10 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 two types of soil texture in the polder area i.e. clay and clay 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 5.4: Detailed soil texture of the surface soil (0-15 cm) in the polder area

Soil Texture	Area (H)	% of NCA
Clay	3,035	95
Clay Loam	160	5
Total	3,195	100

Source: Estimation from SOLARIS-SRDI, 2006

5.1.11 Available soil moisture

The availability of soil moisture varies depending on the soil characteristics. 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 5.5: 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 remain in field level from two to three months	128	4
Medium	Plant extractable soil moisture remain in field level from one to two months	96	3
Low	Plant extractable soil moisture remain in the field level less than one month	2,971	93
Total		3,195	100

Source: Estimation from SOLARIS-SRDI, 2006

5.1.12 Soil salinity

Estimation from SOLARIS-SRDI, 2006, reveals that over the period's soil salinity of the area inside the polder increases gradually. Local farmers reported that most of the water control structures are not functioning properly. As a result, this cannot restrict intrusion of saline water inside the polder which is reported as the major cause of the salinity increment inside the polder. In the field, top soil was tested by tongue and seems to me salt effected. Some SAAOs of DAE and union perished members reported that the soil and water salinity gradually increases with dryness from January and reaches maximum level in the month of March-April and then decreases due to onset of monsoon rainfall. Detailed soil salinity of 1973, 2000 and 2009 of the polder area are presented in Table 5.6.

Table 5.6: Detailed soil salinity in the polder area

Soil Salinity Class	EC (dS/m)	Area ha (1973)	% of NCA	Area ha (2000)	% of NCA	Area ha (2009)	% of NCA
Non saline with some very slightly saline (S1)	2.0- 4.0	2237	70	3	0	2,141	67
Very slightly saline with some slightly saline (S2)	4.1- 8.0	0	0	43	0	0	0
Slightly saline with some moderately saline (S3)	8.1-2.0	958	30	3,035	95	990	31
Moderately saline with some strongly saline (S4)	12.1-6.0	0	0	160	5	64	2
Strongly saline with some very strongly saline (S5)	> 16.0	0	0	0	0	0	0
Total		**3,195**	**100**	**3,195**	**100**	**3,195**	**100**

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

5.1.13 Drainage characteristics

Drainage plays a vital role in the management of soil productivity in the polder area. The drainage characteristics have been divided into six classes by SRDI for agricultural uses. These are excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and very poorly drained. About 6% of the NCA is under imperfectly drained i.e water drains from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land for more than 15 days at a stretch.

During the rainy season, groundwater stands within 1 meter depth and 94% of the NCA is poorly drained. The soil remains under water for 15 days to few months.

Table 5.7: Drainage characteristics in the polder area

Water is drained from the soil slowly. The soil of the polder area indicates that the timely removal of water in rainy/monsoon season is crucial for growing rabi / dry land crops in the polder area. Detailed drainage characteristics of the polder area are presented in Table 5.7.

Drainage	Area(ha)	% of NCA
Imperfectly Drained	192	6
Poorly Drained	3,003	94
Total	**3,195**	**100**

Source: Estimation from SOLARIS-SRDI, 2006

5.1.14 Farming practices

Farming practices largely depend on the land types, length of growing seasons and other environmental as well as socio–economic factors. In the polder area, there are three cropping seasons in a year. They are Kharif-I, Kharif-II and Rabi seasons. The Kharif-I starts from March and ends in June. This season is characterized by the uncertainty of alternating dry and wet spells. Vegetables, jute and sesame crops are grown in this season in the area. The Kharif–II starts from July and ends in October. The Kharif-II season comprises wet and cloudy environment and heavy rainfall but uneven distribution, low solar radiation, high temperature and humidity. According to local farmers T aman rice both local and HYV and some vegetables are grown in this season under rainfed condition. Farmers also provide supplementary irrigation to HYV T aman crops under water stressed situation.

The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses

the crop yield. Wide ranges of crops are grown in this season. In this polder area, irrigated HYV Boro rice, sesame and vegetables are grown. Irrigation is given by Shallow Tube Wells (STW) and Low Lift Pumps (LLPs). There are occasional overlaps of growing seasons because of varying length of crop duration. T. Aman becomes late prolonging to Rabi season. Sometimes rabi crops are also delayed and extends to Kharif-1.

5.1.15 Cropping pattern by land type

The most prominent cropping pattern is Sesame- LT aman-Fallow which is practices in 34% of the NCA. The next dominant cropping pattern is Fallow-HYV T aman-Boro which is practices in 30% of the NCA. According to the local fishermen and local two union parished members, about 192 ha (6%) is rice cum fish culture. Present stasus of the crops are: vegetables growing to harvesting stage, and boro butting to flowering stage. Among the rabi crops and varieties farmers are using high yielding varieties of vegetables and mustard seeds. Detailed cropping patterns by land type are presented in Table 5.8.

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
High land (F0)	Vegetables	Vegetables	Vegetables	160	5
	Jute	Vegetables	Mustard	32	1
Medium High Land (F1)	Fallow	HYV T aman	Fallow	255	8
	Fallow	HYV T aman	Boro	959	30
	Sesame	LT aman	Fallow	1,086	34
	Fallow	LT aman	Fallow	703	22
Total				**3,195**	**100**

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

In the polder area farmers are using different crops varieties (local and HYV). Details of the crop varieties are given in the Table 5.9.

Table 5.9: Varieties cultivated by local farmers

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

Source: Field survey, 2019 and secondary data from local SAAO, DAE.

Photo 5.2: View of HYV Boro rice crops in the polder area

5.1.16 Cropping intensity

Total cropped area is about 5,943 ha of which the coverage of rice is 70% and non rice is 30%. The single, double and triple cropped area is 18%, 78% and 4% of the NCA respectively. Therefore, cropping intensity of the polder is about 186%.

5.1.17 Crop production

In the polder area, the annual total crop production stands at about 16,616 tons of which 9,816 tons of rice is produced and 6,800 tons non-rice crop is produced. The contribution of rice crops about 59% and non-rice is about 41% of total crop production. Among the rice crops, the contribution of Boro rice 22%, HYV Aman 66% and Lt Aman 12%.

In the polder area, some crops damaged by drainage congestion, heavy rainfall etc. as reported by local farmers and the SAAOs. Normally, Boro rice15%,HYV T. Aman 20% and Lt. Aman 15% damaged. Main causes of the damage's are heavy rainfall and drainage congestion. Total loss of rice production is about 511 tons in 429 ha 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 5.10.

Table 5.10: Existing Crop Production and Crop Production Loss of the Polder Area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production	Production	Production (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield	(ton)	loss(ton)	
Boro	540	467	4.2	73	2.5	2,144	124	21.84
HYV T Aman	416	338	3.2	78	1.8	1,222	109	12.45
LT Aman	3204	3026	2.1	278	1.1	6,450	278	65.71
Total rice	**4,160**	**3,831**		**429**		**9,816**	**511**	**59.08**
Sesame	1,067	982	1.1	85	0.7	1,140	34	17
Mustard	261	258	1	3	0.7	260	1	2
Summer vegetable	315	315	12	0	0	3,780	0	66
Winter vegetable	100	100	15	0	0	1,500	0	28
Jute	40	40	3	0	0	120	0	4
Total non-rice	**1783**	**1,695**		**88**		**6,800**	**35**	**40.92**
Total	**5,943**	**5,526**		**517**		**16,616**	**546**	

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

5.1.18 Local price of the crops

In the polder area there are five markets. The price of the different crops were collected from local people, in Tk/kg. Later it was calculated as tk/ton, which is presented in the Table 5.11.

Table 5.11: Local market price of different crops

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

Sources: Farmers interviewed, March, 2019

5.1.19 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 5.12. 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 SAAO,s 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 used (kg/ha)	
	Farmers used	Recommended rate
Boro	48	40
HYV T Aman	50	40
Lt Aman	50	40
Mustard	7	8
Vegetables	As required	3.5-5

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

Labor

In the polder area, almost 40% of the cultural practices for crop production are being done manually. So, agricultural labor (seed sowing, intercultural operations, harvesting and post harvest technologies) is considered as one of the essential inputs for crop production. The labor requirement is not uniform throughout the year. The number of labor requirement varies from crop to crop and season to season. The average number of labor (male and female) used and wages rate per hectare in the polder area is presented in Table 5.13.

Table 5.13: Labor used in the polder area

Crop name	No. Labor and rate/	Labor wages / day (Tk)	
		Male	Female
Boro	140	350	200
HYV T Aman	130	200	160
Lt Aman	110	200	160
Mustard	70	200	100
Vegetables	142	200-300	60-100
JUte	140	200-300	80-100

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

Note: In addition to wages, labors are taking three times meal per day

Fertilizers

The rate of fertilizer use per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Urea, TSP/ SSP/DAP, MP and Gypsum. Farmer and SAAOs reported that they are using TSP or DAP. In many cases farmers use fertilizers in unbalanced way. Organic manures are not used by the farmers in the field crops. Local women, farmers and SAAO of DAE reported that cowdung is used mainly for fuel purpose and partially in the homestead garden. According to local farmers and two SAAO's, almost every local market there is fertilizer dealers. Dealers got training from UAO's office. Local farmers also reported that they don't have enough money to buy all types of fertilizer at a time. Detailed information of chemical fertilizer and cowdung use are presented in Table 5.14

Table 5.14: Fertilizers used in the polder area

Crop Name	Farmers practices (Kg/ha)						Recommended doze (kg/ha)					
	Compost	Urea	TSP	MP	Gypsum	Zinc	Compost	Urea	TSP	MP	Gypsum	Zinc
Boro	0	250	140	120	5	0	0	270	58	58	0	4
HYV T Aman	0	100	80	50	0	0	0	163	22	30	11	3
Lt Aman	0	50	20	0	0	0	0	97	14	17	0	0
Mustard	0	200	120	100	0	0	0	196	60	27	42	3
S. Vegetables	0	200	150	140	0	0	5000	217	80	50	14	3
W. Vegetables	0	190	150	140	0	0	5000	217	80	50	14	3
Jute	0	40	15	20	0	0	0	51	22	70	36	0

Sources: Farmers interviewed, May, 2019

Pesticides

The use of pesticides depends on the degree of pest infestation. According to local SAAO's and farmers, the major insects are stem borer, green leaf hopper, and rice bug.

Local farmers reported that they are using different types of pesticides such as Korjan and Bilakto. Both liquid and granular pesticides are being used to prevent pest infestation in the rice cultivation. Local people visit farmers house to house for pesticide application in different fruit trees and rice and bitter gourd crop. Detailed information of pesticides used is presented in Table 5.15.

Table 5.15: Pesticides used in the polder area

Crop name	Pesticide using by farmers	
	No. of application	**Liq. (ml/ha) apx.**
Boro	2	800
HYV Aman	2	600
Lt Aman	0	0
Mustard	0	0
Vegetables	2-3	1000-1500
Jute	0	0

Sources: Farmers interviewed, May, 2019;

5.1.20 Integrated Crop Management (ICM)

Recently, Integrated Crop Management (ICM) is practiced in many places of the polder area. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo etc. to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. In ICM process, about 35% of the crops are protected without applying pesticides. Trap is another technique for controlling pests in the agriculture fields especially on watermelon and vegetables for attracting insects. Thus, it is possible to control the harmful insects without the application of pesticides. ICM technique is mainly applied on rice and vegetables crops. Field information (Farmers and SAAO of DAE) indicates that ICM is being practiced in the fields in about 20-30% of the cultivated areas and the impact has been found very encouraging.

5.1.21 Irrigation

Surface and ground water are the source of irrigation as reported by local farmers. Khals and in few cases ponds are the source of surface water and STWs are being used for surface water irrigation. Some of the SAAO's and farmers reported that, present irrigated area is about 800 ha. They also reported that if the khals are re-excavated, then farmers can grow other rabi crops, than it will increase. They also reported that if the project is not implemented, irrigated area will be reduced. Farmers also reported that now the cost of irrigation per hectors of land is tk. 4,500 to 5,000. Detailed information on irrigation is presented in Table 5.16.

Table 5.16: Irrigated area by crop

Crop name	Irrigation (Ground water)			Irrigation(Surface water)		
	Irrigated area (ha)	**% NCA**	**Charge (tk/ha)**	**Irrigated area (ha)**	**% NCA**	**Charge (tk/ha)**
Boro	543	17	8,000-9,000	160	5	4,500-5,000
T aman in booting stage (few area)	32*	1	8,000-9,000	0	0	0

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

5.1.22 Crop production constraints

According to local farmers and six SAAOs of DAE in six agriculture blocks, the main constraints in the polder area are salinity, lack of irrigation water in rabi season, siltation and drainage congestion. Farmers are growing some vegetables in the homestead area.

Photo 5.3: Farmers problem identified for crop production through FGD in the polder area

5.1.23 Water Resources Systems

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

Rivers System

Polder 27 is within 85 km distance from the Bay of Bengal coast of Akram Point, and undergoes tidal influence. The polder is surrounded by surrounded by Upper Shalta river in the south, Upper Shoilmari River in the east and Mora Bhadra and Hamkura river (dead) in the west. The Shoilmari river is perennial and drains out water from the entire polder. The Mora Bhadra River on the other hand has been completely silted up in last couple of decades and has been converted as an agricultural land by the local people. This, coupled with the increased amount of river siltation, caused the entire river to be filled up with sediments and eventually been delinked from the Hari River course. The river system of the area is shown in Map 5.9.

Hydrological Connectivity

During high tide, water flows from the Bay of Bengal to the Teliganga River through the Ghengrail-Sibsa River system. The Telikhali River is the only properly functioning peripheral river around the polder and maintains the required water resources functions of the polder. BarobeelerKhal, Sakha BaiKhal, ZialtolaKhal, KadomtolaKhal etc. are the major distributaries of Teliganga River. The Mora Jaykhali River also provides water through some important water courses such as Khanapar Khal, Jhiler Khal etc. There are two seasonal open water reservoirs namely, Zialtola Beel and Kakmari Beel; which are inundated during monsoon and pre-monsoon, and provide required hydrological services to maintain the water resources functions within the polder. These seasonal water storages restore the hydrological connectivity of the polder, espcialy in the south-west, south and south-east areas. In dry season, hydrological connectivity along the central areas is somewhat reduced and only maintained by the *perennial*[4]water courses inside the polder (which is around one-third of the total length of seasonal water courses). The khals of Polder 27 are also shown in Map 5.9.

Surface Water Level

The surface water levels of the BWDB station at Dumuria (Bhadra River) has been analyzed (Figure 5.9). Water levels during high tide range from 1.7 to 2.3 m +PWD, and the low tidal water levels range from 0.7 to 1.2 m below the MSL.

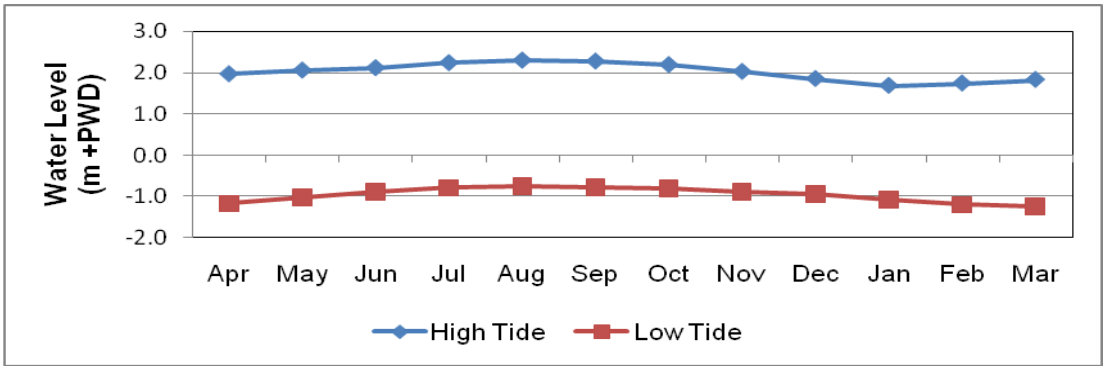


Figure 5.9: Surface Water Level at Dumuria (Bhadra River)

Ground Water

Monthly variations in ground water levels for the years 2000-2013 have been plotted in Figure 5.10 for the ground water observation well at Dumuria Bazar (named as KHU005).The variation pattern shows that the Ground Water Table (GWT) is the lowest in May and the highest in October.

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

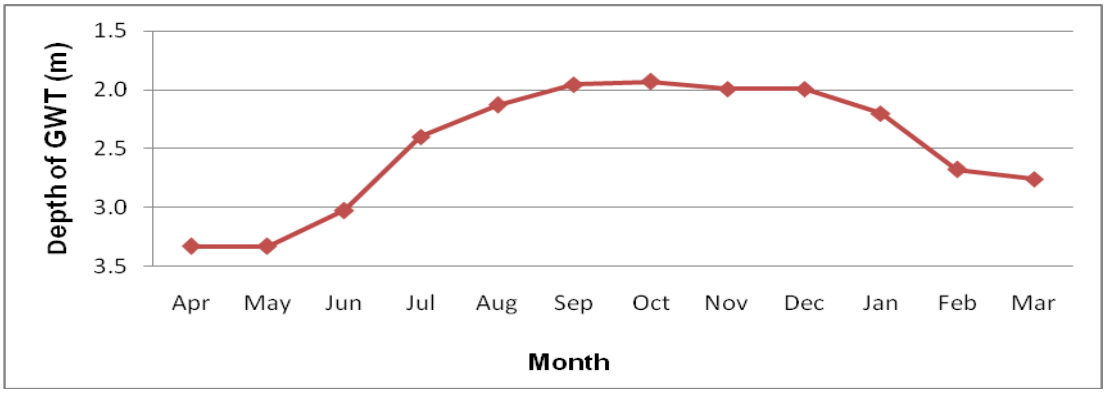


Figure 5.10: Average Monthly Variations of Ground Water Table

Analyses have also been carried out to understand the annual variations of GWT at KHU005 station for May and October (from 2000-2013). The values show an increasing trend in both cases (Figure 5.11 and 5.12).

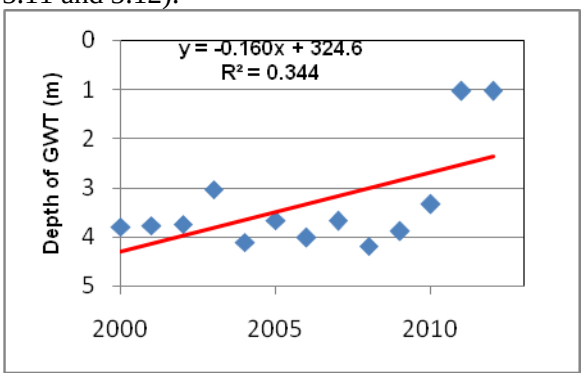


Figure 5.11: Variation of GWT at KHU005 in May (2000 – 2013)

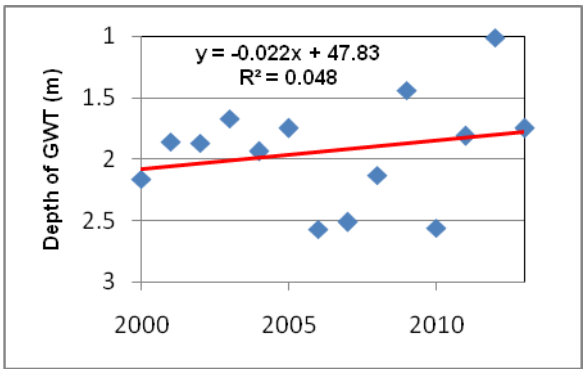


Figure 5.12: Variation of GWT at KHU005 in October (2000 – 2013)

5.1.24 Water Resources Problems

Tidal and Storm Surge Flooding

Local people in Polder 27 opined that the peripheral embankment effectively offers protection from regular tidal flooding in the area. Even though very minor flow leakage is occurring through some of the water control structures, the amounts of flow entering the polder are minimal. Local people reported, during heavy rainfall continue few days or week ling during monsoon, there were flooding observed inside the Polder.

Water Logging and Drainage Congestion

Drainage congestion has been opined by the local people as the most prominent water related issue inside the polder. Water cannot drain out from the internal Khals timely, and it sometimes takes more than a week to drain water out from the polder. Furthermore, the siltation of some of the khals inside the polder also aggravates the drainage congestion problems. From field observations and spatial studies, it can be inferred that around 80% of the internal water courses of the polder suffer from drainage congestion problems. The drainage congestion problems mostly originate from the khal openings and gradually spread inside the polder. Such problems induce minor short term flooding in nearby areas, but no long term water logging occurrences takes place inside the polder.

5.1.25 Water Resources Functions

Water Use

Domestic Use

The standard value of average daily demand of water for domestic and drinking purposes in rural areas is considered as 50 lpc (Ahmed and Rahman, 2010). However, the actual status of drinking water in some of the coastal polders is very poor. During the field survey in Polder 27, it was found

that the average daily domestic use of water was around 30 lpc, which is slightly better than the other adjacent coastal polders studied in the first phase of the Blue Gold Program. The study found that around 455 m^3 of water is consumed daily by the total number of 15,175 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. For other domestic uses, surface water sources are used. Overall, water availability in Polder 27 is not a major concern as local people claimed that they have sufficient surface as well as groundwater sources to meet up their daily need of drinking and domestic purposes.

Irrigation Use

The local farmers in Polder 27 practice Vegetables in Kharif-I (March-June) season, HYV T Aman, LT. Aman and Vegetables in Kharif-II season (July-October); and HYV Boro, Mustard and Vegetables in Rabi (November-February) season. No irrigation is required in Kharif-I and Kharif-II seasons. During the Rabi season, irrigation is required in for Boro and a substantial portion of Vegetables. Based on field visit, it can be inferred that around 300 mm of water is required for each ha of land for Aman, Vegetable, Mustard and Jute cultivation; whereas around 1500 mm water is required for each ha of Boro cultivation. Using these pragmatic standards of water requirements, the study infers that approximately 18 Mm3 of water would be required for irrigation purposes throughout the year. The brief information on irrigation water is provided in Table 5.17 below.

Table 5.17: Irrigation water requirements in Polder 27

Season	HYV Boro	Lt. Aman (ha)	HYV T Aman (ha)	Mustard (ha)	Vegetables (ha)	Jute (ha)	Water requirement (mm/ ha)	Water Used (Mm^3)	Type of irrigation
Kharif-I (March -June)	-	-	-	-	25	15	300	0.12	No irrigation is required
Kharif-II (July - October)	-	540	1,418	-	40	-	300	5.90	No irrigation is required
Rabi (November – February)	790	-	-	-	-	-	1500	11.85	Source of irrigation water is about 80% with ground water and about 20% with surface water (LLPs)
	-	-	-	15	25	-	300	0.12	Ground water irrigation provided for 20 ha vegetables (0.06 Mm^3 water)

Source: Estimation, 2018

Navigation

The peripheral Teliganga Rivers is predominantly used for water-way navigation. Small boats as well as large streamers navigate through the river. 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.

Photo 5.4: Navigation along peripheral River

5.2 Biological Environment

5.2.1 Fish Habitat

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

Capture Fisheries

The estimated fish habitat area is 863 ha where culture fishery contributes the major share (784 ha) and the capture fish habitat shares the rest. The open water fish habitat is represented by khal and floodplain while the culture fish habitat is represented by cultured fish pond as shown in the following Table 5.18. In the study, the peripheral rivers and tidal floodplain has not been considered for fish production estimation of the polder area.

Table 5.18: Fish Habitat Status in the Polder Area

Sl. No.	Category	Habitat Types	Area (Ha)
1	Capture	Khal	34
		Floodplain/Borrow Pit	45
		Sub-total	**79**
2	Culture	Gher (Rice-cum-golda)	*499*
		Fish pond	285
		Sub-total	***784***
		Total	**863**

Source: Field survey data 2017

Among the khals, Khoria khal, Amtali khal, Batiaghata khal are playing important role. The depths of these internal khals range from 0.7-1.7 m (Table 5.19) which is found suitable for the habitation of medium sized fish species particularly during dry season in the low tide situation. Some of the khals are encroached by the muscle men and practicing culture fishery by developing barriers through net. Photo 5.5 (a & b) shows the internal khals in the polder area.

a. Amtoli Khal (Encroached for Fish Culture)

b. Kalatola Khal (Silted Up)

Photo 5.5: Open Water Fish Habitat (Khal) in the Polder Area

Table 5.19: Detailed Information of Importance Khals in Polder 27

Sl. No.	Name of Khal	Wide (m)	Depth (m)	Length (km)	Type of Water Bodies
1	Amtola Khal	20.0	1.7	4.41	Perennial
2	Botiaghata - Baraiyabad Khal	15.6	1.7	2.57	Seasonal
3	Hania Khal	10.1	0.7	3.16	Seasonal
4	Hugolbunia Khal	13.4	2.3	1.13	Perennial
5	Khoria Khal	20.6	1.7	3.28	Perennial
6	Kolatola-Narikeltola Khal	7.2	1.7	4.78	Seasonal
7	Uzukhali Khal	9.7	1.2	4.35	Seasonal

Sources: GIS data, CEGIS, 2014

Siltation is found one of the major problems of the khals to make the habitat unsuitable for larger fishes. This phenomenon is more pronounced at the mouth of sluice gate and impedes the fish migration. For this reason, this habitat cannot function as spawning ground of the resident fish species and thus capture fishery is declining day by day. Rotten duckweed induced water pollution also plays important role in fish declining.

Culture Fisheries

Different types of fish culture systems are adopted by the local people, such as rice-cum-golda (prawn) with white fish culture, mixed culture in pond, golda-cum-white fish etc. Among the aquaculture practices, golda-cum-white fish culture is found increasing trend as such culture yield more benefit than other culture practices even than the agriculture practice. This culture practice is expanding gradually in the polder area. Rice-cum-white fish cultivation is found less pronounced in Batiaghata union in compared to other unions of the polder are because of higher land elevation. The gher and pond fish culture of this area are mainly traditional in nature while improved technology is also adopted by some big farmers (Photo 5.6).

Fish pond

Gher with white fish

Photo 5.6: Different Type of Fish Culture in the Polder Area

5.2.2 Fish Habitat Quality

Aquatic environmental quality is overall satisfactory in the study area. However, some surface water quality parameters (Table 5.20 in Baseline Chapter of water resource) that are related to fish habitat suitability measured in the peripheral river, pond and khal in the polder area. From the data it is observed that pH values little higher but within the limit of usable for fisheries. Dissolved oxygen concentrations of 5 mg O_2/L or more are acceptable for most aquatic organisms (Stickney 2000). The measured DO values are found within the permissible limit for fish and aquatic biota habitation. The salinity value of both river and khal is comparatively higher than the tolerable limit for fresh water fish species.But it is suitable for shrimp and marine fisheries. Turbidity is the term for the amount of dissolved, suspended dirt and other particles in the water, which give the water a brown color. High turbidity of water can decrease fish productivity, as it reduces light penetration into the water and thus oxygen production by the water plants. Dissolved, suspended solids also cause clog filters and injure fish gills (Eira *et al*, 2008). However, Total dissolved suspended (TDS) or turbidity in all water bodies is recorded as higher (>2000 ppm) than the permissible limit for fish.

Table 5.20: Standard Values of Different Parameter of Water Quality for Fisheries

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

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

Aquatic Vegetation

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

(*Eicchornia crassipes*), Water Lettuce (*Pistia sp*), Water fern (*Azolla sp, Salvinia sp,*), Helencha (*Enhydra flactuans*) etc.

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

5.2.3 Fish Production

The estimated total fish production of the polder area is about 563 tons. Bulk of the fish production about 97% is coming from culture fisheries and the rest is contributed by the capture fishery. Fish production trend of the capture fishery is downward in the polder area. The downturn of the production is caused due to obstruction to fish migration, unsuitability of the khals for fish habitation, encroachment of khal, less availability of nutrients. Gher culture is increasing gradually in the area by converting the farmlands. Fish production in the polder area is shown in Table 5.21.

Table 5.21: Fish Production from Different Habitats of the Study Area

Sl. No.	Category	Habitat Types	Fish Production (T)
1	Capture	Khal	6
		Floodplain/Borrow Pit	11
		Sub-total	**17**
2	Culture	Gher (Golda/Bagda with white fish)	345
		Culturable pond	201
		Sub-total	**546**
		Total	**563**

Source: Field data and FRSS, 2011-12

5.2.4 Fishing Effort

Fishing Seasonality

Fishing in the khals as well as in the peripheral rivers starts in April/May and continues up to October. The dominant gear in the polder area are *Jhaki jal, current jal and Veshal jal* . The seasonality of major fishery is furnished in the Table 5.22.

Table 5.22: 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)													
Ber jal (Siene net)													
Thela jal (Push net)													
Badhai jal													
Jhaki jal (Cast net)													
Vesal jal (Dip net)													
Trap gear (Dugair/Chau)													
Lining (Borshi)													
	High			Medium			Low		No occurrence				

Source: Field Survey, 2017

Fishing Crafts and Location

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

Fishing Gears

Different types of nets/gears are used for fishing: (a) Mono filament net, locally known as Current jal, which is used to catch *poa, chingri, tengra, gulsha*, fish; (b) Seine net, which is used to catch all types of small and big fishes; (c) Cast net, locally known as Jhaki jal, which is used to catch puti, bagda, golda, phasa etc. (d) Push net, locally known as thela jal, which is used to catch puti, tengra, chingri, etc. Around 10% of fishermen have fishing boats and around 70% fishermen have fishing gears/nets. Traditional fishing gears of the study area include cast net (Jhaki jal), push net (Thela jal), lining (Borshi), fishing traps etc. (photo 5.8).

Photo 5.7: Fishing Boat in the Polder Area

Photo 5.8: Fishing Gear

5.2.5 Fish Migration

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

5.2.6 Fish Biodiversity

The study area is moderate in fish biodiversity though the biodiversity of fishes has the declining trend over the years. Local people reported that about 100 fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (Photo 5.9). Checklist of the fishes of different habitats reported by local fishermen is analyzed to draw an indicative scenario of the local fish biodiversity of the study area. List of fishes of different habitat in the study area are presented in Table 5.18. Among the fish species *Chingri, Bele, Tengra, Shol, Taki, Puti, Koi, Shing* etc are dominant fresh water fish species.

Photo 5.9: Composition of Fish Catch of the Polder Area

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

Table 5.23: Indicative Fish Species Diversity of Different Fish Habitats in the Study Area

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

Source: Field Survey, 2017, Here, Abundance H= High; M=Medium; L= Low; and NA= Not Available

5.2.7 Species of Conservation Significance

Fish species variety those are locally unavailable for last (10-15) years or become rare reported by the local fishermen and concerned elderly people are given in the following Table 5.24.

Table 5.24: List of Species of Conservation Significance

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

Source: Field Survey, 2017

5.2.8 Area of Conservation Significance

Gonardara Khal, Shostitola khal,Magurkhali khal, Khoria khal, Shairghati Khal, Khajura-shairghata khal and Tiabunia Khal are used as feeding and spawning ground of most of the open water fishes. The local musclemen encroach most parts of the khal and are cultivating shrimp by making barrier of pata jal. For shrimp cultivation, they enter saline water into the khals during dry season. Saline water intrusion in the dry season is degrading the congenial environment for fresh water fishes which cause damage to feeding and spawning ground of the fishes. Due to siltation and losing of water depth, there is no scope for fish sanctuary development in the remaining khals within the polder area.

5.2.9 Fisheries Management

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

5.2.10 Bio-ecological 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 27 polder area encompasses two of these bio-ecological zones, namely the Ganges floodplain and the Saline Tidal Floodplain. The polder is situated at Sobhana, Dumuria and Sahas, Union of Dumuria Upazila of Khulna district. A brief description of the bio-ecological zones are presented below.

Saline Tidal Floodplain

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

where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater (Brammer, 1996).
Several types of palms and bamboo clumps grow in almost all the villages in the polder area. Narikel *(Cocos nucifera)* and Supari *(Areca catechu)* are two 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.Innumerable indigenous weeds grow in beel areas.
The zone affords very lucrative place to game bird waters. During winter season, numerous game birds which include wild goose, wild duck. Cranes, spines, jungle fowl and various waterfowl begin to flock both in the Sundarban and the beel and char areas of this zone. Mangrove, the network of rivers and expanse of beels of this zone teem with different species of fishes.

5.2.11 Terrestrial Ecosystem

Terrestrial Flora

Settlement/Homestead vegetation

Homestead vegetation (560 hectares) is the major type of terrestrial flora of the polder area. 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).* According to the vegetation survey, several tree species are present in different canopy layers and their composition is similar all over the polder area. 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.

Table 5.25 represents dominant tree species of homestead vegetation according to canopy coverage.

Table 5.25: 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 & Thatching	3
Narikel *(Cocos nucifera)*	Palmae	VC	3	Tall monocot	Fruit and Thatching	1,2
Safeda*(Manilkara zapota)*	Zapotaceae	VC	2	T	Fruit	1
Tulshi*(Ocimum americanum)*	Labiatae	VC	1	H	Medicine	3
Babla *(Acacia nilotica)*	Fabaceae	VC	3	T	Timber, fuel wood and fruit	1,2,3
Khai Babla *(Pithecolobium dulce)*	Mimosaceae	VC	2	T	Timber, fuel wood and fruit	1,2,3
Khejur *(Phoneix sylvestirs)*	Palmae	VC	3	Monocot	Fruit	1,2
Tetul*(Temarindus indica)*	Leguminosae	VC	2	T	Timber and Fruit	2
Nim *(Azadirachta indica)*	Meliaceae	VC	2	T	Timber and fuel wood	2
Sirish(Albizia lebbeck)	Leguminosae	VC	2		Fruit & fuel wood	2
Tal *(Boassus flabelifer)*	Palmae	VC	2	Tall	Fruit and	1,2

Tree species name	Family name	Local Status	Saline susceptibility	Habit	Utilization	Ecological Value
				monocot	thatching	
Payra*(Psitium guajava)*	Myrtaceae	VC	2	T	Fruit	2
Sezi *(Euphorbia antiquoram)*	Euphorbiaceae	VC	3	S	Fencing and Medicine	1,2,3
Jiga *(Lennea coromandelica)*	Anacardiaceae	VC	2	S	Fencing	2,3
Aam*(Mangifera indica)*	Anacardiaceae	C	1	T	Fruit and timber	1,2
Jam *(Syzygium sp)*	Myrtaceae	C	1	T	Fruit and timber	1,2
Kola (*Musa sp)*	Musaceae	C	2	H	Fruit	1,2,3
Boroi *(Zizyphus sp)*	Rhamnaceae	C	2	T	Fruit & fuel wood	2
Bash (*Bamboosa* sp.)	Gramineae	C	1	CL	Thatching	1,2,3
Ipil ipil *(Leucauna laucocephalata)*	Mimisaceae	C	2	T	Timber	2
Jambura(*Citrus fistula)*	Rutaceae	C	1	T	Fruit	2
Mahogany (*Swietenia mahagoni)*	Meliaceae	C	2	T	Timber and medicine	2
Thespicia populina	*Malvaceae*	*C*	*4*	*T*	*Fuel and Timber*	*2*
Akashmoni *(Acacia auriculiformis)*	Mimosaceae	O	2	T	Timber and fuel wood	3
Kathal*(Artocarpus heterophyllus)*	Moraceae	O	1	T	Timber and fruit	1,2

Source: CEGIS, Field Survey,2015 Note: Local Stratus: C= Common, VC = Very Common, O = Occasionally, R= Rare; Habit : T= tree, H= Herb, S= Shrub, V=Vine; VC= Very Common, C= common, UC= Uncommon CL=Clump ;Saline Susceptibility: 1 = Highly Susceptible, 2 = Moderately Susceptible, 3 = Slightly Susceptible, 4 = Resistant Ecological Value: 1 = For Wildlife, 2 = For Avifauna, 3 = For micro-Ecosystems

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

Photo 5.10: Homestead vegetation

Photo 5.11:Crop land vegetation

Crop field vegetation

The net cultivated area in the polder area is 1,993ha. 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. Durba (*Cynodon* sp.*)* is

prevalent with *Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus* and *Paspalum* sp. Among the grass species, *Croton, Xanthium, Amaranthus* are also grown sporadically along with grasses. 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. However, vegetation in fallow land has been deemed with increased intensity of soil saline especially at southern portions of the polder. But, during the dry season (especially from late December to late April) there is grazing land but shortage of grass due to salinity which acts as the main barrier for the grasses to grow.

Embankment /Roadside vegetation

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

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

Photo 5.12: Vegetation along embankment road

Photo 5.13: Vegetation along village road

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.

Table 5.26: 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*), and 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: Local people interviewed, March, 2017

5.2.12 Aquatic ecosystem

An aquatic ecosystem is an ecosystem that found in the water body. Flora and fauna along with communities of organisms that are dependent on each other and on their environment live in aquatic environment. The aquatic ecosystem is classified into two categories on the basis of duration of holding water: seasonal and perennial wetlands.

Seasonal wetland

The seasonal wetlands 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.

Aquatic flora

Aquatic floras are mainly concentrating in the waterlogged areas in the field, internal khal and homesteads ponds. Due to having continuous tidal water flow in the channels of the river it does not support any aquatic macrophytes to grow and develop inside or along the bank line. That is why, little aquatic vegetation is observed in the river and river side canals. 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.

- Free floating plants are also common throughout the polder area. Kochuripana (*Eichhornia crassipes*), Kutipana (*Azolla pinnata*), Topapana *(Pistia stratiotes)*, Kuripana *(Salvina cucullata)*, Khudipana *(Lemna perpusilla)* are most dominant in this type of vegetation.
- Submerged plants exist in both perennial and seasonal wetland. Such as, Jhangi (*Hydrilla verticillata)*, Ghechu (*Aponogeton natans)*, Bicha (*Vallisneria spiralis)* etc are found.
- Sedges and meadows plants consist of amphibian plants. These types of plants also found moderately in the polder study area which is one of the most important wetland plant communities. They included Nil Kolmi (*Ipomoea aquatic)*, Kochu *(Colocasia esculenta*) and Helencha *(Enhyra flactuans).*
- Throughout the intertidal plains and subsequent wetlands are dominated by Hogla/Patipata (*Typha elephantalis*) and local brackish grasses species like Chaila gash *(Hemarthria protensa)*. In addition, patches of Golpata (*Nypa fruticans*), Choila/Ora *(Sonneratia caseolaris)* trees are observed sporadically on the torus and along riverside toe of the embankment khal and rivers.

Aquatic fauna

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

<u>Amphibians</u>

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

<u>Reptiles</u>

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

<u>Avifauna</u>

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

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

5.2.13 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 5.27: The Ecosystem Product and its Services Within the Polder Area

Goods/Services/Purpose	Source	Plants Parts used
Food	Supari *(Areca catechu)*, Narikel *(Cocos nucifera)*, Aam *(Mangifera indica)*,Jam *(Syzygium sp)*, Kola (*Musa sp)*, Safeda *(Manilkara zapota)*, Payara (*Psidium guajava)*, etc	Fruit
	Ghechu (*Aponogeton spp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana, (*Eichhornia crassipe*), Phutku (*Hygroryza aristata*) etc.	Leaf and stem
Wood, timber	Aam *(Mangifera indica)*,Jam *(Syzygium sp)*, Bot *(Ficus benghalensis)*, Babla *(Acacia nilotica)*, Mahogany (*Swietenia mahagoni)*,	Trunk
Medicine	Mahogany (*Swietenia mahagoni)*, Tulshi*(Ocimum americanum)*,Sezi *(Euphorbia antiquoram)*, Bel*(Aglemarmelos)*,Nim *(Azadirachta indica)*	Roots, Leaf, Stem
Thatching and mat making	*Cyperus platystylis*, Supari *(Areca catechu)*, Narikel *(Cocos nucifera)*,Bash (*Bamboosa* sp.), Bel *(Aglemarmelos)*, Tal *(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
Biofertilizer/ Guano	Kochuripana,	As compost,
Hydroponics	Kochuripana to make baira (floating platforms)	Grow seedlings and vegetables
Bio-gas	Kochiripana, Khudipana (*Lemna* and *Spirodela spp*.) and other aquatic plants.	All parts of the pant

Source: Field survey, March, 2017

Present threats on ecosystem

Soil salinity and internal canal bed siltation are the main threats on ecosystems of this polder. Intrusion of saline water creates stress for vegetation and its succession. Reduction of water conveyance capacity deemed soil moisture that hampers natural succession at canal side. Non-functioning of water control structures like regulators, causes insufficient drainage and flashing capacity of the polder area that damages vegetation. Loss of vegetation density and succession ultimately impact on wildlife habitats.

Local farmers reported that Mammals' population is very low in the polder area. Big mammals have already disappeared, because change of land use, different human activities and jungle area is

reducing. 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.

5.2.14 Livestock and Poultry Resources

A large number of populations of the polder area earn their livelihood farm raising livestock / poultry. Farmers are using for land preparation, sheep and pigs for saling and own consumption but their health is very poor. Detailed status of livestock and poultry in the household level is presented in Table 5.28.

Table 5.28: Status of Livestock/Poultry in the Polder Area

Live Stock/Poultry	% of Household	No. Livestock/Poultry in the Polder Area
Cattle/cow/bullock	60	6,662
Buffalo	3	222
Goat	2	148
Sheep	3	222
Chicken	70	12,954
Duck	10	740
Pigeon	2	296
Pig	5	278

Source: Based on field information, 2018 and Upazila Livestock Office

Photo 5.14: cattle, sheep and pigs are grazing in the field inside the polder area

Commercial livestock/poultry production

There are about 50-70 poultry farmers according to local poultry farm owners, farmers and DLS. Details are presented below in Table 5.29.

Table 5.29: Status of commercial livestock/poultry production

Livestock/poultry farms	Number of farms	Average nos/farms	Production (Nos)	Management		
				H	M	L
Chicken	50-70	200-1000	1.25-2.5 kg/chicken		M	

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

Photo 5.15: Poultry farm of Sabur in the polder area.

Feed and Fodder

Livestock population is facing problems of availability of fodder and feeds during monsoon season due to non-availability of grazing land. During monsoon, aman crops remain in the field, when rice straw is the main sources of fodder. In addition, rice husk and oil cakes, etc. are other common fodders in this polder area. But, during the dry season (especially from late December to late April) there is grazing land but shortage of grass due to salinity which acts as the main barrier for the grasses to grow. Poultry population and dug at family level survives by scavenging and generally no feed supplements are provided.

Photo 5.16: Rice straw for cattle feed

Livestock and Poultry Diseases

Productions of livestock and poultry are mainly constrained due to diseases and death of the population. Every year livestock population is affected by different diseases like Tarka, Anthrax, Foot and Mouth Disease (FMD), Black Quarter (BQ) and Hemorrhagic Septicemia (HS). Diarrhoea and Pest Des Petits Ruminants (PPR). Major poultry diseases are duck plague, Ranikhet (Newcastle), Fowl Pox and Fowl cholera. During monsoon season, the soggy condition of the animal shelter promotes various kinds of diseases to the bullock and cows. Moreover the unhygienic condition of the courtyard during this season increases the diseases of poultry birds. July to October (rainy season) months are periods of spreading diseases to livestock and poultry population in large scale. There are many deaths of animal and birds every year within in the polder areas because of outbreaks of diseases due to poor drainage conditions.

5.3 Environmental Quality

5.3.1 Water Quality

Water quality parameters (pH, TDS, Temperature, DO and Salinity) have been measured in major field investigation in March 2015, at five different locations of the polder (Table 5.30). The pH values in these locations are higher than neutral scale (pH=7) which means the water in these locations was alkaline in nature in March; this may be because the typical pre-monsoon rainfall did not yet start by then (opined by local people during field visits). Values of TDS were found high at the one location outside the polder (Teliganga River). This may be because of the increased sediment load carried by the tidal water which enters the polder. However, the samples selected from the inside of the polder carried very low TDS concentrations, ranging from 150 to 370 ppm. 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). The polder preserves a sweet water ecosystem, which is not altered by the saltwater concentrations in the peripheral rivers. From the insitu analysis it was found that only the peripheral Teliganga River carries moderate saltwater concentrations (8 ppt), but the internal Khals are mostly free from saltwater

intrusion. There are very limited numbers of water control structures in place at Polder 27, for which a significant numbers of khals are disconnected from the peripheral river. This is a reason for reduced saltwater concentrations observed inside the polder.

Table 5.30: Water Quality Parameters

Location	GPS Reading (Lat-Long)	pH	TDS (ppm)	Temp (ºC)	DO (mg/l)	Salinity (ppt)	Remarks
Teliganga River	22º46'38.9''N 89º20'56.6''E	7.9	1265	32.0	5.3	8	Outside polder
Sakha Bai Khal	22º46'43.6''N 89º21'00.1''E	8.2	370	31.7	4.9	1	Inside polder
Zialtola Khal	22º46'24.1''N 89º21'32.3''E	8.1	156	30.4	5.1	0	Inside polder
Barobeeler Khal	22º47'04.6''N 89º20'41.8''E	8.3	260	29.8	4.7	0	Inside polder
Kakmari Khal	22º45'10.9''N 89º23'18.4''E	8.0	195	30.1	4.8	0	Inside polder

Source: Field survey 2018

5.4 Climate Change

5.4.1 Climate Science

Khulna is identified as one of the 15 most climate change vulnerable areas of the world. Cyclone, storm surge induced flooding, riverine coastal flooding, water logging, salinity intrusion and coastal erosion are the main climate and hydrologic hazards in the area. Upstream cross boundary interventions has reduced freshwater inflows to the region, and construction of coastal polder has gradually reduced the flood-plain storage areas for tidal waters from the Bay of Bengal (Mondal, 2012).

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

The average durations of sunshine in the winter, pre-monsoon, monsoon and post-monsoon seasons were found to be about 7.7, 8.0, 4.9 and 7.4 hours a day respectively. The decreasing trend in winter is about 0.6 hours a day per decade, whereas the post-monsoon sunshine hours have a decreasing trend of 0.4 hours a day per decade. In a monthly scale, the sunshine duration has decreasing trend for all months, except for June, July and August. The trends in December and January of the winter season are statistically significant at 99% and 95% level of confidence, respectively (Mondal, 2012).
The relative humidity at Khulna has increasing trends of 2.3%, 1.3% and 0.3% per decade in the winter, post-monsoon and pre-monsoon seasons, respectively. In contrast, the monsoon season has a decreasing trend of 0.4% per decade. The trends in the winter and post-monsoon seasons are significant at a level of confidence of 99%. The decreasing trend at the monsoon season is significant at lower level. The trend of the pre- monsoon season is not significant (Mondal, 2012).
The rainfalls at Khulna BMD have experienced increasing trends of 8 mm, 31 mm, 9 mm and 6 mm per decade during the winter, monsoon, post-monsoon and pre-monsoon seasons, respectively. Among the monsoon months, June has an insignificant negative trend of 6 mm a decade, July has a non-significant positive trend of 5 mm a decade, August has a positive trend of 14 mm a decade being significant, and September has a positive trend of 7 mm a decade. Thus, the monsoon is found to be strengthening towards the end of the season. The numbers of rainy days during the wet (June-October) and dry (November-May) seasons show increasing trends of 0.6 days and 0.2 days a year respectively. Furthermore, the maximum number of consecutive rainy days in a year is found to be increasing (Mondal, 2012).
Moreover, the annual maximum high tidal water levels, as observed in Chalna (Pasur River) are increasing at a rate of 18 mm per year and the annual minimum low tidal water levels are decreasing at a rate of 8 mm per year.

5.4.2 Climate Change Scenario

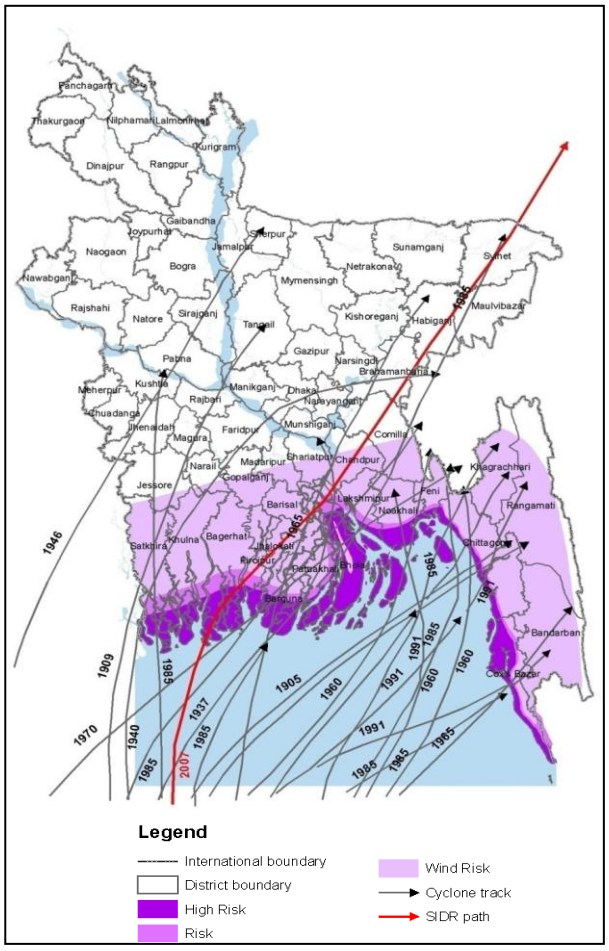
Two greenhouse gas emission scenarios, *A2 Scenario*[5] and *B1 Scenario*[6], from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC-IV) were used because they represent the high and low brackets of the estimated global temperature increases under the report story lines. The summary features of these scenarios, in relevance to Polder 27 have been discussed in Table 5.31 below.

Table 5.31: Summary Features of Climate Projections for Khulna

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

5.4.3 Cyclones and Storm Surges in Polder 27

Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal regions in Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of even more than 9m. For example, the 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m. By observing the tracks of different cyclones affecting the country in the last decade, the country's southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (Map 5.12). Polder 27 falls in the wind risk zone which possesses some vulnerability due to the strong winds, and surge heights associated with cyclones. From field observations, no major damage is found to undergo in the polder during the recent cyclonic events such as SIDR (2007), AILA (2009) and MOHASEN (2013).



Map 5.3: Cyclone Tracks in Bangladesh and Risk Area

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

[6] B1 Scenario is the sustainable development scenario, a convergent world with rapid changes in economic structures toward a service and information economy, with resulting lower greenhouse gas emissions

5.4.4 Environmental Impact on Sundarbans for Rehabilitation works of Polder 27

The Bangladesh portion of Sundarbans covers an area of 6,017 km² of mangrove forests, wildlife sanctuaries and sand bars, out of this 1,874 km² are made up rivers, creeks and canals (Wahid, 1995). The land area of Bangladesh Sundarbans is about 4,017 km² (Katebi, 2001), spreads over of Khulna, Bagerhat and Satkhira districts. As the world's largest mangrove forest, it plays a triple role: that of supplier of livelihoods at local levels, a rich source of biodiversity at the bi-national level, and at the global level, a valuable remnant of our planet's natural heritage. Watered by the twice-daily salty tides of the Bay of Bengal and seasonal freshwater flows from the Ganges-Brahmaputra river system, its biodiversity and health depend on a variable balance of salinity levels in its network of deltaic waterways. These waterways and the tree and shrub-covered mudflats, they intersperse form a mangrove habitat that functions as a nursery for fish and crustaceans, protects inland areas from storm surges, and provides livelihoods to millions.

Sundarbans, the largest outstanding areas of mangroves in the world, supports an exceptional level of biodiversity in both the terrestrial and marine environments, including significant populations of globally endangered cat species, such as the Royal Bengal Tiger. It has Outstanding Universal Value and World Heritage site inscribed in 1987. One of the UNESCO world heritages, the Sundarbans, is an ideal place for habitation of wildlife. The country, Bangladesh is known for her most precious wild animal the Royal Bengal Tiger. Even less than hundred years ago Royal Bengal Tiger was seen almost every part of the country and was a menace to the cattle owners. But ecological imbalance, climate change, deforestation, short rainfall and environmental degradation have contributed to shrink the tiger population in a rapid and drastic rate. Again, illegal wildlife trade and lack of law enforcement strategy have been witnessed a further reduction of tiger and other endangered species population.

The site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. The area is known for its wide range of fauna, including 260 bird species, the Bengal tiger and other threatened species such as the estuarine crocodile and the Indian python. The three wildlife sanctuaries in the south cover an area of 1,39,700 ha and are considered core breeding areas for a number of endangered species. Situated in a unique bioclimatic zone within a typical geographical situation in the coastal region of the Bay of Bengal, it is a landmark of ancient heritage of mythological and historical events. Bestowed with magnificent scenic beauty and natural resources, it is internationally recognized for its high biodiversity of mangrove flora and fauna both on land and water.

A large number of channels and creeks flow within the Sundarbans. The Gorai River is the main tributary of the Ganges is connected to Passur River and indirectly with Sibsa River which are playing an influential role in the Sundarbans ecosystems. Pasur River a big river in the Sundarbans area as an extension of the Rupsa river. South of khulna, the Bhairab or the Rupsa flows further south and is renamed as Pasur near Chalna and falls into the Bay of Bengal flowing to the right of Trikona and Dubla islands. The Baleswar River is fed from the Ganges River in the eastern part of the forest and as a result receives fresh water.

After commissioning of the Farakka Barrage in 1975 on the Ganges river 18 kilometers upstream of Bangladesh, dry season flow is gradually decreasing. The Sundarbans is being slowly choked of its freshwater supply. Salinity measurements at Khulna showed a significant increase after the commissioning of Farakka. The Gorai river, a distributary of the

Ganges and a major supplier of freshwater to the Bangladeshi Sundarbans, has almost discunnected every year from January to April 1988.

The Polder 27 is located at Rangpur, Ghutudia, Dumuria Sadar and Kharnia union under Dumuria upazila of Khulna District. The distance from buffer radius of the Sundarbans mangrove forest (under Nolian range) is about 34 km and from Hiron point 108 km. The Polder is surrounded by Shalta river in its South, upper Shoilmari river in the East and Mora Bhadra and Hamkura river (dead) in the west.

The drainage channels in and around the Polder and peripheral rivers influence of diurnal cycles of high and low tides. During high tide, water flows from the Bay of Bengal to the Shibsa and other peripheral rivers (Shoilmari, Shalta and Bhadra). During the monsoon, when sluice gates are kept open, fresh water flow takes place on both in and out of the polder. According to field investigation by the study team most of the khals are silted up and sluice gates are non-functional which exaggerate the drainage congestion, during monsoon, negatively impacting to the agricultural crops and fisheries within the Polder. The rehabilitation of water infrastructures, agricultural crops and fisheries in the polder area will be impacted positively and as well as water will be drained out, in monsoon, both the rain water and upstream fresh water, to the downstream rivers including Sutarkhali and Shibsa which crisscrossed the Sundarbans mangrove forest.

Map 5.4: Freshwater flow to Sundarbans from the Ganges through Gorai River.

The Polder-27 is far away from the Sundorbans is about 34 km and from Hiron point 108 km. and an independent hydrological unit. Under the Blue Gold Pprogram rehabilitation plan do not have any provision to work at Outfall or ou-side rivers Rivers of the polders. So, no impact on the out-side rivers, the saline water diurnal cycles of high and low tides will remain

same. Through public consultation we came to know that the protection of crops from saline water, during tidal flooding and/or surge during cyclone, will improve through rehabilitation of the proposed water infrastructures. On the other hand, the interventions would have positive impact in reducing crop damage area as well as crop production loss in the polder area since water availability as well as retention capacity will be increased after re-excavation of khals, and the irrigated area inside the polder would be increased.The peripheral river which are connected to downstream river Shibsa that ultimately contributor of freshwater to Sundarbans are not influenced by the rehabilitation works of the Polder under BGP. During the dry season (November to April) when need freshwater for irrigation and other purposes within the polder, then peripheral rivers (out side of the Polder) have no freshwater which might be used for Polder development activities. So, there are no provisions to withdraw freshwater from the surrounding rivers of the polder which ultimately contributor to Sundarbans for freshwater. Finally, it can be said easily, there will have no influence or any adverse effect on the Sundarbans Ecological Critical Area due to its long distance from Sundarbans and the nature of rehabilitation works of Polder 27 under Blue Gold Program.

6 Socio-economic Condition

The study area is situated at Gutudia union (part), Dumuria Sadar union (part) and Kharnia union (part) and Rangpur(p) union under Dumuria upazilla of Khulna district. The socio-economic baseline situation of the study area is described in following sections.

6.1 The people

6.1.1 Demography

The 6,527 households living in the polder area have a total population of 27,736 of which 13,985 are male and 13,751 are female. The male population is higher than the female population. The average male-female sex ratio is 101.5 which is higher than the national figure of 100.3 (HIES) 2010[7]]. The average density of population is 1069 persons per sq. km which is higher than the national density of 1,015 persons per sq. km. The inhabitants of this Polder belong to two religious groups; i.e. the Hinduism and Islam. About 54% of total populations are Hindu and 46% are Muslim. The demographic data of this Polder is presented in Table 6.1.

Table 6.1: Distribution of population and household of polder

District	Upazila	Union	Total HHs[8]	Population			Sex ratio	Population density
				Both	Male	Female		
Khulna	Dumuria	Dumuria Sadar Union	1880	8180	4148	4032	103	1088
		Ghutudia Union	1360	5722	2921	2801	104	1082
		Kharnia Union	751	2950	1471	1479	99	1020
		Rangpur Union	2536	10884	5445	5439	100	1087
Total/Average			6527	27736	13985	13751	101.5	1069

Source: Housing and Population Census, BBS, 2011

In the overall study area, households distribution by number of persons it is found that the highest percentage (28%) of household comprises of 4 persons in each (Figure 6.1). Although average household size is 4.1, a substantial percentage (25%) of households comprises of 3 and over persons in each.

Source: Housing and Population Census, BBS, 2011

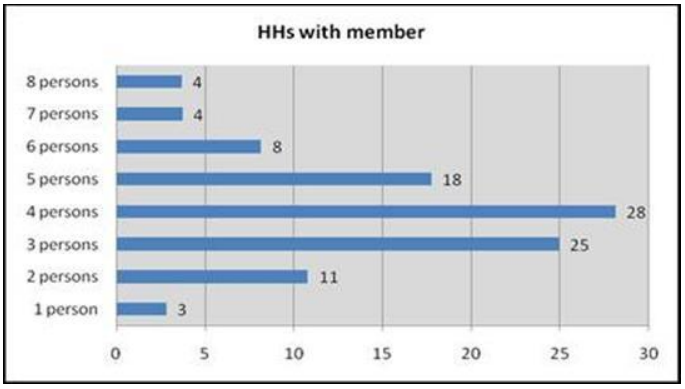


Figure 6.1: Distribution of households comprising member in each

6.1.2 Age Structure

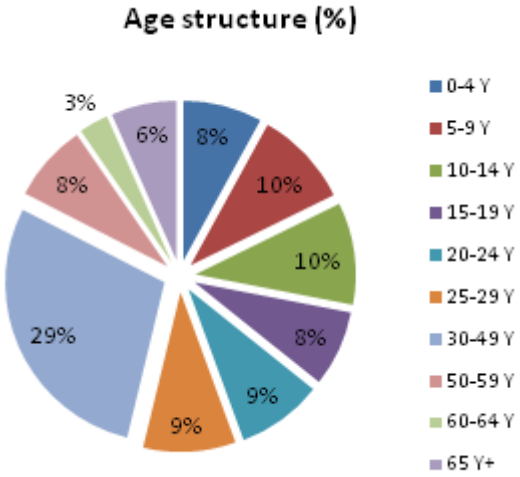
In the study area the highest number of population (28.7%) belongs to age category of 30 to 49 years old. Only 3% people are in 60 to 64 years category. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-54 years as prime working age, 55-64 years as mature working age and 65 years and over as elderly people (source: World Fact Book, CIA[9]). 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.

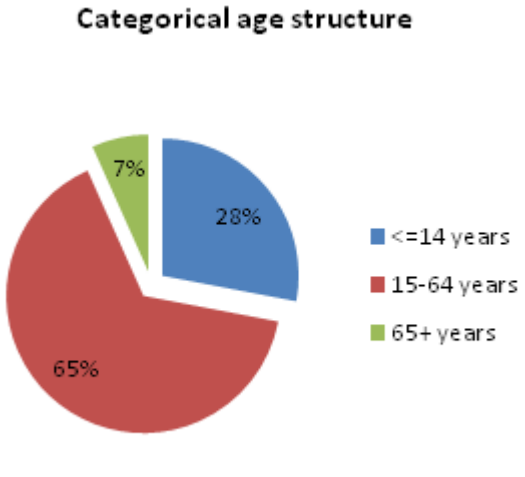
[7] HIES 2010 refers to Household Income and Expenditure Survey conducted by the Bangladesh Bureau of Statistics (BBS) in 2010.

[8] HHs refers to households

[9] 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 66%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[10] is 53 in which child dependency ratio is 43 and aged dependency ratio is 10. It illustrates that total 53 persons are dependent on 100 labour forces in which 43 are children and 10 are elderly people.





Source: Housing and Population Census, BBS, 2011

Figure 6.2: Age structure of the studied population

Figure 6.3: Categorical distribution of studied population

6.2 Education

Literacy rate, based on a definition "ability to write a letter in any language" is 53%, where for male it accounts to 58.4% and female 47%. The rate of literacy reported above is for population of 7 years and over ages. Data confirms that like the national picture of Bangladesh (Male 54.1% and Female 49.4%), in the study area the male populations are more educated than the female counterpart.

Field findings shows there are a total of 55 primary schools, 12 high schools, 14 Ebtedaye/ Dakhil Madrashas in the polder area. There are also two colleges both colleges are providing intermediate level education.

Table 6.2: List of Educational Institutions

Union Name	No of Primary School	No of Madrasha	No of High School	No of Collage
Dumuria Sadar Union	15	4	3	1
Ghutudia Union	12	3	3	-
Kharnia Union	8	2	2	-
Rangpur Union	20	5	4	1
Total	**55**	**14**	**12**	**2**

Source: Field work, 2019

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

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

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

6.3 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 10 community clinics and 4 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% people receive health services from quack doctors and 30% from paramedic/ diploma physicians and only 10% from trained doctor. It is noteworthy that about 5% do not receive treatment facility due to their impoverishment. People reported that the earlier tendency to go to the local healer for treatment has been taken place by registered/trained physicians. It is assumed that economic wellbeing may drive them toward receiving treatment facilities from trained physicians whether it is expensive or cost effective.

Almost six types of disabilities and their proportionate distribution in the respective area(Population Census, 2011). It is found that the study area comprises 1.5% of all types of disabilities and 0.7 people reported that they are physically challenged. 0.4% 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.

6.4 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.

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.

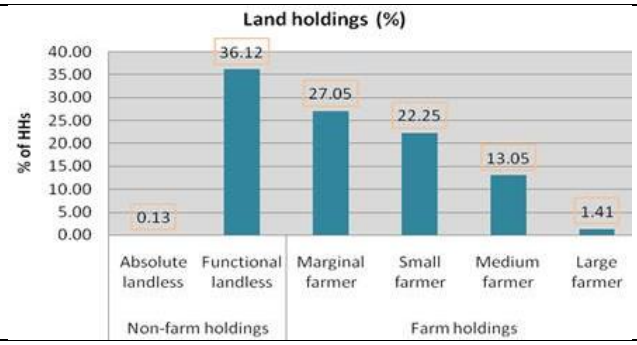


Figure 6.4: Households by land holdings

Source: The Census of Agriculture, 2008, BBS

Farm holding distribution shows 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% large farmer (7.5+ acre) categories. It is evidential that land fragmentation decreases the holding size. Large & medium farmers are gradually being converted to marginal farmers.

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

6.5 Occupations and livelihoods

Out of total 27,736 population, 7,211 (26%) are economically active which include 2,654 (36.8%) employed, 14(0.2%) are looking for work, and 4,543 (63%) engaged in are household work. The

economically active population includes those who are aged 7 and over and not attending school at reference period of Housing and Population Census, 2011. Therefore, the definition include employed, looking for work and household work categories and exclude children below 7 years, attending school population, physically impaired and elderly people who are not engaged in income generation works at reference period. Here household work particularly for women participation is accounted in terms of household activities as well as alternative income generation such as livestock rearing, poultry farming etc.

Women participation in direct income generating activities (employed category) is trivial as education status confirms that whereas not attending males are engaged in employment, females are getting married and in turn, contributed to the highest participation in household work (45%). 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 80% are engaged in agricultural activities, 15% in industry/business and 5% 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. Field findings suggest that land use for settlements is increasing and water bodies are decreasing.

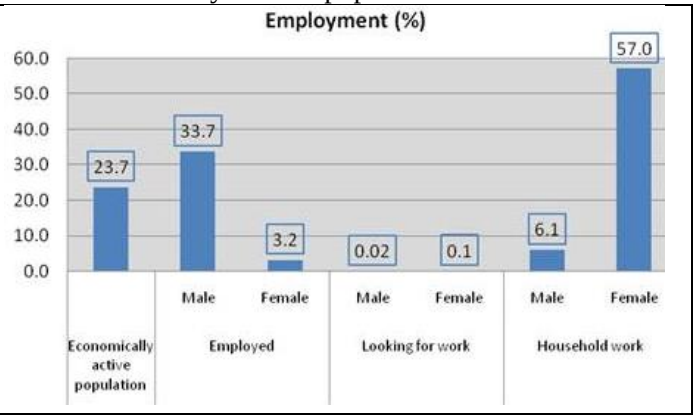


Figure 6.5: Employment status among the studied population

Source: Housing and Population Census, BBS, 2011

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. In the People stated that this contribution shall be increased if favorable assistances (infrastructure, power and re-excavation of khals) are ensured.

6.6 Labor market

The employment rate[11] in the study area is 37 whereas the unemployment rate[12] is 63. It is evident that more than 63% 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 0.2% populations are looking for work.

Data confirms that agriculture, industry and service are the sole sectors to generate employment for the local people (see paragraph of occupations and livelihood section). Field findings documented that peoples who are not permanently employed tend to engage themselves in those sectors in the forms of agricultural labourers, fishers, brick field worker, earth workers, and cleaners. In agricultural sectors most of the labourers are supplied from the local villages.

Field findings documented that female participation in agriculture sectors is higher than that of industry and service. During harvesting period, they take part in action with men in same agricultural field. Some of them are also collect fry fish from river, earthwork etc. The wage rate varies between 400 Tk. to 350 Tk. /day for male whereas women wage rate is about 250 Tk. to 200 Tk. and they can work 20 days continuously in a month.

During field visit, people stated that out migration of labourers is slightly found (3%) in the study area whereas in-migration is almost absent. These out-migrants are mainly agricultural labourer usually go to neighboring upazilas during May to September for better livelihood and lack of employment

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

[12] Unemployment Rate= 100-Employment Rate

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.

6.7 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.

Electricity facility is very poor in whole union. Field findings shows that polder area comprises (35.7%) electricity coverage. Moreover, about 50% households are now use solar electricity in the polder area (Fieldwork, 2019).

The overall housing condition is not satisfactory. The study area shows the predominance of kutcha houses (80.9%) over other three types. Semi-pucka household is 9.2%, pucka is 9% and 1% is still jhupri houses. (Figure 6.8).

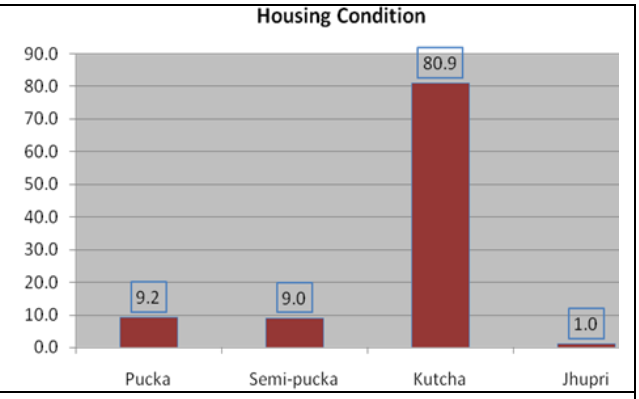


Figure 6.6: Housing condition in the study area

Source: Housing and Population Census, BBS, 2011

Sanitation facilities in the study area show that about 13.2% households use non-sanitary latrines and 39.2% use non water-sealed sanitary 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 (38.8%). 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 6.8).

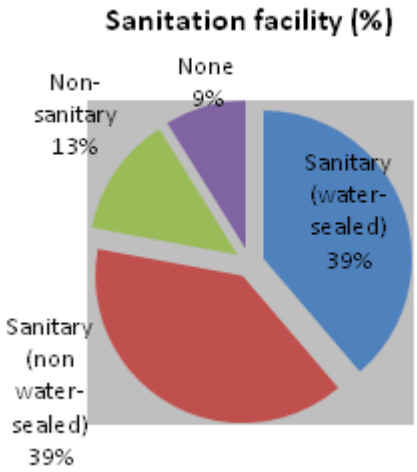


Figure 6.7: Distribution of households by sanitation facilities

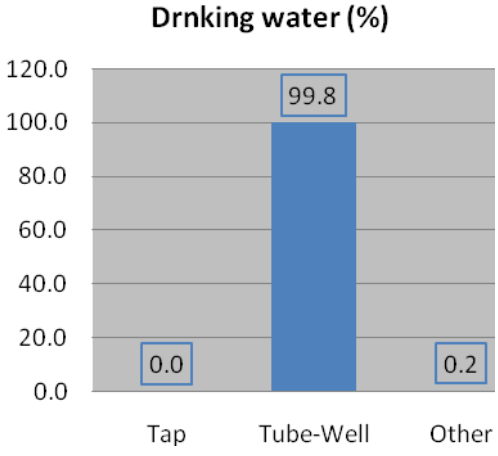


Figure 6.8: Distribution of households by sources of drinking water facilities

Source: Housing and Population Census, BBS, 2011

Collecting drinking water from tube-well is predominant (99.8%) throughout the study area. There is no supply water (source from Tap) in whole polder. However, only 0.2% 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.

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.

6.8 Poverty situation

Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories (Figure 6.11). It is observed that about 35% of the households in average are in the 'deficit' category, 10% are surplus and rest of 55% households are in balance situation. These households have been identified in the RRA as the poor households of the Polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals in a day in the lean period since they could not afford three full meals.

Source: Fieldwork, 2019

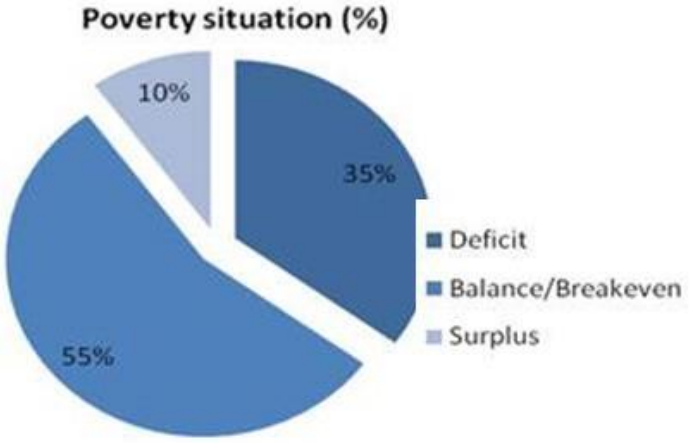


Figure 6.9: Self-assessment of Poverty Status

6.9 Institutions and infrastructure

At present, there is only one growth centre or big market (Dumuria Bazar) in the polder area. Besides, there are seven hat/bazar in the whole polder area of which 2 of these bazar are open every day of the week. High way 5.00 km, internal bituminous road 22 km, brick soling 41 km and earthen road 32 km. Basically this polder is near Khulna-Satkhira high way and inhabitants are using van, rickshaw and easy bike as major transport. Internal road communication facilities fully depend on embankment road and internal roads which are connected with the embankment road.

Photo 6.1: Road networks within the polder

6.10 Extension services

The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social safety nets among the targeted poor households and vulnerable communities to some extent. **Table 6.3** shows the current social services and facilities for alleviating poverty in the study area.

Table 6.3: Households served by different social safety nets programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	6
Food/Taka For Work (F/TFW) of PIO	4
Food for Education/Cash for Education	10
Rural Maintenance Programme (RMP)	6
Old Age Allowance	5
Freedom Fighter Allowance	3
Integrated Poverty Reduction Program of BRDB	6

Source: Fieldwork, 2019

A number of local, national and international NGOs are working in the polder area. The main activities of these NGOs are operating micro credit programs among the rural poor and landless

women/men. The major NGOs working in the area include BRAC (Bangladesh Rural Advancement Centre), ASA (Association for Social Advancement), Bureau Bangladesh, Nobolok, CCDA (Centre for Community Development Assistance) Heed Bangladesh. These NGOs are serving with micro credit while BRAC working for non-formal education, Health, water and sanitation, gender and children development programs. About 45% of households are found to benefit from the NGOs interventions. After disasters (Sidr and Aila) the Nobolok was appeared the most important NGO for the local people.

6.11 Common property resources and its utilization

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

It is observed, there are 12 cyclone shelters among them one is under construction. Besides, there are 32 mosques, 36 temples, 15 Eidgah, 20 graveyards and 21 crematoriums in the polder area.

7 Public Consultation and Disclosure

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 at involving the project stakeholders into the project development and implementation process. A formal meeting comprising of local people who are likely to be impacted was held at Polder 27 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 people, and other stakeholders;
- To identify environmental and social issues such as safety hazards, employment, and vulnerable persons;
- To begin establishing communication and an evolving mechanism for the resolution of social and environmental problems at local and project level;
- To involve Project stakeholders in an inclusive manner i.e. establish and empower community organizations/ water management organizations (WMOs) to sustainably manage their water resources and to make these resources more productive.; and
- To receive feedback from primary stakeholders on mitigation and enhancement measures to address the environmental and social impacts of the Project.

7.3 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 responses from the participants. The stakeholders of the Polder 27 were asked to share their needs, problems, possible sustainable solutions, and their views on the project interventions. The stakeholders' perceived views on important environmental and social components (IESCs) and project's impacts on them, along with perceived benefits, risks, threats and demand from the project were identified through these discussions.

7.3.1 Consultation Process

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

Greetings:

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

Introduction:

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

Respect to the participants:

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

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.

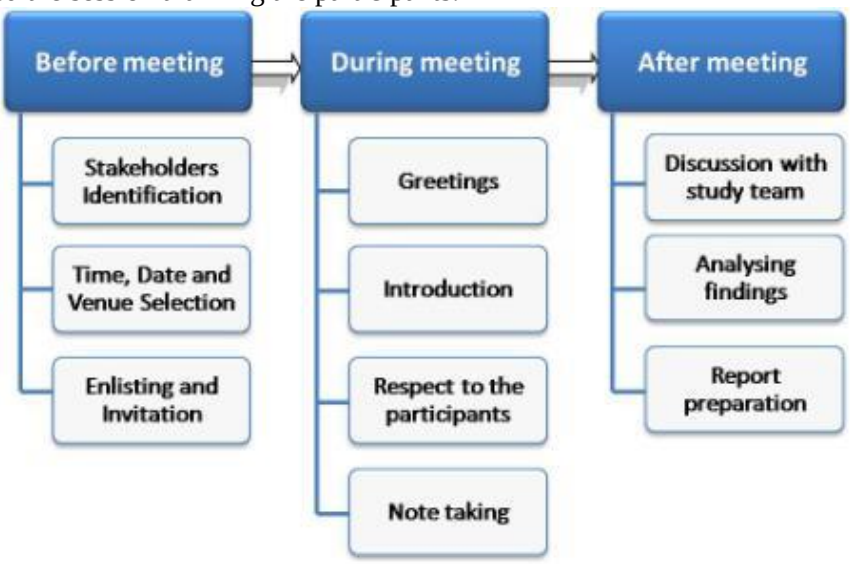


Figure 7.1: Overall public consultation meeting process

7.4 Identification of stakeholders

Stakeholders include all those who are affect 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.

7.4.1 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 27, the primary stakeholders include the people living within the Project area particularly those who reside within and in the immediate vicinity of the polder. The primary stakeholders of the Project include the farmers, fishermen, local business community as well as women groups, and caretakers of community properties. Primary

stakeholders identified and consulted during the present EIA include communities to be benefitted and/or affected by the Project, local leaders, community members and other local representatives.

7.4.2 Secondary Stakeholders

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

7.5 Consultation meeting and FDGs

7.5.1 Consultation time and venue

One PCM and number of FGDs were conducted at different locations of the Polder 27. The details of these FGDs and PCM are presented in Table 7.1 and some photographs of these meetings are given below.

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	22/05/2019	15:00
1	Khulna	Dumuria	Dumuria Sadar	Khajuria	FGD	22/05/2019	10:00
2	„	„	Gutudia	Union auditorium	PCM	25/05/2019	09:00
3	„	„	Kharnia	Bazar	FGD	25/05/2019	16:00
4	„	„	Rangpur	Union auditorium	PCM	26/05/2019	10:00

7.5.2 Consultation Participants

The main participants of these consultation meetings included Blue gold officials, local representative, farmer, trader, members of WMO and daily wage laborers of the Polder 27 and nearby areas. A total of 131 participants attended these consultations. The participant details are provided in Table 7.2 below.

Table 7.2: Participant details

Sl	Meeting venue	Type of consultation	Type of Participants	No. of participants
1	Blue gold office	Consultation	Secondary stakeholders	15
2	Khajuria, Dumuria Sadar	FGD	Secondary and primary stakeholders	25
3	Gutudia Union auditorium	PCM	„	35
4	Kharnia Bazar	**FGD**	„	16
5	Rangpur Union auditorium	PCM	„	40

Photo 7.1: PCM at Dumuria

Photo 7.2: FGD at Khajuria, Dumuria

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

Issues, problems and concerns and the solutions suggested by the participants are provided in Table 7.3.

Table 7.3: Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	Salinity intrusion through damaged structures, drainage congestion, water borne diseases and cyclone are the main community concerns in the polder area.	Comprehensive rehabilitation of the polder should be taken up at the earliest with the active involvement of the local community.
Water resources	- The water control infrastructures are not suitably functional in this polder and salinity intrusion due to damaged gates of the structures and height of embankment has reduced; - Inlet and outlet of every sluice gates are vulnerable and not functioning - Entrance of saline water through damaged structures	- The total 30 km canal of the polder area should be taken under re excavation activities - New canal excavation to prevent water congestion. - Making connectivity with the internal canals with Ghangrail and Bhodra River for draining out the logged water of this area. - Construction of sluice gates beside the river. - Construction of sluice gate at Kadomtola - Paved road to be constructed alongside the canals by the excavated Re-excavated earths
Agriculture resources	- Drainage congestion during transplanting period in Aman season. - Severe scarcity of irrigation water during dry season especially for rabi crops cultivation. - Some people are contaminating the fresh water through inflowing saline water in the polder area	- Re-excavation of khals. - Training for WMAs. - Providing DTW and power tiller facility to the farmers - Training for WMOs as well as the local farmers
Fishery resources	- Deteriorated habitat quality due to 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 and internal khal siltation are the main threats on ecosystems of this polder. - Non-functioning of water control structures like regulators, causes insufficient drainage and flashing capacity of the polder area that damages vegetation. - Intrusion of saline water expands soil salinity that increases stress on vegetation.	- Removing siltation by re-excavation of khal. - Embankment re-sectioning and repairing water control structure along the embankment to protect settlement, road, inter tidal area and crop fields from existing problem.
Socio-economic resources	- Drainage congestion has a significant impact for the loss of agricultural production in Polder 27 area which also impact the economic condition of agriculture based households. - 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. - Arsenic creates health problem to the local people	- Strengthening of WMGs so that mass people can access open water bodies easily. - It is needed to ensure correct operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also manage properly water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc and growing of consciousness among the community in the polder. - Giving priority to the local people in the project activities and ensuring their scopes in the sector of employment generation

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	- Local people are not satisfied with the activities of contractors - Lack of consistency of work between the implementation work authority from Blue Gold and the UP officials	- Let the local UP officials be engaged with the development activities. - Social forestation should be taken beside the canals - Strengthening the WMGs to make the activities prolific - Taking some sustainable initiatives for the local poor people thus they can be self reliant as the area is situated under a naturally vulnerable area.

7.8 The Participants

The name of the participants of different consultations, FGDs, and address including cell phone number (if any) are provided in Table 7.4.

Table 7.4: Name of participants

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

Place: [illegible] Date: 22/10/2015

Sl. No.	Name	Address/Designation	Mobile No.	Signature
1.	[illegible]	[illegible]	01715-597700	[illegible]
2.	[illegible]	[illegible]	01736029622	[illegible]
3.	[illegible]	[illegible]	01784-102106	[illegible]
4.	[illegible]	[illegible]	01930-780092	[illegible]
5.	[illegible]	[illegible]	—	[illegible]
6.	[illegible]	[illegible]	01962-696216	[illegible]
7.	[illegible]	[illegible]	—	[illegible]
8.	[illegible]	,,	—	[illegible]
9.	[illegible]	,,	[illegible]	[illegible]
10.	[illegible]	,,	01976[illegible]	[illegible]
11.	[illegible]	,,	01792361939	[illegible]
12.	[illegible]	,,	[illegible]	[illegible]
13.	[illegible]	,,	01710263470	[illegible]
14.	[illegible]	,,	01[illegible]	[illegible]
15.	[illegible]	[illegible]	01[illegible]	[illegible]
16.	[illegible]	[illegible]	01710-166970	[illegible]
17.	[illegible]	[illegible]	—	[illegible]
18.	[illegible]	,,	01931 393817	[illegible]
19.	[illegible]	,,	01915-597700	[illegible]
20.	[illegible]	,,	—	[illegible]
21.	[illegible]	,,	0928-191544	[illegible]
22.	[illegible]	,,	01987034995	[illegible]
23.	[illegible]	[illegible]	01920-691132	[illegible]
24.	[illegible]	[illegible]	01922-612613	[illegible]
25.	[illegible]	,,	[illegible]	[illegible]

8 Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification of IESCs and Rationale

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

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Ambient Noise Level	The construction works, in particular, the collection and placement of earthen materials and eventual compaction along the polder periphery would require heavy excavators to move over the polder alignment. This may create temporary noise pollution, which might be considered as objectionable by adjacent community. As such, Ambient Noise Level is considered as an IEC.
Saltwater Intrusion	Some of the interventions proposed in Polder 27, i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, saltwater intrusion has been considered as an IEC.
Water Security	Due to khal re-excavation works, the availability as well as access of surface water in Polder 27 may be increased and this might facilitate the multi-purpose use of water. Therefore, water security has been selected as an IEC.
Drainage Congestion and Water Logging	The re-excavation works in the khals may improve the drainage status of the area, and diminish the risk of emergence of water logging problems at some portions of the polder. Therefore, drainage congestion and water logging has been considered as another IEC.
Land Resources	
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 would encourage cultivating more crops in changed situations. Because of this reason, land use has been considered as one of the IECs.
Soil Salinity	Soil salinity increases with the intrusion of salt water in the polder area. The proposed interventions (re-sectioning of embankment, construction and sluices and outlets, re-pairing of sluices and inlet, khals re-excavation etc.) are expected to check the intrusion of saline water which in turn would help in the reduction of soil salinity. Soil salinity level has therefore been selected as an IEC.
Agriculture Resources	
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside Polder 27, which may encourage the farmers to change their cropping patterns and may grow more HYV. This may increase the cropping intensity for such consideration cropping pattern and intensity has been selected as an IEC
Crop production	Agricultural crop production is expected to be increased for the improvement of drainage congestion problem due to re-sectioning of embankment, re-excavation of khals, repairing of drainage/flushing sluices and irrigation inlets. The re-excavation of khals would help to drain out excess water from the crop fields. Repairing of drainage/flushing sluices and irrigation inlets might prevent the intrusion of saline water. The excess rain water inside the polder area would be drained out through drainage/flushing sluices that might help to cultivate the HYVs rice. 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 increased, crop production has been selected as an IEC.
Crop damage	Crops are presently damaged in the polder area due to drainage congestion in the pre-monsoon and rainy season, drainage congestion, salinity, drought, etc. which are expected to be checked due to implementations of the proposed interventions. Reduction in crop damage would be reflected in aerial extent as well as increased yield per hectare contributing to increase in crop production in consideration of which crop damage has been selected as an IEC.

IESCs	Rationale
Irrigated area	Surface water is more preferable than ground water for irrigation use because of its low cost and sediment content contributing towards maintaining the soil nutrient status. The proposed interventions are expected to increase the availability of surface water for irrigation use as well as soil fertility. Irrigation has been selected as an IEC.
Fisheries Resources	
Fish Habitat	The proposed interventions of the project likely alter the fish habitat as well as habitat quality in the polder area. Increased water depth may support different fish species for re-excavation of khals. In this context, fish habitat has been considered as an IEC of the study.
Hatchling and Fish Movement	A few numbers of khals are connected with the peripheral rivers. Most of the khals are silted up but till there is a scope of hatchling as well fish movement from river to khal and tidal area especially in monsoon in the polder area. The proposed interventions like repairing of regulators and re-excavation of khals may have considerable change in fish hatchling movement in the polder area. Thus hatchling and fish movement has been considered as an IEC.
Fish Biodiversity	The brackish and fresh water fish species are declining due to habitat losses, obstruction of migration routes, degradation of fish habitat quality etc. Moreover, the proposed intervention may change the fish migration which might change in fish species diversity in the polder area. So, fish diversity has been considered IEC of this study.
Capture Fisheries Productivity	Open water fisheries especially river fisheries still contribute significantly on fish production in the polder area. The proposed interventions may change the fish abundance which ultimate may increase the fish productivity of both capture and culture fisheries in this area. Due to increased depth and improved water quality for re-excavation of khal, it is expected that capture fisheries productivity inside the polder
Ecological Resources	
Terrestrial Vegetation	Terrestrial vegetation is an important component of the existing ecosystem. This type of vegetation provides habitat for wildlife and also providence of various elements to human. Any change of physical environment causes different intensity of vegetation damage. The proposed interventions may cause impacts to vegetation during construction as well as post construction phases. Therefore, Terrestrial vegetation has been identified as an IEC.
Aquatic 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	One of the main utility of water is its social use i.e. taking shower, washing chores and other social uses. 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 two proposed canals are made, it will ensure the various social use of water. Therefore, social use of 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 hydraulic structures. It is expected that the agriculture production would increase while salinity problem would decrease. Hence, project 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 40% of labour under total local constructing society (LCS) will be females. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.

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 post-construction, 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.
- Landuse surveys in Polder 27 comprising socio-economic status and environmental settings.
- Expert consultation, focus group discussion, and public consultation.

8.2.2 Impact Screening

As part of the environmental impact assessment process, a tailored made screening matrix was used to asses the potential environmental impacts during the pre-construction, construction and operation phases. The matrix examined the interaction of project activities with various components of the environment. The impacts were broadly classified as physical, biological and social, and then each of these broad categories 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 post-construction stages 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	-
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	-
Post-construction 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 on the IESCs of water resources, agriculture, fisheries, and ecological resources during this phase of the proposed interventions. Some temporary impacts may generate on social conditions and their magnitudes have been shown in Table 8.3 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 27 where different activities will be initiated.	Out of total 27,736 population, 7,211 (26%) are economically active which include 2,654 (36.8%) employed, 14(0.2%) are looking for work, and 4,543 (63%) are engaged in household work.	Local unemployed labours will be recruited for carrying and storing of materials, site preparation. Thus, the income of labor will increase temporality	+2

8.4 Impact during Construction Phase

There would be no significant impact on IESCs of water resources, land and agriculture resources during this phase of the proposed interventions. Environmental and social parameters that may be temporary impacted during the construction phase and their magnitudes have been shown in Table 8.4

Table 8.4: Impact Assessment Matrix for the Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Physical Environment				
Activity: Re-sectioning of embankment				
Ambient Noise Level	Along the polder periphery	The 50-th percentile Noise level observed inside the polder are 50 dB	The excavator and associated heavy machineries will create noise disturbance along the polder alignment, and are likely to increase the noise levels by around 5~10 dB	-2
Fisheries Resources				
Activity: Re-excavation of khal				
1. Fish Habitat 2. Hatchling and fish movement	1. Gonardara khal 2. Magurkhali kha 3. Shostitola khal 4. Khoria Khal 5. Khajura-shairghata khal 6. Mirzapur khal 7. Kamolpur Dowaria Khal 8. Tiabunia Khal 9. Shoshthitola Khal	• Most of the khal are seasonal. Average depths of these khals are (0.7-1.7) m is suitable for fish habitation. But habitat quality is degrading day by day. • About 100 fish species (both brackish and fresh water fish) are present.	• Loss of habitat quality and temporary loss of feeding ground and unavailability of fish feed for bottom dweller (e.g. eel fish, baila, crabs etc). • Decrease of fish habitat quality for time being. But after one (01) year the habitat quality will improve.	-2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
			• Fish production would loss temporally about 1 ton per year.	
Activity: Repairing and construction of Water Control Structures				
Fish movement and migration	Repairing of Sluice (Zialtala Sluice) Construction of Sluices (Kadomtola sluices) Construction of inlet (Patibunia, Padmabunia, Borobeler khal, Kurer beler khal Construction of inlet (Out let)	Fish hatchling and some brackish water fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra and boal etc. move through the mal-function of regulator on regular basis during high tide.	Movement and migration of fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, bele etc will be obstructed during repairing of structures. Fish hatchling movement will also be hampered, if the repairing works is implemented during hatchling period (May-June).	-1
Ecological Resources				
Activity: Repairing of embankment				
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: 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. Composed of free floating plants, like Kochuripana, Kutipana, Dhol kolmi, etc which support habitat for fishes and Kingfisher, Egret, Snake, etc. Durba Gash, Biskantali and different types of marginal herbs like Dholekolmi, Kasorti, etc. are dominant along the both side of the khal. Different types of local avifauna roam here for	Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
		their feeding.		
Socio-economic Condition				
Activity: (i) Repairing of embankment (ii) Embankment slope pitching and turfing (iii) Re-excavation khals (iv) Repairing of drainage/ flushing sluices (v) Repairing of drainage outlet (vi) Repairing of irrigation inlet				
Employment generation	Periphery and inside of the Polder 27 where different activities will be initiated.	About 26% population are economically active which include 2,654 (36.8%) employed, 14(0.2%) are looking for work, and 4,543 (63%) 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 27 where different activities will be initiated.	Females are mainly involved in household work and very few of them are working as a day labor or earth worker	According to the project plan, the LCS entails 60% male and 40% female all of them would be engaged from the local area. Thus, employment access to females in the construction works and during operation /maintenance phase will be promoted significantly and they can also take part in different decision making processes.	+3

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

8.5 Impact during Post-construction Phase

Possible impacts of the proposed interventions on the selected IESCs during the post-construction phase have been assessed comparing the future-without-project (FWOP) condition with the future-with-project (FWIP) condition. The impacts on the IESCs under different resources are presented in the following sections and summary of impact are presented in Table 8.10.

8.5.1 Water Resources

a. Saltwater intrusion

Future-Without-Project

Saltwater concentration in the surface water system of the polder may increase in future if the sluice gates are not repaired. At present, very minimal portion of saltwater enters into the polder during dry season through some of the structural leakages and openings. Salinity concentrations within 20-m buffer distance from the Teliganga River are found within 1 ppt. However, as the existing sluice gates are damaged and do not function up to the level desired, saltwater intrusion may be an issue in future. If the proposed structural repairing works are not carried out for the existing sluice gates, around 2 km lengths of khals located within the 20-m buffer distance from Teliganga River (Barobeeler khal, Kadomtola khal, Zialtola khal etc.) may be affected by salinity concentrations up to 8 ppt (equal to the same salinity concentrations of Teliganga River).

Future-With-Project

The possible saltwater leakage into the polder may permanently be prevented, if the existing sluice gates, flushing inlets and drainage outlets are repaired. As a result, no saltwater intrusion will take place inside the polder and values of salinity concentrations in the inner surface water system would drop to 'zero'.

Impacts

Significant impacts would be achieved regarding the prevention of salt water intrusion inside the polder. Salinity values will drop from a foreseeable maximum of 8 ppt inside the polder to 'zero'. Almost 2 km primary water distributaries of the Teliganga River namely, Barobeeler khal, Kadomtola khal, Zialtola khal etc. will be improved from possible saltwater intrusion.

b. Water security

Future-Without-Project

People living in Polder 27 are suffering from freshwater availability concerns at present. They cannot meet up their domestic and drinking water requirements up to the desired level. From the spatial distribution of surface water sources and settlements, it has been estimated that around 15% people inside the polder suffer from water stress13. If the khal re-excavation works are not carried out, the entire polder would suffer from more freshwater scarcities for different uses. With expected khal siltation and probable saltwater intrusion problems in future, it is expected that around 20% people inside the polder may suffer from water stress. This will ultimately impact their water security, and continue to deteriorate the status of community level water-food-energy nexus.

Future-With-Project

An additional volume of around 100,000 m^3 in the re-excavated khals would be available if the project is implemented, which can carry water in all seasons and serve the domestic water demands of a significant number of people. However, around 5% of people in polder may still remain in water stress, especially drinking water stress.

Impacts

Around 15% of people living inside Polder 27 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. Drainage congestion and water logging

Future-Without-Project

Presently, around 60% of the internal water courses (Barobeeler Khal, Sakha Bai Khal, Zialtola Khal etc.) suffer from drainage congestion. The project intends to construct two new outlets and a new sluice along the course of Teliganga River. If the structures are not constructed then drainage

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

congestion situation may further deteriorate and additional 5% lengths of the above mentioned water courses may face drainage congestion. However, no water logging situation may prevail.

Future-With-Project

Drainage congestion in the above mentioned khals would significantly improve, and rainwater would be drained out properly from the area, if the proposed khal re-excavation works are implemented. The study infers that around 20% of khals may still be affected from drainage congestion.

Impacts

Considering the 'future without project' and the 'future with project' scenarios, it can be said that around 45% of the khals adjacent to the Teliganga River courses (Barobeeler Khal, Sakha Bai Khal, Zialtola Khal etc.) would be improved from drainage congestion. This would facilitate improved drainage and other associated hydrological functions.

8.5.2 Land Resources

a. Agriculture land use

Future-Without-project

Presently, NCA is about 75% of the gross area. Of the net cultivable area single, double and triple cropped area is about 18%, 78% and 4% respectively. If the project could not be implemented in future, utilization of land for single, double and triple crop would be about 28%, 70% and 2% of the NCA respectively under FWOP condition (Table 8.5).

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 re-sectioning of embankment, Construction of sluices and out lets, repairing of drainage / flushing sluices, and re-excavation of khals etc. would enhance land utilization. However, the land utilization for single, double and triple cropped area would be around 14%, 80% and 6% of NCA respectively in future with polder condition. Detailed land use has been presented in Table 8.5.

Impacts

Single cropped area would decrease about by 14% but double and triple cropped area would increased by 10% and 4% of the NCA respectively 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 (% of NCA)	FWOP (% of NCA)	FWIP (% of NCA)	Impact (FWIP-FWOP)
Single cropped area	18	28	14	-14
Double cropped area	78	70	80	+10
Triple cropped area	4	2	6	+4
Total	**100**	**100**	**100**	

Source: Estimation based on field information, May 2019

b. Soil salinity

Future- Without -Project

Most of the areas are affected due to capillary raise of saline ground water which is unfavorable for crop production during dry season and remains fallow. If the proposed interventions in the polder area would not been implemented land type and land use might be change. The situation would be aggravated in future without project condition. Besides, the salinity developed by capillary rise due to inadequate and non-functioning of structures, would not be drained out properly in monsoon season. Hence practices of different rice crops such as LT.Aman, HYV T.Aman, and HYV Boro as well as non-rice crops such as Jute, Mustard, S. Vegetables and W. Vegetables would suffer from salt stress in the polder area. Most of the structures would be non-functional due to siltation surrounding the structures. There would be negative impact on crop production due to salinity under future without project condition.

Future- With -Project

The construction of re-tired embankments would prevent the intrusion of saline water into the agriculture fields and are expected to decrease in soil salinity which might enhance crop production and would reduce crop damage. Excess rain water would be removed from the polder area through the

sluice gates. The embankments and structures would also prevent the intrusion of saline surface water during high tide or tidal surge. In addition, soil salinity would be removed through flashing from project area during monsoon season due to onset of rainfall. The crop damage due to salinity might be reduced to a great extent.

Impacts

The structures would have positive impact on reducing soil salinity. 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.

Table 8.6: Impact matrix on agriculture land use and salinity of the polder area

IESCs	Baseline	FWOP	FWIP	Impact (+/-)/ Magnitude 1-10
Re-sectioning of embankment, repairing of drainage/flushing sluices and irrigation Inlets, construction of sluices and inlets and re-excavation of khals etc				
Activity	Collection and disposal of Re-excavated earth earth materials on existing embankment and both side of khals for re-sectioning of embankment and re-excavation of khals by head load/mechanical			
Agriculture land use	Presently, NCA is about 71% of the gross area. Of this net cultivable area single, double and triple cropped areas are about 59%, 39% and 2% respectively.	Utilization of land for single, double and triple cropped area would be about 63.5%, 35% and 1.5% of the NCA respectively under FWOP condition	Utilization of land for single, double and triple cropped area would be about 55%, 42%, 3% of the NCA respectively under FWIP condition	+2
Soil salinity	The polder area is suffered by soil salinity of which about 80% of the NCA is covered by non saline to slightly saline and about 20% of the NCA is suffered by moderately saline to some strongly saline.	Salinity would be increased.	The successful implementation of the project and its proper management would reduce the salinity of the polder area.	+3

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

8.5.3 Agricultural Resources

a. Cropping pattern and intensity

Future- without -Project

Presently, cropping intensity of the polder area is about 186%. If the polder is not implemented, the land type as well as land use would be degraded in failure of embankment, non -repairing of existing drainage/flushing sluices, construction of outlets and sluices as well as siltation of river and drainage channels. Under this condition, there would be negative impact. The cropping intensity is expected to change about 174% (Table 8.7).

Future -With -project

The future with project condition would help to change the hydrologic regime inside the polder area polder which might encourage the farmers to change their cropping patterns. Under FWIP condition, the structures would function well and would influence to drain the excess water during rainy season from the cultivable land as a result land type might be improved. The improved land type would influence the farmers to practices multiple cropping in the polder area. After completion of the interventions, the cropping intensity is expected to increase to around 192%.

Impacts

After completion of the interventions, the cropping intensity is expected to increase to around 18%.

b. Crop production

Future- Without -Project

Presently, total crop production is 16,616 tons of which rice is about 9,816 tons (59%) and non rice is about 6,800 tons (41%). Adverse effect might occur due to siltation of river and drainage channels. The production would be decreased from the base situation. The farmers would be desperate to produce more crops for their increased demand under FWOP condition. A total of 8,832 tons rice is

expected to be produced and a total of 6,347 tons non-rice crop would also be produced in the polder areas (Table 8.7).

Future- With -Project

The crop production would be boosted up significantly under the FWIP condition. The total crop production would be about 18,732 tons of which rice would be about 10,635 tons and non-rice crop would be about 8,097 tons respectively. The rice and non-rice crop production would respectively be 20% and 28% higher in FWIP than that of FWOP. Rice production would be increased due to expansion of HYV Aman, HYV Boro, Jute, Vegetables and Mustard cultivation area (Table 8.7).

Impacts

Additional 1,803 tons (20% higher) of rice and 1,750 tons (28% higher) of non-rice crop would be produced in FWIP over FWOP (Table 8.7).

Table 8.7: Impact on crop production in the polder area

Crop Name	Crop production(Tons)			Impact(FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
Boro	2,144	1,658	2,654	996	60
HYV T Aman	1,222	967	1,878	911	94
LT Aman	6,450	6,207	6103	-104	-2
Total rice	**9,816**	**8,832**	**10,635**	**1,803**	**20**
Sesame	1,140	988	1447	459	46
Mustard	260	213	409	196	92
Summer vegetables	3,780	3567	4067	500	14
Winter vegetables	1,500	1478	1998	520	35
Jute	120	101	176	75	74
Total non-rice	**6,800**	**6,347**	**8,097**	**1,750**	**28**
Total	**16,616**	**15,179**	**18,732**	**3,553**	**23**

Source: Estimation from field information, May 2019

c. Crop damage

Future- Without -Project

Presently, total crop production loss is about 546 tons due to drainage congestion, partial salinity and scarcity of irrigation water etc. The situation would be aggravated maser under FWOP condition. Total crop production loss would be about 666 tons under FWOP situation (Table 8.8).

Future -With -Project

The interventions would have positive impact in reducing crop damage as well as crop production loss. In FWIP condition, rice crop damage would be reduced 64% for the implementation of interventions and its proper management. The total rice production loss would be about 390 tons.

Impacts

It is expected that loss of crop production would be reduced by 431 tons which would be about 65% less in FWIP over FWOP Table 8.8.

Table 8.8: Impact on crop production loss in the polder area

Crop Name	Crop production loss (Tons)			Impact(FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
Boro	124	148	58	-90	-61
HYV T Aman	109	169	57	-112	-66
LT Aman	278	291	103	-188	-64
Total rice	**511**	**608**	**218**	**-390**	**-64**
Sesame	34	54	17	-37	-69
Mustard	1	4	0	-4	-100
Total	**546**	**666**	**235**	**-431**	**-65**

Source: Estimation from field information, May 2019

d. Irrigated area

Future -Without- Project

Presently, irrigated area is about 800 ha. The interventions if not implemented the availability of surface water in the river and khals would decrease due to siltation of river and khals in the area. The irrigated area would decrease about 714 ha in FWIP.

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. The irrigated area would increase about 869 ha in FWIP. The irrigated area would be increased to about 155 ha in FWIP over FWOP.

Impacts

Irrigated area would be increased by about 155 ha in FWIP over FWOP.

8.5.4 Fisheries Resources

a. Fish habitat

Future-Without-Project

Most of the internal khals of Polder 27 are seasonal and silted up. The bed level of these khals are being raised gradually resulting in reduced water depth and causes less suitability of fish habitation. During high tide, saline water intrudes regularly through the mal-functioning of water control structures which is causing the deterioration of the habitat quality. Moreover, the perennial khal including Gonardara khal, Magurkhali khal, and Kamolpur Dowaria Khal are already encroached by local musclemen for shrimp culture. They are allowing saline water in these khals illegally during dry season which are also causing deterioration of water quality further. Due to such activities, the concentration of salinity in that water bodies would be increased. Khals as well as dependant floodplain habitat would be converted into brackish or saline water prone fish habitat in future. The habitat suitability for fresh water fisheries would be lost. As a result, local people would be interested to practice rice cum prawn/shrimp culture inside the polder instead of agriculture practice. Moreover, the existing eroded embankment near in the Rangpur Union may breach by continuous river erosion caused by wave action. For this reason, overtopping chances and damage to pond dyke of cultured ponds may be increased by tidal flooding. This tidal flood may also cause sand carpeting on the fish pond and thus will make it less suitable for fish habitation. Almost every year, the cultured pond at the Raghunathpur area is inundated and the fish are washed out due to heavy rainfalls associated water logging. In FWOP, the vulnerability of cultured pond may be increased. The culture fisheries practice in this area may be declined while floodplain fish habitat would be expanded. It is assumed that the floodplain fish haibitat would be 12ha.The further are included Mirzapur, Khoria, Shoshthitola etc..

Future-With-Project

In FWIP, water depth and surface water availability round the year would be increased for re-excavation of khals. The increased water depth as well as improved water quality would create congenial environment for habitation of different type of fish species at the excavated khals. Besides, repairing of water control structures would prevent saline water intrusion inside the polder area. Due to prevention of saline water intrusion, fresh water habitat for capture fisheries would be restored. The improved water quality will not only support to grow aquatic vegetation both micro and macrophytes in the internal khals but also will support to habitation and feeding for fisheries resources. Moreover, aquatic plants or vegetation could play an important role in the structure and function of the aquatic ecosystem. The rice cum prawn culture may be increased by 10% in the low land of the polder from the base condition. The further area may include Khajura-shairghata, Gonardara, Khajura-shairghata etc along western part of the polder (Map 8.4). Culture fisheries practiceswould be increased significantly due to reduction of flood risk and salinity. Many culturable pond would be converted into cultured pond.

Impacts

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

b. Hatching and Fish Movement

Future –Without- Project

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

Future- With -Project

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

Impacts

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

c. Fish Bio-diversity

Future-without-Project

Fish biodiversity in the polder area is moderate. Due to continue siltation in the khals and saline water intrusion through water control structures, brood stock at perennial khals would be depleted in FWOP condition. Some fish species like *Tengra, Koi, Shol, Taki , Puti, Shing, Baim* would become rare or disappearance from this area due to salinity. Besides, some rare and unavailable fish species like *Ayre, Boal, Roina, Datine, Shing, Magur* may be disappear from the polder area. The fish species composition would be dominated by brackish water fish species.

Future With Project

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

Impacts

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

d. Capture Fisheries Productivity

Future Without Project

In the polder area, at present capture fisheries productivity is 172 kg/ha from khals. Due to the ongoing process of siltation in the khal as well as saline water intrusion would cause less suitable for fish habitation in future. The fresh water fish species would disappear from the habitat simultaneously. Due to this reasons, capture fisheries productivity from the internal khal would be reduced about 10% from the base condition under the FWOP condition.

Future With Project

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

Impacts

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

8.5.5 Ecological Resources

a. Terrestrial vegetation

Future-Without-Project

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

Future-With-Project

Existing trend of vegetation loss due to natural disaster will be reduced for flood protection by repairing of embankment. Hence, improvement of vegetation including fruit trees will support resident wildlife throughout the year. Improvement of drainage system and water conveyance capacity through re-excavation of khals.

Impacts

Terrestrial vegetation in the polder are will be improved.

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.

Impacts

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

8.5.6 Socio-economic condition

a. Social Use of Water

Future- Without- Project

People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their necessity for water through tube well. At present 19% families have poor access and 81% families have medium are access to social use of water and without project situation this number will be 23% for poor and 77% for medim access.

Future- With- Project

With the intervention, 10% families would be good , 19% would be poor and 71% would be medium access to social use of water and benefited through the project.

Impacts

The standard of life for 650 numbers of HHs would be good and 3789 numbers of HHs would be medium access to social use of water. Around 16% people inside Polder 27 would be guaranteed sufficient freshwater availability and access, which would result in benefits in domestic water use. Besides, water for irrigation would also substantially be improved. social use of water. Moreover, it enhances social bonding and cohesion among them.

b. Gender Promotion

Future –Without- Project

40% of the total labour force to be mobilized through the labour contracting under total labor constructing society (LCS) will be females. Since some of the earthwork contract will be awarded to the LCS, It is expected that they will be directly benefited through for these interventions.

Future -With -Project

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

Impacts

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

c. 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.

Impacts

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

Table 8.9: Matrix on Impact Assessment with regard to Post-construction Phase

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
Water Resources				
Saltwater Intrusion	Salinity concentrations within 20-m buffer distance from the Teliganga River are found within 1 ppt.	Around 2 km lengths of khals located within 20-m buffer distance from Teliganga River (Barobeeler khal, Kadomtola khal, Zialtola khal etc.) may be affected by salinity concentrations up to 8 ppt	Salinity concentrations in the inner surface water system would remain 'zero'	+4
Water Security	People from Polder 27 cannot fully meet up their domestic, drinking and irrigation water requirements and around 15% people within the polder remain under water stress	Water security may further deteriorate with increased siltation and saltwater intrusion, and around 20% people may remain under water stress	Domestic water security may improve, but around 5% people may still be subjected to drinking water stress	+4
Drainage congestion and water logging	Around 60% of internal water courses (Barobeeler Khal, Sakha Bai Khal, Zialtola Khal etc.) would suffer from drainage congestion. No water logging prevails.	Around 65% of internal water courses (Barobeeler Khal, Sakha Bai Khal, Zialtola Khal etc.) would suffer from drainage congestion. No water logging would prevail.	Around 20% of the khals may still be affected from drainage congestion	+5
Land Resources				
Agriculture land use	Presently, NCA is about 75% of the gross area. Of this net cultivable area single, double and triple cropped areas are about 18%, 78% and 4% respectively.	Utilization of land for single, double and triple cropped area would be about 28%, 70% and 2% of the NCA respectively under FWOP condition	Utilization of land for single, double and triple cropped area would be about 14%, 80%, 6% of the NCA respectively under FWIP condition	+2
Soil salinity	The polder area is suffered by soil salinity of which about 80% of the NCA is covered by non saline to slightly saline and about 20% of the NCA is suffered by moderately saline to some strongly saline.	Salinity would be increased.	The successful implementation of the project and its proper management would reduce the salinity of the polder area.	+3
Agricultural Resources				
Cropping pattern and intensity	Presently, cropping intensity of the polder area is about 186%.	Cropping intensity would be reduced about 174%.	Expected to cropping intensity would increased about 192%.	+2
Crop production	Total crop production is 16,616 tons	The total crop production is expected to	The total production is expected to increase	+4

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
	of which rice is about 9,816 tons and non rice is about 6,800 tons respectively.	decrease about 15,179 tons of which rice would be about 8,832 tons and non-rice would be about 6,347 tons respectively.	about 18,732 tons of which rice would be about 10,635 tons and non-rice would be about 8,097 tons respectively.	
Crop damage	Total crop production loss is about 546 tons.	Total crop production loss is expected to increase about 666 tons.	Reduction of loss of crop production would be about 431 tons.	+5
Irrigated area	Irrigated area is about 800 ha.	Irrigated area is expected to decrease about 714 ha.	The irrigated area would be increased about 869 ha in FWIP over FWOP	+5
Fisheries Resources				
Fish habitat quality	Habitat quality is comparatively good in the polder area though some pollutants are released from crop fields and are substantially causing damage to fish. Siltation is found one of the major problems of the khals to make the habitat unsuitable for larger fishes.	• The ongoing siltation process, khals bed will be raised, thus reduce the water retention capacity in dry season. • Salinity in the water bodies would be increased. Fresh water fish habitat would be converted into brackish habitat.	Habitat quality would be improved. That would support different types of aquatic vegetation which would be helpful for fish feeding and habitation.	+2
Hatchling and fish movement	Medium	Same as base condition	Hatchling migration hampered but increase the fish movement.	+1
Fish Biodiversity	Moderate and 100 nos. of fish species is present.	Decline from the base situation.	Richness of fish species will improve.	+2
Capture Fisheries Productivity	Khal (kg/ha): 165	Khal (kg/ha): 150	Khal (kg/ha): 170	+1
Culture fish production (golda)	50 tons	22 tons	69 tons	+2
Ecological Resources				
Terrestrial vegetation	Moderate	• Increase threats on surrounding vegetation due to natural disaster and human activities. • Most of the terrestrial faunal species are displaced due to vegetation damaged by existing problem.	• Vegetation loss will be reduced and floral species will be increased due to protect area from existing problem.	+3
Aquatic flora and fauna	Moderate	• Aquatic habitat quality would be deteriorating due to death of aquatic	• Improve Aquatic habitat due to improvement of plant diversity as well as khal	+2

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
		plants. • Reduced depth for continuous siltation caused internal khals habitat deterioration	depth and velocity	
Socio-economic Condition				
Social Use of Water	People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their needs for water through tube well.	In without situation, 23% families have poor access and 77% families have medium access to social use of water	With the intervention, 10% families would be good, 19% families would be poor and 71% families would be medium access to social use of water and benefited through this project	+2
Gender Promotion	In the polder area only 2 % female members are working whereas 98 %male members are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, women are mostly vulnerable and widows who are dependent on others and do not have any definite sources of income. Therefore, in without project situation, this opportunity may not be ensured for gender promotion	The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.	+3
Employment generation	Employment opportunities are still not good in the polder. Because they are living under poor economic condition and they have very few options to develop or adapt this condition.	In without project situation, these sufferings may be same or will be deteriorated in future.	Proposed intervention can ensure improvement in the quality of life. More income opportunity and employment in different interventions can ensure better life and livelihood of people.	+2

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

9 Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

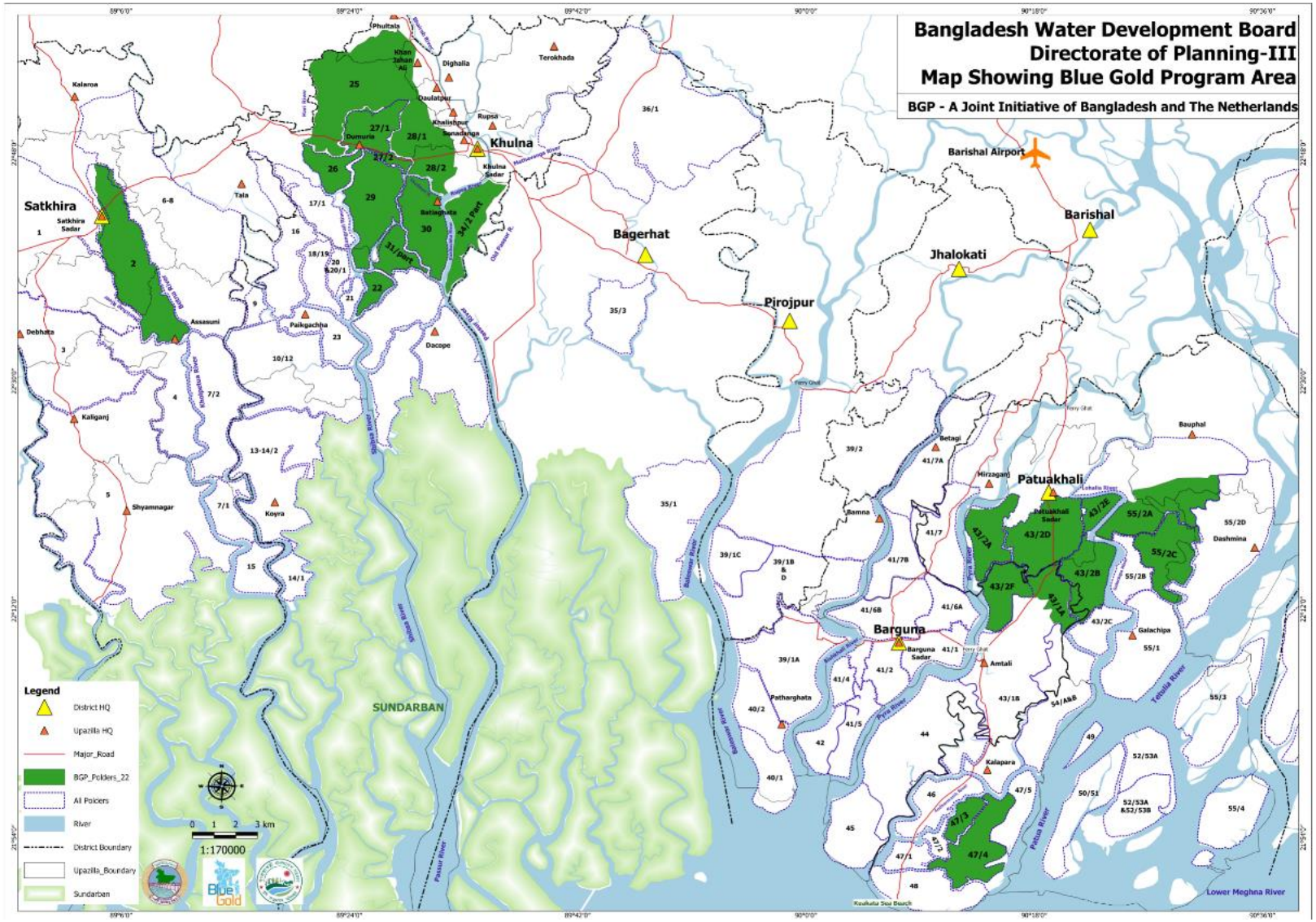
Cumulative impacts entail the total of all impacts to a particular resource that have occurred, or occurring, or may occur as a result of any action or influence in the surrounding area. In the vicinity of Polder 27, a number of other projects also exist apart from the Blue Gold polders. Such projects are affecting the life and livelihood of people, environmental quality, natural ecosystem, flora-fauna etc. Induced impacts, on the other hand are the indirect effects caused for implementation of any project, but occur later in time or at a distance far away from the polder. The reciprocal impacts of climate change and polder include long term effects of climate change induced phenomena into the polder, and the climate change resilience developed in the particular polder due to implementation of Blue Gold program.

9.2 Cumulative Impacts of all Blue Gold interventions on Polder 27

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, Polders 22, 29 and 30 are very adjacent to Polder 27 and therefore may generate some impacts in future. The existing crest levels of Polders 22, 29 and 30 are 3.45m, 3.50~3.60m and 3. 20~3.50m respectively above Mean Sea Level. If re-sectioning works are carried out along the periphery of these polders up to a design elevation of 4.27 m (same as Polder 27), there would be more floodplain sedimentation adjacent to the upstream polders. This may result in increased siltation in the peripheral rivers. 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 27. Furthermore, repairing of existing water control structures of Polders 22, 29 and 30 under Blue Gold program would ensure reduction of dry season flow towards the polders (22, 29 and 30). As such, surface water salinity, surrounding the Bhadra and Jhopjhopia Rivers may increase, which might affect the existing river ecosystem, as well as the multifaceted surface water use of Polder 27.

9.2.1 Synopsis of projects around Polder 27

Apart from Blue Gold interventions, there are some other development projects nearby Polder 27, 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 27, undertaken by different line agencies in Khulna.



Map 9.1: Location of Polders selected for Blue Gold Program

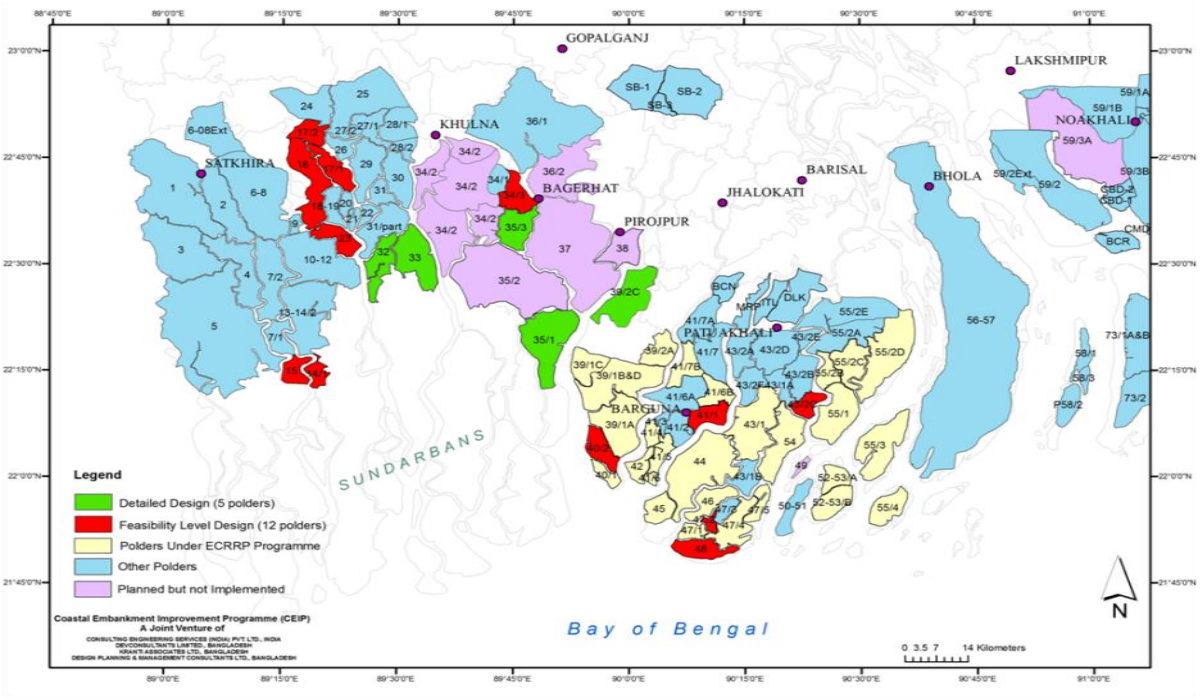
Table 9.1: List of water management projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
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)	2010-2014	Entire country	Negligible	No adjacent WMIP schemes
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008- 2014	Coastal Zone	Negligible	ECRRP polders are far from Polder 27
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 27 are briefly discussed in the following sections.

9.2.2 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.



Map 9.2: Location of CEIP polders

Polders 17/1 and 17/2 are adjacent to Polder 27. The existing crest levels of Polders 17/1 and 17/2 are 3.2~3.5m and 3.3m respectively above MSL. Embankment re-sectioning works are proposed in the polder, which is likely to increase the crest level up to 4.27 m above MSL. This increase would reduce storm surge to enter into the polder, but additional storm surge may be diverted towards Polder 27. Furthermore, if bank revetment works are implemented in Polder 17/1 and 17/2, the stability of river banks may increase, but would create pressure on Polder 27 and the risk of river erosion in this part would increase.

9.2.3 Cumulative Impacts of Other Projects

A number of other projects as shown in **Table 9.1** are functioning near Polder 27 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located away from Polder 27. A synopsis of the indirect effects of these projects with **low sensitivity** on Polder 27 is discussed below.

Projects under Climate Change Trust Fund (CCTF)

Considering Bangladesh's vulnerability to climate change, GoB decided to finance climate change adaptation initiatives from its own revenue budget as Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation. Up until now Environmental Impact Assessment (EIA) studies have been completed for a total number of 30 projects of BWDB, some of which are being implemented throughout the country. The second phase of CCTF is in the pipeline for implementation, with a number of newly proposed projects. Among all the CCTF projects, the geographic extent of one scheme (rehabilitation works in Polder 31) lies within the vicinity of Polder 27. However, the interventions proposed under the project are localized within the polder and no large-scale embankment re-sectioning works are proposed. Therefore the cumulative effects of the CCTF project in Polder 31 would have negligible influence in Polder 27.

Capital Dredging of River system

The GoB planned to implement dredging works under the 'Capital Dredging and Sustainable River Management' project. So far, 23 rivers have been selected for dredging under the project by BWDB. Project works along Upper and Lower Meghna Rivers are relevant to Polder 27. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 27. 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 27 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 27 may be further benefited.

9.3 Induced Impacts of Polder 27

The interventions in Polder 27 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 27 is an existing polder and was further developed under IPSWAM. The proposed rehabilitation works are to cause very minor alteration of the environmental setup outside the polder. Therefore, induced impacts likely to occur are minor and as such discussed qualitatively.

9.3.1 River Sedimentation

The proposed interventions in Polder 27 will safeguard the polder against direct intrusion of tidal water. Therefore, water from Mora Bhardra, Mora Jaykhali and Teliganga rivers carrying sediments will move further downstream or upstream and may cause induced sedimentation. New morphological changes (i.e. formation of new lands, river course shifting) may thus be developed along the peripheral river system. The river system may be subjected to increased floodplain siltation due to sedimentation in the upstream reaches and other anthropogenic development caused by Polder 27 (i.e. waste generation, increased fertilizers etc.).

9.3.2 Tidal and Storm Surge Flooding

Polders 17/1, 17/2, 25. 27/2 and 29 are adjacent to Polder 27. As per design, the crest level of Polder 27 would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 17/1, 17/2, 25. 27/2 and 29) during extreme events. Tidal water may not be able to enter Polder 27 during these events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned adjacent polders. Table 9.2 below shows the existing average crest levels in Polders 17/1, 17/2, 25. 27/2 and 29. Therefore, re-sectioning works in Polder 27 would create higher flooding and storm surge risks in the polder.

Table 9.2: Existing Average Crest levels of Polders adjacent to Polder 27

Polder	Existing crest level (m +PWD)
Polder25	4.27
Polder 28	4.27
Polder 29	4.27

9.3.3 Changes in aquatic habitat, species migration and biodiversity

Due to 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 Mora Bhardra, Mora Jaykhali and Teliganga Rivers system.

9.3.4 Employment opportunities and Livelihood improvement

The development of the polder would create better scope for employment of local people, as well as the people living adjacent to the polder. In a few years time, due to the development of Polder 27, new employment opportunities would be created. This will encourage people from outside the polder to visit the polder for work and improve their livelihood status.

9.3.5 Enhanced local and regional food security

The proposed interventions would drive agro-economic development inside the polder. Thus, the area may provide enhanced food security to the surrounding areas. In future, Polder 27 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 27, 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..

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.

Table 9.3: Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for Polder 27.

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (^{0}C)
Jan	-17.1	1.9
Feb	-6.8	1.9
Mar	-2.2	2.0
Apr	5.3	1.9

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (^{0}C)
May	5.4	1.8
Jun	0.8	1.6
Jul	1.5	1.7
Aug	3.6	1.8
Sep	1.3	1.7
Oct	4.1	1.7
Nov	-3.8	1.7
Dec	-19.4	1.7

Note: the negative (-) value in the table represent the decrease in rainfall or temperature
Source: Climate Wizard, Washington University

Sea Level Rise

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

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

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

Source: IPCC AR4

The simulation results of the annual water for the Polder 27 are shown in Figure 9.3 for the simulation period of 1981 to 2012. The average annual rainfall of Polder 27 is 1812 mm. The monsoon starts from the month of May and reaches its peak in June. There is a decreasing trend of rainfall during the month of July and a tendency of secondary peak during September. The maximum monthly rainfall is about 350 mm for the Polder 27.

Input to the water balance is rainfall while losses occur through evapotranspiration and percolation and as water contributing to stream flow through surface runoff. The annual actual evapotranspiration of the area is 523 mm which is 29 % of annual rainfall. The evapotranspiration is maximum during April and May and which is about 80 mm per month. The evapotranspiration rate is minimum during December to January. The percolation rate for the polder area is 452 mm per year which is 25% of annual rainfall. The percolation rate follows the similar trend like rainfall and the maximum rate is around 100 mm per month. After the losses of water through evapotranspiration and percolation, the remaining water contributes to stream flow as overland flow and lateral (subsurface) flow. Around 46% (838 mm) of rainfall contributes to stream flow through surface runoff while the lateral flow is negligible.

9.4.2 Climate Change Impact on Water Availability

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

The climate change impact on annual water balance for the Polder 27 is given in Table 9.5 for climate change scenario A1B by 2050s. The annual average rainfall for the polder area will be 1865 mm which is about 3% more than the base condition.

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

The surface runoff also increases as there is an increase in annual rainfall. There is a little increase in annual evapotranpiration (4 mm/year) which is mainly due to the increase of temperature. There is also a small amount of increase in annual percolation due to climate change.

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC 2050s
Rainfall	1812	1865
Surface Runoff	838	881
Evapotranspiration	523	527
Percolation	452	457
Baseflow	399	403

The generated water yields were estimated and compared with base condition to assess the impact of climate change on water availability. Water yield is the net amount of water that leaves the polder and contributes to stream flow in the reach during the period (water yield = surface runoff +lateral flow + base flow- total loss- abstraction). The monthly water yield for the base and climate change condition is given in **Figure 9.2**.

The availability of water will increase during May to October as there is an increase in rainfall during that period. During the dry period (Dec-Apr), the water availability will decrease due to climate change by 2050s. The increase in around 6-14 mm and decrease is around 2 mm per month.

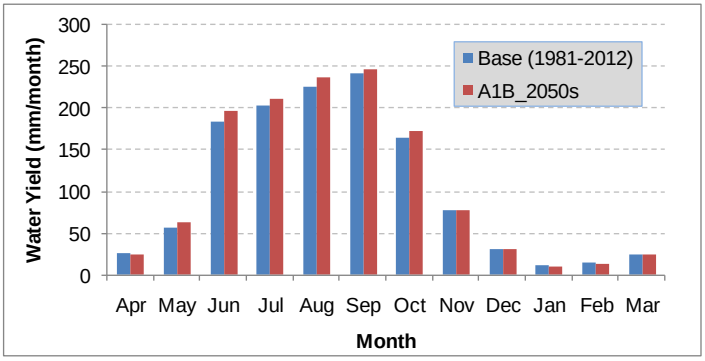


Figure 9.1: Climate change impact on monthly water yield for climate scenario A1B by 2050s

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

Table 9.6 show the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows considerable increase in seasonal water yield during monsoon (4.4 %) and decrease during dry season (5.4%). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Mar-May)	81	6.3
Monsoon (Jun-Sep)	855	4.4
Post-monsoon (Oct-Nov)	242	3.9
Dry (Dec-Feb)	81	-5.4

9.4.3 Climate Change Impact on Water Level

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

The calibrated and validated Delft 3D model for the Gorai-Passur and Sibsa system has been utilized to investigate the impact of sea level rise and increase of upstream water flow to assess the impact on

flood water level outside the polder area. As there is a variability of prediction of sea level rise, an increase of 0.5 m of sea level at Hiron point has been assumed for the present study. At the same time, 16% increase of monsoon flow for the Gorai River has been assumed for the model setup. The model has been simulated for the combination of above two scenarios and the simulated maximum water level during the monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.
From the model simulation, it has been found that the flood level adjacent to the polder area will increased by 60 cm for only the increase of sea level and by 7 cm for only the increase of upstream water flow. The combined effect of sea level rise and increase of upstream water results an increase of 70 cm increase of maximum water level of the rivers surrounding polder-26. The increase in flood water level might be a threat for the embankment and it also interrupt the drainage from the inside polder area. The climate change and sea level rise may increase the drainage congestion and flood risk for the polder.

9.4.4 Climate Change Impact on Salinity

Sea level rise can cause saline water to migrate upstream to points where freshwater previously existed or can intensify the salinity. Several studies indicated that sea level rise would increase the salinity in estuaries, which would result in changes in stratification and estuarine circulation. Salinity migration could cause shifts in salt-sensitive habitats and could thus affect the distribution of flora and fauna. In addition to sea level rise, the decrease in flow during dry season can increase the salinity of rivers through encroaching seawater that moves upstream during periods of low flow.
To assess the impact of climate change and sea level rise on salinity, the delft 3D model has been utilized. It has been assumed that the dry season flow of the Gorai River will be reduced by 15% and 0.5 m of sea level rise has been considered for the scenario model setup. The model has been simulated for those two assumptions and the result has been compared with the base condition. From the simulation, it has been found that the salinity level of the rivers adjacent to the Polder 27 will increase by 1.0 ppt during the dry period. The increase in river salinity may cause the increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.5 Climate Change Resilience Developed in Polder 27

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 victim of climate change induced natural disasters, frequently hitting them and causing massive loss o lives and properties. Increased saltwater intrusion within the polder is severely impacting their daily lifestyle as well as livelihood occupation. Due to some of the initiatives taken through different software interventions by programs other than Blue Gold, the insight of climate resilience is already developed within the polder habitants. Through the community mobilization in Blue Gold program, local people have become more active 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, 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 post-construction phases against the impacts on the IESCs pertaining to water resources, land and agriculture resources, fisheries resources, ecological resources and socio-economic conditions together with a necessary monitoring program.

10.1 Physical Environment

10.1.1 Pre-construction Phase

No significant positive or negative impacts on water resources have been foreseen during the pre-construction phase for the implementation of proposed interventions in Polder 27. As such, no activities under the proposed EMP have been recommended for this phase.

10.1.2 Construction Phase

Table 10.1: EMP Matrix for Construction Phase on Physical environment

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
IESC: Ambient Noise Level				
The excavator and associated heavy machineries will create noise disturbance along the polder alignment, and are likely to increase the noise levels by around 5~10 dB	Construction works near dense settlements (i.e. near west sovna) are to be carried out using manual labour	Not required	**-1**	Blue Gold Program, Contractors and LCS

10.1.3 Post-construction phase

The implementation of proposed interventions may generate some long term positive or negative impacts on water resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation 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 Water Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
IESC: Saltwater Intrusion				
Almost 2 km primary water distributaries will be protected from possible saltwater intrusion.	Not required	Repaired gates are to be operated and maintained properly to protect saltwater intrusion	+5	WMC, BWDB
IESC: Water Security				

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Around 15% of people living inside the polder benefitted with sufficient freshwater availability facilited in domestic water use, irrigatin, cattle, wild lives etc.	Not required	Not required	-	-
IESC: Drainage Congestion and Water Logging				
Around 75% of khals adjacent to the embankment would be improved from drainage congestion.	Not required	Not required	-	-

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

10.2 Land Resources

10.2.1 Pre-construction and Construction phases

There would be no impact on land resources during pre-construction and construction phase. So, there would be no measures required for these phases.

10.2.2 Post-construction phase

After implementation of the project hydrological regime inside the project area will improve. This might change the agriculture land use of the project areas. So, necessary measures may be under taken in this phase Table 10.3.

Table 10.3: 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 to about 9% but double and triple cropped area would increase by about 7% and 2% of the NCA respectively under FWIP condition.	-	• Formation of WMGs (GPWM-2002). • Strengthening of WMGs through imparting training on proper management of structure and utilization of Re-excavated earth earth materials which will be generated from re-excavation. • Involvement of WMGs in different project activities.	+3	BWDB, DAE and WMGs
It is expected that the implementation of options and its proper management would protect the undesirable entry of saline water and would allow draining out the dissolved salts from agriculture land.	Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bundh.	-	+4	BWDB and Contractors

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

10.3 Agricultural Resources

10.3.1 Pre-construction and Construction phases

In pre-construction and construction phases, crop production loss might not occur due to dumping of re-excavated Re-excavated earth earth materials on both side of khals and existing embankment. It is noted that repairing activity would be done on existing embankment. So, no impact on agriculture land i.e crop production loss would occur. So, there would be no measures required from these phases.

10.3.2 Post-construction phase

Table 10.4: EMP Matrix for Post-Construction Phase on Agricultural Resources

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Expected to cropping intensity would increase to about 9%.	-	• Involvement of WMGs in project activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification and improve management practices need to be practiced.	+3	BWDB, DAE and WMGs
Additional 2,330 tons (32% higher) of rice and 725 tons (101% 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. • Involve the WMGs in project activities which would enhance crop production. • Introduction of HYV/Hybrid crop cultivars along with crop diversification and improve management practices need to be practiced.	+5	BWDB, DAE and WMGs
It is expected that loss of rice crop production would be reduced by 752 tons which would be about 73% 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.	+6	BWDB, DAE and WMGs
The irrigated area would be increased by about 155 ha in FWIP over FWOP	-	• Training may be provided to WMGs and SAAO of DAE 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.	+6	BWDB, BADC, DAE and WMGs

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

10.4 Fisheries Resources

10.4.1 During Pre-Construction Phase

There would be no impact during pre-construction phase.

10.4.2 During Construction Phase

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

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
• Temporary loss of feeding ground and unavailability of fish feed for bottom dweller. Turbidity of water would be increased. But after one (1) year the habitat quality of fish will be improved. • Intertidal floodplain fish habitat would be decreased. • Fish habitat especially for Cuchia, baim, Chingri, Baila would be impacted significantly due to re-excavation.	• Avoid re-excavation during fish migration period e.g. month of May to August • Earth spoils to be dumped outside the khal area. • To protect the indigenous fishes and other aquatic creators, re-excavation should be implemented segment wise and one after another. • At least 100 m of each khal should be more depth about 0.5 m than the normal design to protect the fish brood.	N/A	-2	Contractor, BWDB, Department of Fisheries (DoF)

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

10.4.3 During O & M Phase

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

Table 10.6: EMP Matrix for O & M Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Water depth increase and habitat quality would be improved. Saline water pronehabitat would be converted into brackish to fresh water fish habitat. The improved habitat quality would support different types of aquatic vegetation which would be helpful for fish feeding and habitation.	NA	• Awareness development on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area. • Apply IPM in agriculture field for protection of capture fish habitat quality.	+2	Department of Fisheries in coordination with WMC
Hatchling movement from river to polder area through regulators /sluice gates would be obstructed. Few brackish water fish species include Bhetki, Pairsa, Bagda Chingri, Baila etc migrates in regular basis during high tide that would be impacted.	NA	• Properly and timely gate will be open to entrance the fish hatchling in the month of May to July except the tidal surge. • Water Management Committee should be formed including fishers representative.	+2	Department of Fisheries in coordination with Water Management Committee
Richness of capture fish species would be increased fish species composition would be changed.		• Avoid fish culture in different khals. • Release native rare and unavailable fish species in excavated khals • Awareness development on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in polder area.	+2	Department of Fisheries in co-ordination with Management Committee
Capture and culture fish production from khals would increase about 10 % from the base condition.		• 100 m (Deep area) of each re-excavated khal should be kept as non fishing zone for brood fish protection. • Training on fish culture should be provided and pond demonstration and monitoring activities	+3	Department of Fisheries in co-ordination with pond owners.

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
		should be implemented in the polder area. • Ensure pure strain and native fish species for aquaculture in pond culture.		

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

10.5 Ecological Resources

10.5.1 Pre-construction

No significant positive or negative impacts on ecological resources have been foreseen during the both pre-construction phase for the implementation of proposed interventions in Polder 27. As such, no activities under the proposed EMP have been recommended in this phase.

10.5.2 Construction phases

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 immitgbale 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 repairing work.; • Relocation of wildlife due to habitat loss temporarily	•Implement plantation along the slopes of embankment after completing the earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: Re-excavation of khal				
• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khalNo 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

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

10.5.3 Post-construction phase

The implementation of proposed interventions may generate some long term impacts on ecological resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation

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.

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

10.6 Socio-economic Condition

10.6.1 Pre-Construction Phase

In this phase, some employment may be generate for local people which would be positive impact for them. Hence, no mitigation measure is suggested and following enhancement measure may take.

Table 10.9: EMP Matrix for Pre-construction Phase on Socio-economic condition

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Employment generation	-	Ensuring engagement of local labour with paying proper wages.	+2	Blue gold and BWDB

** 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, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, same kind of initiative should be taken more gender promotion activities in future.	+3	Blue gold and BWDB

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

10.6.3 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/ Compensation Contingency/	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Social Use of Water	-	- re-excavate other Khals for ensuring more social use of water (taking shower, washing chores and other domestic purposes)	+4	Blue gold and BWDB
Employment generation	-	- Engage local people in other development activities of the polder.	+2	Blue gold and BWDB
Employment opportunities	NA	- Ensure/arrange training from DAE and DOF for local people.	+3	Blue gold and BWDB

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

10.7 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 arise regarding site selection for Re-excavated earth dumping. It is therefore, important to transport and dispose the Re-excavated earth away from the excavation site in a controlled and systematic manner, considering of all environmental and social issues of the area. Disposal may either be through mechanical equipments, or by manual means.

10.7.1 Framework Proposed for for Re-excavated Earth Management Plan

Polder 27 of BGP entails excavation of a number of khals which would generate a volume of around 2,10,100 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.

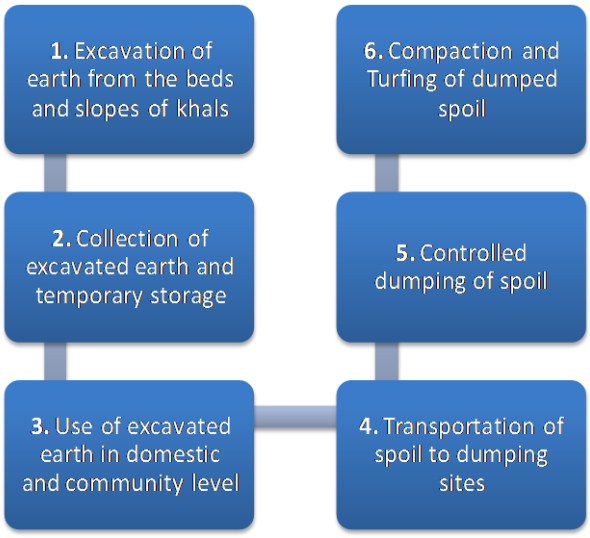


Figure 10.1: Framework for Re-excavated earth Management Plan

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 10% of the excavated earth (20,000 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 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 schools, mosques, community clinics etc. It is expected that around 42000 m^3 Re-excavated earth would be collected by for different uses. The residual portion (around 1,48,000 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	Tetetive Excavated Volume (m^3)	Use of Excavated Soil	Volume (m^3) to be used
Gonardara Khal	29028	Carrying loss	25,000
Shostitola khal	8226	Societal uses (uses in household, schools, mosques, playground, Hut/Bazara, clinics or other shelters)	60,000
Magurkhali khal	29536		
Khoria khal	27987		
Shairghati Branch Khal	8265		
Shairghati -Madabkati Khal	15791		
Khajura-shairghata khal	52002	Dumping along hal bank for development of earthen road	1,39,000
Tiabunia Khal	25332		
Komolpur-Dowania Khal	24985		
Arru-Dowania Branch Khal	2904		
Total	**2,24,000**	**Total Use**	**2,24,000**

10.7.2 Phase wise activities of Re-excavated earth Management

A number of activities are proposed as usual 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.

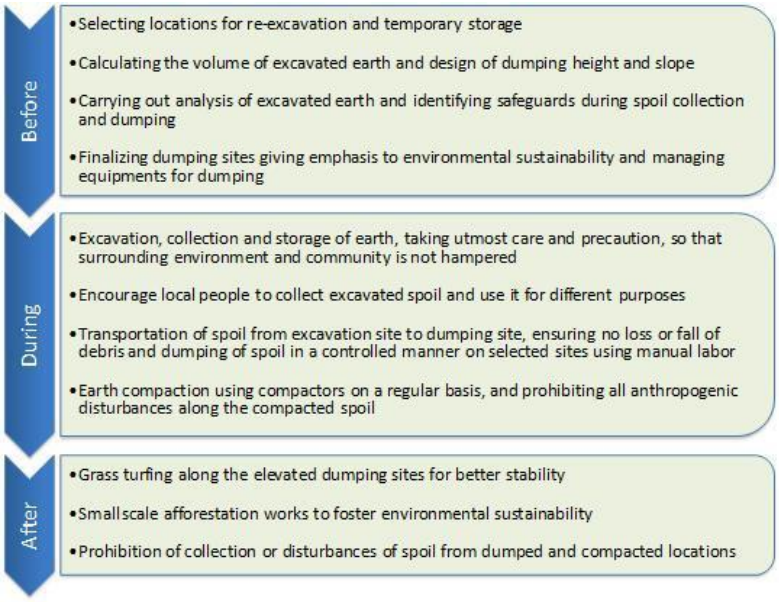


Figure10.2: Phase wise activities of Re-excavated earth Management

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 1,48,000 m^3). For a 2.75 meter wide and 1.25 meter thick wedge, this equivalents to around 43 km length of dumped Re-excavated earth. Polder 27 includes 26 km of re-excavation of khals, and if the residual Re-excavated earth (1,48,000 m^3) is dumped on both sides of the excavated khals up to a height and width of 1.25 m and 2.75 m respectively, around 21.5 km lengths can be used on both sides, leaving around 4.5 km openings in total along both sides of the re-excavated khals. **Figures 10.3** and **10.4** below show the conceptual layouts of proposed dumping technique.

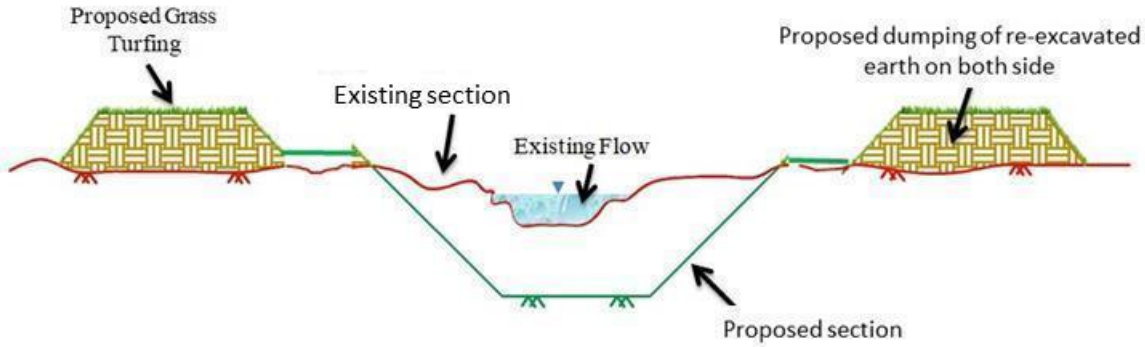


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

Figure 10.3 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 banks of the khals are government owned khas lands and are within the actual width of the khals. Re-excavated earth earth would be dumped on both banks 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 fafter any rainfall canflow into the excavated khals and drain out properly.

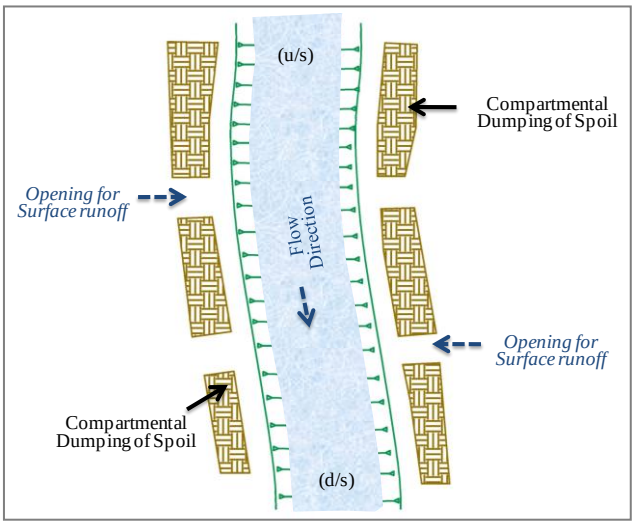


Figure 10.4: Plan form of a typical khal to be re-excavated

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 awared about of 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 uoto a certain height (e.g. 6~8 inches)
- ✓ The works when are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, which may reduce the strength or stability of the dumped Re-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 the environmental and social component of the project in Polder 27.

10.8.2 Monitoring Plan for construction phase

A typical monitoring plan have been prepared which will be followed during construction of rehabilitation of Polder 27. The Monitoring report will be submitted to the concerned organizations as mentioned in the following checklist.

a) Water Resources

i. Monitoring Checklist

Blue Gold Team and Bangladesh Water Development Board

Blue Gold Program: Component II

EMP IMPLEMENTATION

Book No. _____	Monitoring Report No._____
Date:_____	Time:_____
Contract:_____	
Contractor:_____ _	
Work Sites (s):_____	

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

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

C.NON COMPLIANCE:

Period Description :

Class

1. Minor: Under One Month (Contractor alerted)

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

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

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

D.CIRCULATION

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

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

ii. Monitoring Matrix for water resources

Indicator	Method	Location	Frequency	Responsible agency
Re-excavation of Khals, disposal of Re-excavated earth earth materials for Re-excavated earth management and re-sectioning of embankment etc.	Field observation.	Interventions implementation area (Khals and embankment)	Weekly	Contractors and WMGs

b) Ecological Resources

Indicator	Method	Location	Frequency	Responsible agency
Habitat develop	Direct observation	At proposed construction sites	Once before earthworks and	BWDB and DoE
Wildlife occurrence	Direct observation and public discussion	At proposed construction sites	Once before earthworks	BWDB and DoE

10.8.3 Monitoring Plan for post-construction phase

a) 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 & led method)	All the khals inside the polder	Once in a dry season and once in a wet season	WMOs and BWDB
Drainage Congestion & Water Logging	Field observation	Inside the polder	Once in dry season and once in post-monsoon	WMOs and BWDB

b) Land and Agricultural Resources

Indicator	Method	Location	Frequency	Responsible Agency
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

c) Fisheries Resources

Indicator	Method	Location	Frequency	Responsible agency

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

d) 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

e) Socio-economic Condition

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

10.9 EMP and Monitoring Cost

10.9.1 Cost of EMP and monitoring of Water Resources

There is no EMP and monitoring cost for water resources.

10.9.2 Cost of EMP and monitoring of land and agricultural resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	ost LakhTk.)
1	• Formation of WMGs/ WMA/ WMF (GPWM-2002), strengthening of WMGs through imparting training on re-excavation of Khals, Embankment management Group (EMG), landless Contacting Society (LCS), on farm water management and development etc. • Involvement of WMGs in project activities would change positively.	1.75	1	Re-excavation of Khals, disposal of Re-excavated earth earth materials for Re-excavated earth management and repairing of embankment etc.	1.00
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 and other management practices. • 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	1.75	3	Irrigated area	0.50

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	ost LakhTk.)
	increase the expansion of irrigated area. • The WMGs should be involved in the integrated water management through proper maintenance of sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.				
	Total	**5.00**			**3.00**

Total cost of EMP and monitoring of land and agriculture resources is Taka 8.00 lakh (Eight Lakh) Only.

10.9.3 Cost of EMP and monitoring of fisheries resources

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (LakhTk)
1	Awareness development on natural resources and disseminate the knowledge about the important in our daily life through several national and international days like Fish Week, Environment Day, water Day Rally, Discussion etc. Two year in the polder area.	1.0	1	Fish hatchling movement in 4 khals (Two year).	1.0
2	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring) (Training 1.5 Tk and demonstration pond 1.0 Tk) (Number of pond :4 pond area: about 100 decimal)	2.5	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	1.5
EMP Cost =		**3.5**	**Monitoring Cost =**		**2.5**

Total Cost for EMP and Monitoring of fisheries resources is Taka 6.0 Lakh (Six Lakh) Only.

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 10.69 km length of embankment	6.93		Habitat develop	3
				Wildlife diversity	2
	Total	**6.93**		**Total**	**5**

Total cost of EMP and monitoring of ecological resources is Taka 11.93 Lakh (Eleven lakh Ninety Three Tousand) Only.

10.10 Summary of cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost
Water Resources	-	-	-
Land and Agricultural Resources	5.0	3.0	8.0
Fisheries Resources	3.5	2.5	6.0
Ecological Resources	6.93	5.0	11.93
Socio-economic Condition	-	-	-
Grand Total =	**15.43**	**10.5**	**25.93**

Total cost of EMP and monitoring is BDT 25.93 lakh (Taka Twenty Five Lakh and Ninety Three Thousand) only.

10.11 EMP Updating

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

11 Conclusions and Recommendations

11.1 Conclusions

This project aims to improve water management and productivity through rehabilitation or repair of the existing embankment and other water control infrastructures like sluices, regulators, outlets etc. The water management interventions proposed for Polder 27 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 27. 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.

References

Ahmed M. F. and Rahman M. M, 2010, Water Supply and Sanitation: Rural and Low income urban countries, Fourth Edition, ITN, BUET, Dhaka

BARC, 2005, Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council, Farmgate, Dhaka, Bangladesh

BARI 2013. *BARI Developed Crop Varieties*, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur

BARI, 2011-2012, Handbook of Agricultural Technology, Bangladesh Agricultural Research Institute, Joydevpur, Gazipir

BBS, *2008*. *Preliminary Report of Agriculture Census 2008*, Bangladesh Bureau of Statistics (*BBS*), Government of the People's Republic of Bangladesh

BBS, 2011, Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Government of people's Republic of Bangladesh, Dhaka, Bangladesh

Blue Gold Program, 2013, Inception Report, Embassy of the kingdom of Netherlands and Bangladesh Water Development Board, Government of people's Republic of Bangladesh, Dhaka, Bangladesh

Brammer, H. 1996. *The geography of the Soils of Bangladesh*. University Press Ltd., Dhaka. 287 pp.

BRRI 2011, *Adhunik Dhaner Chash*. Bangladesh Rice Research Institute, Joydevpur, Gazipur

Carballo, E., A. Assiah van Eer, Ton van Schie, A. Hilbrands, 2008. *Small-scale freshwater fish farming* (Third revised edition), Digigrafi, Wageningen, the Netherlands.

CEGIS, 2014, Development of National and Sub-National Climate Change Model for Long Term Water Resources Assessment

DoE, 2001. State of Environment. Department of Environment, Ministry of Environment and Forest, Dhaka, Bangladesh.

European Commission, 2009, Ecosystem Goods and Services, Ecosystem Supporting Services, European Commission

FAO/UNDP, 1988. Land Resources Appraisal of Bangladesh for Agricultural Development (Report-2), "Agro-ecological Regions of Bangladesh", Prepared by Food and Agricultural Organization (FAO), United Nations.

FRSS, 2012. Fisheries Statistical Yearbook of Bangladesh 2011-2012. Fisheries Resources Survey System (FRSS), Department of Fisheries, Bangladesh, Volume 29:44 p.

Haque S. A. 2006, *Review article, salinity problems and crop production in coastal regions of Bangladesh.* Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. 38(5): 1359-1365

http://www.ddm.gov.bd/cyclone.php accessed on 01 July, 2014

IPCC, 2007. Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

IUCN, 2000. *Red List of Threatened Animals of Bangladesh.* Eds, Islam, M. A. Ameen, M., and Nisha.A. The World Conservation Union, Dhaka, Bangladesh.

Jack M. Whetstone, Gravil D. Treece, Craig L. Browdy, and Alvin D. Stokes, 2002. Opportunities and Constraints in Marine Shrimp Farming, SRAC Publication No. 2600, July 2002

Katebi, M.N.A. (2001) 'Sundarbans and forestry', in Haider, R. (Ed.): Cyclone '91 – An Environmental and Perceptional Study, BCAS, Dhaka, pp.79–100.

Khondker, M. 2004 (edited). *Limnology*. University Book Publishers. Dhaka, Bangladesh

Mainuddin M, Kirby M, Chowdhury RAR, Sanjida L, Sarker MH, and Shah-Newaz SM (2014) Bangladesh Integrated Water Resources Assessment supplementary report: land use, crop production, and irrigation demand. CSIRO: Water for a Healthy Country Flagship, Australia.

Mazid. M.A 2002, Development of Fisheries in Bangladesh, Plans for Strategies for Income Generation and Poverty Alleviation, Momin Offset Press, Dhaka1205

Ministry Of Environment and Forest, 1992, The National Environmental Policy, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry of Environment and Forest, 1995, National Environment Management Action Plan (NEMAP), Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry Of Environment and Forest, 1995, The Bangladesh Environment Conservation Act, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry Of Environment and Forest, 1997, The Environment Conservation Rules, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry Of Environment and Forest, 2004, The National Biodiversity Strategy and Action Plan for Bangladesh 2004, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry of Environment and Forest, 2009, Bangladesh Climate Change Strategy and Action Plan (BCCSAP), Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry of Water Resources, 1999, The National Water Policy, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Niahat, A., Huq, S.M Imamul, Barua, Suvashish p., Reza, Ali A.H.M., Khan, Moniruzzaman A.S. (eds.), 2002, Bio-ecological Zones of Bangladesh, IUCN Bangladesh Country Office, Dhaka Bangladesh

Pak. J. Bot., 2006, Salinity problems and crop production in coastal Regions of Bangladesh, 38(5): 1359-1365

SOLARIS (Soil and Land Resources Information System), 2006, SOLARIS Model developed by Center for Environmental and Geographic Information Services (CEGIS) for Soil Resource and Development Institute (SRDI)

SRDI (Soil Resource and Development Institute), 1988, Guideline for land and soil resources use. Soil Resource and Development Institute, Thana Nirdashika, Farmgate, Dhaka

Stickney, R. R. 2000. Encyclopedia of Aquaculture. John Wiley and Sons, New York.

Subramanya. K., 1994, Engineering Hydrology, Second Edition, Tata McGraw Hill Publishing Company Limited, Nel Delhi, India

WARPO, 2005. Guidelines for Environmental Assessment of Water Management (flood control, Drainage and Irrigation) projects. National Water Management Project. Water Resources Planning Organization (WARPO), Dhaka

Wahid, S.M. (1995) Hydrological Study of the Sundarbans, UNDP/FAO Project BGD/84/056, Department of Forest, Dhaka, Bangladesh.

Appendix-1: Data Collection Checklist

Water Resources
Baseline Data Collection Form
Environmental Studies for Blue Gold Program

Name of Data Collector: Date:

Project Name:

A. Administrative Information

BWDB Division:	BWDB Circle:
BWDB Zone:	Hydrological Zone:
District(s):	Upazila(s):
Union(s):	Mouza(s):

B. Secondary data (to be obtained before going to the field)

Field	**Source**	**Station(s)**	**Year(s)**	**Analysis**		
				Max.	**Min.**	**Avg.**
Rainfall						
Temperature						
Humidity						
Evaporation						
Wind speed						
Sunshine hours						
Climate change						

C. Primary data (To be collected during field visit)

1. River system & flow direction (inside and outside the project)				
2. Name and location of beels and connectivity with rivers and khals				
3. Name of canals/khals and connectivity with rivers and beels				
4.Topography and Drainage pattern				
5. Location specific drainage congestion (% of extent, and delineate boundary in field map)				
6. Location specific water logging (% of extent, and delineate boundary in field map) in the month of February				
7. Flooding (depth, % of extent, onset, pick and recession)				
7. Flooding (depth, % of extent, onset, pick and recession)				
8. River/ khal erosion	River/khal	Area (ha) eroded	Length (m)	Reason
9. Accretion	River/khal	Area (ha) accreted	Reason	

D. Water Quality (people's perception/measurement)

	People's Perception	Measurement
1. Ground water: (Arsenic/Iron/Salinity)		Arsenic: Iron: Salinity:
2. *Surface water: (Salinity, pH, DO, TDS, BOD, COD)		Salinity: pH: DO:

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

F. Water Use

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

G. Historical severe flood:

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

H. People's opinion about the project

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

I. Collect Project description related information from field office:

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

Sl	Name of Khal	Location-dumping of Re-excavated earth earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
1						
2						
5						
10						
..						
..						

Location of labor shed with their water and sanitation facilities system

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

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

Stockyard information during construction time:

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

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

Agro-ecological regions

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

Land use

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

Land type

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

Soil Texture

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

Soil Salinity

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

Location:

Farming practices

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

Major Cropping Pattern by land type

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

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

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

Inputs Used

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

Irrigation

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

Crop production constraints (including land degradation)

Factors	Year of starting LD	Location	Result of LD
Soil erosion			
Sand carpeting			
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: SFHHs:	River																
		Beel (Leased/non leased)																
		Khal																

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
		Floodplain																
		Mangrove area																
		Fish pond																
		Baor																
		Ghers																

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

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

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

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

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

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

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

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

Ecological Data Collection Form for ESIA Study
Center for Environmental and Geographic Information Services (CEGIS)

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

Bio-ecological Zone(s):

Terrestrial Ecosystem

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

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

Terrestrial Biodiversity

Major Terrestrial Flora

Common Species	Rare Species	Extinct Species	Exotic Species

Major Terrestrial fauna

Species Name	Habitat1	Food Habit2	Breeding Time	Status3	Migration Status4

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

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

Aquatic Ecosystem

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

Name of wetland	Type of Wetland14	Area in ha		Flooding depth (m)	Connectivity with river		Importance15
		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	Utilization16

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			

[14] 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

[15] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[16] 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.

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।

১৯.০২.১৭
এস.এম. সাইফুর রহমান
ভূমি অধিগ্রহণ কর্মকর্তা
খুলনা

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

Chief Engineer
Directorate of Planning
BWDB, Dhaka

107

চেয়ারম্যানের কার্যালয়

১১ নং ডুমুরিয়া সদর ইউনিয়ন পরিষদ

উপজেলা- ডুমুরিয়া, জেলা- খুলনা।

স্মারক নং- ৩৬ তারিখঃ ২০/১০/২০১৯ খ্রিঃ

অনাপত্তি পত্র

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তি পত্রের ছক

১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড।

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নহে।

৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা), ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা- ১০০০।

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ পোল্ডার ২৭, খুলনা জেলার ডুমুরিয়া উপজেলায় অবস্থিত।

৫। প্রকল্পের তহবিল ঃ

জেলার নাম	উপজেলার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
খুলনা	ডুমুরিয়া				মাঝারি উচু ভূমি	হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উঁচুকরণ, স্লুইস গেট ও রেগুলেটর মেরামত, খাল পুনঃখনন ইত্যাদি

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ২৭ পুনর্বাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্ণিত অনাপত্তি প্রদান করা হলো।

১। প্রকল্প/ কারখানা স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।

২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।

৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তার নিশ্চিত করতে হবে।

৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে। এবং অগ্নিকান্ড কিংবা অন্য কোন দুর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।

৫। বায়ু ও শব্দ দুষন করা যাবে না।

৬। কারখানা/প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

উপরে উল্লিখিত যে কোন শর্ত লঙ্ঘন করলে যথোপযুক্ত কর্তৃপক্ষ কর্তৃক কারখানা/প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া যাবে।

তারিখঃ ২০/১০/২০১৯ খ্রিঃ

গাজী মোঃ হুমায়ুন কবির
চেয়ারম্যান
১১নং ডুমুরিয়া ইউনিয়ন পরিষদ
ডুমুরিয়া, খুলনা।
মোবাঃ ০১৭১১-০৪৫১৬৮

চেয়ারম্যানের কার্যালয়

১৩ নং গুটুদিয়া ইউনিয়ন পরিষদ

উপজেলা- ডুমুরিয়া, জেলা- খুলনা।

স্মারক নং- গুঃ ইঃপিঃ/২০১৯/সাধা:/৬৮(২) তারিখঃ ২০/১০/২০১৯ইং

অনাপত্তি পত্র

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তি পত্রের ছক

১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড।

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নহে।

৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা), ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা- ১০০০।

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ পোল্ডার ২৭, খুলনা জেলার ডুমুরিয়া উপজেলায় অবস্থিত।

৫। প্রকল্পের তহবিল ঃ

জেলার নাম	উপজেলার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
খুলনা	ডুমুরিয়া	—	—	—	মাঝারি উচু ভূমি	হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উঁচুকরণ, স্লুইস গেট ও রেগুলেটর মেরামত, খাল পুনঃখনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ২৭ পুনর্বাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্ণিত অনাপত্তি প্রদান করা হলো।

১। প্রকল্প/ কারখানা স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।

২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।

৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তার নিশ্চিত করতে হবে।

৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে। এবং অগ্নিকান্ড কিংবা অন্য কোন দুর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।

৫। বায়ু ও শব্দ দুষন করা যাবে না।

৬। কারখানা/প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

উপরে উল্লিখিত যে কোন শর্ত লঙ্ঘন করলে যথোপযুক্ত কর্তৃপক্ষ কর্তৃক কারখানা/প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া যাবে।

তারিখঃ ২৩/১০/২০১৯ইং

মোঃ [illegible]
চেয়ারম্যান
১৩নং গুটুদিয়া ইউনিয়ন পরিষদ
ডুমুরিয়া, খুলনা।

Appendix-3: Terms of Reference

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 major 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,

commercial factors.

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

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

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

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

20.01.19

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

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

Copy Forwarded to :

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