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Final Report

on

Environmental Impact Assessment (EIA) on Rehabilitation of Polder 29

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CEGIS Center for Environmental and Geographic Information Services
House 6, Road 23/C, Gulshan-1, Dhaka-1212, Bangladesh. Tel: 8817648-52, Fax: 880-2-8823128

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Abbreviations and Acronym

AEZ	Agro -ecological Zone
ASA	Association for Social Advancement
BAU	Bangladesh Agricultural University
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BG	Blue Gold
BMD	Bangladesh Metrological Department
BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBO	Community Based Organizations
CDSP	Char Development and Settlement Project
CEGIS	Center for Environmental and Geographic Information Services
CEIP	Coastal Environmental Improvement Project
COD	Chemical Oxygen Demand
COs	Community Organizers
DAE	Department of Agricultural Extension
dBA	DecciBel
DC	District Commissioner
DEM	Digital Elevation Model
DG	Director General
DO	Dissolve Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DPHE	Department of Public Health Engineering
DPP	Development Project Proforma
EA	Environmental Assessment
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment

EKN	Embassy of the Kingdom of Netherlands
EMP	Environmental Management Plan
ERD	Economic Relations Division
FAO	Food and Agriculture Organization of the United Nations
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/ Irrigation
FCBO	Fisheries Community Based Organization
FGD	Focus Group Discussion
FGs	Functional Groups
FMD	Foot and Mouth Disease
FS	Frame Survey
FPCO	Flood Plan Co-ordination Organization
GIS	Geographic Information System
GoB	Government of Bangladesh
GoN	Government of the Netherlands
GPA	Guidelines for Project Assessment
GPWM	Guidelines for Participatory Water Management
GSB	Geological Survey of Bangladesh
GW	Ground Water
Ha	Hectare
HH	Household
HTW	Hand Tube Well
HYV	High Yielding Variety
ICM	Integrated Crop Management
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IRRI	International Rice Research Institute
IPM	Integrated Pest Management
IPSWAM	Integrated Planning for Sustainable Water Management
IS	Institutional Survey
ISC	Important Social Component
IUCN	International Union for Conservation of Nature

IWM	Institute of Water Modeling
IWMP	Integrated Water Management Plan
Kg	Kilogram
KII	Key Informant Interview
LCS	Labor Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
Lpc	Litre per capita
MoEF	Ministry of Environment and Forests
MoWR	Ministry of Water Resources
MP	Murate of Potash
MPI	Multidimensional Poverty Index
MSL	Mean Sea Level
MT	Metric Ton
MW	Mega Watt
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NDVI	Normalized Difference Vegetation Index
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NIR	Near- Infrared
NOCs	No Objection Certificates
NWRD	National Water Resources Database
O and M	Operation and Maintenance
OHP	Occupational Health and Safety Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Pestedes Petits Ruminants
PRA	Participatory Rural Appraisal

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

Glossary

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

Kharif	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Kutcha Toilet	The earthen made latrine consists of a hole without cover.
Mahajan	A traditional money lender and a powerful intermediary in the value chain.
Perennial khal	A khal where water is available all the year round.
Pucca	Well constructed building using modern masonry materials.
Rabi	Dry agricultural crop growing season; mainly used for the cool winter season between November and February
Ring slab	The simple pit latrine consists of a hole in the ground (which may be wholly or partially lined) covered by a squatting slab or seat where the user defecates. The defecation hole may be provided with a cover or plug to prevent the entrance of flies or egress of odor while the pit is not being used.
Seasonal khal	Water not available in the khal all the year round.
Sidr	Major Cyclone, which hit Bangladesh coast on November 15, 2007.
T. Aman	When preceding a crop means transplanted (T. Aman).
Upazila	An administrative unit of a district.
Water sealed	A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. A water sealed latrine has a bowl fixture that has a set amount of water retained in it. It is operated on the pour to flush system. These types of latrines can be connected to a septic tank system.

Conversion Unit

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, and 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 26 polders in three coastal districts of Bangladesh. This program, initiated in January 2013 and expected to end in December 2018, 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. In view of this, the Blue Gold Program management authority entrusted CEGIS to carry out the EIA study of seven selected polders (Polder 2, 26, 29, 31-part, 43/1A, 43/2B and 43/2E) under the component- 2 (Water resources management) of the Blue Gold Program. This document is the Final EIA study report of Polder 29.

Objective of the study

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

Approach and Methodology

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

Project Description

Polder 29 covers a small portion of Dumuria union, more than half of Sahas union and the entire Bhandar para union as well as Sarappur union of Dumuria upazila, Khulna district. It also has a small portion of Surkhali union of Batiaghata Upazilla, Khulna District under its coverage. The polder was constructed in 1966-71 by the Bangladesh Water Development Board (BWDB) and was one of the two polders selected as pilot project implementation under the Delta Development Project in 1988. The polder was recently rehabilitated under the IPSWAM project from 2003 – 2011. The polder is located in the South-West hydrological

region of Bangladesh, with administrative jurisdiction lying with the Khulna O&M Division – 1, BWDB, Khulna. The polder is surrounded by the Upper Bhadra (east) and Ghengrail (west) rivers.

Existing Problems and Works under the Proposed Interventions

The Polder is enriched with embankment having a length of about 49 km and providing protection against tidal and storm surges and salinity intrusion. There are 14 numbers of drainage sluices and 1 drainage outlet constructed by BWDB within the polder.

The existing condition of the embankment is good in most portions excepting two locations at Baro aria and Jaliakhali, which are severely damaged due to erosion. One retired embankment has already been constructed at Jaliakhali last year by the local community. 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. Besides, most of the structures are not functioning upto the desired level and fail to drain out excess water during heavy rainfall causing drainage congestion. 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. The sluice gate at Bokultala is completely broken. Siltation in the river made the river bed higher and left the sluice gate at Golaimari and Telikhali non-functional. The wheels and shafts for hoisting the gate at Golaimari, Kanchannagar and Ramkhali khal were either missing or found non-operating. Gate openings at Keyakhali and Asannagar khals are to be cleaned from debris as well as water hyacinths which hamper the natural flow through the structures. The present condition of most of the internal drainage khals is completely undesirable. Over the years, siltation, topsoil erosion and other land filling activities have resulted in gradual decrease of water courses within the polder.

Considering the existing problems and needs of local residents, the Blue Gold program has considered the following interventions for rehabilitation of Polder 29:

- **Re-sectioning of the existing embankment** with crest width of 4.27m, with side slopes of 1(V): 3(H) in the river sides and 1(V):2(H) in the country side. The design elevation of the crest of the embankment is at 4.27 m +PWD (above Mean Sea Level). A total of 16.16 km of embankment will be re-sectioned at chainage 0.00 to 1.00, 1.86 to 5.00, 5.98 to 7.50, 21.7 to 22.0, 23.6 to 24.02, 31.155 to 35.80, 37.00 to 41.317, 44.30 to 45.34.
- **Construction of retired embankment** at two eroded locations of Baro aria and Jaliakhali along the chainage 22.00 to 23 and 26.40 to 27.30. The total length of which is 1.9 km and proposed crest width is 4.27 m with side slopes of 1(V): 3(H) on river side and 1(V):2(H) on country side. The design elevation of the crest of the embankment is at 4.27 m +PWD (above Mean Sea Level).
- **Repairing of 13 drainage/flushing sluices** at Katakhali, Kanaidanga, Bakultala, Kanchannagar, Telekhali (Old), Telekhali (New),Jaliakhali, Kudlar Khal, Ruhitmara, Ratankhali, Ashan Nagar, Chatchatia and Golaimari khals .
- **Repairing of two drainage outlets** at Agunkhali and Shundar Mahal khals.
- **Re-excavation of 9 khals** inside the polder and the total length to be re-excavated is around 17.71 km.

Environmental and Social Baseline

The project area experiences tropical climate. The mean maximum temperature stays between 19.3°C to 30.4°C. The maximum rainfall ever recorded in the area is 343 mm in the month of July and lowest in the month of December which is 7 mm. The monthly average relative humidity of the Khulna BMD station varies from 73% to 88%. Daily average sunshine hours are higher than 7 hours which reduces to 5 hours from June to September. Wind speed of the polder area is highest in April (around 160 kph) and lowest in November (around 40 kph).

The water quality of different water bodies has been measured. The pH values were higher than the neutral value (pH=7) which means that water in these locations are alkaline in nature. Values of TDS were found very low inside the polder, but were high in the Ghengrail and Upper Bhadra River samples. This is because of the increased sediment load carried by the peripheral rivers, which, to some extent, is prevented by the water control structures from entering the polder. Values of DO were mostly found close to the standards set by DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l).Temperature values varied within a typical range for different locations as samplings were made in different time of the day. Furthermore, almost all the surface water samples were found having objectionable salinity concentrations. In the month of May, highest salinity was observed as 22 ppt in AmtalaKhal outside the polder.

The Polder is within an aerial distance about 75 km away from the Bay of Bengal. The polder is surrounded by the Upper Bhadra in the east and Ghengrail River in the west. The two rivers are originated from the Sibsa River System, and are directly fed by the oceanic tides. Water levels during high tide range from 1.5 to 2.26 m +PWD at Dumuria, and 2 to 2.78 m +PWD at Sutarkhali. On the other hand, the low tidal water levels range from 0.8 to 1.39 m below the MSL at Dumuria, and to 0.01 to 0.78 m below MSL at Sutarkhali. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. Average daily use of water is around 30 lpc for domestic use.

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

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

The populations of Polder are about 58,397 of which **29,023** are male and **29,374** are female. The average literacy rate in the study area is 51%which is slightly lower than national level (52%).Out of total population, 15,915 (27.25%) are economically active which include 6,148 (38.63%) employed, 39 (0.25%) are looking for work, and 9727 (61%) engaged in are

household work. Sources of drinking water in the area are satisfactory. About 54% households have access to hygienic sanitation facility (water-sealed), 31 % non-water-sealed sanitation facility and 11% non-sanitary facilities in the polder area.

Prediction and Evaluation of Potential Impacts

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

Environmental Management Plan

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

- Construction works near dense settlements (near Dumuria, Sahas and Sarappur) are to be carried out using manual labour
- Repaired sluice gates are to be operated and maintained properly to protect saltwater intrusion
- Formation of WMGs (GPWM-2002)
- Strengthening of WMGs through imparting training on proper management of structure and utilization of spoil earth materials which will be generated from re-excavation.
- Involvement of WMGs in project related different activities
- Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bunch
- Spoil earth materials and others waste should be managed properly
- Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced
- Organic manure should be applied for the restoration of soil fertility
- Irrigation should be provided in optimum level with minimum conveyance loss.

- The WMGs should be given orientation to protect their standing crops from implementation of the intervention and development on farm water management etc.
- Training may be provided to WMGs on “integrated water management” which will be stored or available in the khals/ cannels for different use
- Earth spoil should be dumped at setback distance of the khal
- Re-excavation activity should be done segment wise
- Avoid construction activities during fish migration period e.g. month of May to August
- Excavated khal should keep free from encroachment
- Implement plantation along the slopes of embankment after completing the earth works
- Do not run construction activities at early morning and night to avoid disturbance to wild fauna
- Plant mixed species of native trees along the embankment slopes wherever possible to enhance green coverage.

Furthermore, a conceptual Spoil Management Plan (SMP) has been proposed by the study team for controlled and sustainable disposal of excavated spoil. Follow up of the plan is essential to safeguard the environmental sustainability of the construction sites.

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

1. Introduction

1.1 Background

1. 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. Nearly 38.5 millions of 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.

2. The Government of the Netherlands (GoN), a development partner of the Government of Bangladesh, since 1975 is 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 with the ecosystem and allow the communities to utilize available water resources for productive use and human consumption. Participatory water management received a new impetus In Bangladesh with the adoption of National Water Policy in 1999. The participatory water resources management have been successfully introduced in the coastal region of Bangladesh since 2003 in line with the National water Policy and water resources development strategies of the GoB. The GoN In this effort 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). The GoB and GoN as a follow up project of IPSWAM, 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.

3. 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 2018. Its operations are limited to selected polders of three coastal districts: Satkhira, Khulna and Patuakhali which are part of the South-west and South-central hydrological zones.

4. The total land area of the three districts is 11,463 km² and the total population is 5.6 million. This gives an average population density of 493 people per km² and an average household size of 4.3 persons (BBS, 2011). These districts are chosen because of having (i)

higher incidence of poverty, (ii) ineffective coordination between the local administration and private sector and (iii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. Initially, it was anticipated that 26 polders from these three districts will be included in the program, as illustrated in Table 1.1.

Table 1.1: Tentative district wise distribution of polders based on the preliminary selection

District	Tentative number of polders			
	IPSWAM Fine Tuning	Other Fine Tuning	New Rehabilitation	Total
Patuakhali	6	6	2	14
Khulna	3	4	2	9
Satkhira	0	2	1	3
Total	**9**	**12**	**5**	**26**

Source: Inception Report, Blue Gold Program Program, 2013

5. 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 the Government officers and their operational capacity in particular at local (Union, Upazila and District) level, concentrating on polder development in the three districts.

6. The Blue gold program has five 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, and (v) cross-cutting issues. 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. Accordingly, CEGIS has been engaged to undertake Environmental Impact Assessment (EIA) studies of the component (ii) of Blue Gold Program, for a total number of seven polders(Polder 2, 26, 29, 31-part, 43/1A, 43/2B and 43/2E), selected from the nine IPSWAM polders.

1.2 Rationale of the study

7. 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, dykes, 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.

8. Component (ii) of the Blue Gold Program includes rehabilitation of water resources management infrastructures in the selected polders. Polder 29 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. To fulfill the obligation, the Blue Gold Program, engaged CEGIS to conduct the EIA study.

1.3 Study Area

9. The study area of this EIA study is Polder 29 which is located in Dumuria, Bhandar Para and Sarappur unions under the Dumuria Upazila of Khulna District. The polder covers an area of 7,930 hectare. Map 1.1 shows the base map of the Polder.

1.4 Objectives of the Study

10. The overall objective of EIA study is to comprehensively assess the environmental aspects of the proposed rehabilitation interventions. The specific objectives include the followings:

- To prepare environmental and social baseline of the project area
- To assess potential environmental impacts as well as cumulative, induced and reciprocal impacts for the proposed interventions;
- To identify mitigation measures for minimizing the negative impacts and enhancing of the positive impacts; and
- To Prepare Environmental Management Plan (Mitigation and enhancement plans, compensation and contingency plan) with monitoring plan.

1.5 Scope of Work

11. The scope of works of the assignment are to:

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

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

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

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

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

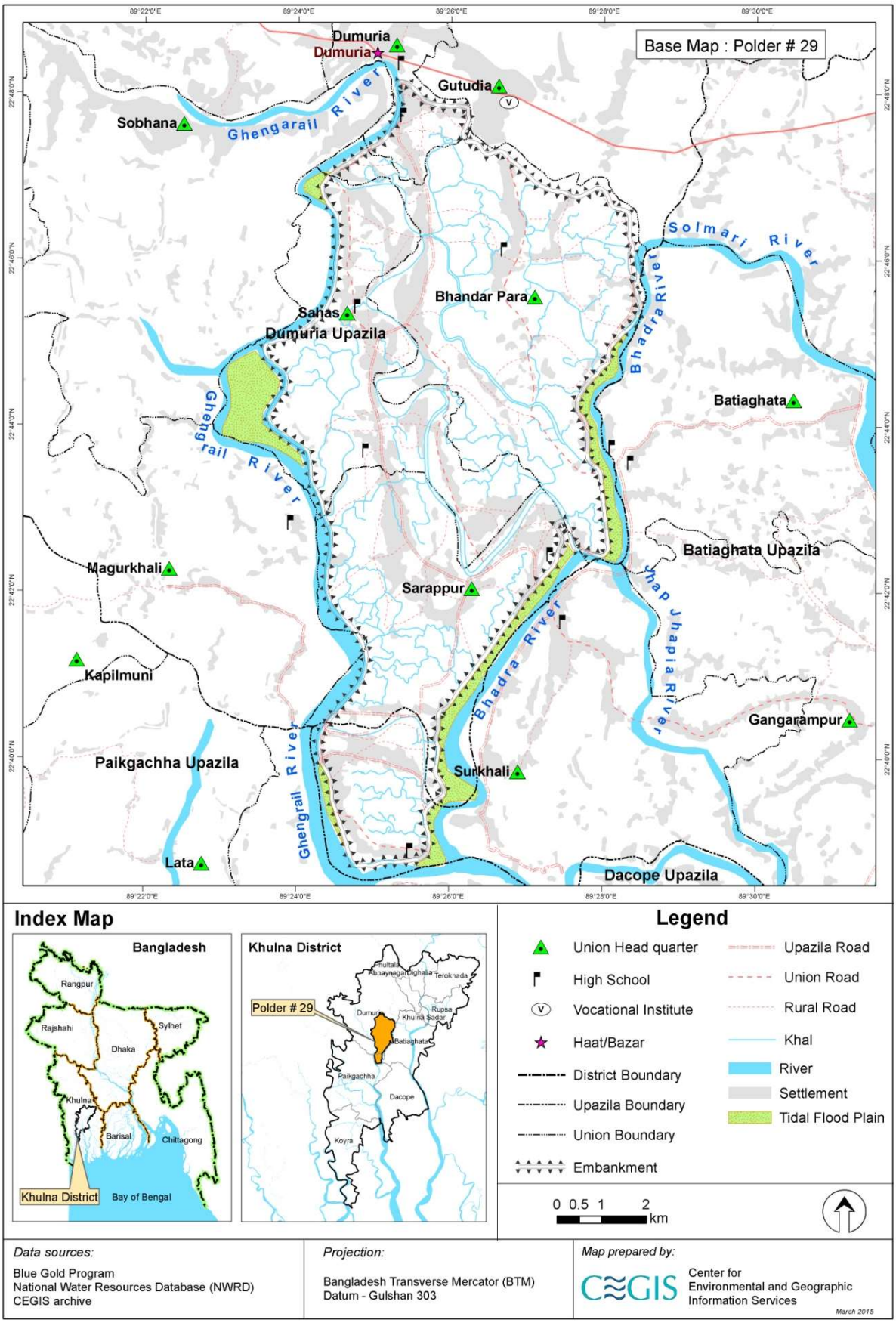
vi. Prepare a land use map and ground truthing.

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

viii. A small section of the EIA (EMP) will indicate occupational health and safety measures to be undertaken for implementation of the work, but no detailed occupational health plan (OHP).

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

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



Map 1.1: Base map of Polder 29

1.6 Limitations

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

1.7 EIA Study Team

13. The multi-disciplinary EIA study team included the following professionals from CEGIS:

1. Mr. Md Sarfaraz Wahed, Water Resources Engineer/ Team Leader
2. Mr. Mujibul Huq, Environmental Advisor
3. Mr. Md. Ebrahim Akanda, Soil and Agriculture Specialist
4. Dr. Ashraful Alam, Fishery Specialist
5. Mr. Mobsher Bin Ansari, Socio-Economist
6. Mr. Fahad Khadim Khan, Junior Water Resources Engineer
7. Mr. Tanvir Ahmed, Water Resource Modeller
8. Ms. Mashuda Parvin, Ecologist
9. Mr. Nasrat Jahan, GIS/RS Specialist
10. Mr. S.M. Shafi-Ul-Alam, GIS Analyst
11. Mr. Md. Amanat Ullah, Ecologist
12. Mr. Md. Azizur Rahman, Field Researcher
13. Mr. Md. Shahadat Hossain, Field Researcher
14. Eva Chowdhury, Field Researcher
15. Mr. Md. Shahidur Rahman, Enumerator

1.8 Report Format

14. This EIA report has the following 11 (eleven) chapters as per ToR:

Chapter 1: ***Introduction*****:** This chapter describes the background of the project, study area, objectives, scope of works 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, relevant with the EIA study

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

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

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

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

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

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

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

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

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

2. Policy, Legal and Administrative Framework

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

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

16. 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. The Policy provides the broader framework of sustainable development in the country. It also states that all major undertakings, which will have a bearing on the environment, will need an initial environmental examination (IEE) and environmental impact assessment (EIA) before initiation of the project. The Policy designates the Department of Environment (DoE), as the approving agency for all such IEE/EIAs.

17. The policy guidelines of fifteen sectors are stated in the Policy. Under the 'Water Development, Flood Control and Irrigation' sector (Section 3.5), it states that it is required to conduct EIA before undertaking projects for water resource development and management (Section 3.5.7).

18. Section 3.5.2 states that it is required to ensure water development activities and that irrigation networks should not create adverse environmental impacts. The Section 3.5.3 provides, 'ensure that all steps taken for flood control, including construction of embankments ... be environmentally sound at the local, zonal and national level'. According to the Section 3.5.5 of the Policy, the rivers and all water bodies are to be free from pollution. The Environment Policy sets out the basic framework for environmental action, together with a set of broad sectoral action and guidelines (MoEF, 1992).

2.1.2 National Environmental Management Action Plan (NEMAP) 1995

19. 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. NEMAP was developed to address issues and management requirements for the period 1995 to 2005 and sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented.

20. NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;

- Promotion of sustainable development; and
- Improvement of the quality of life of the people. (MoEF, 1995)

2.1.3 The National Water Policy, 1999

21. 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. The Policy considers water as being essential for human development, socio-economic development, poverty alleviation and preservation of the natural environment.

22. Sub-clause (b) of Section 4.5 states that planning and feasibility studies of all projects (relevant to water resources management or development or have interference on water sector) will follow the Guidelines for the Project Assessment (GPA), the Guidelines for Peoples Participation (GPP), the Guidelines for Environmental Impact Assessment (EIA), and all other instructions that may be issued from time to time by the Government. Giving importance on the navigation sector, sub-clause (a) of section 4.10 states that if a project may cause disruption to navigation, adequate mitigation measures should be taken.The draft describes the importance of wetlands to the environment of Bangladesh and makes cross-references to the various recent government policy issues that relate to wetland management. In its draft form, it provides a series of recommendations as found in other policies (MoEF, 1999).

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

23. 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. The BCSAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development;
- Improvement in the quality of life of the people (MoEF, 2004).

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

24. The Bangladesh Climate Change Strategy and Action Plan 2009 is built on the following six pillars:

i. Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services including health;

ii. Comprehensive disaster management to further strengthen the country's already proven disaster management system to deal with increasingly frequent and severe natural calamities;

iii. Infrastructure to ensure that existing assets are well maintained and fit-for-purpose and that urgently needed infrastructure is in place to deal with the likely impact of climate change;

iv. Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socio-economic groups, to underpin future investment strategies and to ensure that Bangladesh is networked with the latest global thinking on science and best practices of climate change management;

v. Mitigation and low carbon development to ensure low carbon development options and implement these as the country's economy grows over the coming decades and the demand for energy increases; and

vi. Capacity building and institutional strengthening to enhance the capacity of government ministries and agencies, civil society and the private sector to meet the challenges of climate change and mainstream them as part of development action (MoEF, 2009).

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

25. 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. Water Resources Planning Organization (WARPO) has been assigned to monitor the national water management plan. The major programs in the Plan have been organized under eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources. Each cluster comprises of a number of individual programs, and a total of 84 sub-sectoral programs have been identified and presented in the investment portfolio. Most of the programs are likely to be implemented in coastal areas.

2.1.7 Coastal Zone Policy, 2005

26. 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.

27. The coast of Bangladesh is known as a zone of vulnerabilities as well as opportunities. It is prone to natural disasters like cyclone, storm surge and flood. In this regard, for reducing risk, the policy emphasizes the improvement of coastal polders and seeks to enhance safety measures by combining cyclone shelters, multi-purpose embankments, road system and disaster warning system.

2.1.8 Coastal Development Strategy, 2006

28. 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. Nine strategic priorities, evolved through a consultation process, guide interventions and investments in the coastal zone:

- ensuring fresh and safe water availability
- safety from man-made and natural hazards
- optimizing use of coastal lands
- promoting economic growth emphasizing non-farm rural employment
- sustainable management of natural resources: exploiting untapped and less explored opportunities
- improving livelihood conditions of people especially women
- environmental conservation
- empowerment through knowledge management
- creating an enabling institutional environment

2.1.9 National Conservation Strategy (NCS) 1992

29. 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.

2.2 Legislation, Act and Rules

2.2.1 National Water Act, 2013

30. 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. The Act provides for the formation of a high-powered National Water Resources Council (henceforth termed as the Council) headed by the Prime Minister. An Executive Committee under the Ministry of Water Resources will implement the decisions taken by the Council.

31. As per this Act, all forms of water (e.g., surface water, ground water, sea water, rain water and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. Private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act.

32. The Act addresses the water needs in irrigation and urban areas in the context of available surface water, groundwater, and rainwater.

33. The management of water resources within the territory of the country in rivers, creeks, reservoirs, flood flow zone, and wetlands has been assigned to the Executive Committee under the Ministry of Water Resources.

34. Draining of wetlands that support migratory birds has been prohibited by the Act. Consequently, without prior permission from the Executive Committee, building of any structure that can impede the natural flow of water has been prohibited.

35. A few activities like dredging of rivers for maintaining navigability, land reclamation projects by filling wetlands, and flood control and erosion control structures will be exempted pending prior permission.

36. The Act provides provisions for punishment and financial penalty for non-compliance, including negligence to abide by government policy, ordinance, non-cooperation with government officials, refusal to present necessary documents, providing false information, affiliation with perpetrators, and protection measures for water resources management. The

maximum penalty for violations is set to five years of imprisonment and/or a monetary penalty of Taka10,000.00 (Ministry of Law, Justice and Parliamentary Affairs, 2013).

2.2.2 The Embankment and Drainage Act 1952

37. 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.

38. According to the Section 4 (1) every embankment, watercourse and embanked tow-path maintained by the Government or the Authority, and all land, earth, pathways, gates, berms and hedges belonging to or forming part of, or standing on, any such embankment or water-course shall vest in the Government or the Authority, as the case may be.

39. The section 56 (1) states that, persons will be subject to penalty (500 Taka or imprisonment… if he erects, or causes of willfully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or willfully permits to be obstructed or diverted, any water course. This section could be applied to the person causing damage to the protective works.

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

40. 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.

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

41. 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.

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

42. 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.

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

43. This is an Ordinance to manage ground water resources for agricultural production. This Act authorizes the Thana Parishad to grant license for installing tube wells in its jurisdiction. The Thana Parishad may grant the license if the Parishad is satisfied that the installation of the tube well applied for

a) will be beneficial to the areas where it is to be installed, or

b) will not have any adverse affect upon the surrounding areas, or

c) is otherwise feasible.

2.2.7 The Protection and Conservation of Fish Rules (1985)

44. These are a set of rules in line with the overall objectives of the Fish Act. Section 5 of the Rules requires that “No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters”. Section 6 of the Rules states -“No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters”.

2.2.8 PanishampadParikalpanaAin (Water Resource Planning Act, 1992)

45. 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.

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

46. 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. This Act also provides legal definitions of the protected areas as follows.

- "Game reserve" means an area declared by the government as such for the protection of wild life and increase in the population of important species wherein capturing of wild animals shall be unlawful;
- "National park" means comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed;
- "Wild life sanctuary" means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground primarily for the protection of wild life inclusive of all natural resources, such as vegetation, soil and water.
- Under this law hunting, killing, capture, trade and export of wild life and wild life products are regulated. The Act also designates a list of protected species and game animals.

47. Provided that the government may, for scientific purposes or for aesthetic enjoyment or betterment of scenery, relax all or any of the prohibitions specified.

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

48. The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

49. The main objectives of ECA '95 are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

50. The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

51. Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General of the DoE. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 3 years imprisonment or a maximum fine of Tk. 300,000.00 or both. The DoE executes the Act under the leadership of its Director General (MoEF, 1995).

2.2.11 The Environment Conservation Rules, 1997

52. 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).

53. 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.

54. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE and EIA according to categories of industrial and other development interventions.

55. The Rules are not explicit for water development projects. Rather, this is covered under the broader heading of “exploration, extraction and distribution of mineral resources” under the ‘Red’ category projects.

2.3 Procedure for environmental clearance

56. 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.

57. 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.

58. 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)

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

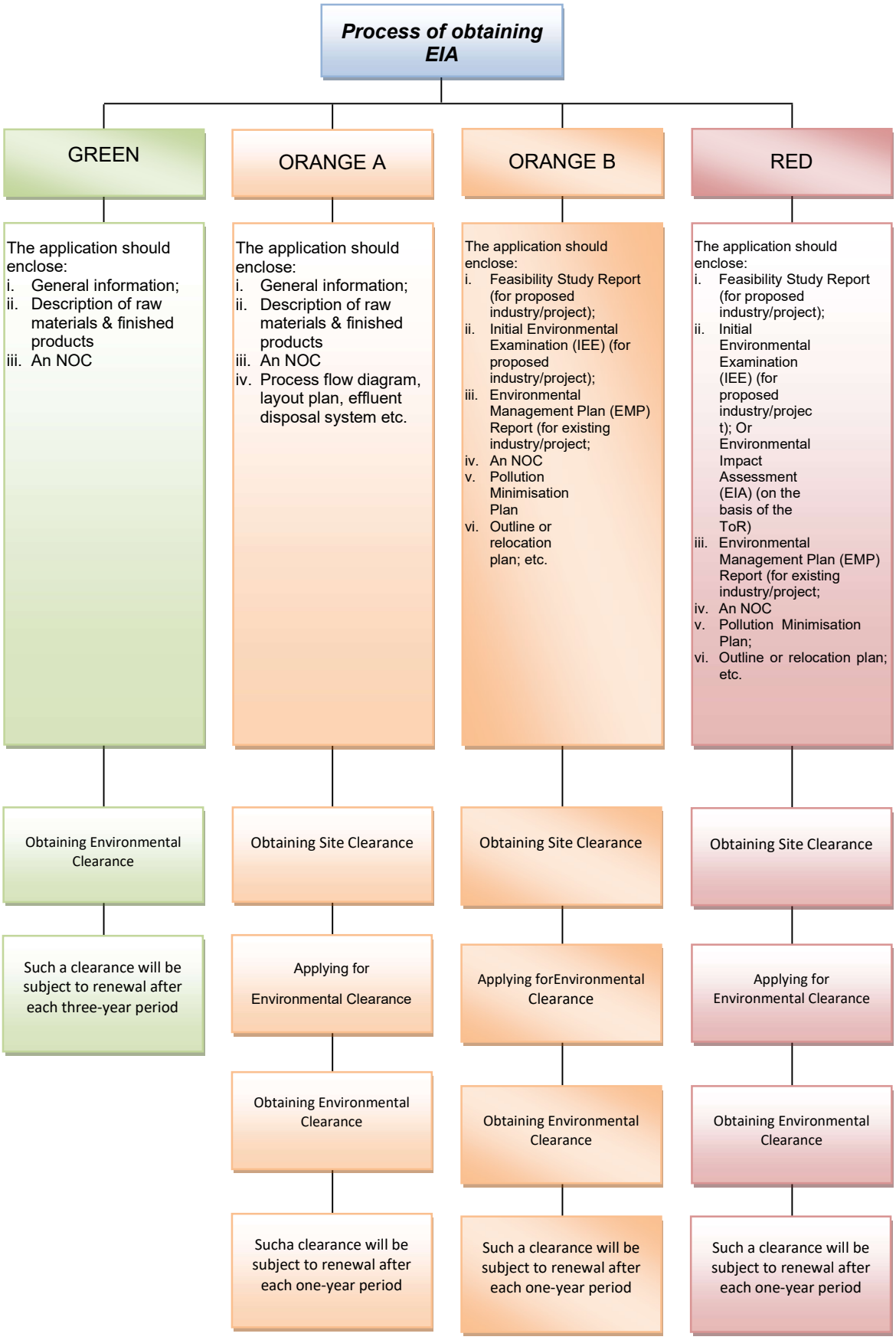


Figure 2.1: Steps Involved in Environmental Clearence folllowing DoE Clearence

2.4 Administrative Framework

60. 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.

61. 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.

3. Approach and Methodology

3.1 EIA Process

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

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

Figure 3.1: The EIA process

3.2 Project Design and Description

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

3.3 Environmental and Social Baseline

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

3.3.1 Climate and Meteorology

66. A discussion has been provided on climate change, based on secondary literature review has been made. The issue was discussed on a regional scale, with respect to the different hydrological regions and administrative divisions of Bangladesh. Long term impacts of climate change have been investigated on temperature and rainfall. An earlier study carried out by CEGIS using PRECIS model (CEGIS 2014) has been reviewed in this regard. Information regarding change in temperature and rainfall for different regions and districts over the last 100 years has been analyzed. The same study was also reviewed to provide an understanding on different climate change scenarios as well. In addition, field level information on the recently occurred natural disasters and their impacts was investigated.

67. Data on different meteorological parameters such as rainfall, temperature, sunshine hours, humidity and wind speed were used for assessing the existing climate which is directly related to the water resources of the study area. The nearest station of Bangladesh Meteorological Department (BMD) at Khulna (which is 8.5 km away from Polder 29), was selected. The data was collected from the National Water Resources Database (NWRD), a web portal maintained by WARPO and CEGIS which contains long time series of temporal data showing daily values for meteorological stations. Spatial analysis using Thiessen's Polygon method has been used for rainfall variation as the entire polder falls inside the polygon around Khulna Station.

3.3.2 Topography and Seismicity

68. To understand the topography of the area through visualization ofReduced Levels (elevations) of different locations within the polder, an analysis using Digital Elevation Model (DEM) has been carried out. To establish the DEM, re-sampled 500m×500m grid levels (elevations) were captured from BWDB's one foot contour maps, which were produced in the late sixties. These spot levels were interpolated into a continuous surface known as the DEM, produced by CEGIS in 1997. The DEM has been downscaled within the processing extent of Polder 29, to develop an understanding of the topographic features inside the polder.

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

3.3.3 Water Resources

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

71. Field visits were made to the study area and primary data on water resources components were collected through discussion with stakeholders. A checklist was used to obtain the information on different resources. Local knowledgeable persons and community representatives were also interviewed. During field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the 'Rehabilitation of Polder 29' on water resources components were assessed by analyzing collected data, community knowledge analysis and professional justification of water resources managers. The management plan for water resources components was incorporated to assess impact risk and water resources status using stakeholders' requirement and experts' judgment.

72. The specific data on different components of water resources were collected from the different sources. The monthly average surface water levels were collected from the BWDB stations at Dumuria (Upper Bhadra River) and at Sutarkhali F.O. (Ghengrail River). Values on monthly average groundwater levels and annual variation of Ground Water Table (GWT) were collected from the BWDB observation well at Dumuria (KHU005). Data on water quality were measured in site, 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). Information on different water resources functions, problems and uses were collected through intensive local level consultations.

3.3.4 Land Resources

73. The agro-ecological region of the proposed study area has been identified using secondary sources (FAO/UNDP). The land use, land type, soil texture data were collected from Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of Soil Resources Development Institute (SRDI). Secondary data of these parameters were verified at field during field visit through physical observations as well as in consultation with the local people and officials of the Department of Agricultural Extension (DAE).

3.3.5 Agricultural Resources

74. Data on agricultural resources included farming practices, crop production constraints, existing cropping patterns, crop variety, crop yield, crop damage and agricultural inputs used. Agriculture data were collected from primary sources through extensive field survey using a questionnaire and in consultation with local people and concerned agricultural officials. Agricultural resources data were also collected from secondary sources from the upazila DAE office. Crop production was determined using the formula:

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

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

3.3.6 Livestock Resources

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

3.3.7 Environmental Quality

78. Under the environmental quality component, noise and water quality were measured at different selected locations in Polder 29. One suitablesite was selected at Sahas bazaar to measure sound levels and comparesthe standard levels and in-situ values. The location was also selected from the polder periphery, where embankment rehabilitation works would be carried out. During field inspection, sound levels were collected near construction site with 10 minute sampling periods. L50 (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L50 is assumed to be equal to Leq, which is the Equivalent Noise Level. The computed Leq was then compared with the standard noise level suggested in Environmental Conservation Rules 1997 of Department of Environment, Bangladesh.

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

3.3.8 Fisheries Resources

Data collection methods:

80. A checklist/ questionnaire was developed before proceeding to collect fisheries data. The checklist covered all points for collection of information including existing and potential

structures of the project. Different survey techniques were used for data collection. The sequential interpretations of the methodological approach were as follows:

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

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

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

Capture and Culture Fish Habitats:
84. Capture fish habitats were assessed through Fishing Effort Survey (FES), habitat based species diversity and composition, identification of species of conservation significance, identification of potential fish habitat prescribing to restore fish conservation, fish migration survey, and habitat identification for fish conservation. Culture fish habitat assessment was performed through homestead culture fish pond survey and commercial fish farm survey.

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

Secondary Data Collection:
86. Relevant secondary data were collected from the upazila fisheries office (UFO) from their annual reports and from various literatures/studies.

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

3.3.9 Ecological Resources

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

89. Land use information on different ecosystems was generated through analysis of high resolution optical satellite images. Time series images of five years were used to

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

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

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

91. 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 FGD and KII methods. An inventory of common flora and fauna was developed based on field survey and the IUCN database.

3.3.10 Socio-economic Condition

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

a) Data collated from BBS, 2011;

b) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;

c) PRA /RRA, FGDs, KII for primary data collection; and

d) Institutional Survey (IS) for primary data collection from upazila level offices like Local Government Engineering Department (LGED) office, Civil Surgeon's office, Social Services office etc.

3.4 Scoping

93. A scoping process was followed for selecting IESCs which are likely to be impacted by the proposed interventions of 'Rehabilitation of Polder 29'. Scoping was performed in two stages. Individual professionals of the EIA study team made preliminary lists of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholders opinions obtained in the scoping sessions are considered in selecting the IESCs.

3.5 Bounding

94. The area likely to be impacted for 'Rehabilitation of Polder 29' was delineated in consultation with the experts of Blue Gold Program and feedback received from the local people during baseline consultation. In addition, processed Remote Sensing (RS) tools were also used for this purpose.

3.6 Major Field Investigation

95. The EIA study team members collected intensive data on possible impact of the project after obtaining the detailed rehabilitation plan from the project authority. The study team carried out a number of comprehensive field investigations during 13 to 25 March, 2015 in order to collect primary data and solicit feedback from local people. Intensive data on Baseline and IESCs were collected from the field during this stage. Information on the IESCs was collected through a mixed method including RRA, PRA and KII using checklists for water resources, land resources, agriculture, livestock, fisheries, ecosystem and socio-economic components. Intensive consultations with the local people were carried out for their feedback on the key parameters. This process helped the multidisciplinary EIA study team to qualify their professional observations. In such exercise attention was given to understand the historical status of the IESCs and the possible condition of the same against the proposed interventions.

3.7 Environmental and Social Impact Assessment

96. Environmental and social impacts on the IESCs for the proposed interventions i.e. for Rehabilitation of Polder 29' have been assessed through several sets of activities. Impacts are generated for the interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of the difference between the future-without-project (FWOP) conditions and the future-with-project (FWIP) conditions. FWOP conditions are generated through trend analysis and consultation with the local people. This reflected the conditions of IESCs in absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions are assessed to generate the FWIP conditions. Comparison and projection methods are used for impact prediction. This included both positive and negative impacts which are considered in preparation of the environmental management plan.

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

i) Changes in the status of the IESCs pertaining to water resources;

ii) Changes in the status of the IESCs pertaining to land resources, agriculture, livestock and poultry;

iii) Changes in the status of the IESCs pertaining to fisheries;

iv) Changes in the status of the IESCs pertaining to ecological resources; and

v) Changes in the status of the IESCs pertaining to socio-economic conditions.

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

3.8 Impact Quantification and Evaluation

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

3.8.1 Assessment Methodology

100. The assessment of effects and identification of residual impacts takes account of any incorporated mitigation measures adopted due to any potential impact of project activities, and are largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative and positive (beneficial), and the methodology defined below has been applied to define both beneficial and adverse potential impacts.

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

Magnitude

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

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

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

Table 3.1: Parameters for determining magnitude

Parameter	Major	Moderate	Minor	Negligible/Nil
Duration of potential impact	Long term (more than 35 years)	Medium term lifespan of the project (5 to 15 years)	Less than project life span	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable

Parameter	Major	Moderate	Minor	Negligible/Nil
				potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

Sensitivity

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

Table 3.2: Criteria for determining sensitivity

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

Assessment of Residual Impacts

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

3.9 Environmental Management Plan

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

3.10 EIA Report Preparation

107. At the end of the process, the present report on “Environmental Impact Assessment of Rehabilitation of Polder 29” is prepared incorporating all findings of the study.

4. Project Description

4.1 Background

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

4.2 Objective

109. The objectives of the Blue Gold Program are to

- Increase sustainability of the development of the polders through effective community participation.
- Protect flood and use water resources effectively
- Increase farmers' income and strength livelihood through improved productivity
- Improve environment and nearly 100% coverage for drinking water and sanitation.

110. The objective of the second component of Blue Gold Program in Polder 29 is to improve the existing status of water management, through rehabilitation and fine-tuning of infrastructures. In short, the specific objectives of the program are:

- Repairing the existing water control structures such as sluice gate and outlet to allow better control on drainage and flushing, and thus improve the agricultural production.
- Constructing retired embankment to protect the area from tidal flooding.
- Re-sectioning of embankment to increase embankment stability and peripheral communication.
- Re-excavation of khals primarily to drain out high peak flow away and rainwater storage to meet up the increasing demand of water use for irrigation.

4.3 Polder Overview

111. Polder 29 covers a small portion of Dumuria union, more than half of Sahas union and the entire Bhandar para union as well as Sarappur union of Dumuria upazila, Khulna district. It also has a small portion of Surkhali union of Batiaghata Upazilla, Khulna District under its coverage. The polder was constructed in 1966-71 by the Bangladesh Water Development Board (BWDB) and was one of the two polders selected as pilot project implementation under the Delta Development Project in 1988. The polder was recently rehabilitated under the IPSWAM project from 2003 – 2011. The polder is located in the South-West hydrological region of Bangladesh, with administrative jurisdiction lying with the Khulna O&M Division – 1, BWDB, Khulna (Map 4.1).

4.4 Present Status Water Management Infrastructures

112. 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 29. Based on field investigation carried out in March 2015, the study team gathered the following information regarding the status of existing infrastructure.

Embankments

113. The length of the Embankment is 49 km with top width varying from 3.7 m to 3.8m. The crest level varies from 3.5 m to 3.6 m above Mean Sea Level (MSL). Existing side slopes varies from 2.15m to 2.25m as hypotenuse on both riverside and countryside. Most part of the embankment has a highly varied range of setback distance of 0 to 90 m, while the rest of the embankment has a setback distance of 60-80m. The existing condition of the embankment is good in most portions excepting two locations at Baro aria and Jaliakhali, which are severely damaged due to erosion. One retired embankment has already been constructed at Jaliakhali last year by the local community. 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.

*[(**a**)paved road surface at Sarappur, suitable for various modes of transportation in all season, (b)unpaved road surface at Char charia which becomes slippery and unsuitable for communication in wet season, (c) Erosion point at Baro Aria, (d) Erosion point at Jaliakhali]*

Photo 4.1: Existing Status of Embankments

Water Control Structures and Culverts

114. There are 14 numbers of drainage sluices and 1 drainage outlet constructed by BWDB within the polder. Among these 6 sluice gates have been repaired and 5 others have been constructed under IPSWAM project from 2003 to 2011. Some of these structures again 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.

115. During field visit in the March 2015, the study team found that some of existing sluice gates and outlets have been subjected to structural damage in recent years and are not maintained properly by local people. The sluice gate at Bokultala is completely broken. A new gate was constructed inside the khal. This is now working as a well-functioning gate.

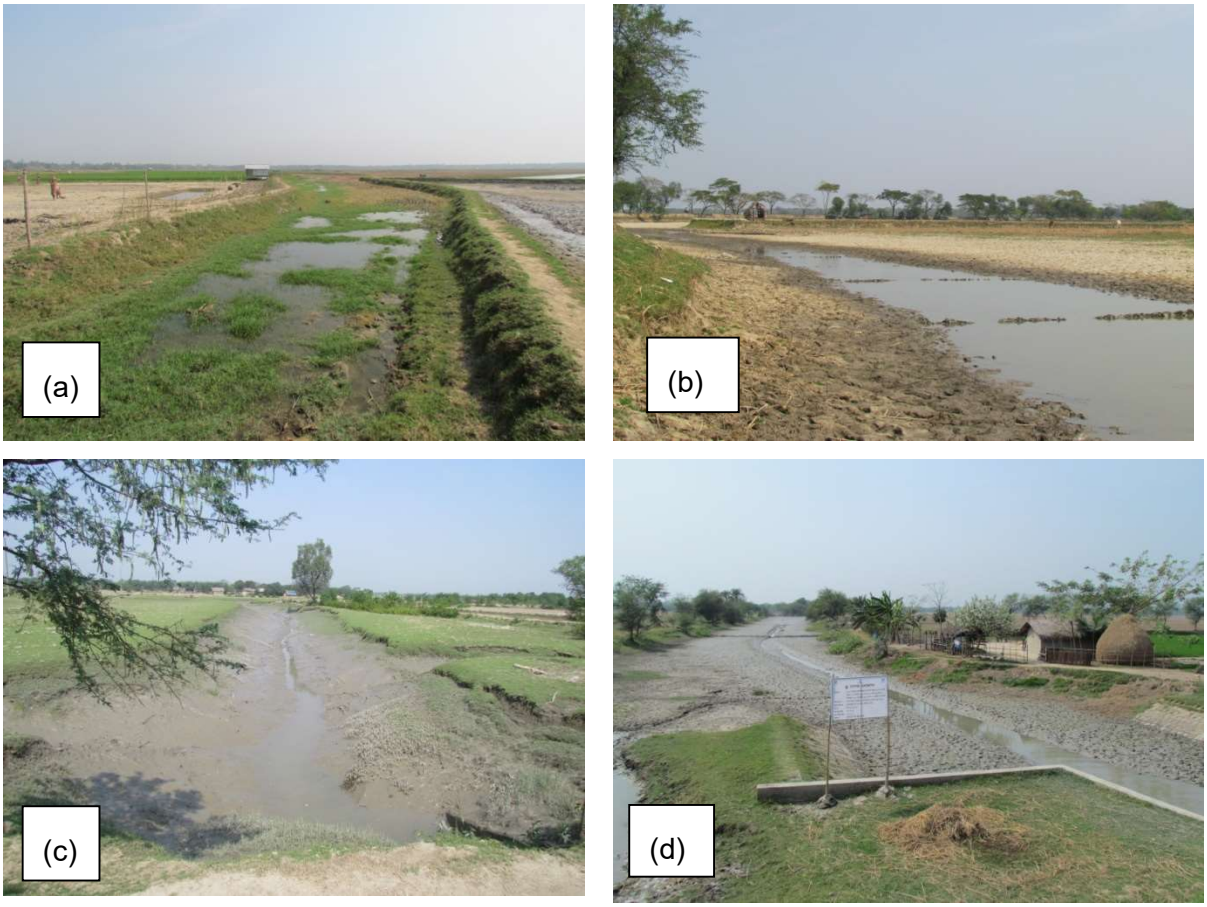
116. Siltation in the river made the river bed higher and left the sluice gate at Golaimari and Telikhali non-functional. The wheels and shafts for hoisting the gate at Golaimari, Kanchannagar and Ramkhali khal were either missing or found non-operating. These hoisting system need re-installation. Mismanagements are also observed in some locations. Gate openings at Keyakhali and Asannagar khals are to be cleaned from debris as well as water hyacinths which hamper the natural flow through the structures.

*[(**a**)Completely broken sluice gate at Bokultala Khal, (**b**)Newly constructed gate inside the Bokulatola khal, (**c**)Sluice gate at Golaimari without a proper hoisting system, (**d**)Opening of Asannagar sluice covered by uncontrolled existence of water hyacinths]*

Photo 4.2: Existing Status of Sluice Gates

4.5 Present Status of Drainage Khals

117. The present condition of most of the internal drainage khals is completely undesirable. Over the years, siltation, topsoil erosion and other land filling activities have resulted in gradual decrease of water courses within the polder. The condition of Aro khal, Asannagar Khal, Golaimari khal and Kata khal is the worst of all. Water course in the Aro khal is almost non-existent with most of its area covered with grass. Width of the water course of Kata khal has come down to 2 feet from a very high range of 30 to 40 feet. Most of the khals inner side of the polder needs to be re-excavated.



*[(**a**)Silted up course along the Aro khal, (**b**)Narrow course of Asannagar khal, (**c**) Very narrow course of water at Golaimari khal, (**d**) Silted up bed of Kata khal]*

Photo 4.3: Drainage Khals within the polder

4.6 Problems and Issues in the Polder

118. A number of problems and issues are hindering the development potential of Polder 29 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. As per opinion of the people, around 40% khals inside the polder (Bokultola, Aro khal, Mora Bhadra, Telikhali etc.) suffer from severe drainage congestion, taking one week or more to properly drain out rainwater. In addition, almost 30% khals (Kanchannagar, Katakhal, Ruthimara etc.) suffer from moderate drainage congestions, taking 2 to 6 days to completely drain out rainwater. Due to the reduced drainage capacity of

khals, rainwater often inundates the adjacent agricultural fields for a period of 4~5 days, and affects the crop production.

119. Another major issue in the polder area is salinity intrusion especially in the dry period. Such salinity intrusion caused severe scarcity of drinking water sources at Char charia, Dighalia, Ratankhali, Jaliakhali, Akra, Chandgarh and Sundar Mahal.

120. Erosion of the embankment at Baro aria and Jalikhali has left those areas and the local community unprotected and totally vulnerable to tidal flooding. The communication system is also being greatly hampered due to this eroded portion.

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

4.7 Proposed Interventions in Polder 29

122. 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 29. The locations of interventions have been shown in Map 4.1.

4.7.1 Re-sectioning of Embankment

123. Re-sectioning works along the peripheral embankment is proposed to be carried out in the selected locations which are found damaged. The proposed crest width is 4.27m, with side slopes of 1(V): 3(H) on river side and 1(V):2(H) on country side. The design elevation of the crest of the embankment is at 4.27 m +PWD (above Mean Sea Level). A total of 16.16 km of embankment will be re-sectioned along the chainage 0.00 to 1.00, 1.86 to 5.00, 5.98 to 7.50, 21.7 to 22.0, 23.6 to 24.02, 31.155 to 35.80, 37.00 to 41.317, 44.30 to 45.34.

4.7.2 Construction of Retired Embankment

124. Retired embankment is proposed to be constructed at two eroded locations of Baro aria and Jaliakhali along the chainage 22.00 to 23 and 26.40 to 27.30. The total length of which is 1.9 km and proposed crest width is 4.27 mwith side slopes of 1(V): 3(H) on river side and 1(V):2(H) on country sides. . The design elevation of the crest of the embankment is at 4.27 m +PWD (above Mean Sea Level). At Jaliakhali, following an embankment breach last year, local people has already constructed an earthen retired embankment approximately at a distance of 20 feet inside the original embankment.

4.7.3 Construction/ Repairing of Water Control Structures

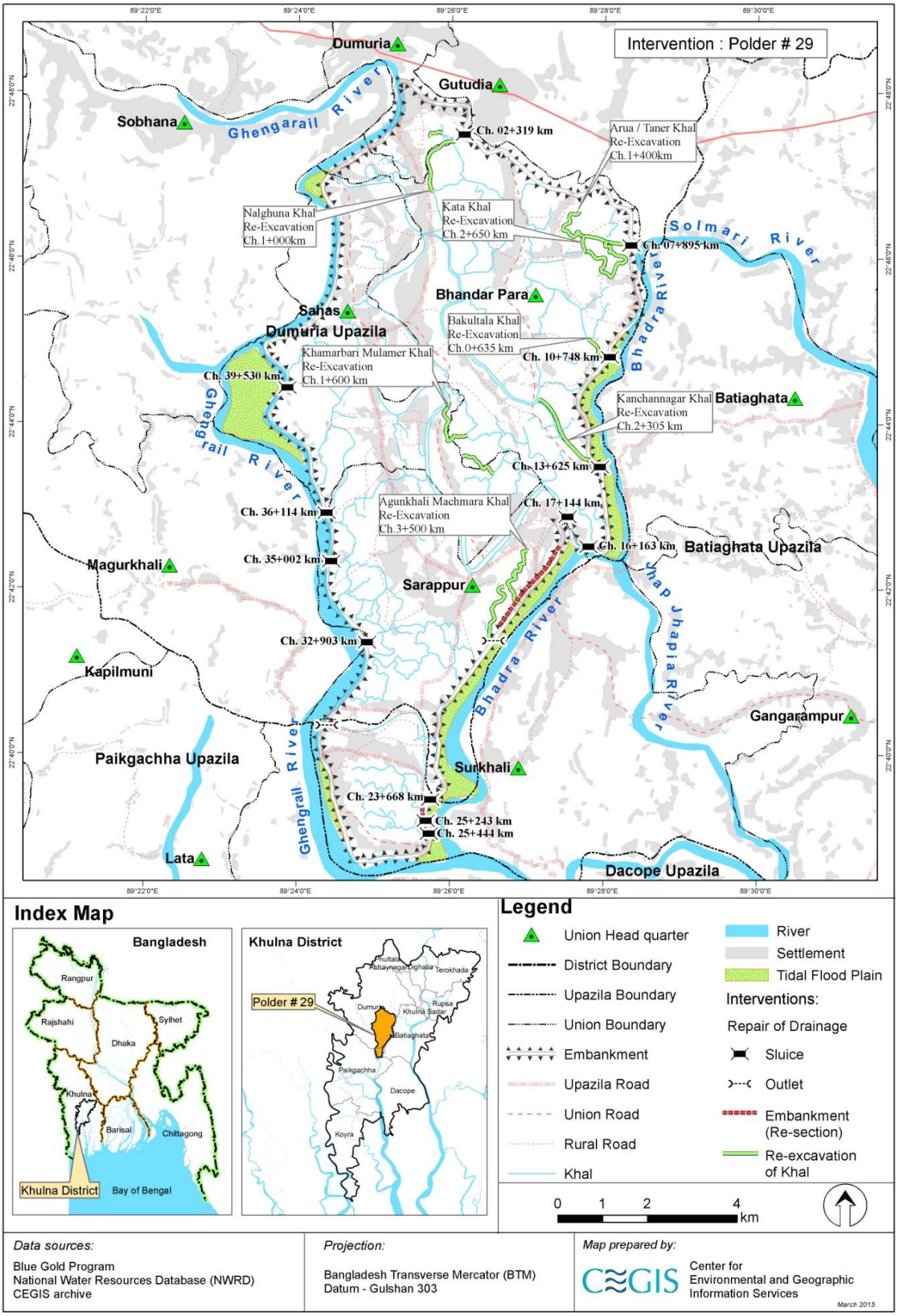
125. All existing sluices of BWDBwithin the polder will be repaired. Some sluices would require new shafts and wheels, whereas some sluices would require Details of all interventions to be undertaken are presented below from Table 4.1 to Table 4.2:

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

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)
1	Katakhali	1-V	1.83 X 1.50	02+319
2	Kanaidanga	1-V	1.20 X 0.90	07+895
3	Bakultala DS	1-V	1.38 X 1.22	10+748

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)
4	Kanchannagar	2-V	1.83 X 1.20	13+625
5	Telekhali (Old)	2-V	1.83 X 1.53	16+163
6	Telekhali (New)	2-V	1.83 X 1.53	17+144
7	Jaliakhali	4-V	1.20 X 0.90	23+668
8	Kudlar Khal Pipe Sluice	3-V	0.90 m dia.	25+243
9	Ruhitmara	1-V	1.83 X 1.20	25+444
10	Ratankhali Sluice	1-V	1.83 X 1.20	32+903
11	Ashan Nagar	1-V	1.38 X 1.07	35+002
12	Chatchatia DS	2-V	1.83 X 1.53	36+114
13	Golaimari	1-V	1.83 X 1.20	39+530

Source: Blue Gold Program, 2015



Map 4.1: Location of proposed interventions

Table 4.2: Detail information on proposed repairing of Drainage Outlets

Sl. No.	Local Name of Outlets	Number of Vent	Dia (mm)	Chainage (km)
1	Agunkhali Outlet	1-V	900	20+206
2	Shundar Mahal (Mora Bhadra) Outlet	1-V	900	30+624

Source: Blue Gold Program, 2015

4.7.4 Khal Re-excavation

126. A total number of 9 khals in polder 29 are considered in the re-excavation plan of Blue Gold program. The total length to be re-excavated is around 17.71 km. The names of the khals and lengths proposed for re-excavated are shown in Table 4.3.

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

Sl. No.	Name of Khals	Approximate Length (km)
1	Kata khal	2.300
2	Bakultala Diversion khal	0.585
3	Kanchan Nagar khal	2.275
4	Asannagar - Keyakhali khal	3.460
5	Ramakhali khal	3.110
6	Mora Bhodra khal	1.900
7	Telikhali Diversion khal	0.745
8	Ruhitmari khal	1.325
9	Aro khal / Taner khal	2.010

Source: Blue Gold Program, 2015

4.8 Construction Details

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

4.8.1 Description of Activities

Construction and Re-sectioning of Embankment

128. At first alignment of embankments has to be fixed with adequate base width for the construction of retired embankment. Base stripping and removal of trees, weed etc will be made as per instruction of the Engineer in charge. The tools required for construction of embankments will be procured during this period. After validating the final design, soil will be excavated or carried earth will be brought and deposited in the selected areas. The sloping and shaping of embankment will be developed after proper compaction in layers. Then required turfing with grass will be provided on the slope of the embankment. Watering and fertilizing will also be provided.

Repairing of Water Control Structures

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

Re-excavation of khals

130. First of all, 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.

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

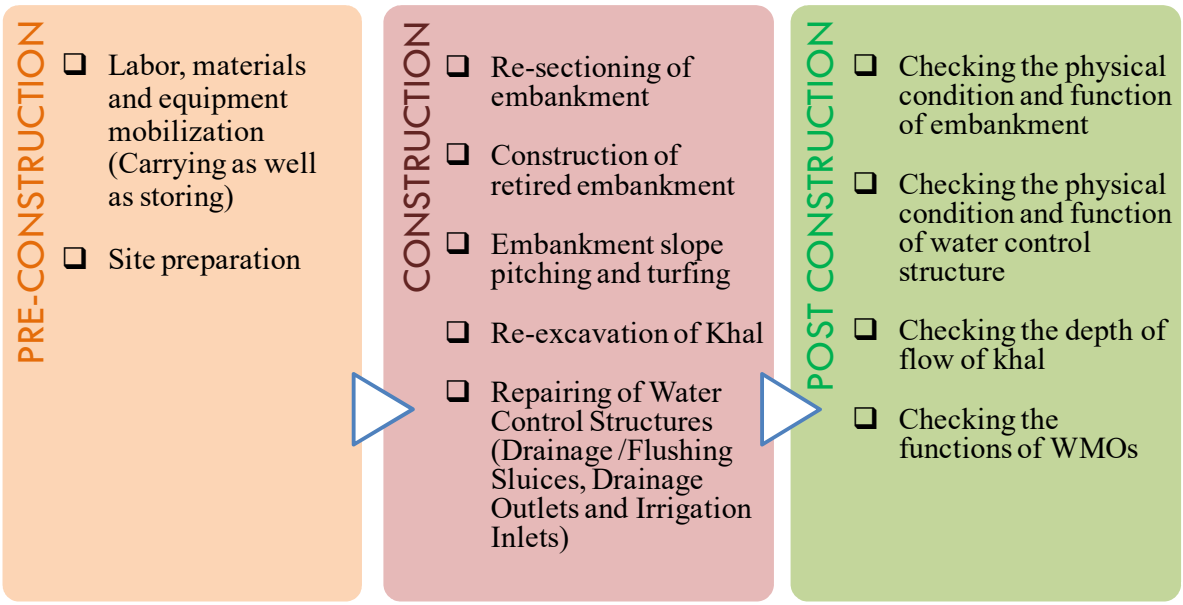


Figure 4.1: Phase wise list of activities in Polder 29

4.8.2 Construction Schedule

132. 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 29 are likely to be completed by June 2016.

Table 4.4: Construction Schedule in Polder 29

Key Activities	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)												
Community mobilization for Water Management Planning (Fine tuning works)												
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives,												

Key Activities	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Components and Initial discussions with WMGs												
Assessment of WMO Functionality												
Strengthening/ capacity building of WMO based on outcome of Assessment												
Community Mobilization for Village Development Plan (VDP) and Polder Development Plan (PDP) Firm-up water management development options Firm-up Sustainable Environmental Management Plan (SEMP)												
Implementation of Water Management fine tuning works with active participation of the WMOs/ WMA through the Quality Control/ Block Committee												

Source: Inception Report 2013, Blue Gold Program and CEGIS field investigations 2015.

4.8.3 Materials Requirement

133. The construction materials required for re-sectioning and retired embankment, water regulators and flushing inlets, and bank protection work will include soil, cement, steel, and sand. Estimated quantities of these materials are presented in Table 4.5 below.

Table 4.5: Construction Materials Requirement in Polder 29

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for Earthwork	75,000 m^3	From the set back location and other khas lands
2	Hoe(or Shovel) and Baskets	100 nos. each	To be procured
3	Compactor	30 nos.	To be procured
Repairing of sluices and flushing inlets			
6	Barrel	2 (1.5 m x 1.8 m)	To be procured
7	Pipe	1 (dia: 0.90 m) 3 (dia: 0.45 m)	To be procured
8	Wheel and Shaft	3 sets	To be procured
9	Materials for Plastering, Slope Filling, Railing and other repairing works	As per requirement	To be procured

Source: CEGIS Estimation, 2015

4.8.4 Manpower Requirement

134. 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, on 50-50 basis.

4.9 Project Management and Implementation

135. 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 29 are discussed in the following sections.

4.9.1 Community Participation through WMO/ CBO

136. 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. Polder 29 comprises of 56 WMGs and 4 WMA, under Blue Gold Program.

137. The Following CBOs have been recommended for this polder under Blue Gold Program.

Water Management Committee (WMC)

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

Landless Contracting Society (LCS)

139. LCSs are the groups selected from landless people consisting of approximately 60 members or more per group. They are responsible to carryout earthworks in a single contract. During formation of LCSs women participation in all groups will have to be ensured.

4.10 Operation and Maintenance Plan

140. Since construction, Polder 29 has been playing a vital role in safeguarding the polder area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, it is observed that due to inadequate maintenance and mismanagement issues over the years, the polder did not serve as per its potential.

4.10.1 Operational Plan

141. 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 29.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 29 has been proposed.

Regulation of Gates

142. 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

143. 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

144. 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 to supervise all preventive maintenance works. Routine monitoring of water management situation and hydrological conditions will supply data which will dictate the needs of adjusting the operational measures.

4.10.2 Maintenance Plan

145. Maintenance of embankments and structures is necessary because it helps to keep 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 29,only those work which directly serve water management should be regularly maintained. The preventive maintenance works can be implemented through community-based functional groups such as LCSs. The works may include:

- All activities related to vegetative covers on embankment and small earthworks on the embankment.
- Cleaning, greasing, and painting of structures
- Minor repair of protective works i.e. re-positioning of the displaced blocks, small patching of brick works, replacing of 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;

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

4.11 Project Cost

146. As per the approved Development Project Proforma (DPP) of the Blue Gold Program, the project cost for carrying out fine-tuning works in Polder 29 has been estimated as 100.00€ per hectare of area (**Appendix-5**). Accordingly, the project cost is 7, 93,000 € i.e. BDT 6.68 crore. (1 € = 84.25 BDT, on 6 January, 2016)

4.12 Expected Benefits and Outcome

147. The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 29 are listed in Table 4.7 below.

Table 4.6: 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 Retired Embankment	✓ Protection from tidal flooding
Repairing of Water Control Structures	✓ Sluice will function properly, agricultural activities during dry and pre-monsoon season may be improved ✓ Drainage situation would improve
Re-excavation of Khals	✓ Potential rainwater storage may be possible ✓ Better irrigation during dry and pre-monsoon period ✓ Better navigation as well as drainage
Outcome of the Project	Apart from the aforementioned foreseeable benefits, the project may create some socio-economic developments i.e. employment generation, reduction of poverty etc. As a result, the local economy in the area may further boost up.

4.13 No Objection Certificate

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

5. Environmental Baseline

5.1 Physical Environment

149. 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

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

Rainfall

151. The average monthly rainfall variation at Khulna (from 1978 to 2008) has been shown in Figure 5.1. The hyetograph shows that the highest and lowest values of rainfall are usually observed during the months of July (343 mm) and December (7 mm) respectively. Furthermore, for better representation of the real world situation, values on rainfall from 1978 to 2008 have also been collected from the four BWDB stations located at Dumuria, Paikgacha, Chalna and Kapilmuni. To take account of the spatial variation of rainfall, Theissen's Polygon have been delineated around these stations (Subramanya, 1994), which have been shown in Map 5.6. The area-weighted average values of monthly rainfall in Polder 29 havealso been plotted in Figure 5.1. The Theissen's Polygon method infers that the peak rainfall is 339 mm in June, which is almost equal to the maximum monthly rainfall observed in the Khulna BMD station in July.

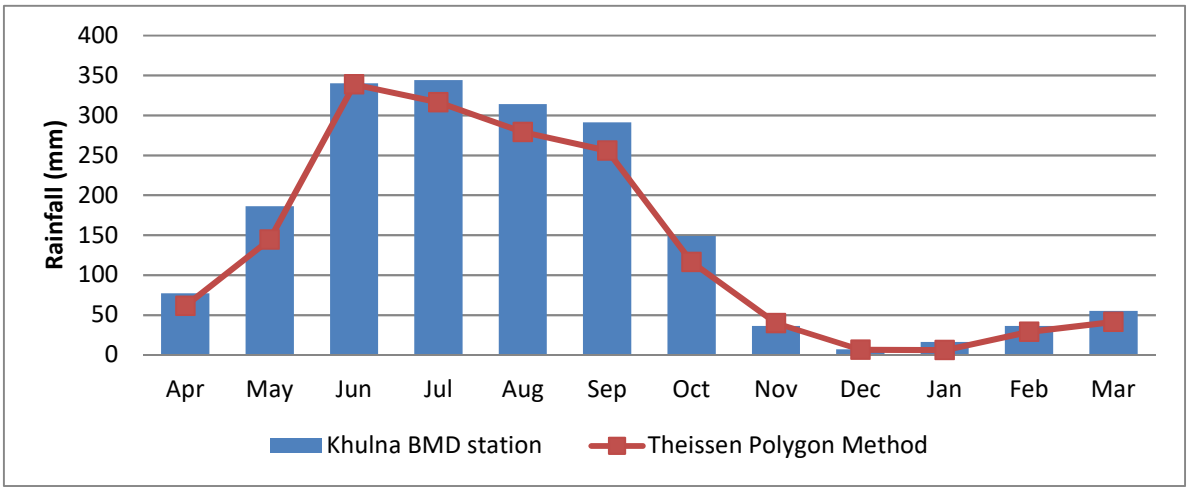


Figure 5.1:AverageMonthly Rainfall at Khulna BMD

Temperature

152. Mean maximum temperature stays between 19.3°C to 30.4°C over the year with the highest temperature experienced in the month of May. There is also significant fluctuation in minimum temperature, which varies between 15.37°C to 25.2°C. The lowest temperature is experienced in the month of January. The results of monthly average, maximum and minimum temperature variations of the polder are shown in Figure 5.2.

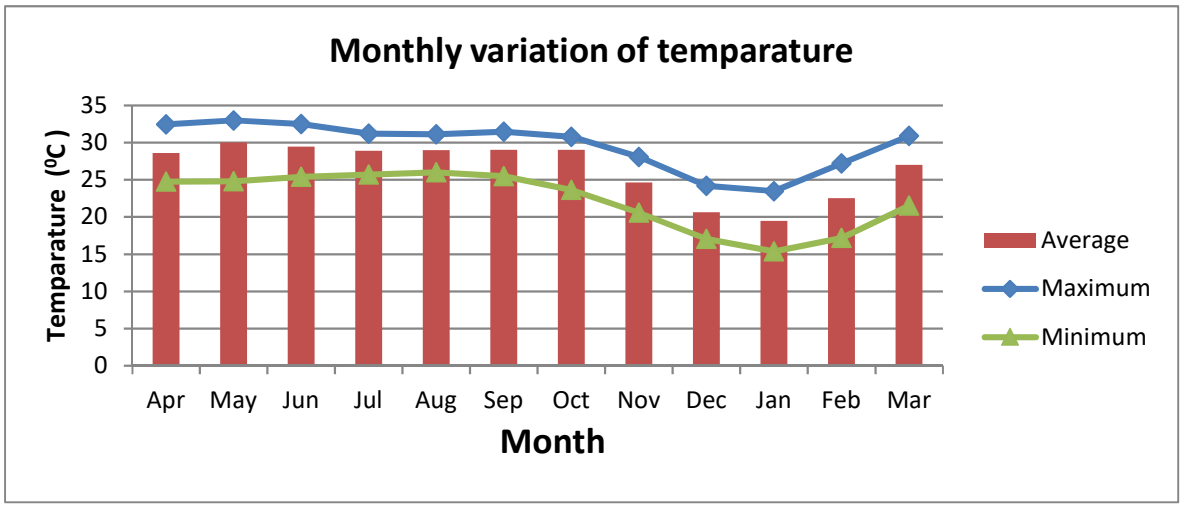


Figure 5.2: Average of Maximum and Minimum Temperatures at Khulna BMD Station

Relative Humidity

153. Figure 5.3 below shows the variation of monthly relative humidity, as recorded by the Khulna BMD station (1978~2011). A significant fluctuation has been observed as relative humidity values start to increase from April (start of summer) due to the increase in atmospheric water vapors coupled with temperature rise. Relative humidity rises above 85% in monsoon (June to September), and starts decreasing from post monsoon season following the monsoon rainfall. In the coastal areas, relative humidity values are usually higher than the other parts of the country. This is because of having a greater extent of water bodies, leading to increased evaporation.

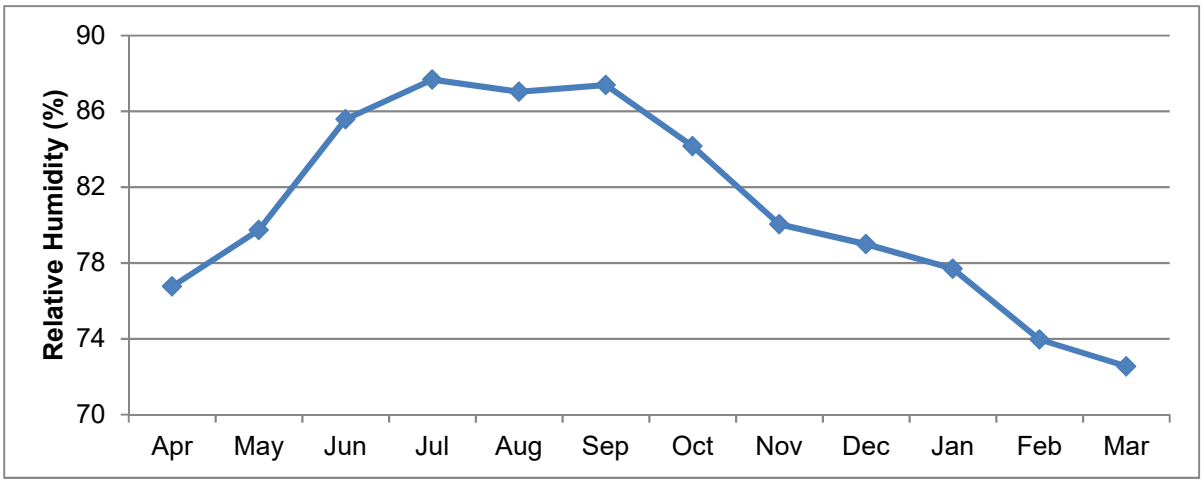


Figure 5.3: Average Relative Humidity at Khulna BMD station

Evaporation

154. Figure 5.4 below provides the monthly variations of evaporation, actual ET and reference ET (ETo). Evapo-transpiration is maximum during monsoon (June to September); and except dry season, all the other months experience significant evapo-transpiration values. ET is actually an indicator that defines crop and plant health, and observed results in Polder 29 therefore implies for better plant health (especially in Kharif-I and Kharif-II).

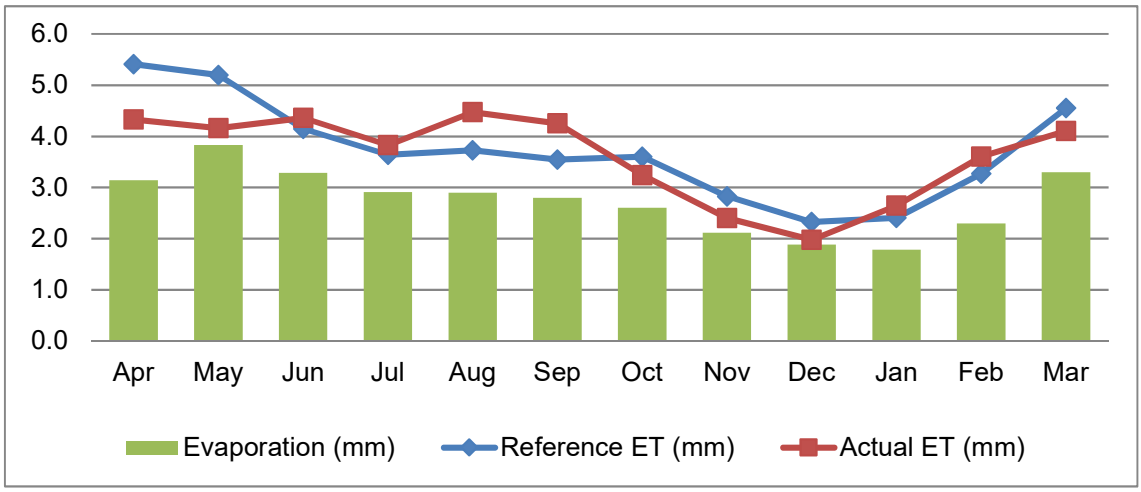


Figure 5.4: Monthly Variation of Evaporation, Reference ET and Actual ET at Khulna

Wind Speed

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

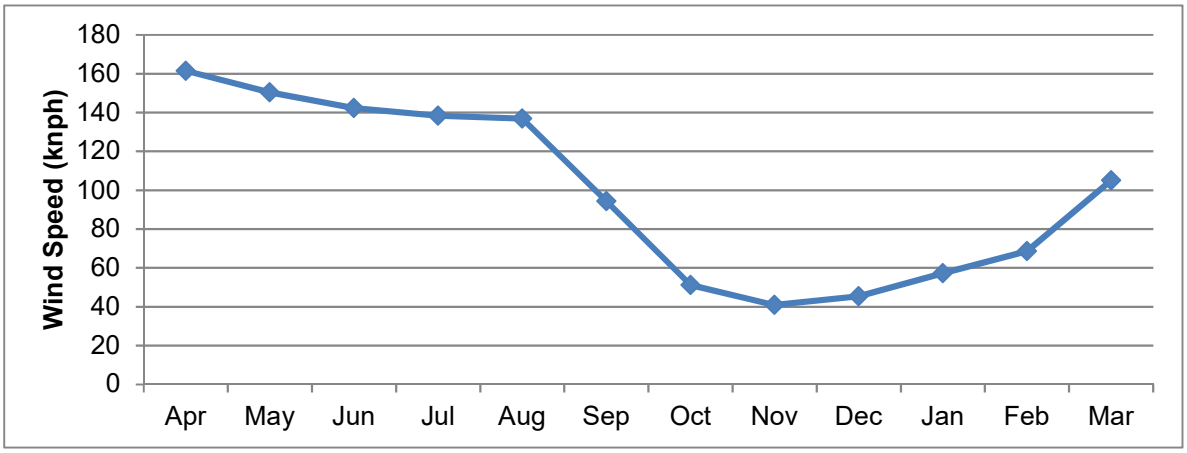


Figure 5.5: Variation of Average Wind Speed at Khulna BMD station

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

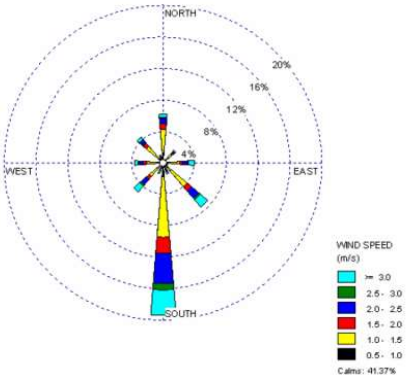


Figure 5.6 (a): Wind Rose for Khulna for a Full Year

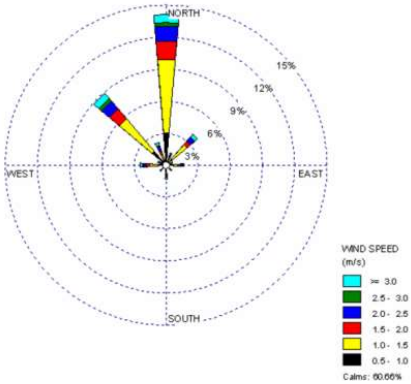


Figure 5.6 (b): Wind Rose for Khulna from November to February

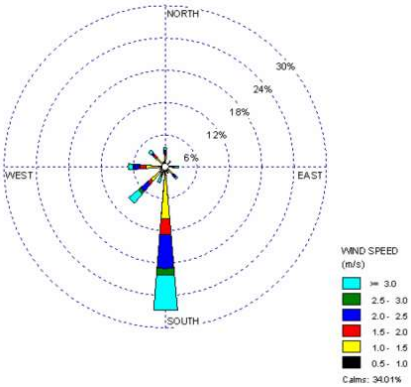


Figure 5.6 (c): Wind Rose for Khulna from March to April

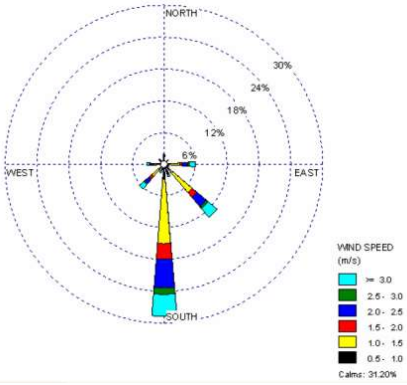


Figure 5.6 (d): Wind Rose for Khulna from May to October

Figure 5.6: Average Wind Direction and Speed for Different Period of a Year

Sun-Shine Hour

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

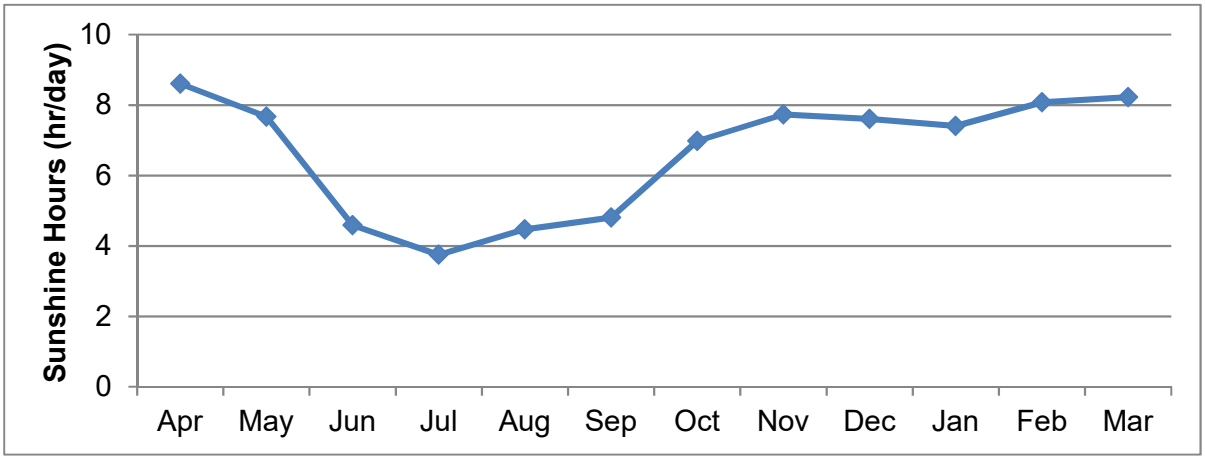


Figure 5.7: Monthly Variation of Average Sunshine Hours at Khulna BMD Station

5.1.2 Topography

158. The study area is located in the south-western hydrological zone of the country, with very low average elevations. Analysis using Digital Elevation Model (DEM) infers that the Reduced Levels (RLs)inside the polder vary from 0.96 to 2.16 m, PWD (from Mean Sea Level), with average RL of around 1.44 m +PWD. From the DEM it is found that around 55% lands of the areas have elevation between 1.38 to 1.61 m above MSL, whereas 37% have elevations above 1.61 m above MSL. The elevations are more or less similar, with a very minor downward sloping from north to south, which eventually draws water from the up-stream basins to the Ghengrail and Bhadra rivers. There is also a radial topographic trend observer, as most of the land elevations near the polderperiphery are higher than that of the central areas. **Map 5.1**below shows the topography of the study area, identifying the rivers and water bodies as well as categorizing land elevations.

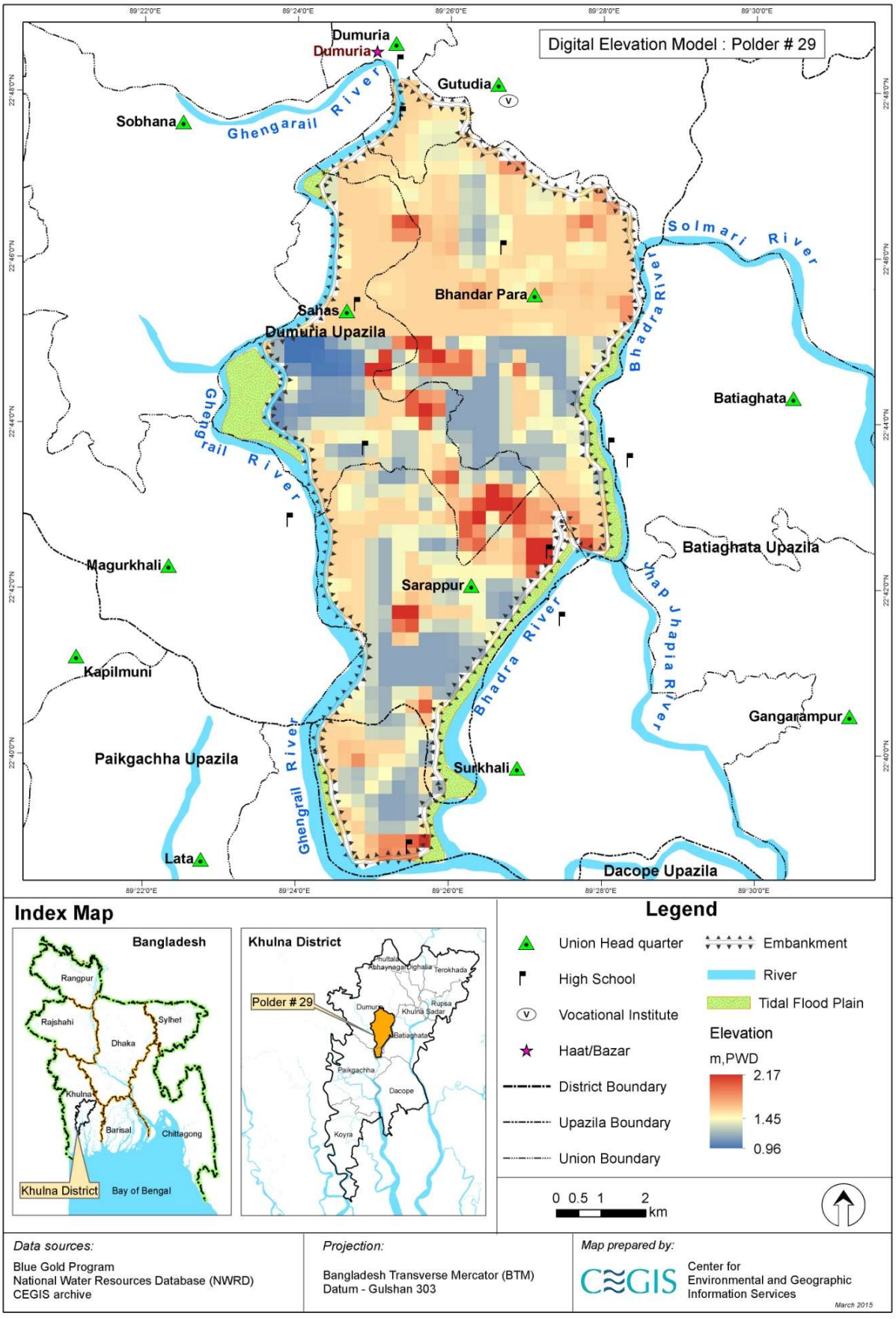
5.1.3 Seismicity

159. Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes in the past 200 years. As per the updated seismic design provisions of Bangladesh National Building Code, 1993, Polder 29 falls under Zone-I, which is considered as a seismically quiet zone, with Seismic Zone coefficient1 of 0.075, comprising the southwest portion of Bangladesh. **Map 5.2**below shows the seismic location of Polder 29.

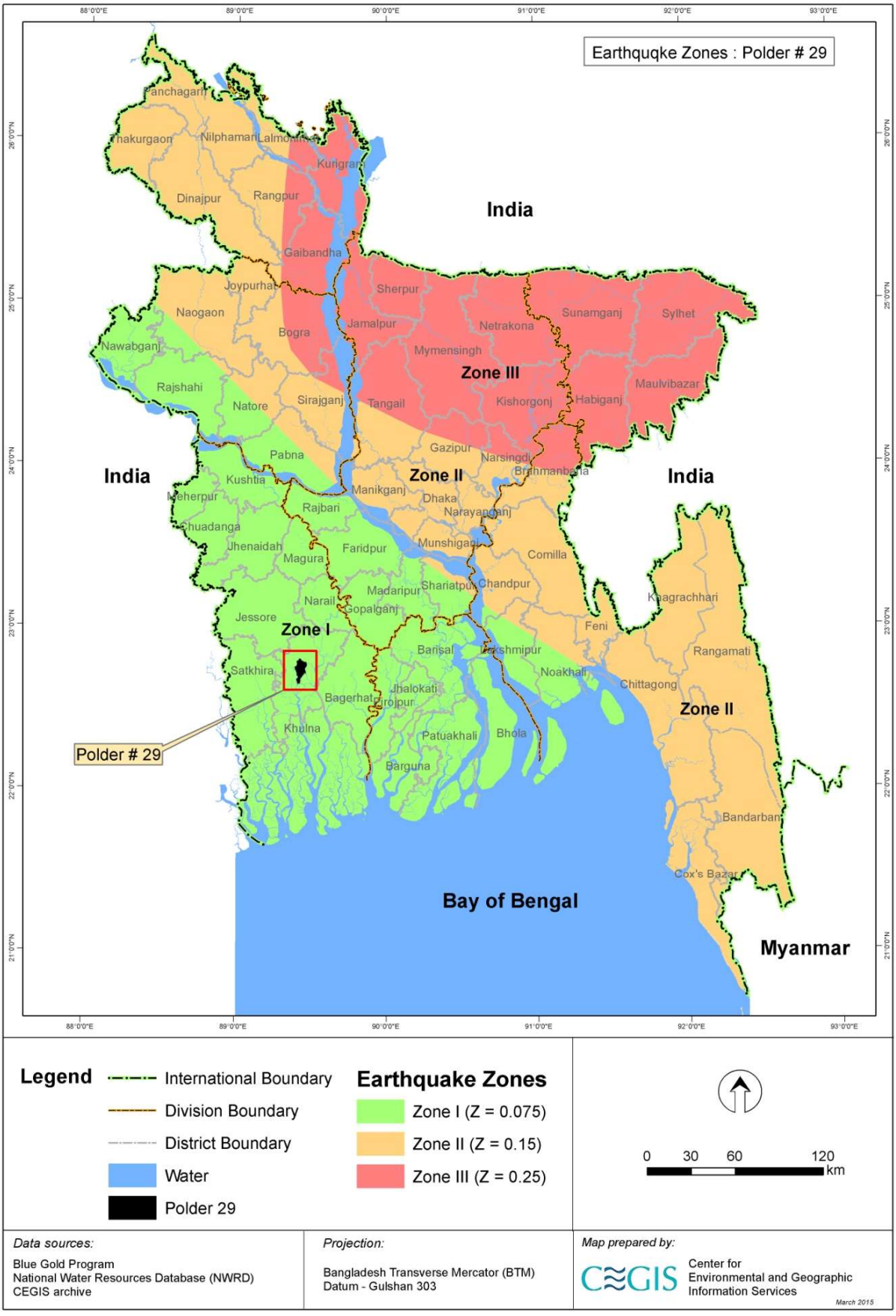
160. Moreover, Polder 29 is located inside the Faridpur Trough, which is situated adjacent to the Hinge Zone, and is characterized by a general gravity-low with the development of Neogene sequence. **Map 5.3** below represents the tectonic units available in Bangladesh and the location of Polder 29 (within the Faridpur Trough).

161. It can therefore be inferred observed that both in consideration of seismicity and stratigraphy, Polder 29 falls on a relatively safer (seismically quiet and tectonically stable) side.

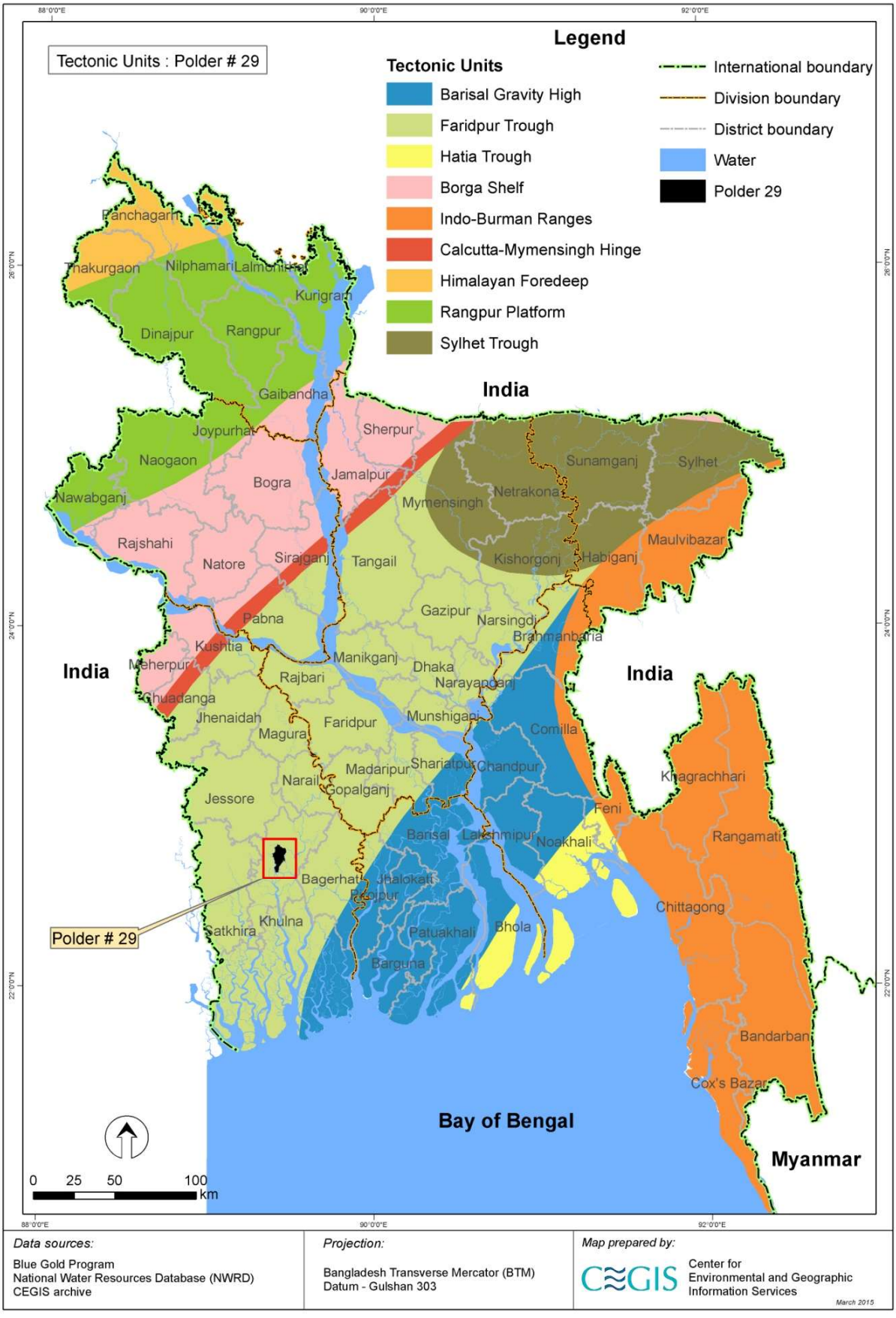
[1]Seismic Zone coefficient is a dimensionless number which represents the (maximum) earthquake acceleration as a fraction of the acceleration due to gravity.



Map 5.1: Digital Elevation Model (DEM) and Flow Direction around Polder 29



Map 5.2: Earthquake Zones of Bangladesh and location of Polder 29



Map 5.3: Tectonic Units Bangladesh and location of Polder 29

5.1.4 Land Resources

162. Land comprises natural resources such as soils, minerals, water and biota. These components are organized in ecosystems which provide a variety of services essential to the maintenance of the integrity of life–support systems and the productive capacity. Fertilizer doses have been collected from secondary sources (BARC, 2012) for different crops using soil nutrient status. High resolution recent satellite imageries of the study area were used for the collection of the base line data on land use, as well as related data on agriculture. Land type data were collected using SOLARIS tool (2006).

5.1.5 Agro Ecological Regions

163. 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 29 area is covered byone AEZ i.e. Ganges Tidal Flood Plain (AEZ-13).

Ganges Tidal Floodplain AEZ-13

164. 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.

5.1.6 Physico Chemical Properties of Soil

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

Table 5.1: Some physicochemical 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

5.1.7 Soil Fertility Analytical Data of Analytical Samples

166. Soil sample were collected from four locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area on 15th and 16th March, 2015. Collected soil samples were analyzed by Soil Resource Development Institute (SRDI), Dhaka. Results of the analysis are presented in the Table 5.2.

Table 5.2: Chemical properties of soil on agriculture land

Number of the polder	Location (Mouza / Village)	GPS reading	Depth (cm)	EC ds/m	pH	OM	N	K	P	S
						%		Meg/ 100g	µg/gm	
29	Uttar Talian	22°45'17.04"N 89°25'31.03"E	0-10	6.02	7.9	2.12	0.12	0.54	5.08	114.30
			10-20	1.07	8.4	2.12	0.12	0.37	6.76	15.06
			20-30	1.03	8.5	1.62	0.09	0.34	8.79	12.54
	Bhulbaria	22°41'41.74"N 89°25'43.43"E	0-10	5.66	7.6	2.41	0.14	0.40	9.15	357.60
			10-20	1.46	7.4	1.62	0.09	0.63	4.25	140.90
			20-30	1.76	6.9	1.88	0.10	0.60	3.35	150.90
	Kukhia	22°43'51.41"N 89°25'20.10"E	0-10	5.55	6.3	2.41	0.14	0.55	7.87	301.21
			10-20	1.95	6.7	2.84	0.16	0.50	6.76	206.15
			20-30	2.22	7.3	1.34	0.08	0.45	5.45	146.30
	Ghona	22°46'16.57"N 89°27'0.04"E	0-10	6.75	7.5	1.72	0.10	0.38	6.25	112.00
			10-20	1.88	7.9	1.34	0.08	0.60	7.21	373.30
			20-30	6.25	7.6	3.22	0.18	1.02	6.25	291.60

Source: SRDI laboratory analysis, 2015

5.1.8 Land Type

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

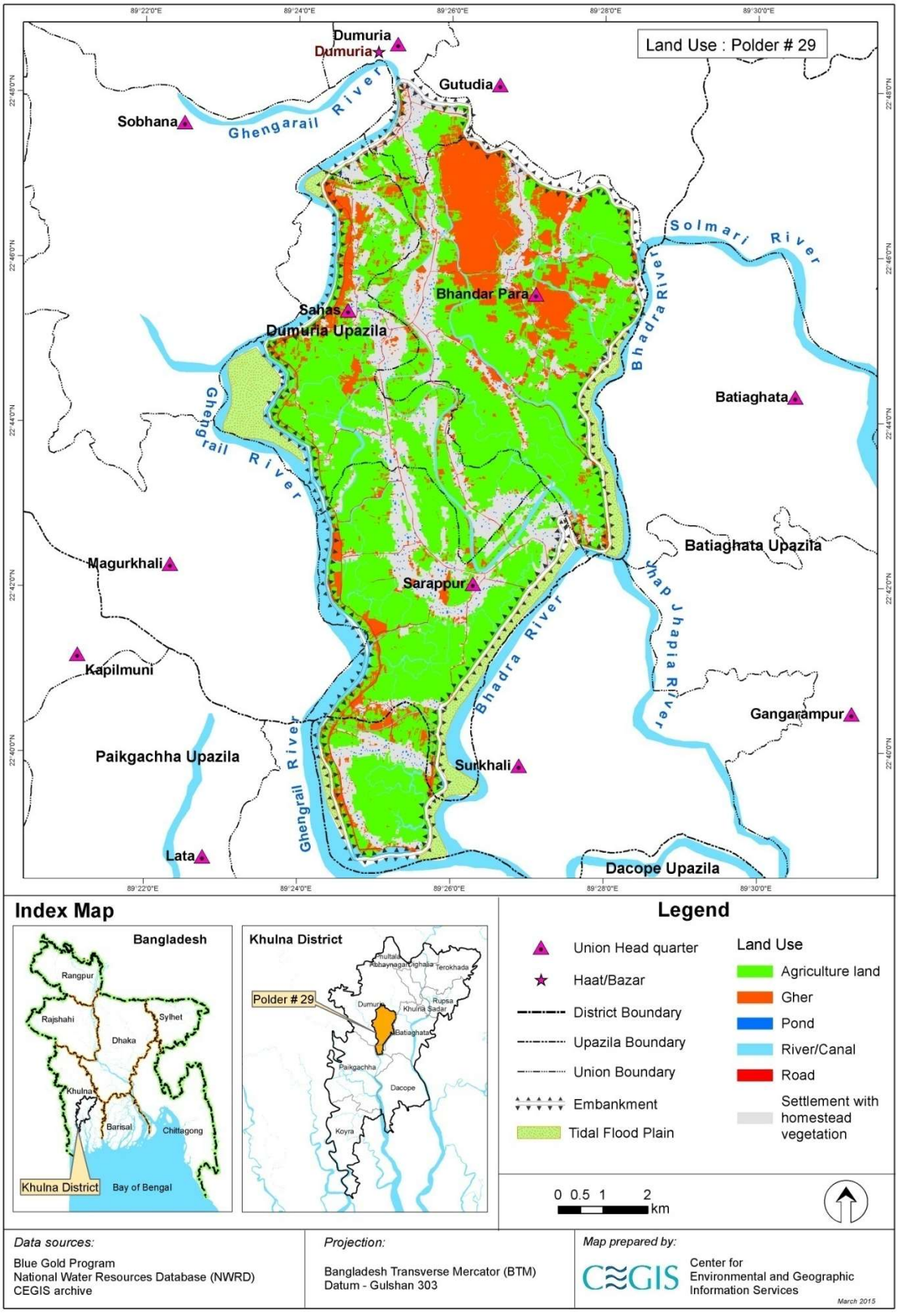
5.1.9 Land Use

168. The gross area of the polder is 7,930 ha of which net cultivable area (NCA) is 5,466 ha. The NCA is about 69% of the gross area. The coverage of settlements is 23%, water bodies (river/khals) is 7% and road is 1% of the gross area. Fishers and CEGIS fisheries expert reported that 390 ha (7% of NCA) is under rice cum fish culture. Detailed 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)	% of Gross Area
Net Cultivated Area (Agriculture)	5,466	69
Settlements	1,811	23
Water bodies (river/khals)	590	7
Road	63	1
Gross area	7,930	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.4: Land use map of the study area

5.1.10 Land Form

169. The major portion of the study area is occupied by ridge5,376 ha (98%) and basin is about 90 ha (2%). These landforms influence the land use related to agricultural crop production. Detailed distribution of land form in the polder area is presented in Table 5.4

Table 5.4: Detailed landform of the polder area

Drainage	Area (ha)	% of the NCA
Basin	90	2
Ridge	5,376	98
Total	**5,466**	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006

5.1.11 Soil Texture

170. Soil texture is an important soil characteristic that determines crop selection, crop production and also field management. It influences many other properties of great significance to land use and management. Soil texture is the relative proportions of sand, silt and clay, four major textural classes: a) sands b) silts c) loams and d) clays. There are two types of soil texture in the polder area i.e. clay and clay loam. It influences many other properties of great significance to land use and management. Detailed distribution of soil texture is presented in Table 5.5.

Table 5.5: Detailed soil texture of the surface soil (0-15 cm) in the polder area

Soil Texture	Area (Ha)	% of NCA
Clay	5,251	96
Clay Loam	215	4
Total	**5,466**	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006

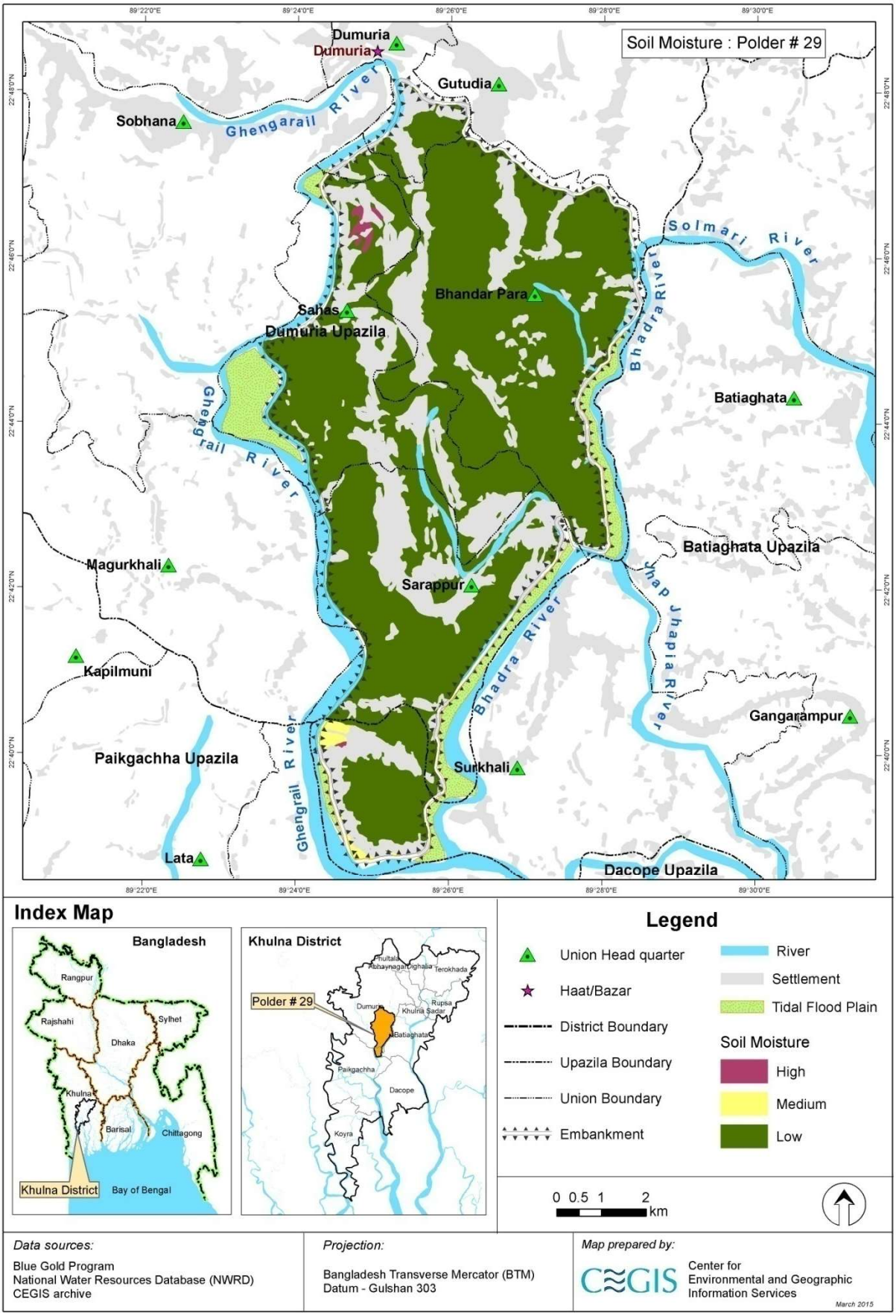
5.1.12 Available Soil Moisture

171. The availability of soil moisture varies depending on the soil characteristics. Three typesof soils, with high, medium and low moisture are available in the polder area. All three levels of soil moisture with the percentage of the NCA of the polder area is presented in Table 5.6 and Map 5.5.

Table 5.6: 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	55	1
Medium	Plant extractable soil moisture remain in field level from one to two months	60	1
Low	Plant extractable soil moisture remain in the field level less than one month	5,351	98
Total		**5,466**	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.5: Soil moisture map of the study area

5.1.13 Soil Salinity

172. CEGIS estimation from SOLARIS-SRDI, 2006, reveals that over the period's soil salinity of the area inside the polder increases gradually. Local farmers reported that most of the water control structures are not functioning properly. As a result, this cannot restrict intrusion of saline water inside the polder which is reported as the major cause of the salinity increment inside the polder. During field visit, local farmers and Agriculture officers reported that the soil and water salinity gradually increases with dryness from January and reaches maximum level in the month of March-April and then decreases due to onset of monsoon rainfall. Detailed soil salinity of 1973, 2000 and 2009 of the polder area are presented in Table 5.7 and Map 5.6.

Table 5.7: Detailed soil salinity in the polder area

Soil Salinity Class	EC (dS/m)	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
Non saline with some very slightly saline (S1)	2.0 - 4.0	3,366	62	-	-	3,366	62
Very slightly saline with some slightly saline (S2)	4.1 - 8.0	-	-	-	-	-	-
Slightly saline with some moderately saline (S3)	8.1 - 12.0	2,100	38	5,029	92	2,100	38
Moderately saline with some strongly saline (S4)	12.1 - 16.0	-	-	437	8	-	-
Strongly saline with some very strongly saline (S5)	> 16.0	-	-	-	-	-	-
Total		**5,466**	**100**	**5,466**	**100**	**5,466**	**100**

Source: SRDI, SRMAF Project, Ministry of Agriculture, 2010; Note: Local farmers and SAAO of DAE informed that soil salinity start to build up in the month of January and reaches to maximum in the month of March and April.

5.1.14 Drainage Characteristics

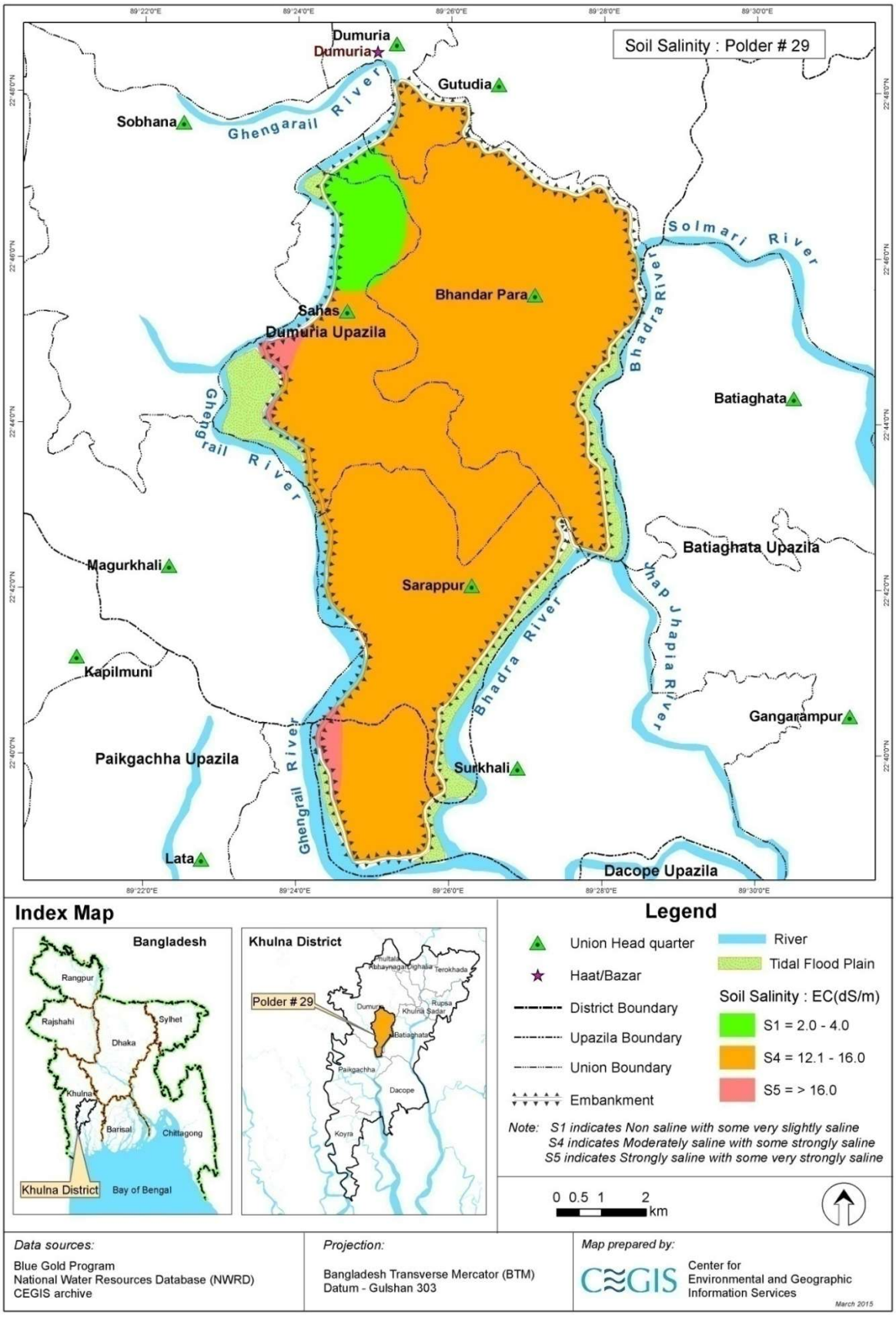
173. Drainage plays a vital role in the management of soil productivity in the polder area. The drainage characteristics have been divided into six classes by SRDI for agricultural uses. These are excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and very poorly drained. About 98% of the NCA is under imperfectly drained i.e. water drains from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land for more than 15 days at a stretch.

174. During the rainy season, groundwater stands within 1 meter depth and 2% of the NCA is poorly drained. The soil remains under water for 15 days to few months. Water is drained from the soil slowly. The soil of the polder area indicates that the timely removal of water in rainy/monsoon season is crucial for growing rabi/dry land crops in the polder area. Detailed drainage characteristics of the polder area are presented in Table 5.8 and Map 5.7.

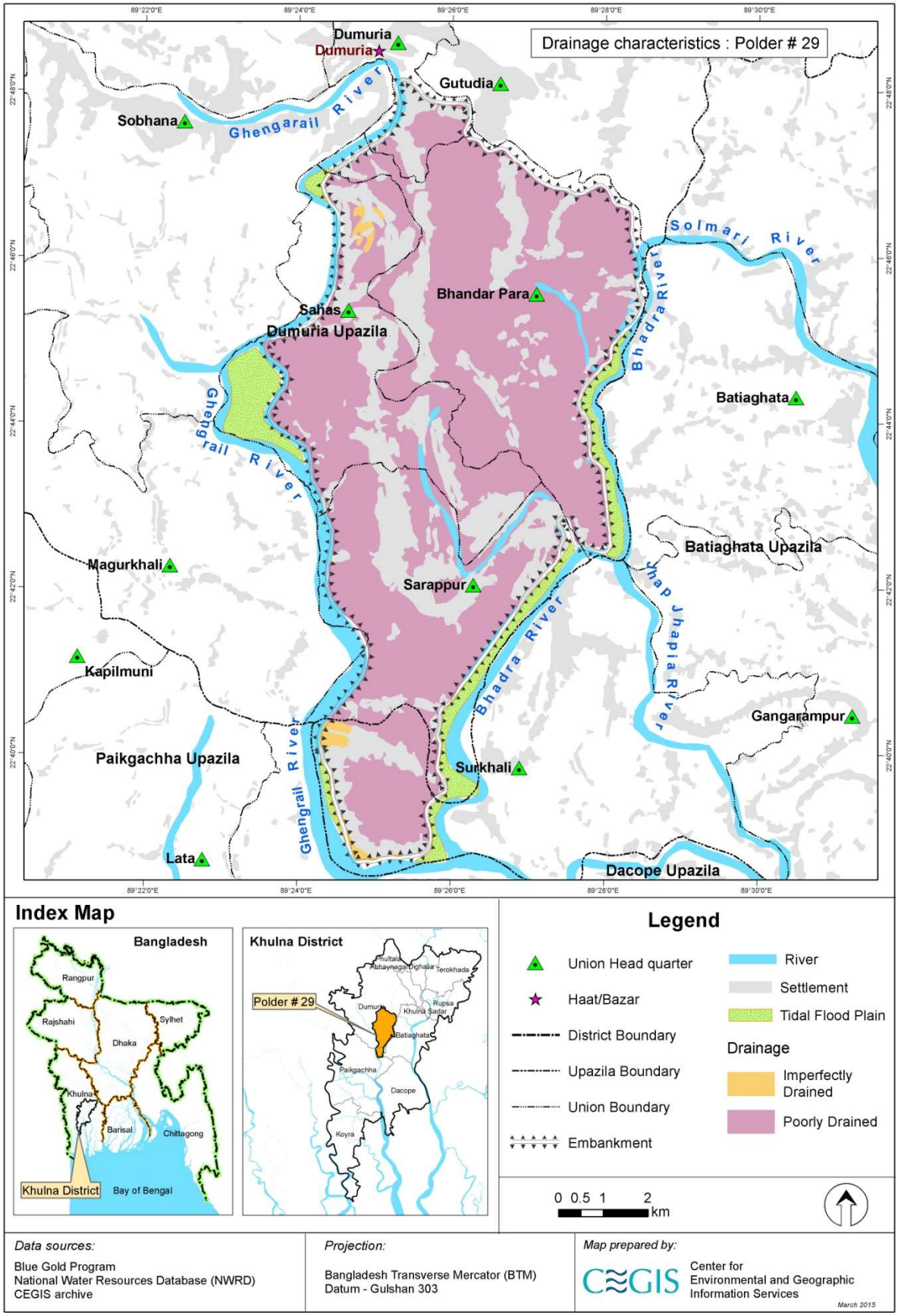
Table 5.8: Detailed drainage characteristics of the polder area

Drainage	*Area (ha)*	*% of NCA*
Imperfectly Drained	***115***	***2***
Poorly Drained	***5,351***	***98***
Total	***5,466***	***100***

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.6: Soil salinity map of the study area



Map 5.7: Drainage characteristics of the study area

5.1.15 Water Resources System

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

Rivers System

176. Polder 29 is 75 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is surrounded by the Upper Bhadra (east) andGhengrail (west) rivers. The two rivers are originated from the Sibsa River System, and are directly fed by the oceanic tides. The river system of the area is shown in Map 5.8.

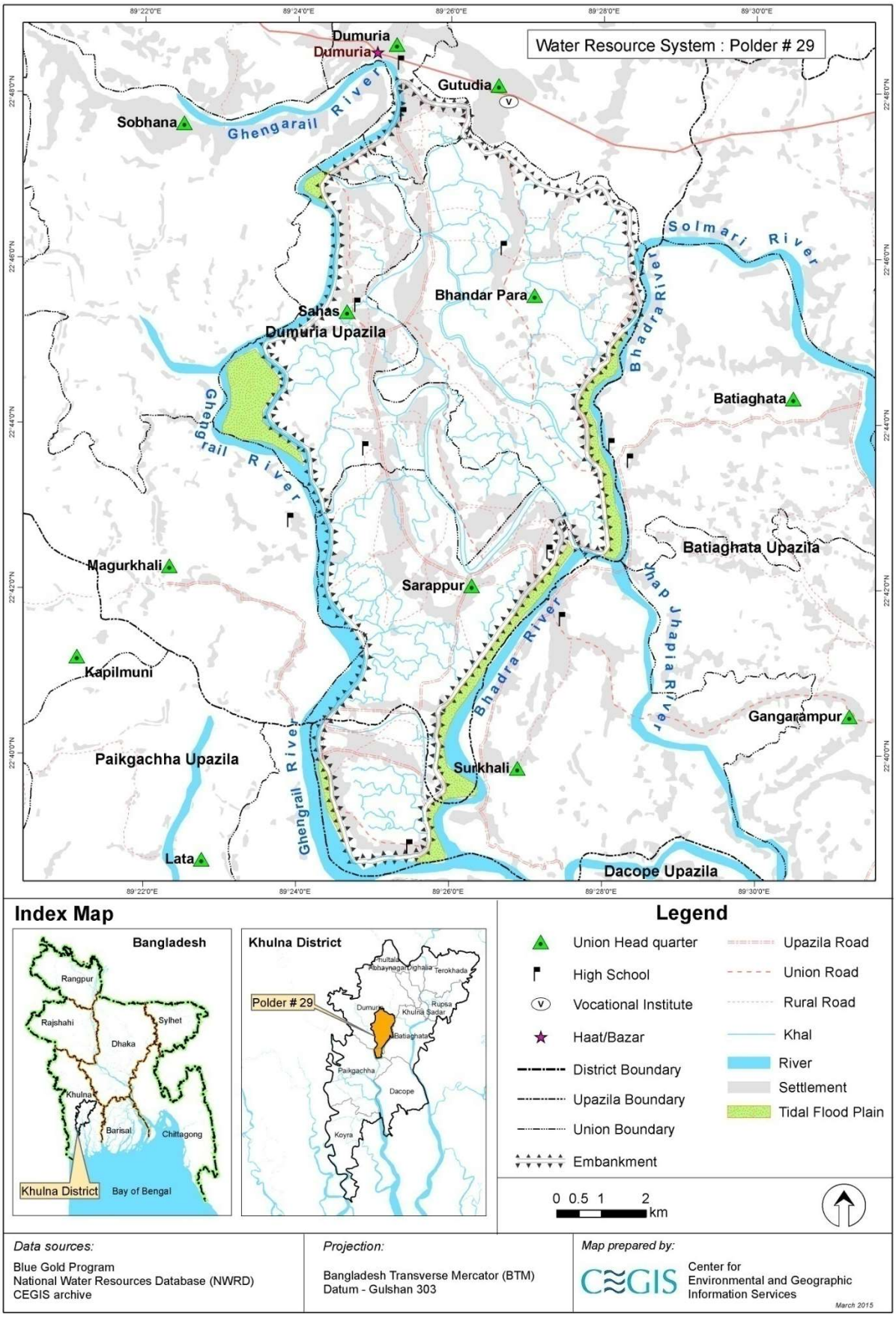
Photo 5.1: Upper Bhadra River

Photo 5.2: Ghengrail River

Hydrological Connectivity

177. During high tide, water flows from Bay of Bengal to the Ghengrail river system, which feeds the peripheral Ghengrail and Upper Bhadra rivers. In addition, a number of khalsalso exist within the polder. The Arorkhal, Ramakhalikhal, Asannagarkhal etc. are the tributaries of the Ghengrail, and maintain the water resources functions of the river. On the other hand, the hydrological functions of the Upper Bhadra River are supported by a number of its tributaries namely, Kata khal, Bakultolakhal, Kanchonnagar khal etc. The internal water courses of the polder facilitate the flow circulation inside the polder, when needed. During low tide, tidal water recedes through the peripheral water courses and reaches the Bay of Bengal.

178. During dry season the khals are usually blocked off by the sluice gates so as to prevent the entry saltwater, whereas in wet season, these khals are used to drain the surplus water out of the polder. However, in recent years, most of the khals have been silted up due to increased siltation. This hampers the flow circulation inside the polder. Moreover, there are some khals which carry saltwater during dry season as the sluice gates placed at the openings of these khals are damaged and kept open. The khals of Polder 29 are also shown in Map 5.9.



Map 5.8: Water Resources System of the Polder Area

Surface Water Level

179. The surface water levels of two BWDB stations at Dumuria (Upper Bhadra River) and at Sutarkhali F.O. (Ghengrail River) from 1970 to 2000 have been analyzed (Figures 5.8 and 5.9). Water levels during high tide range from 1.5 to 2.26 m +PWD at Dumuria, and 2 to 2.78 m +PWD at Sutarkhali. On the other hand, the low tidal water levels range from 0.8 to 1.39 m below the MSL at Dumuria, and to 0.01 to 0.78 m below MSL at Sutarkhali.

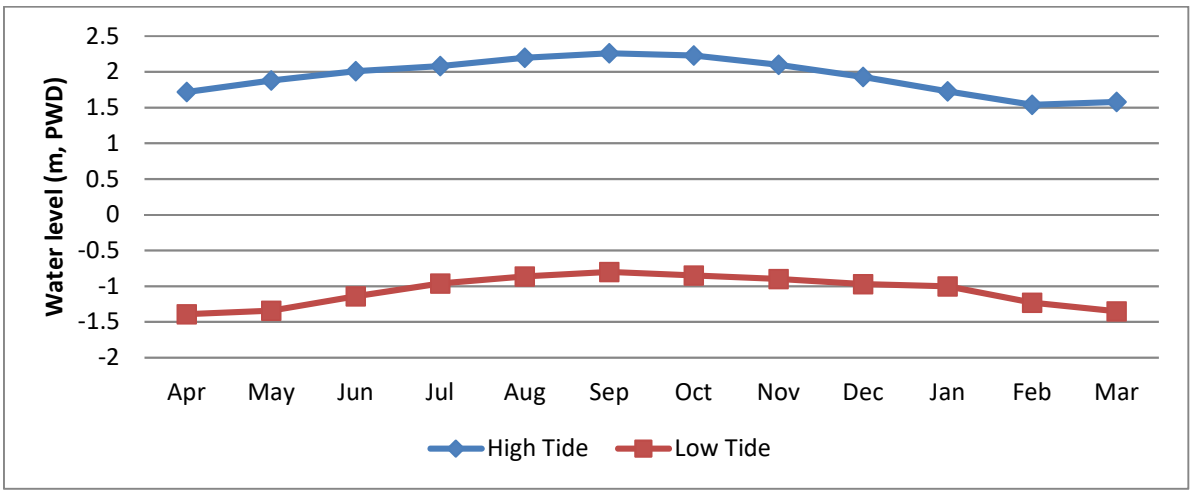


Figure 5.8: Surface water level at Dumuria (Upper Bhadra River)

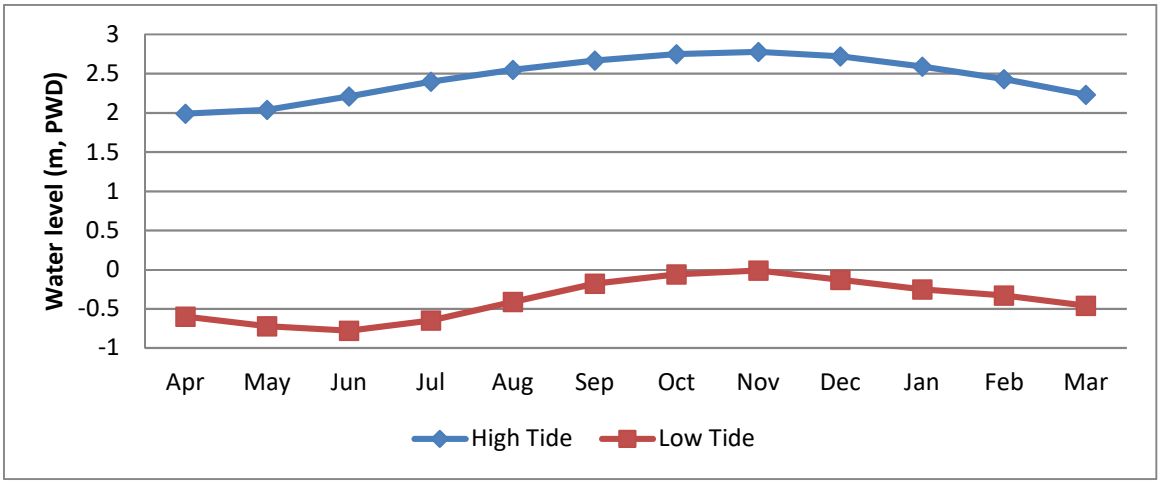


Figure 5.9: Surface water level at Sutarkhali F.O. (Ghengrail River)

180. During field investigation it was observed that most of the internal water courses are heavily silted up, and cannot carry sufficient water during all seasons. Only one khal inside the polder (Mora Bhadra) was identified as a perennial water course2. Around 30% number of khals at Mora Bhadra, Asannagar, Ramakhali etc. carry water upto 5~7 feet depth during dry season. Approximately 35% khals (Telikhali khal, Bokultola khal etc.) carry reduced amount flow, ranging from 2~5 feet deep. Almost 20% khals (Aro khal, Golaimari khal, Kata khal etc.) inside the polder carry no water during dry season.

[2]Perennial water courses are defined as the khals or canals which contain water during all seasons.

Ground Water

181. Monthly variations in ground water levels for year 2007 have been plotted in Figure 5.10 for the ground water observation well named as KHU005 (at Dumurua). The variation pattern for KHU005 station the GWT values are fairly low, with lowest and highest values found in April and December respectively.

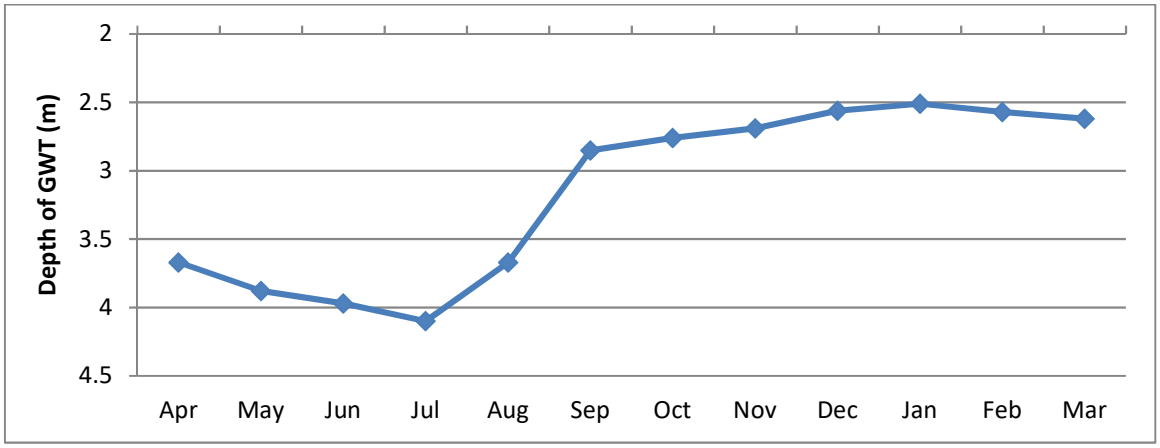


Figure 5.10: Average monthly variations of GWT

182. Furthermore analyses have been carried out to understand the annual variations of GWT at KHU005 station (Table 5.9) for April and September (from 1980-2000). For KHU005 station, the GWT has dropped over the last few years.

Table 5.9: Depth of GWT (m) at the study area at ten years interval (1980-2000)

Station Id	1980		1990		2000	
	April	September	April	September	April	September
KHU005	2.64	1.44	7.02	1.46	3.78	1.96

Source: NWRD

5.1.16 Water Use

Domestic Use

183. The standard value of average daily demand of water for domestic and drinking purposes in rural areas is considered as 50 lpc (Ahmed and Rahman, 2010). However, the actual status of drinking water in some of the coastal polders is very poor. During the field survey in Polder 29, it was found that the average daily domestic use of water was around 30 lpc. The study found that around 1,660 m^3 of water is consumed daily by the total number of 55,304 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. For other domestic uses, surface water sources are used. The use of shallow tubewells is only confined within the domestic purposes. This is because the shallow subsurface layers contain minor salinity (upto 2 ppt), making its drinking water use objectionable. There is a 100 year old historical pold near Akra govt. primary school, which is a much preferred freshwater source for the local people. Around 700 people from the nearby villages collect water from the pond and meet up their drinking purpose. Overall, water availability in Polder 29 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

184. The local farmers in Polder 29 practice Jute, Sesame and Vegetables in Kharif-I (March-June) season; HYV T Aman, LT Aman and Vegetables in Kharif-II season (July-October); and Boro and vegetables in *Rabi* (November-February) season. The rain fed irrigation is sufficient during Kharif-I season for Jute, Sesame and Vegetables. Rainwater is also adequate for most crops in Kharif-II, but around 60 ha areas of HYV T amap requires additional irrigation using groundwater during booting stage. The Rabi season boro crops require high irrigation, around 80% of which is met up by groundwater sources and the rest is provided with surface water sources using LLPs (Table 5.10).

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

Table 5.10: Irrigation water requirements in Polder 29

Season	Lt. Aman (ha)	HYV T Aman (ha)	Boro (ha)	Sesame and Vegetables (ha)	Jute (ha)	Water requirement (mm/ ha)	Water Used (Mm3)	Type of irrigation
Kharif-I (March - June)	-	-	-	2,023	164	300	6.56	No irrigation is required as pre-monsoon rainfall is sufficient
Kharif-II (July - October)	4,045	1,203	-	219	-	300	16.40	Groundwater irrigation is provided in 60 ha HYV T aman crops (0.1% of Kharif-II water requirement) during booting stage, the remaining amount is provided by rainwater
Rabi (November – February)	-	-	1,203	-	-	2000	24.06	Groundwater irrigation is provided in 80% areas, the remaining portion is provided by LLPs
	-	-	-	219	-	300	0.66	No irrigation is required as the moisture content is adequate

Source: CEGIS Estimation, March 2015

5.1.17 Water Resources Problems

Tidal and Storm Surge Flooding

186. Local people in Polder 29 opined that the peripheral embankment effectively offers protection from regular tidal flooding in the area. And even though some of the water control structures are subjected to flow leakage, the amount of flow entering the polder are minimal. As such it can be said that, no tidal flooding takes place inside Polder 29. Local people also alleged that there was no major storm surge flooding in Polder 29 during Aila (2009) and Sidr (2007).

Drainage Congestion and Water Logging

187. Drainage congestion has been identified as the major problem inside the polder. Almost all the khals inside the polder, which are directly connected to the peripheral rivers, suffer from tremendous drainage congestion. Some of the severely affected khals are Aro khal, Asannagar khal, Mora Bhadra River (locally termed as Mora Bhadra khal), Bokultola khal, Telikhali khal etc. During monsoon and post-monsoon periods, these khals cannot cope with the increased rainfall occurrences, leading to moderate to severe drainage congestion problems. Local people opined that, around 40% khals inside the polder (Bokultola, Aro khal, Mora Bhadra, Telikhali etc.) suffer from severe drainage congestion[3], whereas almost 30% khals (Kanchannagar, Katakhal, Ruthimara etc.) suffer from moderate drainage congestion[4] problems. Such drainage congestion problems mostly affect the agriculture and production sector. Due to the reduced drainage capacity of khals, rainwater often inundates agricultural fields for a period of 4~5 days, and affects the Kharif-II crops.

188. The reason for drainage congestion problems is two-fold. In the khals which are connected to Ghengrail, drainage congestion problems have been induced by a gradual sedimentation in the Upper Bhadra River, which resulted in an increased bed level. For this reason, water from the khals could not pass properly to the parent river (Upper Bhadra), leading to gradual siltation of khals and drainage congestion problems. This is a reason why most of the sluice gates placed along the eastern periphery of the polder have been non-functional. On the other hand, the khals connected to the Ghengrail River have mostly been silted up because of the damaged sluice gates placed at the khal openings. Some of the gates (Aro khal, Asannagar khal etc.) became non-functional due to poor maintenance, leading to siltation adjacent to the khal openings. Local people opined that, no prolonged water logging situation exists inside the polder, however, minor rainfed inundation exists at some areas as already discussed above.

Erosion

189. There are two erosion hotspots namely, Baro Aria and Jaliakhali along the peripheral embankment of the polder. The location at Baro Aria is at the southern corner of the polder, where the Upper Bhadra and Ghengrail rivers share a common confluence. Local people informed that, the location is unstable and is being eroded for some 8~10 years. During field inspection, no embankment breach was observed in that location, but there was no setback distance along the riverside floodplain. A key informant living at Baro Aria said that the

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

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

Upper Bhadra River course has frequently moved its way in the past, for which a substantial portion of lands have been eroded already.

190. The other erosion hotspot at Jaliakhali was inspected as well. Similar erosion features and morphological instability were observed in that area, except that there is more riverside setback distance in this location. Following an embankment breach last year, local people constructed an earthen retired embankment approximately 20 feet inside the actual polder alignment, which prevents tidal water from entering the polder.

191. From spatial analysis using the satellite imageries of different time frame (1988, 2003 and 2014), it has been found that around 100 ha of lands have been eroded from the Baro aria point in last 26 years, and around 20 ha lands have been eroded from the floodplain portions of Jaliakhali.

Photo 5.3: Erosion point at Baro Aria

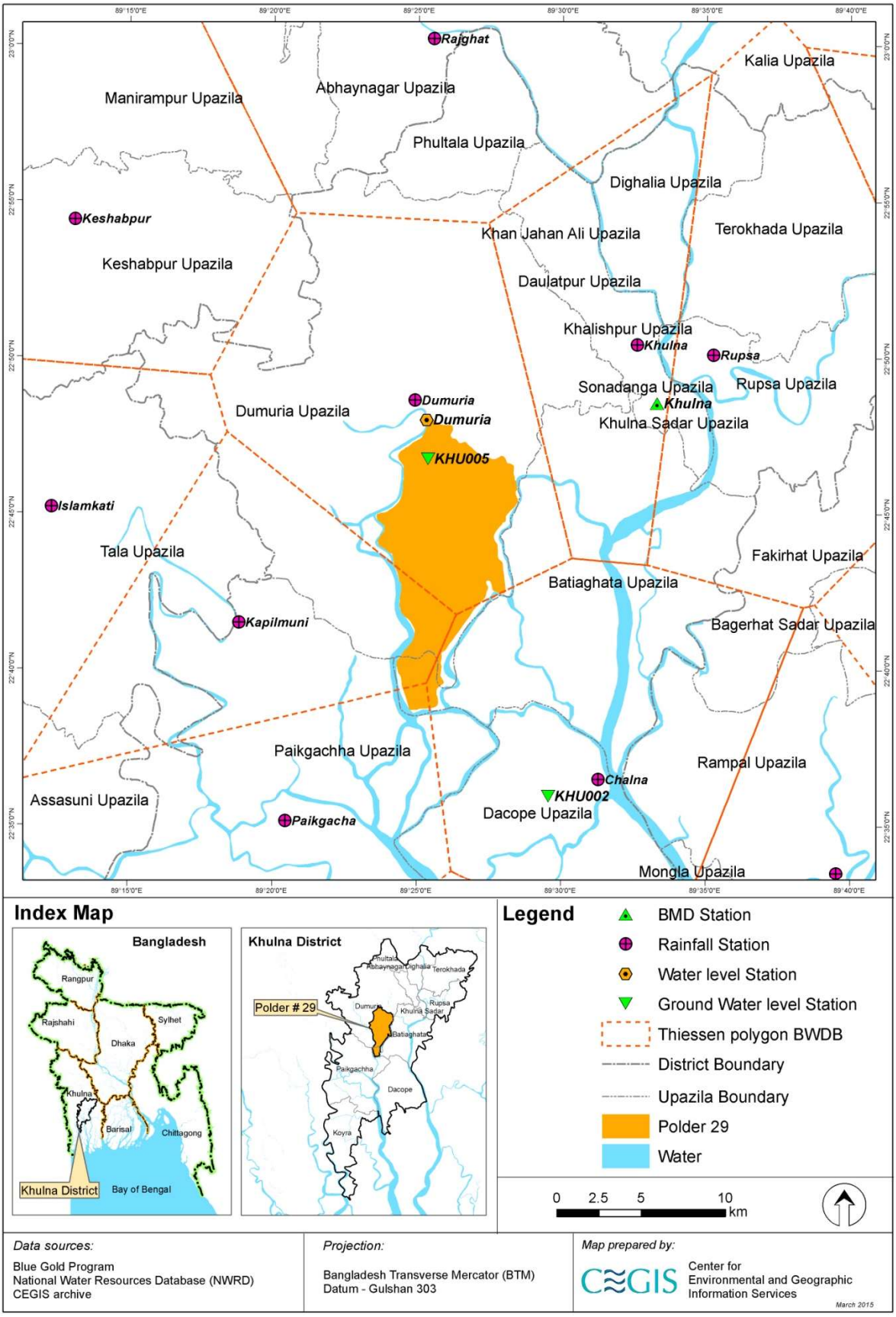
Photo 5.4: Retired embankment at the erosion hotspot at Jaliakhali

Navigation

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

193. Map 5.9 below is a reference map, showing the stations used for collected secondary data on water resources (both surface and ground water); and the Thiessens polygons used for spatial distribution of rainfall.

Photo 5.5: Navigation corner at Ghengrail river



Map 5.9: Map showing BWDB Stations of Rainfall, Theissens Polygon, Water Level Measuring Stations and GW Observation Wells

5.2 Biological Environment

5.2.1 Farming Practices

194. 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.

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

5.2.2 Cropping Patterns by Land Type

196. The most prominent cropping patterns of the polder area are Fallow – LT.aman - Fallow (38%), and Sesame - LT. Aman – Fallow (29%). In Kalikapur Block under Keakhali village, Department of Agricultural Extension conducted some demonstrations with BINA dhan-10 in the polder area. There is a pocket area (about 35-40 ha) where farmers are growing vegetable (mainly bitter gourd). During the field visit, Boro rice crop was found in flowering stage, jute germination started and flowering of bitter gourd just started. Detailed cropping patterns by land type are presented in Table 5.11.

Table 5.11: Detailed existing major cropping pattern by land type

Land Type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Area (ha)	% of NCA
Medium High Land (F_1)	Fallow	HYV T aman	Boro	1,203	22
	Fallow	LT aman	Fallow	2,077	38
	Sesame	LT aman	Fallow	1,585	29
	Vegetables	LT aman	Fallow	219	4
	Jute	LT aman	Fallow	164	3
	Vegetables (Bitter Gourd)	Vegetables	Vegetables	219	4
Total				**5,466**	**100**
Cropping Intensity (%)				**166**	

Sources: Farmers interviewed and SAAO, DAE, March, 2015.

197. In the polder area farmers are using different crops varieties (local and HYV). Details of the crop varieties are given in the Table 5.12.

Table 5.12: Varieties cultivated

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

Sources: Farmers interviewed and SAAO, DAE, March, 2015

Photo 5.6: DAE demonstration with BINA dhan-10 and FGD in Bitter Gourd field

5.2.3 Cropping Intensity

198. Total cropped area is about 9,075 ha of which the coverage of rice is 71% and non-rice is 29%. The single, double and triple cropped area is 38%, 58% and 4% of the NCA, respectively. Therefore, cropping intensity of the polder is about 166%.

5.2.4 Crop Production

199. In the polder area, the annual total crop production stands at about 29,476 tons of which rice is 16,215 tons and non-rice is 13,261 tons. The contribution of rice crops is 55% and non-rice is 45% of total crop production. Among the rice crops, the contribution of HYV T.aman, LT aman and Boro are 23%, 49% and 29%, respectively.

200. According to local farmers and the SAAO,s some crops are damaged by drainage congestion and heavy rainfall. Normally, HYV T.aman, LT. aman, Boro and sesame are damaged, which is about 10%, 15%, 15% and 10% respectively. Main causes of the damage's are heavy rainfall and drainage congestion. Total loss of rice production is about 875 tons in 764 ha and loss of non-rice production is about 55 tons in 158 ha due to drainage congestion, siltation of khals and drainage channels and natural calamities. Detailed crop production and crop production loss with percentage are presented in Table 5.13.

Table 5.13: 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 (%)	% production loss
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield				
HYV T.aman	1,203	1,023	3	180	1.8	3,701	268	23	30
LT.aman	4,045	3,641	2	404	1.2	7,767	322	49	37
Boro	1,203	1,023	4	180	2.5	4,645	285	29	33
Total rice	**6,451**	**5,687**		**764**		**16,215**	**875**	**100**	**100**
Jute	164	164	4	-	-	574	-	4	-
Sesame	1,585	1,427	1	158	0.7	1,530	55	12	100
Summer Vegetables	656	656	12	-	-	7,872	-	59	-
Winter vegetables	219	219	15	-	-	3,285	-	25	-
Total non-rice	**2,624**	**2,466**	**-**	**158**		**13,261**	**55**	**100**	**100**
Total	**9,075**	**8,153**	**-**	**922**		**29,476**	**930**	**-**	**-**

Sources: Farmers interviewed and SAAO, DAE, March, 2015

5.2.5 Local Price of the Crops

201. In the polder area there are five markets. According to local people, the price of the different crops was collected as tk/kg. Later it was calculated as tk/ton, which is presented in the Table 5.14.

Table 5.14: Local market price of different crops

Sl No.	Name of the crops	Local price (Tk/ton)
1	HYV T aman	5,400
2	Lt aman	5,800
3	HYV Boro	5,400
4	Jute	10,000
5	Sesame	20,000
6	Summer Vegetables	10,000
7	Winter Vegetables	9,500

Sources: Farmers interviewed, March, 2015

5.2.6 Inputs Use

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

Seed

203. The seed rate used by the farmers in the polder area is presented in Table 5.15. In case of rice, farmers are using more seed than recommended as they normally use more seedlings per hill. Most of the cases, seedlings are affected by monsoon flood. According to SAAO, 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 5.15: Seed used in the polder area

Name of crops	Seed used (kg/ha)	
	Farmers used	Recommended rate
Boro	50	40
HYV Aman	50	40
Lt Aman	60	40
Sesame	4	7
Jute	7-9	8
Vegetables	3.5-4.0	-

Sources: Farmers interviewed and SAAO, DAE, March, 2015;

Labor

204. In the polder area, almost 50% of the cultural practices for crop production are being done manually. So, agricultural labor (seed sowing, intercultural operations, harvesting and post harvest technologies) is considered as one of the essential inputs for crop production. The labor requirement is not uniform throughout the year. The number of labor requirement varies from crop to crop and season to season. The average number of labor (male and female) used per hectare and wages rate in the polder area are presented in Table 5.16. Locally labors are available for intercultural operations.

Table 5.16: Labor used in the polder area

Crop name	No. Labor used /	Labor wages / day (Tk)	
		Male	Female
Boro	160	300-350	200-250
HYV Aman	140	250-300	150-200
Lt Aman	80	250-300	150-200
Sesame	70	200-250	100-150
Jute	100	200-250	100-150
Vegetables	180	250-300	150-200

Sources: Farmers interviewed and SAAO, DAE, March, 2015; Note: In addition to wages, labors are taking three times meal per day

Photo 5.7: Male and female labors are working together in the different crop fields

Fertilizers

205. 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 Sub Assistant Agriculture Officer (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 six 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 5.17.

Photo 5.8: Cowdung use for fuel purpose in the polder area.

Photo 5.9: Information collection on fertilizer use in the polder area.

Table 5.17: Fertilizers used in the polder area

Crop name	Farmers practice(Kg/ha)								Recommended doze(Kg/ha)							
	Compost	Urea	TSP	SSP	DAP	MP	Gypsum	Zn	Compost	Urea	TSP	SSP	DAP	MP	Gypsum	Zn
Boro	0	214	105	0	0	70	5	0	2,000	270	58	0	0	58	0	4
HYV Aman	0	150	70	0	0	50	0	0	0	163	35	0	0	30	0	0
Lt Aman	0	40	0	0	0	0	0	0	0	97	14	0	0	17	0	0
Sesame	0	15	10	0	0	0	0	0	0	170	60	0	0	31	0	1.3
Jute	0	150	30	0	0	10	0	0	0	51	22	0	0	70	36	0
Vegetables	200	250	150	0	0	100	0	0	5,000	217	80	0	0	50	14	3

Sources: Farmers interviewed and SAAO, DAE, March, 2015

Pesticides

206. 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 5.18.

Table 5.18: Pesticides used in the polder area

Crop name	Pesticide using by farmers	
	No. of application	Liq. (ml/ha) apx.
Boro	1-3	800-1000
HYV Aman	1	600-700
Vegetables (Bitter Gourd)	4-5	1000-1500

Sources: Farmers interviewed and SAAO, DAE, March, 2015

5.2.7 Integrated Crop Management (ICM)

207. Recently, Integrated Crop Management (ICM) is practiced in many places of the polder area. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo etc. to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. There are two ICM schools in the polder area. DAE is providing training from 4.00pm to 6.00pm. In ICM process, about 40% 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 25-30% of the cultivated areas and the impact has been found very encouraging.

5.2.8 Irrigation

208. Surface water is the only source of irrigation as reported by local farmers. Khals and in few cases ponds are the source of surface water for very limited time. Irrigation is provided mainly in boro rice. Occasionally, Low Lift Pumps (LLPs) and STWs are being used for surface water irrigation. According to SAAO, s and farmers, present irrigated area is about 1060 ha. They also reported that if the khals are re-excavated, then farmers can grow other crops like watermelon and groundnut and other *Rabi* crops area will increase by about 2500 ha. 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 5.19.

Table 5.19: Irrigated area by crop

Crop name	Irrigation (Ground water)			Irrigation(Surface water)		
	Irrigated area (ha)	% NCA	Charge (tk/ha)	Irrigated area (ha)	% NCA	Charge (tk/ha)
Boro	1,000	17	8,000-9,000	273	5	4,500-5,000
T aman in booting stage (few area)	60*	1	8,000-9,000	0	0	0

*Source: CEGIS estimation on field information; 2015 * Supplementary irrigation*

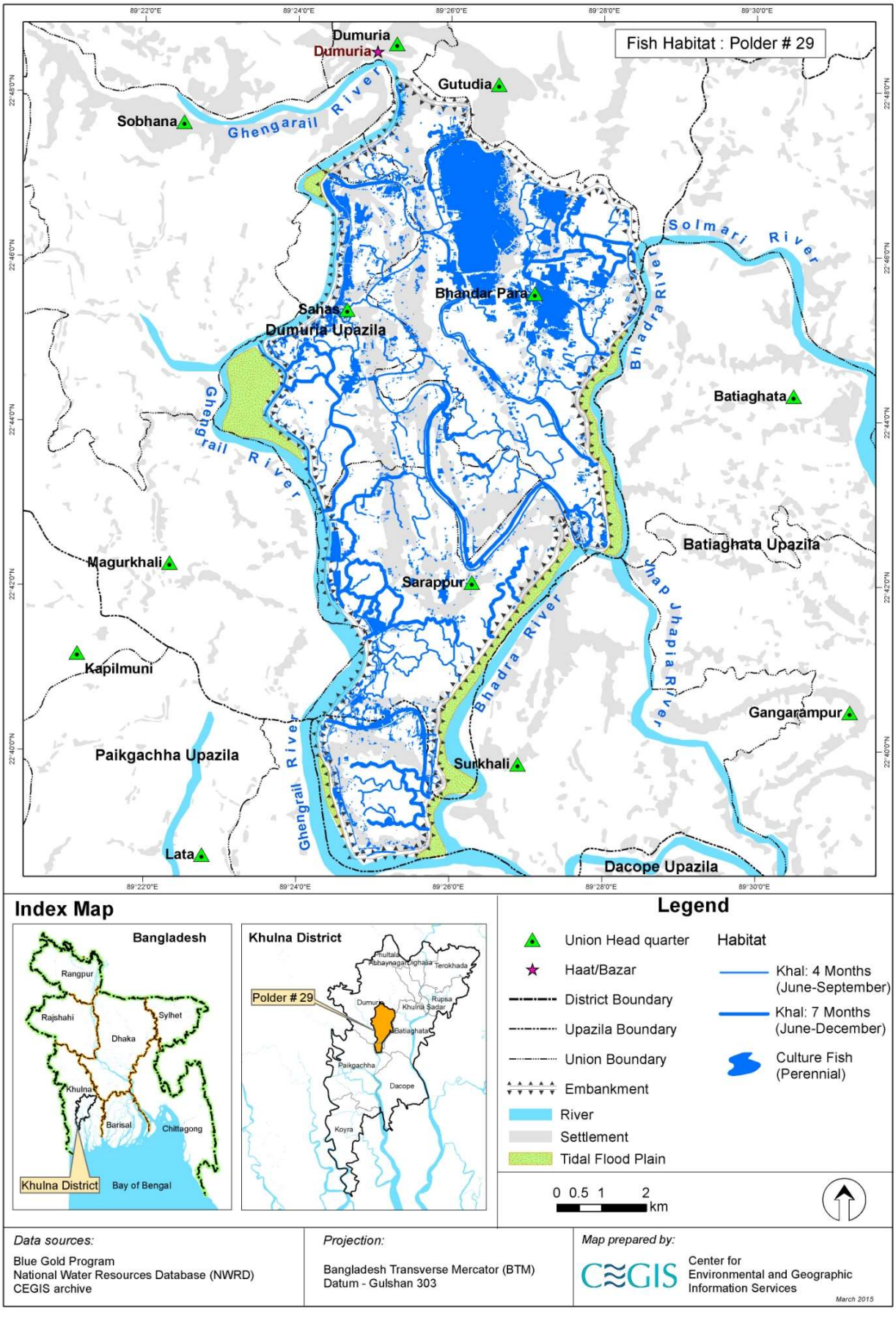
5.2.9 Crop Production Constraints

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

Photo 5.10: Discussion with farmers about constraints of crop production in the polder area

5.2.10 Fish Habitat

210. Polder 29 is located at Dumuria upazila of Khulna district under the coastal region of Bangladesh. This area is tidal in nature and fish habitat is diversified with brackish and fresh water environment. The fish habitats of the polder are primarily classified under two broad categories like capture and culture fishery. Capture fisheries habitats include internal khals, Mora Bhadra River and tidal floodplain near the river side which is flooded during high tide (Map 5.10). Internal khals are mainly acting as major arteries of fish migration for open water fisheries into the polder area. These khals are playing vital role in maintaining fisheries productivity of the open water fish habitats. The culture fishery of the polder area is dominated by golda/shrimp gher and culturable fish pond. A few numbers of cultured ponds is found in the polder area. Moreover, the periphery river namely Sibsa is located on the eastern part and Bhadra River on the southern part of the polder. These rivers influence to facilitate both brackish and fresh water fish species in the polder area.



Map 5.10: Fish habitat in the study area

a. Capture Fisheries

211. The estimated fish habitat in the Polder area is 1105 ha where capture fishery contributes the major share (590 ha) and the culture fish habitat shares the rest. The open water fish habitat is mainly represented by khal as shown in the following Table 5.20. In the study, the peripheral rivers and its tidal floodplain habitat has not been considered in fish production estimation of the polder area.

Table 5.20: Fish habitat status in the polder area

Sl.	Habitat Category	Habitat Type	Area (Ha)	Habitat Status
1	Capture	khal	590	Silted up No water in dry season except Bhadra river Encroachment for gher and agriculture practice The narrow khals dry up during dry season
	Sub-Total		**590**	
2	Culture	Golda & white fish gher	20	Expanding day by day Gher is used as nursery pond of white fish
		Rice cum golda &white fish gher	355	Expanding gradually Gher wall damaged and fish wash out during heady rainfall
		Bagda gher	15	Decreasing trend and converted into golda gher Gher wall damaged and fish wash out during heady rainfall Saline water is provided through pumping
		Culturable pond	122	Ponds are used as water reservoir cum fish culture No supplement feed is applied Many pond are being filled up for homestead
		Cultured pond	3	Increasing trend Lack of quality seed and feed
	Sub-Total		**515**	
	Grand Total		**1105**	

Source: Field visit data, 2015and Image analysis

212. Internal khals especially Mora Bhadra River and Golaimari Khal are perennial water bodies and playing a vital role in conserving fisheries and aquatic resources in the polder area. According to field investigation, most of the internal khals are silted up and appear to be agriculture land. The depth of these khals ranges from 2 to 4 ft except Bhadra river and Golaimari Khal and remain almost water less during dry season. Currently, these khals are not suitable for fish habitation both monsoon and dry season. During field visit, it was observed that many silted up khals are being used for culture fisheries through construction of gher. Photo below shows the internal khal in the polder area.

a) Perennial Water Body (Bhadar River) *b) Seasonal and silted up khal (Aro khal)*

Photo 5.11: Open water fish habitat (khal) in the polder area

b. Culture Fisheries

213. Culture fisheries in the polder area include pond and gher. The estimated area under culture fishery is about 515 ha (Table 5.20) of which pond occupy 37% and gher 63% (Figure 5.11). Most of the fish pond is seasonal, traditional in nature and size is very small. Gher practice is expanding gradually in the polder area. Three types of gher i.e. Bagda gher, Golda white fish gher and rice cum golda gher were found in the polder area during field visit. Among them, rice cum golda and white fish culture is dominant which comprise 91% of total gher area (Figure 5.11). Local people have adopted this practice which is increasing gradually because these are profitable than pond fish culture. Fish pond in the polder area is mainly culturable and cultured pond. The number of cultured pond (5% of total pond) is negligible because local people have more interest to gher practice than pond fish culture. Fish is cultured in culturable pond for one cycle and two cycle in cultured pond. Major constraints of fish culture in the polder area are lack of quality fish seed and fish feed, lack of training on aquaculture/pond culture practices and high expenditure of fish culture. Nevertheless, various types of fish culture systems are practiced by the local people including mono-, poly-, and mix-culture. Different type of fish culture practice in the polder area is shown in Photo 5.12.

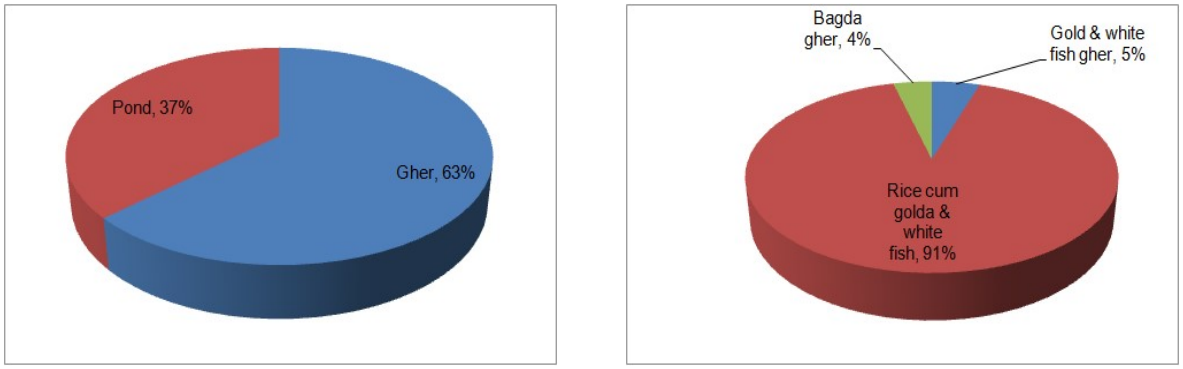


Figure 5.11: Different type of culture fish habitat (Source: Field investigation, 2015)

(a) Rice cum golda gher

(b) Bagda gher

(c) Culturable pond

(d)Cultured pond

Photo 5.12: Culture fish habitat in the polder area

c. Loss of Open Water Fish Habitat

214. The open water fish habitat i.e. khal is losing gradually. During field visit, it was observed that around 80%of depth and 40% of width of most of the khal has been lost due to siltation (Table 5.21). Although some quantity of water is found during high tide after recession of tide water, the khal become fully dry except at the mouth of few numbers of khals near regulators. Major causes indentified by the field investigation for loss of fish habitat are siltation, top spoil erosion from the agriculture land, decomposition of duck weed, encroachment of khal for agriculture as well as gher fisheries practices. Dewatering of khal for HYB boro cultivation was also found in some area of the polder. For this reason, spawning ground of the resident fish species is being damaged and thus capture fishery is declining day by day. This phenomenon also hampers the fish migration.

Table 5.21: Seasonally loss of open water fish habitat

Habitat type	Seasonally/permanent habitat loss (%)	Reason
Khal	80% area of khal except Bhadra River	• Siltation • Topsoil erosion • Closed connectivity • Encroachment for gher • Used pata jal
Cullturable pond	2% of pond/year	• Fill up for homestead • Used as nursery pond for gher culture

(a) Silted up and shrinkage of khal

(b) Khal encroachment for gher practice

Photo 5.13: Present condition of fish habitat

d. Fish Habitat Quality

215. Some surface water quality parameters that are related to fish habitat suitability were measured in different location of the khal and the periphery river. Table 5.22presents the measured water quality of fish habitats. From the analyzed data, the pH value was found to be slightly higher which means water is alkaline and it is bad for fisheries. The value of water temperature in khal fish habitat was found slightly high compare to standard values for fish. Dissolved Oxygen (DO) content was found within the limit of Bangladesh standard (>5.0 mg/l) for fish culture. The salinity in khal and river water is 12 ppt and 18 ppt respectively which is not suitable for prawn (golda chingri) habitation. However, all water quality parameters are within the permissible limit for fisheries resources.

Table 5.22: Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	Temp (ºC)	pH	DO (mg/l)	TDS (ppm)	Salinity (ppt)
Internal Khal	31	8.1	5.1	479	12
Periphery river (upper Bhadra)	30	8.0	5.2	1353	18
Standard values for fish	(28-34)**	(6.5 – 8.5)	4.0-6.0*	1000	(0-4) for prawn and (5 -35) for shrimp**

*Source; Field test, March 2015 (*M AMazid 2002 ** Jack M. et al, 2002)*

5.2.11 Aquatic Vegetation

216. Aquatic plants or vegetation play an important role in the structure and function of the aquatic ecosystem. Different types of hydrophytes like emergent, submerged and floating with leafs is used as habitat and spawning ground of fisheries and other insects and crustaceans. So, low abundance of hydrophytes may harm fish breeding and production. In the 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. Wetlands contain plenty of aquatic floras, such as free floating, submerged, sedges and meadows. Free floating plants especially duck weed are common and their abundance is high in all khals within the polder area. The presence of duck weed has created congenial environment for habitation of snake head

(*Taki, shol, Magur* etc.) and benthic fishes (mud eels). However, some types of aquatic plants with leafs are used as habitat and spawning ground of fisheries as well as other insects and crustaceans in the polder area.

5.2.12 Fish Productivity and Production

217. The fish productivity in the polder has been assessed through fish catch survey and consultation with local fishers. The fish productivity of the polder area is presented in Table 5.23.The open water fish productivity i.e. khal productivity rate is 87 kg/ha which is lower than national productivity (172 kg/ha). As per field investigation, major reason of low productivity of khal are siltation of most portion of a khal, no water during dry season in most of the khals, saline water intrusion through regulators, encroachment of khal for gher practice, indiscriminate fishing by illegal gears etc. In case of culture fishery, the production rate is also lower than the national productivity. The main reason of low production of culture fishery in the study area is the less interest of pond owners about culture due to tidal flooding, risk for mal-functioning of sluices and regulator, lack of seed and feed, and lack of training of modern fish culture.

Table 5.23: Fish productivity of the Polder area

Fishery Category	Habitat Types	Productivity (kg/ha)
Capture	Khal	87
Culture	Golda &white fish gher	960
	Rice cum golda &white fish gher	600
	Bagda gher	580
	Culturable pond	11,00
	Cultured pond	1,900

Source: Field Survey 2015

218. The estimated total fish production of the polder area is about 432 tons. Bulk of the fish production (about 88%) is coming from culture fisheries and the rest is from the capture fishery. Among the culture fisheries production, rice cum golda contribute major share of the fish production. Fish production trend of the capture fishery is downward in the polder area. Fish production in the polder area is shown in Table 5.24.

Table 5.24: Fish Production from Different Habitats of the Polder Area

Sl.	Category	Habitat Types	Fish Production (Ton)
1	Capture	Khal	51
		Sub-total	**51**
2	Culture	Golda and white fish gher	19
		Rice cum golda and white fish gher	213
		Bagda gher	9
		Culturable pond	134
		Cultured pond	6
		Sub-total	**381**
		Total	**432**

Source: Field survey, 2015

5.2.13 Fishing Effort

Fisher Number

219. Local people reported that there are about 950 (5% of the total households)fisher households in the polder area. The fisher household includes commercial, subsistence and part-time fishers. Among the fisher households, 30% are engaged as

professional/commercial fisheries and they spend around 8-10 hours in a day in fishing activities throughout the year. Rest of the households is involved in part time fishing, and subsistence level fishing. Most of the commercial fishers are from Hindu community (97% of the total fishers' community). There are two fishers village such as Sahos Jele Palli and Toyerpur Jele Palli in the polder area. The fishers of these Pallies are traditional fishers and Hindu cast. Their economic condition is poor and fishing is the only source of income to maintain their family. They usually catch fish in the nearby rivers and internal khals. In addition, a number of fish traders and fish farmer are reported in this area. The seasonal vulnerability of the fishers starts from late October to January of the year. During this period, the fish catch hardly recorded due to cool water for winter. In this period, most of the fishers go to Sundarban and sea to catch fish. Some fishers are involved in catching fish in the pond/gher for remuneration and also involved in fish trading.

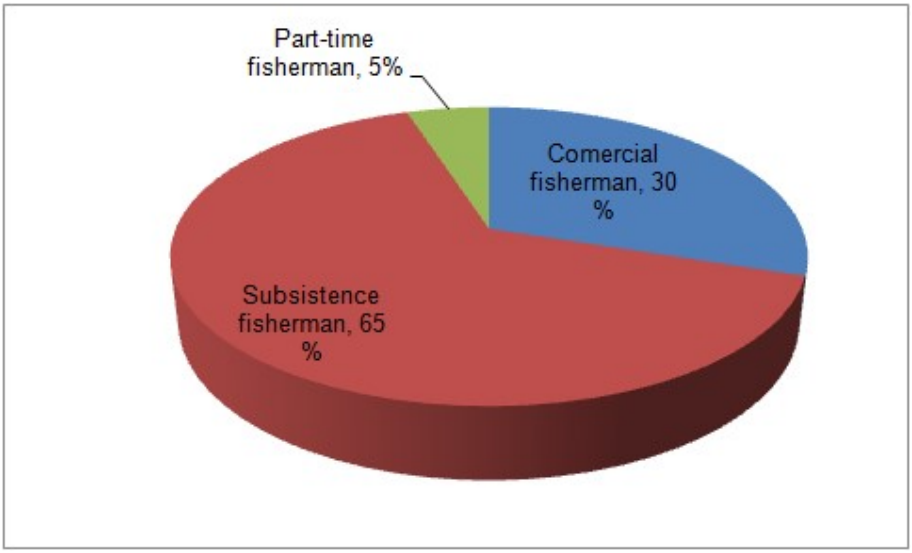


Figure 5.12: Number of fishers in the polder area (Source: Field investigation, 2015)

Fishing Season

220. Fishing season in the polder area starts from April-May and continue up to December. Most of the fish catch by different gears occur during late June to Mid November. Besides, fishers catch fish through Ber jal and Bendi/Badhai jal in the periphery river round the year. The seasonality of major fishery is furnished in the Table 5.25.

Table 5.25: Fishing Seasonality of the Polder Area

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

Source: Field Survey, 2015

Fishing Crafts and Location

221. The commercial fishers of the polder area catch fish in the peripheral rivers and internal khals by using both mechanized and traditional boats including Jala Nouka and Kusha, Dingi fishing boats etc. Fishing boat in the polder area is shown in the following photo 5.14.

Photo 5.14: Fishing boats in the Polder Area

Fishing Gear

222. Different types of nets/gear are used in the polder area. Table 5.26 presents the different type of gher and targeted fish species. During field investigation, Katha was also found in the deep pool area of perennial khals as a fish shelter inside the polder. The katha is mainly constructed for fish sheltering from late October to April to catch all type of fishes. Local people reported that around 5% of fishers have fishing boats and around 80% fishers have fishing gears/nets. Jhaki jal(cast net) and Thela jal are common traditional fishing gear and found all over the polder area (photo5.15).

Table 5.26: Fishing gear and trap used at Polder area

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

Source: Field Survey, 2015

(a) Common fishing gear (Jhaki jal)

(b) Fishing Katha

Photo 5.15: Fishing gear and Trap

5.2.14 Fish Migration

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

5.2.15 Fish Biodiversity

224. The study area is moderate in fish biodiversity though the biodiversity of fishes has the declining trend over the years. Local people reported that about 90 numbers of fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (photo below). List of fishes of different habitat in the study area are presented in Table 5.27.

Photo 5.16: Composition of Fish Catch of the Polder Area

Table 5.27: Status of Indicative Fish Species Diversity of Different Fish Habitats in the Study Area

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

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

225. In the polder area, *Taki, Shol, Cheng, Puti, Koi, Shing, Chingri, mMola, Baim* (guchi) etc were reported as common in the khal. These species contribute 70% of total fresh water fish production in the polder area. Moreover, some brackish water fish species e.g. Vetki, Pairsa, are found in the khal but their abundance is very low. Local people reported that 90% of carp production has decreased in the polder area. Moreover, abundance of Golda Chingri, Kathali Chingri Goda Chingri has also declined in the polder area. This may be due to reducing depth of khal, low water flow, indiscriminate fishing by illegal gears. The dominant

cultured fish species include Tilapia, Bighead, Silver carp, Thai sarputi etc. Culture of carp fishes (e.g. Tilapia, Rui, catla, silver carp etc.) was found comparatively high (85% of pond) and almost all golda gher.

5.2.16 Role of SIS in Fish Biodiversity

226. The availability of Small Indigenous Species (SIS) of fishes and their role in fish production in the polder is very negligible. According to field visit and consultation with local people, some SIS like *Puti, Koi, Mola, Chanda, Taki, Magur, Khalisa, Bele,Shing,Tara baian, Guchi Baim,Tengra, Meni, Tit Puti* etc are found in the polder area. Among them, Tit puti, Mola, Taki, shing, Bele are still common and available in different habitat like khal, golda gher, ditch etc in the Polder area. But their existence in all water bodies is at stake. Due to indiscriminate exploitation of brood and young SIS by using destructive gears, shrinkage of khal due to siltation, saline water intrusion in the khal, increased gher practices in the wetland which lead SIS to high level of risk to extinction. Local people reported that about 80% of SIS production has been declined in the the polder from the 10-15 years back. Based on Matshya Arot visit at Dumuria within the Polder, the present scenario of SIS in fish production are shown in table 5.28. From the table it is found that SIS contributes 20% of total fish sale. Local fish traders opined that 10-15 years back, the contribution of SIS was 60% of total fish catch.

Table 5.28: Daily fish sale from Dumuria Matshya Arot

Fisheries type	Daily sale (mond)	% of total sold
White fish	100	43
Shrimp/prawn	80	35
SIS	45	20
Others	5	2
Total		**100**

Source: Field visit, 2015 (April, 2015)

5.2.17 Threatened Fish Species

227. As per field investigation and consultation with elderly local people, threatened fish species those are locally rare and unavailable for last (10-15) years are given in Table 5.29. Among the threatened fish species Sarputi, Ayre, Pabda, Kain and Gojar are reported as extinct in the polder area. Brackish water fish species like Golda Chingri, Kathali Chingri, Goda Chingri, Pairsa, Koral was found vulnerable due to lack of water availability, saline water intrusion through sluices and regulators, loss of flow and water depth because of siltation, increasing of gher practices, and obstruction of fish hatchling due to improper and irregular operation of water control structures.

Table 5.29: List of threatened fish species

Local Name	Scientific Name	Polder Status	IUCN Status
Shorputi	*Puntius sarana*	Extinct	Cr
Mola	*Amblyphyrngodon mola*	Vu	En
Boal	*Wallago attu (*Bloch)	Cr	C
Boro baim	*Mastacembelous armata*	Extinct	En
Ayre	*Mystus aor*	Extinct	Vu
Kian	*Plototus canius*	Extinct	Vu
Pabda	*Ompok bimaculatus*	Extinct	En
Lal chanda	*Chanda ranga*	En	C
Magur	*Clarious Batrachus*	En	C

Local Name	Scientific Name	Polder Status	IUCN Status
Gutum	*Lepidocephalus guntea*	Extinct	C
Gojar	*Chanda marulius*	Extinct	En
Chanda Nama	*Chanda nama*	Vu	Vu
Meni	*Nandus nandus*	En	Vu
Lal Kholisha	*Colisa lalia*	Cr	C
Chuna Kholisha	*C. chuna*	Cr	C
Baro baim	*Mastacembelus armatus*	Cr	En
Foli	*Notopterus notopterus*	Cr	Vu
Koral	*Lates calcarifer*	Vu	-
Pairsa	*Liza parsia*	Vu	-
Ramchos/Taposi	*Paradise threadfin*	Vu	-
Golda Chingri	*Macrobrachium rosenbergii*	Vu	-
Kathali Chingri	*Macrobrachium villosimanus*	En	-
Goda Chingri	*Macrobrachium dolichodactylus*	Vu	-

Source: Field Survey, 2015; Here- C-common, Vu-Vulnerable, En-Endangered, Cr-Critically endangered

228. To conserve the threatened fish species, the perennial khals Morabhadra river and Gollaimari khaland re-excavated khal like Kata khal, Bakultala Diversion khal, Kanchonnagar Khal, Asannagra-Keyakhali khal, Ramakhali khal, Mora Bhadra khal, Telekhali Diversion khal, Ruhitmari khal, Aro Khal where water is retained round the year can conserve the fish breeding for the next year. Although there is a fish sanctuary in the Morabhadra River near Baniakhali Bazar, it should be managed through formation of CBFM (community based fisheries management) committee. Moreover, a few number of fish sanctuary can be constructed at the deep pool of Bhadra River and Golaimari khal. Illegal fish catch and use of unauthorized gear (pata jal) should be stopped. Proper gate operation during fish migration period should be ensured. Integrated Pest Management (IPM) instead of pesticides use in the crop land should be introduced all over the polder area.

5.2.18 Fish Marketing and Post Harvest Facilities

229. Fish edible quality is in good condition for human intake. But local people reported that pesticides coming from agriculture field especially watermelon field and decomposition of duck weed are causing deterioration of habitat quality as well as fish diseases. Sometime, this causes unsuitable for consumption.

230. Local fishers sale bulk of their catch either directly to the local fish market at Dumuria, Sahos, Baniakhali, Sarappur bazaar or to the fish traders. The fish traders or buyers (Bepari) come from Dumuria, Khulna Sadar and Chuaknagar to purchase fishes. There is Matshya Arot at Dumuria within the polder. Huge amount of fish is sold from this Arot twice a day. No structured fish-landing centers were found in the polder area. There are two ice factories inside the polder area, located at Dumuria. Besides, fish trader collect ice from KhulnaSadar for icing the harvested fish. Transportation facility at root level is moderately developed. Local fishers and fish traders use Van and Motorcycle to carry fish. There is no private hatchery inside the polder area. Availability of fish feeds for culture ponds and ghers are insufficient. Fish seeds for culture fishery are collected from the hatcheries and nurseries which are situated at Khulna, Jessore and Bageraht. But Post Larva (PL) of Bagda is collected from Cox's Bazar directly or through the fish traders of Jessore. Fish fry (white fish) are also collected from mobile buyer who comes from Khulna, Jessore, Satkhira etc district.Wild fish fry like Vetki, pairsa, Korsola are collected from the local fishers which are caught during PL catching from the Periphery Rivers. The local people opined that the ratio of sources of wild and hatchery are 5% and 95% respectively.


Photo 5.17: Daily fish trading at Matshya Arot in Dumuria

5.2.19 Fisheries Management

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

5.2.20 Bio Ecological Zones

232. IUCN-The World Conservation Union has identified 25 bio-ecological zones (2002) in Bangladesh. The aspects on which these zones are primarily centered are physiography, climate, soil type, flooding depth and biodiversity. These bio-ecological zones can be classified as major ecosystems of the country. The 29 polder area encompasses two of these bio-ecological zones, namely the Ganges floodplain and the Saline Tidal Floodplain. The polder is situated at Bhandar para, Dumuria, Magurkhali, Sahas, Sarappur and Surkhali Union of Batiaghata and Dumuria Upazila of Khulna district. A brief description of the bio-ecological zones is presented below.

The Ganges Floodplain

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

234. Major groups of oriental birds are presented in this zone by different species. In addition, a large number of migratory birds are found here during the winter. Beside this,

different species of freshwater tortoise and turtles are found in the rivers and ponds. Among the amphibian species, toads, frogs and tree frogs are well known. Foxes, Jackals, rats, mice, squirrels, bats etc are common mammals of this zone.

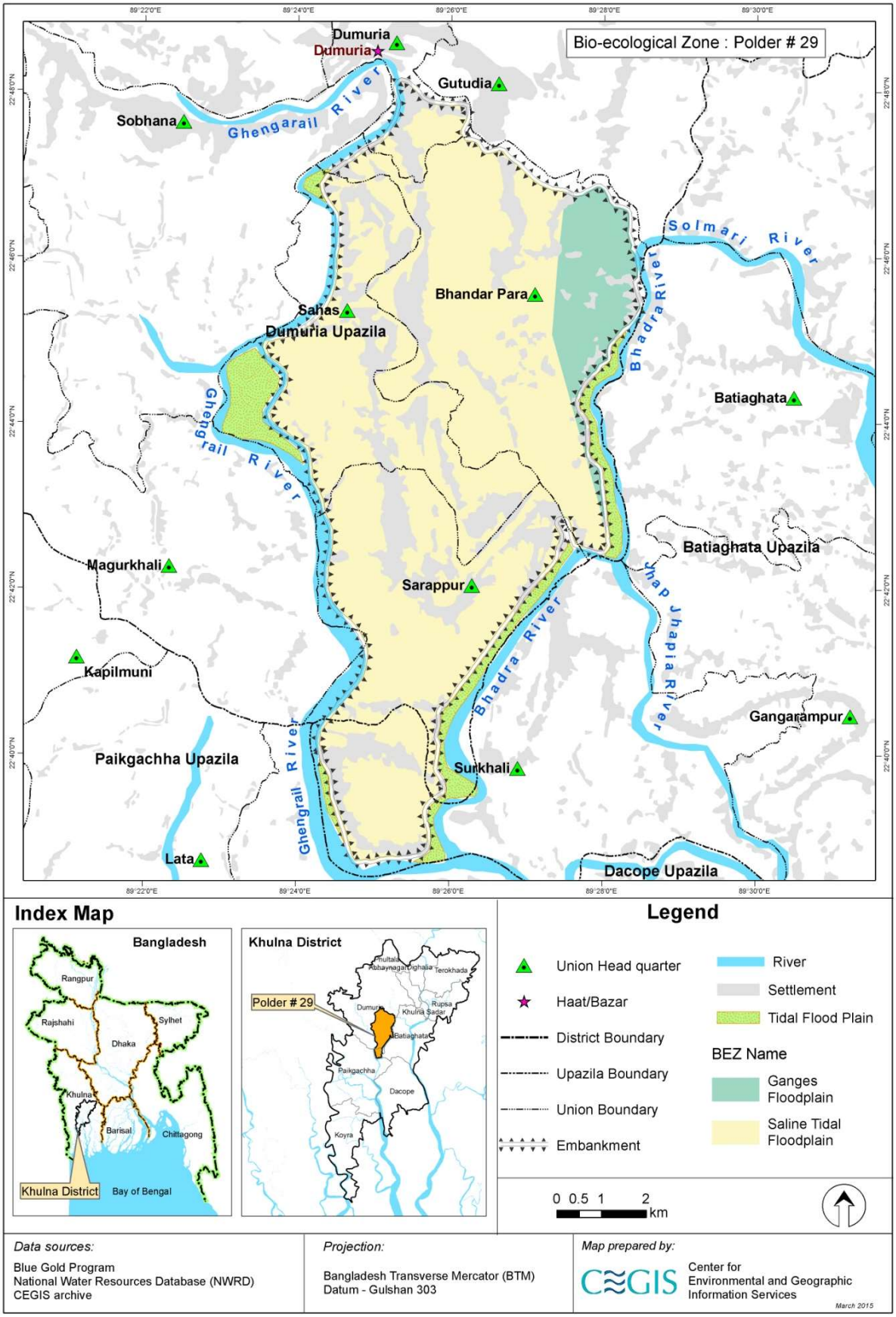
Saline Tidal Floodplain

235. Saline tidal floodplain has a transitional physiography, which is located in the administrative district of Satkhira, Khulna, Bagerhat, Jhalokathi and Barguna. It has a low ridge and basin relief, crossed by innumerable tidal rivers and creeks. Local differences in elevation are less than 1 m. The sediments are mainly composed of non-calcareous clays, although in the riverbanks, they are silty and slightly calcareous. The soil is non-saline throughout the year over substantial amount of areas in the north and east, but they become saline to varying degrees in the dry season in the south west and remain saline for much of the year in Sundarban. The rivers carry fresh water throughout the year to the east and northeast, but saline water penetrates increasingly further inland towards the west mainly in the dry season, and for most or all of the monsoon season in the southwest. In the northeast, there is moderately deep flooding during the monsoon season, mainly due to accumulation of rainwater on the land when water level in the Ganges distributaries and the lower Meghna are high. Elsewhere, there is mainly shallow flooding at high tide, either throughout the year or only in the monsoon season, except where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater (Brammer, 1996).

236. Several types of palms and bamboo clumps grow in almost all the villages in the polder area. Narikel (*Cocos nucifera*) and Supari (Areca catechu) are two commonest palm of this area. The mango (Mangifera indica), Sirish (*Albizia saman*), Babla (Acacia Arabica), Khai Babla (*Pithocelobium dulci*),Taal (*Borassus flabeliffer*), Gab(*Diospyros perigrina*)etc supply the timber and are used for daily needs. Existence of mangrove patches along riverside or even beside homestead forest indicates presence of water and soil salinity of that zone.

237. The dominant aquatic floral types are in the polder area: the Kochuripana (Eicchornia crassipes), Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Helencha (*Alternanthera philoxeroides*), Topapana (*Pistia strateotes*), Chechra (Schenoplectus articulatus), Keshordam (*Ludwigia adscendense*), Kolmi (*Ipomoea aquatica*), Dhol kolmi *(I.fistulosa*)etc. innumerable indigenous weeds grow in beel areas.

238. The zone affords very lucrative place to game bird waters.At the advent of winter season, numerous game birds which include wild goose, wild duck. Cranes, spines, jungle fowl and various waterfowl, begin to flock both in the Sundarban and the beel and char areas of this zone. Mangrove, the network of rivers and expanse of beels of this zone teem with different species of fishes.



Map 5.11: Polder inside the Bio-ecological Zones of Bangladesh

5.2.21 Terrestrial Ecosystem

a. Terrestrial Flora

Settlement/Homestead vegetation

239. Homestead vegetation (1811 hectares)is the major type of terrestrial flora of the polder area.It can be divided into two groups considering floral diversity and density derived by soil salinity as well as distance between settlement and the river. Density of homestead trees along polder peripheries is low due to having saline nature of soils. The trees which are successfully adapted in peripheral homesteads are: Sirish (Albizia saman),Babla (Acacia Arabica), Khai Babla (*Pithocelobium dulci*),Taal (*Borassus flabeliffer*) and Narikel (*Cocos nucifera*). On the other hand, the homesteads far from polder peripheries show comparatively high density and diversity of vegetation. According to the vegetation survey, several tree species are present in different canopy layers and their composition is similar all over the polder area. The most common plants that are now planted by local people are: Aam, Kola, Boroi, Tatul, Peyara etc. Bamboo bushes are also commonly found in each homestead area. With regards to utilization and annual return, the homestead habitat is highly productive land. In addition to providing food, fodder, medicine, timber and other household requirements, homestead vegetation is also the major source of and renewable biomass energy.Many species of undergrowth wild plants are found in homestead vegetation and village groves. Among this type, Swetkan (*Euphorbia thymifolia*), Bhui amla (*Phylanthus niruri*), Nata (*Caesalpinia bonduc*), Sezi (*Euphorbia antiquorum)* and Jiga (*Lennea coromandelica*) are common. Table 5.30 represents dominant tree species of homestead vegetation according to canopy coverage.

Table 5.30: Major trees species within the homestead area

Tree species name	Family name	Local Status	Saline susceptibility	Habit	Utilization	Ecological Value
Supari *(Areca catechu)*	Palmae	VC	2	Monocot	Fruit and Thatching	3
Narikel *(Cocos nucifera)*	Palmae	VC	3	Tall monocot	Fruit and Thatching	1,2
Safeda*(Manilkara zapota)*	Zapotaceae	VC	2	T	Fruit	1
Tulshi*(Ocimum americanum)*	Labiatae	VC	1	H	Medicine	3
Babla *(Acacia nilotica)*	Fabaceae	VC	3	T	Timber, fuel wood and fruit	1,2,3
Khai Babla *(Pithecolobium dulce)*	Mimosaceae	VC	2	T	Timber, fuel wood and fruit	1,2,3
Khejur *(Phoneix sylvestirs)*	Palmae	VC	3	Monocot	Fruit	1,2
Tetul*(Temarindus indica)*	Leguminosae	VC	2	T	Timber and Fruit	2
Nim *(Azadirachta indica)*	Meliaceae	VC	2	T	Timber and fuel wood	2
Sirish(Albizia lebbeck)	Leguminosae	VC	2		Timber and fuel wood	2
Tal *(Boassus flabelifer)*	Palmae	VC	2	Tall monocot	Fruit and thatching	1,2
Payra*(Psitium guajava)*	Myrtaceae	VC	2	T	Fruit	2
Sezi *(Euphorbia antiquoram)*	Euphorbiaceae	VC	3	S	Fencing and Medicine	1,2,3
Jiga *(Lennea coromandelica)*	Anacardiaceae	VC	2	S	Fencing	

Tree species name	Family name	Local Status	Saline susceptibility	Habit	Utilization	Ecological Value
						2,3
Aam*(Mangifera indica)*	Anacardiaceae	C	1	T	Fruit and timber	1,2
Jam *(Syzygiumsp)*	Myrtaceae	C	1	T	Fruit and timber	1,2
Kola (*Musa sp)*	Musaceae	C	2	H	Fruit	1,2,3
Bot*(Ficus benghalensis)*	Moraceae	C	1	T	Timber	1,2,3
Gab*(Diospyros perigrina)*	Ebenaceae	C	2	T	Fruit and fuel wood	1,2
Boroi *(Zizyphus sp)*	Rhamnaceae	C	2	T	Fruit and fuel wood	2
Bash(*Bamboosa* sp.)	Gramineae	C	1	CL	Thatching	1,2,3
Ipil ipil *(Leucauna laucocephalata)*	Mimisaceae	C	2	T	Timber	2
Jambura(*Citrus fistula)*	Rutaceae	C	1	T	Fruit	2
Dumur*(Ficus religiosa)*	Moraceae	C	2	S	Fruit , Fuel wood	2,3
Mahogany (*Swietenia mahagoni)*	Meliaceae	C	2	T	Timber and medicine	2
Thespicia populina	*Malvaceae*	*C*	*4*	*T*	*Fuel and Timber*	*2*
Akashmoni *(Acacia auriculiformis)*	Mimosaceae	O	2	T	Timber and fuel wood	3
Bel*(Aglemarmelos)*	Rutaceae	R	1	T	Fruit and Medicine	2
Kathal*(Artocarpus heterophyllus)*	Moraceae	O	1	T	Timber and fruit	1,2

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

Photo 5.18: Homestead vegetation

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

Crop field vegetation

241. The net cultivated area in the polder area is 5,466 ha. Verities of crops and cropping patterns have been discussed in the agricultural section of this report.

242. A part of crop fields remain seasonally (March-June) fallow for 3-4 months of a year. During this time the land is covered by grassy vegetation with some other wild herbs. Durba (Cynodonsp.) is prevalent with Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus and Paspalum sp. Among the grass species. Croton, Xanthium, Amaranthus are also grown sporadically along with grasses. The seasonal fallow lands have important roles in ecosystem functioning as they support grazing for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna. However, vegetation in fallow land has been deemed with increased intensity of soil saline especially at southern portions of the polder. But, during the dry season (especially from late December to late April) there is grazing land but shortage of grass due to salinity which acts as the main barrier for the grasses to grow.

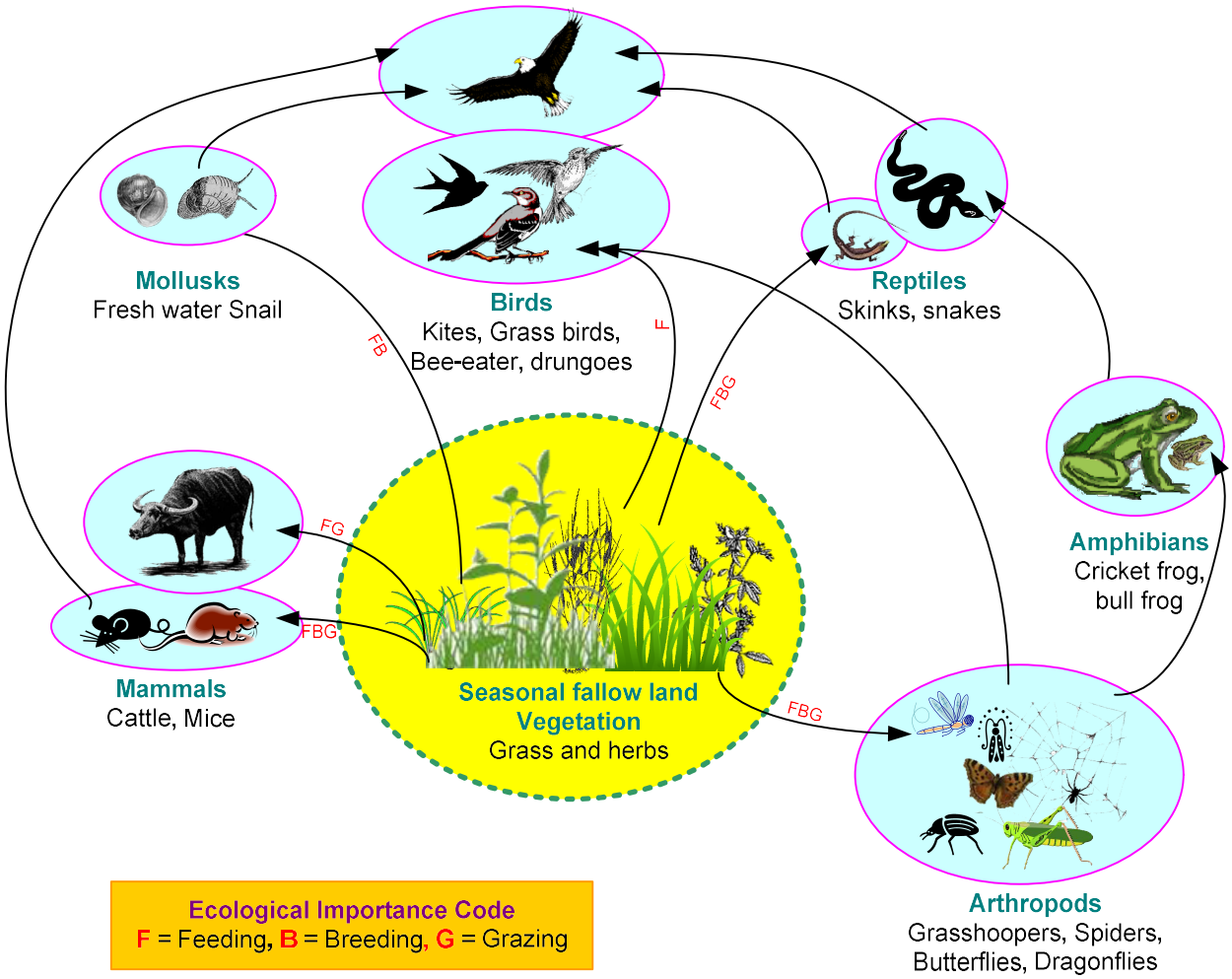


Figure 5.13: Ecological importance of seasonal fallow land's vegetation for different faunal communities along with partial food web

a. Embankment /Roadside vegetation

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

Photo 5.19: Rows of Babla tree along the embankment sides at the polder

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

Photo 5.20: A portion of internal village road showing Seziplant

b. Terrestrial Fauna

245. There are diversified terrestrial fauna with different species in the polder area. The major terrestrial fauna are different types of mammals, birds, reptiles and amphibians. The major fauna of different species with their habitat is shown in the following table.

Table 5.31: List of terrestrial fauna of the polder area

Types of Species	Name (generic name)	Habitat
Mammals	Small mammals, such as Jackal (*Canis aureus*), Grey mask shrew (*Suncus murinus*) and small Indian civet (*Viverricula indica*), Common Mongoose (*Herpestes edwardsii),* Jungle Cat (*Falis chaus*), Bengal Bandicot Rat (*Bandicota bengalensis*), Common House Rat (*Rattus rattus*), Squirrel *(Cllosciurus pygeryhrus)* and bats like Short-nosed Bat	Mostly in bamboo thickets, cropped fields or broken, bushy areas.

Types of Species	Name (generic name)	Habitat
	(*Cyynopterus sphinx*)	
Birds	Common bird of prey species found in the polder area are Brahminy Kite (*Heliastur indus*). Other common bird species in the project area are Common Myna (*Acridotheres tristis*), Red-vented Bulbul (*Pycnonotus cafer*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*), Blue Rock Pigeon (*Columba livia*), Black Drongo (*Dicrurus macrocercus*), Asian Koel (*Eudynamys scolopacea*), Larged-billed crow (*Corvus macrohynchos*).	Terrestrial birds can be divided into two major groups: birds observed in floodplains and wetland, and birds observed in dry habitat such as homestead, open woodland, scrub and grass land.
Reptiles	Common Kukri Snake (*Oligodon arnenesis*), Buffstriped Keelback (*Amphiasma stolata*), Rat Snake *(Ptyas mucosus*), Monocellate Cobra (*Naja kaouthia*) Garden Lizard (*Calotes versicolor*), House Lizard (*Hemidactylus brooki*).	Habitats belongs to these species are homestead, cropland and garden vicinity.
Amphibians	Common toad *(Bufo melanostictus),* Cricket Frog *(Fejervarya limnocharis),* Jerdon's Bull Frog *(Hoplobactruchus crassus)*	Wetland areas and the dried areas

Source: Local people interviewed, March, 2015

5.2.22 Aquatic Ecosystem

246. Aquatic ecosystems of the polder area can be divided according to wetland types and its duration of water holding period. The polder and its surrounding area contain following types of wetlands:

- Rivers
- Canals
- Homestead ponds
- Intertidal plains

247. The polder is surrounded by two rivers (Bhadra and Shibsha) those contain tidal flow whole of the year. But water salinity of these rivers vary in different seasons. Numerous canals have crisscrossed through all over the polder area and some of which are connected with surrounding rivers. Most of the canals are shallow and silted up from a long time. Canals of this polder have a major contribution to keep drainage facility for the polder area. Each of the homesteads contains one or two ponds inside the polder area. Homesteads ponds are usually used for domestic uses and fish culture.

b. Aquatic flora

248. Aquatic floras are mainly concentrated in internal canals and homesteads ponds, due to having continuous tidal water flow in the channels of the river. It does not support any aquatic macrophyte to grow and develop inside or along the bank line. Within the polder area the ponds and khal contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows.

Table 5.32: List of aquatic flora of the polder area

Kochuripana (*Eichhornia crassipes*), Kutipana (*Azolla pinnata*) and Khudipana (*Lemna perpusilla*) also common species among the free floating type.
Submerged plants in both perennial and seasonal wetlands are Jhangi (*Hydrilla verticillata*), Ghechu (*Aponogeton natans*), Bicha (*Vallisneria spiralis*) etc. Almost all of these plants belong to closely related families like Aponogetonaceae, Hydrocharitaceae and Potamogetonacea.
Sedges and meadows called amphibian species. This type of vegetation has the highest species diversity and one of the most important wetland's plant communities in the polder area. They include Dhol kolmi (*Ipomoea aquatic*) and, Kochu *(Colocasia* spp.) etc.

Throughout the intertidal plains, some species of brackish grasses likeChaila gash *(Hemarthria protensa)*.are dominated. In addition, patches of Gewa *(Ecocaria agallocha),* Choila/Ora *(Sonneratia caseolaris)* trees are observed sporadically on the torus and along riverside toe of the embankment. Aquaculture in this tidal plain hinders regular tidal fluctuation that decrease succession of natural vegetation and reduced habitat suitability of dweller animals.

Source: CEGIS field survey, March, 2015

Photo 5.21: Internal canal and pond contains different types of aquatic plants

c. Aquatic fauna

249. The life cycle of aquatic fauna is dependent on seasonal variation as well as inundation depth and availability of water in all types of wetlands. Naturally, wetlands provide food and shelter to the aquatic fauna. Considering other polders, this polder contains lower population and diversity of aquatic fauna. Siltation of internal canals, compartmentalization of intertidal area and application of pesticides are the major causes of poor faunal diversity. A brief description of aquatic fauna is presented below.

Table 5.33: List of aquatic fauna of the polder area

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

Source: Local people interviewed, March, 2015

5.2.23 Ecosystem Services

d. Output of ecosystem services

250. UNEP defines an ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment, interacting as a functional unit. Humans are an integral part of ecosystems. Ecosystem services are the tangible and intangible benefits people obtain from ecosystems. These include provisioning services such

as food and water; regulating services such as flood and disease control, cultural services such as spiritual, recreational, and cultural benefits, and supporting services, such as nutrient cycling, that maintain the conditions for life on earth.

251. 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.

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

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

Table 5.34: showing the ecosystem product and its services within the polder area

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

b. Present threats on ecosystem

254. Soil salinity and internal canal bed siltation are the main threats on ecosystems of this polder. Specially, Akra village is near the embankment that's why the soil salinity is higher than other villages. Intrusion of saline water creates stress for vegetation and its

succession. Reduction of water conveyance capacity deemed soil moisture that hampers natural succession at canal side. In addition, riverbank erosion (Village: Jaliakhali and Bara Aria) is also another threat that destroys homestead vegetation in each year. Non-functioning of water control structures like regulators, causes insufficient drainage and flashing capacity of the polder area that damages vegetation. Loss of vegetation density and succession ultimately impact on wildlife habitats.

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

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

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

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

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

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

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

5.2.24 Livestock and Poultry Resources

260. A large number of populations of the polder area earn their livelihood from raising livestock / poultry. Farmers are using cattle for land preparation but cattle health is very poor. Detailed status of livestock and poultry in the household level is presented in Table 5.35.

Table 5.35: Status of Livestock/Poultry in the Polder Area

Live Stock/Poultry	% of Household	No. Livestock/Poultry in the Polder Area
Cattle/cow/bullock	70	28,476
Buffalo	30	8,136
Goat	5	1,356
Chicken	95	77,292

Live Stock/Poultry	% of Household	No. Livestock/Poultry in the Polder Area
Duck	50	27,120
Pigeon	6	3,254
Pig	3	610

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

Photo 5.22: Land preparation by country ploughand Cattle are grazing in the field

5.2.25 Commercial Livestock/Poultry Production

261. There are about 100 poultry farmers according to local poultry farm owners, farmers and DLS. Details are presented below in Table 5.36.

Table 5.36: Status of commercial livestock/poultry production

Livestock/poultry farms	Number of farms	Average nos/farms	Production (Nos)	Management		
				H	M	L
Chicken	100	300-1000	1.25-2.5 kg/chicken		M	
Duck	2	100-300	1-2 kg/duck			L

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

5.2.26 Feed and Fodder

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

Photo 5.23: Rice straw for cattle feed

Photo 5.24: Supplementary feed for ducks

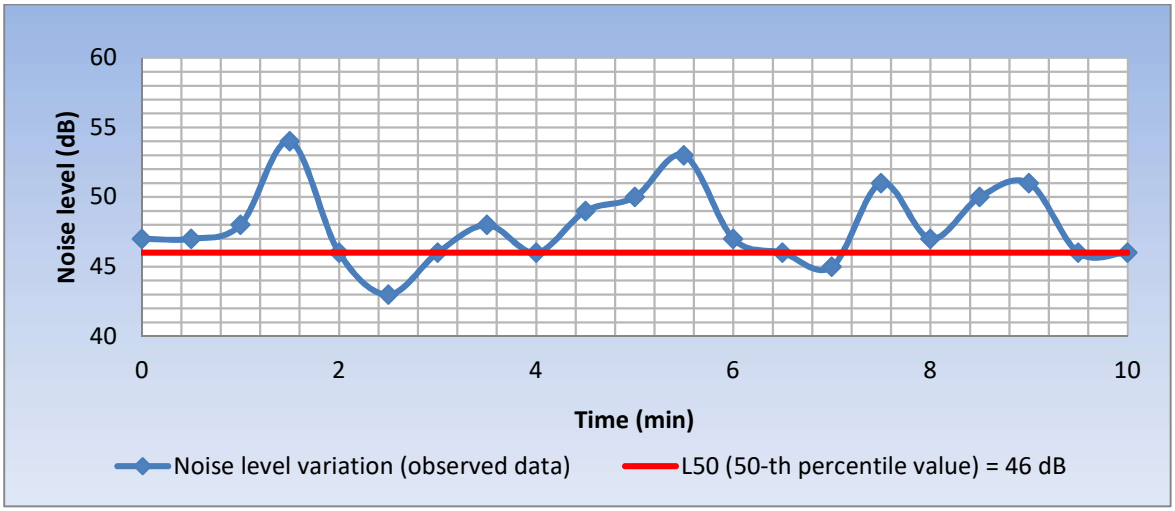
5.2.27 Livestock and Poultry Diseases

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

5.3 Environmental Quality

5.3.1 Sound Quality

264. During field inspection, sound levels were measured at Sahas bazaar (22º45'22.9''N and 89º23'48.3''E), with a 10 minute sampling period. The L_{50} (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L_{50} is assumed to be equal to Leq, which is the Equivalent Noise Level. In the study area, the L_{50} value was found as 46 dB, which is lower than the standard Leq value for residential zone set by ECA 1997 (50 dB). As the project implementation works are to be carried out manually i.e. without the use of any typical heavy loaded vehicle, it can be assumed that the sound levels generated from the construction sites due to project implementation works would have very minor contributions in the equivalent noise levels of the polder.



Source: CEGIS field survey, January 2015; N.B.: All values were collected during day time

Figure 5.14: Variation of sound levels for 10 minute sampling period at Sahas bazaar (22º45'22.9''N and 89º23'48.3''E)

5.3.2 Water Quality

265. Four major water quality parameters (pH, TDS, DO and salinity) have been measured during the major field investigation in March 2015, from different locations of the study area (**Table 5.37**). The pH values in the inspected surface water sources were higher than neutral scale (pH=7), which means the water in these locations was alkaline. This may be because the typical pre-monsoon rainfall did not start by then (as opined by local people during field visits). Values of TDS were found very low inside the polder, but were high in the Ghengrail and Upper Bhadra river samples. This is because of the increased sediment load carried by the peripheral rivers, which, to some extent, is prevented by the water control structures from entering the polder. Values of DO were mostly found close to the standards set by DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l).

266. Almost all the surface water samples were found having objectionable salinity concentrations.One shallow tubewell was also tested and found saline (with 2ppt) at the Akra govt. primary school. Salinity values at Ghengrail and Upper Bhadra river samples were found as 16 and 18 ppt respectively. There are some khals in which the tidal water enters because of having damaged gate openings (Ramakhalikhal). These khals have salinity concentrations similar to the feeding rivers. On the other hand, some khals are somewhat protected by water control structures, but still carry some salinity as the high tidal water often leaks the sluice gates and contaminates these khals (public opinion). Water quality of a 100 year old historical pond at Akra, was also inspected by the study team, and no salinity was found in the sample. Local people opined that due to severe drinking water crisis in the area, they prefer using this ponds (at Akra) water to meet up their drinking water demand. Salinity values from outside the polder were found similar to those inside the polder as most of the sluice gates are malfunctioned and water enters during high tide. In the month of May, highest salinity was observed as 22 ppt in AmtalaKhal outside the polder.

Table 5.37: Water Quality Parameters

Location	GPS Reading (Lat-Long)	pH	TDS (ppm)	DO (mg/l)	Salinity (ppt)	Remarks
RamakhaliKhal	22º42'57.1''N 89º24'13.7''E	8.1	479	5.0	14	Inside polder

Location	GPS Reading (Lat-Long)	pH	TDS (ppm)	DO (mg/l)	Salinity (ppt)	Remarks
Asannagarkhal	22º42'51.7''N 89º24'13.7''E	7.9	212	5.3	7	Inside polder
Ghengrail River	22º42'56.6''N 89º24'09.3''E	8.1	1202	6.1	16	Outside polder
STW at Akra govt. primary school	22°40'33.4"N 89°25'21.2"E	7.5	128	4.9	2	Shallow Tube well inside the polder
Pond at Akra	22°40'38.7"N 89°25'17.1"E	7.7	231	5.2	0	Pond inside the polder
Telikhalikhal	22°42'51.7"N 89°27'21.0"E	8.2	659	4.5	3	Inside polder
Upper Bhadra River	22°40'13.2"N 89°25'38.5"E	8.0	1353	5.2	18	Outside polder

Source: CEGIS field survey, March 2015

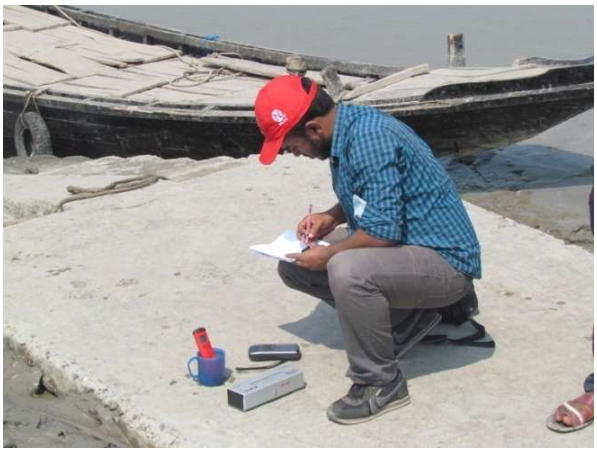


Photo 5.25: Water Quality measurement at Ghengrail River

Photo 5.26: Water Quality Measurement at Ramakhali khal

5.4 Climate Change

5.4.1 Climate Science

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

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

269. The average durations of sunshine in the winter, pre-monsoon, monsoon and post-monsoon seasons were found to be about 7.7, 8.0, 4.9 and 7.4 hours a day respectively. The decreasing trend in winter is about 0.6 hours a day per decade, whereas the post-monsoon sunshine hours have a decreasing trend of 0.4 hours a day per decade. In a monthly scale, the sunshine duration has decreasing trend for all months, except for June,

July and August. The trends in December and January of the winter season are statistically significant at 99% and 95% level of confidence, respectively (Mondal, 2012).

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

271. The rainfalls at Khulna BMD have experienced increasing trends of 8 mm, 31 mm, 9 mm and 6 mm per decade during the winter, monsoon, post-monsoon and pre-monsoon seasons, respectively. Among the monsoon months, June has an insignificant negative trend of 6 mm a decade, July has a non-significant positive trend of 5 mm a decade, August has a positive trend of 14 mm a decade being significant, and September has a positive trend of 7 mm a decade. Thus, the monsoon is found to be strengthening towards the end of the season. The numbers of rainy days during the wet (June-October) and dry (November-May) seasons show increasing trends of 0.6 days and 0.2 days a year respectively. Furthermore, the maximum number of consecutive rainy days in a year is found to be increasing (Mondal, 2012).

272. Moreover, the annual maximum high tidal water levels, as observed in Chalna (Pasur River) are increasing at a rate of 18 mm per year and the annual minimum low tidal water levels are decreasing at a rate of 8 mm per year.

5.4.2 Climate Change Scenario

273. Two greenhouse gas emission scenarios, *A2 Scenario*[5] and *B1 Scenario*[6], from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC-IV) were used because they represent the high and low brackets of the estimated global temperature increases under the report story lines. The summary features of these scenarios, in relevance to Polder 29 have been discussed in **Table 5.38**below.

Table 5.38: Summary Features of Climate Projections for Khulna

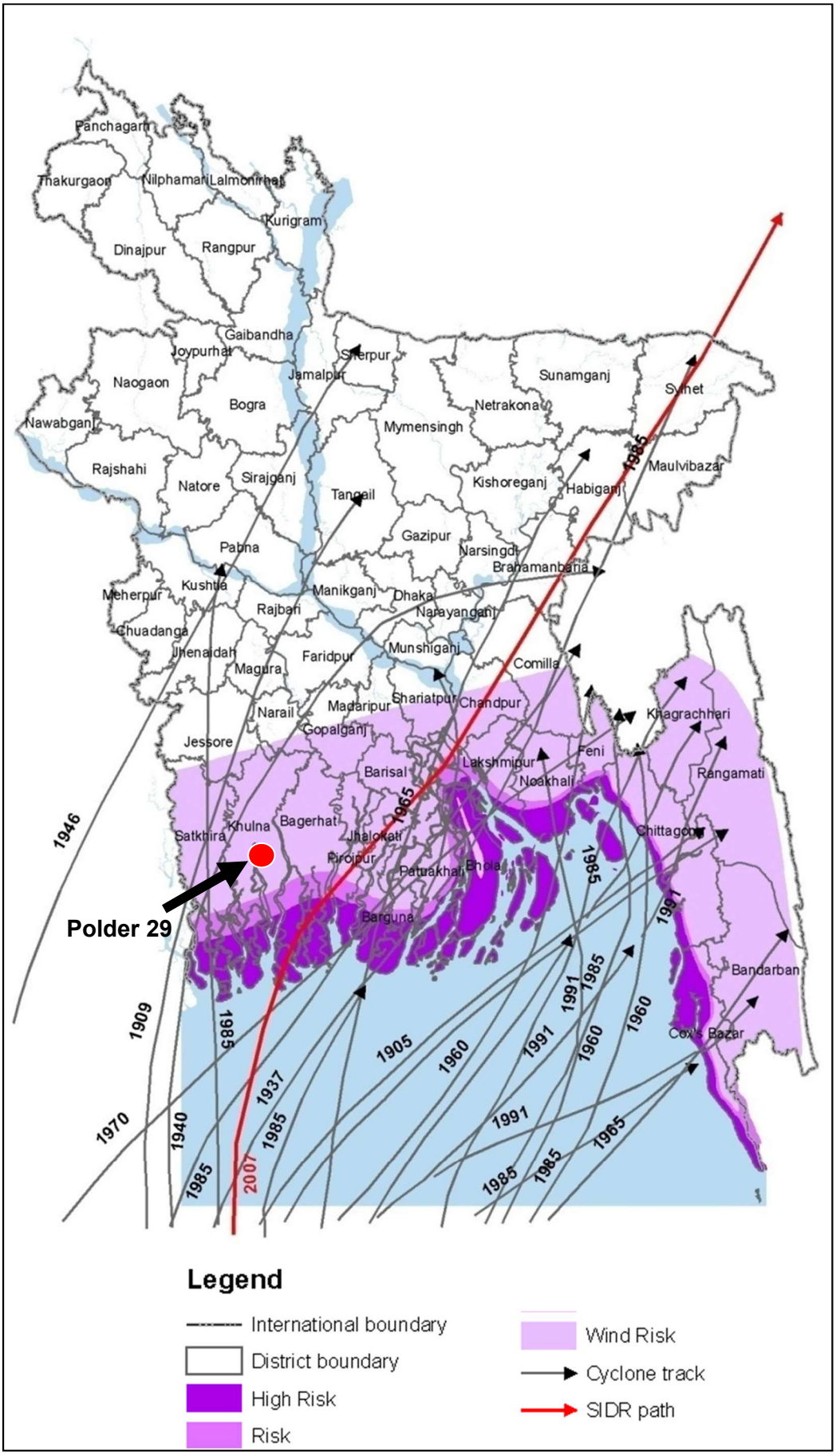
Scenario	A2	B1
Temperature	The average monthly temperature rise by 2050 varies from +0.5^{0}C in October to +1.7^{0}C in January and February.	The average monthly temperature rise by 2050 varies from +0.5^{0}C in June, July, and August to +1.5^{0}C in February and April.
Rainfall	The annual rainfall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

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

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

5.4.3 Cyclones and Storm Surges in Polder 29

274. Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal regions in Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of even more than 9m. For example, the 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m. By observing the tracks of different cyclones affecting the country in the last decade, the country's southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (**Map 5.12**). Polder 29 falls in the wind risk zone which possesses some vulnerability due to the strong winds, and surge heights associated with cyclones. From field observations, it was found that the polder did not undergo any major damage during the recent cyclonic events such as SIDR (2007), AILA (2009) and MOHASEN (2013).



Map 5.12: Cyclone Tracks in Bangladesh and Risk Area

6. Socio Economic Condition

6.1 Introduction

275. The socio-economic condition of the people living in 'Polder 29 EIA' (i.e. the study area) is captured in this chapter. In doing so, primary data were collected using a range of RRA techniques including Key Informant Interview (KII), Focus Group Discussion (FGD), observation and public consultation. Moreover, relevant secondary information were compiled from the community series of the Population Census 2011 published by Bangladesh Bureau of Statistics (BBS).

276. The study area contains 5 unions under 2 upazilas of Khulna district. The socio-economic baseline situation of the study area is described in the following sections.

6.2 The people

6.2.1 Demography

277. The 13,560 households living in the polder area have a total population of 55,304, of which 27,485 are male and 27,818 are female. The female population is higher than the male population. The average male-female sex ratio is 99 of which there are 99 males per 100 females which is lower than the national figure of 100.3 (HIES) 2010[7]]. The average density of population is 1023 persons per sq. km which is higher than national density of 1,015 persons per sq. km. The inhabitants of this Polder belong to three religious group; i.e. the Islam, Hinduism and Buddhism. About 96% of total populations are Muslim and the rests are Hindus and Christians. The demographic data of this Polder is presented in **Table 6.1**.

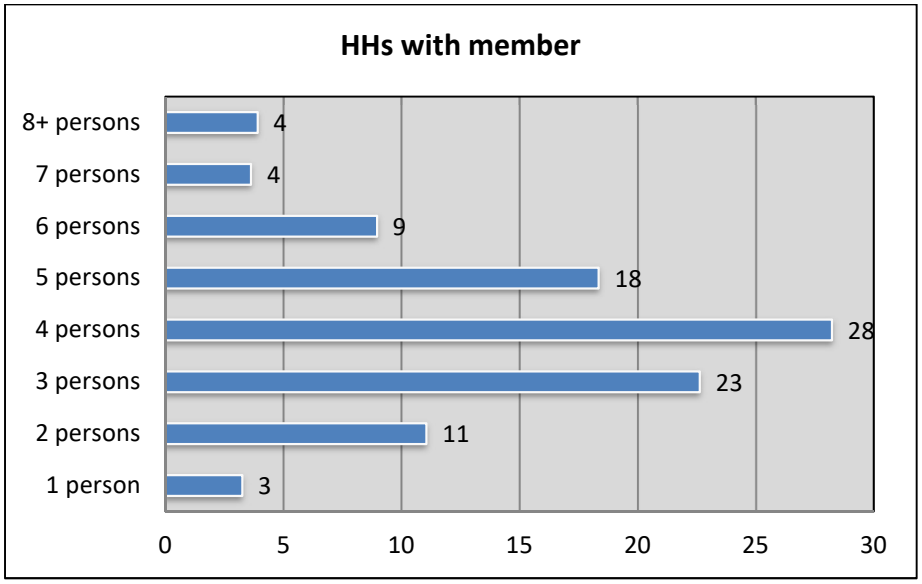
Table 6.1: Distribution of population and household of polder

District	Upazila	Union	Total HHs[8]	Population			Sex ratio	Population density
				Both	Male	Female		
Khulna	Dumuria	Bhandar Para	3861	15860	7951	7909	101	1015
		Dumuria	451	1986	1000	986	101	1088
		Sahas	4654	19295	9603	9693	99	1024
		Sarappur	3908	15266	7524	7742	97	965
	Batiaghata	Surkhali	1445	5990	2944	3046	97	1024
Total/Average			14319	58397	29023	29374	99	1023

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

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

[8] HHs refers to households



Source: Housing and Population Census, BBS, 2011

Figure 6.1: Distribution of households comprising member in each

6.2.2 Age Structure

279. The highest number of population (28%) belongs to age category of 30 to 49 years old in the study area. Only 3% people are in 60 to 64 years category. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-54 years as prime working age, 55-64 years as mature working age and 65 years and over as elderly people (source: World Fact Book, CIA[9]). This classification is important as the size of young population (under age 15) would need more investment in schools, while size of older populations (ages 65 and over) would call for more invest in health sector.

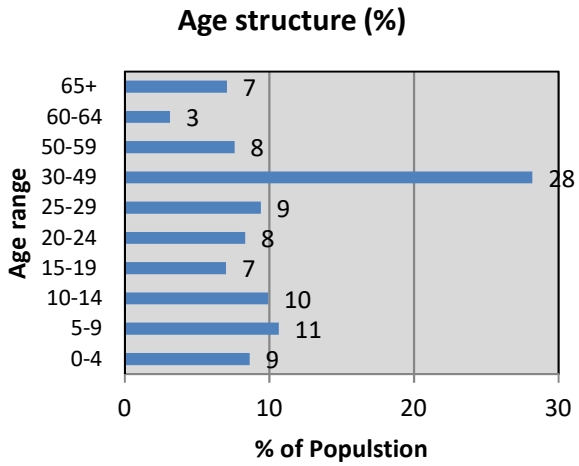
280. The population data when analyzed to ascertain the size of (potentially) active working population then it appears that 61% percent population who are in the age bracket of 15-64 can be classified under this category. A small percentage (7%) is of 65 years above. The categorization is made on the basis of ILO reference for opting out potential labour force and dependent population. Population of 15 to 64 years category is considered as labour force whereas, populations below 14 years and above 65 years are considered as dependent. Thus, the total dependency ratio[10] is 56 in which child dependency ratio is 45 and aged dependency ratio is 11. It illustrates that total 56 persons are dependent on 100 labour forces in which 45 are children and 11 are elderly people.

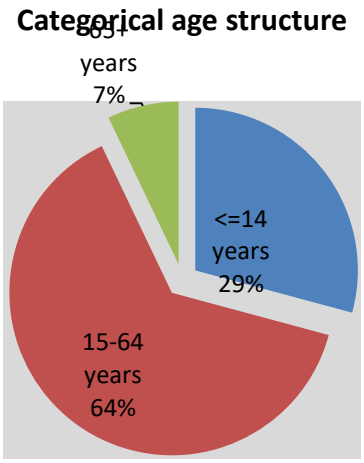
[9] Retrieved on 09/04/2015 from https://www.cia.gov/library/publications/the-world-factbook/docs/notesanddefs.html

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

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

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





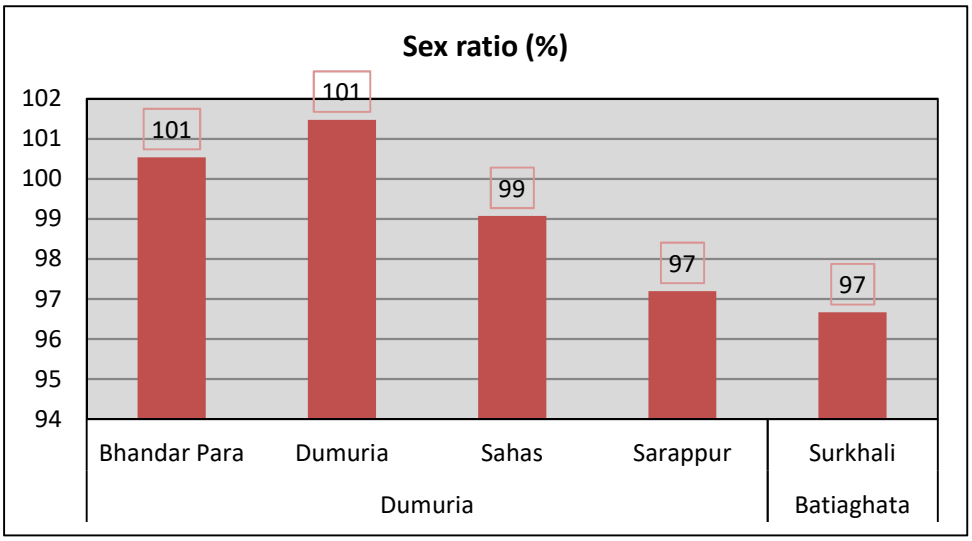
Source: Housing and Population Census, BBS, 2011

Figure 6.2: Age structure of the studied population

Figure 6.3: Categorical distribution of studied population

6.2.3 Sex Composition

281. Sex ratio when analyzed per upazila appears to be almost similar. According to BBS (2011) data in the study area overall sex ratio is 99, which means females are comparatively higher (100) than that of males (99). Male population is higher in Bhandar Para (101) and Dumuria (101), when the lower ratio is in Sarappur (97) Surkhali (97) and Sahas (99) unions. The data indicates that like national average (100.3), the discrepancy between male-female numbers is gradually decreasing.



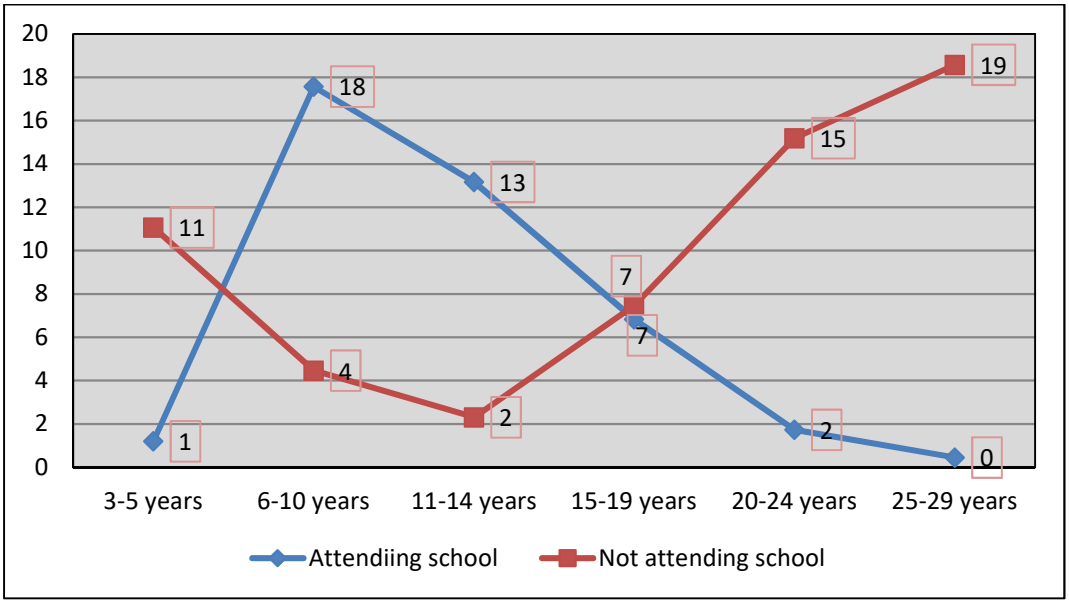
Source: Housing and Population Census, BBS, 2011

Figure 6.4: Sex ratio among the studied population

6.2.4 Education

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

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



Source: Housing and Population Census, BBS, 2011

Figure 6.5: Difference between attending and not attending rate

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

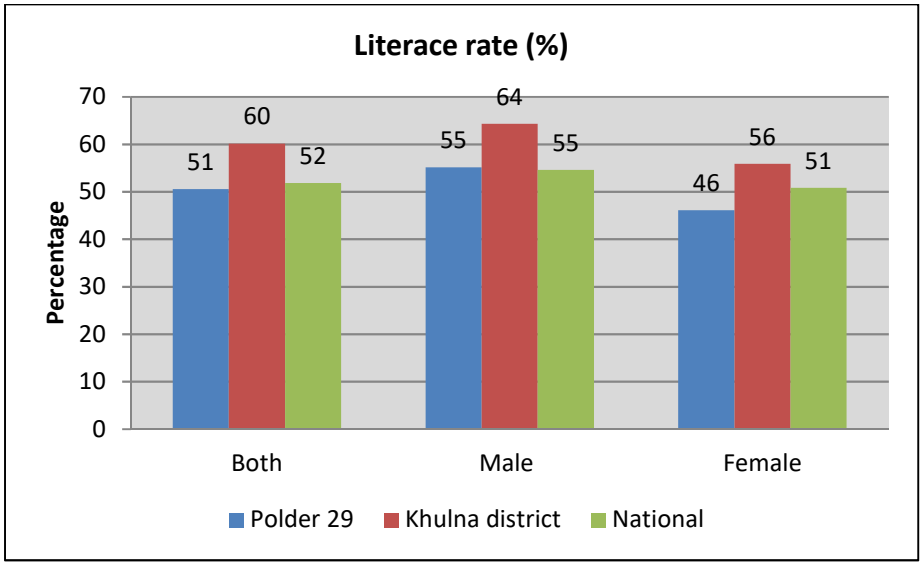


Figure 6.6: Litaracy rate in the study area

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

286. Field findings shows there are 67 primary schools, 16 high schools and 21 Ebtedaye/ Dakhil Madrashas in the polder area (**Table 6.2& Photo 6.1**). There are also two colleges both colleges are providing intermediate level education (Source: CEGIS field work, 2015).

Table 6.2: Education Institutions in the Polder

Union Name	No of Primary School	No of Madrasha	No of High School	No of Collage
Bhandar Para	12	1	5	-
Dumuria	15	5	5	01
Sahas	10	03	07	-
Sarappur	12	03	02	01
Surkhali	18	4	2	-
Total/Average	**67**	**16**	**21**	**02**

Source: CEGIS field work, 2015

Photo 6.1: Local educational institution at Polder area

6.2.5 Public Health

Access to health service

287. Access to health services and facilities refer to availability and adequacy of supply, affordability, physical accessibility and socio-cultural acceptability. Field data shows that there are 1 upazila Health Complex (UHC) at upazila level. Besides, there are 12 community clinics and 5 union complexes at union level providers also provide health services to the local people. People stated that the existing services are almost inaccessible to rural poor people therefore, a substantial pattern tends to receive services from local chemist and or village trained physicians. They stated that most of the community clinics are located at preferable location of local political leaders therefore; remote villagers have limited access than that of these adjacent villagers.

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

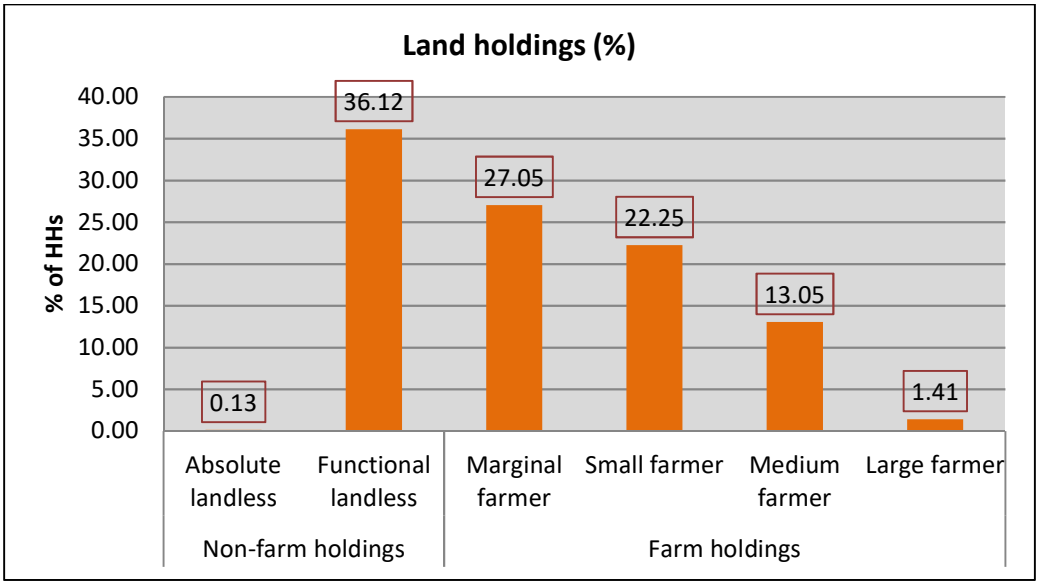
Photo6.2: Sarappur Union Complex

289. The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the polder area. It is found that the study area comprises 2.8% of all types of disabilities and 1% people reported that they are physically challenged. 0.5% mentioned speech and mental disorder. Local people opined that the incidence of Diarrhea and dysentery is the most prevalent ailment for dry season whereas cough/cold, skin diseases are also common for winter season in the Polder area.

6.2.6 Ownership and utilization of land

290. The Census of Agriculture, 2008 by BBS classified land holdings into two broad categories- one is farm-holdings and another is non-farm holdings. A farm holding is defined as being an agricultural production unit having cultivated land equal to or more than 0.05 acre. Conversely, non-farm holding includes landless households and households having lands up to 0.04 acre. The study area shows that out of total holdings 59.32% is farm and the rest 40.38% is non-farm.

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



Source: The Census of Agriculture, 2008, BBS

Figure 6.7: Households by land holdings

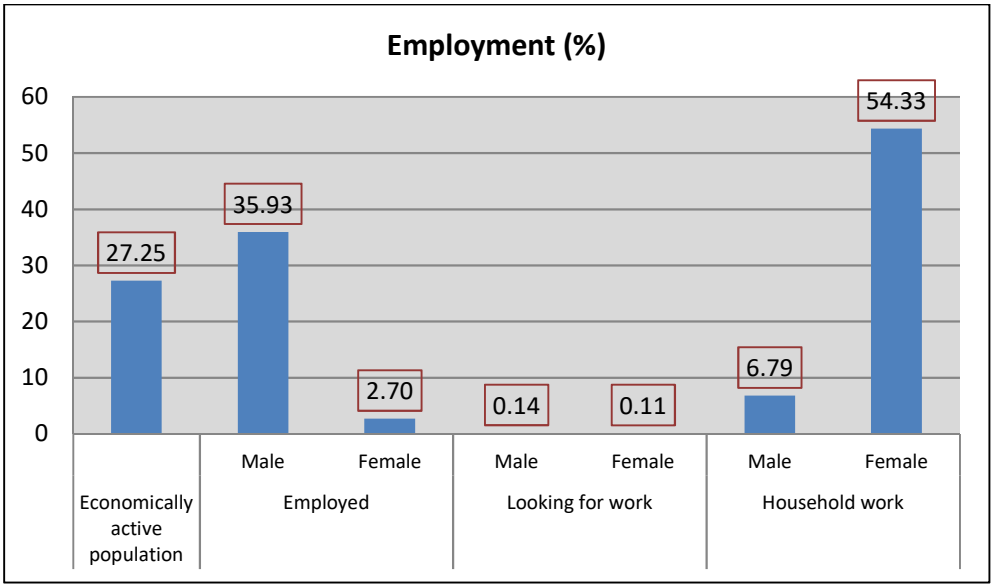
292. On the other hand, farm holding distribution shows that 27.05% households belong to marginal farmer (0.05 to 0.99 acre), 22.25% belong to small farmer (1.00 to 2.49 acre), 13.05% belong to medium farmer (2.5 to 7.49 acre) and 1.41% belong to large farmer (7.5+ acre) categories. It is evidential that land fragmentation decreases the holding size therefore; large and medium farmers are gradually being converted to marginal farmers.

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

6.2.7 Occupations and livelihoods

294. Out of total 58,397 population, 15,915 (27.25%) are economically active which include 6,148 (38.63%) employed, 39 (0.25%) are looking for work, and 9727 (61%) engaged in are household work. The economically active population includes those who are aged 7 and over and not attending school at reference period of Housing and Population Census, 2011. Therefore, the definition include employed, looking for work and household work categories and exclude children below 7 years, attending school population, physically impaired and elderly people who are not engaged in income generation works at reference period. Here household work particularly for women participation is accounted in terms of household activities as well as alternative income generation such as livestock rearing, poultry farming etc.

295. Women participation in direct income generating activities (employed category) is trivial as education status confirms that whereas not attending males are engaged in employment, females are getting married and in turn, contributed to the highest participation in household work (42.6%). The employed category also includes child labour as it was accounted from 7 years old population.



Source: Housing and Population Census, BBS, 2011

Figure 6.8: Employment status among the studied population

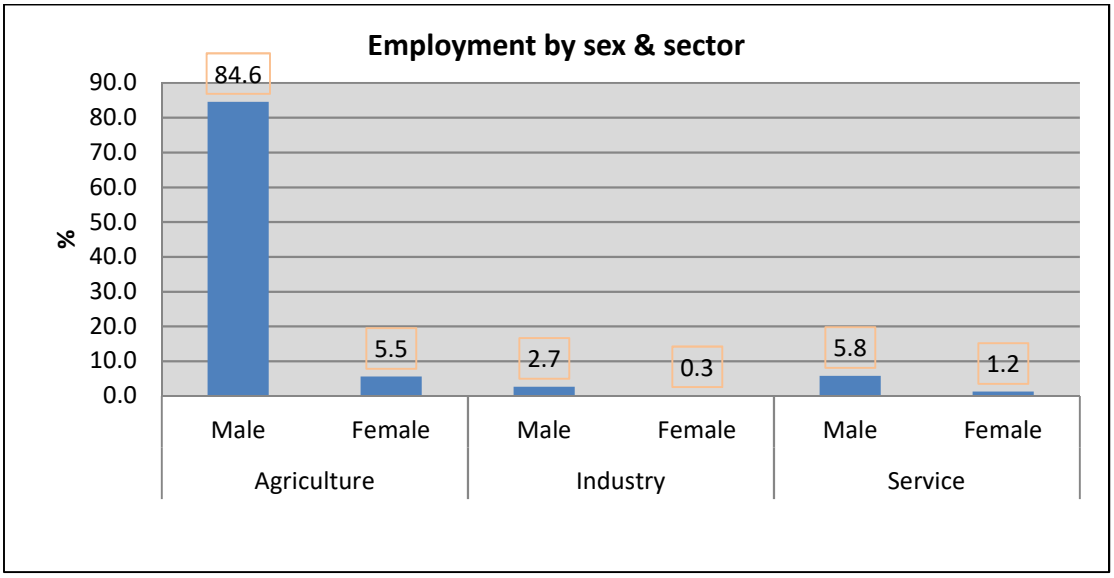
296. Distributing employed population at reference period of census it is found that 35% are engaged in agricultural activities, 1% in industry and 3% in service. Agricultural activities includes broadly crop farming, fishery and livestock and poultry farming. Scope of employment in agricultural sectors is gradually decreasing due to lack of sweet water tending to convert the lands into fellow land or shrimp farm. Data confirms that lands used for agriculture is 56%, for settlement is 38% and rest of them for other purposes as water bodies or industrial sector is 6%. Field findings suggest that land use for settlements is increasing and water bodies are decreasing. It is evident that once upon a time this area is known as fully saline prone area and now this characteristic is now changing for last 10 years. People are now realizing the curse of salinity and they interested for either crop farming or sweet water shrimp cultivation. In the People stated that this contribution shall be increased if favorable assistances (infrastructure, power and re-excavation of khals) are ensured.


Photo6.3 : Different modes livelihood activites at polder 29

6.2.8 Labor market

297. The employment rate[11] in the study area is 38.63 whereas the unemployment rate[12]is 61.37. It is evident that more than 60% of the total economically active population is still unemployed. Most of the unemployment populations are females who are solely involved in household work, and only 0.25% populations are looking for work (see section 6.2.7).

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



Source: Housing and Population Census, BBS, 2011

Figure 6.9: Distribution of population by sex and field of activity

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

[12] Unemployment Rate= 100-Employment Rate

299. The above figure implies that female participation in agriculture sectors are higher (5.5%) than that of industry and service (1.5%). Field findings documented that during harvesting period, they take part in action with men in same agricultural field. Some of them are also collect fry fish from river, earthwork etc (**Photo 0.00**).The wage rate varies between 400 Tk. to 350 Tk. /day for male whereas women wage rate is about 250 Tk. to 200 Tk. and they can work 20 days continuously in a month.

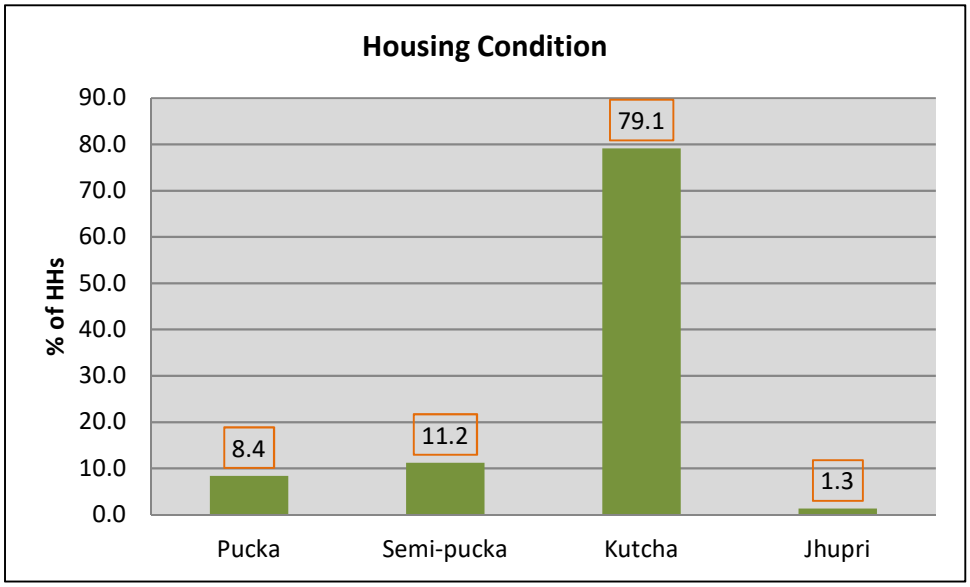
300. During field visit, people stated that out migration of labourers is slightly found (2%) in the study area whereas in-migration is almost absent. These out-migrants are mainly agricultural labourer usually go to neighboring upazilas (Gopalganj, Khulna, Dhaka) during May to September for better livelihood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

6.2.9 Standard of living

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

302. Data shows that about 50.5% households are under grid electricity coverage. BBS data shows Dumuria Union comprises highest (61.1%) electricity coverage whereas Surkhali Union comprises lowest (29%) coverage among other unions of this polder. Moreover, about 35% households are now use solar electricity in the polder area (CEGIS fieldwork, 2014).

303. The study area shows the predominance of kutcha houses (79.1%) over other three types. Semi-pucka household is 11.2% pucka is 8.4% and one percent is still jhupri houses. Most of the pucka houses are located in Dumuria municipal areas, whereas semi-pucka are predominant at the peripheral areas of municipality. Kutcha houses are predominant in the rural area (**Figure 6.10**).

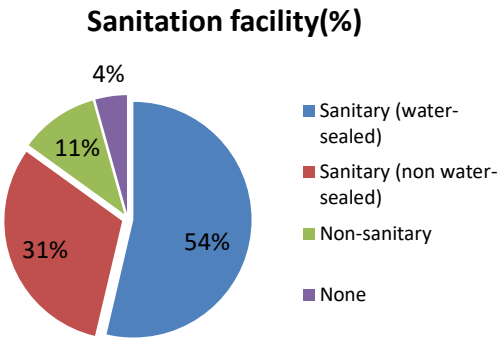


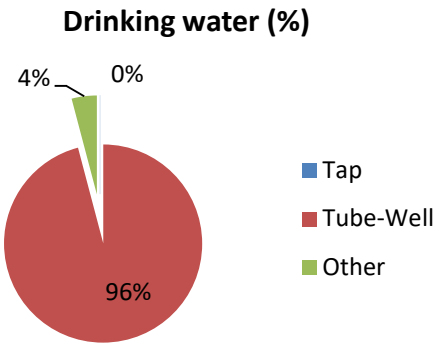
Source: Housing and Population Census, BBS, 2011

Figure 6.10: Housing condition in the study area

Photo 6.4: Housing structure at polder area

304. Sanitation facilities in the study area show that about 11% households use non-sanitary latrines, 31% use non water-sealed sanitary latrines and 4% use none latrines. Field findings confirm that non-sanitary latrines are predominant among kutcha houses. As water-sealed sanitary latrines are used by kutcha, semi-pucka and pucka households, it contains the highest coverage (54%). Water-sealed sanitary latrines are available predominantly in pucka houses. However, there are 4% houses, which have no sanitation facilities but tend to use on shared basis and in some cases uses open spaces (**Figure 6.11**).





Source: Housing and Population Census, BBS, 2011

Figure 6.11: Distribution of households by sanitation facilities

Figure 6.12: Distribution of households by sources of drinking water facilities

305. Status of drinking water in the polder area is deplorable. BBS data shows, collecting drinking water from tube-well is predominant (96%) throughout the study area. There is no use of tap water in whole polder area. However, 4.1% households are still depending on unorthodox sources of drinking water such as waterbodies; they are from poor classes and living in the rural areas having no access to tube-wells. On the other hand, Salinity is the main problems for drinking water especially during dry season. Besides, they also mentioned arsenic problem which is observed for last 2 to 3 years. They are depends on inadequate number of ponds and pond sand filter (PSF) for drinking water. Local people express that drinking water crisis is very severe especially during from November to May in the villages of Akhra, Bahir Akhra, Chadgarh, Jaliakhali, Ratankhali. During this period, the villagers collect drinking water from the neighboring 100 years old Akhra's pond. Even they also buy water from Dumuria at a cost of 20tk for every 30 litre jar by 25/30 Tk. During monsoon i.e. June

to October, they collect rain water and preserve it to meet their drinking water demand. Major sources of drinking water in Polder 29 are shown in **photo 6.6&**(**Figure 6.12**).

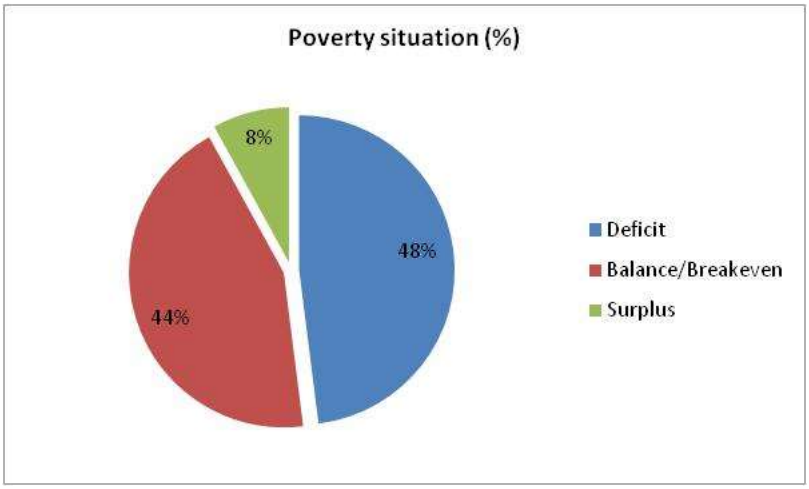
Photo 6.5: 100 years old Akhra's pond

Photo 6.6: Domestic level PSF

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

6.2.10 Poverty situation

307. Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories (**Figure 6.13**). It is observed that about 48% of the households in average are in the 'deficit' category, 8% are surplus and rest of 44% households are in balance situation. These households have been identified in the RRA as the poor households of the Polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals in a day in the lean period since they could not afford three full meals.



Source: CEGIS fieldwork, 2014

Figure 6.13: Self-assessment of Poverty Status

5.5.1 Institutions and infrastructure

308. At present, there is only one growth centre or big market (Dumuria Bazar) in the polder area. Besides, there are seven hat/bazar in the whole polder area of which 2 of these bazar are open every day of the week. The most notable hat/bazars in the polder are Noakhathi (open in every Saturday and Tuesday), Balikhali, Baroaria etc.

5.5.2 Extension services

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

Table 6.3: Households served by different social safety nets programs

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

Source: CEGIS Fieldwork, 2015

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

7. Public Consultation

7.1 Introduction

311. Public consultation is a regulatory process by which the public's input on matters affecting the local population is sought. It is a part of the EIA process aimed in involving the project stakeholders into the project development and implementation process. A formal meeting comprising of local people who are likely to be impacted was arranged at the Polder 29 project location. During consultation meeting the proposed project interventions and their associated impacts were discussed following a comprehensive checklist. Such consultations are organized to solicit people's opinion and feed on the project activities and make the project socially acceptable and environmentally sustainable based on their feedbacks. The participants expressed their opinion spontaneously and shared their experiences.

7.2 Objectives of stakeholder consultations

312. Keeping in view the following key objectives the consultation process was design and implemented

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

7.3 Identification of stakeholders

313. Stakeholders include all those who will be affected and/or perceived to be affected by the policies, decisions or actions within a particular system. Stakeholders can be groups of people, organizations, institutions and sometimes even individuals. Stakeholders can be divided into primary and secondary stakeholder categories. In the context of this study stakeholders are those who are and/or could be affected by the project interventions.

7.3.1 Primary Stakeholders

314. Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed project in Polder 29, the primary stakeholders include the people living within the project area particularly those who reside within and in the immediate vicinity of the polder. The primary stakeholders of the Project include the farmers, fisher, local business community as well as women groups, and

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

7.3.2 Secondary Stakeholders

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

7.4 Approach and Methodology

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

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

318. During the FGDs and PCM, the EIA team displayed maps of the project area, shared the initial concepts on proposed interventions and facilitated the discussions to solicit responsesfrom the participants. The stakeholders of the polder 29 were asked to share their needs, problems, possible sustainable solutions, and their views on the project interventions. The stakeholders' perceived views on important environmental and social components (IESCs) and project's impacts on them, along with perceived benefits, risks, threats and demand from the project were identified through these discussions.

Consultation Process

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

Greetings:

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

Introduction:

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

Respect to the participants:

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

Ensuring peoples' voice:

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

Note taking:

324. Discussed issues and opinions were written in notebook carefully. All issues were given equal importance.

Recapitulation and closing the session:

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

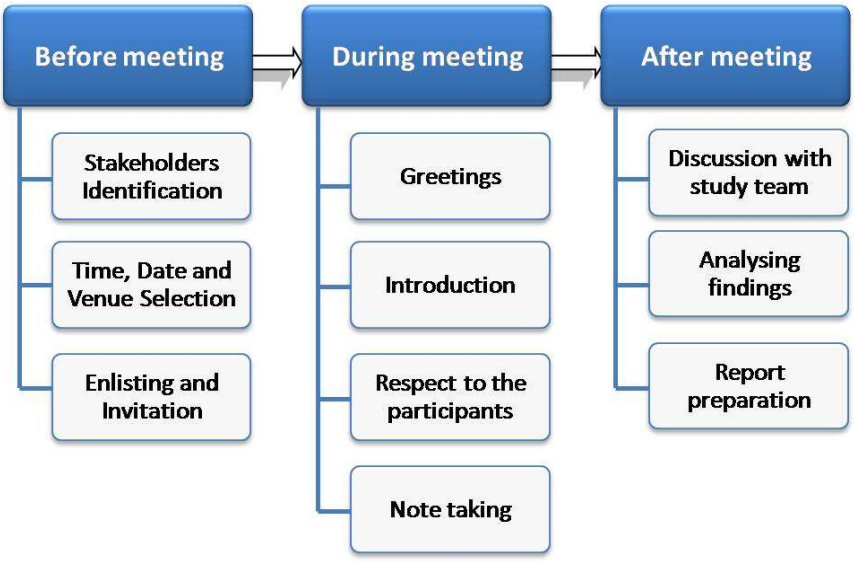


Figure 6.14: Overall consultation process

7.5 Consultation meetings and FDGs

7.5.1 Consultation Process

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

Table 7.1: Consultation Details

Sl	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Khulna	Khulna	Khulna	Blue gold office	consultation	16/03/2015	14:00
1	Khulna	Dumuria	Sarappur	Sarappur union auditorium	PCM	23/03/2015	10:00
2	,,	,,	Sahas	Noakathi bazar	,,	15/03/2015	11:00
3	,,	,,	Bhandar para	Telikhali vilage	,,	15/03/2015	14:00
4	,,	,,	”	Sundarmahal Bazar	,,	15/03/2015	15:30
5	,,	,,	Sarappur	Sarappur bazar	,,	16/03/2015	11:00


Photo 7.1: Knowledge sharing consultation meeting with Blue gold officials, Khulna


Photo 7.2 Meeting with Executive Engineer, BWDB; Khulna

7.5.2 Consultation Participants

327. The participants of these consultation meetings included Blue gold officials, local representatives, farmers, and traders, members of WMO and daily-wage laborers of the Polder 29 and nearby areas. A total number of 95 participants attended these consultations. The details of the participant are provided in **Table 7.2** and **Photo 7.3 to Photo 7.5** below.

Table 7.2: Participant details

Sl	Meeting venue	Type of consultation	Type of Participants	No. of participants
1	Blue gold office	Consultation	Secondary stakeholders	15
2	Sarappur union auditorium	PCM	Secondary and primary stakeholders	45
3	Noakathi bazar	"	,,	9
4	Telikhali vilage	"	,,	16
5	Sundarmahal Bazar	"	,,	10


Photo 7.3: PCM at Sarappur UP, Dumuria


Photo 7.4: FGD at Noakathi bazar, Sahas UP


Photo7.5: FGD at Telikhali village, Bhanderpara

7.6 Issues Discussed in FGDs and Meetings

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

- ❖ Water resources:
  - Surface water (tidal flooding, drainage, salinity, siltation)
  - Water management (flood control, drainage, irrigation)
- ❖ Land resources:
  - cropping practice,
  - production and yield,
  - water logging and drainage congestion
  - crop damage.
- ❖ Socio-economic aspects:
  - Occupation and Employment (unemployment/joblessness)
  - Migration (temporary/permanent out-migration)
  - Poverty (food and income poverty)
  - Education (poor literacy rate, non-schooling, less female education, drop out etc)
  - Health and nutrition (illness, diseases, poor nutrition)
  - Quality of life (poor housing and sanitation facilities, scarcity of drinking water, fuel and fodder)
- ❖ Disasters:
  - Cyclones
  - River erosion
  - Associated damages
- ❖ The sustainable and integrated solutions of the main problems being faced in the Polder:
  - Water resource management
  - Agriculture and fisheries management
  - Land resource management
  - Disaster management.
- ❖ Community involvement
  - To establish and empower community organizations/ water management organizations (WMOs) to sustainably manage their water resources and to make these resources more productive.

7.7 Community Concerns and Suggested Solutions

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

Table 7.3: Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	Salinity intrusion, drainage congestion and cyclone are the main community concerns in the polder area.	Comprehensive rehabilitation of the polder should be taken up at the earliest with the active
Water resources	- The water control infrastructures are not suitably functional in this polder and salinity intrusion due to damaged gates of the structures and height of embankment has reduced; - Water unavailability - Siltation of khals and drainage congestion	- Damaged part of the embankment should be re-sectioned as early as possible and slope of embankment must include protection with forestation. - Bank protection measures should be taken in the critical river bank erosion prone areas. - Replace the damaged/non-functional sluice gates and construct new ones where required - Re-excavation of proposed khals
Agriculture resources	- Soil salinity is the problems for crop production; - Drainage congestion during transplanting period in Aman season; - The level of sea water increases due to impact of climate change which is responsible for natural calamities such as tidal surge, cyclone etc. - Severe scarcity of irrigation water in dry season especially for rabi crops cultivation; - The siltation caused raise of bed of different internal drainage khals.	- Sluice gates repair - Khal re-excavation - Training for WMOs
Fishery resources	- Deteriorated habitat quality due to salinity and siltation in the khal - Pond overtopping during heavy rain - Illegal fish culture in the internal khal through pata jal by the local musclemen.	- Repairing the water control structure - Re-excavated the silted up khals - Apply fisheries rules and regulations strictly by the Government - Strengthening WMA/WMO activities
Ecological resources	- Soil salinity, internal canal bed siltation and riverbank erosion are the main threats on ecosystems of this polder. - Encroachment of saline water will slowly destroy fresh water ecosystem. - Drainage congestion and natural disaster is also another threat that destroys homestead and riverside vegetation. - Loss of vegetation density and succession ultimately impact on wildlife habitats.	- Removing siltation by re-excavation of khal. - Embankment re-sectioning and repairing water control structure along the embankment to protect settlement, road, inter tidal area and crop fields from existing problem.
Socio-economic	- Drainage congestion has a significant	- Strengthening of WMGs so that

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
resources	impact for the loss of agricultural production in polder 29 area which also affect to the economic condition of agricultural based households. - During dry season, scarcity of drinking water at Akhra, bahir Akhra, Chadgarh, Jaliakhali, Ratankhali and fresh water crisis is another problem in the polder area. Due to malfunctioning of water control structures, lack of reserve sweet fresh water in khals, saline water is being trapped for long time in almost whole polder area and this is responsible for intrusion of salinity in the groundwater aquifers. - Lack of adequate expertise and experienced manpower to carry out the O&M of the polder and the numbers of field staffs are also insufficient and inadequate in some places of the polder with respect to the actual requirement. - Local powerful persons, including the political leaders illegally interfere on the water control/ management infrastructure.	mass people can access to open water bodies easily. . - Scope of sweet water storage may be improved within internal khals and protective ponds by proper functioning of associated water control structures; - It is needed to ensure proper operation of the project infrastructure, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also manage properly water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc and growing of consciousness among the community in the polder. - The Government should rehabilitate the affected farmers who are affected by salinity intrusion; - Need awareness building about water management among the communities;

7.8 Participant list:

330. The name of the participants of different meetings, their age, occupation and address including cell phone number (if any) are provided in **Table 7.4.** Signed copies of the participants are enclosed as **Appendix 3**.

Table 7.4: Name of participants

SL	Name	Gender	Occupation	Age	Address
01	Md. Abdul Hamid	M	Business	40	01735-505766
02	Md. Rofiqul islam	M	,,	45	-
03	Md. Mostafizur Rahman	M	Veterinary Doctor	45	01719-503155
04	Md. Idris Ali	M	Fisher	42	01763-341096
05	Md. Kamrul Islam Sheikh	M	Agriculture	32	01865-970336
06	Md. Nurul Islam Sardar	M	Shrimp farm owner	35	01936-160567
07	Toiyab Haoladar	M	,,	55	-
08	Kuddus Mondal	M	Agriculture	40	01768-185124
09	Md. Hasan	M	,,	50	01767-896328
10	Nur Mohammad Morol	M	Shrimp farm owner	38	01734-800215
11	Md. Shahidul Islam	M	,,	45	01712-309679
12	Kajal Biswas	M	Business	56	01718-700194
13	Kingkor Mondal	M	Agriculture	40	01969-773324

SL	Name	Gender	Occupation	Age	Address
14	Md. Lutfur Rahman Mollah	M	Business	57	01953-835378
15	Md. Rahat Mollah	M	Day labor	35	01928-042230
16	Sri Siddartha Sankar Roy	M	Village Doctor	40	01719-566689
17	Abdur Rauf Mollah	M	Day Labor	35	-
18	Mijanur Sheikh	M	,,	40	01933-827968
19	Sheikh Delowar Hossain	M	Agriculture	36	01717-388882
20	Md. Sajjad Mallik	M	,,	45	-
21	Zahidul Islam	M	Day Labor	35	01718-912515
22	Md. Ismail Hossain Mollah	M	Agriculture	48	01714-932917
23	Md. Sattar Gazi	M	,,	50	01960-019655

8. Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification of IESCs and Rationale

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

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Ambient Noise Level	The construction works, in particular, the collection and placement of earthen materials and eventual compaction along the polder periphery would require heavy excavators to move over the polder alignment. This may create temporary noise pollution, which might be considered as objectionable by adjacent community. As such, Ambient Noise Level is considered as an IEC.
Saltwater Intrusion	At the moment the polder is severely affected by surface water salinity intrusion. Some of the interventions proposed in Polder 29, i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, saltwater intrusion has been considered as an IEC.
Water Security	Due to khal re-excavation works, the availability as well as access of surface water in Polder 29 may be increased and this might facilitate the multi-purpose use of water. Therefore, water security has been selected as an IEC.
Erosion Vulnerability	The construction of retired embankment proposed at Jaliakhali and Baro Aria will shift a significant length of the peripheral embankment into a safer alignment. This may eventually impact the erosion vulnerability of the peripheral embankment, and therefore, erosion vulnerability has been considered as another IEC
Drainage Congestion and Water Logging	The re-excavation works in the khals may improve the drainage status of the area, and diminish the risk of emergence of water logging problems at some portions of the polder. Therefore, drainage congestion and water logging has been considered as another IEC.
Tidal Flooding	The construction of retired embankment proposed at Jaliakhali and Baro Aria may prevent tidal water from entering into the polder through the two erosion prone locations in future. This may influence the tidal flooding situation inside the polder. As such, tidal flooding has been considered as another IEC.
Land Resources	
Soil Salinity	Soil salinity increases with the intrusion of saline water in the polder area. The proposed interventions (construction of retired embankment and re-excavation of khals) are expected to check the intrusion of saline water which in turn would help in the reduction of soil salinity. Soil salinity has, therefore, been selected as an IEC.

IESCs	Rationale
Agriculture land use	It is expected that the present land use might be changed due to implementation of the polder for the change of hydrologic regime inside the polder area. Farmers of the polder area are expected to feel encouraged to cultivate more crops in changing situation. Because of this reason, land use has been considered as one of the IECs.
Agriculture Resources	
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside polder 29 areas, which may encourage the farmers to change their cropping patterns and may be for more HYV. This may increase the cropping intensity in consideration of cropping pattern and intensity has been selected as an IEC.
Crop production	Agricultural crop production is expected to be increased for the improvement of drainage system due to the construction of re-tired embankment and re-excavation of khals. The re-excavation of khals would help to drained out excess water from the crop fields. The excess rain water inside the polder area would be drained out through drainage that might help to cultivate the HYVs rice and other crops. Moreover, the surface water might be available in the re-excavated khals which would be used as irrigation purpose. This situation would be favorable for enhanced crop production. As such, crop production has been selected as an IEC.
Crop damage	Crops are presently damaged in the polder area due to water lodging in the pre-monsoon and rainy season, drainage congestion, salinity, drought, etc. which are expected to be checked due to implementation of the proposed interventions. Reduction in crop damage would be reflected in aerial extent as well as increased yield per hectare contributing to increase in crop production in consideration of which crop damage has been selected as an IEC.
Irrigated area	Surface water is more preferable than ground water for irrigation use because of its low cost and sediment content contributing towards maintaining the soil nutrient status. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.
Fisheries Resources	
Open water fish habitat	The proposed interventions of the polder are likely to alter the fish habitat as well as habitat quality in the polder area. Increased water depth due to re-excavation of khals may restore the open water fish habitat (silted up khal) and change the water quality which may support different types of fish species. In this context, open water fish habitat has been considered as an IEC of the study.
Golda/Bagda gher habitat	Aquaculture practice e.g. rice cum prawn (golda), shrimp along with prawn is mostly cultivated in the polder area. Mixture of prawn and white fish culture is a common practice in the polder area. It is expected that the proposed intervention especially re-excavation of khal and repairing of regulators may further increase the rice cum fish culture practice in this area. Thus, gher habitat has been considered as an IEC.
Fish movement and migration	Internal fish movement and migration through khal is still the driving force for capture fisheries of the polder area. A few numbers of internal khals are connected with the peripheral rivers. But the major portion of the khals are silted up and covered with water hyacinth particularly in the northern part of

IESCs	Rationale
	the Bhadra River. Therefore, fish movement and migration is being obstructed partially or fully in the dry season. Proposed interventions especially khal re- excavation may increase water flow and depth of water in turn may facilitate the lateral fish migration. Thus, fish movement and migration has been considered as an IEC.
Fish species diversity	Fresh water fish species are declining in the polder area due to the loss of open water fish habitat for siltation and intrusion of salinity through mal-functioning of regulators etc. Currently, fresh water fish species are under serious threat of disappearing from the polder area fish habitats. A significant number of indigenous fresh water fish species are either endangered or threatened due to said causes. It is expected to change through implementation of the proposed interventions. As such, fish species diversity has been taken as an IEC.
Capture fish production	Fish production from open water sources has been declining over the years due to habitat loss, aggravated khal beds, and unfavorable environment due to increased water temperature during dry season and disrupted migratory routes. Therefore, capture fish production has been considered as an IEC.
Culture fish production	Culture based fish production from both brackish and sweet water fish habitats (gher and pond) contribute major shares of the fish production in the polder area. Production from these habitats has the increasing trends especially gher production. Implementation of the proposed interventions may protect these fish habitats. Thus, culture fish production has been considered as an IEC.
Ecological Resources	
Terrestrial vegetation	Terrestrial vegetation of area provides habitats for local wildlife as well as ecosystem services to the ecological components. Vegetations of the polder area are consequentially damaged by saline water intrusion, natural disaster and erosion in every year. Repairing and construction of retired embankment may protected existing problem and improve the vegetation condition. But all types of proposed construction activities are suspected to change of existing vegetation at construction sites. So terrestrial vegetation is considering an important IEC.
Aquatic flora and fauna	Aquatic flora and faunal status relies on wetland water salinity, quality, depth which plays an important role in the existing wetland ecosystem. Proposed intervention especially khal re-excavation is expecting to change water quality as well as fresh water flow which may impact on aquatic flora and fauna. Impacts can be positive and/or negative in long run. Hence, aquatic flora and fauna is considering as an IEC.
Socio Economic Condition	
Social Use of Water	One of the main utility of water is its social use i.e. taking shower, washing chores and other social uses. During the summer, most of the open water bodies i.e. Khals, ponds are being dry up and seen scarcity of water where the proposed canals are to be dug. As a result, people cannot use water for their social needs. Hence,if the two proposedcan als are made,it will ensure the various social use of water. Therefore,social use of water is regarded as an.ISC

IESCs	Rationale
Crisis of Drinking Water	There is a dearth of drinking water in certain parts of the polder area and people are suffering from differnt kinds water borne diseases such as diarrhoea, arsenic etc during dry season due to salinity in ground water. .Thus, villages of the polder i.eAkhra, Bahir Akhra, Chadgarh, Jaliakhali, Ratankhali collect drinking water from the neighboring 100 years old Akhra's pond or even buy from Dumuria Therefore,if the proposed canals are . reexcavated,the dearth of drinking water during dry season will partially be solved. and the scarcity of drinking water may beremovedHence, crisis of . drinking water isregarded as an.ISC
Employment Generation	The construction work will generate a significant amount of employment over its construction period for the local people. People will also be involved to carry out the operation and maintenance related jobs to operate the hydraulic structures. It is expected that the agriculture production would increase while salinity problem would decrease. Hence, project which will create opportunities indirectly, for agriculture, business and commercial services. Thus, employment generation can be considered as an ISC.
Gender Promotion	In polder area, people are living under poor condition. Specially, the females are mostly vulnerable to distressed and widow who are dependent on others and do not have any definite sources of income. It is proposed that about 40% of labour under total local constructing society (LCS) will be females. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.

8.2 Prediction and Evaluation of Potential Impacts

8.2.1 Preamble

332. This section identifies the potential environmental and social impacts that may be caused by various project activities during the three stages of construction works: pre-construction, construction, and operation, on the identified IESCs. Proposed interventions which may cause potential environmental impacts during pre-construction, construction, and post-construction stages have been identified in Chapter 4. The following detailed investigations have been carried out to assess the magnitude of these impacts:

- RRA survey to assess loss of vegetation, occupation, income and poverty levels of the affected households, etc.
- Environmental quality baseline monitoring of noise, surface water, groundwater and soil.
- Ecological surveys comprising vegetation, wildlife and fisheries covering both terrestrial and aquatic ecosystem.
- Land use surveys in Polder 29 comprising socio-economic status and environmental settings.
- Expert consultations, focus group discussions, and public consultations.

8.2.2 Impact Screening

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

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

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

Table 8.2: Screening Matrix

Project Phases and Activities	Water Resources						Land & Agriculture						Fisheries			Ecological		Socio-economic			
	Ambient Noise Level	Saltwater Intrusion	Water Security	Erosion Vulnerability	Drainage Congestion and Water Logging	Tidal Flooding	Soil Salinity	Agriculture land use	Cropping pattern and intensity	Crop production	Crop damage	Irrigated area	Open water fish habitat	Golda/Bagda with white fish culture	Fish movement migration	Terrestrial vegetation	Aquatic flora and fauna	Social Use of Water	Crisis of Drinking Water	Employment Generation	Gender Promotion
Pre-construction Phase																					
Labor, materials and equipment mobilization	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MP	-
Site preparation	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MP	-
Construction Phase																					
Re-sectioning of embankment	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MN	-	-	-	HP	-
Construction of Retired Embankment	MN	-	-	-	-	-	-	-	-	I	I	-	-	-	-	MN	-	-	-	HP	-
Embankment slope pitching and turfing	MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	HP	-
Re-excavation of khal	MN	-	-	-	-	-	-	-	-	-	-	-	MN	-	MN	-	MN	-	-	HP	-
Repairing of Water Control Structures	MN	-	-	-	-	-	-	-	-	-	-	-	MN	-	MN	-	-	-	-	HP	-
Operation Phase																					
Checking the physical condition and function of the embankment	-	HP	MP	MP	MP	MP	MP	MP	HP	HP	MP	MP	MP	MP	I	HP	MP	MP	MP	MP	MP
Checking physical condition and function of water control structures	-	HP	MP	MP	MP	MP	MP	MP	HP	HP	MP	MP	MP	MP	I	HP	MP	MP	MP	MP	MP
Checking functions of WMOs	-	HP	MP	MP	MP	MP	MP	MP	HP	HP	MP	MP	MP	MP	I	-	-	MP	MP	MP	MP

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

8.3 Impact during Pre Construction Phase

335. There wouldbe no significant impact during the pre construction phase on IESCs of water resources, agriculture, fisheries and ecological resources because some activities *like* materials and equipment mobilization (carrying as well as storing and land acquisition)would be carried out during this phase. The proposed activities may generate some temporary impacts on social conditions. The descriptions of such impacts as well as their magnitudes have been shown below.

Table 8.3: Impact Assessment Matrix for the pre Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Socio Economic Condition				
Activity: (i) Labor, materials and equipment mobilization (carrying and storing (ii) Site preparation				
Employment generation	Periphery and inside of the Polder 29 where different activities will be initiated.	Out of total 58,397 population, 15,915 (27.25%) are economically active which include 6,148 (38.63%) employed, 39 (0.25%) are looking for work, and 9727 (61%) engaged in are household work.	Local unemployed labors will be recruited for carrying and storing of materials, site preparation. Thus, the income of labor will increase temporality	2

8.4 Impact during Construction Phase

Impacts on IESCs during construction phase by the proposed interventions are presented in the following table 8.4.

Table 8.4: Impact Assessment Matrix for the Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-) / Magnitude
Water Resources				
Activity: *Re sectioning of embankment and Construction of retired embankment*				
Ambient Noise Level	Along the polder periphery	The 50-th percentile Noise level observed inside the polder are 46 dB	The excavator and associated heavy machineries will create noise disturbance along the polder alignment, and are likely to increase the noise levels by around 5~10 dB	-2
Land Resources				
There will be no impact during the construction phase.				
Agricultural Resources				
Activity: *Collection and dumping of spoil earth materials for construction of re-tired embankment*				
Crop production loss	Jaliakhali and Bara Aria	About 5.0 ha of agricultural land of which about 3.0 ha is under HYV Boro cultivation.	About 12 tons of HYV Boro crop production would be lost.	-1
Fisheries Resources				
Activity: *Re excavation of khal*				
• Fish habitat • Fish migration and movement	Arua/Taner khal (1.40 km) Nalghona khal (1.00 km) Agunkhali-Machmara khal (3.50 km) Khamarbari/Mulamer khal (1.60 km)	Tidal in nature, Silted up, shallow water or water less during dry season	• Feeding and breeding ground of the bottomdweller fishes will be lost. But after 1-2 year the habitat quality will be improved. • Turbidity of water willbe increased. Increased turbidity will inhibit to light penetration in water resulted photosynthesis of aquatic flora and fauna will be reduced. • Movement of some particular fish species like Cheng, *Taki, Puti, Koi, Shing* etc would be impacted.	-2
Activity: *Repairing and construction of Water Control Structures*				
Fish movement	• Repairing of (13 nos) Drainage	• Fish hatchling and some brackish	• Movement and migration of fish species	-1

IESC	Location	Baseline Condition	Impact	Impact (+/-) / Magnitude
and migration	Sluices and two Drainage Outlet (location of the sluices and outlet has already been mentioned in the water resources section) • Construction of Kodla-Mothbari Drainage Outlet	water fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra etc. move through the mal-function of regulator on regular basis during high tide.	like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, bele etc would be obstructed during repairing of structures. • Fish hatchling movement would also be hampered, if the repairing works is implemented during hatchling period (May-June).	
Ecological Resources				
Activity: *Repairing of embankment*				
Terrestrial vegetation	Both sides of the embankment at repairing points	• Embankment side vegetation is the main type. • Embankment side vegetation is dominated by medium sized trees, shrubs and herbs e.g. Shirish, Babla, Khai Babla, Akand, Bhat, Sezi and etc. • This vegetation provides feeding ground for mammals, birds, reptiles and amphibians. • Vegetation is facing risk due to natural disaster and human activities	• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for re-sectioning work.; • Relocation of wildlife due to habitat loss temporarily.	-2
Activity: *Construction of retired embankment*				
Terrestrial vegetation	Village: Jaliakhali and Bara Aria	• Embankment/polder side vegetation is dominated by medium sized trees, shrubs and herbs e.g. Babla, Khai Babla, Taal, Narike, Akand, Bhat, Sezi and etc. • This vegetation provides feeding ground for mammals, birds, reptiles and amphibians. • Vegetation is facing risk due to river erosion.	• Permanently damages of herbs, shrubs, various type of grass and bushes due to construction work. • Relocation of wildlife due to habitat loss temporarily.	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-) / Magnitude
Activity: *Re-excavation of khal*				
Aquatic flora and fauna	All the khals which are proposed to be re-excavated	• Most of the khals are shallow and silted up from a long time and being waterless in dry season. • No aquatic vegetation is observed in the river side khals because of tidal flow and salinity. • Vegetation along internal khal side is low, some grasses are found along the marshy parts of proposed Khals.	• Water depended fauna as Skipper frog, Bullfrog, Kingfisher, Egret, common aquatic Snake, etc. will be temporary re-located due to habitat loss in the khal area. • Grasses will be damaged due to storage of soil along the both side of the khal.	-3
Socio economic Condition				
Activity: *(i) Repairing of embankment (ii) Construction of retired embankment (iii) Embankment slope pitching and turfing (iv) Re-excavation khals (v) Repairing of drainage/ flushing sluices (viii) Repairing of drainage outlet (iv) Repairing of irrigation inlet*				
Employment generation	Periphery and inside of the Polder 29 where different activities will be initiated.	About 27.25% are economically active which include 6,148 (38.63%) employed, 39 (0.25%) are looking for work, and 9727 (61%) engaged in are household work.	A significant number of local labour will be recruited for earth work, repairing of embankment and afforestation, soil dumping and compaction of earth.	2
Gender Promotion	Periphery and inside of the Polder 29 where different activities will be initiated.	Females are mainly involved in household work and very few of them are working as a day labor or earth worker	According to the project plan, the LCS entails 60% male and 40% female all of them would be engaged from the local area. Thus, employment access to females in the construction works and during operation /maintenance phase will be promoted significantly.	3

8.5 Impact during Operation Phase

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

8.5.1 Water resources

a. Saltwater Intrusion

Future without Project

337. The sluice gates, if not repaired, may further increase the saltwater concentration in the surface water system of the polder in future. Almost all the water control structures of the polder are not functioning up to the desired level. At present salt water enter into the polder during dry season through some of the structural leakages, and the salinity concentrations found at 20-m buffer zone inside the polder are around or above 3 ppt. If the existing water control structures are not repaired, the 10 km khals prevailing with 3 ppt salinity concentrations, may increase to around 7 ppt salinity concentrations; while additional 20 km khals, located within additional 30-m buffer zone may be affected by up to 3 ppt.

Future with Project

338. If the existing sluice gates, flushing inlets and drainage outlets are repaired, the salt water leakage into the polder may be permanently prevented. In future, the 3 ppt salinity contour line would be diminished and salinity concentrations in the surface water system of the polder would drop to ‘zero’.

Impact

339. Significant impacts would be achieved regarding the prevention of salt water intrusion inside the polder. Salinity values will drop from a foreseeable maximum of 7 ppts inside the polder to ‘zero’. This will also foster other sectoral benefits within the polder.

b. Water Security

Future without Project

340. People living in Polder 29 are suffering from freshwater availability concerns at present. They cannot meet up their domestic and drinking water requirements up to the desired level. From the spatial distribution of surface water sources and settlements, it has been estimated that around 25% of people living inside the polder suffer from *water stress*[13]. The khals are heavily silted up at the moment and carry very limited flow during dry season. The entire polder would suffer from more freshwater scarcities for different uses if the khals are not re-excavated. With increased siltation and saltwater intrusion, it is projected that around 40% people inside the polder may suffer from water stress. This will ultimately impact their water security, and continue to degrade the status of community level water-food-energy nexus.

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

Future with Project

341. If the project is implemented, additional volumes of around 106,260 m^3 in the re-excavated khals would be available, which can carry water in all seasons and serve the domestic water demands of a significant number of people. However, the drinking water situation may not be improved due to implementation of the project as the project does not directly include any water supply measures. The shallow sub-surface layers within the polder are contaminated with increased salinity concentrations which would still deteriorate the drinking water situation within the polder. Therefore, around 5% people in polder may still remain in water stress, especially drinking water stress.

Impact

342. Around 35% of people living inside the polderwould be guaranteed sufficient freshwater availability and access, which would result in immense benefits in domestic water use. Besides, water for irrigation would also substantially be available.

c. Tidal Flooding

Future without Project

343. The peripheral embankment at present, effectively offers protection from regular tidal flooding in the area. However, the two vulnerable locations at Baro Aria and Jaliakhali maybreach in future. If the embankment is not retired at these two locations, tidal flooding may be induced through these two locations. An estimated area of 150 ha near Baro Aria and Jaliakhali may be subjected to regular tidal flooding in future, if the two aforementioned locations suffer from any embankment failures or breaches.

Future with Project

344. The proposed embankment if retired at Baro Aria and Jaliakhali, long term tidal flooding may be prevented. The two locations would offer better protection against the entry of tidal water. There may be no regular tidal flooding.

Impact

345. Almost 150 of ha areas near Baro Aria and Jaliakhali may be protected from tidal flooding occurrences in future. This may induce other associated benefits.

d. Erosion Vulnerability

Future withoutProject

346. The two vulnerable locations at Baro Aria and Jaliakhali have been eroded by up to 126 ha in last 26 years (found from image analysis). The spatial analysis on shifting of river plan form indicates that in future, around 3 km of embankment at Jaliakhali and some 2.5 m embankment at Baro Aria may be vulnerable from river erosion. The situation may lead to sudden breach in the embankment, and eventually erode a significant amount of areas in Baro Aria and Jaliakhali areas of the polder.

Future with Project

347. The proposed retired embankments if implemented at Baro Aria and Jaliakhali, the existing alignment of the polder would be altered. Around 1.9 km embankment (1 km at Jaliakhali and 0.9 km at Baro Aria) would be shifted to the inner side of the polder through a new alignment. The shifted portion will be secured from probable river erosion.

Impact

348. Around 64% lengths of the total vulnerable areas would be secured from probable river erosion. Risk of erosion at the two proposed locations would considerably decrease. This will in fact contribute to the over reduction of erosion vulnerability of the polder.

e. Drainage congestion and water logging

Future without Project

349. Presently, around 40% of the khals inside the polder (Bokultola, Aro khal, Mora Bhadra, Telikhali etc.) suffer from *severe drainage congestion*[14], and almost 30% of the khals (Kanchannagar, Katakhal, Ruthimara etc.) suffer from *moderate drainage congestion*[15]. If the re-excavation works under project is not implemented, the existing khals with moderate drainage congestion problems will be subjected to severe drainage congestion. Furthermore, around 5 km additional lengths of the affected khals (Bokultola, Aro khal, Mora Bhadra, Telikhali, Kanchannagar, Katakhal, and Ruthimara etc.) may be subjected to drainage congestion. It may be summarized that, almost 75% of khals will be affected from drainage congestion in future. However, the study infers no prolonged water logging events in future.

Future with Project

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

Impact

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

8.5.2 Land Resources

a. Agriculture land use

Future without Project

352. Presently, NCA is about 69% of the gross area. Of the net cultivable area single, double and triple cropped area is about 38%, 58% and 4% respectively. If the project is not implemented, single, double and triple cropping would be practiced in about 43%, 534% and 3% of the NCA respectively (Table 8.4).

Future with Project

353. The interventions would increase land use in the polder areas. Drainage congestion is expected to be removed due to implementation of different interventions of the polder. The

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

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

area under different land types would improve which would create scope of enhanced land use. It is expected that construction of re-tired embankment and re-excavation of khals would enhance land utilization. However, the land utilization for single, double and triple cropped area would be around 30%, 65% and 5% of NCA respectively in future with project condition. Detailed land use has been presented in Table 8.4.

Impact

354. The overall impact of different options on land use would be very positive. Single cropped area would decrease by about 13% but double and triple cropped area would increase by about 11% and 2% of the NCA respectively under FWIP condition. Detailed land use has been presented in Table 8.5.

Table 8.5: Detailed agriculture land use of the polder area

Agriculture land use	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)
	% of NCA	% of NCA	% of NCA	
Single crop	38	43	30	-13
Double crop	58	54	65	+11
Triple	4	3	5	+2
Total	**100**	**100**	**100**	**0**

Source: CEGIS estimation based on field information, 2015

b. Soil salinity

Future without Project

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

Future with Project

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

Impact

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

8.5.3 Agricultural Resources

a. Cropping pattern and intensity

Future without Project

358. Presently, cropping intensity of the polder area is about 166%. If the proposed interventions are not implemented, the land type as well as land use would be degraded through failure of embankment and siltation of river and drainage channels. Under this condition, there would be negative impact. The cropping intensity is expected to decreaseto about 160% (Table 8.5).

Future with Project

359. Rehabilitation of Polder 29 would help to change the hydrologic regime inside the polder area which might encourage the farmers to change their cropping patterns (Table 8.6). Under FWIP condition, the structures would function well and would influence to drain the excess water during rainy season from the cultivable land and as a result land type might be improved. The improved land type would influence the farmers to practices multiple cropping in the polder area. After completion of the interventions, the cropping intensity is expected to increase to around 175%.

Impact

360. After completion of the interventions, the cropping intensity is expected to increase by 15%.

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

Land Type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Baseline	FWOP	FWIP	% Change
				% of NCA	% of NCA	% of NCA	
Medium High Land (F_1)	Fallow	HYV T aman	Boro	22	17	28	11
	Fallow	LT aman	Fallow	38	43	30	-13
	Sesame	LT aman	Fallow	29	27	30	3
	Vegetables	LT aman	Fallow	4	4	4	0
	Jute	LT aman	Fallow	3	6	3	-3
	Vegetables (Bitter Gourd)	Vegetables	Vegetables	4	3	5	2
Total				**100**	**100**	**100**	**0**
Cropping Intensity (%)				**166**	**160**	**175**	**0**

Source: CEGIS estimation based on field information, 2015

b. Crop production

Future without Project

361. Presently, total crop production is 29,476 tons of which rice is 16,215 tons (55%) and non rice is 13,261 tons (45%). Adverse effect might occur due to siltation in river and drainage channels. The production would be decreased from the base situation. Total crop production would come down to 23,718 tons of which 12,834tons would be rice and 10,884 tons would be non-rice (Table 8.6).

Future with Project

362. The crop production would be boosted up significantly under the FWIP condition. The total crop production would be about 35,168 tons of which rice would be about 18,334 tons

and non-rice would be about 16,834 tons respectively. The rice and non-rice production would respectively be about 43% and 55% higher respectively in FWIP than that of FWOP. Rice production would be increased due to expansion of HYV Aman and HYV Boro, Sesame and vegetables cultivation area (Table 8.6).

Impact

363. Additional 5,500tons (43% higher) of rice and 5,950 tons (55% higher) of non-rice would be produced in FWIP over FWOP (Table 8.7).

Table 8.7: Impact on crop production in the polder area

Crop Name	Production (ton)			Impact (FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
HYV T.aman	3,701	2,323	4,637	2,314	100
LT.aman	7,767	7,259	7,544	285	4
Boro	4,645	3,252	6,153	2,900	89
Total rice	**16,215**	**12,834**	**18,334**	**5,500**	**43**
Jute	574	1,246	574	-672	-54
Sesame	1,530	1,325	1,947	623	47
Summer Vegetables	7,872	6,017	9,945	3,928	65
Winter vegetables	3,285	2,296	4,368	2,072	90
Total non-rice	**13,261**	**10,884**	**16,834**	**5,950**	**55**
Total	**29,476**	**23,718**	**35,168**	**11,450**	**48**

Source: CEGIS estimation from field information, 2015

c. Crop damage

Future without Project

364. Presently, crop production lossdue to drainage congestion, partial salinity and scarcity of irrigation water is about 930 tons of which rice is about 875 tons and non-rice is about 55 tons. The situation would be aggravated under FWOP condition. Total 1,169tons of rice and 77 tons of non-rice crops production would be lost under FWOP situation (Table 8.7).

Future with Project

365. In FWIP condition, crop damage would be reduced by 68% for the implementation of interventions and their proper management. The interventions would have positive impact in reducing crop damage area as well as crop production loss. The total rice and non-rice production loss would be about 793 tons and 57 tons respectively.

Impact

366. It is expected that loss of crop production would be reduced by 850tons which would be about 68% less in FWIP over FWOP (Table 8.8).

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

Crop Name	Production loss (ton)			Impact(FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
HYV T.aman	268	279	107	-172	-62
LT.aman	322	612	146	-466	-76

Crop Name	Production loss (ton)			Impact(FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
Boro	285	279	122	-156	-56
Total rice	**875**	**1,169**	**376**	**-793**	**-68**
Sesame	55	77	20	-57	-74
Total non-rice	**55**	**77**	**20**	**-57**	**-74**
Total	**930**	**1,246**	**396**	**-850**	**-68**

Source: CEGIS estimation from field information, 2015

d. Irrigated area

Future without Project

367. Presently, irrigated area is about 1,333 ha. The availability of surface water in the river and khals would decrease due to siltation of river and khals in the area under the FWOP condition. The irrigated area would decrease about 948 ha.

Future with Project

368. After implementation of the proposed interventions in the polder, water will be available and retained in the rivers and khals. Irrigation would be provided from different rivers and khals in rabi crops by using LLPs up to February. The irrigated area would increase to about 1,600 ha in FWIP. The irrigated area would be increased to 652 ha in FWIP over FWOP.

Impact

369. The irrigated area would be increased by 652 ha in FWIP over FWOP (Table 8.8).

8.5.4 Fisheries Resources

a. Open water Fish habitat

Future without Project

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

Future with Project

371. Water flow as well as water depth of khal would be increased after re-excavation of khal. Silted up and seasonal khal would be perennial khal.The improved habitat quality would support different types of fishes and aquatic vegetation which would be helpful for feeding and habitation of fisheriesand aquatic biota. It is mentionable that turbidity of khal's

water would be increased due to re-excavation activity temporarily. But after one or two year, the turbidity will be reduced naturally.

Impact

372. All seasonal khal would become perennial again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota.

b. Bagda/golda farming

Future without Project

373. Three types of gher i.e. Bagda gher, Golda white fish gher and rice cum golda gher are found in the polder area.Among them, rice cum golda and white fish culture is dominant which comprise 91% of total gher area. In future without project, bagda area would be slightly increased for salt water intrusion through the mal-function of regulators and water entering by the local people illegally. It is expected that bagda gher would be increased to 18 from the base condition. The golda gher area would remain same or slight decrease.

Future with Project

374. In future with project situation, bagda gher area would be totally (15 ha) decreased due to stopped saline water intrusion for repairing of water control structures. But rice cum gold would be increased after rehabilitation of the project interventions. It is assumed rice cum golda gher area would be increased to 426 ha.

Impact

375. Bagda gher areawould bedecreased to3 ha. Golda gher area would be increased by 71 ha.

c. Fish movement and migration

Future without Project

376. Fish speciesbothfreshwater and brackish water as well as hatchling move from river to khal through sluice gate at some stage of their life cycle for nursing and feeding purposes. In FWOP condition, hatchling and fish movement would be facilitated round the year due to existing malfunction of water control structures. Moreover, substantially progressing of khal bed due to siltationwill lead to reduce the water depth. Thus fish movement would be hampered fromriver to khal vice-versa. On the other hand, duck weed covered with most of the part of khal would also obstruct movement of the pelagic fish species.

Future with Project

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

Impact

378. Fish as well as hatchling movement would be slightly. Internal fish migration would befacilitated significantly.

d. Capture fisheries productivity

Future without Project

379. In future without project situation, the catch per unit area (CPUA) would reduce from the current CPUA due to the ongoing process of siltation in the khal as well as raising of bed level of khal would cause less suitable for fish habitation. Many fish species would be disappeared from this habitat which ultimately leads to decrease the fish biodiversity in the polder area. Due to this reasons, it is assumed that capture fisheries productivity would be decreased by 20% fromthe base condition under FWOP condition. The capture fisheries productivity would be 60 kg/ha.

Future with Project

380. Implementation of proposed activities i.e. re-excavation of khal will increase the water depth, water availability as well as water quality which ultimate will increase catch per unit area (CPUA) in the polder area. It is expected that the capture fisheries productivity would beincreased to 130 kg/ha compare to baseline situation (87 kg/ha) due to aforementioned reasons.

Impact

381. Capture fisheries productivity would be increased by 70 kg/ha.

e. Culture fish production

Future without Project

382. In future without project situation, itis expected that shrimp production would increase to 10.8 tons due to increasing of salt water intrusion in the polder. Production of rice cum golda would remain same or slightly increased.

Future with Project

383. The bagda production in the polder area would be decreased to 9 tons. Rice cum golda production would be increased to 255 tons.

Impact

384. Bagda production would be lost by 1.8 tons whereas rice cum golda production would be increased by 42 tons.

8.5.5 Ecological Resources

a. Terrestrial vegetation

Future without Project

385. 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.

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

Future with Project

387. 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

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

b. Aquatic flora and fauna

Future without Project

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

Future with Project

390. 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

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

8.5.6 Socio Economic condition

a. Social Use of Water

Future without Project

392. People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their necessity for water through tube well. At present 13% families have poor access and 87% families have medium access to social use of water and without project situation this number will be 26% for poor and 74% medium access.

Future with Project

393. With the intervention, 26% families would be good, 21% families would be poor and 53% families would be medium access to social use of waterand benefited through this project.

Impact

394. The standard of life for 962 numbers of HHs would be good and 1,961 numbers of HHs would be medium access to social use of water. Around 15% people inside Polder 26 would be guaranteed sufficient freshwater availability and access, which would result in

benefits in domestic water use. Besides, water for irrigation would also substantially be improved.

b. Gender Promotion

Future without Project

395. 40% of the total labourforce to be mobilized through the labour contracting under total labor constructing society (LCS) will be females. Since some of the earthwork contract will be awared to the LCS, It is expected that they will be directly benefited through for these interventions.

Future with Project

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

Impact

397. 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

c. Employment generation

Future without Project

398. 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

399. 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

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

Table 8.9: Matrix on Impact Assessment with regard to Operation Phase

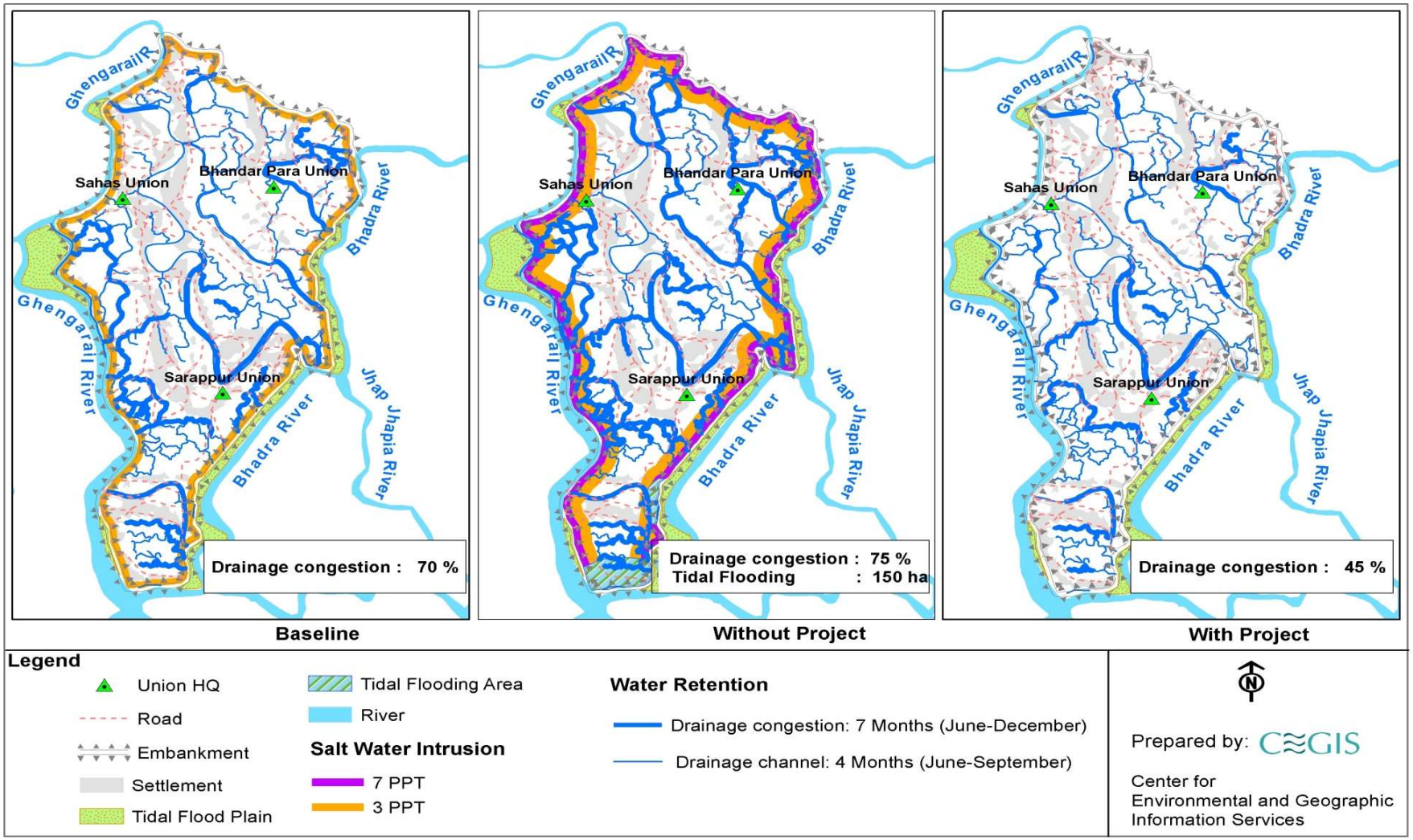
IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
Water Resources				
Water Security	People of Polder 29 cannot meet up their domestic, drinking and irrigation water requirements and around 25% people within the polder remain under water stress	Water security may further deteriorate with increased siltation and around 40% 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	No tidal flooding occurs within the polder	An estimated area of 150 ha near Baro Aria and Jaliakhali may be subjected to regular tidal flooding	Tidal flooding would be completely prevented	+3
Erosion Vulnerability	Baro Aria and Jaliakhali have been eroded by up to 126 ha in the last 26 years	Around 3 km of the embankment at Jaliakhali and some 2.5 m embankment at Baro Aria may be vulnerable from river erosion	Around 64% lengths of the total vulnerable areas at Baro Aria and Jaliakhali would be secured.	+2
Drainage congestion and water logging	Around 40% of khals inside the polder (Bokultola, Aro khal, Mora Bhadra, Telikhali etc.) suffer from severe drainage congestion, and almost 30% of khals (Kanchannagar, Katakhal, Ruthimara etc.) suffer from moderate drainage congestion. No water logging situation prevails.	Around 75% of khals inside the polder (Bokultola, Aro khal, Mora Bhadra, Telikhali, Kanchannagar, Katakhal, Ruthimara etc.) would suffer from severe drainage congestion. No water logging would occur.	Drainage congestion in the upstream portions of the khals would be diminished but around 45% khals' at the downstream portion may face moderate drainage congestion.	+4
Land Resources				
Agriculture land use	Presently, NCA is about 69% of the gross area. Of this net cultivable area single, double and triple cropped area is about 38%, 58%, and 4% respectively.	Single, double and triple cropped area would be about 43%, 54%, and 3% of the NCA respectively under FWOP condition	Single, double and triple cropped area would be about 30%, 65%, and 5% of the NCA respectively under FWIP condition	+3
Soil salinity	About 38% of the NCA is slightly saline with some moderately saline soils.	Salinity would be increased.	The successful implementation of the project and its proper management would reduce the salinity of the polder 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 166%.	Cropping intensity would be reduced to 160%.	Cropping intensity would be increased to about 175%.	+3
Crop production	Total crop production is 29,476 tons, of which rice is 16,215 tons and non rice is 13,261 tons.	The total crop production is expected to decrease to 23,718 tons of which rice would be 12,834 tons and non-rice would be 10,884 tons.	The total production is expected to increase 35,168 tons of which rice would be 18,334 tons and non-rice would be 16,834 tons.	+3
Crop damage	Total crop production loss is 930 tons of which rice is 875 tons and non-rice is 55 tons respectively.	Total crop production loss is expected to increase to 1,246 tons of which rice would be 1,169 tons and non-rice would be 77 tons.	Loss of rice production would be 793 tons and non-rice would be 57 tons.	+4
Irrigated area	Irrigated area is about 1,333 ha.	Irrigated area is expected to decrease to about 948 ha.	The irrigated area would be increased by 652 ha in FWIP over FWOP	+4
Fisheries Resources				
Fish habitat	• In the polder area, fish habitat include internal khal and fish pond • Siltation and excessive duck weed are major problems of the khals which are causing unsuitable for fish habitation.	• The ongoing siltation process, khals bed will be raised, thus reduce the water retention capacity in dry season. • Perennial khal would be converted to seasonal khal	• Habitat quality would be improved. This habitat would support to grow different types of aquatic vegetation which would be used for fish feeding and habitation.	+2
Bagda/Golda farming	• Bagda gher is 15 ha and golda gher 355 ha	• Bagda gher would be lost totally ha while golda gher increased to 426ha	Bagda gher would be decreased by 15 ha while golda gher area would be increased by 71 ha	+3
Fish movement and migration	• Some fish species move and migrate through water control structures on regular basis during high tide	• Same as base condition or would be improved	• Fish and hatchling movement would be hampered slightly but internal fish migration would be improved	+2

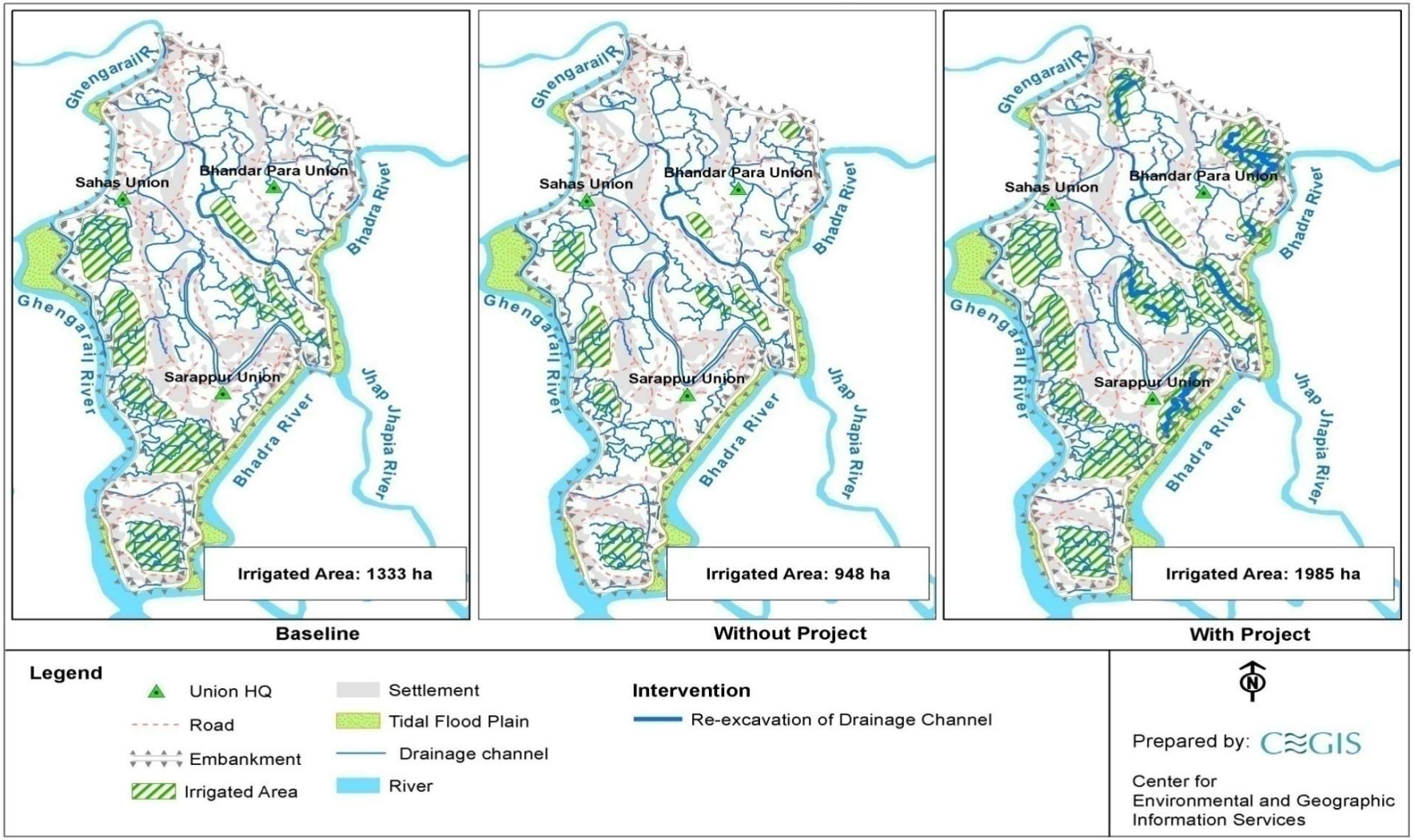
IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
Capture fisheries productivity	Productivity is 87 kg/ha	Productivity is 60 kg/ha	Productivity is 130 kg/ha	+4
Culture fish production (shrimp/golda)	Shrimp : 9 tons Rice cum golda: 213 tons	Shrimp : 10.8 tons Rice cum golda: 213 tons	Shrimp : 9 tons Rice cum golda: 255 tons	+2
Ecological Resources				
Terrestrialvegetation	Moderate	• 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 cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their needs for water through tube well.	In without situation, 13% families have poor access and 87% families have medium access to social use of water and without project situation this number will be 26% for poor and 74% medium access	With the intervention, 26% families would be good, 21% families would be poor and 53% families would be medium access to social use of water and benefited through this project	+2
Gender Promotion	In the polder area only 2 % female members are working whereas 98 male members are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, women are mostly vulnerable and widows who are dependent on others and do not have any definite sources of income. Therefore, in without project situation, this opportunity may not be ensured for gender promotion	The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.	+3

IESC	Baseline	FWOP	FWIP	Impact (+/-) / Magnitude (1-10)
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
Social Use of Water	People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their needs for water through tube well.	In without situation, 13% families have poor access and 87% families have medium access to social use of water and without project situation this number will be 26% for poor and 74% medium access	With the intervention, 26% families would be good, 21% families would be poor and 53% families would be medium access to social use of water and benefited through this project	+2

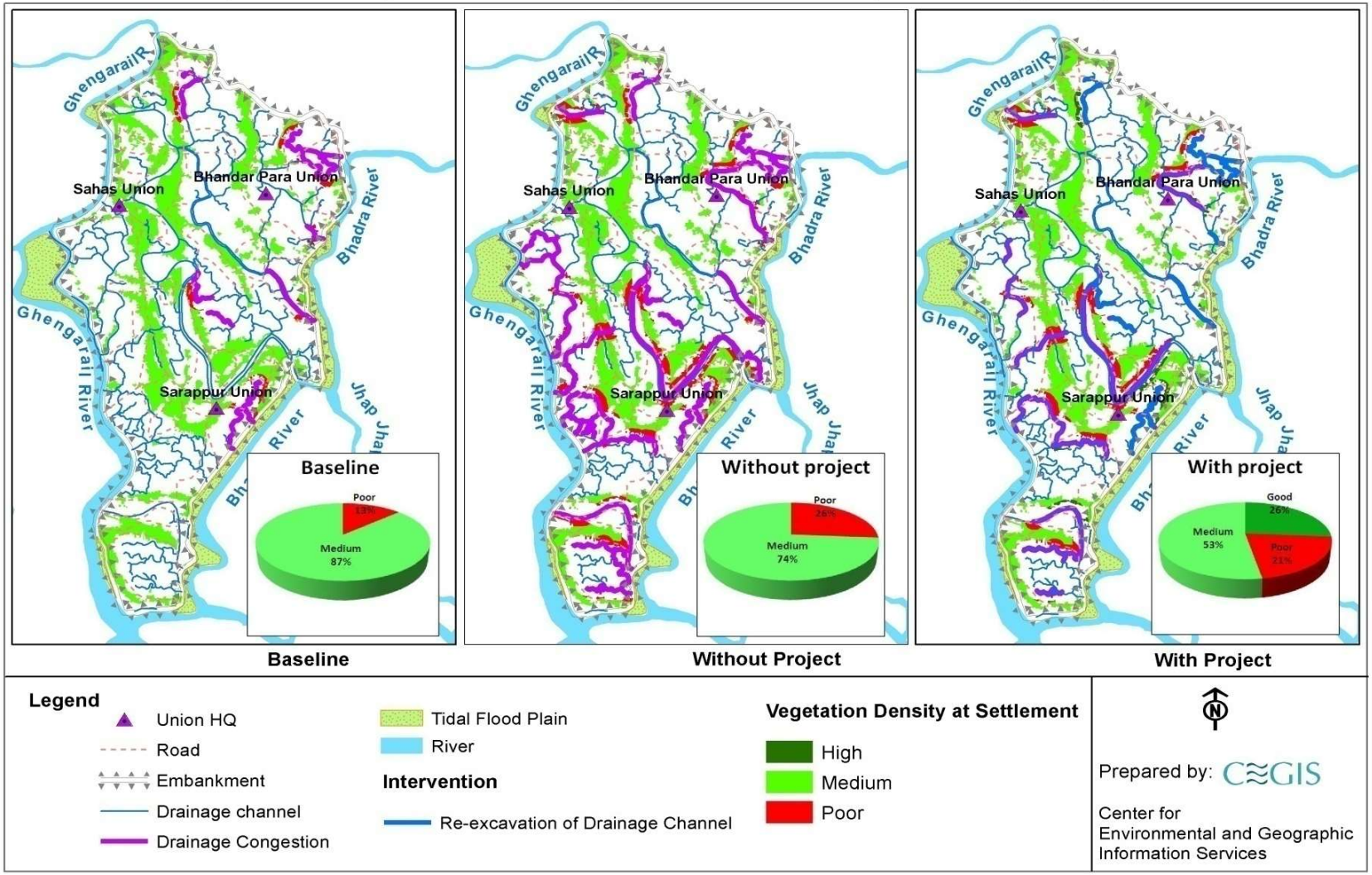
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



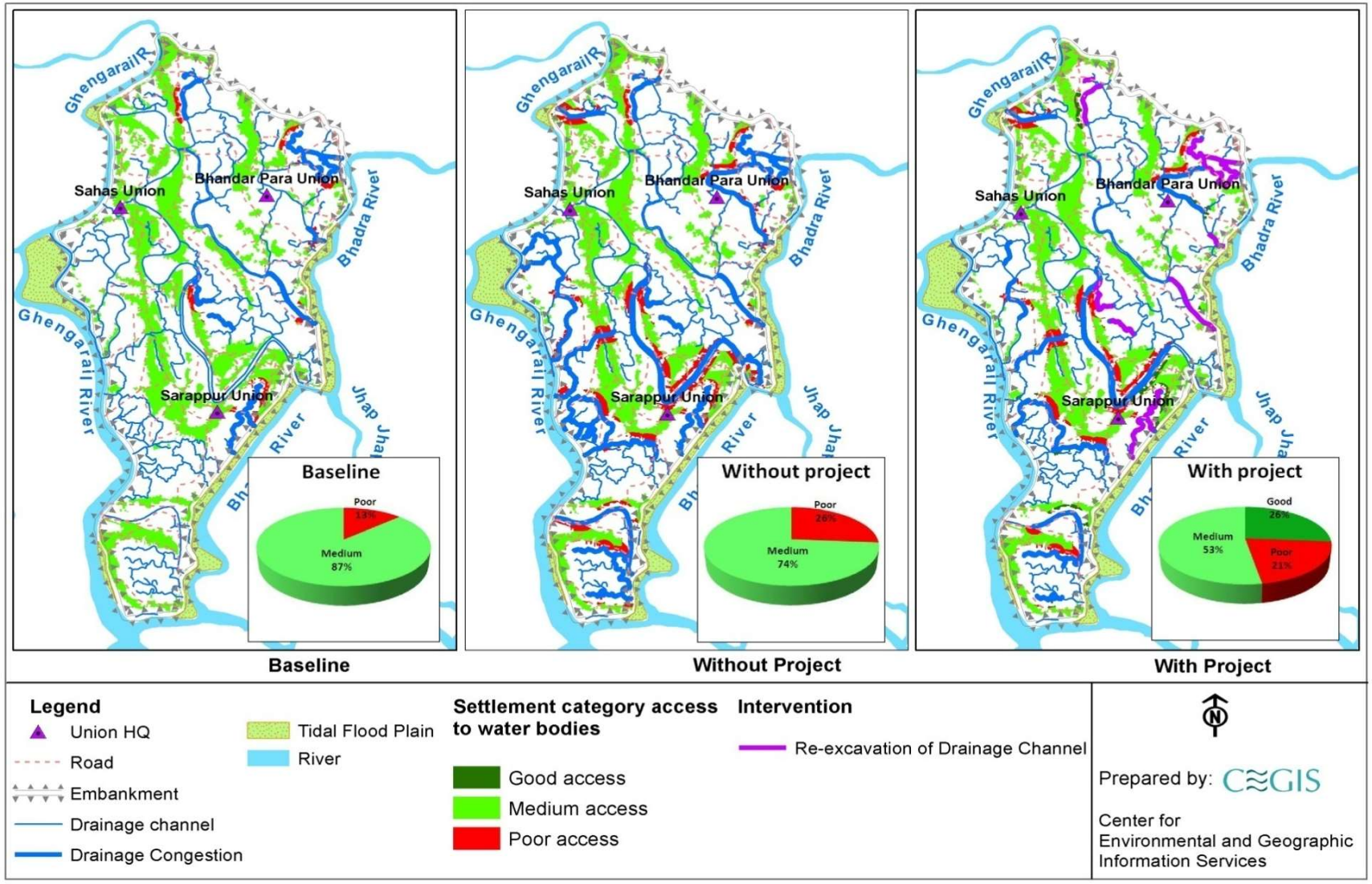
Map 8.1: Impacts on water resources: drainage congestion, tidal flooding and salt water intrusion



Map 8.2: Impacts on Land and Agricultures : Changes in irrigated area



Map 8.3: Impacts on Ecological Resources: Changes in terrestrial vegetation condition



Map 8.4: Impact on socio-economic condition: changes in access to open water bodies

9. Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

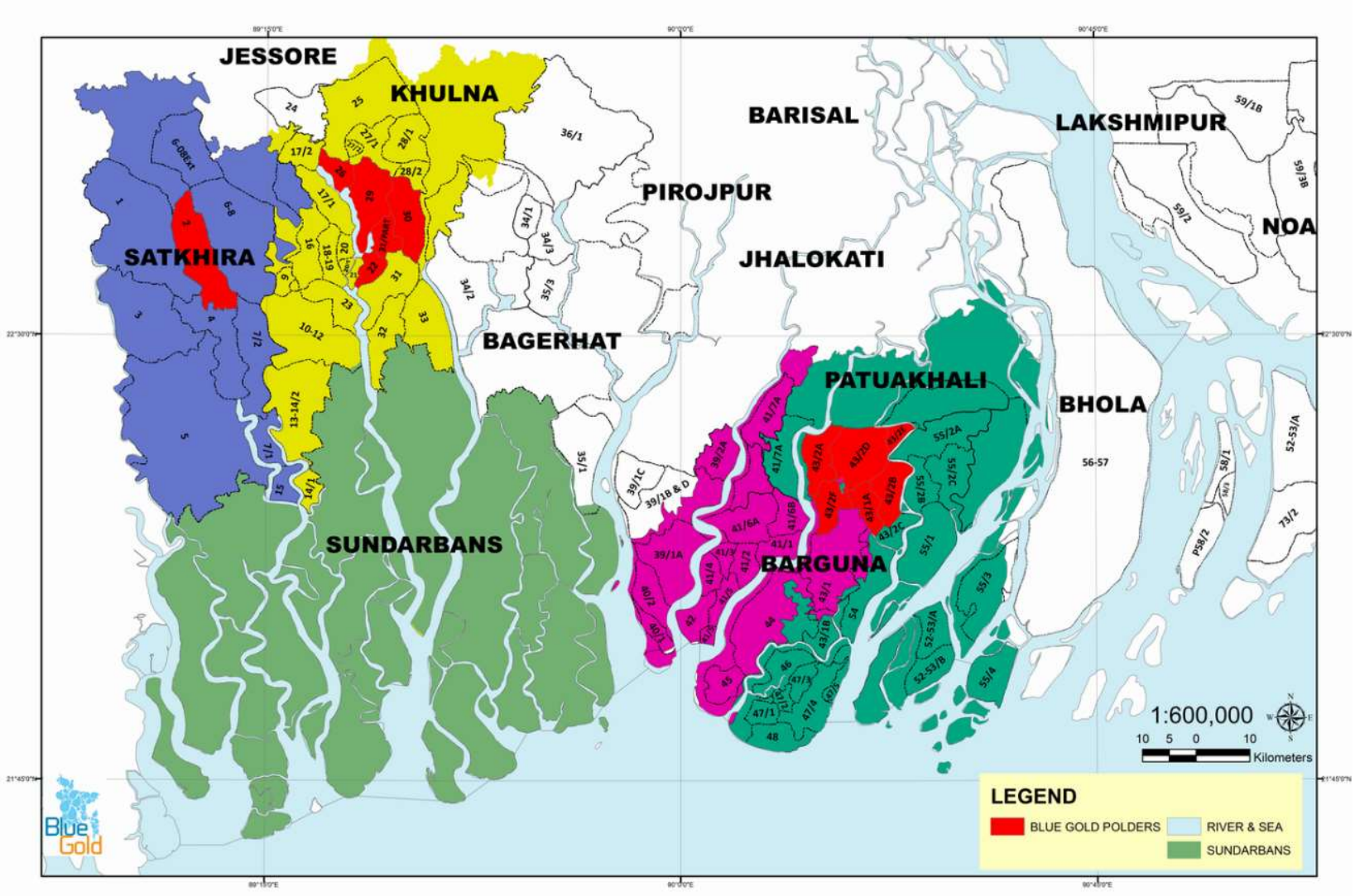
401. Cumulative impacts entail the total of all impacts to a particular resource that have occurred, or occurring, or may occur as a result of any action or influence in the surrounding area. Apart from the Blue Gold polders, a number of other projects also exist in the vicinity of Polder 29. Such projects 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 29

402. A total number of 12 polders in Satkhira, Khulna and Patuakhali districts have been selected for implementation of the program in the first phase. The selected polders are shown in **Map 9.1**. Among these, three polders (Polders 26, 30and 31/part) are very adjacent to Polder 29 and therefore may generate some impacts in future. The existing crest levels of Polders 26, 30 and 31 (part) are 3.5m, 3.20~3.50m and 3.50~4.00m respectively above Mean Sea Level. If re-sectioning works are carried out along the periphery of these polders up to the design elevation of 4.27 m (same as Polder 29), there would be more floodplain sedimentation adjacent to the upstream polders. This may result in increase in sedimentation along the Bhadra-Jhapjhapia river system. With reduced river sections along the upstream, tidal flow velocity might increase in the downstream which would create more pressure along the peripheral embankment of Polder 29. Furthermore, repairing of existing water control structures of Polders 26, 30 and 31 (part) under Blue Gold program would ensure reduction of dry season flow towards the polders 26, 30 and 31 (part). As such, surface water salinity, surrounding the Upper Bhadra and Jhopjhopia Rivers may increase, which might affect the existing river ecosystem, as well as the multifaceted surface water use of Polder 29. Moreover, if any bank protection works are carried out in future in the aforementioned polders 26, 30 and 31 (part), the morphological behavior of Mora Bhadra and Jhopjhopia Rivers may be changed. This might increase risk of river erosion in Polder 29.

9.2.1 Synopsis of projects around Polder 29

403. Apart from Blue Gold interventions, there are some other development projects nearby Polder 29, 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 29, undertaken by different line agencies in Khulna.



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

Table 9.1: List of water management projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
MoWR, BWDB	Construction of Ganges Barrage	To be implemented	Pangsha, Ganges River	High	
MoDMR	Comprehensive Disaster Management Program (CDMP), Phase II	2010-ongoing	Entire country (40 districts with direct interventions)	Low	
BWDB	Projects under Climate Change Trust Fund	2013-ongoing	Entire country	Low	
	Capital Dredging of River system of Bangladesh	2012-ongoing	Entire country	Low	
	Water Management Improvement Project (WMIP)	2010-ongoing	Entire country	Negligible	No WMIP schemes nearby Polder 29
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008-ongoing	Coastal Zone	Negligible	ECRRP polders are far from Polder 29
BWDB	Coastal Embankment Improvement Project (CEIP)	2012-ongoing	Coastal zone	Moderate	
Local					
LGED	Flood Rehabilitation Project in the Area of Rural Development Project-18 (Greater Khulna, Jessore and Kushtia District)	2000-2003	Khulna, Satkhira, Bagerhat	Negligible	
	Greater Khulna District Infrastructure Development Project	2000-2004	Khulna, Satkhira, Bagerhat	Negligible	
	Biodiversity Conservation in Sundarban Reserve Forest.	1999-2005	Satkhira, Khulna, Bagerhat	Negligible	
	Rural Infrastructure Development Project	2008-ongoing	Khulna, Bagerhat andSatkhira	Negligible	
	Union Infrastructure Development Project	2010-ongoing	Khulna, BagerhatandSathkhira	Negligible	
DoF	Extension of Culture Technology of Marine Shrimp	1997-2004	Khulna, Bagerhat, Satkhira and Cox's Bazar	Negligible	
KCC	Solid Waste Disposal and Environmental Improvement in Khulna City Corporation	1996-2004	Khulna	Negligible	

404. 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 29 are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

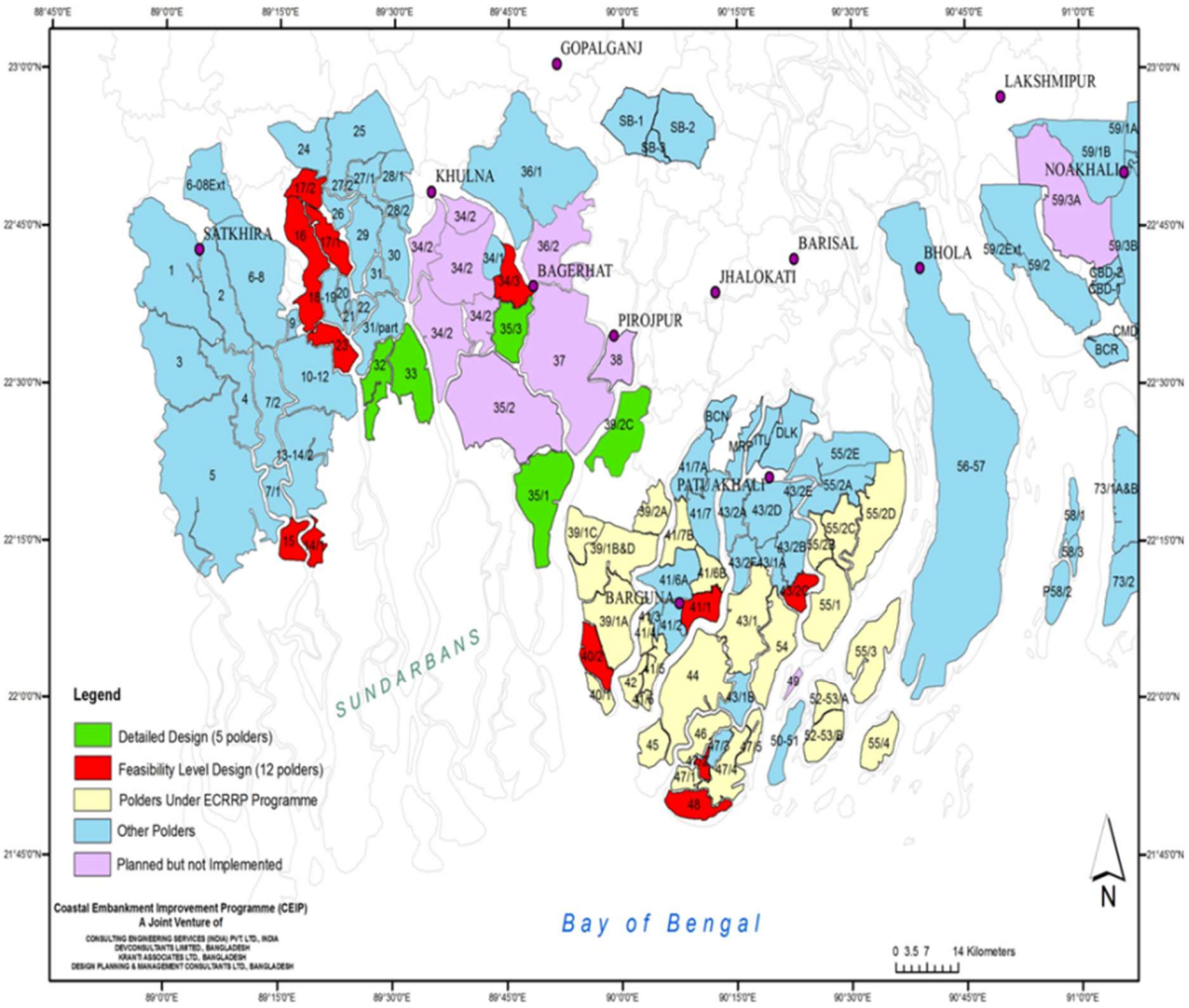
405. Ganges Barrage Project is perhaps the most significant project for the downstream region (coastal zone) of Bangladesh. The project is planned to manage the water resources system, promoting socio-economic development in equitable manner, and to recover the existing environmental degradation. GoB already finalized the feasibility level investigation of the project. The selected site at Pangsha is situated at the lower stretch of the river, at 32 km upstream of the Jamuna-Ganges confluence. The main function of the 2116.50 m long barrage would be to store water for dry season through flow control.

406. Sufficient dry season flow may cause remarkable hydrological changes in the Ganges and adjacent river systems. The Barrage will meet up the demand of utilizing Ganges water of different sectors, leading to sustainable development of the Ganges Dependent Area (GDA). Diversion of Ganges water from the upstream of the barrage through the Hisna-Mathabhanga-Kopotaksha system, the Gorai- Modhumati-Nabaganga system and the Chandana-Barasia system will rejuvilinate these rivers with flow of fresh water in dry season which would push down the salinity frontier. In addition, the increased upland discharge would result in lowering the rate of river sedimentation. The mean annual water level of downstream reaches would decrease. An overall situation of enhanced water security would be established.

407. Polder 29 is located within the GDA, and bears high sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 29 would be the reduction of surface water salinity in its adjoining river system. Dry season water use may be benefited tremendously and more surface water irrigation is expected to increase inside the polder. This would eventually enhance the production and food security of the area. Several saltwater species may face extinction in the long run, creating scopes for new ecological diversities of freshwater tolerant species. On social context, the effects may be significant as more livelihood shifting phenomena would take place. Existing shrimp farming practices along the polder floodplain may disappear, and the rural livelihood would shift towards enhanced farming practices. More regional and local developments are foreseen, and the environment of the polder as a whole may highly be benefited.

9.2.3 Cumulative Impacts of Coastal Embankment Improvement Project (CEIP)

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



Map 9.2: Location of CEIP polders

409. Polder 32 and 33 are located within a distance of 14 km downstream of Polder 29 along the Passur River.Polder 32 and 33 are included in the first phase of CEIP. The existing crest levels of these polders range between 3.4 to 3.8 m above MSL. Re-sectioning works are proposed in these polders under CEIP, which would increase the crest levels up to 5.27 m (Polder 33) and 5.8 m (Polder 32) above MSL. This increase in crest levels would reduce storm surge to enter into the polder, and additional storm surge may be diverted towards Polder 29.

410. The other CEIP polder adjacent to Polder 31/Part is Polder17/1. Polder 17/1 is located in the upstream of Polder 29 along the Solmari River. The existing crest level of Polder 17/1 ranges between 3.2 to 3.5 m above MSL.Embankment re-sectioning is proposed in the polder under CEIP, which would increase the crest level up to 4.27 m above MSL. This increase in height of the crest would reduce storm surge to enter into the polder, but additional storm surge may be diverted towards Polder 29.

9.2.4 Cumulative Impacts of Other Projects

411. A number of other projects as shown in **Table 9.1**are functioning near Polder 29 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located far away from Polder 29. A synopsis of the minor indirect effects of these projects with **low sensitivity** on Polder 29 is discussed below.

9.2.5 Projects under Climate Change Trust Fund (CCTF)

412. Considering Bangladesh's vulnerability to climate change, GoB decided to finance climate change adaptation initiatives from its own revenue budget as Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation. Till now Environmental Impact Assessment studies have been completed for a total number of 30 projects, which are being implemented throughout the country. The second phase of CCTF is in the pipeline for implementation, with a number of newly proposed projects. Among all CCTF projects, the geographic extent of one scheme (rehabilitation works in Polder 31) lies within the vicinity of Polder 29. However, the interventions proposed under the project are localized within the polder and no large-scale embankment re-sectioning works are proposed. Therefore the cumulative effects of the CCTF project in Polder 31 would have negligible influence onPolder 29.

9.2.6 Comprehensive Disaster Management Program, Phase II (CDMP-II)

413. CDMP was launched by GoB in 2003 as a key strategy to advance combined risk reduction efforts. CDMP ensures established and fully operational Disaster Management Regulatory Framework, strengthened capacities and integration of line agencies and ministries, improved functioning of Disaster Management Committees, effective early warning communication and response in all coastal districts, reduced risks through structural and non-structural interventions etc. There are 16 schemes under CDMP-II in the Dacope and Dumuriaupazilas of Khulna district. The schemes are maintained from the Local Disaster Risk Reduction Fund (LDRRF) of CDMP, and are mostly software initiatives which include local level capacity strengthening on Climate Change and Disaster Management. Two of the aforementioned schemes, located in Chalna and Shorafpur unions, are adjacent to Polder 29. Implementation of CDMP has contributed in the overall disaster management preparedness of local people, which in turn have indirectly facilitated their interest and credibility towards implementation of the Blue Gold program.

9.2.7 Capital Dredging of River system

414. The GoB planned to implement dredging works under the 'Capital Dredging and Sustainable River Management' project. So far, 23 rivers have been selected for dredging under the project by BWDB. There is also a dredging project being carried out by BIWTA to restore the major navigation routes. Among these dredging projects, Project works along Upper and Lower Meghna Rivers are relevant to Polder 29. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 29. 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 29 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 29 may be further benefited.

9.3 Induced Impacts of Polder 29

415. The interventions in Polder 29 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 29 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

416. The proposed interventions in Polder 29 will safeguard the polder against direct intrusion of tidal water. Therefore, water from Bhadra, Mora Jaykhaliand Ghengrail rivers carrying sediments will move further downstream or upstream and may cause induced sedimentation. New morphological changes (i.e. formation of new lands, river course shifting) may thus be developed along the Rupsa-Passur river system. The river system may be subjected to increased floodplain siltation due to sedimentation in the upstream reaches and other anthropogenic development caused by Polder 29 (i.e. waste generation, increased fertilizers etc.).

Tidal and Storm Surge Flooding

417. Polders 17/1, 20, 22, 26, 30, 31, and 27/1 are adjacent to Polder 29. As per design, the crest level of Polder 29 would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 17/1, 20, 22, 26, 30, 31, and 27/1) during extreme events. Tidal water may not be able to enter into Polder 29 during these events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned adjacent polders. **Table 9.2** below shows the average existing crest levels inPolders 17/1, 20, 22, 26, 30, 31, , and 27/1. Therefore, re-sectioning works in Polder 29 would create higher flooding and storm surge risks in the polder.

Table 9.2: Existing Average Crest levels of Polders adjacent to Polder 29

Polder	Existing crest level (m +PWD)
Polder 17/1	3.2~3.5
Polder 20	3.45
Polder 22	3.45
Polder 26	3.5
Polder 30	3.20~3.50
Polder 31	3.53~3.75
Polder 27/1	3.50~3.85

Changes in aquatic habitat, species migration and biodiversity

418. The increased floodplain sedimentation outside the polder may slightly affect the aquatic habitat. Flow cross sections may decrease considerably, causing change in spacing for aquatic habitat. With the increased flow velocity along the upstream and downstream of the polder, new options for species migration and biodiversities may be opened up. Salinity concentration may increase in the peripheral rivers in future, and the salinity tolerant aquatic species may dominate while fresh water aquatic species may decrease. Biodiversity of aquatic life may also decrease in the Bhadra, Mora Jaykhaliand Ghengrailsystem.

Employment opportunities and Livelihood improvement

419. 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 29, new employment opportunities would be created. This will encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

420. 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 29 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

421. In order to investigate the reciprocal impacts of Climate Change and Polder 29, both quantitative assessments and qualitative judgments have been carried out. Two separate hydrological and hydrodynamic models have been setup and simulated with data input from climate and hydro-meteorology to assess the impact of climate change on some sensitive issues of the polder namely, water availability, flood security and salinity. On the other hand, resilience towards climate change developed in the polder has been discussed based on field findings.

9.4.1 Development of Models

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

Digital Elevation Model (DEM)

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

River Bathymetry Data

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

Discharge and Water level data

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

Land Use Data

426. 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

427. 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

428. 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

429. The 50 percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in **Table 9.3**. The results infer that the monthly rainfall will increase for the period of April to October and decrease for November to March. Around 20% of the monthly rainfall will be decreased by 2050s for December and January though the amount of rainfall is very low during that period. The monthly rainfall will increase by 1.3-3.6% during July to September by 2050s. The monthly temperature will increase by 1.6 to 2.0 ^{0}C with an average of 1.8 ^{0}C by 2050s for the study area.

Table 9.3: Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for Polder 29.

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (^{0}C)
Jan	-17.1	1.9
Feb	-6.8	1.9
Mar	-2.2	2.0
Apr	5.3	1.9
May	5.4	1.8
Jun	0.8	1.6
Jul	1.5	1.7
Aug	3.6	1.8
Sep	1.3	1.7
Oct	4.1	1.7
Nov	-3.8	1.7
Dec	-19.4	1.7

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

Sea Level Rise

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

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

Scenarios	Sea Level Rise (m)
B1	0.18 – 0.38

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

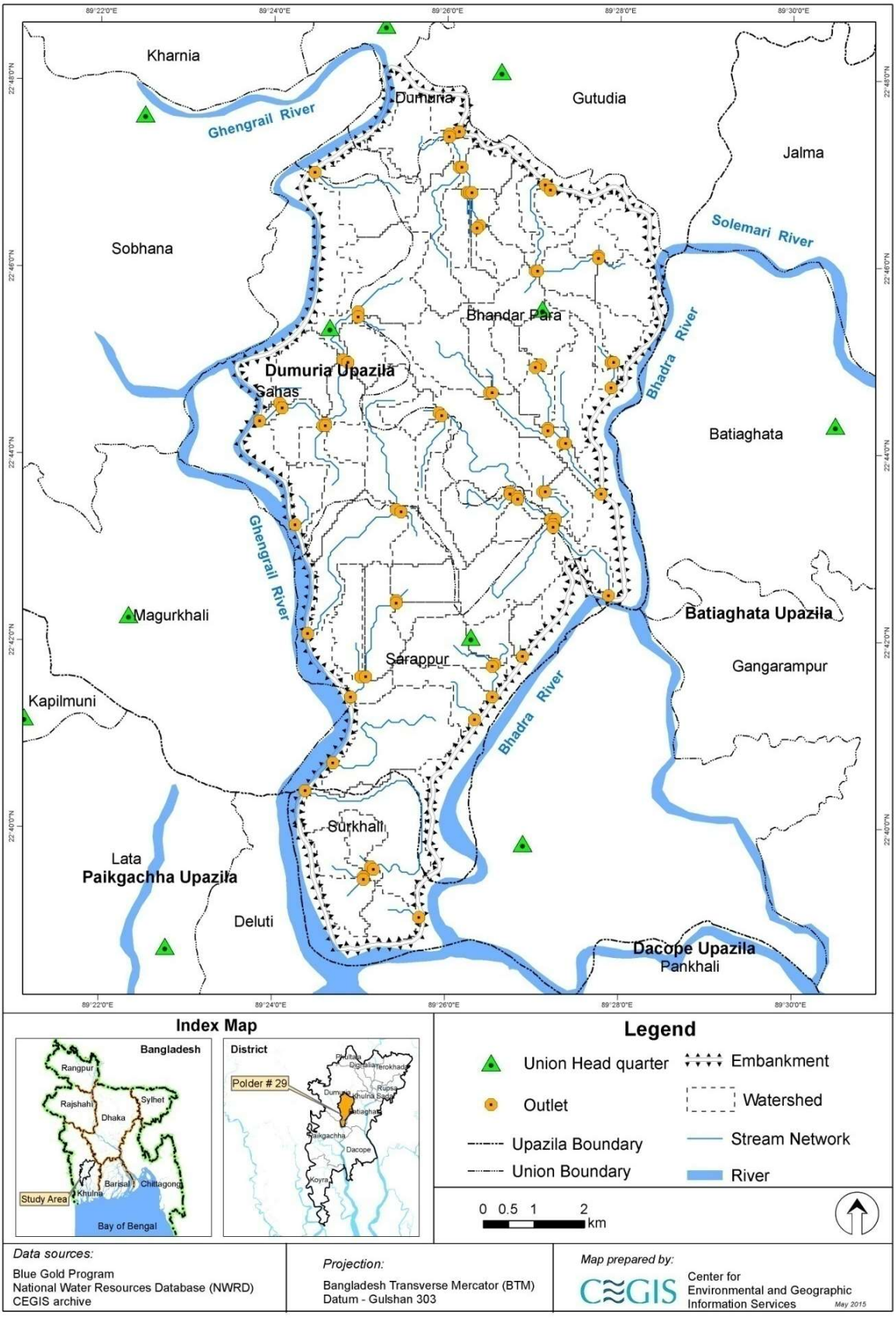
Source: IPCC AR4

9.4.2 Model Schematization

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

(a) SWAT model Setup

432. Five sequential steps are followed to schematize the SWAT model: watershed delineation, Hydrological Response Unit (HRU) definition, weather data definition, assembling and editing SWAT inputs, and the actual simulation run. The watershed delineation is performed with the automatic delineation tool of SWAT 2012 using the DEM and the river network. All the watershed delineation steps such as filling sink, defining flow direction and accumulation have been automatically done through the user interface. The watershed delineation results 73 watersheds for the entire polder area. The delineated watershed for polder 29 is given in **Map 9.3**. After the delineation of watershed, the next step of model setup is the definition of HRU. HRU is the unique combination of land use, soil and slope class. Six land classes, four soil classes and 73 watersheds results 505 numbers of HRUs. The daily precipitation, maximum and minimum air temperature data have been used as weather input for the period of 1981 to 2012. The model has been simulated for the period of 1981 to 2012 based on data availability.



Map 9.3: Delineated watershed during model schematization using SWAT for polder-29

(b) Delft 3D model Setup and Calibration

433. A 2-D hydrodynamic model was setup for the Gorai-Passur and Sibsa river system. The schematization of the model is shown in **Figure 9.1**. The model starts from Gorai to the Bay of Bangal. The bathymetry of the river has been generated from the interpolation of available cross-sections at a distance of 100 m using the HEC-RAS model. Daily discharge data of BWDB at Gorai Rail Bridge has been utilized as upstream flow boundary and hourly water level data of BIWTA at Hiron point has been utilized as downstream boundary condition. The model has been simulated with a time step of 10 min for the year 2000 and 2001. It has been simulated for water level, discharge and salinity.

434. The model has been calibrated using Manning's n values for the rivers, against the water level data at Mongla as shown in **Figure 9.2**. The model shows good agreement with the observed water level. It can simulate both high and low water level during the calibration period.

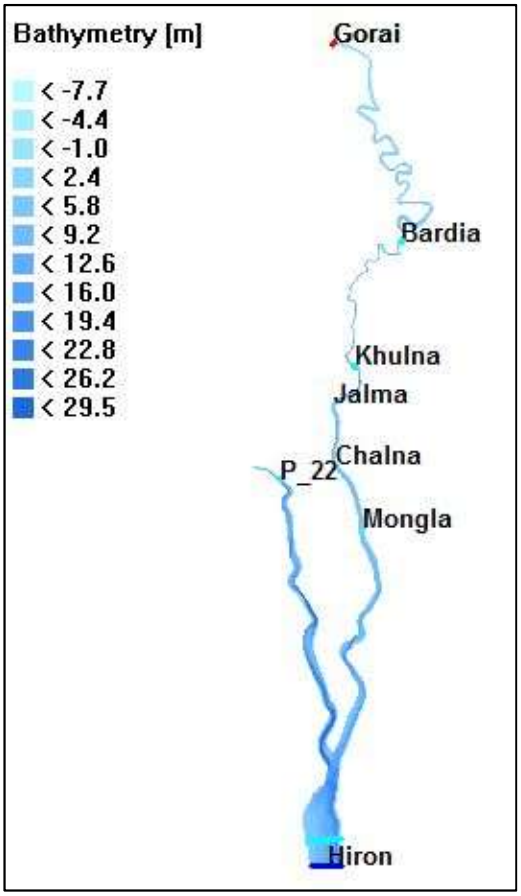


Figure 9.1: Schematization of hydrodynamic model using Delft 3D

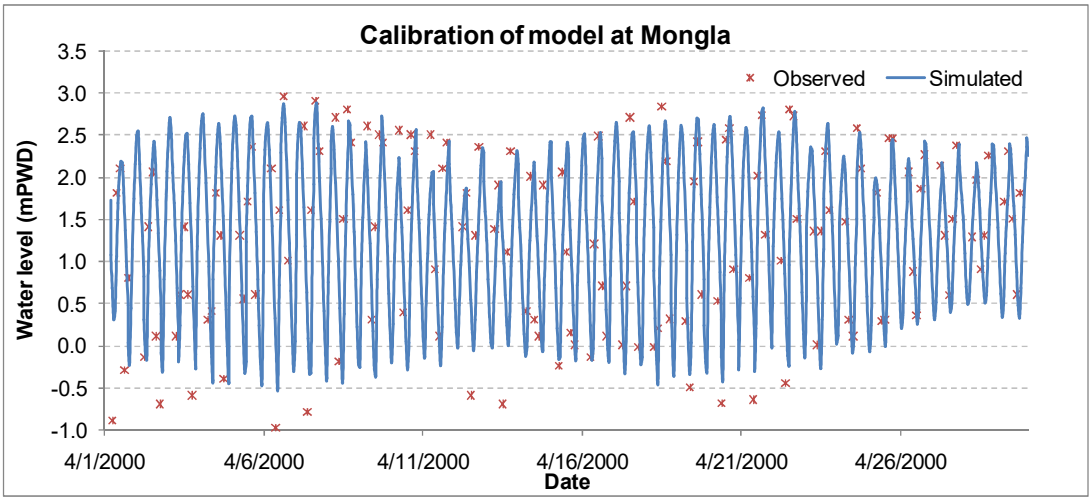
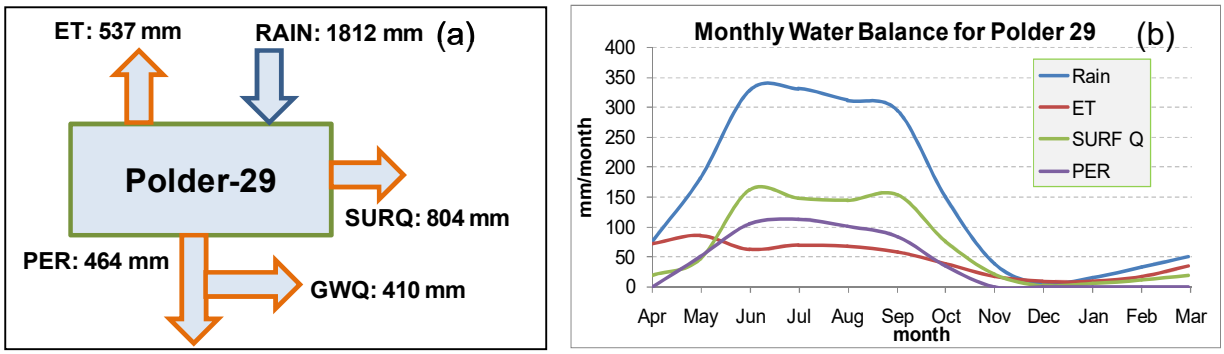


Figure 9.2: Calibration of model results at Mongla for April, 2000

(c) Water Balance of the Study Area

435. Water balance is the assessment of water resources and its use in the system. The model has been simulated for the period of 1981 to 2008 to estimate the availability of water during base period (1981 to 2012). The annual water balance for the Polder 29 is shown in **Figure 9.3.**



Note: Rain: Rainfall; ET: Evapotranspiration; PER: Percolation; SURQ: Surface Runoff

Figure 9.3: Water balance for polder 29, (a) average annual, (b) average monthly during the period of 1981 to 2012

436. The simulation results of the annual water for the polder 29 are shown in Figure 9.3 for the simulation period of 1981 to 2012. The average annual rainfall of polder 29 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 29.

437. 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 537 mm which is 30 % of annual rainfall. The evapotranspiration is maximum during April and May and which is about 90 mm per month. The evapotranspiration rate is minimum during December to January. The percolation rate in the polder area is 464 mm per year which is 26% of annual rainfall. The percolation rate follows the similar trend like rainfall and the maximum rate is 115 mm per month. After losses of water through evapotranspiration and percolation, the remaining portion contributes to stream flow as overland flow and lateral (subsurface) flow. Around 44% (804 mm) of rainfall contributes to stream flow through surface runoff while the lateral flow is negligible.

9.4.3 Climate Change Impact on Water Availability

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

439. The climate change impact on annual water balance in the Polder 29 is given in **Table 9.5** for climate change scenario A1B by 2050s. The annual average rainfall for the polder area will be 1865 mm which is about 3% more than the base condition. The surface runoff will also increase as there will be an increase in annual rainfall. There will be slight increase in annual evapotranpiration (3 mm/year) which is mainly due to the increase of temperature. There will also be a minor increase in annual percolation due to climate change.

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

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC 2050s
Rainfall	1812	1865
Surface Runoff	804	847
Evapotranspiration	537	540
Percolation	464	470
Baseflow	410	416

440. 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 shown in **Figure 9.4**.

441. The availability of water will increase during May to October as there will 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 will be around 6 to 14 mm and decrease around 2 mm per month.

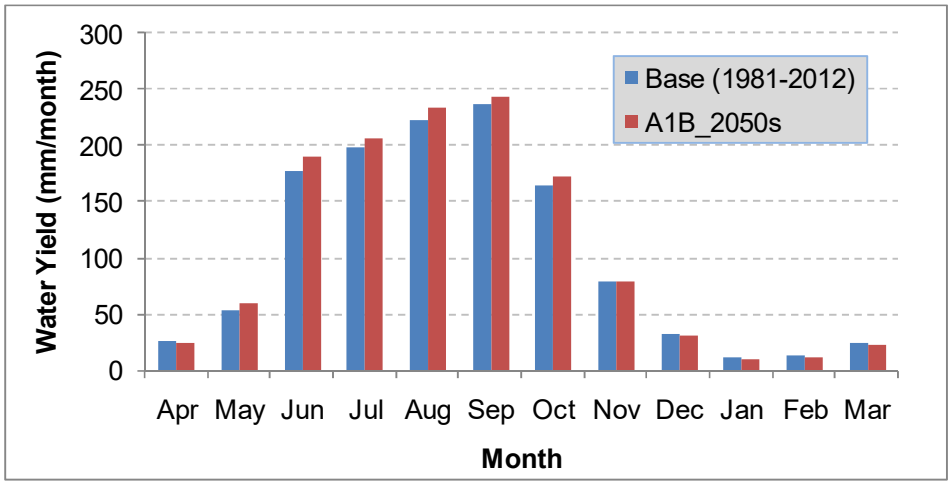


Figure 9.4: Climate change impact on monthly water yield for climate scenario A1B by 2050s

442. **Table 9.6** below shows the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows a considerable increase in seasonal water yield during monsoon (4.6 %) and decrease during dry season (5.2%). Minor seasonal water yields during pre-monsoon and monsoon would also take place.

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

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Mar-May)	79	5.7
Monsoon (Jun-Sep)	836	4.6
Post-monsoon (Oct-Nov)	243	3.9
Dry (Dec-Feb)	81	-5.2

9.4.4 Climate Change Impact on Water Level

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

444. The calibrated and validated Delft 3D model for the Gorai-Passur and Sibsa system has been utilized to investigate the impact of sea level rise and increase of upstream water flow to assess the impact on flood water level outside the polder area. As there is a variability of prediction of sea level rise, an increase of 0.5 m of sea level at Hiron point has been assumed for the present study. At the same time, 16% increase of monsoon flow for the Gorai River has been assumed for the model setup. The model has been simulated for the combination of the above two scenarios and the simulated maximum water level during the monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

445. From the model simulation, it has been found that the flood level adjacent to the polder area will increased by 60 cm for only the increase of sea level and by 7 cm for only the increase of upstream water flow. The combined effect of sea level rise and increase of upstream water results an increase of 70 cm increase of maximum water level of the rivers surrounding polder-29. The increase in flood water level might be a threat for the embankment and may also interrupt the drainage from the inner side of the polder area. The climate change and sea level rise may increase the drainage congestion and flood risk for the polder.

9.4.5 Climate Change Impact on Salinity

446. 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.

447. To assess the impact of climate change and sea level rise on salinity, the delft 3D model has been utilized. It has been assumed that the dry season flow of the Gorai River will be reduced by 15% and 0.5 m of sea level rise has been considered for the scenario model setup. The model has been simulated for those two assumptions and the result has been compared with the base condition. From the simulation, it has been found that the salinity level of the rivers adjacent to the Polder 29 will increase by 1.0 ppt during the dry period.

The increase in river salinity may cause increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.6 Climate Change Resilience Developed in Polder 29

448. During field investigations it was found that the local people are mostly aware of the climate change consequences and events. In recent years they are the victims of climate change induced natural disasters, frequently hitting them and causing massive loss o lives and properties. Increased saltwater intrusion within the polder is severely impacting their daily lifestyle as well as livelihood occupation. The initiatives already undertaken through different software interventions by programs other than Blue Gold, the insight of climate resilience has been developed within the polder habitants. Through the community mobilization in Blue Gold program, local people have become more active towards building a climate resilient society. They are now driven by the concept of climate smart village. Most of the people who are able to afford are now re-building their houses and infrastructures on a relatively higher level. Local people claimed that they would use the excavated spoil from the internal khals for their household purpose if available. This will allow them to have their house and other infrastructures on a re-built higher land. The local farmers are now more concerned about climate change issues as well. They regularly follow and take part in the knowledge development and capacity building programs organized by Blue Gold, which they believe have enhanced their understanding and preparedness on flood and disaster management.

10. Environmental Management Plan

449. 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

450. No significant positive or negative impacts on water resources have been foreseen during the both pre-construction and construction phases for implementation of proposed interventions in Polder 29. As such, no activities under the proposed EMP have been recommended for these phases.

10.1.2 Operation Phase

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

Table 10.1: EMP Matrix for Post Construction Phase on Water Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
IESC: Ambient Noise Level				
The excavator and associated heavy machineries will create noise disturbance along the polder alignment, and are likely to increase the noise levels by around 5~10 dB	Construction works near dense settlements (near Dumuria, Sahas and Sarappur) are to be carried out using manual labour	Not required	-1	Blue Gold Program, Contractors and LCS
IESC: Saltwater Intrusion				
Significant impacts would be achieved regarding the prevention of saltwater intrusion inside the polder. Salinity values will drop from a foreseeable maximum of 7 ppts inside the polder to 'zero'.	Not required	Repaired sluice gates are to be operated and maintained properly to protect saltwater intrusion	+6	WMC and BWDB
IESC: Water Security				
Around 35% people inside Polder 29 would be guaranteed sufficient freshwater availability and	Not required	Not required	-	-

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
access, which would result in immense benefits in domestic water use.				
IESC: Tidal Flooding				
Almost 150 ha of areas near Baro Aria and Jaliakhali may be protected from tidal flooding in future.	Not required	Not required	-	-
IESC: Erosion Vulnerability				
Around 64% lengths of the total vulnerable areas would be secured from probable river erosion. Risk of erosion at the two proposed locations would be considerably decreased.	Not required	Not required	-	-
IESC: Drainage Congestion and Water Logging				
Around 30% of khals adjacent to the periphery of the polder would be improved from drainage congestion problems.	Not required	Not required	-	-

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

10.2 Land Resources

10.2.1 Pre Construction and Construction phases

452. No significant positive or negative impacts on land resources have been foreseen during the both pre-construction and construction phases for the implementation of proposed interventions in Polder 29. As such, no activities under the proposed EMP have been recommended for these phase.

10.2.2 Operation Phase

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

Table 10.2: EMP Matrix for Post Construction Phase on Land Resources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact / Magnitude (1-10) with EMP	Responsible agency
Single cropped area would decrease by 13% but double and triple cropped area would increase to 11%, 2% of the NCA	-	• Formation of WMGs (GPWM-2002). • Strengthening of WMGs through imparting training on proper management of	+4	BWDB, DAE and WMGs

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact / Magnitude (1-10) with EMP	Responsible agency
respectively.		structure and utilization of spoil earth materials which will be generated from re-excavation. • Involvement of WMGs in project related different activities.		
It is expected that the implementation of options and its proper management would protect the undesirable entry of saline water and would allow draining out the dissolved salts from agriculture land. The structures would have positive impact on reducing soil salinity.	Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bunch.	-	+3	BWDB and Contractors

10.3 Agriculture Resources

10.3.1 Pre Construction Phase

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

10.3.2 Construction phase

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

Table 10.3: EMP Matrix for Construction Phase on AgricultureResources

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

10.3.3 Post Construction Phase

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

Table 10.4: EMP Matrix for Construction Phase on AgricultureResources

Impact	Mitigation measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Cropping intensity would increase by about 15%.	-	• Involvement of WMGs in project activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs
Additional 5,500tons (43% higher) of rice and 5,950 tons (55% higher) of non-rice would be produced in FWIP over FWOP.	-	• Organic manure should be applied for the restoration of soil fertility. • Farmers group should have close contact with SAAO of DAE for adaptation of various measures on ICM. • Irrigation should be provided in optimum level with minimum conveyance loss. • Involvement of WMGs in project activities would enhance crop production. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs
It is expected that loss of crop production would be reduced by 850tons which would be about 68% less in FWIP over FWOP.	-	• The repair of flushing sluice, repair of drainage Outlet and irrigation Inlet would help to reduce crop damage situation. • The WMGs should be given orientation to protect their standing crops from implementation of the intervention and development on farm water management etc.	+5	BWDB, DAE and WMGs
The irrigated area would be increased about 652 ha in FWIP over FWOP	-	• Training may be provided to WMGs on “integrated water management” which will be stored or available in the khals/ cannels for different use. • The WMGs should be involved in the integrated water management through proper maintenance of khals, irrigation inlets and drainage/flushing outlets for the expansion of irrigated area.	+5	BWDB, BADC, DAE and WMGs

10.4 Fisheries Resources

10.4.1 Pre Construction Phase

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

10.4.2 Construction Phase

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

Table 10.5: EMP Matrix for Construction Phase on Fisheries Resources

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

10.4.3 Post Construction Phase

459. 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
Seasonal khal would be perennial again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would 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
Bagda gher area would be decreased to 3 ha. Golda gher area would be increased by 71 ha	Encourage to cultivation of rice cum golda farming		+3	Local people with the help of DoE
Movement of both brackish and fresh water fish species as well as hatchling movement through water control structures would be hampered slightly. But internal fish migration would befacilitated significantly.	NA	• Properly and timely gate will be opened to entrance the fish hatchling in the month of May to July except the tidal surge. • Water Management Committee should be formed including fishers representative.	+3	Department of Fisheries in coordination with Water Management Committee
Capture fisheries productivity would be increased by 70 kg/ha. Culture fish productivity would also be increased significantly.		• Re-excavated khal should be kept free from encroachment. • Construct deep pool in the perennial khals	+5	Department of Fisheries in coordination with pond owners.
Bagda production would be lost by 1.8 tons whereas rice cum golda production would be increased by 42 tons.	Encourage to cultivation of rice cum golda farming		+4	

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

10.5 Ecological Resources

10.5.1 Pre Construction Phase

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

10.5.2 Construction Phase

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

Table 10.7: EMP Matrix for Construction Phase on Ecological Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Activity: Repairing of embankment				
• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for re-sectioning work.; • Relocation of wildlife due to habitat loss temporarily	• Implement plantation along the slopes of embankment after completing the earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: Construction of retired embankment				
• Permanently damages of herbs, shrubs, various types of grass and bushes due to construction work. • Relocation of wildlife due to habitat loss temporarily	• Implement plantation along the slopes of embankment after completing the earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-2	Contractor and BWDB
Activity: Re-excavation of khal				
• Water depended fauna as Skipper frog, Bullfrog, Kingfisher, Egret, common aquatic Snake, etc. will be temporary re-located due to habitat loss in the khal area. • No large tree only grasses will be damaged due to storage of soil along the both side of the khal.	• Keep untouched the deepest points of the khal as much as possible. • Create new habitat adjacent to the existing habitat before going to re-excavation of khal.	N/A	-2	Contractor and BWDB

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

10.5.3 Post Construction Phase

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

Table 10.8: EMP Matrix for Post Construction Phase on Ecological Resources

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

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

10.6 Socio Economic Condition

10.6.1 Pre Construction Phase

463. The implementation of proposed interventions may generate some long term impacts on social resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts, enhancement for positive impacts and compensation, or contingency measures for immitigable residual impacts as shown in following Table 10.9.

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

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

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

10.6.2 Construction Phase

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

Table 10.10: EMP Matrix for Construction phase on Socio-economic condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Employment generation	-	Ensure employment for local people for both technical and non-technical works. If possible, maximum labor should be recruited locally.	+2	Blue gold and BWDB
Gender Promotion	-	According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for female in future.	+3	Blue gold and BWDB

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

10.6.3 Post Construction Phase

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

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

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Social Use of Water	-	re-excavate rest of Khals for more social use of water (taking shower, washing chores and others purposes)	+4	Blue gold and BWDB
Safe Drinking Water	-	Install rain water harvesting system (PSF, filter etc.) by Blue gold entrepreneurship.	+3	Blue gold and BWDB
Employment generation	-	Engage local people in other development activities.	+2	Blue gold and BWDB

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

10.7 Spoil Management Plan (SMP)

The term 'Spoil' is used for soil or dirt resulting from excavation of earthen canals or khals, and discarded off site. Effective management of spoil is necessary because its volume usually inflates three times after excavation. The spoil may also cause other problems if not dumped in a planned and controlled manner. The physical quality of nearby water courses may be hampered due to transportation of debris, agricultural lands may be disrupted, and social conflicts may raise regarding site selection for spoil dumping. It is therefore, important to transport and dispose the spoil away from the excavation site in a controlled and systematic manner, considering proper accounts of all the environmental and social issues of the area. Disposal may either be through mechanical equipment, or by manual means.

10.7.1 Framework Proposed for SMP

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

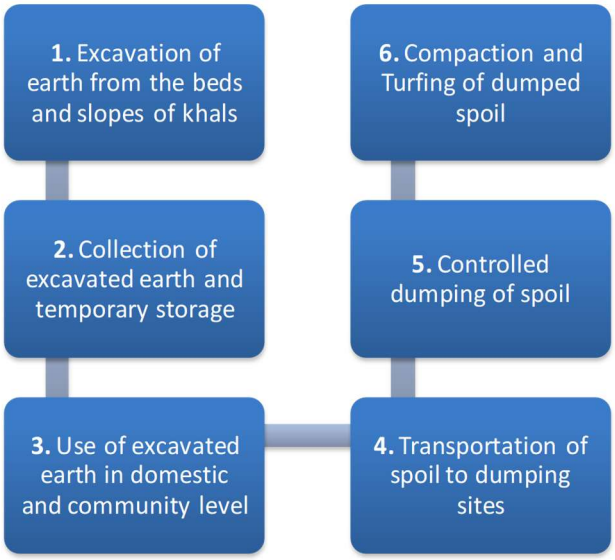


Figure 10.1: Framework for Spoil Management

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

Table 10.12: Tentative volume calculation and distribution of excavated spoil

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

10.7.2 Phase wise activities of Spoil Management

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

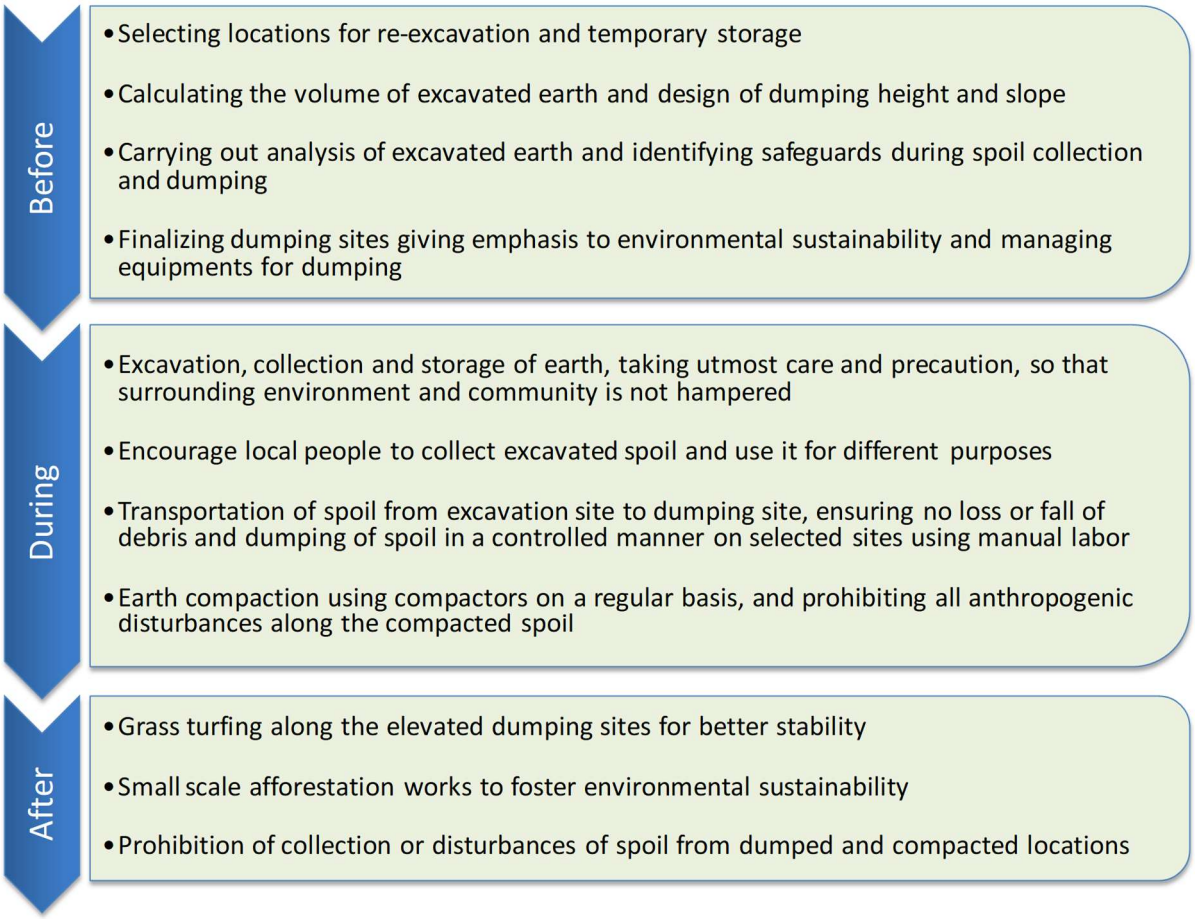


Figure 10.2: Phase wise activities of Spoil Management

10.7.3 Method of Spoil Dumping

The proposed re-excavation works for the Polder would require dumping of a significant amount of spoil (around 73,200 m^3). For a 2.5 meter wide and 1 meter thick wedge, this equivalents to around 29.28 km length of dumped spoil. Polder 29 includes 17.71 km of re-excavation of khals, and if the residual spoil (73,200 m^3) is dumped on both sides of the excavated khals up to a height and width of 1 m and 2.5 m respectively, around 14.64 km lengths can be used on both sides. **Figures 10.3** and **10.4**below show the conceptual layouts of proposed dumping technique.

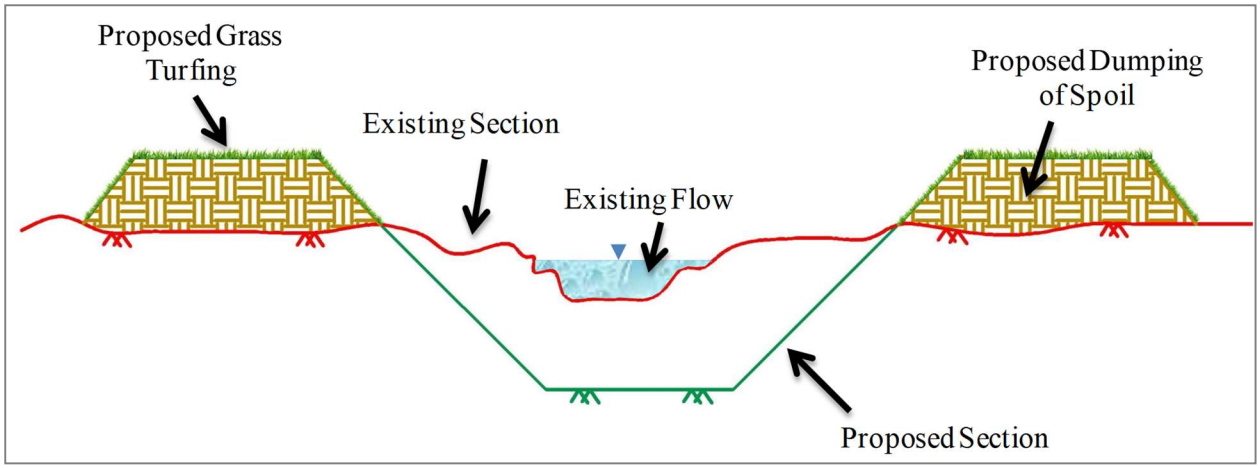


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

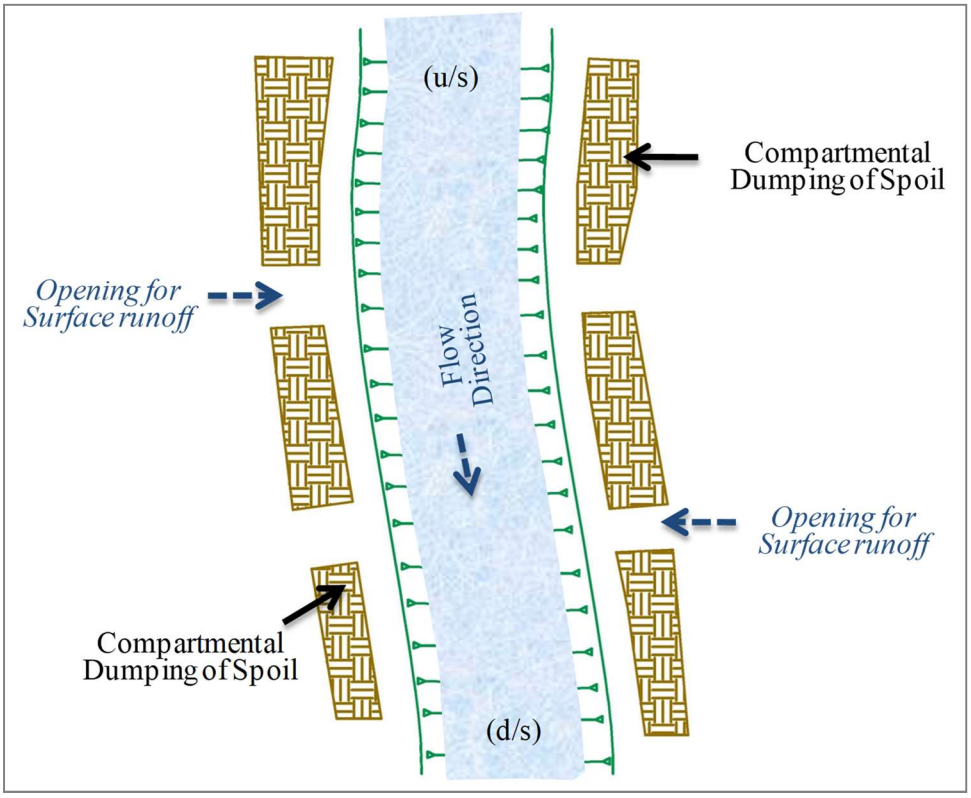


Figure 10.4: Plan form of a typical khal to be re-excavated

Figure 10.3 illustrates the cross section of a typical khal which is to be re-excavated under the Blue Gold Program. The depths of khals have decreased over the years and re-excavation works would be carried out through the centerline of the khals. The bank sides of the khals are government owned khas lands which fall within the actual width of the khals. Spoil earth would be dumped on both bank sides of the khal, on these khas lands. This would provide raised level through the bank lines of excavated khals, which may prevent khal siltation in future through erosion of top soil. **Figure 10.4** shows a plan of the khal which is to be re-excavated. The figure shows that compartmental dumping spots could be created along the sides of the excavated khals, so that surface runoff following rainfall events can enter the excavated khals and drain out properly.

10.7.4 Safety Measures and Precautions

Along with the activities discussed above, a number of safety measures and precautions are to be maintained by the corresponding communities and agencies, during the process of excavation, collection, transportation and dumping of spoil 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 spoil should properly aware about the health and hygienic aspects.
- ✓ Sufficient washing and cleaning arrangements are to be in place for the LCS laborers
- ✓ Dumped spoil needs to be compacted thoroughly, after the disposal upto a certain height (e.g. 6~8 inches)
- ✓ The works when are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, which may reduce the strength or stability of the dumped spoil
- ✓ 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 spoil falls back into the water courses
- ✓ It should also be ensured that the dumped spoil is not weathered and transported to any privately owned lands or lands of agricultural interests.

10.8 Environmental Monitoring

10.8.1 Monitoring plan for pre-construction phase

466. No specific monitoring plan is required to be followed during the pre-construction phase of environmental and social component of the project in Polder 29.

10.8.2 Monitoring plan for Construction Phase

467. A typical monitoring plan has been prepared which will be followed during construction of rehabilitation of Polder 29. The Monitoring report will be submitted to the concerned organizations as mentioned in the following checklist.

Blue Gold Team and Bangladesh Water Development Board

Blue Gold Program: Component-2

EMP IMPLEMENTATION

Book No. _____ Monitoring Report No._____

Date:_____ Time:_____

Contract:_____

Contractor:_____

Work Sites (s):_____

A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5	A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5
1	Correct dumping of re-excavated spoil				4	Inconsistencies in water control structures repairing works			
2	Inconsistencies or mismanagement in embankment re-sectioning and retired embankment construction				5	Avoid the usage of heavy machineries at suggested locations to prevent noise pollution			
3	Proper compaction of earth materials on embankment				6	Any threat caused to river bank area			

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

C.NON COMPLIANCE:

Period Description :

Class

1. Minor: Under One Month (Contractor alerted)

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

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

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

D.CIRCULATION

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

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

10.8.3 Monitoring plan for post construction phase

Water Resources

Indicator	Method	Location	Frequency	Responsible agency
Surface water salinity	In-situ testing	All the khals inside the polder	Once in a month from December to May	BWDB
Depth of khals	Field survey (e.g. boat and led method)	All the khals inside the polder	Once in a dry season and once in a wet season	WMOs and BWDB
Drainage Congestion and Water Logging	Field observation	Inside the polder	Once in dry season and once in post-monsoon	WMOs and BWDB
Embankment Breaches and River Erosion	Field observation	Throughout the peripheral embankment of Polder 29	Once in a month (during monsoon and post-monsoon)	WMOs and BWDB

Land and Agricultural Resources

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

Indicator	Method	Location	Frequency	Responsible agency
Irrigated area	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire project area	During Rabi season (Will continue two years).	BWDB, DAE, BADC and WMGs

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible Agency
Species diversity and 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.
Gher water quality	Field and laboratory test	Selective gher in the polder area	Monthly	Gher owner, DoF
Fish hatchling movement	Savar netting	Near sluice gate in major khals.	Once per week during fish migration period (June – August)	DoF in cooperation with Water management committee and local fishers.

Ecological Resources

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

Socio-economic Condition

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

10.9 EMP and Monitoring Cost

10.9.1 Cost of EMP and monitoring of Water Resources

468. 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,	1.50	1	Re-excavation of Khals, disposal of spoil earth	1.0

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
	Embankment management Group (EMG), landless Contacting Society (LCS), on farm water management and development etc. • Involvement of WMGs in project related activities would change positively.			materials for spoil management and repairing of embankment etc.	
2	• Organic manure should be applied for the restoration of soil fertility. • Farmers group should have close contact with DAE for adaptation of various measures on ICM. • Irrigation should be provided in optimum level with minimum conveyance loss. • Involvement of WMGs in project activities would enhance crop production. • Introduction of HYV crops with crop diversification need to be practiced.	2.50	2	Crop production and damage	1.50
3	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area. • Construction of alternate dykes during construction of re-tired embankment to overcome the risk of breach of the concerned temporary bundh. • The WMGs should be involved in the integrated water management through proper maintenance of sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.50	3	Irrigated area	1.50
	Total	**5.50**			**4.00**

469. Total Cost for EMP and Monitoring of land and agricultural resources is**Taka 9.50 Lakh**.

10.9.3 Cost of EMP and monitoring of fisheries resources

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
1	Awareness development on natural resources and disseminate the knowledge about the important in our daily life through several national and international days like Fish Week, Environment Day, water Day Rally, Discussion etc. Two year in the polder area.	2.5	1	Fish hatchling movement in six khals (Two year).	1.0
2	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring) (Training 1.5 Tk and demonstration pond 0.5 Tk) (Number of pond :4 pond area: about 100 decimal)	2.0	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three	2.0

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
				market survey once in a week (two year).	
	EMP Cost	**2.5**		**Monitoring Cost**	**3.0**
	Total cost	**5.5**			

470. Total Cost for EMP and Monitoring of fisheries resources is **Taka 5.50 Lakh**

10.9.4 Cost of EMP and monitoring of ecological resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
1.	Embankment would facilitate to enhance habitat quality as well habitat size through tree plantation program but the area for re-sectioning has not estimated yet. However here is mentioned the plantation cost for each (16.38+27.30=43.68) km length of embankment	28.04	1.	Habitat develop	3
			2.	Wildlife diversity	2
	Total	**28.04**		**Total**	**5**

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

10.9.5 Cost of EMP and monitoring of socio-economic condition

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

10.10 Summary of cost

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

473. Total cost of EMP and monitoring is BDT 48.04 lakh (taka forty eight lakh and four thousand only).

10.11 EMP Updating

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

11. Conclusion and Recommendations

11.1 Conclusions

474. This project aims to improve water management and productivity through rehabilitation of the existing embankment and other water control infrastructures like sluices and regulators. Since it does involve construction of Retired Embankment and re-excavation of khals, there may be some minor effects during the construction and post-construction phases. The other interventions proposed for Polder 29 include re-sectioning of embankment, repair of water control structures and drainage outlets. Drainage congestion, tidal flooding and water logging are very prevalent in Polder 29. The proposed interventions will bring about huge beneficial effects for the inhabitants inside the polder e.g. drainage congestion will be removed from 30% of the congested khals; re-excavation of khals will increase surface water availability, about 35% of total people will be benefited in the polder area; construction of retired embankment at the two proposed locations would considerably decrease the erosion and re-sectioning of embankment will provide more flood protection from tide; repairing of existing sluice gates, flushing inlets and drainage outlets will prevent salt water leakage permanently 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. However during construction phase, there will be some negative impacts on agriculture, terrestrial vegetation and fisheries. During re-sectioning of the embankment, slope pitching and turfing, loss of vegetation like herbs and shrubs will occur i.e. there will be a temporary loss of habitat for some small reptiles and mammals such as rats, frogs etc. Moreover, movement of fresh and brackish water fisheslike *Puti, Chingri, Tengra, Baila* and *vetki* etc. from the river to the polder area would be obstructed due to the repair of water control structures. The embankment also plays an important role in maintaining communication which will be improved. Moreover, proposed intervention will improve the quality of life and better livelihood.

11.2 Recommendations

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

- A good water management plan should be prepared for proper utilization of surface water for agriculture cultivation.
- 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.

- Local communities should be made involved in operation and maintenance of the structure for ensuring sustainability of the interventions.

476. 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: Check list

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 spoil
Location specific Spoil management plan for individual khal

Sl	Name of Khal	Location-dumping of spoil earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
1						
2						
3						
4						
5						
10						
..						
..						

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

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

Stockyard information during construction time:

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

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

Agro-ecological regions

Name of AEZ	Area (ha)	%	Soil characteristics

Land use

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

Land type

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

Soil Texture

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

Soil Salinity

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

Location:

Farming practices

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

Major Cropping Pattern by land type

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

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

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

Inputs Used

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

Irrigation

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

Crop production constraints (including land degradation)

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

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

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

Feed and Fodder

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

Diseases

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

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

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

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

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

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

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

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

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

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

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

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

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

Ecological Data Collection Form 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 Wetland16	Area in ha		Flooding depth (m)	Connectivity with river		Importance17
		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	Utilization18

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			

[16] 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

[17] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[18] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

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

Present status and negative impacts on flora & fauna

Impacted Species	Existing Status	Cause of impact

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		

SOCIO-ECONOMIC BASELINE DATA COLLECTION

Checklist for Rapid Rural Appraisal (RRA)

Facilitation Information

Name of Facilitator	
Date of Facilitation	

Project Information

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

Study Area

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

Educational Institution

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

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

Disease Prevalence

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

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

Health Facilities

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

Peripheral Health Facilities (if any)

Number	
Name	
Description/status	

Sources of Treatment Facilities

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

Electricity Coverage

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

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

Income and Expenditure

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

Labor and Wage

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

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

Self Assessed Subsistence Poverty

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

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

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

Disaster and Damage (in last five years)

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

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

Migration Trend

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

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

Professional/occupational Conflict

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

Miscellaneous

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

Profile of RRA Participants

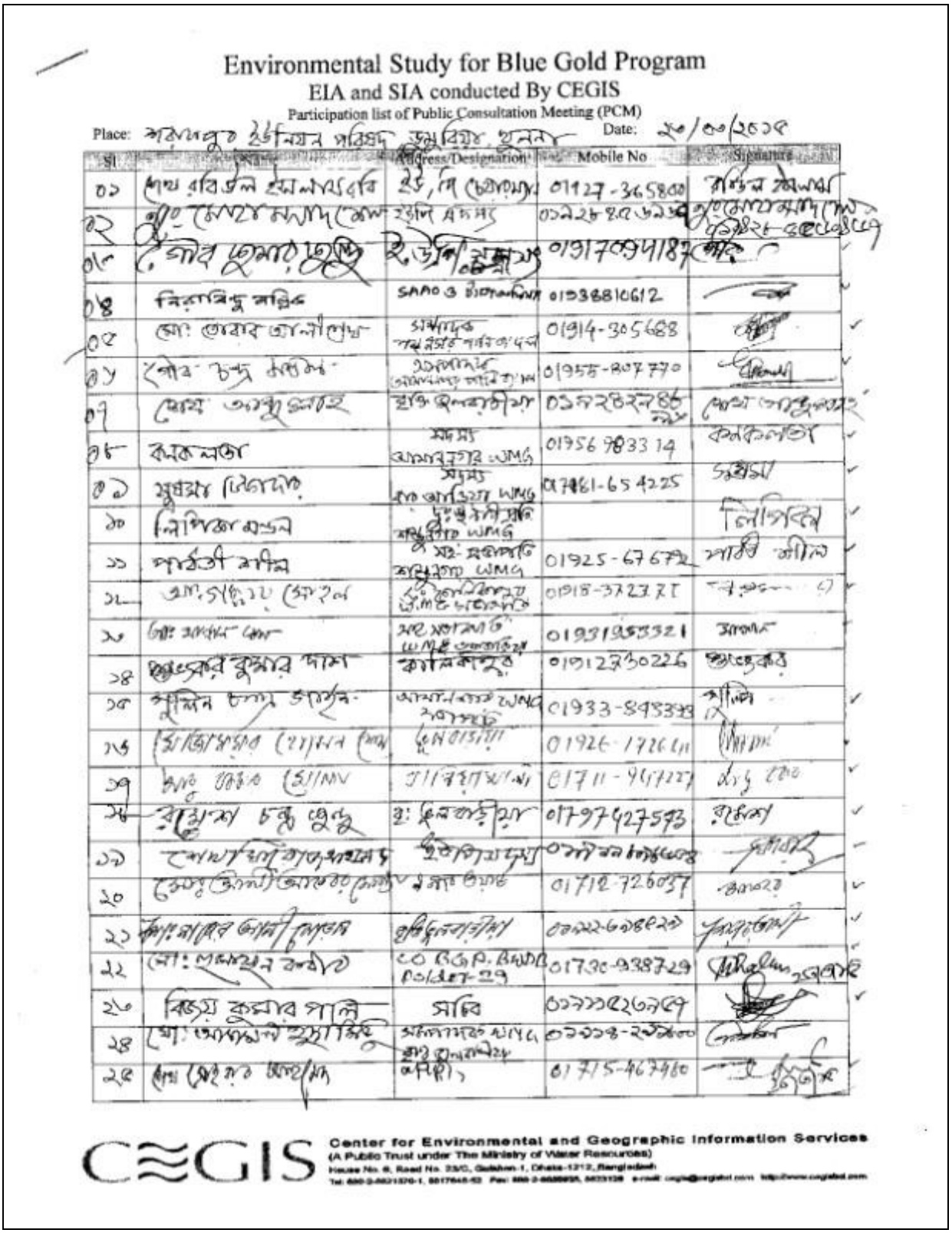
Name	Age	Occupation	Address/ Mobile no.

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

Appendix 2: No Objection Certificate

Appendix 3: Participant list of PCM

Participant list of PCM at Sarappur Union, Dumuria, Khulna



Environmental Study for Blue Gold Program

EIA and SIA conducted By CEGIS

Participation list of Public Consultation Meeting (PCM)

Place: সরাপপুর ইউনিয়ন পরিষদ, ডুমুরিয়া, খুলনা Date: ২০/০৩/২০১৫

Sl.	Name	Address/Designation	Mobile No	Signature
০১	শেখ রবিউল ইসলাম	ইউ, পি চেয়ারম্যান	01927-365800	
০২	[illegible]	[illegible]	[illegible]	
০৩	[illegible]	[illegible]	01917-[illegible]	
০৪	নিরঞ্জন মল্লিক	SAPO 3 চাঁদাবাজিয়া	01938810612	
০৫	মো: তাহার আলী শেখ	সাধারণ সম্পাদক	01914-305688	
০৬	[illegible]	[illegible]	01955-807770	
০৭	[illegible]	[illegible]	01[illegible]	
০৮	[illegible]	সদস্য WMG	01956 783314	
০৯	[illegible]	সদস্য WMG	01[illegible]-654225	
১০	[illegible]	WMG		
১১	[illegible]	সহ: সভাপতি WMG	01925-676[illegible]	
১২	[illegible]	[illegible]	01918-372[illegible]	
১৩	[illegible]	WMG	01931953321	
১৪	[illegible]	[illegible]	01912[illegible]226	
১৫	[illegible]	[illegible]	01933-895[illegible]	
১৬	[illegible]	[illegible]	01926-[illegible]	
১৭	[illegible]	[illegible]	0171[illegible]	
১৮	[illegible]	[illegible]	01797427[illegible]	
১৯	[illegible]	[illegible]	[illegible]	
২০	[illegible]	[illegible]	01712-726[illegible]	
২১	[illegible]	[illegible]	[illegible]	
২২	[illegible]	[illegible]	01730-938[illegible]	
২৩	[illegible]	সাবি	[illegible]	
২৪	[illegible]	[illegible]	[illegible]	
২৫	[illegible]	[illegible]	01[illegible]-467[illegible]	

CEGIS Center for Environmental and Geographic Information Services
(A Public Trust under The Ministry of Water Resources)
House No. 6, Road No. 23/C, Gulshan-1, Dhaka-1212, Bangladesh
Tel: 880-2-8821570-1, 8817645-52 Fax: 880-2-8828929, 8833138 e-mail: cegis@cegisbd.com http://www.cegisbd.com

Environmental Study for Blue Gold Program

EIA and SIA conducted By CEGIS

Participation list of Public Consultation Meeting (PCM)

Place: [illegible] Date: 26/04/2012

Sl	Name	Address/Designation	Mobile No	Signature
২৮.	[illegible]	[illegible]	—	[illegible]
২৯.	[illegible]	[illegible]	—	[illegible]
২৫.	[illegible]	[illegible]	01927365699	[illegible]
২৭.	[illegible]	[illegible]	01932-24176	[illegible]
৬০.	[illegible]	[illegible]	01950155625	[illegible]
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House No. 6, Road No. 23/C, Gulshan-1, Dhaka-1212, Bangladesh
Tel: 880-2-8821570-1, 8817648-52 Fax: [illegible] e-mail: [illegible] http://www.cegisbd.com

Appendix4: Terms of Reference

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

Memo No: DoE/Clearance/5403/2015/ ৪ 3 Date: 15 /02/2015

Subject: Exemption from Initial Environmental Examination (IEE) and Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) in favor of the Proposed Rehabilitation and Improvement of Infrastructure of Seven Coastal Polders (Polder Nos. 2, 26, 29, 31-Part, 43/1A, 43/2B and 43/2E) under Blue Gold Program.

Ref: Your Application dated 22/12/2014.

With reference to your application dated 22.12.2014 for the subject mentioned above, the Department of Environment hereby gives exemption from IEE and approval of ToR for Environmental Impact Assessment (EIA) of the proposed Rehabilitation and Improvement of Infrastructure of seven coastal Polders (Polder Nos. 2, 26, 29, 31-Part, 43/1A, 43/2B and 43/2E) under Blue Gold Program.

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

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

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

4a. Project activities:

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

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

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

4d. Map and survey information

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

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)
   - Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
   - Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora & 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

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

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

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

8. Management Plan/Procedures:

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

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

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

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

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

10. Conclusion and Recommendations

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

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

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

15.02.2015

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

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

Copy Forwarded to :

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

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Appendix5: Development Project Proforma