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 55/2C

February 2020

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Abbreviation and Acronyms

ADB	Asian Development Bank
AEZ	Agro -ecological Zone
AWD	Alternate Wetting and Drying system
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BGP	Blue Gold Program
BMD	Bangladesh Metrological Department
BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
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
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
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
FGD	Focus Group Discussion
FGs	Functional Groups
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
ISC	Important Social Component
IWM	Institute of Water Modeling
Kg	Kilogram
KJDRP	Khulna Jessore Drainage Rehabilitation Project
KII	Key Informant Interview
LCS	Labor Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
MoEF	Ministry of Environment and Forest
MoWR	Ministry of Water Resources
MP	Murate of Potash
MSL	Mean Sea Level
MT	Metric Ton
NCA	Net Cultivable Area
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NWRD	National Water Resources Database
O and M	Operation and Maintenance
PCM	Public Consultation Meeting
PP	Project Proforma
PPM	Parts per Million
PPR	Peste des Petits Ruminants
PRA	Participatory Rural Appraisal
PWD	Public Works Department
RL	Reduced Level
SAAO	Sub Assistant Agriculture Officer
SIA	Social Impact Assessment
SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UAO	Upazila Agriculture Officer
UFO	Upazila Fisheries Officer
UNO	Upazila Nirbhahi Officer
WARPO	Water Resources Planning Organization
WMA	Water Management Association
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 ware house in a market place from which Aratdar conducts the business.

Aratdar A wholesaler and/or commission agent. At times covers both functions, who carries out public auctions and often is the main provider of credit in the marketing chain.

Aus A group of rice varieties sown in the pre-monsoon season and harvested during the monsoon season. These rice varieties are broadcast/transplanted during March-April and harvested during June-July.

B. Aus When preceding a crop means broadcast (B. Aus)

Bagda Shrimp (*Penaeus monodon*), brackish/slightly saline water species.

Bazar Market

Beel A saucer-shaped natural depression, which generally retains water throughout the year and in some cases, seasonally connected to the river system.

Boro A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly planted in December-January and harvested before the onset of monsoon in April- May.

Golda Prawn (*Macrobrachium rosenbergii*), non-saline/fresh water species

Gher Farm lands converted into ponds with low dykes and used for cultivation of shrimp/prawn/fish.

Haat Market place where market exchanges are carried out either once, twice or thrice a week, but not every day.

Jaal Fishing net used to catch fish from the water bodies.

Jolmohol Section of river, individual or group of beels (depression), or individual pond owned by the government but leased out for fishing. They are also called Jalkar, or Fishery.

Jhupri Very small shed for living, made of locally available materials. A type of house/hut used by very poor communities.

Kutcha A house made of locally available materials with earthen floor.

Khal A water drainage channel usually small. These may or may not be perennial.

Kharif Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).

Kutcha Toilet The earthen made latrine consists of a hole without cover.

Mahajan A traditional money lender and a powerful intermediary in the value chain.

Perennial khal A khal where water is available all the year round.

Pucca Well constructed building using modern masonry materials.

Rabi Dry agricultural crop growing season; mainly used for the cool winter season between November and February

Seasonal khal Water not available in the khal all the year round.

SIDR Major Cyclone, which hit Bangladesh coast on 15 November 2007.

T. Aman When preceding a crop means transplanted (T. Aman).

Upazila An administrative unit of/under 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.	:	55/2C
District	:	Patuakhali
Upazila	:	Dashmina and Galachipa
Union	:	Kalagachia, Chiknikandi, Bakulbaria, Alipura and Betagi Sankipur
O&M Division of BWDB	:	Patuakhali O&M Divison, Patuakhali
Gross Area (ha)	:	6275ha
Khal	:	Sutabaria khal on part of North-East & South-West and Kolagachia khal on part of North-West

Major Water Management Infrastructure

Embankment (km)	:	47.55 km
Regulator/Sluics (nos.)	:	7 nos
Inlet		39 nos
Outlet		0 nos
Khal (km)	:	385 km

Conversion Units

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

Executive Summary

Background

Bangladesh, the largest river delta in the world, has about 710 km of coast line along the Bay of Bengal. Nearly 38.5 millions of people live in the coastal area. About 38% of the population in the coastal region live below the poverty line and face high vulnerabilities in terms of access to food, employment, income, water and health service. Integrated and participatory water resources management has the potential to contribute significantly to food security, safety, income level, health and economic growth. In this context, the Government of the Netherlands (GoN) as a development partner of Bangladesh has been supporting water resources management projects in Bangladesh since 1975. These projects are mostly operated by the Bangladesh Water Development Board (BWDB).The Blue Gold Program (BGP), is one of such initiative that will cover 22 polders in four coastal districts of Bangladesh. This program, initiated in January 2013 and expected to end in December 2020, is built on the results and lessons learnt in managing water resources from previous programs and projects. The explicit objective of Blue Gold Program is to reduce poverty and increase people's income through value chain development in an integrated approach. Initially, all water control structures of the selected polders of the coastal districts will be rehabilitated and fine tuned in line with project objectives. However, to proceed with implementation, the BGP needs environmental clearance from the Department of Environment. This is due to the fact that under the Environment Conservation Rules (ECR, 1997), construction/reconstruction/expansion of flood control embankments, polders, dikes, etc. are classified as **'red'** category projects, and are subject to mandatory for Environmental Impact Assessment (EIA) study. This document is the Final EIA study report of Polder 55/2C.

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 55/2C is located in Dashmina and Galachipa upazila of Patuakhali district. It is surrounded by Sutabaria khal on part of North-East & South-West and Kolagachia khal on part of North-West (Map 1.1). The Polder covers an area of 6,275 ha, with a Net Cultivable Area (NCA) of 5,020 ha.

The polder is bounded by 47.55 km embankment that was built to protect against tidal waves and salinity intrusion. There are 7 nos drainage/flushing regulator/sluices, no drainage outlets and 39 flushing inlets constructed by BWDB within the polder. These structures need repairing as almost all of these are not functioning up to the desired level. A number of the gates do not operate smoothly due to damages in the wheels and shafts used to elevate gates. The internal drainage channels of the polder recognized 87 nos of 385 km lengths. Topsoil erosion, and other land filling activities have resulted in gradual decrease of water courses within the polder over the years.

Existing problems and works under the proposed interventions

The Polder was constructed in 1990-95, and later on was rehabilitated under the IPSWAM project from 2003 to 2011. However, a number of the gates do not operate smoothly due to damages in the wheels and shafts used to elevate gates. Functionally, the drainage outlets cannot drain out water properly after heavy rainfall events, especially during post monsoon. The sluice gates are not able to

provide full protection against salinity intrusion. Poor maintenance is another issue in the polder, which results in damages in water control structures as well as peripheral embankments. Tidal flooding (at Hajikhali, Hajikhali Abad, Gerakhali and Tafalbaria mauzas) and low water availability for irrigation are other issues affecting the local people. Most of the khals is found in good flow condition but the hydrological connectivity is found disrupted at some locations where water from low lying lands does not carry into the khals, a situation which generates drainage congestion.

Blue Gold Program has taken interventions like re-sectioning of embankment, repairing of water control structures, construction of water control structures, re-excavation of khals considering the existing problems and need of the local residents to mitigate the existing water management problems.

Environmental and Social Baseline

The average maximum temperature values range from around 29°C (January) to around 36°C (April). Significant fluctuations in average minimum temperatures have been found, which varies from 10.3°C (January) to 24°C (August). The highest and lowest values of rainfall are observed during the months of July (590 mm) and December (7 mm) respectively. It shows an increasing trend from April to July and after that decreasing pattern was observed. The relative humidity shows an increasing trend from April to July and after that decreasing pattern was observed.

Polder 55/2C is about 60 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is surrounded by a number of tidal rivers namely, Golachipa river (on part of North & West), Patabunia khal (on part of south), Gaburia khal (on part of south and east) and remaingn part by road (Map 1.1). Tidal influence governs within the polder, with the occurrence of diurnal tidal shifts (a high tide followed by a low tide, and then another high tide) at about 6 hour intervals in each day.

Total cropped area is about 11,334 ha of which 66% is covered with rice and the rest 34% is occupied by non-rice crops. The cropping intensity is about 176%. Recently, Integrated Crop Management (ICM) is practiced in some areas of the polder. The estimated total fish production of the polder area is about 735 tons. Bulk of the fish production (97%) is coming from culture fisheries and the rest is contributed by the capture fishery. In the polder area, tidal flood and drainage congestion are the main threats for ecosystem sustainability. A huge amount of vegetation including homesteads and crop fields are damaged. Damages of vegetation severely impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

There are 15, 715 households in the polder area having a total population of 71,840 of which 34,631 are male and 37,209 are female (BBS, 2011). The female population is found to be higher than the male population. The average literacy rate in the study area is 52% which is slightly better that national level (51%). The polder area is comprised of different occupations. Agriculture is still is still the mainstay of the economy in the polder area. Most of the population of polder is engaged in agriculture sector (75%). These occupational groups are mainly farmer, agricultural labor, fishers, day labors etc. About 19% population is engaged in salaried service sector and only 6% is engaged in industry, petty trade, handicrafts and other manual sectors. In case of sanitation, 30%households have hygienic sanitation facility (water-sealed), 50 % have not water-sealed sanitation facility, 19% have non-sanitary sanitation facility and 2%have no sanitation facility. Overall status of drinking water in the area is satisfactory. On an average, 98% people can collect drinking water from tube well and rest of the 2% can collect drinking water from other sources.

Prediction and Evaluation of Potential Impacts

The proposed interventions will affect many environmental and social components either positively or negatively. The proposed interventions would reduce the tidal flooded areas considerably. It is expected that flood free area would be 75% from the existing impacted areas. The project would have a positive impact on agricultural resources especially in crop production. 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. The productivity of capture fish habitat may be increased significantly. Existing trend of vegetation loss due to natural disaster will be reduced for flood protection by re-sectioning of embankment. Existing khal bank side and crop field vegetation will be improved by reducing drainage congestion due to construction of water control structures. The households of the polder area will be benefitted since they will have access and sharing open water bodies which would ensure social use of water. Moreover, this would enhance their social bonding and cohesion in every aspects of life.

The cumulative and induced effects of the proposed interventions in Polder 55/2C have been investigated based on qualitative assessments. The study infers positive long term cumulative effects in Polder 55/2C due to other proposed regional and local projects. The proposed Ganges Barrage may largely change the surface water salinity frontier of the area in the future. On the other hand, the proposed Ganges Barrage would have positive impact especially in dry season water use; enhancing surface water irrigation practices within the polder. This would eventually enhance production and food security of the area. Several saltwater species may face extinction in the long run, creating scopes for new ecological diversities of freshwater tolerant species. On a social context, the effects may be significant as the rural livelihood would shift towards enhanced farming practices. The rehabilitation works in Polder 55/2C may generate some minor induced effects in connection with river siltation, employment generation and food security. The reciprocal impacts of climate change on the polder have also been assessed. The study infers that water level and surface water salinity in adjacent areas may increase in the future due to climate change, whereas dry season water availability may decrease. The climate resilience of local people in Polder 55/2C has also been found to have become enhanced due to the implementation of many capacity development initiatives.

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 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 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).

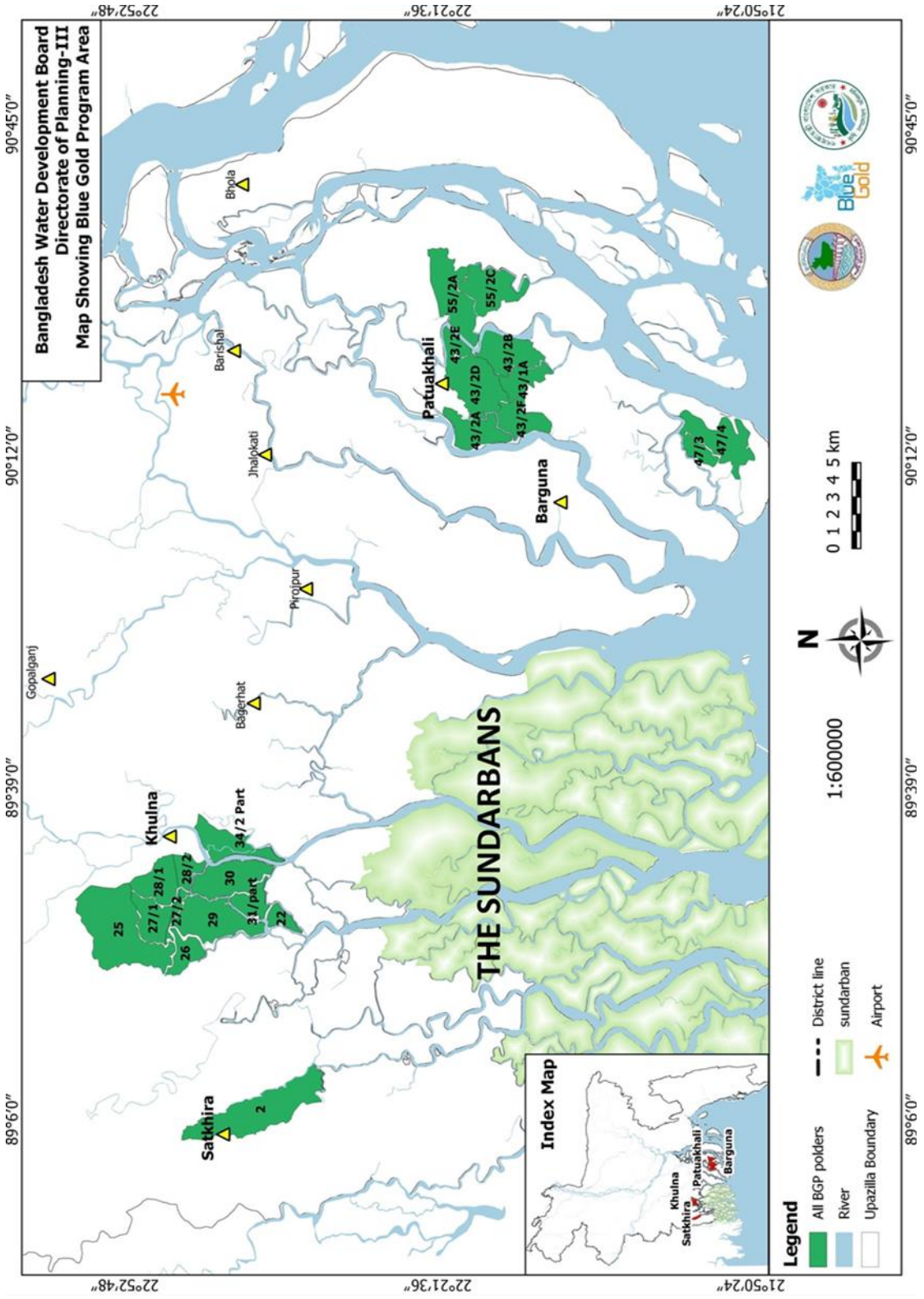
These districts are chosen because (i) higher incidence of poverty, (ii) ineffective coordination with the local administration and private sector and (iii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. 22 polders from these four districts are included 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 foru districts.



Map 1.1: Blue Gold Program Area

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

1.2 Rationale of the Study

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

Component (ii) of the Blue Gold Program includes rehabilitation of water resources management infrastructure in selected polders. Polder 55/2C 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 55/2C is managed by the Bangladesh Water Development Board (BWDB) and was constructed during the Early Implementation Project from 1988 to1990. The characteristics of the polder can be found in Table 1 and the location map of the polder with respect to Upazilla and Union headquarters is shown in Map 1.2

1.4 Study Method and Partners

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

1.5 Study Objective

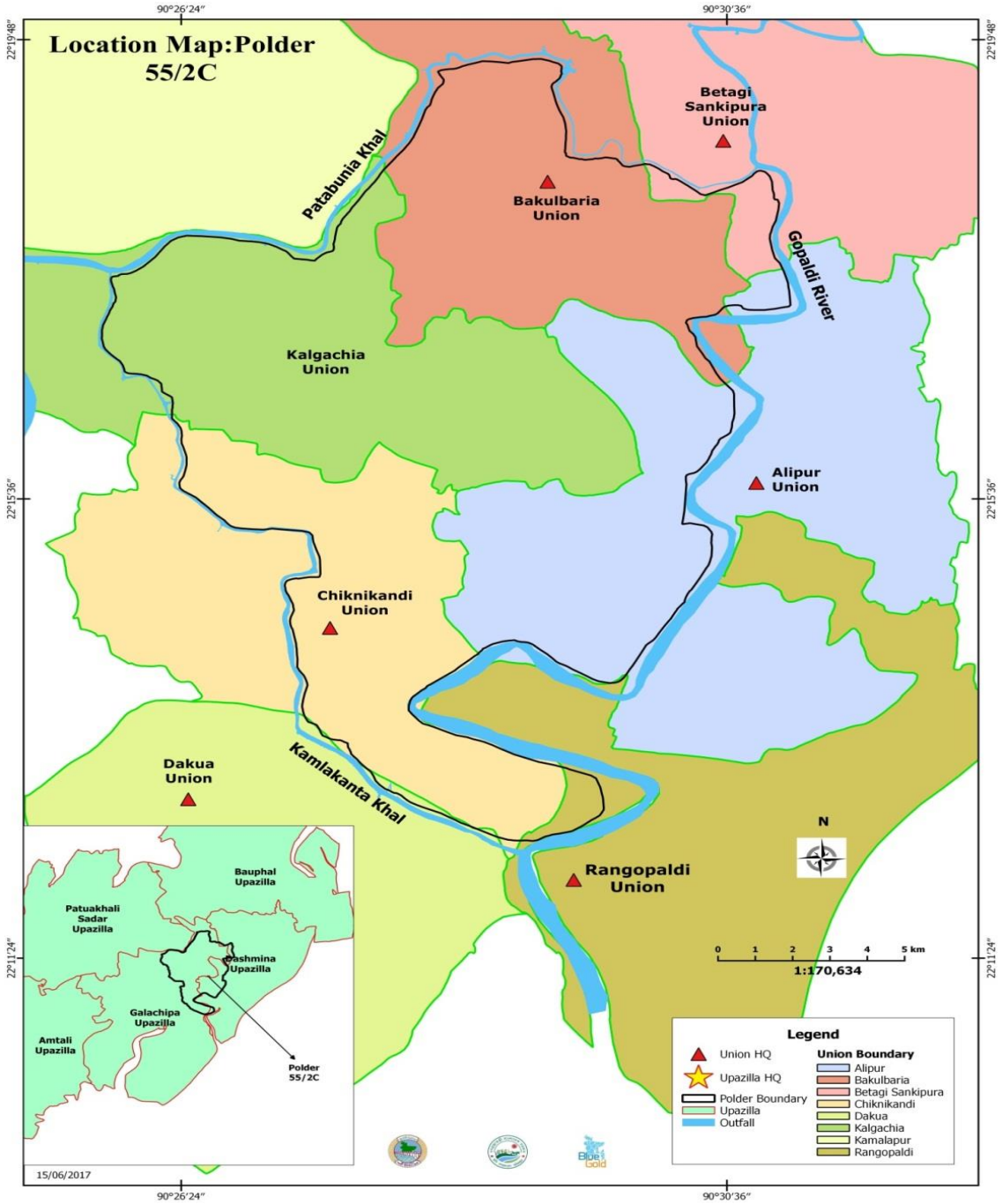
The objective of the Environmental Impact Assessment (EIA) study is to comprehensively assess the environmental aspects of the proposed interventions under project aimed for eco-friendly development and improving the socio-economic condition of the entire project area.

1.6 Scope of Work

The scope of works of the assignment is summarized below.

i. Carry out detailed field investigation for environmental and social baseline focusing on tidal flooding and associated impact on crop and fish production, land loss and socio-economic condition of of the area.

ii. Identify the Important Environmental and Social Components (IESCs) which may be impacted by the proposed interventions.
iii. Assess environmental condition related to water resources management of the area.
iv. Assess potential impacts from the proposed intervantions through identification, analysis and evaluation.
v. Identify the specific reciprocal impact of climate change and polder infrastructures.
vi. Conduct landuse and land cover classification as well as damage assessment due to flood, water logging and erosion.
vii. A small section in the EIA (EMP) will indicate occupational health and safety measures to be undertaken during implementation.
viii. Investigate the existing institutional contexts (local institutions, NGOs, government policies and regulations etc.) for polder management.
ix. Prepare Environmental Management Plan (mitigation and enhancement plan, compensation and contingency plan as well as monitoring plan).



Map 1.2 :Map of Polder 55/2C polder boundary and Unions

1.7 Limitations

The limited time assigned for conducting the EIA studies of 4 (four) project/Polders has not adequate. The secondary data and information used in this study have been collected from existing data sources for different time intervals. The inference drawn from implied hydrologic and hydrodynamic models are mostly subjected to the authenticity of used data.

1.8 EIA Study Team

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

1. Mr. Md. Amirul Hossain, Superintending Engineer/Director, Planning-III & Progaram Coordinating Director, BGP, BWDB, Dhaka.
2. Mr. Md. Rahmat Ali, Deputy Chief (Fisheries), Planning-III & BGP, BWDB, Dhaka.
3. Ms. Nasrin Akter Khan, Executive Engineer, Planning-III & BGP, BWDB, Dhaka.
4. Mr. Shafiqul Islam, Assistant Chief (Sociology), Planning-III & BGP, BWDB, Dhaka.
5. Ms. Shahnaz Akter, Assistant Chief (Economics), Planning-III & BGP, BWDB, Dhaka.
6. Mr. Md. Shariful Alam, Sub-Divisional Engineer, Planning-III & BGP, BWDB, Dhaka.
7. Mr. Tanvir Islam, Value Chain/Fisheries Expert/Joint Manager Innovation Fund, Technical Assistant Team, BGP, Dhaka.
8. Dr. Munir Ahmed, Livestock Expert, Technical Assistant Team, BGP, Dhaka.
9. Mr. Md. Joynal Abedin, Environmental Expert, Technical Assistant Team, BGP, Dhaka.

1.9 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 & social components are also highlighted with 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 Rule

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.

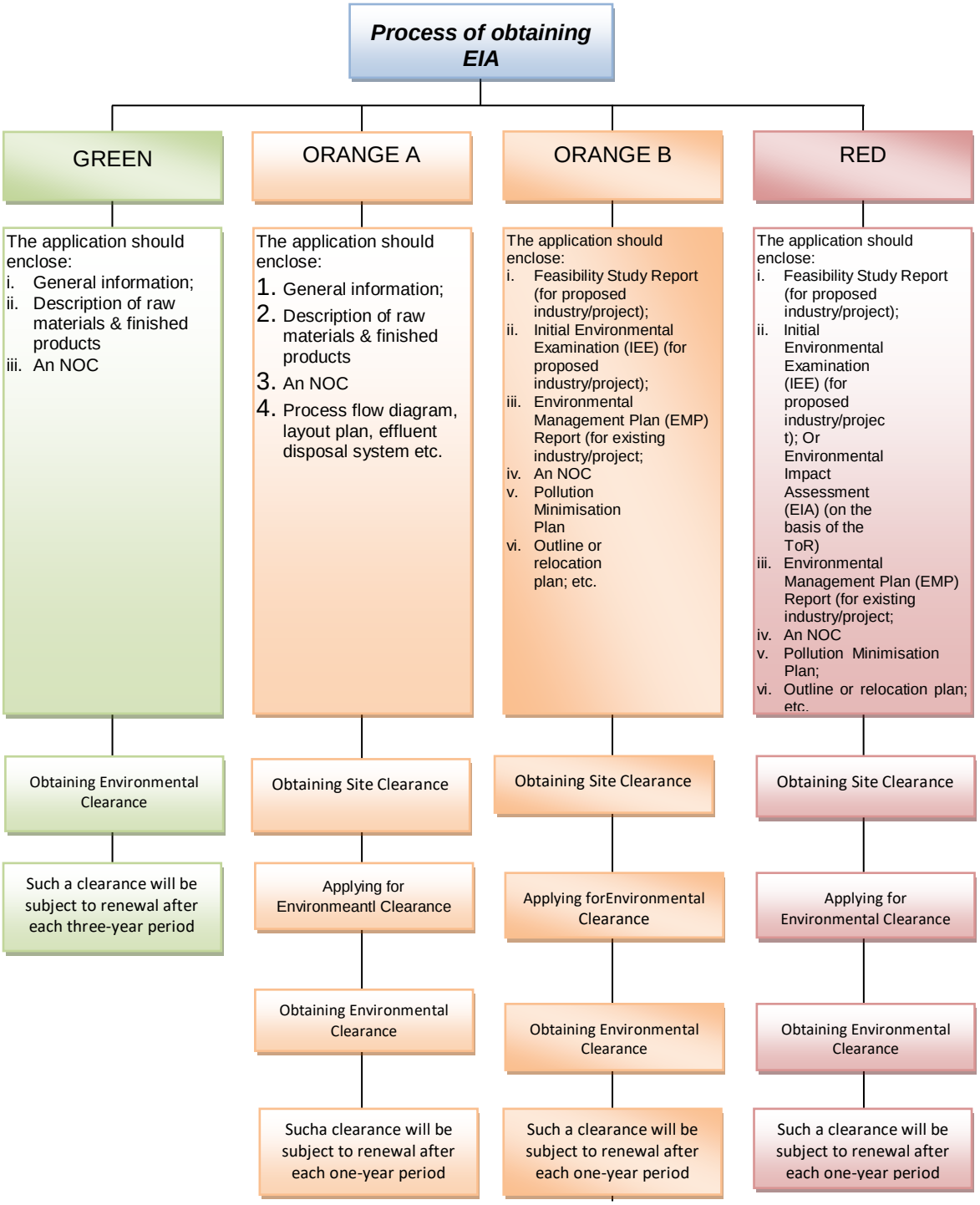


Figure 2.1 Steps Involved in Environmental Clearence folllowing DoE Clearence

3 Approach and Methodology

3.1 EIA Process

The 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) was followed for conducting the 'Environment Impact Assessment of Rehabilitation of Polder 55/2C.

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

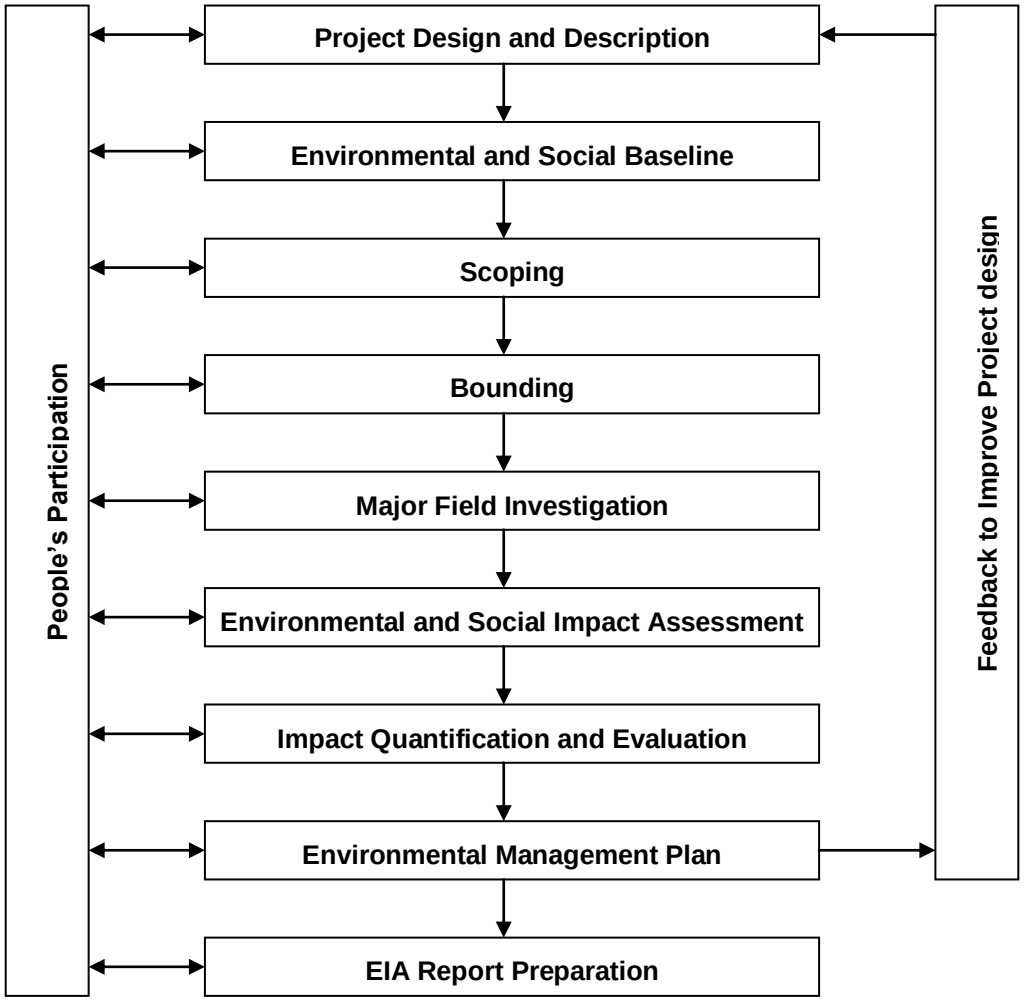


Figure 3.1: The EIA process

3.2 Project Design and Description

The rehabilitation activities or interventions which are to be implemented under the Blue Gold Program were identified. The area of influence (or Project area for short) was demarcated. This included the area inside the polder where most of the Project interventions would take place, and the area immediately outside the polder embankments (this area could be used for staging of construction works, material stockpiling, and/or earth borrowing). A detailed description of the proposed works to be carried out has been provided. Supplementary information on design and implementation of the project interventions were collected from Blue Gold officials. Afterwards, a field investigation was conducted by the EIA study team, which helped in the verification of locations and the rationale of the proposed interventions. The existing water management and other small scale problems were also identified during the investigation. The existing situation of the available water management infrastructures were also inspected the during field investigation. An Operation and Maintenance Plan for the rehabilitation works has been developed under the study. 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 information collected from secondary and primary data sources through literature review, field investigations and consultation with different stakeholders. The baseline condition was established in respect of meteorology, seismicity, water resources, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic conditions including identification of problems in respect to the proposed project site and adjoining area. The baseline data collection and analysis of the methodology are presented in the following section:

3.3.1 Climate and Meteorology

Data on different meteorological parameters such as rainfall, temperature, sunshine hours, humidity and wind speed were used for assessing the existing climate which is related to the water resources of the study area. The nearest station of the Bangladesh Meteorological Department (BMD) at Patuakhali was selected. The data were collected from National Water Resources Database (NWRD) of the Water Resources Planning Organization (WARPO) that contains long time series of temporal data showing daily values for meteorological stations. The rainfall measuring station of BWDB is located almost a similar distance away (to that of the Patuakhali BMD station) from the polder and as such no further rainfall analysis has been carried out. The BMD station in Patuakhali does not measure evaporation, and as no other BMD stations were located nearby, discussions on evapo-transpiration has been omitted for Polder 55/2C. The issue of climate change has been discussed on a regional scale. Through a review of existing literatures on different climate change scenarios for the South-Central hydrological region (which is relevant to the Patuakhali district), an understanding has been obtained regarding probable climate change consequences in the future.

3.3.2 Topography and Seismicity

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). Topographical data were collected from the GSB and (NWRD) of (WARPO).

3.3.3 Water Resources (both surface water and ground water)

Water resource data under the headings of river hydrology, river morphology, ground water availability, drainage pattern, ground and surface water quality and water use were collected from secondary sources and primary observation. The professionals from multidisciplinary study team received feedbacks from local people during their field investigations. 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 river-khal-beel network, water availability, drainage pattern, water quality (surface and ground water), flash flood, risk of erosion 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 information on the different resources. Local knowledgeable persons and community representatives were also interviewed. During the field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the 'Rehabilitation of Polder 55/2C' on water resources components were assessed by analyzing collected data, community knowledge and through professional justification of water resource managers. The management plan for water resources components was incorporated to assess impact magnitude and water resources status using the stakeholders' requirements and experts' judgment.

The specific data on different events of water resources were collected from the different sources. There are two surface water stations of BWDB in the vicinity of the polder at Bauria River and at Golachipa River. Information from Patuakhali station could be more relevant, but the station collected data upto 1987 only and as such, the station at Mirjaganj was considered for analyzing surface water levels in this study. The monthly variations in Groundwater Table (GWT) from 1978 to 2013 was collected from the observation well of BWDB designated as PAT002 (6.5 km distance from polder). Data on water quality were measured at site by collecting surface and ground water samples from different locations within the polder. Surface water salinity was measured from different locations during high tide (mostly near the high water slack period). Furthermore, information on different water resources functions; problems and uses were collected through intensive local level consultations.

3.3.4 Land Resources

The Agro-ecological Region of the proposed study area was identified using secondary sources (FAO/UNDP). Land use, land type, soil texture data were also collected from the Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of the Soil Resources Development Institute (SRDI). Secondary data on 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 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 by using a developed questionnaire and in consultation with local people as well as relevant agricultural officials. Agricultural resources data were also collected from secondary sources from the 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). Crop damage data for the last three years were collected from the field.

3.3.6 Livestock Resources

The present status of livestock [(cows/bullock, buffalo, goats and sheep and poultry (ducks and chickens) in the study area was evaluated through field level survey in consultation with the local people using PRA, (Participatory Rural Appraisal)] RRA (Rapid Rural Appraisal) and Key Informant Interview (KII). Livestock resources data were also collected from secondary sources from the upazila livestock office.

3.3.7 Fisheries Resources

Data collection methods: The fisheries data were collected for the EIA study by considering the seasonal variance of dry and wet seasons. Prior to undertaking data collection, a checklist and a questionnaire were developed. The checklist included all kinds of information of existing and potential structures of the project. A combination of survey techniques was used for data collection. The survey techniques included sampling site selection, data collection, data analysis and reporting. The sequential steps 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 on the intervened and non-intervened areas to find out the difference between them in terms of fisheries impact.

Data Collection: Data were collected in multiple ways which can be broadly divided into two classes, for instance, (i) primary data collection and (ii) secondary data collection. Primary data were collected from the fishermen community, fisher households and local key informants and secondary data were collected from upazila fisheries office during field visits.

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

Capture & Culture Fish habitats: Capture fish habitat assessment was carried out through Fishing Effort Survey (FES), Frame Survey (FS), micro- scale Catch Assessment Survey (CAS), habitat based species diversity & composition. The habitat based species diversity & composition survey included identification of species of conservation significance, identification of potential fish habitat prescribing to for fish conservation, fish migration survey and habitat identification for fish conservation. Culture fish habitat assessment was carried out through homestead culture fish pond survey and commercial fish farm survey.

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

Secondary Data Collection: Relevant secondary data were collected from the upazila fisheries office from their annual report as well as from various literatures/studies.

Data Analysis and Output: Fish production for individual habitats were obtained through a series of calculation procedures using the collected information of FES, FS, CAS and Habitat area.

Aggregating the fish production from all habitat types, the total fish production of the study area was estimated. Secondary information that was collected from the UFOs and literatures was with primary data for production estimation.

3.3.8 Ecological Resources

Information on bio-ecological zones and their characteristics was collected from the publications of the International Union for Conservation of Nature (IUCN). For ecological baseline, data were collected on terrestrial and riverine ecology including flora, birds, reptiles, amphibians, mammals, and migratory birds. The field activities included collecting ecosystem and habitat information, sensitive habitats ecological changes and potential ecological impacts.

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

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

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

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

3.3.9 Socio-economic condition

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

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

a) Data collected from BBS, 2011;
b) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;
c) PRA /RRA, FGDs, KII for primary data collection; and
d) Institutional Survey (IS) for primary data collection in upazila level offices which included the Local Government Engineering Department (LGED) office, the Civil Surgeon's office, the Social Services office etc.

3.4 Scoping

A scoping process was followed for selecting Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions of 'Rehabilitation of Polder 55/2C'. Scoping was done in two stages. Individual professionals of EIA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholder opinions obtained in the scoping sessions was considered in selecting the IESCs.

3.5 Bounding

The area likely to be impacted by 'Rehabilitation of Polder 55/2C' was delineated in consultation with the Blue Gold Authority and feedback received from the local people during baseline consultation. In addition, processed RS tools were also used for this purpose.

A semi-distributed hydrological model SWAT (Soil and Water Assessment Tools) was setup in order to assess availability of water for the study area. Hydrodynamic modeling was simulated using Delft 3D as modeling tool. All data used in the model calibration (including topography, soil maps, land use maps, and weather data, river network and cross-section, water level, discharge and salinity) and simulation were obtained from different sources. Furthermore, participatory public consultations were carried out for validation of the model outputs, and drawing socio-technical conclusions.

3.6 Major Field Investigation

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

3.7 Environmental and Social Impact Assessment

Environmental and social impacts of the proposed interventions 'Rehabilitation of Polder 55/2C' on the IESCs have been assessed through several sets of activities. Impacts are caused as a result of interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of difference between the future-without-project (FWOP) condition and the future-with-project (FWIP) condition. FWOP conditions were generated through trend analysis and consultation with the local people. This reflected conditions of IESCs in the absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions were assessed to generate the FWIP condition. Comparison and projection methods were used for impact prediction. This included both positive and negative impacts which were considered in the preparation of the environmental management plan.

The sequence of assessment of environmental and social impacts was as follows:

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

3.8 Impact Quantification and Evaluation

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

3.8.1 Assessment Methodology

The assessment of effects and identification of residual impacts takes account of any incorporated mitigation measures adopted due to any potential impact of Project activities, and will be largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative and positive (beneficial),

and the methodology defined below has been applied to define both beneficial and adverse potential impacts.

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

3.8.2 Magnitude

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

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

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

Table 3.1: Parameters for determining magnitude

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

3.8.3 Sensitivity

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

Table 3.2: Criteria for determining sensitivity

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

3.8.4 Assessment of Residual Impacts

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

3.9 Environmental Management Plan

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

3.10 EIA report preparation

At the end of the process, the present report on "Environmental Impact Assessment of Rehabilitation of Polder 55/2C" was prepared incorporating all the findings of the EIA study.

4 Project Description

4.1 Background

The Polder 55/2C is situated in Patuakhali Districts, Dashmina and Galachipa Upozilla with unions of Kalagachia, Chiknikandi, Bakulbaria, Alipura and Betagi Sankipur. Gross area is 62750ha. 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 as follows:

- Increase sustainability of the development of the polders through effective community participation. The community organizations will become the driving force for the natural resources based development. Eenvironment, gender and good governance to be addressed.
- Protect floods, salinity and improve drainage in the Polder area for improve water resources management;
- Increase farmers' income and strengthpromote livelihood through improved productivity.

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

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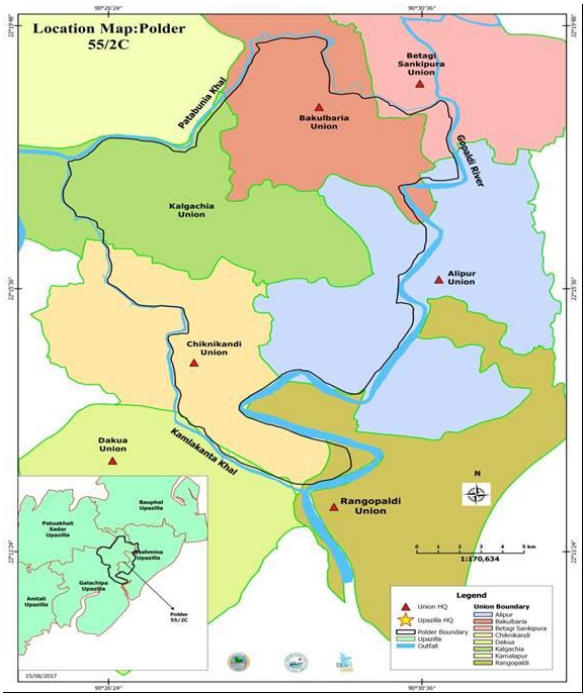
4.3 Polder Overview

Polder 55/2C is managed by the Bangladesh Water Development Board (BWDB) and was constructed during the Early Implementation Project from 1988 to1990. It is under Patuakhali O&M Division.



Map 4.1 **:** Location of Polder 55/2C with Unions

4.4 Present Status Water Management Infrastructures

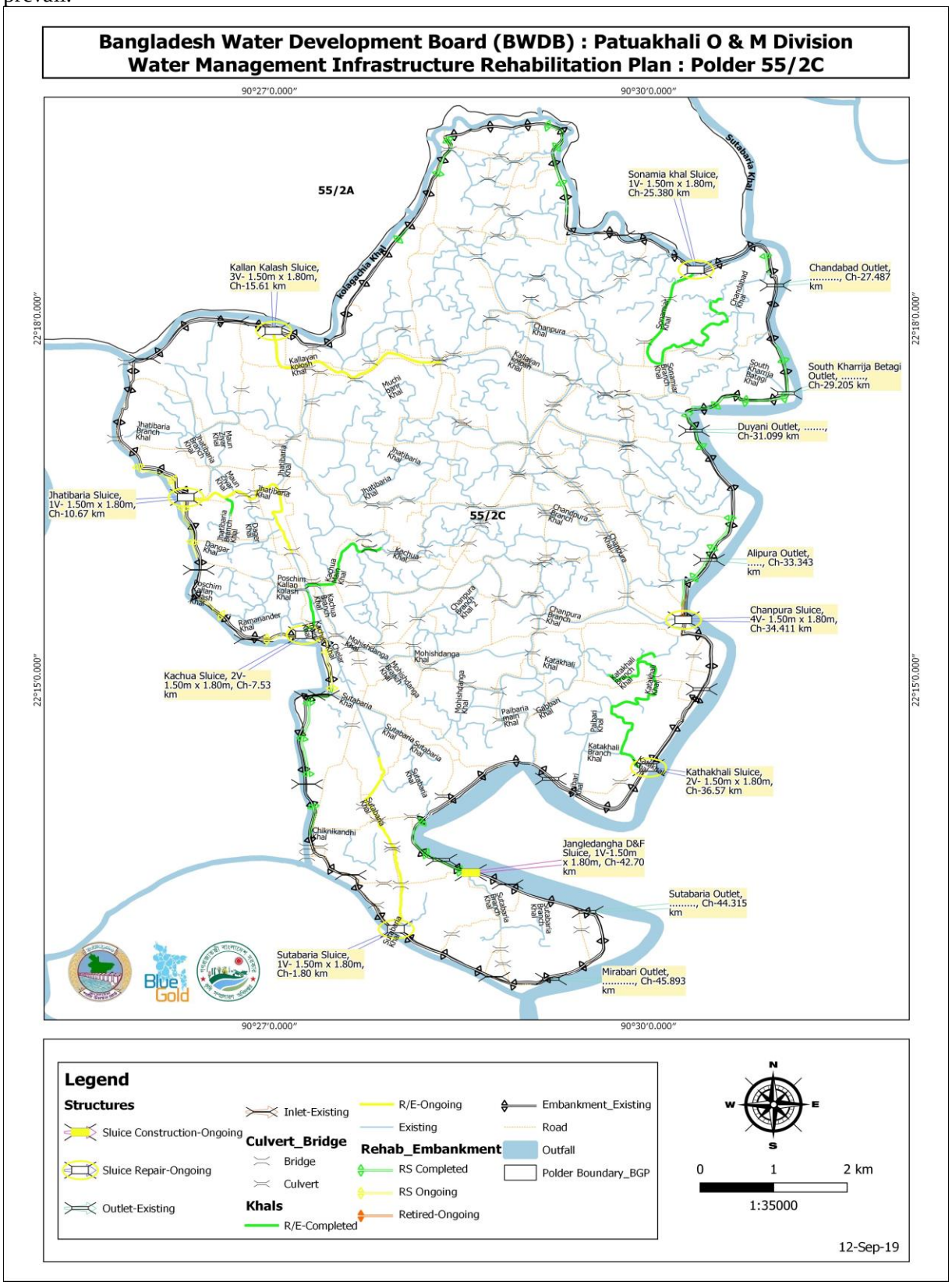
Water Management Infrastructures are the physical interventions which ensure sustainable management, optimal use and equitable sharing of water resources. There are some typical water management infrastructures such as peripheral embankments, sluices, drainage outlets, flushing inlets in Polder 55/2C (Porject area Map 4.1). Based on field investigation the study team gathered the following information regarding the status of existing infrastructure.

Embankments

The length of the Embankment is 47 km. Interior Dyke 44.00km to 47.00km i.e. 3 km with top width 4.3 m. The crest level is at 4.3 m above Mean Sea Level (MSL) existing side slopes are 1:3 in riverside and 1:2 in countryside and 44km marginal dyke 0.00km to 44.00km i.e. 44 km with top width 2.5 m the crest level is at 4.3 m above Mean Sea Level (MSL) and existing side slopes are 1:2 in riverside and 1:2 in countryside. . The existing condition of the embankment is good in most portions. 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.

Water Control Structures

There are 08 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.



Map 4.2 :Location of proposed interventions Polder 55/2C with infrastructures

During the field visit in the Polder, study team found that part of the Embnakment deteriorated and the local injabitants reported that saline water entered in the polders in those sections during high tides. Long time there was no matenance of the Embankment. I has been observed some of existing regulator/sluices in poor condition with structural damage in recent years and are not maintained duw to lack of resources. Many of the gates are in-operable.

Photo 4.1: Existing Status of Embankments

4.5 Present Status of Drainage Khals and Rivers

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

Photo 4.2: Existing Status of Sluice at Polder 55/2C

4.6 Problems and Issues in the Polder

A number of problems and issues are hindering the development potential of Polder 55/2C at the moment. Drainage congestion is one of the major problems inside the polder area. During monsoon and post-monsoon periods, most of the khals running through the polder area cannot cope with the increased rainfall occurrences, leading to moderate to severe drainage congestions.

Among the sluices some needs repair but Jangaldanga Sluice gate is in vulnerable condition and need re-construction. In addition to all these issues, mismanagement is resulting in various damages in water control structures as well as peripheral embankments. The unpaved portion becomes unusable for heavy vehicles during wet season.

4.7 Proposed Interventions in Polder 55/2C

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 55/2C. The locations of interventions have been shown in Map 4.1.

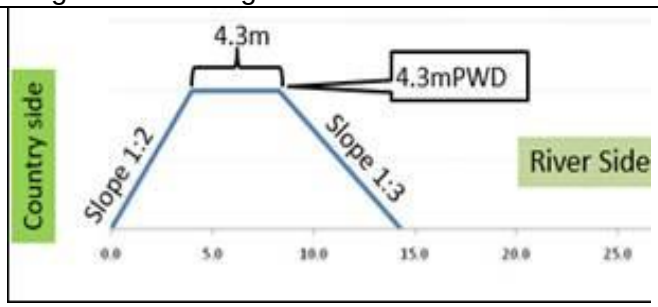
4.7.1 Re-sectioning of Embankment

Re-sectioning works along the peripheral embankment is proposed to be carried out some locations where they are found damaged. The proposed crest width is 4.3m, with side slopes of 1(V): 3(H) on river side and 1(V):2(H) on country sides, with exception of 1(V): 2(H) on both river and country sides for marginal dykes. The design elevation of the crest of the embankment is at 4.30 m +PWD (above Mean Sea Level). Considering the vulnerability of coastal zones due to natural calamities like more frequent cyclones, storm surges, salinity effect and climate change scenario, design office of BWDB has reviewed the design and set the parameters for re-sectioning or repairing of embankments which is shown below. There is no Sea Facing Embankment of this Polder, this Embankmsnt is of Interior tyke.

Table 4.1: Detail information on proposed Re-sectioning of Embankment

Sl. No.	Chainage	Length(km)
1	km 4.770 - km 6.470	1.7
2	km 6.470 - km 8.126	1.656
3	km 8.870 - km 9.270	0.4
4	km 9.970 - km 11.570	1.6
5	km 18.568 - 19.701 & km 20.110 - km 20.570	1.593
6	km 24.524 - km 26.334	1.81
7	km 26.334 - km 28.324	1.99
8	km 28.324 - km 29.974	1.65
9	km 29.974 - km 30.324 & km 31.200 - km 32.600	1.75
Total		14.149

Figure 4.1: Design Parameter of Embankment



Source: Blue Gold Program Office, 2019

Photo 4.3: Drainage Khals within the polder

4.7.2 Construction/ Repairing of Water Control Structures

All existing sluices of BWDB within the polder will be repaired. Some sluices would require new shafts and wheels, whereas some sluices would require replacements of barrels and gates. A number of inlets and outlets also require repairing.

Table 4.2: Detail information on proposed repairing of Drainage /Flushing Regulator/Sluices

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)	Remarks
1	Sutabaria Regulator/Sluice	1-V	1.50mX1.80m	1.800	Repair
2	Kachua Regulator/Sluice	1-V	1.50mX1.80m	7.530	
3	Jhatibaria Regulator/ Sluice	1-V	1.50mX1.80m	10.670	
4	Kallyankhalash Regulator/ Sluice	1-V	1.50mX1.80m	15.610	
5	Sonamia Regulator/Sluice	1-V	1.50mX1.80m	25.380	
6	Chandpura Regulator/Sluice	1-V	1.50mX1.80m	34.410	
7	Katakhali Regulator/ Sluice	1-V	1.50mX1.80m	36.760	
1	Jangaldangar Sluice	1-V	1.50mX1.80m		Construction

Source: Blue Gold Program Office, 2017. Repair Regulator/Sluices, Vent sizes will not be changed.

4.7.3 Khal Re-excavation

A total number of 11 khals are under the re-excavation plan of Blue Gold program in polder 55/2C. The total length to be re-excavated is 30km nad tentative volume of Earth to be re-excavated, as per design is about 1,92,000 cum. The names of the proposed khals to be re-excavated with tentetive lengths and Volume of Earth are shown in Table 4.3.

Table 4.3: Detail information on proposed re-excavation of Khals

Sl. No.	Name of Khals	chainage (km)	Tentetive volume of earth (cu-m) to re-exavted
1	Katakhali Main Khal	3.300	9235
2	Kachua Main Khal	2.400	20150
3	Sonamiar Khal	4.000	21808
4	Katakhali Branch Khal	0.700	15740
5	Jhatibaria Main Khal	2.700	11029

Sl. No.	Name of Khals	chainage (km)	Tentetive volume of earth (cu-m) to re-exavted
6	Jhatibaria Branch Khal	0.300	3715
7	Kallan Kalas Khal	4.500	49060
8	Sutabaria Khal	3.000	12770
9	Kachua Branch khal	2.700	10560
10	Chandpura khal	3.400	10700
11	Chandpura Branch khal	3.00	10260

Source: Blue Gold Program Office, 2017

4.8 Repair Maintenance and Construction Details

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

Description of Activities

Re-sectioning of Embankment

After validating the final design, soil will be excavated or carried earth will be brought and deposited in the selected areas. The sloping and shaping of embankment will be developed after proper compaction in layers. Then required turfing with grass will be provided on the embankment. Watering and fertilizing will also be provided. The earth required for re-sectioning of the embankment will mainly be collected from the borrow pit of the Polder. Dredging Re-excavated earths from re-excavation of drainage channels will also be used for the re-sectioning of embankment.

Repairing-Maintenance and Construction of Drainage Regulator/Sluices and Outlets

Seven numbers of Regulator/Sluice will be repaired nd one new construction (Jangallerdanga 1V, Polder 55/2C) has been planned in this Polder. 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.

Repairing of Flushing Inlets

A suitable site for the materials of the structure will be selected and prepared accordingly. Alternative diversion channels will be developed before starting of construction works. After completion of all activities, the embankments will be constructed and turfed with grass. Finally, a channel is to be excavated through lead cut and tail cut to make the flow to be channeled through the flushing gate.

Re-excavation of khals

At first the required tools will have to be procured for re-excavation of the drainage channels. A schematic diagram showing the centerline and layout plan will be prepared for the re-excavation work and the design depth and width of excavation are to be noted. The entire channel will then be divided into a number of segments. The excavation will be started from the upstream portion of the channel. Cross dams are to be provided at the starting and final locations of the reach, and then soil from the channels will be excavated and removed upto required depth and width. The excavated soil/ sludge should be disposed along the sides of khals. Proper compaction would be made on khal banks, and after finalizing the excavation in one reach, the other reach at its downstream would be excavated following similar procedures as stated for the first reach. Accordingly, all the reaches of the khal will be re-excavated. To summarize, a list of activities under each phase is shown in Figure 4.1.

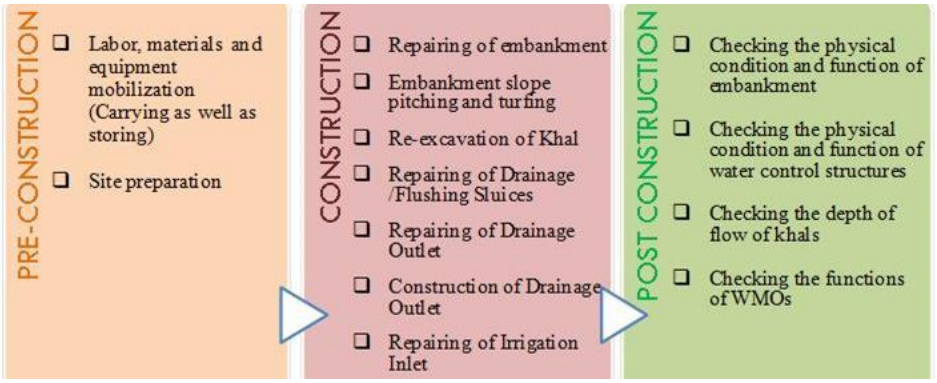


Figure 4.1: Phase wise list of activities in Polder 55/2C

4.9 Maintenance and Reapir Works Schedule

The construction works would be carried out during dry season, and will be kept at abeyance during wet season. Other supportive works would be carried during the entire year. The interventions proposed in Polder 55/2C are likely to be completed by June 2020.

Table 4.4: Construction Schedule in Polder 55/2C

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												
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												

4.9.1 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.

4.9.2 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.

4.10 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 55/2C are discussed in the following sections.

4.10.1 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.

4.10.2 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.

4.10.3 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.

4.11 Operation and Maintenance Plan

Since construction, Polder 55/2C 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.

4.11.1 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 55/2C. 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 55/2C 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.

4.11.2 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 55/2C, 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 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.

4.12 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 55/2C has been estimated as 300.00€ per ha area (DDP is attached in Appendix-8) . Accordingly, the project cost is 1771490.00 € i.e. BDT 15.06 crore (1€ = 85 BDT, on October 2016).

4.13 Expected Benefits and Outcome

The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 55/2C are listed in Table 4.5 below.

Table 4.5: Expected benefits and outcome of proposed interventions

Interventions	Benefits
Re-sectioning of Embankment	✓ Protection against salinity intrusion ✓ Increased side slopes will enhance the stability of the embankment ✓ Communication facilities may improve
Construction of an Outlet	✓ Drainage situation will 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.

4.14 No Objection Certificate

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

5 Environmental Baseline

5.1 Physical Environment

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

5.1.1 Meteorology

This section provides an analysis on meteorological parameters (temperature, rainfall, wind speed and humidity) of Polder 55/2C area. It is to be mentioned here that data and information for different analyses have been collected for different time intervals, depending on data availability, data variation and significance in connection with the study.

Rainfall

The average monthly rainfall variation at Patuakhali BMD station (from 1980 to 2008) is shown in Figure 5.1.

The hyetograph shows that the highest and lowest values of rainfall are observed during the months of July (547 mm) and January (7 mm) respectively.

Source: BMD, 2017

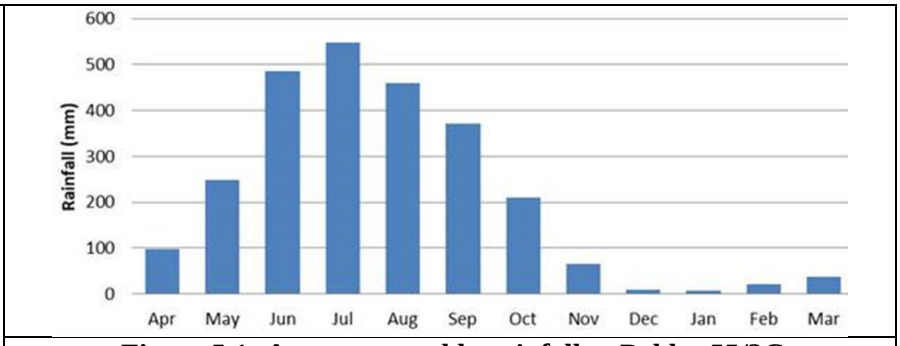


Figure 5.1: Average monthly rainfall at Polder 55/2C

Temperature

Figure 5.2 below shows the variations of average maximum and average minimum temperatures at the Patuakhali BMD station (from 1973 to 2013).

The average maximum temperature values range from around 29°C (January) to around 36°C (April). Significant fluctuations in average minimum temperatures have been found, which varies from 10.3°C (January) to 24°C (August).

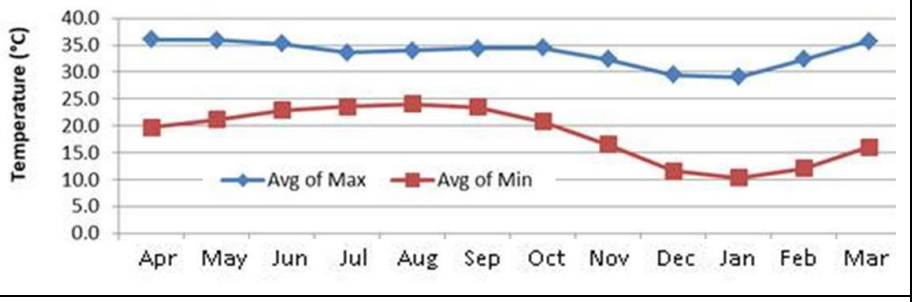


Figure 5.2: Average of maximum and minimum temparature at Patuakhali BMD station Source: BMD, 2014

Relative Humidity

Figure 5.3 below shows the variation of monthly relative humidity, as recorded in the Patuakhali BMD station (from 1973 to 2013). Significant fluctuation is 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. An increasing trend is observed from April to July, after which a decreasing pattern is found.

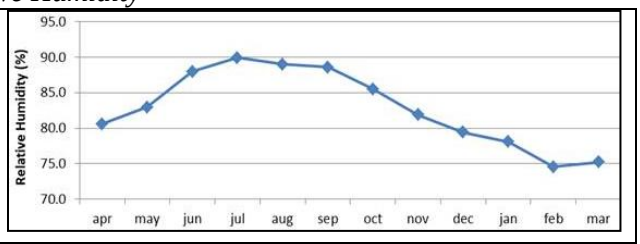
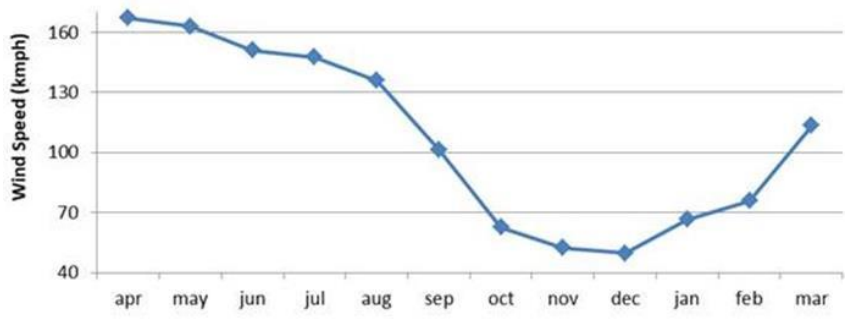


Figure 5.3: Average relative humidity at Patuakhali BMD station. *Source: BMD, 2017*

Wind speed

Figure 5.4 below shows the distribution of average monthly wind speed at Patuakhali BMD station (from 1973 to 2013). Wind speed is the highest in April (around 167 kph) and the lowest in December (around 49.7 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 caused devastating impacts due to high wind speed whereas the latter one is related more to the increased storm surge.



Source: BMD, 2014

Figure 5.4: Variation of average wind speed at Patuakhali BMD station

Sunshine Hour

The average sunshine hour data were collected from the Patuakhali BMD station (1985-2013). Figure 5.5 below shows an increasing trend from August to March. Maximum sunshine hour is found in March (7.65 hrs/ day). However, a decreasing trend is observed from April to July. Sunshine hours were minimum in June (3.2 hrs/ day) and July (2.9 hrs/ day) due to the presence of monsoon cloud.

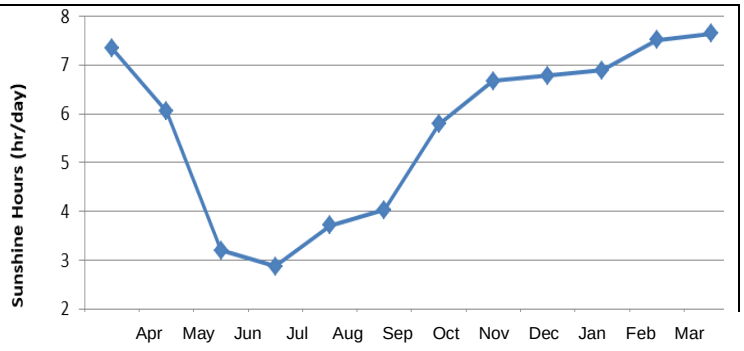
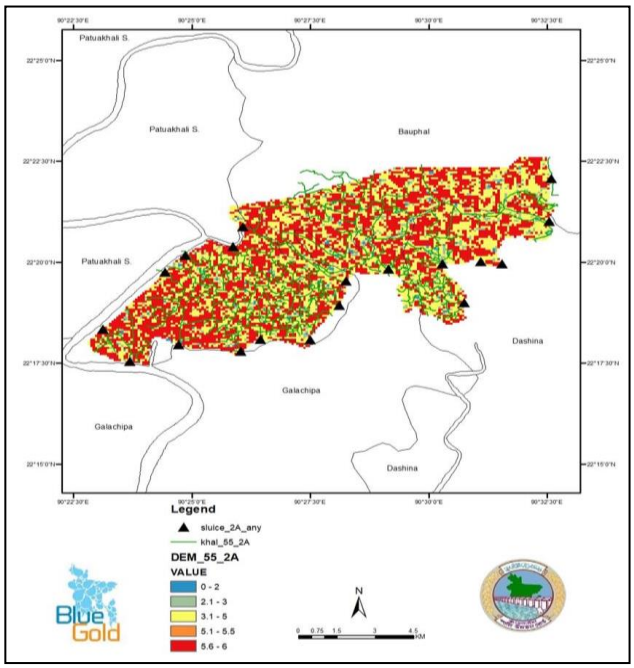


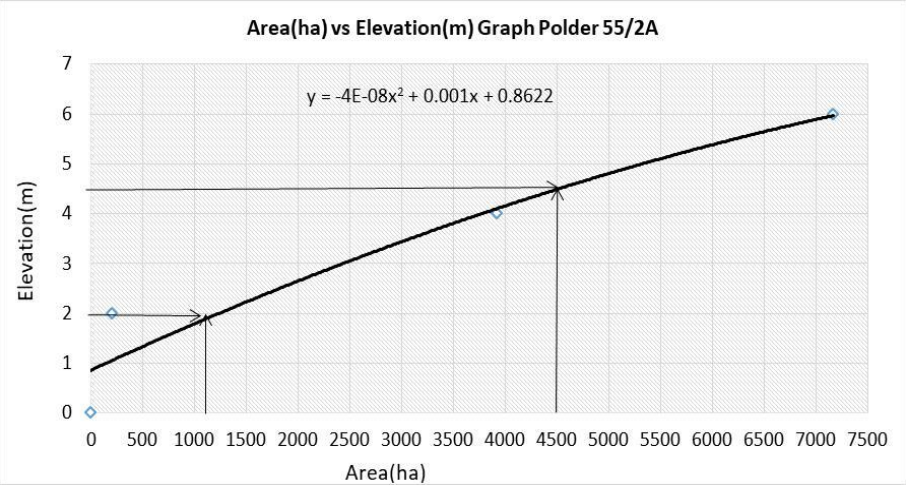
Figure 5.5: Monthly variation of average sunshine hours at Patuakhali BMD station. ***Source: BMD, 2017***

5.1.2 Topography

To visualize the elevations of different locations within the polder an analysis using Digital Elevation Model (DEM) has been carried out (Map 5.1). DEM analysis infers that the Reduced Levels inside the polder are low, varying from 1.13 to 1.95 m, PWD (a surface which is 0.46 m below the Mean Sea Level), with average elevations of around +1.54 m, PWD. The ground level of the entire polder is higher than the low tidal water levels observed in Mirjaganj (Payra River). The DEM analysis also indicates that the peripheral locations are slightly higher than most of the inside portions of the polder. Map 5.1 shows the topography of the study area, presenting the rivers and water bodies as well as categorizing land elevations.



Map 5.1: Digital Elevation Model (DEM) around Polder 55/2C



5.1.3 Seismicity

Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes in the past 200 years. Polder 55/2C falls in the Zone-III earthquake zone.

This Zone is a seismically quiet zone with Seismic Zone coefficient of 0.04. Seismic Zone coefficient is a dimensionless number which represents the maximum earthquake acceleration as a fraction of the acceleration due to gravity. Map 5.2 shows the seismic location of Polder 55/2C. As per the updated seismic design provisions of Bangladesh National Building Code, 1993, Map 5.2 presents the tectonic units available in Bangladesh and the location of Polder 55/2C. The map shows that the polder is located on the Barisal Gravity High tectonic unit. The 60 km wide zone is located between the Faridpur trough and Hatiya trough of the Bengal Foredeep. The zone has not been sufficiently studied for seismic surveys; however, it can be concluded that in consideration of both seismicity and stratigraphy.

It can therefore be inferred that both in consideration of seismicity and stratigraphy, Polder 55/2C falls on a relatively safer (seismically quiet and tectonically stable) side.

Map 5.2: Earthquake Zones of Bangladesh and location of Polder 55/2C

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 55/2C area is covered by one AEZ i.e Ganges Tidal Flood Plain (AEZ-13). These layers are:

- Physiography (land forms and parent materials)
- Soils
- Depth and duration of seasonal flooding and

– Agro-climatology [It comprises four elements: length of *Kharif* and *Rabi* growing seasons, length of pre-kharif transition period, number of days below certain critical winter temperatures (<15^{0}C) and number of days with extremely high summer temperature (>40^{0}C)].

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

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. Soils of the Sundarbans area are alkaline. General fertility level is high with low to medium organic matter content and very high CEC and K status. There are limitations of high exchangeable Na and low Ca / Mg ratio. The Zn status is low to medium and the B and S status is medium to optimum. Some of the physico-chemical properties of soils of AEZ-13 are provided in Table 5.1.

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

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

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

5.1.6 Soil fertility analytical data of analytical samples

Soil sample were collected from three locations at three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month of January, 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: Fertility status of soils in the polder area

Number of the polder	Location	Depth (cm)	EC	pH	OM	N	K	P	S
					%		Meq/ 100g	µg/gm	
55/2A	Madda Para Sehakati	0-10	0.72	5.7	0.93	0.05	0.10	3.16	135.47
		10-20	0.74	6.9	0.93	0.05	0.13	2.72	149.06
		20-30	0.86	7.2	2.07	0.12	0.15	2.60	146.12
	Purba Jainkati	0-10	1.09	6.0	2.02	0.11	0.13	6.75	142.10
		10-20	1.09	7.0	0.52	0.03	0.16	3.07	39.29

Number of the polder	Location	Depth (cm)	EC	pH	OM	N	K	P	S
					%		Meq/ 100g	µg/gm	
		20-30	0.95	7.3	1.40	0.08	0.16	4.19	37.84
	Purba Jainkati	0-10	0.44	6.2	0.93	0.05	0.20	3.61	32.86
		10-20	0.39	7.2	0.83	0.08	0.15	4.53	38.31
		20-30	0.42	7.7	1.81	0.10	0.17	5.16	25.21
	Patukhali	0-10	4.64	4.9	2.29	0.26	0.13	2.52	97.45
		10-20	4.08	5.9	1.90	0.25	0.11	2.69	109.11
		20-30	4.49	5.6	1.10	0.30	0.06	3.15	41.99

Source: Laboratory analysis report, 2015

5.1.7 Land type

Land type is a system of classifying cultivated land based on the seasonal inundation depth in normal flooding year. According to Soil Resource Development Institute (SRDI, 1988), five types of land(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 (F_1) which is normally flooded between 30 to 90 cm depth of water continuously more than two weeks to few months during the monsoon season.

5.1.8 Land use

The gross area of the polder is about 6,275 ha of which 4,330 ha (69%) is NCA. Settlement 1,631 ha (26%), Water bodies (rivers/khals) 251 ha (4%) and roads 63 ha (1%) of the total polder area. Detail land use of the polder area is presented in Table 5.3 and Map 5.4.

Table 5.3: Detailed land use of the polder area

Land use	Area (ha)	Total area (%)
NCA	4,330	69
Settlements	1,631	26
Road	63	1
Water bodies (river/khal)	251	4
Gross Area	**6,275**	**100**

Source: Estimation from SOLARIS-SRDI, 2006

5.1.9 Soil texture

Soil texture is an important soil characteristic that guides crop selection, crop production and also field management. Soil texture is the relative proportions of sand, silt and clay. Soil can be classified as one of four major textural classes: a) sands b) silts c) loams and d) clays.

Crop production also depends on soil texture. 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

Texture	Area(ha)	% of NCA
Clay	1,061	24.5
Clay Loam	3,247	75
Loam	22	0.5

Source: Estimation from SOLARIS-SRDI, 2006

5.1.10 Available soil moisture

The availability of soil moisture varies depending on the soil characteristics. According to SRDI, the available soil moisture has been classified into four (Low, Medium, High and Very high) categories. The distribution of available soil moisture is presented in Figure 5.6

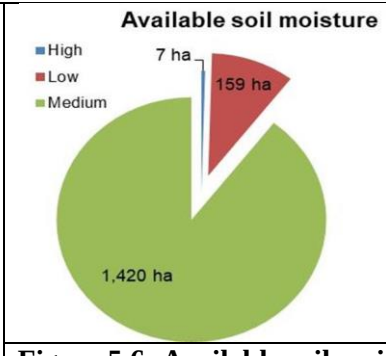


Figure 5.6: Available soil moisture in Polder 55/2C

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	173	4
Medium	Plant extractable soil moisture remain in field level from one to two months	217	5
Low	Plant extractable soil moisture remain in the field level less than one month	3,940	91
	Total	**4,330**	**100**

Source: Estimation from SOLARIS-SRDI, 2006

5.1.11 Soil salinity

Estimation from SOLARIS-SRDI, 2006, reveals that the soil salinity of the area inside the polder increases gradually over the period. 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.

Local people reported that the soil and water salinity gradually increases with dryness from January and reach to maximum level in March-April and then decreases due to onset of monsoon rainfall. Detailed soil salinity of 2000 and 2009 of the polder area are presented in Table 5.5 and Map 5.7.

Table 5.6: Detailed Soil salinity of the polder area

Soil Salinity class (EC=ds/m)	Description	Area (ha) (in 2000)	% of NCA	Area (ha) (in 2009)	% of NCA
2.0 - 4.0	Non saline with some very slightly saline	00	00	390	9
4.1 - 8.0	Very slightly saline with some slightly saline	4,330	100	3,940	91
	Total =	**4,330**	**100**	**4,330**	**100**

Note:Year 1973 salinity data is not available.; Sources: Estimation from SOLARIS-SRDI, 2006.

5.1.12 Drainage characteristics

Drainage plays vital role in the management of soil (salinity, soil health) in the polder area. According to SRDI (1988), the drainage characteristics have been divided into six classes (Excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and Very poorly drained) from the agriculture point of views. In the polder area, 77% of the NCA is under poorly drained condition and the rest 23% is imperfectly drained condition. The poorly drained condition i.e, normally is flooded between a depth 30 to 90 cm continuously for more than two weeks to few months during the flood season. The dominance of poorly drained soil of the polder area indicates that the removal of water in rainy/ monsoon season is the main constraint for growing dry land crops in the polder area. Poorly drained characteristics along with area are presented the Table 5.7.

Table 5.7: Drainage characteristics of the study area

Drainage classes	Drainage characteristics	Area (ha)	Percent of NCA
Imperfectly Drained	Water drained 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 more than 15 days at a stretch. In rainy season, groundwater stands within one meter at least for some time.	996	23
Poorly Drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season.	3,334	77
Total		**4,330**	**100**

Source: Estimation from SOLARIS-SRDI, 2006

5.1.13 Water Resources Systems

The water resources system is the source of water supply and plays crucial role in assimilating and diluting wastes, attenuating and regulating vital water resources functions such as flood, drainage, recharge aquifer, and maintaining the environment for aquatic habitats. The following sections discuss the water resources system within the Polder 55/2C.

River Systems

Polder 55/2C is within an areal distribution of 45 km from the coast of the Bay of Bengal, undergoing diurnal tidal influence. The polder is surrounded by a tidal river namely, the Golachipa River on the east and north direction, the Shuddurbaria khal on the south portion and the Naotana khal along the north direction. Apart from these rivers, there are approximately 385 km of drainage and irrigation canals (khals) within the polder (Gopaldi Don, Patabunia Khal and Kamalakalia Khal. etc.). The river system of the area is shown in Map 5.9.

Hydrological Connectivity

Water from the peripheral river is pushed towards the polder area during the high tide while the opposite situation takes places during low tide. However, during dry season, sluice gates are kept closed and most of the high tidal water cannot enter into the polder. The gates are kept open during monsoon and post-monsoon as a result free circulation of tidal water takes place within the polder. A number of distributaries of Lohalia River (Shuddhrbaria Main khal, Katura Taluk khal, Dholkhali khal, Shib Bari khal, Durlab khal, Katakhali khal, Naotana khal etc.) also contribute to the high tidal water to flow into the polder, whereas some other internal khals (Jugir Sota khal, Bahaitala khal, Dhopal khal, Natua Main Khal etc.) ensure free circulation of tidal water to circulate within the polder. These khals also help to drain out the internal water of the polder through the peripheral gates.

Surface Water Level

The surface water level is an important issue of water resources. Figure 5.7 presents the variation of monthly water levels, it shows that water level during high tide ranges from +1.1 m, PWD to +2.4 m, PWD, whereas low tidal water level ranges from -0.3 m,PWD to +0.4 m,PWD. *Source: BWDB, 2015*

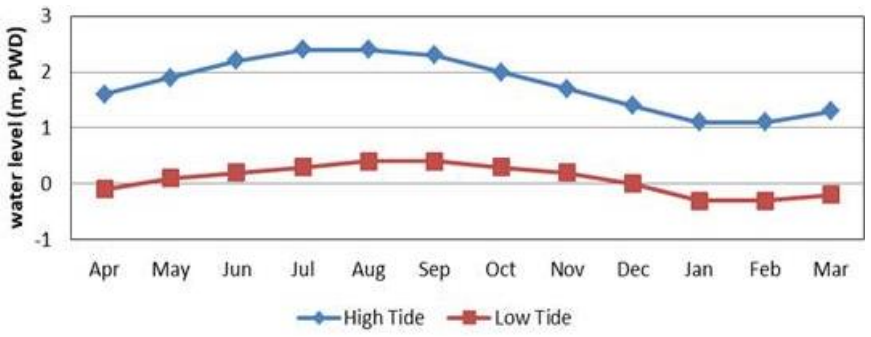


Figure 5.7: Surface water level at Mirjaganj (Payra River)

Ground Water

The observation well of BWDB at Patuakhali Sadar (PAT003) has been considered for investigating the monthly variations in Ground Water Table (GWT).

The station is located inside the polder area. Monthly average data on GWT from 1973 to 2013 have been analyzed and shown in Figure 5.8. The monthly variation pattern shows that GWT is the highest during August-September and the lowest in March. *Source: BWDB, 2015*

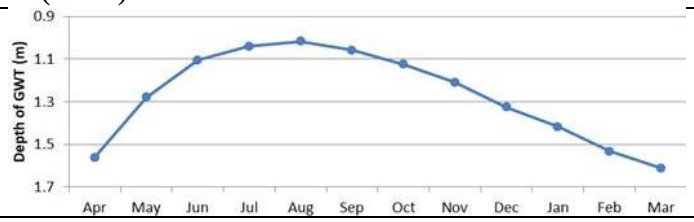
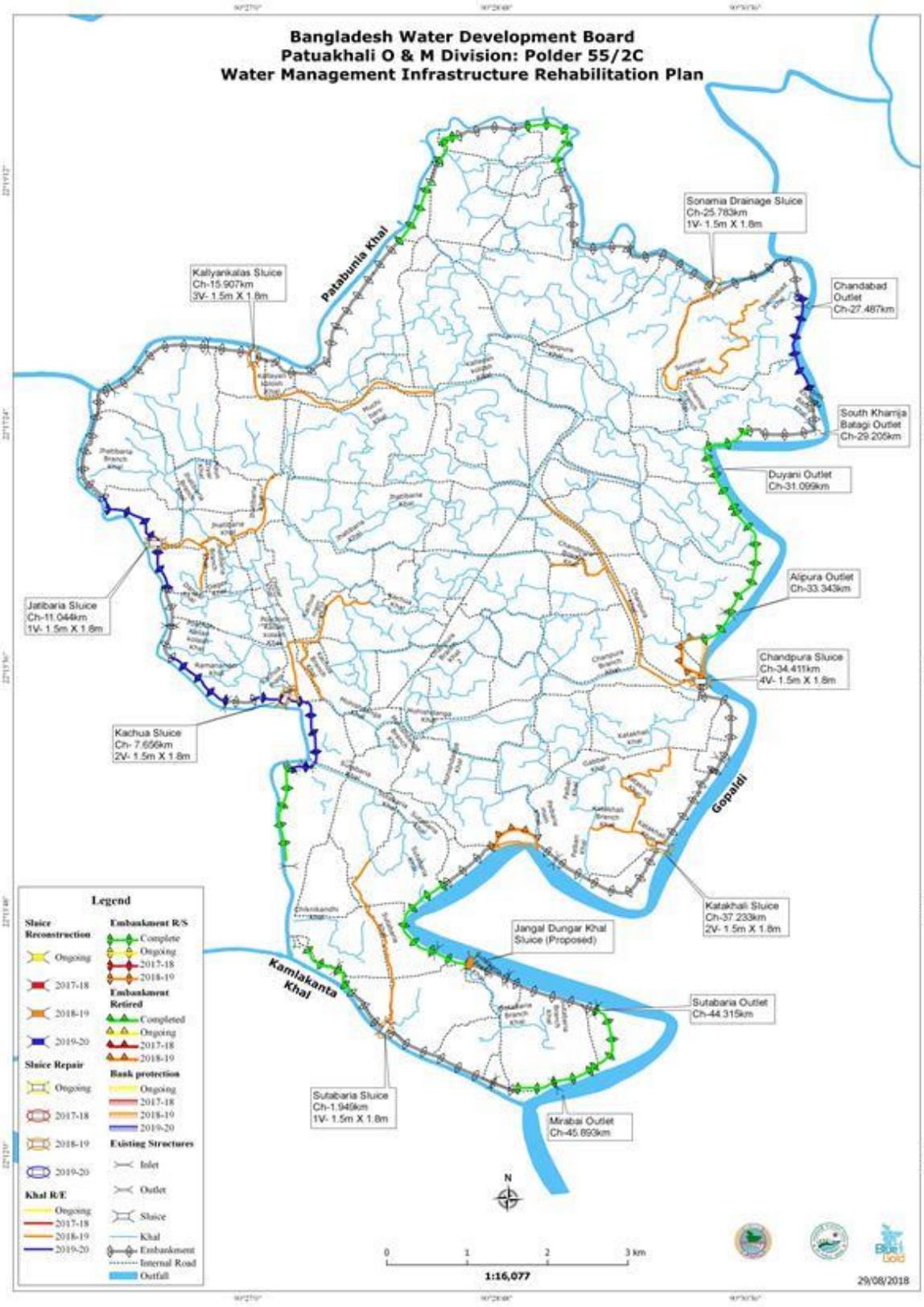
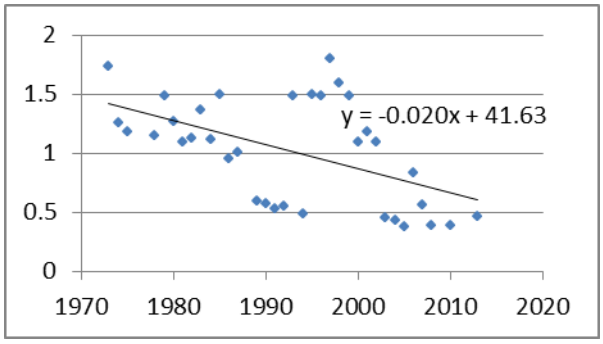


Figure 5.8: Average monthly variations of GWT

Analyses have also been made to understand the long term annual variations of GWT from 1978 to 2013 at BAG001 station, for the month of March (driest period) and August-September (wettest period). The values are presented in Figure 5.9 and 5.10. A mild decreasing trend of annual GWT variation is observed in both cases.



Map 5.3: Water resources system of the study area



Source: BWDB, 2014

Figure 5.9: Variation of GWT at PAT003 in August (1973-2013)

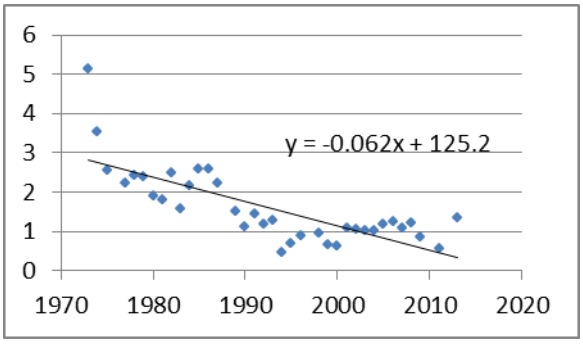


Figure 5.10: Variation of GWT at PAT003 in March (1973-2013)

5.1.14 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 liter/person(lpc) (Ahmed and Rahman, 2010). However, the actual status of drinking water status in some of the coastal polders is not upto the standard or to some extent, poor. During field survey in Polder 55/2C, it was found that the average daily domestic use of water was around 35 lpc, which is slightly better than those of the other adjacent coastal polders studied in the first phase of Blue Gold Program. The study found that around 590 m^3 of water is consumed daily by the total number of 26,510 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 or house hold uses, surface water sources are used. Overall, water availability in Polder 55/2C is not a major concern as local people claimed that they have sufficient surface and groundwater sources to meet up their daily need of drinking and domestic purposes.

Irrigation Use

The local farmers in Polder 55/2C practice Lt. Aus in Kharif-I (March-June) season, HYV Aman and Lt. Aman in Kharif-II season (July-October) and some other crops (HYV Boro, mungbean, chili, khesari, groundnut, watermelon) in Rabi (November-February) season. The rain fed irrigation is sufficient during Kharif-I and Kharif-II seasons for Lt. Aus, HYV Aman, and Lt. Aman crops, whereas surface water irrigation is provided for wheat, watermelon and mungbean crops during Rabi season. Water is also required for other rabi season crops such as khesari and sesame, but no surface water irrigation is needed for these crops as sufficient soil moisture is available during the season.

Previous studies of CEGIS have inferred that around 300 mm of water per ha is usually required for each ha of areas of Aus and Aman cultivation. For mungbean, khesari, watermelon and other *Rabi* season crops practiced in the area required around 200 mm of water per ha area. Using these pragmatic standards of water requirements, the study infers that approximately 1.32 Mm^3 of water would be required during Rabi season to ensure effective irrigation. The surface water irrigation coverage is around 57% of the NCA of the Polder 55/2C and local people claimed that the low water availability marked by reduced water carrying capacity of khals, and poor functioning of water control structures are the major reasons for which more areas cannot be irrigated during the Rabi season. However, for HYV boro, the amount of water required is relatively high, as it has been found that in clay soils, approximately 1500 mm water is required for irrigating each ha of area. Local farmers do not need surface water irrigation for practicing HYV Aus and LT Aman as rain water availability is sufficient enough. For irrigation of HYV boro, approximately 3.13 mm^3 of water is used each year. This amount of water for boro irrigation is taken from the existing surface water system of Polder 55/2C using several irrigation canals and LLPs.

Table 5.6: Irrigation water requirements in Polder 55/2C

Season	Lt. Aus (ha)	Lt. Aman (ha)	HYV Boro (ha)	Khesari (ha)	Watermelon and Mungbean (ha)	Water requirement (mm/ ha)	Water Used (Mm3)	Type of irrigation
Kharif-I (Mar - Jun)	474	-	-	-	-	300	0.91	No supplementary irrigation is required as rainwater is sufficient
Kharif-II (Jul - Oct)	-	3954	844	-	-	300	3.48	No supplementary irrigation is required as rainwater is sufficient
Rabi (Nov – Feb)	-	-	-	742	-	200	0.56	No irrigation is provided as existing soil moisture is sufficient
	-	-	-	-	1727	200	1.32	Surface water irrigation in 660 ha areas is provided using LLP and other traditional methods

Source: Estimation, June 2019

5.1.15 Water Resources Functions and Problems

The following sections point out the status and other phenomena of different water resources functions and problems in the polder area. The water resources functions and problems were identified by the study team during their field investigation in September 2019.

Tidal Flooding

Local people of Polder opined that the peripheral embankment effectively protected the polder area from tidal flooding. As such, no tidal flooding occurs inside the polder. However, the tidal floodplains outside the polder are often flooded during the period of high tide, and in monsoon, high tidal water levels reach up to a level of around 2~3 m below the crest level of the peripheral embankments. During public consultation the entire polder area is found to be free from tidal flooding.

Drainage Congestion and Water Logging

IN many art of the Polder 55/2C, drainage congestion within the polder were observed due to khals silted up heavily and water control structures, Regulators and sluices are not in full operation due t lack of repair maintenance for long time. The khals within the polder area are not properly carrying and draining out water from the polder.

Navigation

The peripheral Golachipa River of Polder 55/2C is predominantly used for waterway navigation. Large launches and streamers carrying passengers navigate through the river towards Patuakhali, Barisal (Golachipa). However, negligible navigation takes place inside the polder, only small fishing boats are found to navigate through the internal khals.

Erosion and Accretion

The polder is mostly morphologically stable, except few pocket area. During field investigation of the study team in September 2019, it has been observed minor erosion has been going on in Modhupura, Sutabaria, Ronua Bazar and Alipura sluice areas. No severe erosion hotspots around the polder was noticed or reported.

5.2 Biological Environment

5.2.1 Farming practices

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

rice both local and HYV and some vegetables are grown in this season under rainfed condition. Farmers also provide supplementary irrigation to HYV T aman crops under water stressed situation.
The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield. Wide ranges of crops are grown in this season. In this polder area, irrigated HYV Boro rice, sesame and vegetables are grown. Irrigation is given by Shallow Tube Wells (STW) and Low Lift Pumps (LLPs). There are occasional overlaps of growing seasons because of varying length of crop duration. T. Aman becomes late prolonging to Rabi season. Sometimes rabi crops are also delayed and extends to Kharif-1.

5.2.2 Cropping pattern by land type

The most prominent cropping pattern is Fallow-Lt. Aman- Mung bean which is practices in 26% of the NCA. The next dominant cropping pattern is Lt. Aus-Lt. Aman- Mung bean/Kheshari which is practices in 18% of the NCA. 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 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
Medium High Land	Fallow	Lt. Aman	Mung bean	1,126	26
	Lt. Aus	Lt. Aman	Mung bean/Kheshari	779	18
	Fallow	Lt. Aman	Watermelon	693	16
	Fallow	Lt. Aman	Fallow	390	9
	Fallow	Lt. Aman	Khesari/Felon	433	10
	Fallow	Lt. Aman	Chilli	346	8
	Fallow	Lt. Aman	Potato	303	7
	Fallow	Lt. Aman	Groundnut	130	3
	Fallow	Fallow	HYV Boro	130	3
			Total	**4,330**	**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		Aus	
	Local	HYV	Local	HYV	Local	HYV
1	Sarnamasuri, Kalamadari, Karangal, Dudkalam, Kajalshail, Balashar mota	BRRI dhan 30, BRRI dhan 31 and BRRI dhan 35	nil	BRRI dhan28, Hera 2, BINNA dhan-10 and Taj	Kalishaitta, Kalamota	nil

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

Photo 5.1: View of HYV Boro rice crops in the polder area

5.2.3 Cropping intensity

Total cropped area is about 8,747 ha of which the coverage of rice is 60% and non rice is 40%. The single, double and triple cropped area is 10%, 78% and 12% of the NCA respectively. Therefore, cropping intensity of the polder is about 202%.

5.2.4 Crop production

In the polder area, the annual total crop production stands at about 20,691 tons of which 8,291 tons of rice and 12,401 tons of non-rice crops. Contribution of rice about 40% and non-rice is about 60% of total production. Among the rice, the contribution of Boro rice 21%, Lt. Aman 71% and Lt Aus 8%. 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 crop production is about 805 tons in 725 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 (ton)	Production Loss (ton)	Production (%)
		Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)			
Lt. Aus	474	474	1.4	-	-	664	-	8
Lt. Aman	3954	3551	1.6	403	0.5	5883	443	71
HYV Boro	844	720	2.25	124	1	1743	155	21
Total rice	5272	4745	-	527	-	8,291	598	40
Mungbean	1092	1092	0.9	-	-	983	-	8
Kheshari	742	708	0.5	34	0.2	354	10	3
Watermelon	635	581	15	54	13	8715	108	70
Chilli	546	490	0.7	56	0.2	343	28	2
Potato	278	266	7	12	3	1862	48	15
Groundnut	222	180	0.8	42	0.5	144	13	1
Total non-rice	3515	3317	-	198	-	12,401	207	60
Grand Total	8,787	8,062		725		20,691	805	100

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

5.2.5 Local price of the crops

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

Table 5.11: Local market price of different crops

Sl No.	Name of the crops	Local price (Tk/ton)
1	T Aus	5,000
2	Lt Aman	5,300
3	HYV Boro	5,000
Sources: Farmers interviewed, March, 2019		

5.2.6 Inputs use

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

Seed

The seed rate used by the farmers in the polder area is presented in Table 5.12. 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
Aus	45	40
Lt Aman	40	40
Boro	45	40
Mung bean	24	25
Kheshari	45	40
Potato	1400	1500

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.

Table 5.13: Labor used in the polder area

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.

Crop name	No. Labor and rate	Labor wages / day (Tk)	
		Male	Female
Boro	140	350	200
Lt Aus	130	200	160
Lt Aman	110	200	160
Mung bean	140	350	200
Kheshari	100	200	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
Aus	150	60	70	20	10	0	0	141	22	20	8	2
Lt Aman	130	0	40	10	0	0	0	97	14	17	0	0
HYV Boro	180	0	120	70	50	0	0	272	44	58	17	4
Khasari	100	0	15	0	0	0	0	21	17	20	0	0
Mungbean	0	45	20	10	0	0	45	67	20	0	0	0

Sources: Farmers interviewed,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.**
Aus	1	300
Lt Aman	0	0
HYV Boro	2	700
Khasari	0	0
Mungbean	2	1600

Sources: Farmers interviewed, May, 2019;

5.2.7 Integrated Crop Management (ICM)

Recently, Integrated Crop Management (ICM) is practiced in many places of the polder area. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo

etc. to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. 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.

5.2.8 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 450 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)	Charge (tk/ha)	Irrigated area (ha)	Charge (tk/ha)
Boro	343	8,000-9,000	124	5,500-6,500
T aman in booting stage (few area)	67*	8,000-9,000	0	4,500-5,000

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

5.2.9 Crop Production Constraints

The following constraints on crop production have been identified through our visit and group discussions with the local farmers and field level officials of the Department of Agricultural Extension (DAE):

- Drainage congestion during transplanting period in Aman season;
- Sea level risedue to climate change has caused natural calamities such as tidal surge, cyclone etc.
- Severe scarcity of irrigation water during dry season especially for rabi crops cultivation; and
- Rise of the bed of different internal drainage khals for siltation.

Above situations are unfavorable for crop production.

5.2.10 Fish Habitat

Polder 55/2C is located in Dashmina and Galachipa Upazila. The polder is surrounded by a tidal river namely, the Lohalia River on the east and north direction, the Shuddurbaria khal on the south portion and the Naotana khal along the north direction. These water bodies are tidal in nature having potentials habitats for saline and brackish water fish species. However, fish habitats of the Polder 55/2C and its adjacent area are primarily classified under two broad categories, such as capture and culture fishery. Capture fisheries habitats include peripheral river, tidal floodplain, intertidal floodplain and internal khals. The open water fish habitats of the area are mainly khals which are acting as major arteries of fish migration into the polder area. These are playing vital roles in maintaining fisheries productivity of the open water fish habitats inside the polder area. The culture fishery of the polder area is dominated by culturable fish pond.

Capture Fisheries

The estimated fish habitat area is 586 ha where culture fishery contributes the major share (436 ha) and the capture fish habitat shares the rest.

Table 5.17: Fish habitat status in the polder area

The open water fish habitat is represented by khal alone shown in the **Table 5.17**. The peripheral rivers and tidal floodplainof the polder area are not been considered in the study for estimating fish production.

SL. No	Fishery Category	Habitat Type	Area (Ha)
1	Capture	khal	150
		Sub-Total=	***150***
2	Culture	Culturable pond	*296*
3		Cultured pond	*140*
		Sub-Total=	***436***
		Grand Total=	**586**

Source: Field survey data, 2017

Among the khals Mirer khal, Chear khal, Patabunia khal, Dhaniapura khal, Zamir Mridah khal, Lalar khal, Hashkhali khal are playing important role as fishery habitat. The depths of these internal khals are is found suitable for the habitation fish species particularly during dry season in the low tide situation. Some of the khals are encroached by the local people and are using for culture fishery by developing barriers through net. Photo 5.10 shows the internal khals of the polder area.

Culture Fisheries

Aquaculture has an increasing trend in the polder area. Estimated area under cultured pond and culturable pond is about 436 ha (**Table 5.17**). Among the culture fish habitat culturable pond is 296 ha and cultured fish pond is 140 ha. Cultured pond is perennial while culturable pond is seasonal where water retains for six to seven months. Nevertheless, various types of fish culture systems are practiced by the local people including mono, poly, and mix-culture. It is reported that almost every household have a pond which is used as fresh water reservoir cum fish culture.There is no shrimp/prawn gher in the polder area. Fish pond of the polder area is shown in **photo 5.2**.

Perennial khal

Silted up khal

Photo 5.2: Open water fish habitat (khal) in polder area

Loss of open water fish habitat

The open water fish habitat especially khal habitat is gradually decreasing. Local people reported that about 30% of the perennial internal khal has been converted into seasonal khal where little water is observed in the dry season. Even some of the seasonal khals seem to be agriculture land. The main causes of reducing such fish habitat are siltation, topsoil erosion, decomposition of excessive duck weed, encroachment of khal by the local people for agriculture land and fisheries culture practices. For this which reason, spawning and grazing ground of the resident fish species are being damaged and thus capture fishery in the polder area is declining with time.

Siltation is one of the major problems of the khals to make the habitat unsuitable for fishes. This phenomenon is more pronounced at the entry of the sluice gate and impedes the fish migration. For which, this habitat cannot function as spawning ground of the resident fish species and thus capture fishery is declining with time.

Fish Habitat Quality

Some surface water quality parameters which are related to fish habitat suitability were measured and presented in Table 5.18**.**From the table is it found that pH values slightly high but within the limit of suitable for fisheries while water temperature is slightly low than the standard values for fish. The reported low temperature is due to variation of seasonal temperature. It is mentionable that the water quality was measured in winter season. Dissolved Oxygen (DO) values are found within the permissible limit for fish and aquatic biota habitation.Total dissolved solids (TDS) or turbidity in all water bodies is recorded and found low but within the permissible limit for fish. The salinity value of both river and khal is nil (in winter season) which is suitable for fresh and brackish water biota. However, aquatic environmental quality is satisfactory in the study area.

Table 5.18: Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	Temp (ºC)	pH	DO (mg/l)	TDS (ppm)	Salinity (ppt)
Khal	26.5	7.81	4.5	128	0
Standard values for fish	(28-34)**	(6.5-8.5)*	4.0-6.0*	1000*	(0-4) for prawn and (5 -35) for shrimp**

*Source - *M A. Mazid 2002 ** Jack M. et al, 2002; Water quality measured January,2017*

Photo 5.3: Culture fish pond the polder area

Photo 5.4: Present condition of fish habitat

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 along with other insects and crustaceans. So, low abundance of hydrophytes may harm to fish breeding and production. In wetland, some fishes lay eggs in the body of plants. Beside these, some fishes 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. 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. Moreover, Shapla (*Nymphaea nouchali / N. stellata*) , Chandmala (*Nymphoides* sp.) are top frequent rooted floating plants available in the ponds and khals. Sedges and meadows plants consist of amphibian plants. This type has the highest species diversity and is one of the most important wetland plant communities in the polder area.

Fish productivity and Production

The fish productivity rate in the khals is 130 kg/ha which is comparatively lower than that of the national productivity. The main reason of low productivity are reduction of water depth due to siltation, fishing by sluice net, obstruction of fish hatchling movement during pre-monsoon and monsoon due to improper management of sluice gates. The productivity of culturable and cultured pond is also low. Low production of culture fish is due to lack of seed and feed, and lack of training of modern fish culture.

Table 5.19: Fish productivity of the Polder area

Nevertheless, aquaculture practicing is increasing significantly in the polder area.The fish productivity of the polder area is presented in Table 5.17.

Fishery Category	Habitat Types	Productivity (kg/ha)
Capture	Khal	130
Culture	Culturable pond	1400
	Cultured pond	2200

Source: Field Survey, 2017 and Professional Judgment

The estimated total fish production of the polder area is about 742 tons. Culture fisheries contribute bulk portion of the fish production (about 97%) followed by capture fishery. Fish production in the polder area is shown in Table 5.20.

Table 5.20: Fish production from different habitats of the study area

Sl. No	Fishery Category	Habitat type	Production (MT)
1	Capture	khal	20
		Sub-Total=	**20**
2	Culture	Culturable pond	414
		Cultured pond	308
		Sub-Total=	**722**
		Grand Total=	**742**

Source: Estimation based on field survey, 2017

Fishing Effort

Fishing Season

Fishing in the khals and the peripheral rivers continues throughout the year but more catch of fishes starts in April / May and continues up to December. The seasonality of major fishery is furnished in the **Table 5.21.**

Table 5.21: Fishing seasonality in 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)																						
Dhela jal/net jal (Push net)																						
Jhaki jal (Cast net)																						
Shuti jal (Siene 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 polder area catch fish in the peripheral rivers and internal khals by using mechanized boat, Kosha and Dingi fishing boats etc. Fishing boat in the polder area is shown in **Photo 5.10.**

Fishing Gears

Different types of nets/gears are used for fishing: (a) Mono filament net, locally known as Current jal is used to catch poa, chingri, tengra, gulsha, and koi fish;(b) Push net, locally known as thela jal, is used to catch puti, tengra, chingri, etc; (c) Seine net which is used to catch all types of small and big fishes; (d) Cast net, locally known as Jhaki jal is used to catch puti, bagda, golda, phasa etc. (e) Sluice/Dip net locally known Sluice jal is found at the mouth of sluice gate to catch all types of fishes. Around 15% of fishermen have fishing boats and around 80% fishermen have fishing gears/nets. Traditional fishing gears of the polder area i.e. cast net (Jhaki jal) is shown in the following photo 5.6.

Photo 5.5: Fishing boat (Kusa) in polder area

Photo 5.6: Photo showing fishing and gear (Jhaki jal) in polder area

Fish Migration

Fish generally migrate from one habitat to another for breeding, feeding or sheltering purpose. Many fish species migrate horizontally to these water bodies as part of their life cycle. The internal khal acts as longitudinal fish migration route in the polder area. The present fish migration condition of the khal is not satisfactory because migration route is deteriorating due to raising of its bed by sedimentation. Fish migration of brackish water fish species like *tengra, gulsha, persa, bata, chingri, Baila* etc. in the study area usually occur during high tide. 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 improper management and mal-functioning of the water regulatory structures, fishing by net and inactive of the Water Management Organizations (WMOs).

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 more than 90 fish species are found in the area. The study area comprises an assemblage of both fresh and brackish water fish species (**photo 5.7**). 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.

Photo 5.7: Composition of fish catch in polder area

List of fishes of different habitat in the study area are presented in **Table 5.22.**

Table 5.22: Indicative fish species diversity of different fish habitats in the study area

Scientific Name	Local Name	Habitat type		
		Peripheral River	Khal	Pond
Brackish water fish species				
Metapenaeus monocerus	*Horina Chingri*	H	L	NA
Penaeus monodon	*Bagda chingri*	M	L	L
Harpodon nehereus	*Lottiya*	L	NA	N/A
Lates calcarifer	*Koral/Bhetki*	M	L	N/A
Setipinna paasa	*Phasa*	M	L	N/A
Trypauchen vagina	*Sada Cheowa*	H	L	NA
Apocryptes bato	*Chiring*	M	M	NA
Tenualosa ilisha	*Ilish*	H	NA	NA
Mystus gulio	*Guila Tengra*	H	L	L
Sillaginopsis panijus	*Tular Dandi*	M	NA	NA
Liza parsia	*Pairsa*	M	NA	NA
Pangasius pangasius	*Pungus*	L	NA	NA
Pama pama	*Poa*	L	NA	NA
Polynemus paradiseus	*Topse*	L	NA	NA
Macrobrachium rosenbergii	*Golda chingri*	L	L	L
Scylla serrata	*Kankra*	L	M	L
Fresh water fish species				
Puntius chola	*Chola puti*	L	M	M
Channa punctatus	*Taki*	NA	H	L
Glossogobius giuris	*Baila*	H	M	L
Channa striatus	*Shol*	NA	M	L
Mystus vittatus	*Tengra*	M	H	L
Mastacembelus pancalus	*Chirka baim*	M	M	NA
Macrognathus aral	*Tara baim*	NA	M	L
Chanda spp	*Chanda*	NA	M	NA
Wallagu attu	*Boal*	L	L	NA
Clarius batrachus	*Magur*	NA	L	NA
Aorichthys seenghala	*Guijja Ayre*	L	NA	NA
Puntius sophore	*Jat puti*	L	M	L
Eutropiichthys vacha	*Bacha*	M	NA	NA
Lepidocephalus guntea	*Gutum*	NA	M	L
Channa marulius	*Gojar*	NA	N	NA
Culture fish species				
Labeo rohita	*Rui*	L	L	L
Catla catla	*Catla*	L	L	L
Oreochromis nilotica	*Telapia*	NA	L	H

Scientific Name	Local Name	Habitat type		
		Peripheral River	Khal	Pond
Puntius sarana	*Sharputi*	NA	L	L
Pangasius suchi	*Pungus*	L	NA	H
Hypophthalmichthys molitrix	*Silver Carp*	NA	L	H
Hypophthalmichthys nobilis	*Brig head*	NA	L	H

Source: Field Survey, 2015; Note: Abundance, H= High, M= Medium, L= Low and NA=Not Available

Fresh water fish species e.g. *Rui, Catla, Ayre* are commonly found in the internal khals. Now there abundance is in the decreasing trend. Almost 80% production from species have been declined due to reduction of water depth in the khal and damaging of fishing ground due to siltation, obstruction of fish hatchling movement during pre monsoon and monsoon. Plenty of fisheries species like Golda*Chingri, Kathali Chingri, Goda Chingri* were found in the last decade in all habitats of the polder area. It is now hardly found only in the perennial khal and their abundance is negligible. This may be due to the presence of less salinity in the water bodies, obstruction of fish migration route, indiscriminate fishing by slice net, and construction of closure. The dominant cultured fish species include Tilapia, Bighead, and Silver carp in the polder area which contribute 80% of the total culture fish production. Besides, Pungus and Thai sarputi are also cultured commercially in the polder area. The culture of *Rui* and *Catla* in the fish pond is very low in the polder area.

Threatened fish species

Threatened fish species which are locally rare and unavailable for last (10-15) years as reported by the local fishermen and concerned elderly people are given in Table 5.23. The *Golda Chingri, Kathali Chingri, Goda Chingri, Bagda Chingri, KoralVetki* are presenting not available due to decreasing of salinity and surrounding water bodies of polder, obstruction of fish migration route, indiscriminate fishing by sluice net. Depth water preferable fish species like *Ayre* is in the decreasing trend due to declining of water depth and deterioration of water quality due to decomposition of duck weed, pesticides coming from *Rabi* crop (water melon) field; and obstruction of fish hatchling due to improper and irregular operation of water control structures.

Table 5.23: List of threatened fish species

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Lates calcarifer	*Koral*		√
Paradise threadfin	*Ramchos/Tapose*	√	
Aorichthyes aor	*Ayre*		√
Peneous monodon	*Bagda*		√
Macrobrachium rosenbergii	*Golda Chingri*		√
Macrobrachium dolichodactylus	*Goda Chingri*		√

Source: Field Survey, 2017

To conserve the threatened fish species**,** the perennial khals like Noatana Khal, Katakhali Khal, Durlob Khal, Gagonkhati Khal, Dholkhali Khal, Suddurbaria Khal, Moubaria Khal where water retain throughout the year can conserve the fish breeding for the following year. Fish sanctuaries in the closed perennial khal can be constructed in the deep pool area. Moreover, illegal fish catch and unauthorized use of gear should be banned. Proper gate operation during fish migration period should be ensured. Integrated Pest Management (IPM) instead of using pesticides in the crop land should be introduced throughout the polder area.

Fisheries Management

There is no active Community Based Fishers Management (CBFM) in the polder area. Department of Fisheries (DoF) has taken a project namely IAPP (Integrated Agricultural Productivity Project) funded by the World Bank. The main objective of this project is to ensure food security through motivation of culture fisheries adopting advanced culture system both in mono-sex Tilapia and mix culture of carp species. There is no community based fisherman association. The activities of fisherman association for working along with WMA/WMO of the polder are totally absent. The fishermen have full fishing right on existing fish habitats. Department of Fisheries (DoF) has limited activity for fisheries resource conservation and management in this area. Every year, they arrange training in upazila and union level training program for the fish farmers on modern fisheries. Some NGOs Grameen Bank, ASA, BRAC etc. are working, but their activities are very much limited in micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation is weak inside the polder area.

5.2.11 Bio-ecological Zone

IUCN- the World Conservation Union has identified 25 bio-ecological zones (Nishat *et al*, 2002) in Bangladesh. The aspects of these zones are primarily centered on physiographic, climate, soil type, flooding depth and biodiversities. These bio-ecological zones can be classified as the major ecosystems of the country. The polder area encompasses one of these bio-ecological zones; namely the Ganges Floodplain.

Ganges Floodplain

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

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

5.2.12 Terrestrial Ecosystem

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

a. Homesteads
b. Crop fields
c. Roads and embankment

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

a. Terrestrial Flora

Settlement/Homestead Vegetation

Homestead vegetation is the major type of terrestrial flora of the polder area. Most of the homestead vegetation consists of fruit bearing plant, timber trees and medicinal plants. The homestead vegetation is also important place for wildlife. Local people reported that, most of the household are vegetated by local plant such as, Kola (*Musa sp*.), Tal (*Boassus flabellifer)*, Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), Suparee *(Areca catechu*), Bansh (*Bambusa*Sp.*)*, Peyara *(Psitium guajava)* and the exotic plants Akashmoni *(Acacia moniliformis*), Mehagoni (*Sweitenia mahogoni*), Eucalyptus (*Eukalyptus citriodora*), etc and a small portion of the coverage is occupied by wild shrubs and herbs. According to the vegetation survey, several tree species are present in different canopy layers and their composition is similar throughout the polder area. Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), Suparee (*Areca catechu*) occupied the top canopy. Other wild shrubs and herbs occupy the lower canopies. Among this type, Akand (*Calotropis procera*), Vaant/Bhat (*Clerodendron viscosum*), Hatisur (*Heliotropium indicum*), Dudhikalmi (*Ipomoea alba*) are common.The major tree species of homestead vegetation are shown in table 5.24.

Table 5.24: List of plant species found in the homestead of the polder area

Local/English Name	Scientific Name	Abundance
Chalta	*Dillenia indica*	H
Kola	*Musa sp*	H
Akasmoni	*Acacia auriculiformis*	M
Kalo Koroi	*Albizia lebbeck*	H
SadaKoroi /Sil Koroi	*Albizia procera*	H
Chambul/Raj Koroi	*Albizia richardiana*	H
Supari	*Areca catechu*	H
Kanthal	*Artocarpus heterophyllus*	L
Eucalyptus	*Eucalyptus camaldulensis*	L
Kotbel	*Limonia acidissima*	M
Sisoo	*Dalbergia sissoo*	M
Aam /Mango	*Mangifera indica*	M
Khejur /Date Palm	*Phoenix sylvestris*	H
Khoiya Babla	*Pithocelobium dulci*	M
Peyara/Guava	*Psitium guajava*	M
Raintree	*Samanea saman*	H
Amra	*Spondias dulcis*	M
Mahogoni	*Swietenia macrophylla*	H
Tetul	*Tamarindus indica*	M
Kul	*Ziziphus mauritiana*	M
Jamrul	*Syzygium samarangense*	M
Kodom	*Anthocephalas chinensis*	M
Krisnachura	*Delonix regia*	L
Bamboo/Bash	*Bamboosa spp.*	M
Tal	*Boassus flabellifer*	H
Shimul	*Bombax ceiba*	M
Jambura	*Ciitrus grandis*	L
Narikel/Coconut	*Cocos nucifera*	H

Source: CEGIS field survey, 2015 (Note: Abundance Code, H= High, M= Medium, L= Low)

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

Crop field vegetation

Verities of crops and cropping patterns have been discussed in the agricultural section of this report. The net cultivated area in the polder area is more than 4,330 ha. Land is used mainly for Lt Aman in rain feed condition in kharif –II season, in kharif-I season there are few Lt Aus and in rabi season farmers grow HYV Boro, mungbean, Groundnut etc. Verities of crops and cropping patterns have been discussed in the agricultural section of this report.

A part of crop fields being seasonal (March-June) fallow for 3 to 4 months of a year. During this time the land covers with grassy vegetation and other wild herbs. Durba (*Cynodon* sp.*)* is prevalent with *Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus and Paspalum* spp. 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 grazing ground for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna.

In cropland, some floras which are found along with crops and which are not cultivated, called agricultural weeds. The weeds have important roles in terms of ecosystem those contribute to the ecosystem functionality. The dominant cropland's wild species in this polder area are Hatisur (*Heliotropium indicum*), Bothua Shak (*Chenopodium album*), Durba Gash (*Cynodon dactylon*), Biskantali (*Polygonum* Sp.), Thankuni (*Centella asiatica*), etc.

Embankment /Village Road and Bank side vegetation

Major species in village roads found are: Tal (Boassus flabelifer), Narikel (*Coccos nucifera*), Suparee (*Areca catechu*), Khejur (*Phoenix sylvestris*) etc. Akand (*Calotropis procera*), Vaant (*Clerodendron viscossum*) and Hatisur (*Heliotropium indicum*) are common wild shrubs and herbs sighted along most of the roadsides.

Riverside embankment is exclusively dominated by Babla *(Acacia Arabica)*, Sirish (*Albizia odoratissima)*, Chambul/Rajkoroi *(Albizia richardiana)*, Kola *(Musa sp)*, Bash *(Bamboosa spp).*Vegetation of this type supports good habitats for local avifauna.

There is another type of vegetation found along the riverand khals bank side of the polder area. Different types of marginal herbs like Narikel (*Coccos nucifera*), Dholkolmi (*Ipomoea aquatic*), Bishkatali (*Polygonum sp*.), Mutha gash (*Cyperus sp*), Kasorti (*Eclipta sp*) etc. are dominant in the river and khal banks. A list of plant species found in the embankment/roadside of the polder area is shown in table 5.25 below.

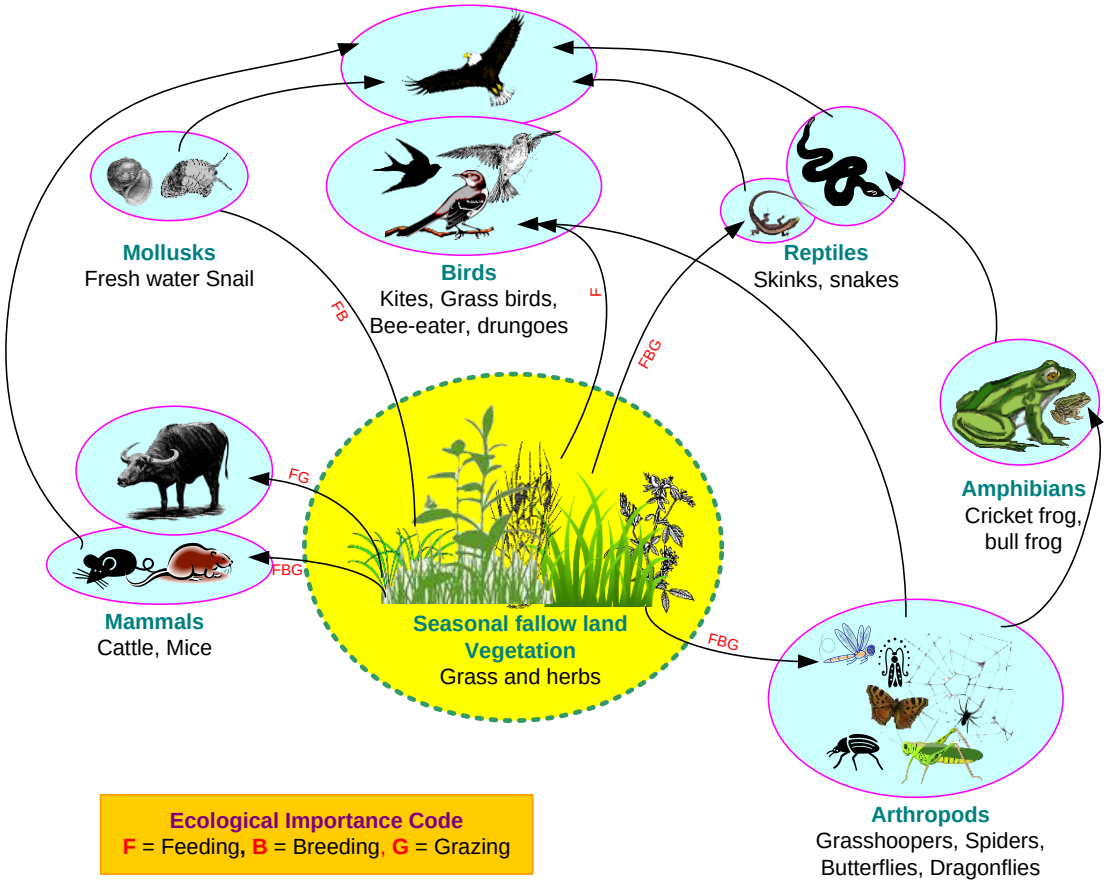


Figure 5.11: Ecological importance of seasonal fallow land's vegetation for different faunal communities along with partial food web

Table 5.25: List of plant species found in the embankment/roadside of the polder area

Local/English Name	Scientific Name	Abundance
Akasmoni	*Acacia auriculiformis*	M
Babla	*Acacia nilotica*	H
Kala Koroi	*Albizia lebbeck*	H
SadaKoroi /Sil Koroi	*Albizia procera*	H
Chambul/Rajkoroi	*Albizia richardiana*	H
Tal	*Boassus flabellifer*	H
Narikel/Coconut	*Cocos nucifera*	H
Sisoo	*Dalbergia sissoo*	M

Jiga	*Lennea coromandelica*	M
Ghora Neem	*Melia azedarach*	M
Khejur /Date Palm	*Phoenix sylvestris*	M
Khoiya Babla	*Pithocelobium dulci*	M
Raintree	*Samanea saman*	H
Mahogoni	*Swietenia macrophylla*	M
Pitali	*Trewia nudiflora*	L
Kola	*Musa sp*	H
Bash	*Bamboosa spp*	M

Source: Field survey, 2019 (Note: Abundance Code, H= High, M= Medium, L= Low)

a. Terrestrial Fauna

Local people reported that, many diversified terrestrial fauna are found in the polder area. The major terrestrial fauna are different types of mammals, birds, reptiles and amphibians. The major fauna of different species with their habitat is shown in the following Table 5.26.

Table 5.26: List of terrestrial fauna of the polder area

Types of Species	Name (*generic name*)	Habitat
Mammals	Indian Jackal *(Canis aureus)*, Mole Rat *(Bandicota bengalensis)*, Common House Rat *(Rattus rattus)*, Short-nosed Bat *(Cynopterus sphinx)*, Flying fox *(Pteropus giganteus)*, Common mongoose *(Herpestes edwardsi)*, Large Indian Civet *(Viverra zibetha) and* Jangle Cat *(Felis chaus)*	Mostly in bamboo thickets, cropped fields or broken, bushy areas.
Avifauna	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. Birds of prey survive well in the area. Common bird of prey species found in the polder area are Brahminy Kite (*Heliastur indus*). Other common bird species in the polder 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*), Large-billed crow (*Corvus macrohynchos*)	All types of vegetation
Reptiles	Common Vine Snake *(Athaetulla nosuta)*, Common Wolf snake *(Lycodon aulicus)*, Common Grass Skink *(Mabuya carinata)*, Stripped Keelback *(Amphiastma stolatum)*, Kal Keotey/ Common Krait*(Bungarus caeruleus)*, Gui Sap/Bengal Monitor(*Varanus bengalensis*),Spotted Pond Turtle (*Geoclamys hamiltonii)*, Garden Lizard *(Calotes versicolor)*,and House Lizard *(Hemidactylus brooki).*	Both wet land and dry areas
Amphibians	Common toad *(Bufo melanostictus)*, Cricket Frog *(Fejervarya limnocharis)*, Jerdon's Bull Frog *(Hoplobactruchus crassus)*	Wetland areas & the dried areas

Source: Field survey, 2019

5.2.13 Aquatic ecosystem

The wetland is an important aquatic ecosystem of this area. It contains rich varieties of flora and fauna and mostly provides food and habitat to the aquatic fauna. Aquatic ecosystem of the polder area includes rivers, homestead ponds and khals. Most of the wetlands, especially khals were found risky due to siltation. For this reason, these types of wetlands having no water in dry season but totally changes the scenario is changed in wet season, when water flows on khals, creates drainage congestion. The wetlands are divided into two major categories; seasonal and perennial wetlands.

Seasonal wetland holds water for 3 to 4 months and is usually flooded during rainy season. Seasonal wetland mainly creates floodplains and important grazing ground for the fishes.

Perennial wetland contains water throughout the year. Perennial wetlands are good shelters for most of the aquatic flora & fauna. Homestead ponds and khals are the perennial wet lands of the polder area.

a. Aquatic flora

Within the polder area ponds and khals contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows. A list of plant species found in wetland of the polder area is shown in following Table 5.27.

Table 5.27: List of plant species found in the wetlands of the polder area

Local/English Name	Scientific Name	Abundance
Ghechu	*Aponogeton natans*	M
Kutipana	*Azolla pinnata*	H
Kakra	*Bruguiera gymnorrhiza*	L
Kochu	*Colocasia esculenta*	L
Kochuripana	*Eichhornia crassipes*	H
Helencha	*Enhyra flactuans*	L
Chaila gash	*Hemarthria protensa*	M
Jhangi	*Hydrilla verticillata*	M
Nil Kolmi	*Ipomoea aquatica*	M
Khudipana	*Lemna perpusilla*	H
Fern	*Lindsaea ensifolia*	M
Bishkatali	*Polygonum barbatum*	H
Shapla/Poddo	*Nymphaea nouchali Nymphaea stellata*	M
Chandmala	*Nymphoides sp.*	M
Golpata	*Nypa fruticans*	M
Topapana	*Pistia stratiotes*	H
Karanja/Chimti	*Pongamia pinnata*	M
Kuripana	*Salvina cucullata*	H
Bakful	*Sesbania grandiflora*	L
Choila/Ora	*Sonneratia caseolaris*	H
Hogla	*Typha elephantalis*	M
Bicha	*Vallisneria spiralis*	L

Sources: Field Survey 2019. (Note: Abundance Code, H= High, M= Medium, L= Low)

b. Aquatic fauna

The life cycle of aquatic fauna is dependent on seasonal variation as well as inundation depth and availability of water in all types of wetlands. Naturally, wetlands provide food and shelters to the aquatic fauna. A brief description of aquatic fauna is presented below:

Table 5.28: List of terrestrial fauna of the polder area

Types of Species	Name (*generic name*)	Habitat
Avifauna	Little Egret *(Egretta garzetta),* Great Egret *(Casmerodious albus),* Common Kingfisher *(Alcedo atthis),* Little Cormorant *(Phalacrocorax niger*), Grey Heron *(Ardea cinerea),* Indian pond heron *(Ardeola grayii*)	Along mudflats, canal systems and seasonal wetlands
Reptiles	Common aquatic snakes include the checkered keelback *(Xenocrophis piscator),* smooth water snake *(Enhydris enhydris),* Rat snake *(Ptyas mucosus),* and Common wolf snake *(Lycodon aulicus)*	Both wet land and dry areas
Amphibians	Jerdon's Bull Frog *(Hoplobactruchus crassus),* skipper frog *(Euphlyctis cyanophlyctis)*	Wetland areas and the dried areas
During winter, moderate numbers of migratory birds roam along the riverside of the polder. Fresh water Snail and Oyster are also commonly found in all floodplains and even in perennial water bodies.		

5.2.14 Ecosystem Services

UNEP defines that an ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment, interacting as a functional unit. Humans are integral part of ecosystems. Ecosystem services are the tangible and intangible benefits which people obtain. 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 maintenance of 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) from different common plants of the polder areas.

Table 5.29: Tangible ecosystem goods from different common plants of the polder area

Goods/Services/ Purpose	Name of Plants	Plants Parts used by local people
Food	Supari *(Areca catechu)*, Narikel *(Cocos nucifera)*, Aam *(Mangifera indica)*, Jam *(Syzygiumsp)*, Kola (*Musa sp)*, Safeda *(Manilkara zapota)*, Payara (*Psidium guajava)*, Tal *(Boassus flabellifer)*, Amra *(Spondias pinnata)*, Katbadam *(Terminalia catappa)*, Boroi *(Ziziphus jujuba)*,	Fruit
	Ghechu (*Aponogeton spp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana, (*Eichhornia crassipe*), Ipil Ipil (*Leucaena leucocephala*)	Leaf and stem
Timber	Aam *(Mangifera indica)*, Jam *(Syzygiumsp)*, Babla *(Acacia nilotica)*, Mahogany (*Swietenia mahagoni)*, Neem *(Azadirachta indica)*, Akashmoni *(Acacia auriculiformis)*, SadaKoroi /SilKoroi *(Albizia procera)*, Chambul/Rajkoroi *(Albizia richardiana)*, Sisoo *(Dalbergia sissoo)*, Raintree *(Samanea saman)*,	Tree Trunk, Bole
Medicine	Tetul (*Tamarindus indica)*, Tulshi *(Ocimum americanum)*, Sezi/Dudhiya *(Euphorbia antiquoram)*, Bel *(Aglemarmelos)*, JatNeem *(Azadirachta indica)*, Arjun *(Terminalia arjuna)*, Gab *(Diospyros perigrina)*,	Roots, Leaf, Bark, fruit
Thatching and mat making	Supari *(Areca catechu)*, Narikel *(Cocos nucifera)*, Tal *(Boassus flabellifer)*, Hogla/Patipata (*Typha elephantalis*), Golpata (*Nypa fruticans*), Bamboo (*Bambusa spp.)*	leave
Fuel	Babla *(Acacia nilotica)*, Raintree *(Samanea saman)*, Akashmoni *(Acacia auriculiformis)*, Boroi *(Ziziphus jujuba)*, Aam *(Mangifera indica)*, Khoiya Babla *(Pithocelobium dulci)*,	Branches, Leaf
Organic Fertilizer (compost)	Kochuripana (*Eichhornia crassipes*), Topapana (Pistia stratiotes), Khudipana (*Lemnaperpusilla*) and other aquatic plants.	All parts of the pant

Sources: Field Survey 2019 Note: Abundance Code, H= High, M= Medium, L= Low)

5.2.15 Present threats on ecosystem

Terrestrial flora

Local people reported that lack of advance knowledge about homestead plant biodiversity, improper maintenance of embankment and sluice gates and internal canal bed siltation are the main problem in the polder area. Tidal flood and drainage congestion are also the threats for ecosystem sustainability.

Pests and diseases attack, improper homestead space planning, utilization and natural disaster are the other problems.

Terrestrial fauna

Local people reported that Mammals' and poisonous snake population is very low in the polder area due to human settlement, development activities and anthropogenic disturbance. Large mammals have already been disappeared, because of changes in land uses system, jungle cutting and different human activities.

Several species are listed in the IUCN *Red Data Book* of which the species of the polder area are given is the Table below.

Aquatic fauna

The hydrological cycle and the presence of perennial and seasonal wetlands 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 could not adapt with 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.

On the other hand, various types of snail and oyster can also be found in fresh water of khal and river. A fresh water snail is one kind of fresh water mollusk, the other types being fresh water clams and mussels. Specifically fresh water is a gastropod that lives in a watery non marine (fresh water) habitat.

Table 5.30: List of several species in the IUCN *Red Data Book* occurs within the polder area

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

Source: Field survey, 2019 and Red Data Book of IUCN Bangladesh.

5.2.16 Livestock and Poultry Resources

Status of livestock and poultry

Livestock provide significant draft power for crop cultivation and poultry being essential elements of integrated farming system play an important role in the economy of the 55/2C polder area. A large number of populations of the polder area earn their livelihood through work associated with raising

Table 5.31: Status of Livestock/Poultry in the polder area

Livestock / poultry (Cow/Bullock, Buffalo, Goat and Sheep and poultry Duck and Chicken). Livestock resources data were collected from secondary sources from Upazila Livestock Office and from local people through informal discussions with stakeholders and RRA. Detailed status of livestock and poultry are presented in Table 5.31.

Live stock/Poultry	% of household
Cattle/cow/bullock	70
Goat	40
Chicken	90
Duck	70

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

Feed and Fodder

The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to unavailability of grazing land. Aman crops remain in the field during this reason, 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 dry season especially from late December to late April although there is grazing land but exist shortage of grass due to presence of

aus crops in the field and also for salinity which acts as the main barrier for the grasses to grow. Poultry population, duck and pigeon at family level survives by scavenging and generally no feed supplements are provided.

Livestock and poultry diseases

Production 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 the poultry birds. However, there is vulnerable period in between July to October (rainy season) months for spreading diseases to livestock and poultry population. Twenty five pigeon rarer informed that they have not observed any pigeon disease.

5.3 Environmental Quality

5.3.1 Water Quality

Five major water quality parameters (pH, TDS, Temp., DO and Salinity) were measured on-site from four different sampling locations of the polder in January 2015. The samples were collected from different surface water sources (three from outside and one from inside of the polder). The results of the in-situ water quality measurements are shown in Table 5.32.

Table 5.32: Water quality parameters of this study area

Location	Sampling Water Source	pH	TDS (ppm)	Temp. (ºC)	DO (mg/l)	Salinity (ppt)
Noatana sluice	Galachipa River, outside the polder	7.68	184	25.1	5.6	0
Proposed outlet at Durlab Khal	Durlab Khal, inside the polder	7.59	134	26.4	4.8	0
Dolkhali Sluice	Galachipa River, outside the polder	7.65	172	24.3	5.4	0
Moubaria Khal	Galachipa River, outside the polder	7.79	168	25.4	5.8	0

Source: Field survey, January 2017

The pH values were higher than the neutral value (pH=7) which means that the water in these locations are alkaline in nature during January. The polder is situated beside Galachipa River, which is directly connected with the Bay of Bengal. However, the polder is not directly connected with the river. This eventually results in reduced sediment transportation near the polder, for which the values of TDS were found very low. The Values of DO were mostly found close to the standard values set by the DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). Temperature values varied within a typical range for different locations as samplings were made in different time of the day. Furthermore, all samples were found with zero salinity. The local people claimed that no surface water salinity exist in the area in the dry season (December to February). March and April are the only two months where the surface water system outside the polder becomes slightly saline. It can be inferred that due to the increased amount of freshwater discharge from the upstream; Meghna River system towards the rivers of the South Central hydrological region, surface water salinity is very low compared to those of other coastal areas of the country, and for the local people it is not a major concern.

5.4 Climate Change

5.4.1 Climate Science

Rainfall

The variation of rainfall in pre monsoon, monsoon and post monsoon seasons of different representative districts (from different hydrological regions) are shown in Figure 5.12 below. The pre-monsoon and post-monsoon rainfall patterns show increasing trends for all the selected stations.

Patuakhali and Barisal, locations of the south central region, however has very negligible change. It can therefore be concluded that the long term seasonal variations of rainfall in Patuakhali will also be very negligible. Patuakhali data (10 years BWDB data) showed maximum rainfall in June and July 538mm and 586 mm respectively. Yearly cumulative is 2654mm. June, July and August months cumulative rainfall 1621 mm (61% of the annual cumulative)

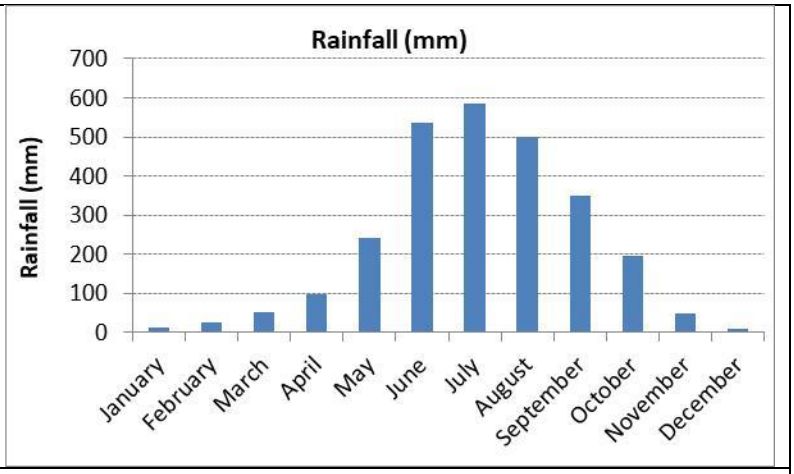


Figure 5.12:Monthly Rainfall Patuakhlai (10 yrs – BWDB data)

Temperature

Max temp recorded in themonth of May 34.6 ^{0}C and minimum temp in the mpnth of January 13 ^{0}C, indicated May is the hottest amnd January is the coolest month of the year.

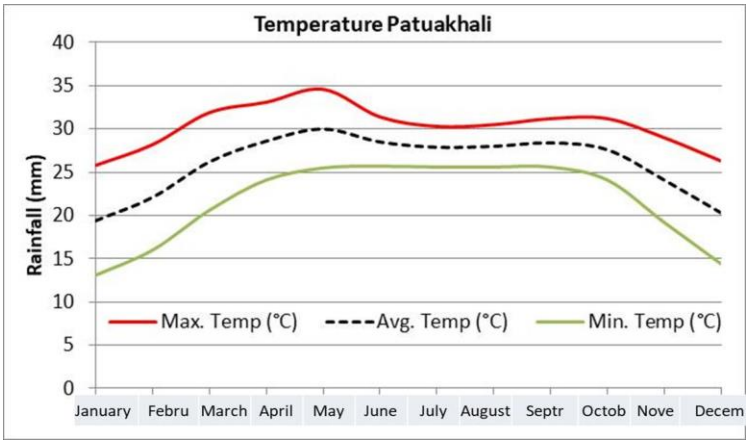


Table 5.33 represents a comparison of temperature variation for each BMD station located within the south central hydrological region. The Table shows that average temperature has decreased by 0.9^{0}C in hundred years in Patuakhali, whereas the country as a whole observed average values of decrease 0.48 ^{0}C in hundred years.

Table 5.33: Trend analysis for temperature of the South Central Region

Hydrological Region	Station	Temperature Change, °C per 100 years				
		Max	Avg. Max	Min	Avg. Min	Avg.
South Central	Faridpur	4.4	2.59	1.7	2.45	0.4
	Madaripur	-0.8	0.43	1.4	4.53	-3
	Barisal	0.7	2.89	-3.8	2.25	-0.5
	Bhola	-0.2	0.8	-0.4	0.9	1.1
	Patuakhali	2.8	4.74	-3.3	-0.96	**-0.9**
	Khepupara	1.7	3.0	-5.2	0.8	-1.5
Country Average =		*-0.32*	*2.63*	*-0.47*	*1.38*	***0.48***

5.4.2 Climate Change Scenario

Two greenhouse gas emission scenarios, *A2 Scenario*[1] and *B1 Scenario*[2], 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

[1] 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.

[2] 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

the report story lines. The summary features of these scenarios, in relevance to Polder 55/2C has been discussed in Table 5.34 below.

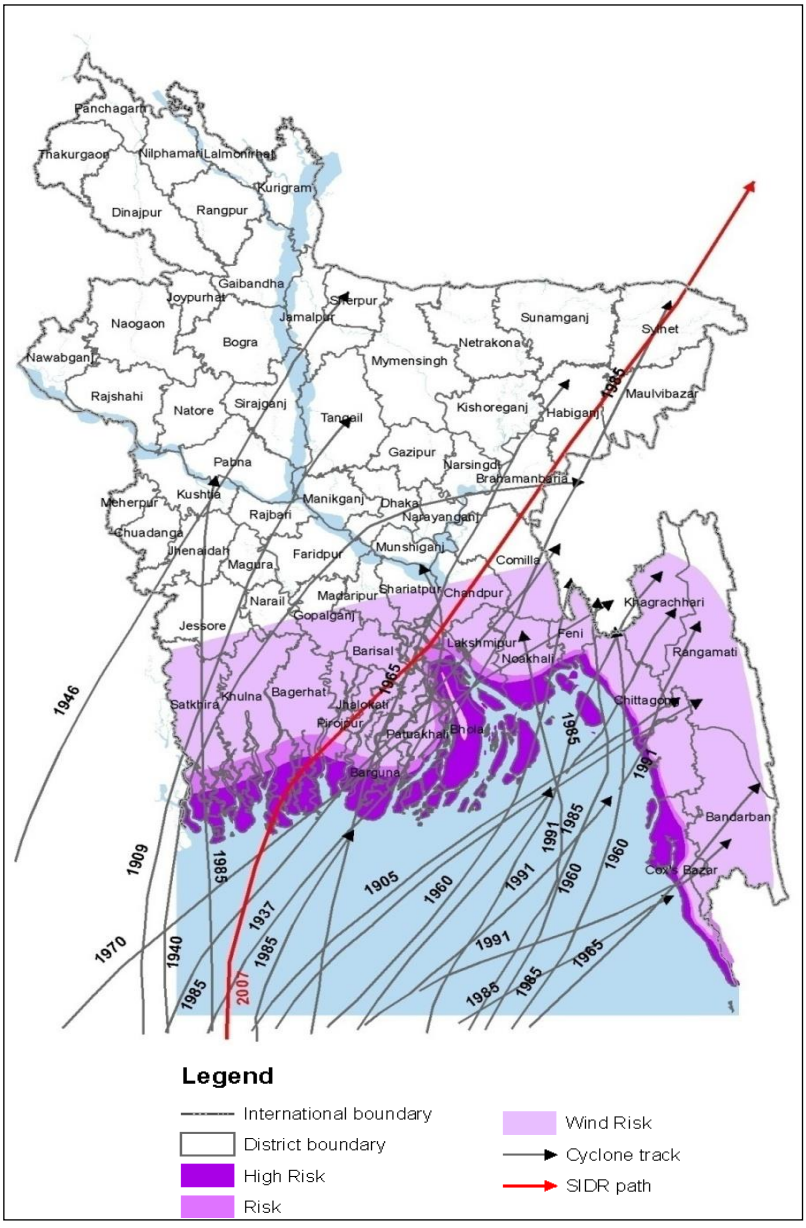
Table 5.34: Summary of climate projections for 2050 in Patuakhali

Parameter	Scenarios	
	A1B	A2
Maximum Temperature	The average monthly maximum temperature may increase by 1.5^{0}C in March-May and 2^{0}C in December-February.	The average monthly maximum temp. may increase by 1.5^{0}C in March-May and 2^{0}C in December-February.
Minimum Temperature	The average monthly minimum temperature may rise by 1^{0}C in March-May and 1.5^{0}C in December-February.	The average monthly temperature may increase 2^{0}C in March-May and 3^{0}C in December-February.
Seasonal Rainfall	Seasonal rainfall may increase up to 100 mm in June-August	Seasonal rainfall may increase up to 100 mm in June-August

5.4.3 Cyclones and Storm Surges

Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal region 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. The 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m (Department of Disaster Management, GoB). Observing the tracks of different cyclones affecting the country, the country's southward portion has been classified into three risk zones namely high risk zone, risk zone, and wind risk zone (Map 5.4). Polder 55/2C falls in the wind risk zone which has some vulnerability due to strong winds and surge heights associated with cyclones.

During field level consultation with local people, it was learnt that no major damage had been occurred in the area during recent cyclones and storm surge events. The peripheral embankments were not very much affected during the disasters.



Map 5.4: Cyclone Tracks in Bangladesh and Risk Area

6 Socio-economic Condition

The socio-economic condition of the people living in 'Polder 55/2C EIA' (i.e. the study area) is captured in this chapter. In doing so, primary data were collected using a range of RRA techniques including Key Informant Interview (KII), Informal discussions with stakeholders, observation and public consultation. Moreover, relevant secondary information was compiled from the community series of the Population Census 2011 published by Bangladesh Bureau of Statistics (BBS). The socio-economic baseline situation of the study area is described in the following sections.

6.1 Demography

There are 10,173 households in the polder area with a total population of 26,510. The female population is found to be higher than the male population. The average male-female sex ratio is 94 which mean there are 94 males per 100 females which is lower than the national figure of 100.3 (BBS 2011). The average density of population is about 641 persons per sq. km which is very less than the national density of 1,015 populations per sq. km. About 95% of the total population in the polder area is Muslim while the rest comprises Hindus and Christians. The key demographic data of the polder is presented in Table 6.1.

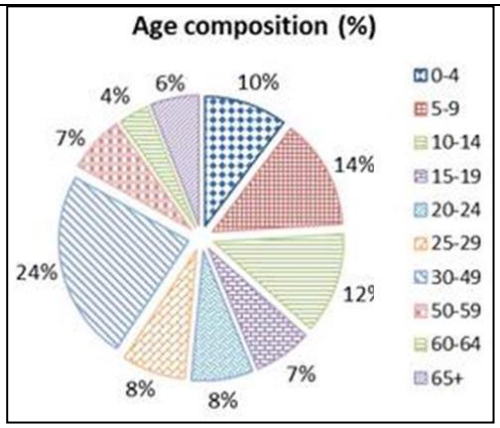
Table 6.1: Demographic data of the polder

Total Households	Total Population	Sex ratio	Population density (No. of population/sq. km)
10,173	26,510	94	641

Source: Population Census 2011, BBS

6.1.1 Age Composition

About 37% of the population is young and are less than 14 years old. 54% belongs to age bracket of 15 to 59 years of age, and 9% are over 60 years of age. However, a disaggregated analysis of population data as per various age groups shows that 25% of total population falls between 30-49 years age category. On the other hand, the data shows that around 46 percent of the population depends on the 54 percent of the earning member's of their households. Hence the dependency ratio 3 in 85 which are higher than the national rate is 56. Details of the age structure are shown in the figure (Figure 6.1).

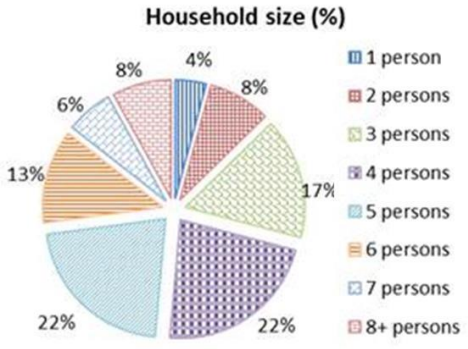


Source: Population Census 2011, BBS

Figure 6.1: Age distribution at polder 55/2C

6.1.2 Household size

The following figure (**Figure 6.2**) shows the proportionate distribution of households in terms of persons who are the members of respective households. It is found that the highest percentage of households (22%) comprise 5 persons in each, whereas the lowest 4% comprises single person in each. The average size[4] of household in the study area is 4.6 i.e. there are more than 4 members in each household which is slightly higher than that of the national average (4.5).



Source: Population Census 2011, BBS

Figure 6.2: Distribution of household members at polder

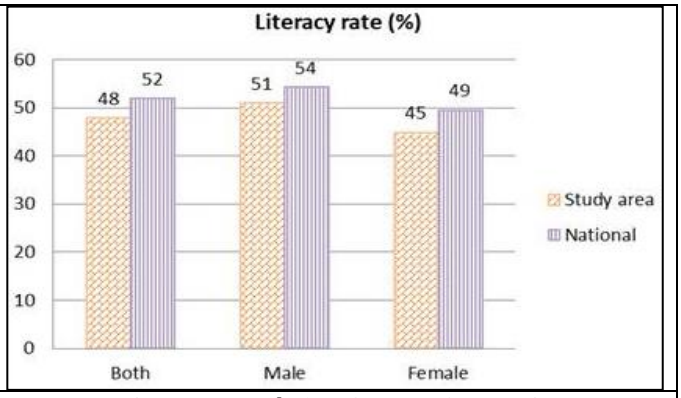
[3]Dependency ratio refers to ratio of dependent population (population aged up to 14 years and above 59 years) to the working age population (population aged between 15 to 59 years).

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

6.2 Education

6.2.1 Literacy rate

The average literacy rate in the study area is 48% which is slightly lower than the national level (52%) (**Table 6.3**). Data confirms that like the national picture of Bangladesh (Male 54.1% and Female 49.4%), the male populations are more educated than the female counterpart in the study area, the rate being 51% for male with 45% for female. Local people opined that, unemployment and lack of facilities are the main reason behind such low female education rate. But now they perceived that they have to find out the way to overcome the present situation and education can only lead them towards benchmark.



Source: Population Census 2011, BBS

Figure 6.3: Literacy rate at polder 55/2C area

According to field findings there are 54 primary schools, 16 high schools and 17 Ebtedaye/ Dakhil Madrashas in the polder area. There are 3 colleges in the polder area. All colleges are providing intermediate level education.

6.3 Health

6.3.1 Access to health service

There is 2 upazila complex, 5 union health complex and 17 community clinics. These health centers are not adequately functioning. As a result, for health services, local people visit the hospitals in Patukhali. However, it is observed that communication within the polder areas as well as with the Upazila headquarters is not good and some parts of the existing road network are earthen. Nevertheless, the people always have the tendency to go upazila or district hospitals for better treatment. Local people emphasized the need and urgency of constructing paved roads networks as early as possible.

Field survey also confirmed that nearly 45 percent people receive health services from *quack* doctors, 30 percent from paramedic/ diploma physicians and only 10 percent from trained doctor. It is noteworthy that about 5 percent do not receive any treatment facility due to their impoverishment. People reported that the earlier tendency of going to the local healer for treatment has been replaced by registered/trained physicians. It is assumed that economic wellbeing may drive them toward receiving treatment facilities from trained physicians whether it is expensive or cost effective (F*ieldwork, 2019*).

6.3.2 Prevalence of diseases

The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the polder area. It is found that the study area comprises 1.4% of all types of disabilities and 0.5% people reported that they are physically challenged. 0.3% mentioned speech and mental disorder. Local people opined that the incidence of Influenza/Common fever is the most prevalent ailment for dry season whereas cough/cold, skin diseases are common for winter season in the Polder area.

Land price in the area is increasing with time like other parts of Bangladesh. Local people reported, agricultural land price is relatively lower. The land price of commercial land is highest in comparison to other homestead or agricultural land. The details lands prices are shown in the Table 6.2

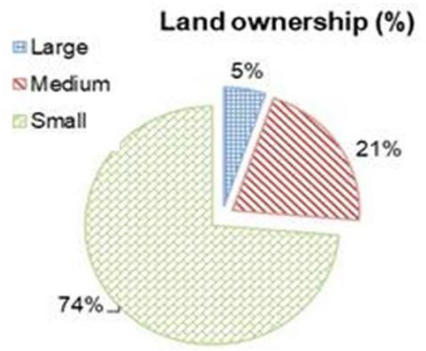
Table 6.2: Sell value of land at polder 55/2C

Land type	Sale value	Year
Homesteads land	Taka 5-6 lacs per decimal (depends on location)	2018
Agricultural land	Taka 2-3 Tk. per decimal	2018
Commercial land	Taka 4-4.5 lacs per decimal (depends on location)	2018

Source: Fieldwork, 2019

6.4 Ownership and utilization of land

Land ownership pattern[5] can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 74% smallholders, 21% medium and only 5% large land holders.In the study area, arable land is mainly used for crop production. Generally small and medium holders cultivate variety of crops in these lands. They however, cannot harvest the full potential from their land due to drainage congestion and siltation of water bodies. (Figure 6.4).

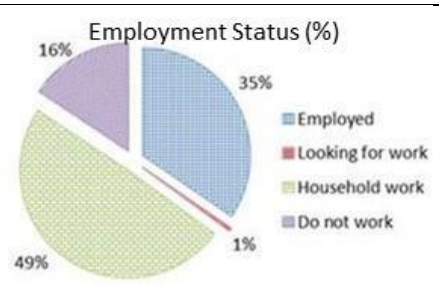


Source: BBS, Agriculture Census, 2008

Figure 6.4: Landownership pattern in polder

6.5 Occupations and livelihoods

Employment status in the polder area is about 35% of total population is employed, 49% is engaged in household work, only one percent is looking for work and about 16% of total population is not working. **Figure 6.5** shows the employment status of the people in the Polder area.



Source: Population Census 2011, BBS

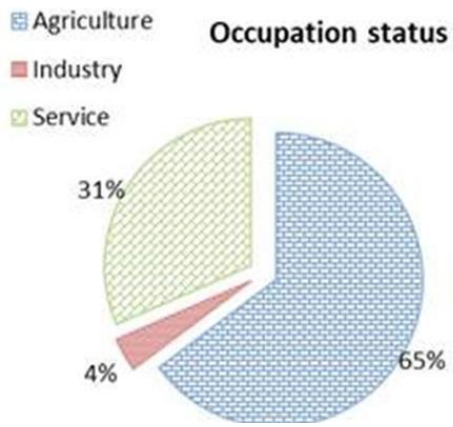
Figure 6.5: Distribution of employment status by polder area

6.6 Labour market

6.6.1 Wage level and labour condition

Field findings show that people tends to cultivate their own land rather than depending on sharecropping system. About 10-12% of total households hire labor for agricultural production. The wage rate varies between Taka 400 to Taka 450/day for male whereas for women it varies in the range of Taka 200 to Taka 250/day.

The employed population of the polder area is engaged in different occupations. According to BBS 2011, most of the population is engaged in agriculture sector (65%). Here agricultural sector includes farmers, agricultural labors, fishers, day labors etc. About 31% population is engaged in salaried service sector. It includes population who are employed in government, private and self-employment for harnessing their livelihood. Lastly, industrial sector comprises only 4% population implying that y the study area administrativel is under the coastal region of Bangladesh as a result industrialization is still underdeveloped. (Figure 6.6)



Source: Population Census 2011, BBS

Figure 6.6: Distribution of population by Occupational group

[5] Agricultural Census by BBS (2008) defined farm holding into three broad categories such as- a) small: having minimum cultivable land 0.05 acre but operate land more than this minimum but upto 2.49 acres; b) medium: having operated land in between 2.50 to 7.49 acres; and c) large: having operated land 7.50 acres and above.

6.6.2 Labor Migration

Seasonal labour migration is very frequent phenomena under males in the months there is no work as agricultural day labourer. The majority of those who temporarily migrate for work go to Dhaka; other places that they temporarily migrate to include Patuakhali and Chittagong. The activities they engage in are rickshaw-pulling, labour in road construction & brick-field, work as a masionman & construction labour, Industrial labour and hawking in towns. Besides these, a substantial portion of labour works in fishing boat for fishing in the sea.

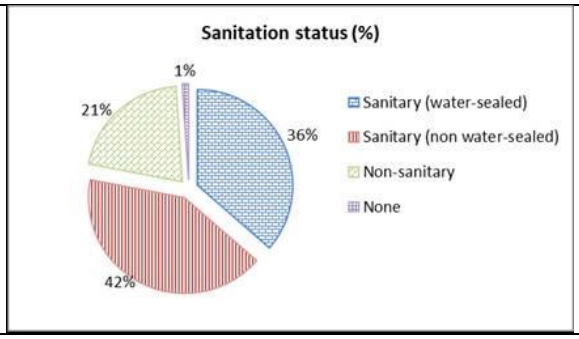
6.7 Standard of living

6.7.1 Access to electricity

Electrification as reported in the Population Census, 2011 is not satisfactory in the polder area. On an average, only 35% households are under grid electricity coverage. Besides, some of the households are now using solar electricity through borrowing money from NGOs and personal level solar electrification are also observed in the study area. In this regard, Infrastructure Development Company Limited (IDCOL) has already been installed under the solar electrification program in the rural area of the polder and at present 2% of households is benefited under this program in the whole polder (F*ield work, 2019*).

6.7.2 Sanitation

The sanitation facilities [6] adopted by households of the polder area are presented here. It shows that about 36% households have access to hygienic sanitation facility (water-sealed), 42 % to non water-sealed sanitation facility, 21% uses non-sanitary facilities and 1% has access to no sanitation facility at all. Statistics shows that the polder situated near sadar area and that's why sanitation facility is better in comparison to other polder of Patuakhali district.



Source: Population Census 2011, BBS

Figure 6.7: Sanitation facilities by union at polder 55/2C

6.7.3 Drinking water

Overall status pertaining to sources of drinking water in the area is satisfactory. On an average, 99% people can collect drinking water from tube well while only 1% collects drinking water from other sources such as ponds, Pond sand filter (PSF); rain water etc. There is no coverage tap water within the study area (*Source: Population Census 2011, BBS*).

Photo 6.1: Domestic level tube well

6.7.4 Cooking fuel

For fuel consumption, almost every household in this area mainly use cow dung sticks as fuel. People also used wood, chips naturally produced herbs and shrubs etc. to meet up their fuel needs.

[6] BBS defined four types sanitation in Bangladesh such as **(i) Sanitary (water-sealed):** A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. **(ii) Sanitary (not water-sealed/ring slab),** latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing in-sects from flying into or coming out of the pit; and **(iii) Non-sanitary (Kucha)**:latrine is a frame or platform extending over earth or water; an "open pit latrine" does not have a squat platform or slab on the pit and **(iv) No facilities**: Defecation in bushes or fields or other outdoor locations.

6.7.5 Floor of the house

The overall housing condition[7] is not satisfactory. Only 1% of houses are Pucka, 4% houses are semi-pucka and 1% houses are Jhupri whereas 94% percent are kutcha. On the other hand, in 2011 at national level, 25.12% of the households reported to have used brick/cement in the walls of the main dwelling structure. With reference to national statistics it can safely be argued that the large percentage of the households of the study area belong to poor category in term of housing type.Figure 6.8 shows represent housing types of the polder.

Source: Population Census 2011, BBS

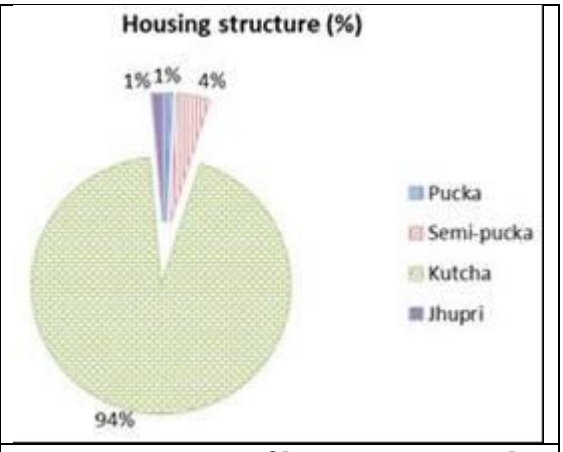


Figure 6.8: Types of housing structure by union at polder 55/2C

6.8 Poverty

Poverty is often defined by one dimensional measure. However, no one dimension alone can capture the various dimensions of poverty. Multidimensional Poverty Index (MPI) is composed of several factors that constitute poor people's experience of deprivation- These are:

- Poor health;
- Lack of education ;
- Inadequate living standard;
- Lack of income;
- Disempowerment;
- Poor quality of work; and
- Threat from violence.

A Multidimensional measure can incorporate a range of indicators to capture the complexity of poverty and better inform policies to relieve it. MPI has been assessed for the above category of the people. The detail process and methods of the MPI are given in the appendix -3.

6.8.1 Analysis of MPI Poor and result

The MPI poor analysis of the polder is given below:

Table 6.3: Weighted score and status of MPI poor of Polder 55/2C

Poor Category of People	Landless persons work in share cropping and agricultural labour (L)	Day labourers work in Brick Field (DL)	Marginal Grosser sell things in the rural bazar (MG)
Weighted Score (deprivation score)	27.78%	38.89%	22.22%
Status: MPI poor (33.33%)	Less than MPI poor	Equal to MPI poor	Less than MPI poor

It is seen in polder 55/2C that about 22% of L and MG category hhs are seen non poor. The DL category of people is seen poor.

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

Table 6.4: Results of MPI

According to Table 6.4, for Polder 55/2C, headcount ratio (H) about 33% of people live in poor households. In the context of intensity of poverty (A) is deprived more than 38% of the weighted indicators. Thus the MPI of the polder is 0.130 (in 2014) compared to Bangladesh 0.292 (in 2007)[8] which indicates status of poor HHs have been reducing very rapidly.	Factor H for the Polder	0.333
	Factor A for the polder	0.389
	MPI	0.130

6.9 Institutions and infrastructure

The current status regarding market and growth center at polder area is not satisfactory. There are only two growth centers and 15 markets/bazaars are observed in polder area. According to local people, these facilities are not enough to serve all necessary purpose in their day to day life.

6.10 Transport networks

Road networks and communication system is not better in the polder area. Local people communicate through both roadways and waterways. There are some roadways cum embankments along the polder which are often threatened to river bank erosion and homestead damage. The peripheral roads of the polder are of different types such as paved, brick soling and earthen road. The greatest part of the internal road network is kaacha (earth made) road. During monsoon it is difficult to communicate through earthen roads inside the polder due to heavy mud formation. Intra connectivity of the polder is road communication which is made by mixed with carpeting, herringbone and earthen roads. The markets/growth Centers are connected with pacca carpeting roads (40 km) but the villages are connected with markets by herringbone and earthen roads (70 km). The outside connectivity of the polder is road and naval route with Patuakhali and Galachipa and Dasmina upazila sadar. During monsoon it is very difficult to communicate through earthen roads inside the polder due to heavy mud formation.The earthen roads serving the people moderately in the dry season but become useless during the wet season. Local people also urged that the poor communication system is the main hindrance for the development of the polder

6.11 Social Safety Nets

The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development (VGD), Food/Taka for Works (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 6.5 shows the current social services and facilities for alleviating poverty in the study area.

Table 6.5: Households Served by Different Social Safety Nets Programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	6
Food/Taka For Works (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. Major NGOs working in the area include BRAC (Bangladesh Rural Advancement Committee), ASA (Association for Social Advancement), Space Bangladesh, Grameen Bank, Nazrul Sriti Sangsad (NSS), CODEK,

[8]http://en.wikipedia.org/...../Multidimensional_Poverty_Index (web page) p.6.

MERISTOPES etc. (Table 6.6). Operation of micro credit program among the rural poor women/men of the area is one of the main activities of these NGOs. Several NGOs however, implement few 'rural development' programs. These NGOs are serving with micro credit while BRAC working for non-formal education, Health, human rights, water and sanitation, gender and children development programs. About 45% of households could be classified as beneficiaries of NGOs interventions.

Table 6.6: NGOs and their programs in polder area

NGOs	Type of Programs						
	Credit	Education	Water and Sanitation	Health	Seeds	Gender	Children
BRAC	✓	✓	✓	✓	✓	-	-
ASA	✓	-	-	-	-	-	-
Ahsania mission	✓		-	-	✓	-	-
Space bangladesh	✓	-	-	-	-	-	-
Grameen Bank	✓	-	-	-	-	-	-
Heed Bangladesh	✓	-	-	-	-	-	-
CCDA	✓	-	-	-	-	-	-

Source: Fieldwork, June 2019

6.12 Common property resources and their 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). It is observed that there are 28 cyclone shelters am 25 graveyards and 24 crematoriums in the polder area These are used by the local people for the purposes of religious, social and cultural gathering. Beside these, the BWDB embankment is also very commonly used for different livelihood purposes i.e. living or taking shelter by the local inhabitants.

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7 Public Consultation and Disclosure

7.1 Introduction

Public consultation is a regulatory process by which the public's input on matters affecting them 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 arranged at the close vicinity of the Polder 55/2C project location. During consultation meeting the proposed project intervention and its associated impacts were discussed following a comprehensive checklist. The participants expressed their opinion spontaneously and considered this attempt as a neutral platform to share their experiences with a view of ensuring the proposed project to be socially acceptable and environmentally sustainable.

7.2 Objectives of stakeholder consultations

The following objectives have served as the moving force for the design, implementation and fact findings during the participation process:

- To provide key project information and create awareness among various stakeholders about project intervention;
- To have interaction for primary and secondary data collection with project beneficiaries, affectees, and other stakeholders;
- To identify environmental and social issues such as safety hazards, employment, and vulnerable persons;
- To establish 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 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) in the Polder 55/2C. The consultants first discussed with the Bangladesh Water Development Board (BWDB) officials of the polder area to share the Feasibility and EIA process of the Blue Gold program. The local government officials/representatives were consulted to identify the potential stakeholders at the Polder level, With available support from the Blue Gold officials and UP chairman, the union level public representatives as well as the key persons were contacted over telephone and informed about the specific consultation meetings and requested them to be present in the meeting. Accordingly, the venue, date and time of the consultation meetings were fixed. Later, the consultant team organized the meetings at the local level. The participants provided their names, occupations and addresses in that meeting.

Photo 7.1: Upzilla level discussion and orientation program

Upzilla level discussion and orientation program was held at Upzilla Auditorium, Kalapara Upzilla, Patuakhali. About 50 participants were attended from different agencies and organisations, namely WMOs, UPs, UNO office, BADC, DAE, DoF, DLS, Upazila Vice-Chaiman, Upazilla Social Welfare and BWDB (Dhaka and Patuakhali Offices).

Following are the key discussion points:

Agency/Discussent	Discussion Points
Mr. Abul Kashem, Training & Communication, BGP-BWDB	• Wellcome the participants. BGP objectives, activities, Introduction of Stakeholders & Partners, Program Implementation process and participatory water management approach;
Mr. Md , Hasanuzzaman Executive Engineer, Patuakhali O&M Division, BWDB, Patuakhali.	• Blue Gold Program objectives, activities, Introduction of related Agencies, Stakeholders & Partners, Program Implementation process and participatory water management approach. • Importance of Polder Water Management and basic information of repair, rehabilitation activities, name and key structures, benefits of those infrastructures. • Rehabilitation and maintenance problem due to resources constraints, many of the Khals silted up and structures out of Operation, there are problems of drainage congestions durng onsoon and lack of irrigation water durng dry period. • Expected/planned rehabilitation, repair & maintenance activities of water infrastructures under Blue Gold Program will remove the water related problems of this polder, the Polder-55/2C.
Mr. Shohrab Hossain, Zonal Coordinator	• WMO formation process, steps and activities • Introduction of the legal entity i.e. registration process of Water Management Organizations
Mr. Delower Hossain, Civil Engineer, BGP, Patuakhali	• Presented the details of rehabilitation, repair & maintenance activities of water infrastructures of Polder 47/3 under BGP. • Explain the WMO formation process, steps, different activities and roles of WMo in water management process. • Mentioned about the obstruction of flow of Khals in many places with illegal Cross-Dam or Pata (Local name) for Fish cultivate by the local influential, those causing water congestion durig monsoon.
Md Dulal Chowdhury UP Chairman, Kalagachia, and Mr Sajjad Hossain, Up Chairman, Chiknikandi, Galachipa.	• Both of them Explained that Blue Gold Program is working with good coordination, involved local people and UP from the beginning. Union Parishad will cooperate in every step of Blue Gold Program. • Khal re-excavation and structure repair for proper drainage in monsoon and store irrigation water in dry period is the key problem of the area. • Union Parishad ready to support BGP team to solve probels and support in conflict resolution related to land and water management problems.
Mr. Abdul Mannan, Agriculture Officer, DAE, Galachipa Upazila, Patuakhali	• Updated the agricultural activities under BGP in the Polder 55.2C. • He expecting better coordination among the Agencies and WMOs will help for higher agricultural production. • Before construction of these polders, the cropping intensity in this area was 100% but now this is about 200% and above. But in the time being khal, canal in the polder area is refilled. That is why water logging occurs in this polder area. For agricultural production improvement, repair or rehabilitation of the water related structures and re-excavation of Khals is needed to improve the productivity and cropping intensity.
Mr. Aowlad Hossain, Institutional Advisor, BGP-BWDB.	• Explained the involvement & roles of local Govt. Institutions (Upazila Parishad, UP and other organizations) with Blue Gold Program and importance of strong linkage between LGIs and WMOs.
Md. Apu Saha, Senior Upozila Fisheries Officer, Galachipa, Patuakhali.	• Importance of re-excavation in segment wise of ekhals and one after another to protect indigenous fishes and other aquatic fauna. • Importance of natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation. • Timely and properly Gate Operation of Water control structures to facilitate the Fish movement.

Mr Md.Mahabub Hassan, Upazila Palli Unnayon Officer, Galachipa Upazilla, Patuakhali	• 218 number of Farmer′s Group under these polders. If BGP develop linkages and coordination with WMG and Upazila farmer's group it will accelerate the program activities. • Assured that his department will help to unify Water Management group and Upazila farmer's group.
Dr. Abu Sayem Upozila Livestock Officer, Dashmina Patuakhali.	• Importance of local technology improvemet and adaptation in Polder for local chicken, duck, cattle etc. • Importance local chicken production and haching improvement to enhance production and reducing deaths/losses. • Importance of vaccination for the livestocks, chickens ducks etc and assistance for and facilities at Upozilla Livestock Office for.
Mrs. Nargis Sultana, Vice-Chairmen, Upazila Parishad, Galachipa, Patuakhali	• Appreciated the participatory approach in water management i.e. involvement of local people, Union Parishad and UZ Parishad in program implementation. • Expressed his willingness and commitment to remove any illegal cross dams or obstruction on the Khals created by the influential people. • He recognized Blue Gold Program for involving community people in this process. He gave his commitment to extend his support to Blue Gold in implementing the program.
Mr. Tauesef Ahmmed, UNO, Galachipa, Patuakhali.	• Acknowledged BWDB for arranging this orientation where he got the glimpse of Blue Gold Program for the very first time since its inception. • He appreciated the participatory approach in water management i.e. involvement of local people and wished its success. • A requested to provide rehabilitation plan of structure of the Polder to his office so that he can share with the concerned line department to avoid any overlapping of development activities in this polder area.
Mr. Hasanuzzaman, Executive Engineer, Patuakhali, BWDB.	• He summarized the workshop and thanked distinguished participants specially the Upazila Chairman, UNO and other Upazila level officers of line departments.

A number of informal discussions with stakeholders were also arranged as public consultation process. In order to conduct these discussions, five checklists were prepared covering the aspects including an overview of the proposed Blue Gold program, information on the ongoing EIA process, and seeking information on the problems of the area with their potential solutions. The local needs and demands have been discussed by providing equal opportunity to all participants attending in the meeting. During consultation meeting all relevant issues on water resources, land resources, socio-economic resources, and disaster aspects were discussed in detail.
During informal discussions with stakeholders and PCM, the EIA team displayed maps of the Project area, shared the initial concepts on proposed interventions and facilitated the response of the participants. The stakeholders of the Polder 55/2C were asked to share their needs, problems, possible sustainable solutions, and their views on the Project interventions. The stakeholders' perceived views on Important Environmental and Social Components (IESCs) and Project's impacts on them, along with perceived benefits, risks, threats and demand from the Project were identified during discussions.

7.4 Identification of stakeholders

Stakeholders include all those who will be affected and are being affected by policies, decisions or actions within a particular system. Stakeholders can be groups of people, organizations, institutions and sometimes even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

7.4.1 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 55/2C, 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 which could contribute to the study, play a role in implementation at some stage, or affect decision making on Project aspects. In this Project NGOs, concerned government departments, and line agencies fall under this category.

Secondary stakeholders for the Project include local government institutions (LGI), Bangladesh Water Development Board (BWDB), the Ministry of Water Resources, Department of Forest, other government agencies, academia, NGOs, the Blue Gold officials at Patuakahli, the Netherlands govt. officials and general public at large.

7.5 Consultation meetings

7.5.1 Consultation Process

Stakeholders Consltation Meeting was held at various levl of the study. A PCM and number of informal discussions with stakeholders were conducted at different locations of the Polder 55/2C. In addition a number of meetings were held at Patuakhali BWDB Office and Blue Gold Program Office.

Photo 7.1: Knowledge sharing consultation meeting with Blue Gold officials and WMG, Patuakhali

Photo7.2: Stakeholders Consultyation Meeting Polder 55/2C, Patuakhali

7.5.2 Consultation Participants

The participants of these consultation meetings included Blue Gold Program officials, local representative, farmer, trader, members of WMO and daily-wage laborers of the Polder 55/2C and nearby areas. A total of number 95 participants attended these consultations. The details of the participant are provided in Photo 7.3 and 7.4 below.

7.6 Issues discussed in informal discussion with stakeholders and PCM

At the outset of these informal discussions with stakeholders 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)
- 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 water resources and to make these resources more productive.

7.7 Community Concerns and Suggested Solutions

The outcomes of the informal discussions with stakeholders and PCM in terms of concerns and the suggested solutions were noted and organized by themes are presented in the Table 7.1 below.

Photo 7.3: Informal discussion with stakeholders at Chiknikabdi bazar

Photo 7.4: Informal discussion with stakeholders at Alipura

Table 7.1: Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	✓ Drainage congestion due to siltation certain parts of the polder and poor communication system 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.

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Water resources	✓ Drainage congestion is the most prominent problem in the area as opined by local people ✓ Surface water scarcity	✓ Re-excavation of khals ✓ Repairing of Sluice gates, inlets and outlets
Agricultural resources	✓ Drainage congestion and water logging during T Aman (Kharif-II season). ✓ Scarcity of irrigation water in Rabi season.	✓ Repair of sluice gates are expected to decrease siltation which may enhance crop production and may reduce crop damage and to introduce new crops. ✓ Re-excavation of khals to remove drainage congestion. ✓ All proposed intervention should be protected existing problem in the polder area.
Fishery resources	✓ Reducing depth of internal khals and habitat quality degradation due to siltation ✓ Fish and hatchling movement disrupted due to in proper operation of water control structures. ✓ Indiscriminate fishing by Sluice net	✓ Re-excavation of khal will help to increase the richness of fish species in the polder area. ✓ Strengthening of WMA/WMO activities ✓ Strong of fisheries rules and regulation by the government
Ecological resources	✓ The major problems identified in the polder area that homestead plant biodiversity and are due to the lack of advanced knowledge, technologies, pests and diseases attack, improper homestead space planning and utilization, maintenance of embankment and sluice gates, intrusion of partial saline water, low productivity, recurring natural disasters, khals siltation and water logging. Consequently, faunal population and diversity is also decreasing due to natural disaster and various human activities.	✓ Re-sectioning of embankment and repairing of water control structure along the embankment will protect settlement, road, inter tidal floodplain area and crop fields from existing problem. ✓ Re-excavation of khal to remove drainage congestion and water logging.
Socio-economic resources	✓ Scarcity of fresh water is the main problem in the polder area during dry season. Due to malfunctioning of water control structures, lack of reserve fresh water in khals, saline water is being trapped for long time in almost entire polder area and this is responsible for intrusion of salinity in the groundwater aquifers. ✓ Lack of adequate expertise and experienced manpower to carry out the O&M of the polder, the numbers of field staffs are also insufficient and inadequate in some places of the polder with respect to the actual requirement.	✓ Scope of fresh water storage may be improved within the internal khals and protective ponds by proper functioning of associated water control structures; ✓ For sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) needs to be ensured and also the water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc must be managed properly, and there should be growth of consciousness among the community in the polder.
Socio-economic resources	✓ Local influential, including the political leaders, illegally interfere on the water control/ management infrastructure.	✓ The Government should rehabilitate the affected farmers who are affected by salinity intrusion;
Socio-economic resources	✓ The occupations of local people has been changed due to salinity and closeness to urbanization ✓ Lack of hospitals with trained Docotrs ✓ The doctors do not behaves in the professionalism manner in their activities ✓ Lack of cyclone center ✓ Lack of place for dumping Re-excavated earth materials ✓ Lack of training on livestock rearing ✓ Lack of growth centers	✓ Need awareness building about water management among the communities. ✓ Alternative occupation opportunities should be created for the farmers ✓ Adequate number of trained physician should be recruited in this area ✓ It is very urgent to develop the internal communication facility of this area ✓ Market management should be strengthened ✓ Provide alternative training facilities for income generation

7.8 Perceptions towards proposed interventions

The interventions proposed by the Blue Gold Program for rehabilitation of the polder were discussed with local people by the EIA study team. A list of identified problems and the suggested solutions made by the local people are shown in Table 7.3. The solutions opted by the local people are mostly found similar to these proposed by the Blue Gold Program for this polder. During public consultation meeting conducted by this team, the participants were also requested to provide their overall perception about the proposed interventions. The opinions received were positive, as almost all the local participants spoke in favour of the proposed interventions. The generalized perception was that they believe that the interventions proposed (discussed in Chapter 4) have the outright potential to remove the existing water management problems and concerns in Polder 55/2C.

7.9 Participant list

The name of the participants of different informal discussions with stakeholders, their age, occupation and address including cell phone number are provided in Table7.2. Similarly, an inventory of the participants of PCM was maintained in attendance sheet containing their contact numbers

Table 7.2: Name of participants

SL	Name	Gender	Occupation	Age	Address/Mobile No
1	Arab Ali Sardar	M	Business	35	-
2	Delawar Hossain	M	Agriculture	22	01760-164500
3	Md. Billal Hossain	M	Student	19	01751-739140
4	Md. Monirul Islam	M	,,	27	01715-295401
5	Kamal Hossain	M	Driver	35	01714-795939
6	Ali Akbar Sarder	M	Agriculture	50	01778-912964
7	Md. Helal Hossain	M	Driver	25	01710-255118
8	Rasel Hossain	M	Student	30	01713-957570
9	Md. Jamal Hossain	M	Service	30	01730-973142
10	Md. Hasan	M	Agriculture	25	-
11	Md. Oadud Hawladar	M	Business	35	01713-933230
12	Md. Mahbub Alam	M	,,	55	01735-666802
13	Md. Rubel Mriddha	M	Student	50	01745-396992
14	Syed Sajal	M	Service	60	01711-124651
15	Md. Al Amin	M	,,	45	01788-801227
16	Md. Yakub Khandakar	M	,,	50	01754-271523
17	Md. Ebrahim Khandakar	M	Business	40	01719-543556

8 Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification of IESCs and Rationale

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

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Surface Water Availability	The re-excavation of 11 numbers of khals within the polder improve those water carrying as well as water retention capacity and hence allow more usable surface water to be available. This may improve the different uses of water in the area like irrigation, domestic usages, bathing and cleaning, wild lives, cattle etc. In additionan, post monsoon, those re-excavated khals shell be a source of retaining rain water for the use in subsequent dry season, provding source of more water available. Therefore, water availability has been considered as an IEC.
Drainage Congestion and Water Logging	The repairing of water control structures and construction of mew water control structures significantly improve the drainage status within some locations of the polder, and might restore the existing water logged areas. The proposed re-excavetd khals, mpstly with the regulator/sluice connecting, significantly improve the water carrying capacity, contribute quick passing of rain water, improve drainage. As such, drainage congestion and water logging has been considered as another IEC
Land Resources	
Agriculture land use	It is expected that the present land use would be changed due to implementation of the interventions in the polder for the change of hydrologic regime inside the polder area. Farmers of the polder area would be encouraged cultivating more crops in changing situation. During monsoon, with proper drainage, Amon cultivation and summer vegetables area would be increased. In addition, during dry season (December to May) with more water storage/retained in the khals and wth improved carrying capacity, dry season crops cultivation wold be imroved/increased. Because of this reason, land use has been considered as one of the IEC.
Agriculture Resources	
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside polder 55/2C area, which may encourage the farmers to change their cropping patterns and may be more HYV. With facility of quick drainage, more water intake during high tide and more water retention/preserve in the khals facilitate more area to be brought under cultivation. This may increase the cropping intensity in consideration of which 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-excavation of the Khals. The re-excavation of khals would help to drain out excess water from the crop fields. Repairing of sluice gate may prevent the intrusion of saline water. The excess rain water inside the polder would be drained out through regulators which might help to cultivate the HYVs rice. Moreover, the surface water might be stored in the re-excavated khals which could be used for irrigation. This situation would be favorable for enhancing crop production. As such, crop production has been selected as an IEC.
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 of the soil. In the Polders of Patuakhali, farmers enjoyed mostly free of cost irrigation (no mechanical pumping) using the advantage iof high tide twice a day. During the cropping season (eithr in the monsoon or dry period) when necessary, the farmers of the Poder take in the river water to their respective fields/farms during high tide. Water level variation in low tide nd high tide is about 3.5m. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.

IESCs	Rationale
Fisheries Resources	
Fish habitat and habitat quality	The proposed interventions of the polder are likely to alter the fish habitat as well as habitat quality in the polder area. Increased water depth due to re-excavation of khals may change the water quality which may support different type of fish species. In this context, fish habitat and habitat quality has been considered as an IEC of the study.
Fish movement and migration	Internal fish movement and migration through khal is still the driving force for capture fisheries of the polder area. Few numbers of internal khals are connected with the peripheral rivers. The major portions of the khals are silted up. These khals are covered with water hyacinth which is hampering the fish movement and migration. Proposed interventions especially khal re- excavation may increase water flow and depth of water and in turn will facilitate the lateral fish migration. Thus, fish movement and migration has been considered as an IEC.
Fish productivity	Open water fisheries contribute a small portion of fish production in the polder area. People of the area are mainly dependent on culture fisheries. Implementation of proposed interventions may change the fish abundance which ultimately changes the fish productivity. So, fish productivity has been considered as an IEC.
Ecological Resources	
Terrestrial Vegetation	Terrestrial vegetation is an important component of the existing ecosystem. This type of vegetation provides habitat for wildlife and also provides various elements to human. Any change of physical environment causes different intensity of vegetation damage. The proposed interventions may cause impacts on vegetation during construction and 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 and depth play an important role in the existing wetland ecosystem. Proposed intervention especially khal re-excavation is expecting to change the water quality as well as fresh water flow as well as availability which may have 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	
Access to open water bodies	All khals and surrounding rivers are recognized as the sources for open water bodies in the polder. At present, mass people has limited access to open water bodies for instance, khals which are to be excavated in the proposed interventions. In most cases, khals are being silted up. Thus, it can be mentioned that, if the proposed khals are re-excavated, it will ensure social use of water and access for mass people into khals. As such, access to open water bodies is considered as one of the IESCs.
Gender promotion	Most of the people in polder area are living on 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 it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS.With additional amount of usable water in the Polder facilitate the homestead gardening, vegetabl cultuivation etc would give additional opportunity for the women of the area for income as well as family level nutrition. With more crop cultivation also faciliutate more job opportunity for the women of th area. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them to better life and livelihood. Hence, gender promotion is considered as an IESC.
Employment opportunity	The construction work will generate a significant opportunity of employment over its construction period for local people and other associated professionals. People will also be involved in operation and maintenance related jobs to operate the hydraulic structures. Increased agricultutural activities, more area under cultivstion nd increased cropping intensity creats large opportunity of job at local level. Other related activities, like land preparation, harvesting of crops, carrying and selling of products, more inputs (seeds, fertilizer, insecticides etc) etc also creats additional job and business facility in the area. It is expected that proposed intervention will create employment opportunities for different occupational groups. Thus, employment opportunity is considered as an IESC.

8.2 Prediction and Evaluation of Potential Impacts

8.2.1 Preamble

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

- RRA survey to assess loss of vegetation, occupation, income and poverty levels of the affected households, etc.
- Environmental quality baseline monitoring of noise, surface water, groundwater and soil.
- Ecological surveys comprising vegetation, wildlife and fisheries covering both terrestrial and aquatic ecosystem.
- Land surveys in Polder 55/2C comprising socio-economic status and environmental settings.
- Expert consultation, focus group discussions, and public consultations.

8.2.2 Impact Screening

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

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

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

Table 8.2: Screening Matrix

Project Phases and Activities	Water Resources		Land & Agriculture			Fisheries			Ecological		Socio-economic		
	Surface Water Availability	Drainage congestion & water logging	Cropping pattern and intensity	Crop production	Irrigated area	Fish habitat and habitat quality	Fish movement and migration	Fish productivity	Terrestrial Vegetation	Aquatic flora and fauna	Gender promotion	Employment opportunities	Access to open water bodies
Pre-construction Phase													
Labor, materials and equipment mobilization	-	-	-	-	-	-	-	-	-	-	-	-	MN
Site preparation	-	-	-	-	-	-	-	-	-	-	MN	I	-
Construction Phase													
Re-sectioning of embankment	-	-	-		-	-	-	-	MN	-	-	HP	-
Embankment slope pitching and turfing	-	-	-		-	-	-	-	I	-	-	MP	I
Re-excavation of khal	-	-	-		-	MN	MN	I	I	MN	-	MP	-
Repairing of Drainage sluices/Flushing sluices	I	I	-		-	-	MN		-	-	-	I	-
Repairing of drainage outlet	I	I	-		-	-	I		-	-	-	I	-
Construction of Drainage Outlet	I	I	-		-	-	-		-	-	-	I	-
Repairing of Irrigation inlets	I	I	-		-	-	I		-	-	-	I	-
Operation Phase													
Checking the physical condition and function of the embankment	HP	HP	HP	HP	MP	MP		I	MP	I	MP	MP	HP
Checking physical condition and function of water control structures	HP	HP	HP	HP	MP	MP		HP	I	MP	MP	HP	HP
Checking the functions of WMOs	HP	HP	HP	HP	MP	MP		HP	I	MP	MP	HP	HP

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 duringPre-construction Phase

There will be no impact during the pre-construction phase on IESCs of water resources, agriculture, fisheries, ecological resources and socio-economic condition because some activitiessuch as materials and equipment mobilization (carrying as well as storing and land acquisition)would be carried out during this phase. Impact of these activities on the said IESCs is negligible.

8.4 Impact during Construction Phase

Impact on IESCs during construction phase for the proposed interventions are presented in the following table 8.3

Table 8.3: Impact Assessment Matrix for the Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Water Resources				
There will be no impact during the construction phase				
Land Resources				
There will be no impact during the construction phase.				
Agricultural Resources				
There will be no impact during the construction phase.				
Fisheries Resources				
Activity: *Repairing of Water Control Structures*				
Fish movement and migration	• Drainage/flushing Sluices (locations as mentioned in the water resources section) • Irrigation Inlets (which locations as mentioned in the water resources section)	• Fish hatchling and some brackish water fish species like *Chingri, Baila, Pairsa, Vetki* and fresh water fish like *Puti, Tengra* and SIS move through the water control structure during high tide throughout the year.	• Movement and migration of fish species like *Chingri, Baila,* Pairs and Vetki and fresh water fish like *Puti, Tengra* and SIS etc would be obstructed/limited during repairing of structures.	-1
Activity: *Re-excavation of khal*				
Fish habitat and habitat quality	• Katakhali Main Khal • Kachua Main Khal • Sonamiar Khal • Jhatibaria Main Khal • Kallan Kalas Khal	Tidal in nature, shallow water depth, most of the part are silted up	• Feeding and breeding ground of the bottom dweller fishes will be lost.	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
	• Sutabaria Khal • Kachua Branch khal • Chandpura khal • Chandpura Branch khal			
Ecological Resources				
Activity: *Repairing of embankment*				
Terrestrial vegetation	Both sides of the embankment in the repairing points	• Embankment side vegetation is dominated by medium sized trees, shrubs and herbs e.g. *Kola, Tal, Khejur, Shirish, Akand, Bhat, Hatisur* and etc which provide 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 types of grass and bushes due to soil dumping for repairing works. • Relocation of wildlife due to temporarily loss of habitat.	-2
Activity: *Construction of drainage outlet*				
Terrestrial vegetation	Gopaldi Don khal	• Moderate condition. • Composed of free floating plants, like *Kochuripana, Kutipana, Dhol kolmi,* etc, which support habitat for fishes and Kingfisher, Egret, Snake, etc. • Durba Ghas *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp) are dominant along both sides of the khals. • Different types of local avifauna roam here for feeding.	• Temporary reduction of habitat quality due to obstruction in the flow in the khal.	-2
Activity : *Re-excavation of khal*				
Aquatic flora and fauna	All khals proposed for re-excavated	• Moderate condition • Composed of free floating plants, like Kochuripana, Kutipana, Dhol kolmi, etc which support habitat for fishes and Kingfisher, Egret, Snake, etc. • Durba Ghas *(Cynodon dactylon)*, Biskantali	• 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)
		(*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp), etc. are dominant along both sides of the khal. • Different types of local avifauna roam here for feeding. • Reduced water retention area for siltation.		
Socio-economic Condition				
Employment Opportunity	Periphery and inner side of the polder where different activities will be initiated.	About 35% of total population is employed, 49% is engaged in household work, only one percent is looking for work and about 16% of total population is not working	A huge number of local labor will be needed in earth works, re-sectioning of embankment and afforestation, soil dumping and compaction in different repair works	+2
Gender Promotion	Periphery and inner side of the polder where different activities will be initiated.	About 52% of female are working at household level whereas few of them are working as day labor or earth worker	According to the project plan, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS, all of them would be engaged from the local area. Thus, employment of female in the construction works and during operation/ maintenance phase will be promoted significantly and they can take part in different decision makings.	+3

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

8.5 Impact during Operation Phase

The possible impacts during Operation phase of the proposed interventions on the selected IESCs have been assessed comparing the Future-without-Project (FWOP) condition with the Future-with-Project (FWIP) condition. The impacts on the IESCs under different resources are presented in the following sections and summary in of impact are presented in a tabular form.

8.5.1 Water Resources

a. Surface *Water* Availability

Future-without-Project

People living in Polder 55/2C are suffering from scarcity of water forirrigation as khals are gradually being silted up. Local people cannot fulfill irrigation demand upto the desired level due to the reduction of surface water availability. Water scarcity will be more acute in the coming future if the proposed khal is not re-excavated (Kachua main Khal, Sonamia khal, Chandpura khal and Shutabaria Khal etc.). The top-soil erosion and other anthropogenic activities in connection with land development may cause further siltation in the khals, and the water carrying capacity might be further constrained in future. The study infers that around 10% people in the Polder might be suffering from water scarcity in future, if the project is not implemented.

Future-with-Project

The study infers that if re-excavation works are carried out as per design, an additional volume of 59,000 $m^3$of water would be available in the water courses within the polder. Assuming 60% flow probability on an annual average due to seasonal water fluctuation and other water losses, it can be said that around 3% people would still remain under water stress.

Impacts

From the spatial distribution of khals to be re-excavated, it is observed that around 1856 people (7% of total population) in adjacent mauzas would have sufficient surface water and access to the same. This would result in immense benefits in water use. Water for domestic purposes would also be increased; moreover water for irrigation would also be available substantially during dry season.

b. Drainage congestion and water logging

Future-without-Project

The existing khals usually drain out a large volume of water after any major rainfall (Kachua main Khal, Sonamia khal, Chandpura khal and Shutabaria Khal etc.) have gradually been silted up over the years mainly due to poor maintenance of water control structures. Approximately 7 km length of water courses within the polder may suffer from drainage congestion in future. This may result other environmental and social problems as well. However, no water logging problems has observed inside the polder.

Future-with-Project

The proposed re-excavation works if executed are carried out and water control structures are fully been repaired as suggested, the drainage congestion problems in most of the peripheral portions can be reduced. The khals would not be affected by drainage congestion problems, and this would also reduce other associated problems. Furthermore, the construction of proposed outlet at the opening of Durlob khal would prevent possible drainage congestion in that khal.

Impact

Considering the ‘future without project’ and the ‘future with project’ scenarios, it can be concluded that around 7 km of khals (20% of total) would be benefited from drainage congestion in future, due to the overall improvement in the drainage capacity of re-excavated khals.

8.5.2 Land Resources

a. Agriculture land use

Future-without-Project

Presently, NCA is about 69% of the gross area. Of the net cultivable area single, double and triple cropped area as practiced are 10%, 78% and 12% respectively. The polder if not rehabilitated, utilization of land for single, double and triple crop would be about 19%, 73 % and 8% of the NCA respectively under FWOP condition (Table 8.4.)

Table 8.4: Detailed agriculture land use of the polder area

Agriculture land use	Baseline	FWOP	FWIP	Impact
	% of NCA	% of NCA	% of NCA	(FWIP-FWOP)
Single crop	10	19	5	-14
Double crop	78	73	77	+4
Triple	12	8	18	+10
Total =	**100**	**100**	**100**	**-**

Source: Estimation based on field information, 2019

Future-with-Project

The interventions if executed would increase the land use of the polder areas. Drainage congestion is expected to be removed due to implementation of various interventions of the polder. The area under different land types would be improved which would create scope of enhanced land use. It is expected that re-sectioning of embankment, repairing of drainage / flushing sluice, drainage Outlet, repair of irrigation Inlets etc. would enhance land utilization. However, the land utilization for single, double and triple cropped area would be 5%, 77% and 18% of NCA respectively in future with project condition. Detailed land use has been presented in Table 8.5.

Impact

The overall impact of different options on land use would be very positive. Single cropped area may decrease by 14% while double and triple cropped area would be increase by 4%, 10% of the NCA respectively under FWIP condition. Detailed land use has been presented in Table 8.5.

8.5.3 Agricultural Resources

a. Cropping pattern and intensity

Future-without-Project

Presently, cropping intensity of the polder area is about 202%. The proposed interventions in the polder if not implemented, the land type as well as land use would be degraded in absence of embankments, structures and siltation of river and drainage channels. Under this condition, there would be negative impacts. The cropping intensity is expected to change to about 189% (Table 8.5).

Table 8.5: Cropping intensity under FWOP and FWIP condition in the polder area

CI (%)	**Baseline** % of NCA	**FWOP** % of NCA	**FWIP** % of NCA	**Impact (FWIP-FWOP)**
Cropping Intensity	***202***	***189***	***213***	***+24***

Source: Estimation based on field information, 2019

Future-with-Project

Implementation of the interventions would increase the cropping intensity due to improvement of land type of the polder area. The future with polder condition would help to change the hydrologic regime inside the polder area, which might encourage the farmers to change their cropping patterns as shown in Table 8.5. Under FWIP condition, the structures would function properly and would drain the excess water during rainy season from the cultivable land as a result land type might be improved. The improved land type would influence the farmers to practices multiple cropping in the polder area and more HYV will be cultivated. After completion of the interventions, the cropping intensity is expected to increase to 214%.

Impact

It is expected that, more crops will be cultivated. Farmers will so far more HYVs and cropping intensity would be increased by about 24% under FWIP over FWOP.

b. Crop production

Future-without-Project

Presently, total crop production is 20,691 tons of which rice is 8,291 tons (40%) and non rice crop is 12,401 tons (60%). 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 7,365 tons of rice is expected to be produced and a total of 9,774 tons non-rice would also be produced (Table 8.6).

Table 8.6: Impact on crop production in the polder area

Crop name	Production (ton)			Impact (FWIP-FWOP)	% of Impact
	Baseline	FWOP	FWIP		
Lt. Aus	664	589	723	134	22.75
Lt. Aman	5,883	5,578	6,939	1,361	24.40
HYV Boro	1,743	1,198	2,203	1,005	83.89
Total rice	**8,291**	**7,365**	**9,865**	**2,500**	**33.94**
Mungbean	983	778	1,234	456	58.61
Kheshari	354	290	423	133	45.86
Watermelon	8715	6578	10245	3667	55.75
Chilli	343	298	556	258	86.58
Potato	1862	1689	2098	409	24.22
Groundnut	144	141	256	115	81.56
Total non-rice	**12,401**	**9,774**	**14,812**	**5,038**	**51.54**
Grand Total	**20,691**	**17,139**	**24,677**	**7,538**	**43.98**

Source: Estimation from field information, 2019

Future-with-Project

The crop production would boost up significantly under the FWIP condition. The total crop production would be 24,677 tons of which rice would be 9,865 tons and non-rice would be about 14,812 tons. The rice and non-rice production would respectively be about 34% and 52% higher in FWIP than those of FWOP. Rice production would be increased due to expansion of Aman, HYV Boro, Mungbean and Watermelon cultivation area.

Impact

Additional 2,500 tons (34%) of rice and 5,038 tons (52%) of non-rice crop would be produced in FWIP over FWOP Table 8.6.

c. Crop damage

Future-without-Project

Presently, total crop production loss is about 805 tons of which rice is 598 tons and non-rice is 207 tons due to drainage congestion, scarcity of irrigation water etc. The situation would aggravate more under FWOP condition. Total 848 tons of rice and 222 tons of non-rice crops production would be lost under FWOP situation (Table 8.7).

Table 8.7: Impact on crop production loss in the polder area

Crop name	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	% of Impact
Lt. Aman	443	503	210	-293	-0.58
HYV Aman	155	345	56	-289	-0.84
Total rice =	**598**	**848**	**315**	**-533**	**-0.63**
Khesari	10	35	0	-35	-1.00
Watermelon	108	321	12	-309	-0.96
Chilli	28	65	9	-56	-0.86
Potato	48	87	5	-82	-0.94
Groundnut	13	19	7	-12	-0.63
Total non-rice =	**207**	**222**	**93**	**-129**	**-0.58**
Total =	**805**	**1,070**	**408**	**-662**	**-0.62**

Source: Field information, 2019

Future-with-Project

Crop damage would be reduced by 62% for the implementation of interventions and their proper management. The interventions would have positive impact in reducing crop damage area as well as

crop production loss. The total rice production loss would be 315 tons and 93 tons of non-rice crops production would be lost in FWIP situation

Impact

It is expected that loss of crop production would be reduced by 662 tons which would be 62% less in FWIP over FWOP.

d. Irrigated area

Future-without-Project

Presently, irrigated area is about 450 ha. The interventions if not be implemented, the soil salinity would be increased beyond the critical limit (<4.0 dS/m) and the availability of surface water in the river would decrease due to siltation of river and khals in area. The irrigated area would decrease to about 389 ha in FWIP.

Future-with-Project

After implementation of the proposed interventions in the polder, water will be available and retained in the river and khals. Irrigation can be provided from river and different khals in Rabi crops by using LLPs up to February. The irrigated area would increase to 608 ha in FWIP.

Impact

It is expected that, irrigated area would be increased by 219 ha under FWIP over FWOP.

8.5.4 Fisheries Resources

a. Fish habitat and habitat quality

Future-without-Project

In future without project situation, continuous siltation would cause scarcity in water availability in the internal khal. As consequences, perennial khals would be converted to seasonal khal even a portion of the khal would become agriculture land. It is assumed that about 40% of khal would become seasonal khal. Open water fish habitat would be decreased and its water quality for fish habitation would also be declined.

Future-with-Project

Water depth as well as water availability in the internal khals would be increased due to re-excavation of khal. Silted up resulted seasonal khals would be again converted perennial khals. Water quality of those khal and their connectivity would be enhanced for fish habitation. But feeding and breading ground of bottom dweller fish species would damaged due to re-excavation of khals. Turbidity of the water in the khals would be increased. Increased turbidity would hamper to increase of primary productivity. For less primary productivity, fish production may be slightly reduced. Such impact is temporary and after 1 or 2 year of re-excavation, would be improved.

Impact

Seasonal khal would again turn into perennial. The improved habitat quality would support different types of fishes and aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota.

a. Fish movement and migration

Future-without-Project

Most of the freshwater and brackish water fish species as well as fish hatchling move from river to khal through sluice gate at some stage of their life cycle for nursing and feeding purpose. Substantial progress of khal bed siltation would lead to reduce the water depth. Thus, fish movement and migration would be hampered from river to khal and vice-versa. In FWOP condition, hatchling and fish movement would be facilitated round the year due to existing malfunctioning and mismanagement of water control structures.

Future-with-Project

The movement of hatchling of brackish and fresh water fish from river to polder area would be obstructed / regulated due to repairing of sluices and drainage inlets and outlets. Brackish water fish species like *Puti, Chingri, Tengra, Baila* and *Pairsa, vetki* etc which moves on regular basis during high tide would be limited due to repairing of sluices/ regulators. But increased water depth and water availability in the khal due to re-excavation would facilitate the internal fish movement and migration significantly.

Impact

Movement of both brackish and fresh water fish species as well as hatchling through water control structures would be slightly hampered. But internal fish movement and migration would be facilitated significantly.

b. Fisheries productivity

Future-without-Project

The Catch per Unit Area (CPUA) in future without project situation would be reduced for the continuity of the ongoing process of siltation in the khal as well as rising of the bed level of khals. Many fish species may disappear from this habitat which ultimately will lead a decrease the fish biodiversity in the polder area. It is assumed that capture fisheries productivity would be decreased by 10% from the base condition. The estimated productivity of capture fisheries might be 117 kg/ha where base line productivity is 130 kg/ha. Production of snake head fish species like *Taki, Cheng, Shol, Gojar* etc and benthic species like *Baim, Gutum, Shing, Magur, Meni* etc may increase for low water depth and excessive duck weed in future without project situation.

Future-with-Project

Implementation of proposed activities especially the re-excavation of khal would increase the water depth, water availability as well as water quality of the khals.Due to increase of water depth and water availability, Catch per Unit Area (CPUA) of fish in the polder will be increased in future with project situation. Moreover, improved fish habitat and habitat quality would change the fish diversity and its fish composition. The open water fisheries productivity would be increased, especially the productivity of carp and SIS would be increased significantly while production of snake head and benthic fishes may be decreased for destroying its congenial environment by removal of duck weeds. It is expected that the capture fisheries productivity would be increased by 15% (147 kg/ha) compare to that of the baseline situation (130 kg/ha). On the other hand, re-sectioning of embankment and repairing of water control structures would the reduce flood vulnerability to aquaculture pond. Therefore, area of culture fisheries might be increased which would boost up the culture fisheries productivity.

Impact

Capture fisheries productivity would be increased by 30 kg/ha. Culture fish productivity would also increase significantly.

8.5.5 Ecological Resources

a. Terrestrial vegetation

Future-without-Project

Terrestrial vegetation including climbers, herbs, shrubs, trees will be further deteriorated due to increase of soil salinity, drainage congestion and riverbank erosion. Currently, there is no high-density settlement but moderate. It is also observed that, settlement density is higher in line with the polder embankments and lower near the peripheral settlement of the polder.

In addition, yearly riverbank erosion, natural disaster is also another threat that destroys homestead as well as terrestrial vegetation. Malfunctioning of water control structures like regulators causes insufficient drainage and flashing capacity of the polder area, which causes vegetation damage. Intrusion of saline water will be degraded habitat quality, and vegetation loss those disrupt in continuation of ecosystem services.

Future with Project

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

Impact

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

a. 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 go under further degradation due to in sufficient water in the khals especially in the dry season.

Future with Project

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

Impact

In future the aquatic habitat quality will improve for sure. Moreover, after implementation of the designed 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

- **Social Use of Water**

Future without Project

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

Future with Project

With the intervention, 35% families would be good, 15% families would be poor and 50 % families would be medium access to social use of water and benefited through this project.

Impact

The standard life for 3,890 HHs would be good and 6,423 HHs would be medium access to social use of water. Around 30% people inside polder 55/2C would be benefitted with sufficient fresh water availability and access, which would result in benefits in domestic water use. Besides, water for irrigation would also substantially be improved.

- **Gender Promotion**

Future without Project

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

Future with Project

According to the project plan, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS. Thus, employment access to females in the construction works and during operation /maintenance phase will be promoted significantly and they can also take part in different decision-making processes.

Impact

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

- **Employment generation**

Future without Project

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

Future with Project

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

Impact

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

Table 8.8: Matrix on Impact Assessment with regard to Post-construction Phase

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
Water Resources				
Water Security	People of polder 55/2C cannot meet up their domestic, drinking and irrigation water requirements and around 10% people within the polder remain under water stress.	Water security may further deteriorate with flooding and around 20% people would remain under water stress.	Domestic water security may improve, but around 5% people may still be subjected to drinking water stress	+4
Tidal Flooding	Very limited tidal flooding occurs within the polder.	Some areas may be subjected to regular tidal flooding.	Tidal flooding would be completely prevented.	+3
Erosion Vulnerability	No area vulnerable to erosion as reported by the local people and as observed during field visits.	Modhupura, Sutabaria, Ronua Bazar and Alipura sluice areas may be fallen in erosion vulnerability.	The embankment would expected to be further strengthened and secured due to implementation of embankment re-sectioning works.	+2
Drainage congestion and water logging	Presently, around 30% of the khals inside the polder suffer from drainage congestio, 42 khals are moderately suffer in drainage congestion.	Around 80% of khals inside the polder would suffer from moderate to severe drainage congestion.	Re-excavation of khals may improve the drainage status of the area, and decrease the risk of emergence of water logging problems at some portions of the polder.	+4
Land Resources				
Agriculture land use	Presently, NCA is about 69% of the gross area. Of the net cultivable area single, double and triple cropped area is about 10%, 78% and 12% respectively.	If the project is not implemented, single, double and triple cropping would be practiced in about 19%, 73% and 8% of the NCA respectively.	The overall impact of different options on land use would be very positive. Single cropped area would decrease by about 14%, and double and triple cropped area would increase by 4% and 10% of the NCA respectively under FWIP condition	+3
Soil salinity	Most of the areas are affected due to capillary raise of saline ground water during dry season which is unfavorable for crop production and as a result the land remains fallow.	Salinity would be increased.	The successful implementation of the project and its proper management would reduce the salinity of the polder area.	+2

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
Agricultural Resources				
Cropping pattern and intensity	Presently, cropping intensity of the polder area is about 202%.	Cropping intensity would be reduced to 189%.	Cropping intensity would be increased to about 213%.	+3
Crop production	Presently, total crop production is 20,691 tons of which rice is 8,291 tons (40%), and non-rice crops is 12,401(60%) tons.	The total crop production would be decreased from the baseline situation by 3,552 tons in FWOP.	Crop production would be boosted up significantly under the FWIP condition. The total crop production would be increased by about 7,538 tons in FWIP over FWOP.	+4
Crop damage	Crops are presently damaged in the polder area due to water lodging in the pre-monsoon and monsoon season and drought in the winter months. Presently, the salinity problem is the great problems in the polder areas.	The situation would be aggravated under FWOP condition.	It is expected that loss of crop production would be reduced which would be about 62 % less in FWIP over FWOP.	+4
Irrigated area	Presently, irrigated area is about 450 ha.	The availability of surface water in the pond and khals would decrease due to siltation of river and khals. Irrigated area expected to decrease about 389 ha.	After implementation of the proposed interventions in the polder, water will be available and retained in the ponds and khals. Irrigated area would be increased by 219 ha in FWIP over FWOP	+4
Fisheries Resources				
Fish habitat and habitat quality	• Tidal in nature • Silted up and low water availability	• Perennial khals would be converted to seasonal khals • Habitat quality would be declined with damage of feeding and breeding ground.	• Habitat quality would be improved. • This habitat would support to grow different types of aquatic vegetation which would be used for fish feeding and habitation.	+2
Fish movement and migration	• Fresh and brackish fish species move and migrate through water control structures on regular basis during high tide	• Same as base condition or would be increased	• Fish movement and hatchling would be restricted but internal movement and migration would be improved	+2
Capture fisheries productivity	Capture fisheries production in	Capture fisheries production would	Capture fisheries production would	+3

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
	Khal is about 130 kg/ha	decrease to 117 kg/ha	increase to about 147 kg/ha	
Ecological Resources				
Terrestrial vegetation	Low	▪ Increase threats on surrounding vegetation due to river erosion, increasing salinity, 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 plants. ▪ Reduced depth for continuous siltation caused internal khals habitat deterioration	▪ Improve aquatic habitat due to improvement of plant diversity as well as khal depth and velocity	+2
Socio-economic Condition				
Social Use of Water	People can less use water for taking shower, washing clothes, washing utensil and others purposes due to unavailability of fresh water bodies. At present 25 % families have poor access and 75 % families have medium access to social use of water.	In without project situation this number will be 35% for poor and 65% medium access.	With the intervention, 35% families would be good, 15% families would be poor and 50 % families would be medium access to social use of water and benefited through this project.	+2

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
Gender Promotion	In the polder area only 30 % female members are working whereas 70% male members are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, women are mostly vulnerable and widows who are dependent on others and do not have any definite sources of income. Therefore, in without project situation, this opportunity may not be ensured for gender promotion	According to the project plan, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS. Thus, employment access to females in the construction works and during operation /maintenance phase.	+3
Employment generation	Employment opportunities are 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

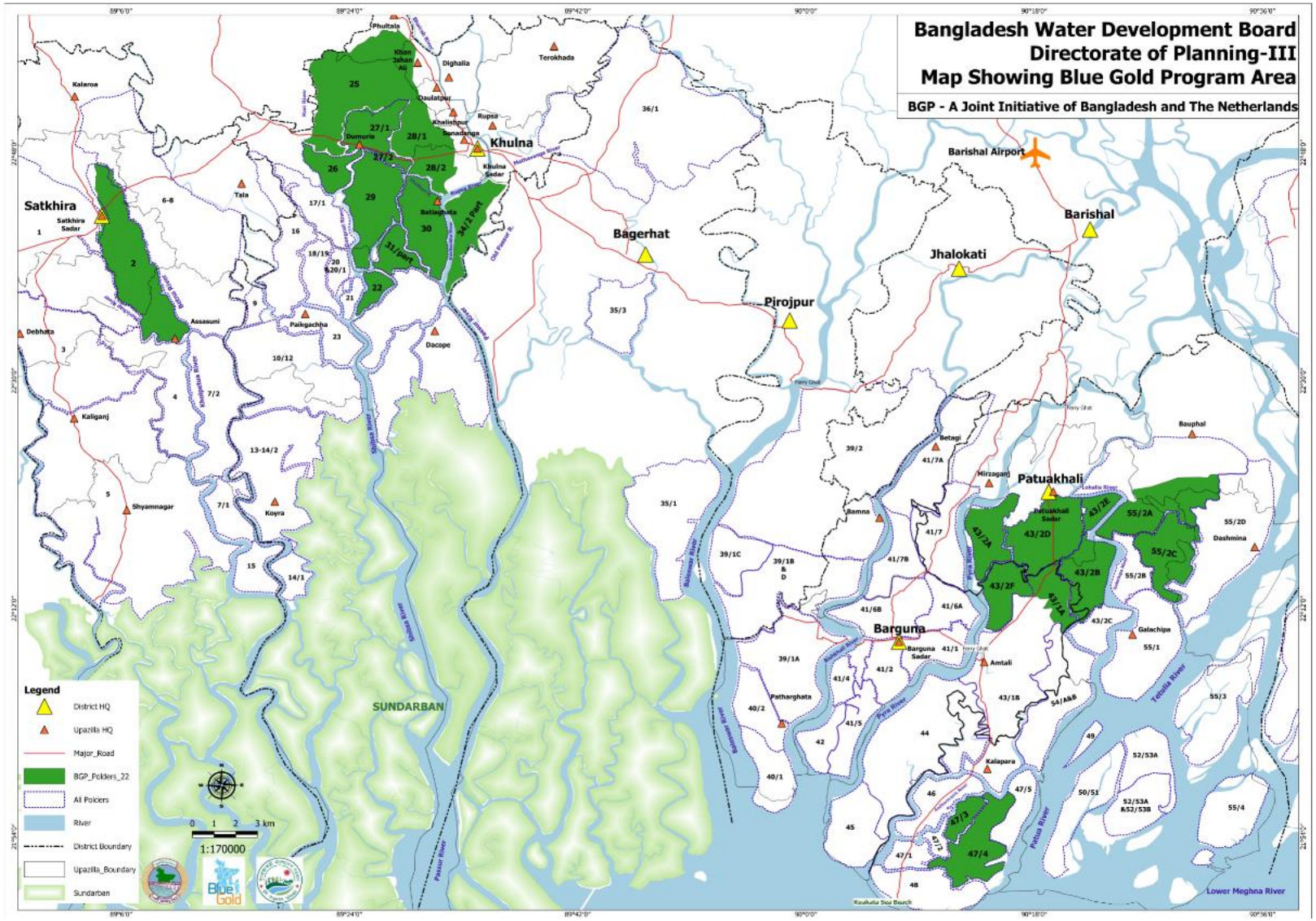
This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 55/2C. These effects include cumulative and induced impacts of Polder 55/2C, and the reciprocal impacts of climate change and polder. Cumulative impacts entail the total of all impacts to a particular resource that have occurred, or occurring, or may occur as a result of any action or influence in the surrounding area, Apart from the Blue Gold, a number of other projects In the vicinity of Polder 55/2C polders also exist. 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 55/2C

A total number of 12 polders in Satkhira, Khulna and Patuakhali districts have been selected for implementation of the program in the first phase. The selected polders are shown in **Map 9.1** below. Among these, Polders 55/2A are located adjacent to Polder 55/2C and therefore, may generate some impacts in future. The existing crest levels of Polder 55/2C ranges from 3.65 to 3.86 m above MSL and that of Polder 55/2C ranges from 3 to 4 m above MSL. Rate of sedimentation may increase along the Lohalia River if re-sectioning of the embankment is executed in Polder 55/2C. This is because when the crest levels of these polders would be raised up to an elevation of 4.27 m above MSL and some of the water control structures would be repaired and reconstructed, tidal flow from the Lohalia River may not enter the polders, which would confine the river sediments within these two river system. With reduced river sections along the river, flow velocity might also increase, creating more pressure along the South-West corner of Polder 55/2C. This may increase river erosion in Polder 55/2C in future. Formation of adjacent polders may have a major impact on the socio-economic scenario. Due to similar physical and social structure, local communities from these polders may collaborate and cooperate in various ventures which might change the social and economic spectrum of this area.

9.2.1 Synopsis of projects around Polder 55/2C

Apart from Blue Gold interventions, there are some other development projects nearby Polder 55/2C, 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 55/2C, undertaken by different line agencies in Patuakhali and Barisal districts.



Map 9.1: Location of Polders selected for Blue Gold Program

Table 9.1: List of water management projects

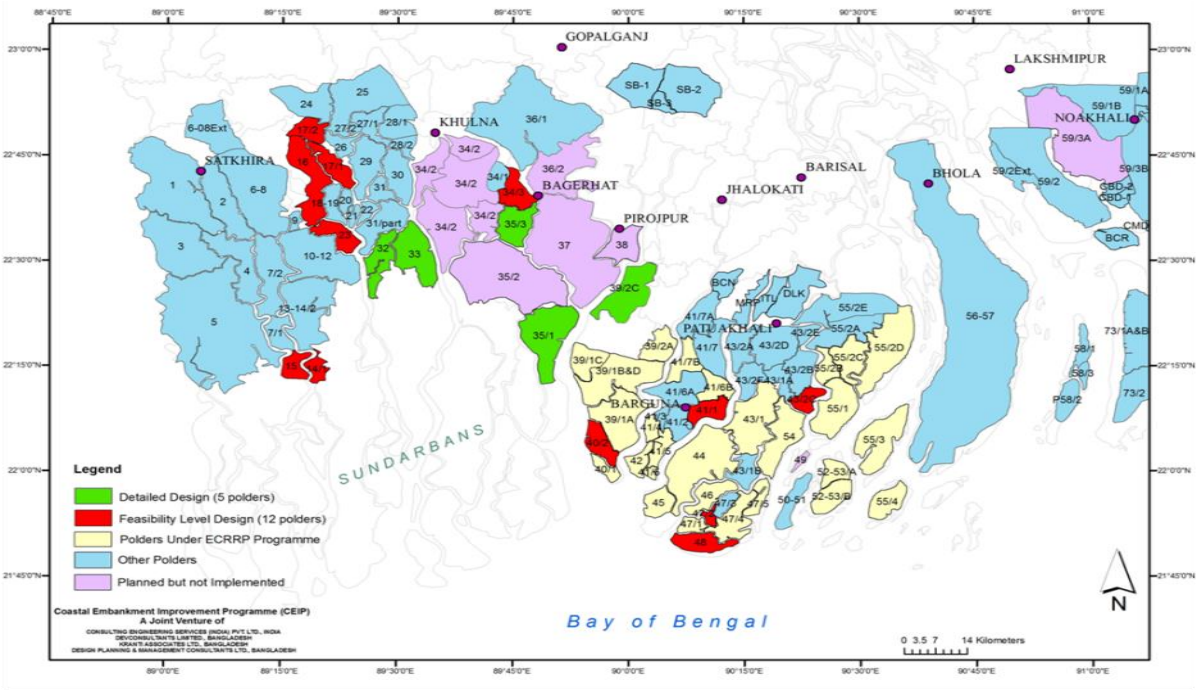
Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
BWDB	Projects under Climate Change Trust Fund	2013-ongoing	Entire country	Low	
	Capital Dredging of River system of Bangladesh	2012-2015	Entire country	Low	
	Water Management Improvement Project (WMIP)	2010-2014	Entire country	Negligible	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 55/2C
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	

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 55/2C 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.

Polder 55/2C are adjacent to Polder 55/2C. The existing crest levels of Polder 55/2C 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 55/2C. Furthermore, if bank revetment works are implemented in Polder 55/2C, the stability of river banks may increase, but would create pressure on Polder 55/2C and the risk of river erosion in this part would increase.



Map 9.2: Location of CEIP polders

9.2.3 Cumulative Impacts of Other Projects

A number of other projects as shown in Table 9.1 are functioning near Polder 55/2C with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located away from Polder 55/2C. A synopsis of the indirect effects of these projects with low sensitivity on Polder 55/2C 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 55/2C. 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 55/2C.

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 55/2C. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 55/2C. 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 55/2C may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 55/2C may be further benefited.

9.3 Induced Impacts of Polder 55/2C

The interventions in Polder 55/2C 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 55/2C is an existing polder and was further developed under IPSWAM. The proposed rehabilitation works

are to cause very minor alteration of the environmental setup outside the polder. Therefore, induced impacts likely to occur are minor and as such discussed qualitatively.

River Sedimentation

The proposed interventions in Polder 55/2C will safeguard the polder against direct intrusion of tidal water. Therefore, water from Lohalia River carrying sediments will move further downstream or upstream and may cause induced sedimentation. The river system may be subjected to increased floodplain siltation and new morphological changes (i.e. formation of new lands, river course shifting) may be developed along the Lohalia River.

Tidal and Storm Surge Flooding

Polder 55/2C located adjacent to Polder 55/2C. As per design, the crest level of Polder 55/2C would be raised up to 4.3 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders during extreme events. Tidal water may not be able to enter Polder 55/2C during such events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders.

Affect on water quality

The interventions in Polder 55/2C would lead to infrastructural developments, increased settlements and other human induced output in future. This would generate debris/ waste which may reach the peripheral rivers. Pollution phenomena might increase in the peripheral Lohalia River. Furthermore, due to expansion of agricultural area, more agriculture practices and industrialisation are expected, which might pollute the chemical composition of surface water system near the polder.

Changes in aquatic habitat, species migration and biodiversity

Due to increased floodplain sedimentation outside the polder, aquatic habitat may slightly be affected. Flow sections may decrease considerably and spacing for aquatic habitat might change. With the increased flow velocity along the upstream and downstream of the polder, new options for species migration and biodiversities may be opened up. Salinity concentration might increase in the peripheral rivers in future as a consequence of prevention of dry season entry of saline water, for which the salinity tolerant aquatic species may dominate while fresh water aquatic species may decrease. Biodiversity of aquatic life may also decrease in the Lohalia River.

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 55/2C, new employment opportunities would be created. This may encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

The proposed interventions would drive agro-economic development inside the polder. Thus, the area may provide enhanced food security to the surrounding areas. In future, Polder 55/2C 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 55/2C, 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.

Digital Elevation Model (DEM)

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

Land Use Data

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

Soil Data

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

Weather Data

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

Climate Change Data

The 50 percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in Table 9.2. The results infer that the monthly rainfall will increase for the period of April to October and decrease for November to March. Around 20% of the monthly rainfall will be decreased by 2050s for December and January though the amount of rainfall is very low during that period. 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 9.2: Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for polder 55/2C

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (^{0}C)
Jan	-17.4	1.9
Feb	-8.2	1.9
Mar	-2.7	2.0
Apr	5.8	1.9
May	5.5	1.8
Jun	0.6	1.6
Jul	1.5	1.7
Aug	3.5	1.8
Sep	1.5	1.7
Oct	4.2	1.7
Nov	-3.0	1.7
Dec	-19.5	1.7

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

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

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

Scenarios	Sea Level Rise (m)
B1	0.18 – 0.38
A1T	0.20 – 0.45
B2	0.20 – 0.43

climate scenario A1F1. For A1B scenario, the range of sea level rise is 0.21 to 0.48 m.	A1B	0.21 – 0.48
	A2	0.23 – 0.51
	A1FI	0.26 – 0.59
	B1	0.18 – 0.38
Source: IPCC AR4	A1T	0.20 – 0.45

Model water level data at Chandpur and Hatiya is shown in Figure 9.1. The model has been calibrated only for the maximum and minimum water level due to the unavailability of hourly or three hourly time series data. The model shows good agreement with the observed water level for both high and low tides at Hatiya and for the Chandpur, the model can capture the high tide but slightly over-estimate during the low tide. In a word, the model performs well to simulate the tidal fluctuations.

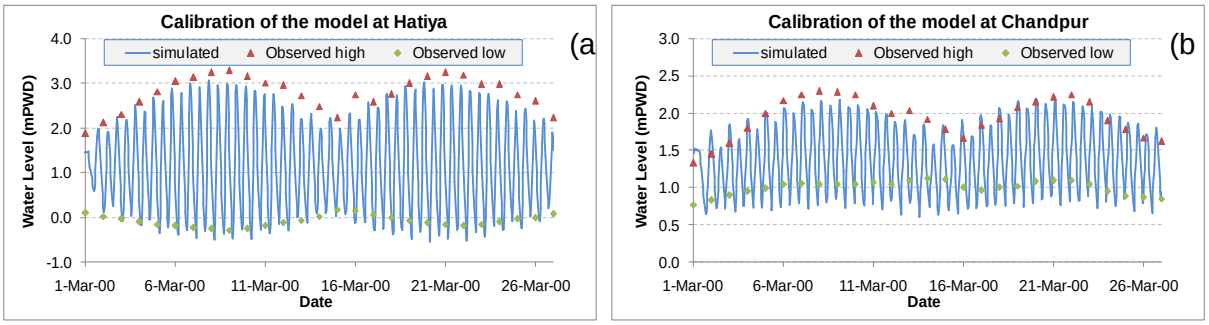


Figure 9.1: Calibration of model results at (a) Hatiya and (b) Chandpur for March, 2000

The simulation results of the annual water for the Polder 55/2C is shown in Figure 9.3 for the simulation period of 1981 to 2012. The average annual rainfall of Polder 55/2C 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 55/2C.

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.

9.4.1 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 55/2C is given in Table 9.4 for climate change scenario A1B by 2050s. The annual average rainfall for the polder area will be 1865 mm which is about 3% more than the base condition. The surface runoff 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.

Table 9.4: Climate change impact on water balance for the scenario A1B by 2050s

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC 2050s
Rainfall	1812	1865
Surface Runoff	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

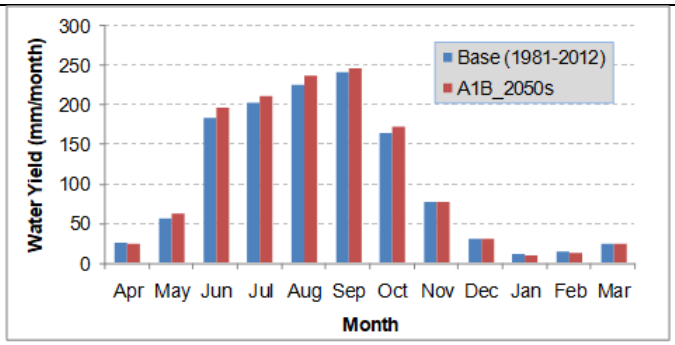


Figure 9.2: Climate change impact on monthly water yield for climate scenario A1B by 2050s

Table 9.5 below show the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows considerable increase in seasonal water yield during monsoon (4.4 %) and decrease during dry season (5.4%). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

Table 9.5: Climate Change impact on seasonal water yield by 2050s for scenario A1B

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

9.4.2 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 Padma River will be reduced by 5% 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 55/2C will increase by 1.7 ppt during the dry period. The increase in river salinity may cause increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.3 Climate Change Impact on Salinity

Sea level rise can cause saline water move upstream further, 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.

With reduced dry season flow of the Gorai River will be reduced by 15% and 0.5 m of sea level rise has been considered. From the simulation, it has been found that the salinity level of the rivers adjacent to the Polder 55/2C 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 problem of drinking water and irrigation water for the polder area.

9.4.4 Climate Change Resilience Developed in Polder 55/2C

The local people in Polder 55/2Care aware of the climate change consequences and natural hazards. In recent years they have been affected by frequent climate change induced natural disasters, causing massive loss to lives and properties. Due to some of the initiatives taken through different software interventions by programs other than Blue Gold, the insight of climate resilience has already been developed within the polder habitants. Through the community mobilization in Blue Gold program, local people have become more active towards building a climate resilient society. They are now driven by the concept of climate smart village. The people who can afford are now rebuilding their houses and infrastructures on higher plinth 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 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 operation phases against the impacts on the IESCs pertaining to water resources, land and agriculture resources, fisheries resources, ecological resources and socio-economic conditions together with a necessary monitoring program.

10.1 Water Resources

10.1.1 Pre-construction and Construction phases

No significant positive or negative impacts on water resources have been foreseen during both pre-construction and construction phases for implementation of the proposed interventions in Polder 55/2C. As such, no activities under the proposed EMP have been recommended for these phases.

10.1.2 Operation phase

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

Table 10.1: EMP Matrix for 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: Surface water availability				
People in the Polder would be benefitted for having sufficient surface water availability and access to water for irrigation, domestic uses, bathing, cattle, wild lives etc.	Not required	Not required	+4	-
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 by about 14% but double and triple cropped area would increase by 4%, 10% respectively in FWIP over FWOP.	-	• 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 polder activities.	+3	BWDB, DAE and WMGs

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

10.3 Agricultural Resources

10.3.1 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 that cropping intensity would increase by about 24%.	-	• Involvement of WMGs in polder activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs
Additional 2,500 tons (34%) of rice and 5,038 tons (52%) of non-rice would be produced in FWIP over FWOP.	-	• Organic manure should be applied for 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 polder activities which would enhance crop production. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+5	BWDB, DAE and WMGs
It is expected that loss of cleaned crop production would be reduced to 662 tons which	-	• The repair of flushing sluice, drainage Outlet and irrigation Inlet would help to reduce crop damage situation. • The Water Management Groups (WMGs) should be given orientation to protect	+4	BWDB, DAE and WMGs

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
would be 62% less in FWIP over FWOP.		their standing crops from implementation of the intervention and development on farm water management etc		
The irrigated area would be increased by 219 ha in FWIP over FWOP.	-	• Training may be provided to WMGs on "integrated water management" • The WMGs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area.	+3	BWDB, BADC, DAE and WMGs

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

10.4 Fisheries Resources

10.4.1 Pre-construction phase

No significant positive or negative impacts on fisheries resources have been foreseen during pre-construction phase for the implementation of proposed interventions in Polder 55/2C. As such, no activities under the proposed EMP have been recommended in this phase.

10.4.2 Construction phase

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

Table 10.5: EMP Matrix for Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
• Movement and migration of fish species like *Chingri, Baila, Pairsa, Vetki* and fresh water fish like *Puti, Tengra* and SIS etc would be obstructed/limited during repairing of structures. • Feeding and breeding ground of bottom dweller fishes will be lost	• Avoid construction activities during fish migration period e.g. month of June to August • Re-excavation activity should be implemented in segment wise • Re-excavated earth earth should be dumped at a setback distance from the khals • To protect indigenous fishes and other aquatic creators, re-excavation should be implemented in segment wise and one after another.	N/A	0	Contractor, BWDB, Department of Fisheries (DoF)

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

10.4.3 Post-construction phase

The implementation of proposed interventions may generate some long term positive or negative impacts on fisheries resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impact, enhancement for positive impacts and compensation, or contingency measures for immitigable residual impacts as discussed in the following Table 10.6.

Table 10.6: EMP Matrix for Post-Construction Phase on Fisheries Resources

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

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Seasonal khal will be perennial again. The improved habitat quality will support different types of fishes as well as aquatic vegetation which will be helpful for fish feeding and habitation.	NA	• Excavated khal should keep free from encroachment • 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.	+3	Department of Fisheries in coordination with WMC
Movement of both brackish and fresh water fish species as well as hatchling movement through water control structures will be hampered slightly. But internal fish migration will be facilitated significantly.	NA	• Properly and timely gate will be opened to entrance the fish hatchling in the month of May to July except the tidal surge. • Water Management Committee should be formed including fishers representative.	+3	Department of Fisheries in coordination with Water Management Committee
Capture fisheries productivity in the polder area would be increased by 30 kg/ha.		• keeping free from encroachment of re-excavated khal • Construct deep pool in the perennial khals	+4	Department o Fisheries i coordination with pon owners.

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

10.5 Ecological Resources

10.5.1 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 55/2C. 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 temporarily loss of habitat	• Plantation along the slopes of embankment after completing the earth works; • construction activities should be avoided in the early morning and night to evade disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: *Construction of drainage outlet*				
• Temporary reduction of habitat quality due to obstruction of flow in the khal	• The works should be completed within the scheduled time	N/A	-2	Contractor and BWDB
Activity: *Re-excavation of khal*				
• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes e.g. Egret. • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	• Keep the deepest points of the khal untouched as much as possible; • The works should be completed in scheduled time to minimize habitat disturbance to wildlife	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).*

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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 generating 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 plan, it is about 25% of works will be done by labor constructing society (LCS) of which one third will be done by women LCS. Thus, employment access to females in the construction works and during operation /maintenance phase will be promoted significantly.	+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/ Contingency/ Compensation	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

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 55/2C of BGP entails excavation of 10 numbers of khals which would generate a volume of around 192,000 m^3 of Re-excavated earth. A few of this volume be temporarily used for cross dam/cross bundh construction to facilitate bailing out of water from khal bed. 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 re-excavated earth earth for their community uses, like filling up playground, school, hut-bazar, clinic, union parishod etc. Tese common us has been encouraged. Even few stakeholder willing to use those re-excavated earth for raising their houses and homestead. 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.

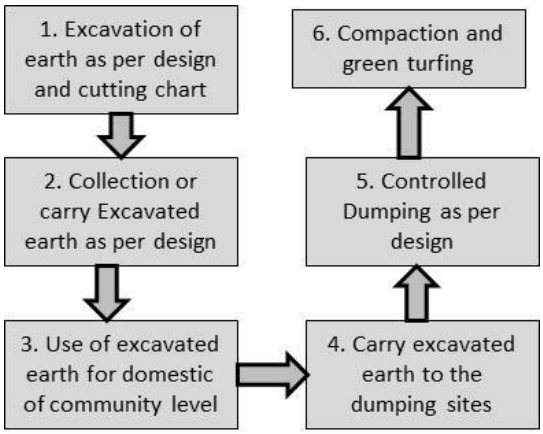

Figure 10.1: Framework for Re-excavated earth Management Plan

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 40000 m^3 Re-excavated earth would be collected by for different uses. The residual portion (around 1,12,000 m^3) of Re-excavated earth may then be disposed on both in a controlled manner.

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

Khals to be Excavated	Excavated Volume (m^3)	Uses of Excavated Soil	Volume (m^3) to be used
Katakhali Branch Khal	9235	Carrying loss	20,000
Katakhali Main Khal	15740		
Kachua Main Khal	20150	Societal uses (uses in household, schools, play grounbd, union parishod, mosques, clinics or other shelters)	40000
Sonamiar Khal	21808		
Jhatibaria Main Khal	11029		
Jhatibaria Branch Khal	3715		
Kallan Kalas Khal	49060		
Kachua Branch khal	10560		
Sutabaria Khal	12770	Dumping along the khal	112000

Khals to be Excavated	Excavated Volume (m^3)	Uses of Excavated Soil	Volume (m^3) to be used
Chandpura khal	10700	bank to develop village road	
Chandpura Branch khal	10260		
Total Excavation	**192,000**	**Total Use**	**192,000**

10.7.2 Phase wise activities of Re-excavated earth Management

A number of activities are proposed to be carried out during different phases associated with efficient management of re-excavated Re-excavated earth (Figure 10.2). Before commencement of khal re-excavation, a number of works are to be carried out, which would include both desk works and field level investigations. These activities would finalize the locations of dumping of Re-excavated earth. During implementation of re-excavation works of khals, a number of activities have been recommended as well. These activities would ensure the environmental sustainability and social viability of the excavation works. Moreover, some activities are suggested to be carried out to enhance the stability of dumping spots, and ensure the environmental sustainability of the area.

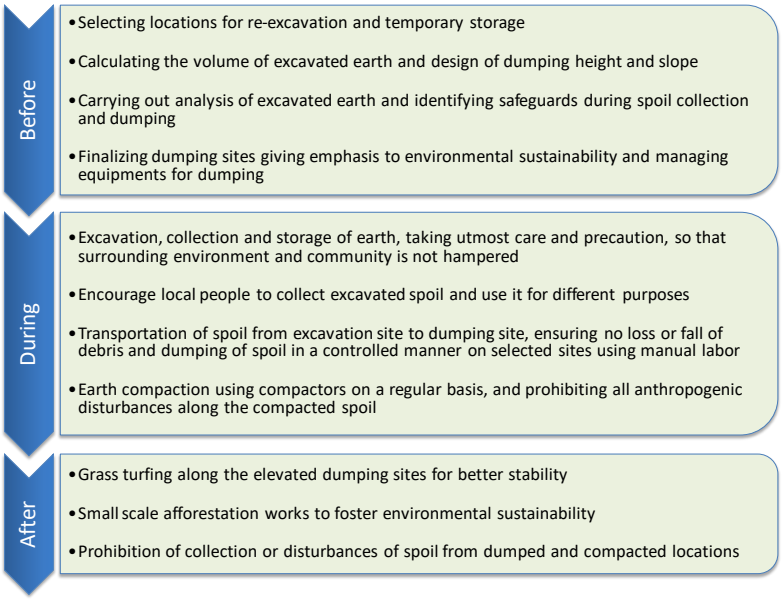

Figure 10.2: Phase wise activities of Re-excavated earth Management

10.7.3 Method of Re-excavated earth Dumping

The proposed re-excavation works for the Polder would require dumping of a significant amount of Re-excavated earth (around 1,92,000 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 55/2C includes 30 km of re-excavation of khals, and if the residual Re-excavated earth (1,92,000 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.

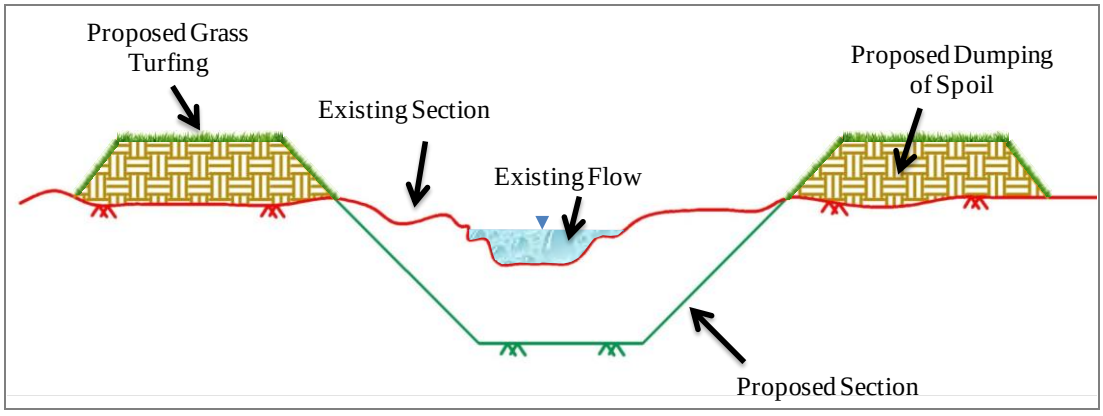

Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

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.

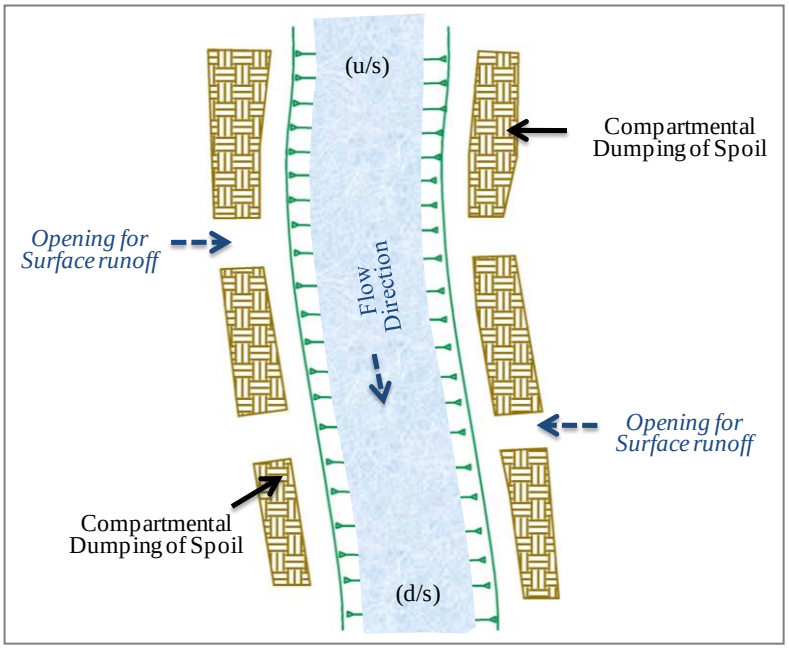

Figure 10.4: Plan form of a typical khal to be re-excavated

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 55/2C.

10.8.2 Monitoring Plan for construction phase

A typical monitoring plan has been prepared which will be followed during construction of rehabilitation of Polder 55/2C. 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	**Field EHS Expert of Contractor**
(Full Name & Signature)	(Full Name & Signature)
*EHS- Environment Health & Safety	
*****RE – Resident Engineer	
***ES – Environmental Supervisor of Consultants.**	

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

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
Species diversity and richness of fish	Catch monitoring/ observations and local fish market survey.	Perennial khals and adjacent floodplain in inside the polder area.	Twice per month in each location and continue two year.	DoF in cooperation with water management committee and local fishers.
Water quality monitoring	Field and laboratory test	Selective gher and khals	Quarterly of a year	Local fish farmer, DoF
Fish hatchling movement	Savar netting	Near sluice gate in major khals.	Once per week during fish migration period (June – August)	DoF in cooperation with Water management committee and 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	Cost (Lakh Tk.)
1	• Formation of WMGs/ WMA/ WMF (GPWM-2002), strengthening of WMGs through imparting training on re-excavation of Khals, Embankment Management Group (EMG), landless Contacting Society (LCS), on farm water management and development etc. • Involvement of WMGs in polder activities would change positively.	1.00	1	Re-excavation of Khals, disposal of Re-excavated earth earth materials for Re-excavated earth management and re-sectioning of embankment etc.	0.75
2	Involvement of WMGs in polder activities would enhance cropping pattern and intensity. Introduction of HYV/Hybrid crops cultivars along with crop diversification need to be practiced.	1.00	2	Cropping intensity	0.50

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
3	Organic manure should be applied for the restoration of soil fertility. Farmers group should have close contact with DAE for adaptation of various measures on ICM. Irrigation should be provided in optimum level with minimum conveyance loss. Involvement of WMGs in polder activities would enhance crop production. Introduction of HYV crops with crop diversification need to be practiced.	2.00	3	Crop production	0.75
4	Dumping of Re-excavated earth earth materials on non-agricultural land. WMGs should be involved in the construction and post construction phase which might reduce crop damage.	1.00	4	Crop damage	0.50
5	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area. • The WMGs should be involved in the integrated water management through proper maintenance of sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.00	5	Irrigated area	0.50
	Total =	**6.00**			**3.00**

Total cost of EMP and monitoring of land and agriculture resources isTaka 9.00 lakh.

10.9.3 Cost of EMP and monitoring of fisheries resources

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
1	Construct fish sanctuary in the deep pool of perennial khals	1.2 (0.6 x 2= 1.2 Tk for two number of sanctuary)	1	Fish hatchling movement in four khals (Two year).	1.0
2	Awareness development on natural resources and disseminate the knowledge about the important in our daily life through several national and international days like Fish Week, Environment Day, Earth day, water Day Rally, Discussion etc. Two year in the polder area.	1.5	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	1.0
3	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring)	Tk 2.0 (Training 1.5 and demonstration pond 0.5 Tk) (Number of pond :4 pond area: about 100 decimal)		-	-
	EMP Cost =	**4.7**		**Monitoring Cost =**	**2.0**
	Total cost =	**6.7**			

Total Cost for EMP and Monitoring of fisheries resources is Taka 6.70 Lakh

10.9.4 Cost of EMP and monitoring of ecological resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
1.	Plantation along the embankment up to 20 km length of embankment	12.0	1	Habitat develop	4.0
			2	Wildlife diversity	4.0
	Total =	**12.0**		**Total =**	**8.0**

Total cost of EMP and monitoring of ecological resources is Taka 20.00lakh.

10.9.5 Cost of EMP and monitoring of socio-economic condition

	Pre-construction	Construction	Post construction	Total/ Lac
Total Monitoring cost	-	-	2.0	2.00
			Grand total =	**2.00**

Total cost of monitoring of socio-economic condition is Taka 2.00 lakh

10.10 Summary of cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost
Water Resources	-	-	-
Land and Agricultural Resources	6.00	3.00	9.00
Fisheries Resources	4.70	2.00	6.70
Ecological Resources	12.00	8.00	20.00
Socio-economic Condition	-	2.00	2.00
Grand Total =	**22.70**	**15.00**	**37.70**

Total cost of EMP and monitoring is BDT 37.70 lakh (Taka thirty seven tlakh and seventy 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 55/2C 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 55/2C. 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 fishes like *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 be encouraged to follow and maintain the EMP.

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

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Appendix-1: Data Collection Checklist

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

Name of Data Collector: Date:

Project Name:

A. Administrative Information

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

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

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

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

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

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

	People's Perception	Measurement
1. Ground water: (Arsenic/Iron/Salinity)		Arsenic: Iron: Salinity:

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

F. Water Use

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

G. Historical severe flood:

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

H. People's opinion about the project

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

I. Collect Project description related information from field office:

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

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

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

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

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

Stockyard information during construction time:

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

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

Agro-ecological regions

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

Land use

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

Land type

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

Soil Texture

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

Soil Salinity

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

Farming practices

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

Major Cropping Pattern by land type

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

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

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

Inputs Used

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

Irrigation

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

Crop production constraints (including land degradation)

Factors	Year of starting LD	Location	Result of LD
Soil erosion			
Sand carpeting			

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

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

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

Feed and Fodder

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

Diseases

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

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

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

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

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

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

Fish Migration				**Fish Biodiversity**		**Species List**					**Species Composition**				
						River	**Khal**	**Beel**	**Pond**	**Other**	**Group**	**River**	**Khal**	**Beel**	**Pond**
Previous Migration Status				Fish diversity status (Poor/Moderate/Rich)/%							Major carp				
											Exotic carp				
											Other carp				
											Catfish				
											Snakehead				
Present Obstacle to fish migration:	1. 2. 3.			Reasons of increase or decrease	1. 2. 3. 4.						Live fish				
											Other fish				
											Shrimp/prawn				
											Hilsa/Bombay duck/Indian salmon				
											Pomfret				
Important breeding, feeding and over wintering ground					5.						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 Wetland9	Area in ha		Flooding depth (m)	Connectivity with river		Importance10
		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	Utilization11

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			

[9] 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

[10] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[11] 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	M L		H M L	

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

Self Assessed Subsistence Poverty

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

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

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

Disaster and Damage (in last five years)

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

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

Migration Trend

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

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

Professional/occupational Conflict

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

Miscellaneous

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

Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

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

Appendix-2: No Objection Certificate

০২ নং আলীপুর ইউনিয়ন পরিষদ কার্যালয়

উপজেলা-দশমিনা, জেলা-পটুয়াখালী

স্মারক নং- ৮৩৭৭), ইউপি-২৮/২২ তারিখ-১৬/১০/২২ই.

অনাপত্তি পত্র

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

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

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

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ ৫৫/২সি, দশমিনা এবং গলাচিপা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
পটুয়াখালী	দশমিনা এবং গলাচিপা				মাঝারী উচু ভূমি	৬২৭৫ হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উচুকরণ, স্লুইজ গেট ও রেগুলেটর মেরামত, খাল পূন:খনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৫৫/২সি পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নবর্নিত অনাপত্তি প্রদান করা হলো।

শর্তাবলীঃ

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

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

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

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

৫। বায়ু ও শব্দ দূষন করা যাবে না।

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

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

তারিখ ঃ ১৬/১০/২২ই. ১৬/১০/২২ই.

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীল

ইঞ্জিঃ বাদশা ফয়সাল আহমেদ
চেয়ারম্যান
২নং আলীপুর ইউনিয়ন পরিষদ
দশমিনা, পটুয়াখালী।

০৭ নং চিকনিকান্দী ইউনিয়ন পরিষদ কার্যালয়

উপজেলা-গলাচিপা, জেলা-পটুয়াখালী

স্মারক নং- চিচনী- ২০/২৩ তারিখ- ২৫/১০/১৯২৩

অনাপত্তি পত্র

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

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

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

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ ৫৫/২সি, দশমিনা এবং গলাচিপা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
পটুয়াখালী	দশমিনা এবং গলাচিপা				মাঝারী উচু ভূমি	৬২৭৫ হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উচুকরণ, স্লুইজ গেট ও রেগুলেটর মেরামত, খাল পূনঃখনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৫৫/২সি পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নবর্নিত অনাপত্তি প্রদান করা হলো।

শর্তাবলীঃ

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

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

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

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

৫। বায়ু ও শব্দ দূষন করা যাবে না।

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

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

তারিখ ঃ ২৫/১০/১৯২৩

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীল

সাজ্জাদ হোসেন (রিয়াদ)
চেয়ারম্যান
৭নং চিকনিকান্দী ইউনিয়ন পরিষদ

০৯ নং কলাগাছিয়া ইউনিয়ন পরিষদ কার্যালয়

উপজেলা-গলাচিপা, জেলা-পটুয়াখালী

স্মারক নং- ক,ইউ.প-২৫/২২ তারিখ-২৫/১০/২২

অনাপত্তি পত্র

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

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

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

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ ৫৫/২সি, দশমিনা এবং গলাচিপা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
পটুয়াখালী	দশমিনা এবং গলাচিপা				মাঝারী উচু ভূমি	৬২৭৫ হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উচুকরণ, স্লুইজ গেট ও রেগুলেটর মেরামত, খাল পুন:খনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৫৫/২সি পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নবর্নিত অনাপত্তি প্রদান করা হলো।

শর্তাবলীঃ

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

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

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

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

৫। বায়ু ও শব্দ দূষন করা যাবে না।

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

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

তারিখ ঃ ২৫/১০/২২

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীল

আলহাজ্ মোঃ দুলাল চৌধুরী
চেয়ারম্যান
৯ নং কলাগাছিয়া ইউ/পিঃ
গলাচিপা, পটুয়াখালী।

Appendix-3: Terms of References

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

Memo No: 22.02.0000.18.72.114.19·506

Date: 04/11/2019

Subject: **Approval of Terms of Reference for EIA of the Proposed Rehabilitation and Improvement of Infrastructure of Four Coastal Polders (Polder-25, 47/3, 47/4 & 55/2C) under Blue Gold Program, Bangladesh Water Development Board, Hasan Court, Motijheel C/A, Dhaka.**

Ref: Your Application received on 22/10/2019.

With reference to your letter received on 22/10/2019 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 Four Coastal Polders (Polder-25, 47/3, 47/4 & 55/2C) under Blue Gold Program, Bangladesh Water Development Board, Hasan Court, Motijheel C/A, Dhaka subject to fulfilling the following terms and conditions.

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

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

4a. Project activities:

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

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

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

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

1

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.

০৭.১১.১৯

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

Director (Planning-III)
& Program Coordinating Director
Blue Gold Program
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, Barishal Divisional Office, Barishal.
3) Director, Department of Environment, Khulna Divisional Office, Khulna.
4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.