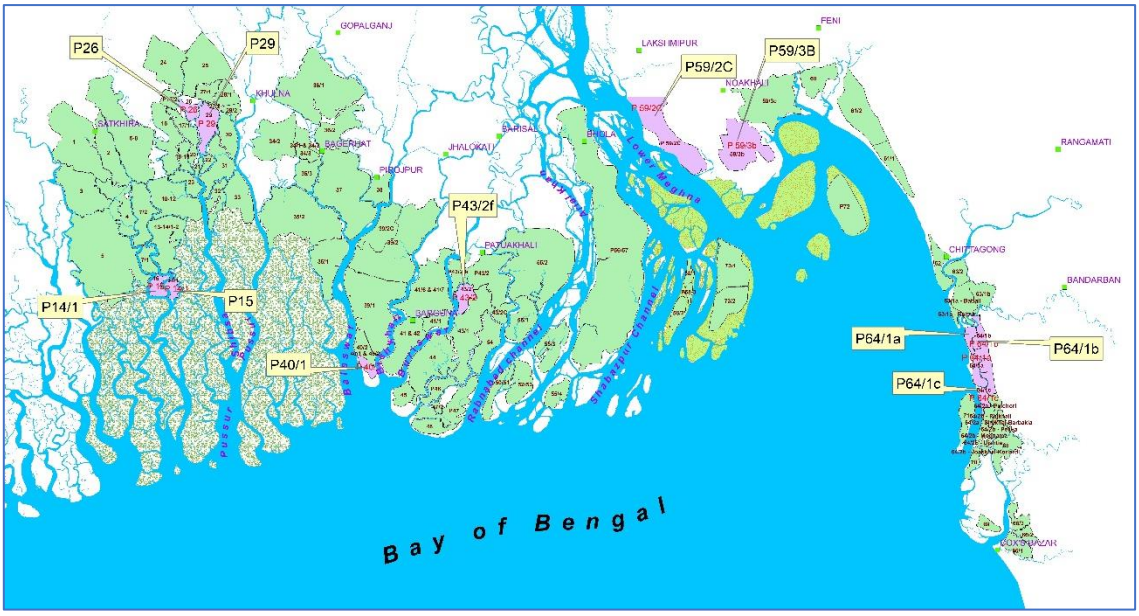
Ministry of Water Resources

Bangladesh Water Development Board

Coastal Embankment Improvement Project, Phase-I (CEIP-I)

Long Term Monitoring, Research and Analysis of Bangladesh Coastal Zone (Sustainable Polders Adapted to Coastal Dynamics)



Report
on
Selection of Polders for Conceptual Design as Pilot Program (Revised)

March 2021

IWM
Water Environment & Climate

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1. Background

It is realized that the improved concepts of the polder design and management would be developed under this study and the output of the analysis can be replicated to any future polder rehab project/ program in the coastal zones of Bangladesh. The scopes of works are to establish conceptual design for 5 polders as pilot program considering climate change, subsidence, possible land heights, land use, economic activities, required infrastructure for water management, drinking water facilities for long-term stability. Make a cost estimate for the redesign of the polders and assess the benefits and beneficiaries in the new situations. It is also important to make reports for each of the 5 polders with a description of; present situations, boundary conditions (scenarios), matching with polder options, established design including management plan, cost and benefits. In accordance with the ToR, a technical report needs to be prepared on long term polder improvement measures and polder development Plan.

In view of the above, eleven numbers of representative polders of the different regions of coastal area including polders under CEIP-1 and BlueGold Program were shortlisted to select 5 polders finally. The shortlisted 11 polders were 14/1, 40/1, 43/2f, 64/1a, 59/2, 15, 26, 29, 55/1, 59/3b, 64/1b where the selection criteria for shortlisting have been; representative for a cluster of polders/specific costal region, degree of vulnerability against storm surge, river bank erosion, drainage congestion, subsidence, salinity intrusion, water management, opinion of local BWDB officials and economic activities.

In finalizing 5 polders, the consultants conducted a meeting at the office of Mr. A. M. Aminul Haque, ADG (planning) BWDB who chaired the meeting on 5 September 2019. The participants from BWDB and BUET were, Mr. Md. Habibur Rahman, Chief Engineer and Project Director, CEIP-1, Mr. Md. Fazlur Rashid, Chief Planning, BWDB, Mr. Mohammad Ali, Executive Engineer, CEIP-1 and Dr. Sujit Kumar Bala, Professor and Head, IWFM, BUET. After discussing all pros and cons including the selection criteria of 11 polders, the meeting selected 5 polders as representative for conceptual design of long term stability of the polders. The selected polders are 15, 29, 40/1, 59/2, 64/1a & 64/1b. BWDB suggested to consider polders 64/1a & 64/1b as one polder.

Steps and activities of Component 5

The following steps are necessary to be carried out to accomplish component -5 and each of the steps are expected to be covered under separate deliverables.

- Selection of 5 polders for conceptual design (Deliverable D-5A:1)
- Analyze and prepare conceptual design of the 5 selected polders (Deliverable D-5A:3)
- Information from the above steps would be utilized to upscale to the 17 CEIP-polders (Deliverable D-5A:2)
- Develop Polder development plan for all 139 polders (Deliverable Component)

The necessary activities to accomplish the above steps would be:

- Field visits including primary and secondary data collection and engineering surveys
- Stakeholder consultation meetings
- Review/Improvements on-going works of CEIP-I to describe the situation of CEIP-I polders, the key improvement achieved, socio-economic situation including current flood risks and possible impacts of climate change, etc.
- Flood risk assessment

- Review history of polder reconstruction and review water management issues in the polders of Bangladesh
- Assessment of future impacts of the on-going and proposed CEIP-1 interventions
- Review risk assessment to provide initial insights in the costs and benefits of the project
- Conceptual design of 5 selected polders considering climate change, subsidence, possible land heights, land use, economic activities, infrastructure needed for water management and water management policy, drinking water facilities for long term stability
- Cost estimates for the redesign of the polders and estimate of the benefits and beneficiaries in the new situation

2. Field Visit

To finalize 5 polders as representatives of hydro-morphological characteristics of 4 regions of Bangladesh for the conceptual design, the consultants shortlisted 11 polders out of the 139 coastal polders. The 4 regions are:

- Ganges Tidal Plain West (South-West Zone Polders):
- Ganges Tidal Plain East (South-Central Zone Polders)
- Meghna Deltaic Plain (South-East Zone Polders)
- Chittagong Coastal Plain (Eastern-Hilly Zone Polders)

The idea of finalizing 5 polders from 4 different zones is that the design of a polder for a region will be replicated to the neighboring polders of the same region. However, the consultants conducted several meetings with the BWDB officials including field offices and set criteria for shortlisting coastal polders for finalization of 5 polders. The criteria for shortlisting are:

- Selected polders are to be representative for each zone of hydro-morphological characteristics
- Availability of data/ information for polders
- Degree of vulnerability against bank erosion, storm surge, drainage congestion, flood, salinity, subsidence etc.
- Opinion of the stakeholders including local BWDB officials, local inhabitants and economic activities
- Water management issues
- At least one CEIP-I polder and one BlueGold polder to be included in the shortlisting

Based on the above criteria the consultants shortlisted 11 polders (Table 1) and shared the findings in a meeting with PD at his office.

After the shortlisting, Consultants visited 11 polders and consulted with local community and BWDB. List of visited polders presented in the Table 1.

Table 1: Summary of schedule and location of field visits

Sl No	Name of Polder	Region/District
1	Polder 14/1	Khulna
2	Polder 40/1	Barguna
3	Polder 43/2f	Patuakhali
4	Polder 64/1a or Polder 64/1c	Chittagong
5	Polder 59/2	Noakhali
6	Polder 15	Satkhira
7	Polder 26	Khulna
8	Polder 29	Khulna
9	Polder 55/1	Patuakhali
10	Polder 59/3b	Noakhali
11	Polder 64/1b	Chittagong

During field visits, BWDB local officials accompanied and assisted the consultant team and appraised the present situations and ongoing problems of the polders. In addition, the team discussed with the

local people on the issues of importance. All the information as obtained from the field visits are summarized in the form of a matrix indicating present situation and vulnerability. Finally based on experience, importance, degree of vulnerably and representability in terms of zone, 5 polders will be finalized in a meeting with PD's office and the selection committee of BWDB for the pilot program on conceptual polder design under Long Term Monitoring project. The location map of the polders is presented in Figure 1. Table 2 illustrate the general information of the proposed polders.

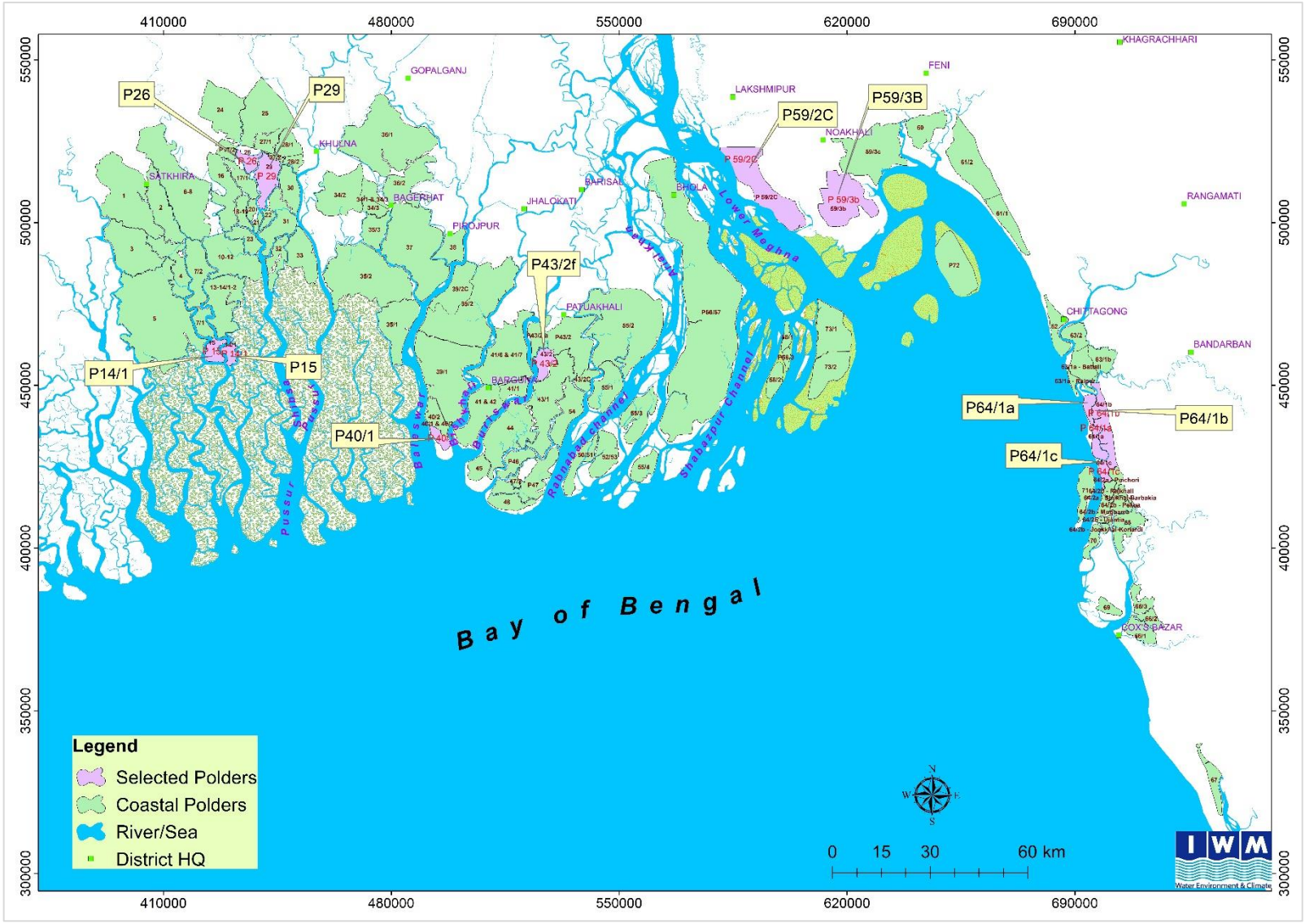


Figure 1: Proposed selection of the polders from the all coastal polders of Bangladesh

Table 2: Polders data summary（general information）

Sl No.	Polder Name	Gross Protected Area (Ha)	Cultivable Land				Main Project Feature				*Polder population	Remarks (under different projects)
			Total (Ha)	Crop (Ha)	Shrimp (Ha)	Salt (Ha)	Embkt. (km)	No. of Regulators	No. of Flushing Inlet	Drainage Channel (km)		
1	Polder 14/1	2933	2350	1880	470	0	25	4	0	0	20578	CEIP-1 Project
2	Polder 40/1	2105	1684	1684	0	0	23.45	28	24	14.5	13547	
3	Polder 43/2f	4130	2590	2590	0	0	33	16	42	27	28000	BlueGold Program
4	Polder 64/1a or Polder 64/1c	5750	4600	4140	230	50	58	24	0	28	71341	
5	Polder 59/2	25000	20000	20000	0	0	96.41	21	0	91	727827	
6	Polder 15	3441	2925	900	2025	0	27	5	0	0	31788	CEIP-1 Project
7	Polder 26	2696	2100	2100	0	0	29	4	0	18	13350	BlueGold Program
8	Polder 29	8218	6570	6570	0	0	49	11	81	39	53268	BlueGold Program
9	Polder 55/1	10325	7230	7230	0	0	46.16	11	24	14	59291	
10	Polder 59/3b	31376	23532	23532	0	0	70	13	0	116	247074	
11	Polder 64/1b	8000	7200	7050	150	230	53	35	0	73.96	148238	

*Note: Population of each polder in 2011 was estimated from the population density in each union. Total population of each union in 2001 was projected to the year 2011 with growth rate of 2001 population census. Accordingly, the population density of each union was calculated. Then population for each union and part of different unions were calculated and total population in each polder has been obtained

2.1 Polder 14/1 and Polder 15

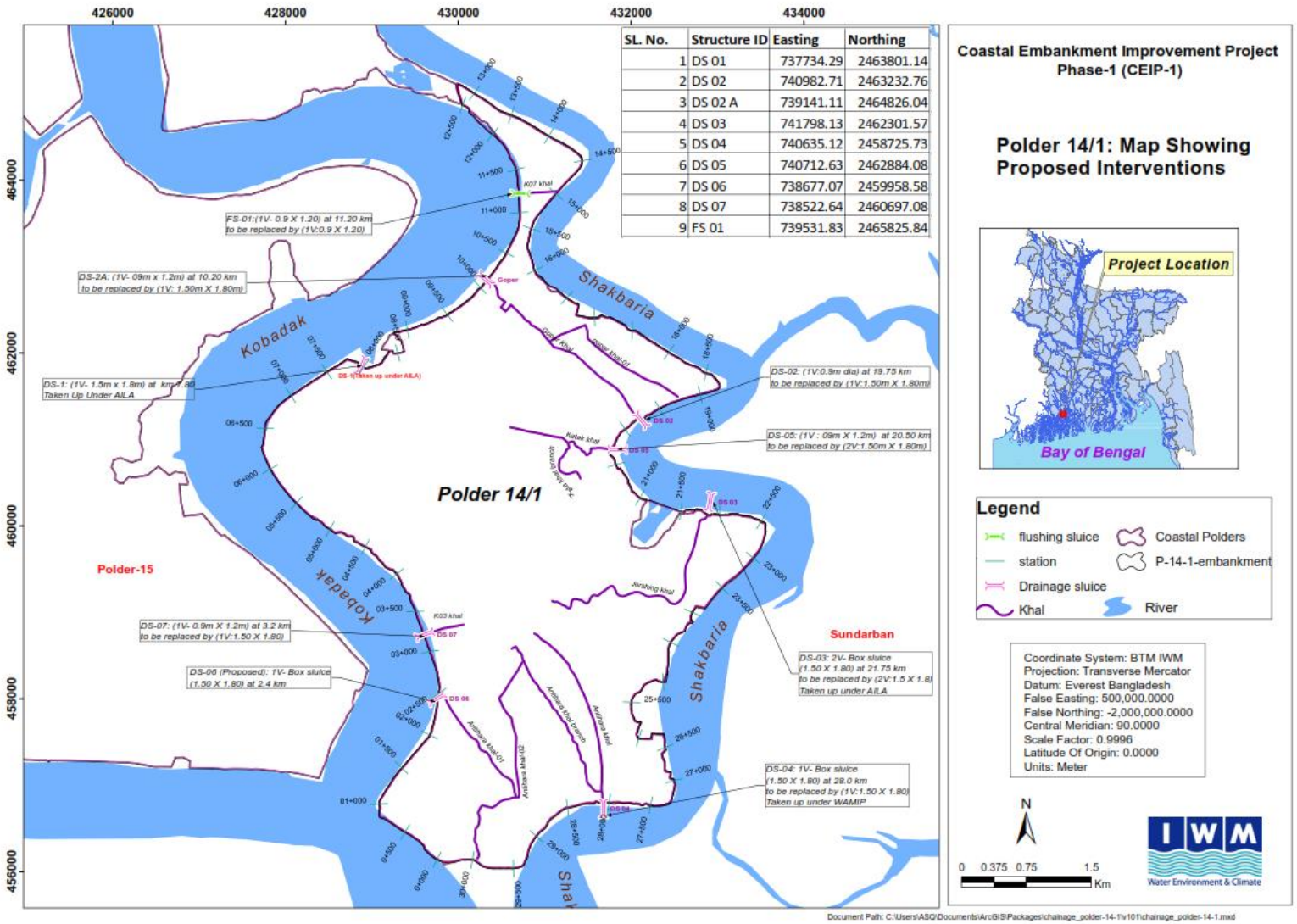
Mr. Pankaj Kumar Maitra from, Senior Survey Engineer, IWM visited the Polder-14/1 and 15 under package -3, CEIP-1 on 8 June 2019 to observe the existing condition of the polders. The detailed maps of these polders are shown in Figure 2 and Figure 3. He visited the erosion prone locations and discussed with local community. Foreshore is silted up and depth of water during high tide was almost 1.00m. The existing width of this foreshore is about 30 -40 meters from existing bank of the river, where mangrove afforestation can be made to reduce storm surge height. The adjacent embankment is subjected to wave action for which slope protection is required. The polder experiences drainage congestions. It is vulnerable to cyclonic storm surge.

Bank Protection works from km 23.40 to 23.70（300m） in Polder-15 is proposed from BWDB. At this location there is a newly constructed LGED bridge and there is small village market and Launch Station. The intensity of the erosion is substantially high which needs protective measures.

The existing embankment of Polder 15（from km 8.60 to 8.80 ）has been protected by Slope Protection works by CC blocks about 50 m length has already been damaged due to wave action. The embankment is prone to river erosion as well as wave action. Bank protection work is essential to protect the embankment, crops and local community. Recent bathymetric survey suggests that the existing Bank of the river is about 70-80 meters away from the toe of the existing embankment. On the other hand, the cross-section indicates that the slope of the bed of the river is not very stiff and the location of the same is far away from the existing embankment. Mangrove afforestation is required.

At present the polder area remains under saline water and 100 percent of the land area is now under shrimp culture Ghers and there is no agriculture land inside the polder. It has been observed that the existing sluices are not functional fully for proper drainage and have deteriorated due to long use and saline water. Local people are constructing cross dams to store the water which creates water logging problem in the polder. Some photographs are presented showing the common pictures in the Polders 14/1 and Polder 15.

In 2020, Polder 15 was affected severely by cylone Amphan. A breach on the embankment had occurred and caused servere flooding in Polder 15.



SL. No.	Structure ID	Easting	Northing
1	DS 01	737734.29	2463801.14
2	DS 02	740982.71	2463232.76
3	DS 02 A	739141.11	2464826.04
4	DS 03	741798.13	2462301.57
5	DS 04	740635.12	2458725.73
6	DS 05	740712.63	2462884.08
7	DS 06	738677.07	2459958.58
8	DS 07	738522.64	2460697.08
9	FS 01	739531.83	2465825.84

Figure 2: Detailed map of Polder 14/1 under CEIP-1 project

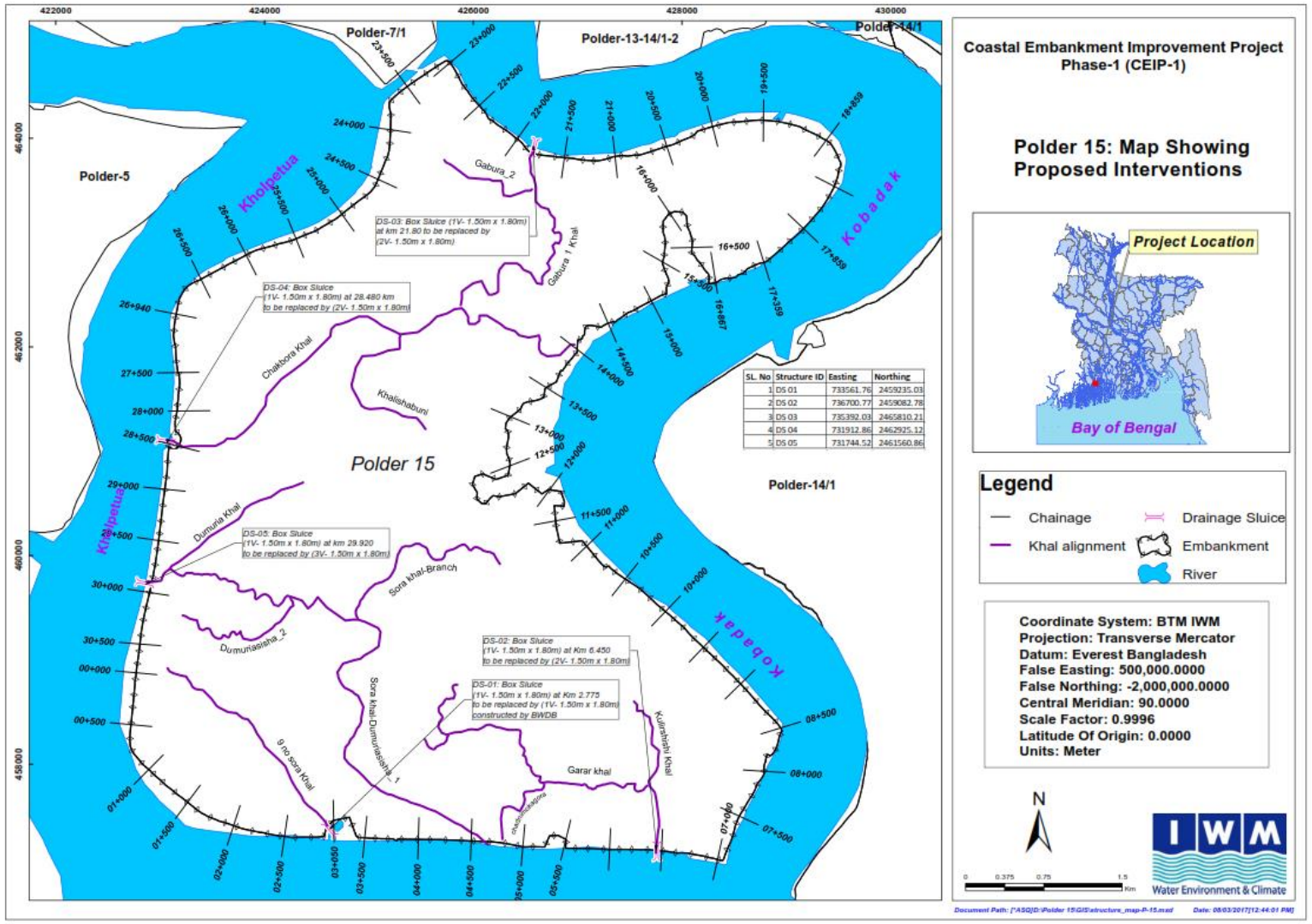


Figure 3: Detailed map of Polder 15 under CEIP−1 project

Figure 4: River bank erosion and Fish ghers in the Polder 14/1 and Polder 15

2.2 Polder 40/1

A 2-member team from IWM consisting of Mr. Upal Mahamud and Mr. Syed Shamsil Arefin visited Polder 40/1 on 03/07/2019 and Polder 55/1 on 04-07-2019 to perceive the existing condition of the polders.

Polder 40/1 is situated on the southern-most tip of the coastal area under Patharghata Upazila of Barguna district and Baleswar River is at the west, Bishkhali River is at the east, Polder 40/2 is in the north. And Bay of Bengal is in the south of the polder. The foreshore is very wide and long, where mangrove forest was planted (Figure 6).

The Team met with Mr. Dipak Ranjan Das, Executive Engineer, BWDB at his office at Barguna and Sub-Assistant Engineer Mr. Md. Khalilur Rahman. They informed about the existing condition of this polder. The main problem of this polder is erosion due to cyclonic storm surge and at present there is no water-logging problem.. During the visit of these Polders, Sub-Assistant Engineer, BWDB, Mr. Jamal Hossain and Mr. Yousuf Joardar (Sub-Assistant Engineer, BWDB) accompanied IWM team and provided full cooperation to make the field visit successful.

The polder was severely damaged during the Cyclone SIDR in 2007. The team visited the most vulnerable part of this polder at Padma Hat and Rohita area along the left bank of Baleswar river. Local people informed the team about the damage in the polder during Cyclone SIDR and recent condition around these areas. The retired embankment was built at Rohita area after the cyclone which was totally damaged during SIDR and this embankment is now again vulnerable to erosion. So, the BWDB official informed that the structure has repaired recently, and the team also observed the recent repair work (Figure 5). In Padma Hat area, a long stretch of the existing embankment is vulnerable to erosion and emergency protective works by geo-bag was made by BWDB (Figure 6). Planned protective measures considering, river flow, cyclonic storm surge, climate change and mangrove afforestation is required

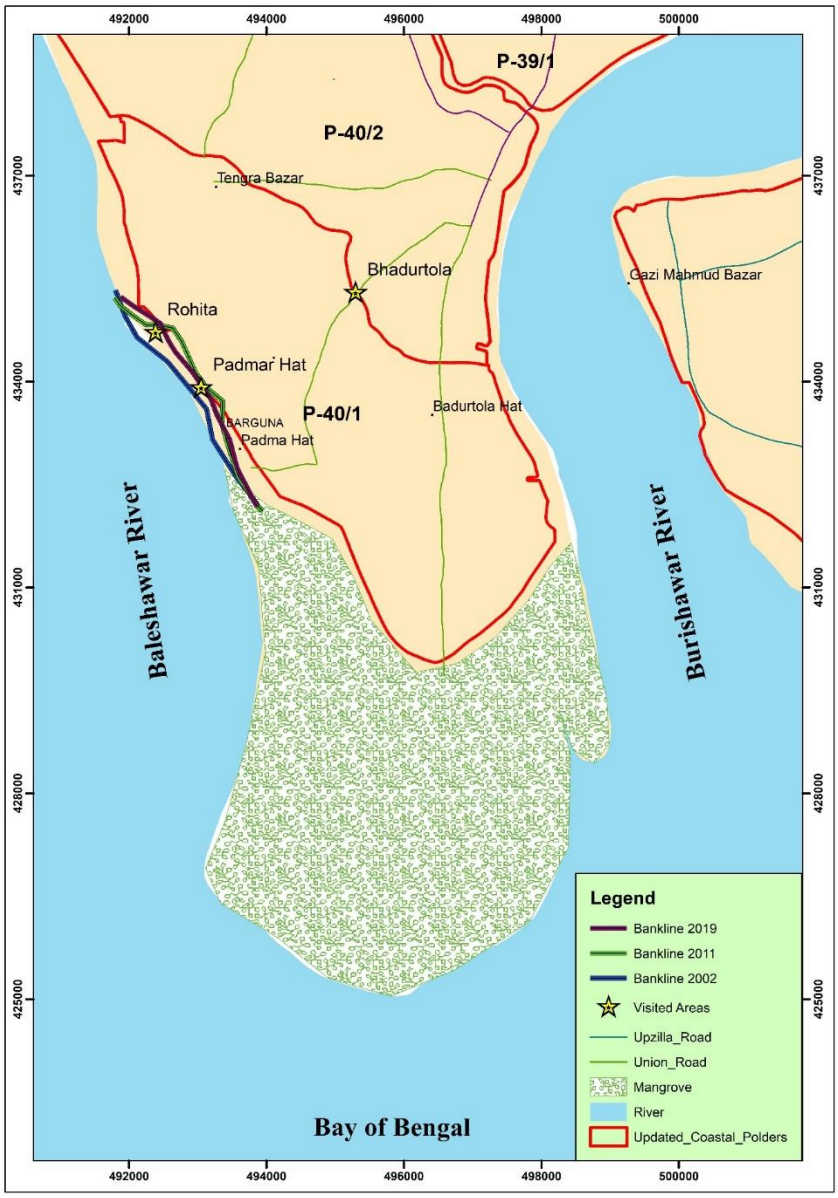


Figure 5：Location map of field visit at Polder 40/1

Figure 6：Repaired damaged regulator and erosion protective work in Polder 40/1

2.3 Polder 43/2f

Polder 43/2f is located in Gulishakhali union of Amtali upazila, Barguna district. The polder is surrounded by Gulishakhali and Payra rivers in the west and the Kukua River (in the east) (Figure 7). The polder covers an area of 4,130 ha, with a Net Cultivable Area (NCA) of 2,590 ha (63%). The polder area is bounded by a 33 km embankment that protects the area against tidal and storm surges as well as salinity intrusion. The embankment beside the Payra River at Angulkata, Gulishakhali, Dalachara and Naiapara is vulnerable to erosion and tends to be eroded whenever a moderate flood occurs. Besides, there are 16 drainage sluices, 4 drainage outlets and a number of flushing inlets within the area. The existing water control structures are not functioning up to the desired level due to damages in the wheels and shafts. There are also severe mismanagement issues regarding the water control structures. Around 37 km (40% of the total length) of water courses inside the polder are affected by drainage congestion problems. Drainage congestion at some places leads to water management issues, which affect the agriculture sector within the polder. Figure 7 shows the existing regulators, khals and peripheral river network

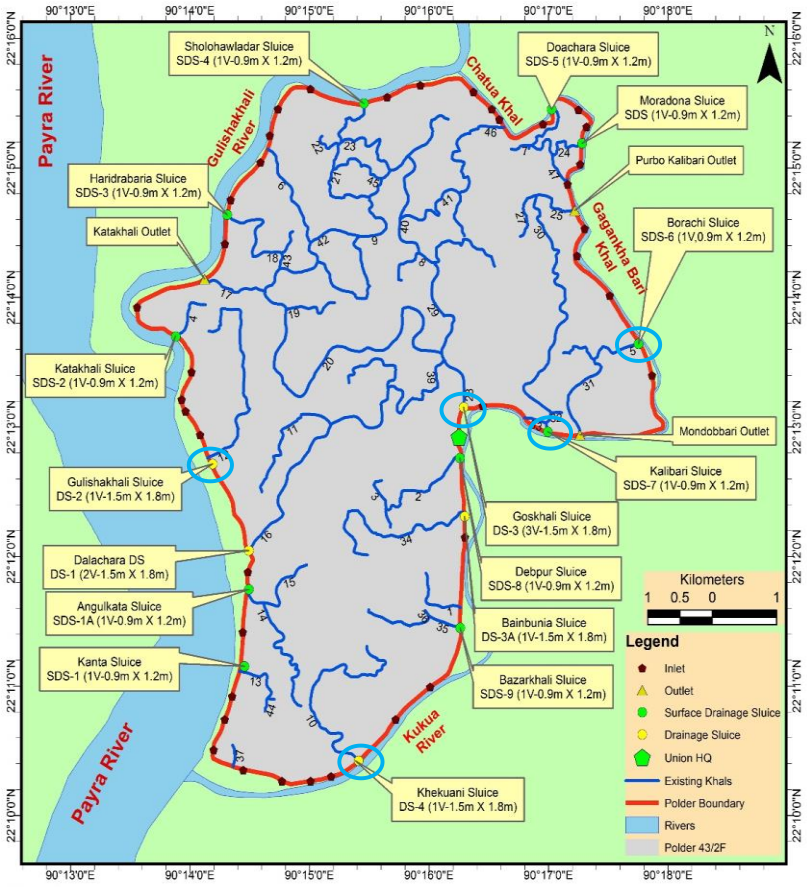


Figure 7: Map showing the khals and sluices of Polder 43/2f

Few years back, IWM carried out a research project in this polder and collected topography data, khal and structure information. IWM found that this polder is experiencing some severe problems. Therefore, there is an opportunity to introduce some engineering innovations in this polder for the better water management. There are huge potentials to increase the cropping intensity and economic activities of local communities since river water salinity remain below 1ppt all over the year and road communication is very good. The existing problems inside the polder are presented in the Figure 8.

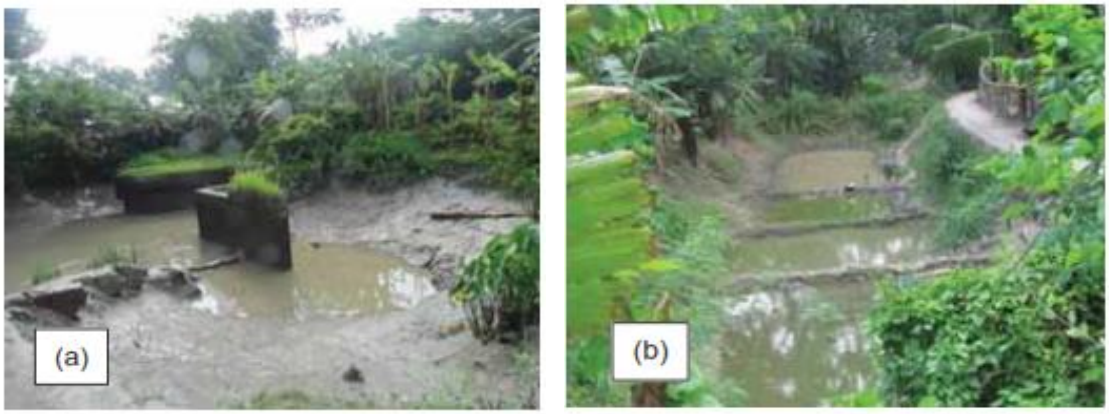


Figure 8: Present condition of existing regulators（a） Keukhali sluice and Cross dam in Sutanalir Khal（b）

2.4 Polder 64/1a and Polder 64/1b

A 2-member team from IWM consisting of Mr. Pankaj Kumar Maitra and Mr. Mohammad Ziaur Rahman visited Polder 64/1a and Polder 64/1b on 23-07-2019 to perceive the existing condition of the polders and the peripheral khals & rivers. The team met Mr. Julfiqar Tareq, Executive Engineer, Chittagong, division-2, BWDB at his office at Chittagong and a Section Officer Mr. Dhiman Krishno Chowdhuri and had discussions on the conditions of the polders. According to them, the polders presently do not have waterlogging and drainage problems. The peripheral khal Jolkador needs dredging for smooth drainage during flash flood.

The team has visited the Polder 64/1a and Polder 64/1b together with a BWDB officials. The visited locations of Polder 64/1a and Polder 64/1b are listed in Table 3. The Polder area and visited locations are shown in the **Error! Reference source not found.**. Field photgraphs are presented in the A ppendix-A4

Polder 64/1b:

- Polder 64/1b is situated in the Easter Hilly region of Bangladesh in the Upazilas of Banshkhali of Chattogram district and is surrounded by Sangu River（north and part of north-east), Jalkador Khal （West） river and Banshkhali Upazila road （East）（Photograph-10). The total length of Jalkador Khal is about 31.00 km. The total embankment length of the polder is about 81.00 km and gross protected area is about 88.4 Sq. km. The existing crest level of the embankment is about 3.0-5.92 m PWD.The Eastern portion（Banshkhali Upazila road） of the peripheral embankment of polder is fully paved. The western portion of the polder is brick soiling（5%） and kancha road.

- The major problem at present in the Polder as observed was erosion （Photograph-12）at the Sangu River along left bank at Sangu Bridge to outfall of the River. According to

BWDB, 5.0 km along left bank of Sangu River at Hajigaon to Eshorbabur Hat is under threat of erosion. Around 60-200 m has been eroded since 2004-2016.

- At first, visit was made at Jalkadar Khal and the breach of embankment and eroded area by the Sangu River River (Photograph-10, Photograph-11 & Photograph-12). The team visited bank protection at Esshorbabur Hat (390m). The erosion threat area is already protected by the construction of revetment from Sangu Bridge to outfall of the River. The total length of the revetment work (Photograph-12) is 3300 m. The overall condition of the revetment is good. The bank protection work has been constructed in two phases of 2100 m (near Polder 64/1b) and 1200m (near 64/1a).
- The team discussed with local community. Water logging problems was not observed during the visit. However, it was reported that the polder facing water logging problems for 2-3 days during Flash Flood According to local people. Jalkadar khal needs to re-excavate from Sangu confluence to outfall. The team observed that Jalkadar Khal is wider and deeper in the South (Photograph-21). Only the upper part of the Khal is narrow and silted up which needs to re-excavate (Photograph-16). The polder is exposed to Bay of Bengal and vulnerable to cyclonic storm surge There is need of excavation internal khal system.

A typical existing condition of Polder 64/2b is shown in the Figure 9

Polder 64/1a:

- Polder 64/1a is situated in the Easter Hilly region of Bangladesh in the Upazilas of Banshkhali of Chattogram district and is surrounded by Sangu River (north), Jalkador Khal (East) and Bay of Bengal (West) (Photograph 1). The total length of Jalkador Khal is about 31.00 km. The total embankment length of the polder is about 54.00 km and gross protected area is about 52.24 Sq km. The existing maximum crest level of the embankment is about 6.20 m PWD. The existing condition of the peripheral embankment is good in most of the portion of the Eastern side (Photograph 4). The embankment of polder is brick soiling and partially paved.
- The embankment at the sea side of the polder is kancha and damaged in the salt farming areas. The team observed the damaged embankment at sea side near Haliapara in Polder 64/1a. The embankment is damaged due to movement of Salt carrying tractors (Photograph-18). The part of the embankment of Polder 64/1a needs to be repaired and maintenance.
- The erosion threat area is already protected by the construction of revetment from Essorbabur Hat to outfall of the Sangu River. The total length of the revetment work (Photograph 3) is 1200 m near Polder 64/1a.
- Sea dike and Slope protection construction work has been ongoing from Moulobipara to Khankhanabad (4800m) (Photograph-15) and Gondamara to oufall of Jalkadar Khal (1900m) (Photograph-20). Only the erosion prone areas in the sea side has been protected by these Dyke. The construction has been implemented by BWDB.

- Team observed the area under afforestation reduced bank erosion and accelerate land reclamation outside the embankment of Polder 64/1a （Photograph-17）.
- The team visited kataria Sluice at West Bagmara and observed heavy deposition at the upstream of the structure （Photograph-16`）. Re-excavation of Khal is required for smooth functioning of the regulator. According to local people the low land area of Polder 64/1A facing water logging problem due to silted up of drainage khals. There are some encroachment of khals. in Polder 64/1a.

A typical existing embankment and sea-dyke condition of Polder 64/2a is shown in the Figure 10.

Table 3: The visited locations of Polder 64/1a and Polder 64/1b

GPS Point	BTM_X	BTM_Y	Remarks
141	696636	446360	Jalkadar Khal
142	696290	446864	Outfall Jalkadar Khal
143	696200	446969	Sangu River Erosion
144	696220	446962	Esshorbabur Hat_Bank Protection（3300m）
145	696573	445204	Silted up Jalkadar Khal
146	696573	445204	Embankment and inside of the Polder（P-64/1A）
147	696534	445206	Embankment and inside of the Polder（P-64/1A）
148	696530	445203	Embankment and inside of the Polder（P-64/1A）
149	692788	442637	Sea Dyke（Khankhanabad-4800m）
150	692790	442617	Sea Dyke（Khankhanabad-4800m）
151	695282	440550	Embankment and inside of the Polder（P-64/1A）
152	695806	439065	Regulator
153	694815	438076	Embankment Haliapara
154	695016	436769	Damaged Embankment
155	695156	431406	S Alom Coal Based Power Plant
156	695437	428816	Gondamara Sea Dyke（1900m）
157	695447	428797	Gondamara Sea Dyke（1900m）
158	699993	429470	Jol Kadar Khal at Banglabazar

Figure 9：Eroded river bank with bank protection work and sedimented khal with broken structure in the Polder 64/1b

Figure 10：Broken embankment and sea-dyke protection work in the Polder 64/1a

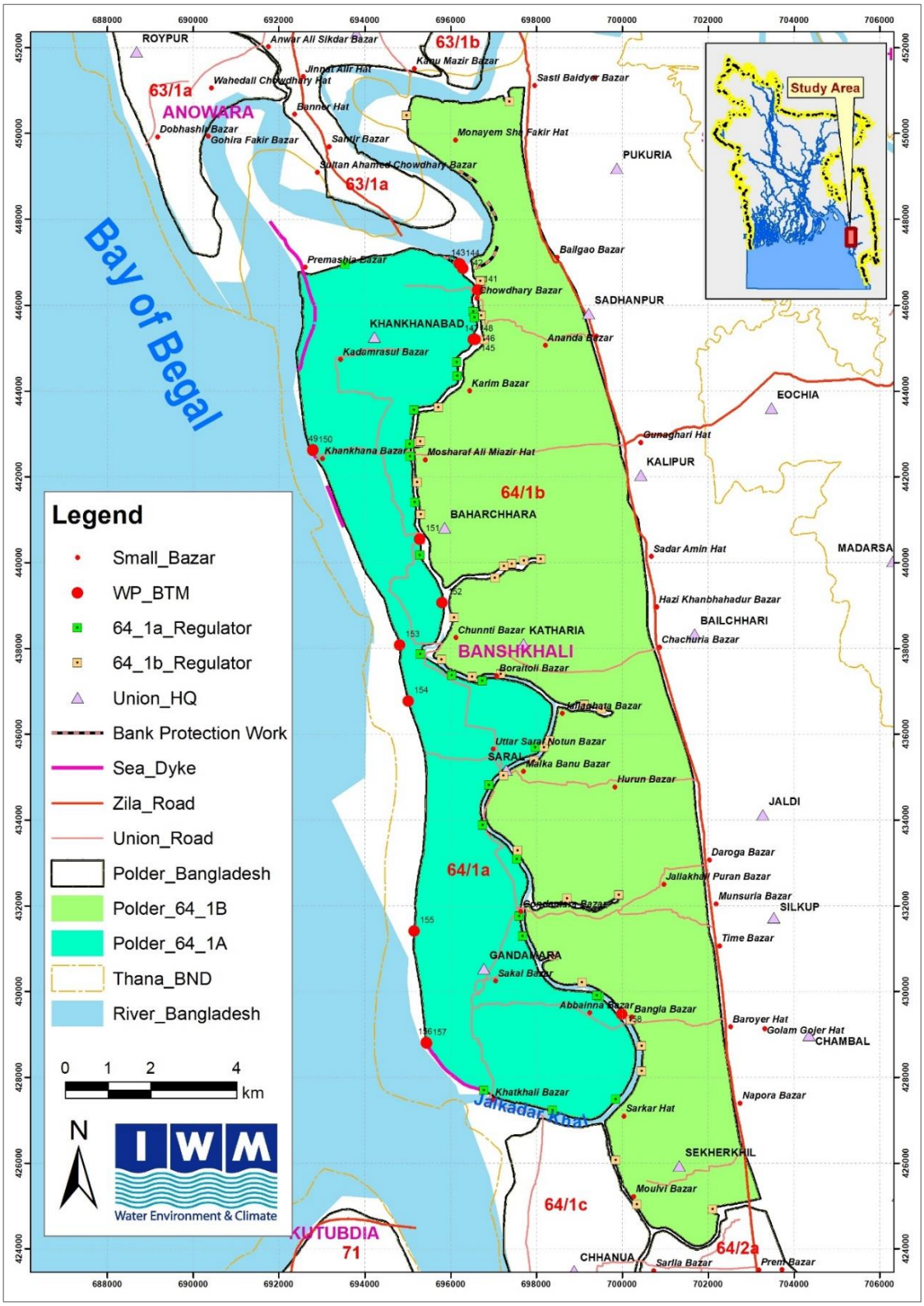


Figure 11: Map Showing Field Visit Observation of Polder 64/1A and Polder 64/1B

2.5 Polder 59/2C and Polder 59/3B

Two members from IWM has made a field visit from 3-5 July 2019 in Noakhali. One Sectional Officer from Noakhali O&M Division and one Sectional Officer from Lakshmipur O&M Division joined the IWM team. On the first day, the team visited Ramgati protection works in the lower Ramgati and later at Kamalganj area of Polder 59/2. Had discussions with local officials, nearby people and returned to Noakhali and made night halt. On 4th July, the team had visited Subornachar area, Noakhali Khal, Nobogram, Kalmi, and Gangchil regulators of Polder 59/3B. One Assistant Engineer (Mr. Nasir) from Noakhali O&M Division joined the IWM team.

2.5.1 Polder 59/2C

A protection work has been carried during (2016-17) and (2017- 18) in the severe eroded areas. Part of the protection works of 600m at the tail end of Ramgati and 3000m at Kamal Nagar has been implemented and the performance is satisfactory except areas at terminal points. A detail reconnaissance survey will provide the status of present revetment and the need of bank protection at all areas of Ramgati. Figure 12 shows the historical bank erosion and Figure 13 shows the existing bank protection work at Lower Meghna.

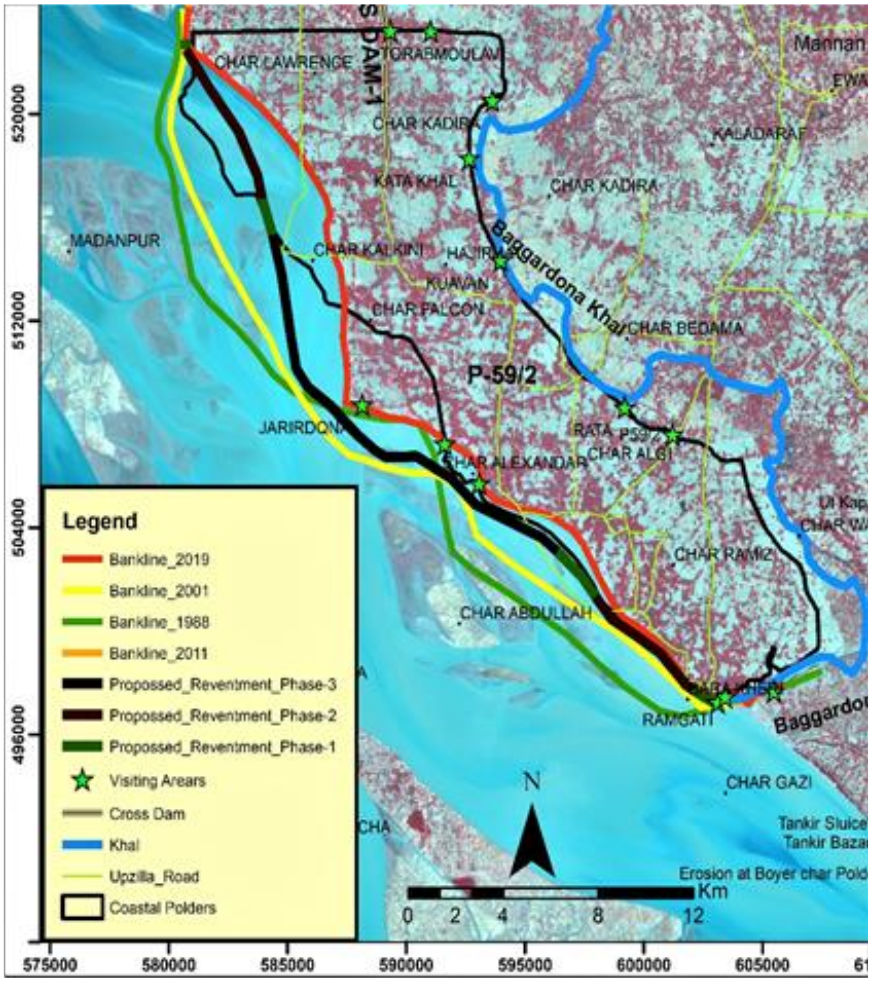


Figure 12: Map of Ramgati west coast showing bank lines of different years

Figure 13: Bank protection at Kamalgonj area and upstream termination

2.5.2 Polder 59/3B

Polder 59/3B has become an upland polder meaning it has lost connection with peripheral rivers. The rainfall runoff is often hindered causing water logging and there is no arrangement to make use of either rain water or water of the peripheral rivers (Noakhali khal, Baggerdona channel). Once the Noakhali Khal is rejuvenated (next year), the regulators at east will be functional for drainage as well as for intake of water for appropriate water management. Potentials are there for use of surface water from Baggerdona river also. Location of Polder-59/3B is shown in Figure 14.

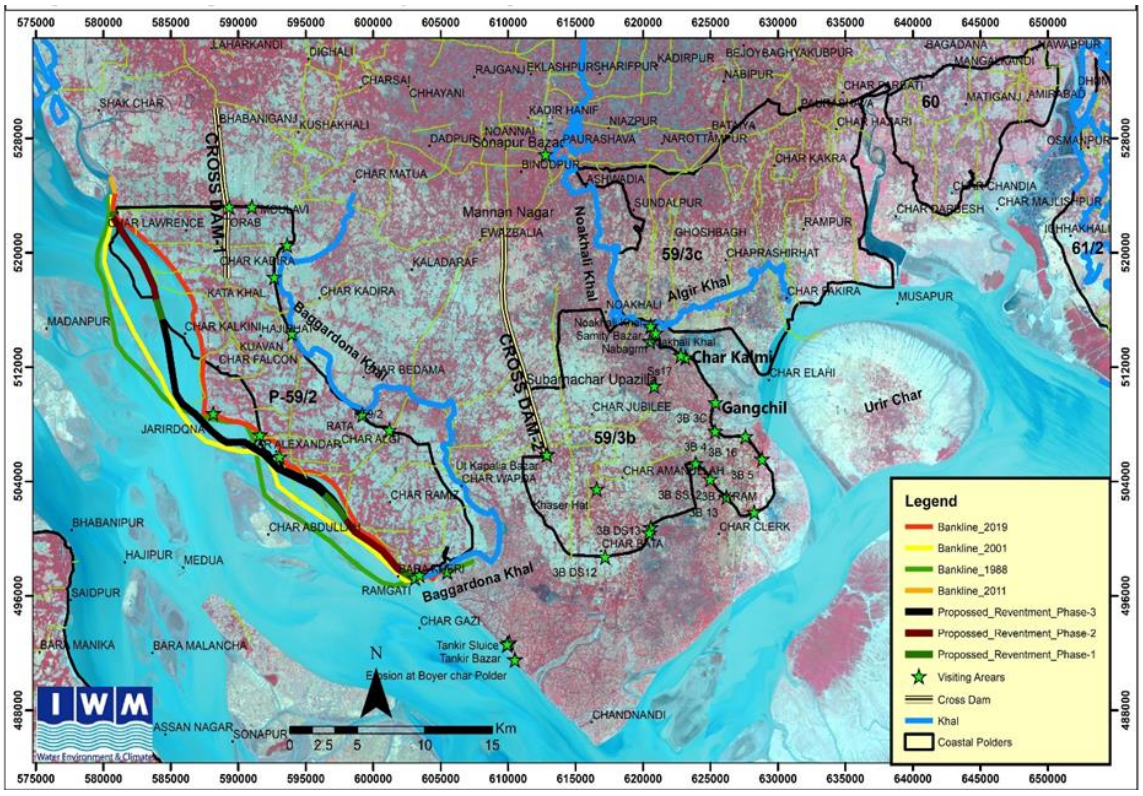


Figure 14: Polder-59/3B with surrounding khals and rivers

There are two important canal system- Noakhali khal and Baggerdona channel. In addition, the area is linked in the south near Urir Char. These canals and Bay area are used as outfall for drainage of the area.

Noakhali Khal

It has been silted up often from sediment laden water from downstream. Thus, any re-excavation was not successful. This year re-excavation has started with close monitoring keeping then downstream closed.

- Excavation completed up to 12 Km length (3 m depth & 40 m bed width). Benefit from such excavation is not available as the downstream end is kept closed to arrest entry of any sediment.
- Remaining reach of Noakhali khal is planned for re-excavation next year when entire area will benefit from drainage through Algir Khal.

Excavated area of Noakhali Khal and nearby embankment

Drainage Regulator at Nabagram

Nabagram Regulator（up and downstream）

No drainage has been observed through the regulator during the visit. The downstream canal linked to Noakhali khal is water logged and will have to wait so long full length of re-excavation is over for drainage. Water logging is expected during the rainy season in absence of drainage from the area.

Drainage Regulator at Gangchil

Gangchil regulator is functioning properly. However, approach channel got significantly silted up inside the polder due to allowing of sediment laden water during high tide. Improvement of channel and appropriate operation of regulator can help improved and sustainable drainage. Any positive response from nearby people on the flushing of water was not available.

Drainage Regualtor at Gangchil（up and downdtream）

Status of Baggerdona Channel has to be collected from ground inventory, its bathymetry, drainage flow, upstream connectivity and downstream conditions（year to year deposition if any）. It is also important to collect information on the current use of water for fisheries, agriculture or drinking. Encroachment of the river banks needs to be noted.

Status of Urir Char channel linking Noakhali coast is important to determine the drainage of the area. There are past data of the area at IWM, however, as the area faces faster siltation, fresh bathymetry would be useful.

2.6 Polder 29 and Polder 26

A 2-member team from IWM consisting of Mr. Tarek Bin Hossain and Mr. Syed Shamsil Arefin visited Polder 29 and Polder 26 on 27-06-2019 to perceive the existing condition of the polders and the peripheral rivers. The team met Mr. Md. Mizanur Rahman, SDE, Dumuria O&M Sub-division, BWDB at his office at Khulna and two of his Sub-Assistant Engineers Mr. Rahedul Islam and Mr. Hasnat and had discussions on the conditions of the polders. According to them, rehabilitation of some water control structures and water management issues of the polders are in progress on Blue Gold Programs. The polders presently do not have waterlogging and drainage problems. During visit to the Polders, Sub-Assistant Engineer, Mr. Rashedul Islam and a representative of Mr. Hasnat（Sub-Assistant Engineer）accompanied the visiting IWM team and provided full cooperation to make the field visit successful.

2.6.1 Polder 29

Polder 29 is situated in the south-west region of Bangladesh in the Upazila of Dumuria & Batiaghata of Khulna district and is surrounded by Lower Shalta (north and east), Lower Bhadra (east and south) and Gangreil (west) river (Figure 3). The total embankment length of the polder is about 49 km and gross protected area is about 8,218 ha. The cultivable land is about 6,570 ha. The existing crest level of the embankment is 4.27 m PWD.

A significant portion of the peripheral embankment of polder 29 is paved and can be motorable throughout the year. The visiting team moved through the polder dyke and discussed with BWDB representative and local people. Water logging and drainage problems were not observed during the visit. It was reported that Blue Gold program since 2013 has conducted various interventions for rehabilitation of the polder which removed the existed drainage and water logging problems. The various interventions done under Blue Gold program have been Re-sectioning of the existing embankment, repairing of drainage/flushing sluices, repairing of drainage outlets and re-excavation of drainage canals, etc.

The major problem at present in the Polder as observed was erosion at the Bhadra River along right bank at Chandghar and Baroaria. According to Rashedul Islam of BWDB, 3 km (ch. 25.3 km to ch. 28.3 km) along right bank of Bhadra river at Baroaria is under threat of erosion and a portion of it has suddenly been eroded on the night of April 19, 2019. The reason behind it as reported is the development of a bar at the middle of Bhadra river which made the flow area constricted on the side channels. As a result, the near bank velocity along the right bank of Bhadra river at Baroaria is increased and caused bank erosion. However, BWDB has taken it up on an emergency basis through protective work by Geobag placement. Precautionary protective work by Geobag is also been done under Blue Gold program at Chandghor and other places, but they are not enough. A permanent solution to the problems is the demand of the local inhabitants.

Erosion problem in the peripheral river of Polder 29 is presented in the Figure 15 and some problems photographs are shown in the Figure 16.

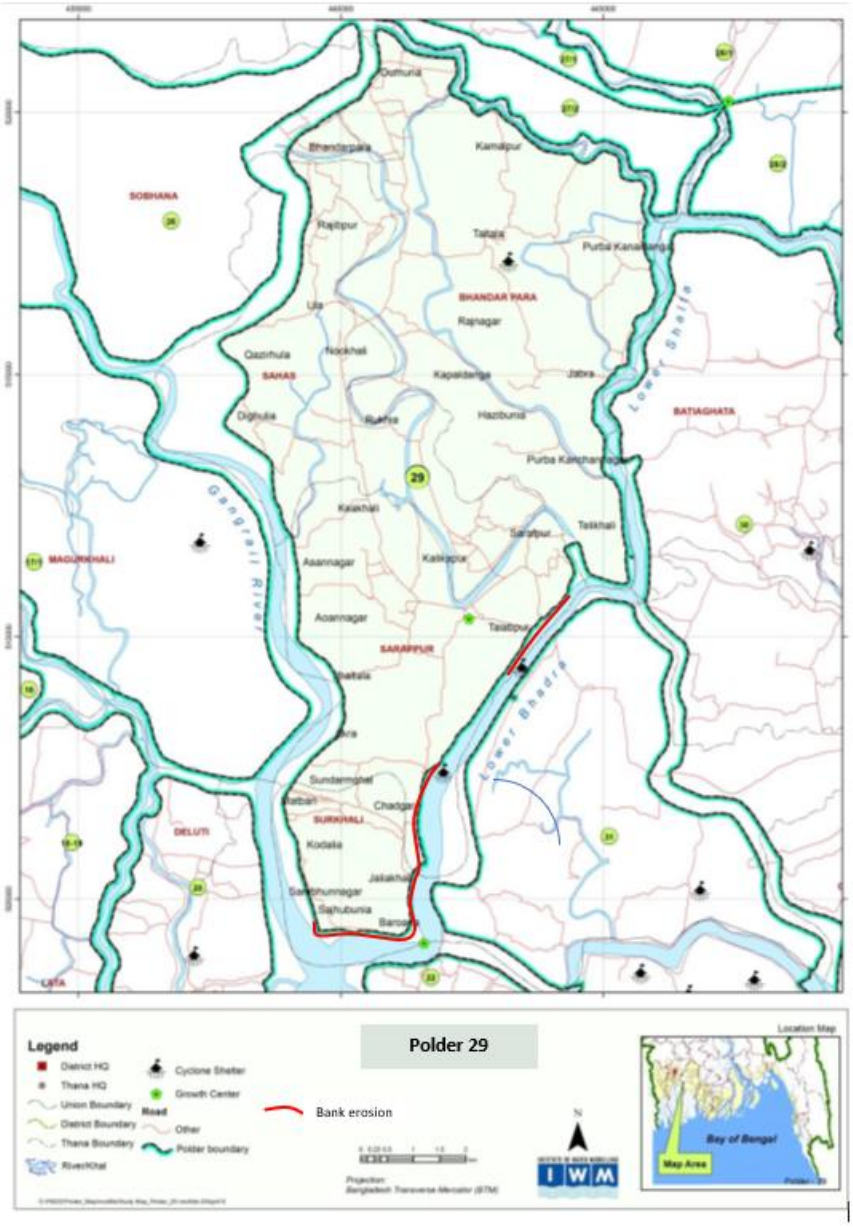


Figure 15: Detailed map of Polder 29 under Blue Gold Program

Figure 16: River bank erosion and siltation problem in the Polder 29

2.6.2 Polder 26

Polder 26 is situated in the south-west region of Bangladesh in Dumuria Upazila of Khulna District. The polder is surrounded by Mogra Bhadra River on the east and Teligati River on the west (Figure 4). The total embankment length of the polder is about 28 km and gross protected area is about 2,696 ha. The cultivable land is about 1,993 ha.

The existing condition of the peripheral embankment is good in most of the portion and only around 5% of it is paved. Blue Gold Program in this polder was initiated in January 2013 and their interventions for rehabilitation like re-sectioning of the existing embankment, repairing of 2 drainage sluices, construction of 2 new 2-vent sluices, construction of 2 new outlets and re-excavation of 9 inside drainage khals have made the polder free from the existed water logging and drainage problems. According to Mr. Hasnat (concerned Sub-Assistant Engineer, BWDB), no outstanding issue at present exists in Polder 26. However, he stated that siltation in Teligati river from Khornia Bridge towards south is being in progress which would be creating drainage problem for the polder soon. Figure 17 shows the detailed features of Polder 26.

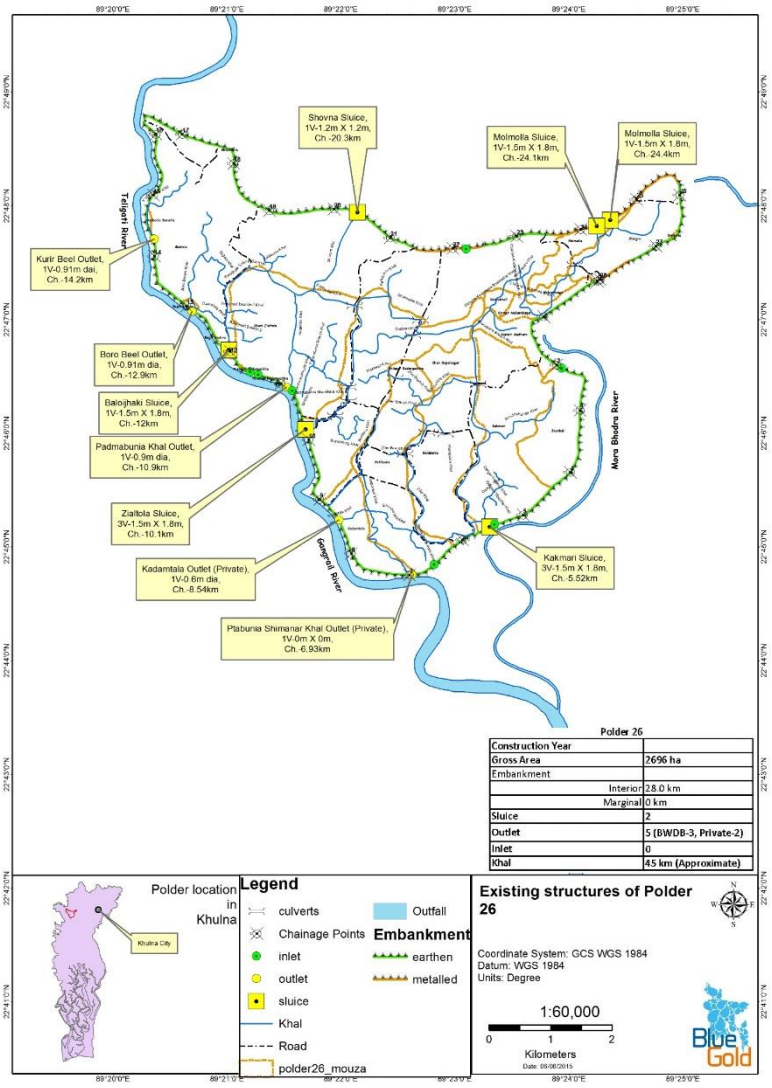


Figure 17: Detailed map of Polder 26 under Blue Gold Program

During the filed, some polder improvement work photographs have taken which are presented in the Figure 18.

Figure 18: Polder improvement activities in Polder 26

2.7 Polder 55/1

A 2-member team from IWM consisting of Mr. Upal Mahamud and Mr. Syed Shamsil Arefin visited Polder 55/1 on 04-07-2019 to perceive the existing condition of the polders. Polder 55/1 is situated in the south-central region of Bangladesh in Galachipa Upazila of Patuakhali District. The polder is surrounded by Tetulia River on the east and Lohalia River on the west (

).

The Team met Mr. Md. Hasanuzzaman, Executive Engineer, BWDB at his office at Patuakhali and Assistant Engineer Mr. Md. Miraz Gazi. They informed about the existing condition of this polder. The main problem of this polder is river bank erosion and the polder presently do not have waterlogging and drainage problems.

The team visited the most vulnerable part of this polder at Panpatty Bazar and Panpatty launch Ghat area along the bank of the confluence of Lohalia and Tetulia river. Local people informed that this area was mostly affected during the Cyclone SIDR, 2007 and still it is vulnerable to erosion. Some emergency protection work by sand geo-bag was observed and some new erosion area also found in this area (see the Photographs). Local people were also informed the team that there is some more erosion vulnerable area along the right bank of Tetulia river. Prior to visit Panpatty Bazar, the team also visited Boalia Sluice and the structure looks good in condition (Figure 20).

Figure 19: Location map of field visit at Polder 55/1

Figure 20: Existing sluice gate condition (Boalia) and erosion prone location at Panpatty Bazar in Polder 55/1.

3. Conclusions

There is a need of selecting 5 polders for conceptual design considering external drivers of change and preparation of a technical report in accordance with the ToR. Based on recent field visits, consultation with local communities and BWDB local officials, past experience and judgement and specific criteria eleven number of polders were short listed in order to select 5 polders. The main criteria of selecting the polders are; Opportunities of livelihood and water management, degree of vulnerability against storm surge, river bank erosion, drainage congestion, subsidence, salinity intrusion, water management, opinion of local BWDB officials and economic activities. BWDB will select 5 polders out of these 11 polders in consultation with the consultants of this research project. The detailed analysis and conceptual design will be carried out after selection of 5 polders.

The short-listed polders and their present situation and problems are summarized in the Table 4.

Out of the 11 short shortlisted polders 4 polders are located in the South-West Coastal region (Ganges Tidal Plain West), 3 in South-Central Coastal region (Ganges Tidal Plain East), 2 in South-East Coastal region (Meghna Deltaic Plain) and 2 in Eastern Hilly region (Eastern-Hilly Zone Polders). Selection of 5 polders for conceptual design need to be such that at least one polder has to represent a region. Moreover, as intended by the client, one polder of CEIP-I and one from BlueGold are to be included in the list of 5 polders to check the performances and need for further improvement. Considering all these, 5 polders have been finally selected in a meeting chaired by ADG (Planning), BWDB on 5 September 2019 with BWDB officials and a BUET representative. The meeting also decided to consider Polder 64/1a and Polder 64/1b as one polder. Table 5 summarizes the final list of 5 polders for the conceptual design.

Table 4: Short listed polders and their key characteristics

Polder Name	District	Coastal Region	Peripheral River	Key Characteristics	Remarks
Polder 14/1	Khulna	South-West Coastal region	Kobadak River and Sakbaria River	➢ Very little Freshwater flow from upstream River (Ganges) ➢ Influenced by strong tidal action, salinity problem is acute. ➢ Peripheral river Sedimentation is a major Problem; which creates drainage problem. People inside coastal polder ➢ Experiencing prolonged water logging. ➢ River bank erosion problem	Lack of fresh water, Salinity problem, Sedimentation in the internal drainage channels, lack of proper water management and water logging problem
Polder 15	Satkhira		Kobadak River and Kholpetua River		
Polder 29	Khulna		Lower Bhadra River and Teka Hari Teli Gang		
Polder 26	Khulna		Upper Bhadra and Teka Hari Teli Gang		
Polder 55/1	Patuakhali	South-Central Coastal region	Tentulia River	➢ Polder Embankment is facing river Erosion problem. ➢ Vulnerable to cyclonic storm surges.	Erosion and cyclonic storm surge
Polder 40/1	Barguna		Baleswar River and Bishkhali River		
Polder 43/2f	Patuakhali		Gulishakhali, Payra and Kukua River	➢ Vulnerable to storm surge ➢ vulnerable to erosion at Payra River side ➢ Severe water congestion inside the polder	Cyclonic storm surge, erosion and waterlogging
Polder 59/2	Noakhali	South-East Coastal region	Shahbazpur Channel (East)	➢ Morphologically active place; land accretion is dominant than erosion. ➢ Severe river erosion due to, thalweg migration. ➢ Vulnerable to cyclonic storm surge. ➢ Some area subjected to prolonged water logging due to encroachment and land reclamation by closing of Tidal creeks.	Morphological problem, cyclonic storm surge and water logging problem
Polder 59/3b	Noakhali		Noakhali khal		
Polder 64/1a	Chittagong	Eastern Hilly region	Sangu River, Jalkadar Khal and Open Sea	➢ Vulnerable to storm surge. ➢ Prone to flash flood due to steep gradient of river and intense rainfall. ➢ Water logging ➢ Erosion around Sangu River	Cyclonic storm surge, flash flood, water logging and erosion
Polder 64/1b	Chittagong		Sangu River and Jalkadar Khal		

Table 5: Final list of polders for Conceptual Design

Polder Name	District	Coastal Region	Peripheral River	Key Characteristics	Remarks
Polder 15*	Satkhira	South-West Coastal region	Kobadak River and Kholpetua River	➢ Very little Freshwater flow from upstream River (Ganges) ➢ Influenced by strong tidal action, salinity problem is acute. ➢ Peripheral river Sedimentation is a major Problem; which creates drainage problem. People inside coastal polder ➢ Experiencing prolonged water logging. ➢ River bank erosion problem	Lack of fresh water, Salinity problem, Sedimentation in the internal drainage channels, lack of proper water management and water logging problem
Polder 29**	Khulna		Lower Bhadra River and Teka Hari Teli Gang		
Polder 40/1	Barguna	South-Central Coastal region	Baleswar River and Bishkhali River	➢ Polder Embankment is facing river Erosion problem. ➢ Vulnerable to cyclonic storm surges.	Erosion and cyclonic storm surge
Polder 59/2	Noakhali	South-East Coastal region	Shahbazpur Channel (East)	➢ Morphologically active place: land accretion is dominant than erosion. ➢ Severe river erosion due to, thalweg migration. ➢ Vulnerable to cyclonic storm surge. ➢ Some area subjected to prolonged waterlogging due to encroachment and land reclamation by closing of Tidal creeks.	Morphological problem, cyclonic storm surge and water logging problem
Polder 64/1a	Chittagong	Eastern Hilly region	Sangu River, Jalkadar Khal and Open Sea	➢ Vulnerable to storm surge. ➢ Prone to flash flood due to steep gradient of river and intense rainfall. ➢ Water logging ➢ Erosion around Sangu River	Cyclonic storm surge, flash flood, water logging and erosion
Polder 64/1b	Chittagong		Sangu River and Jalkadar Khal		

Note: *CEIP-1 Polder and **BlueGold Polder

Appendix-A: Comments and Responses

Comments and Suggestions of the World Bank and Responses by the Consultants

Short reference to report text/figure	Comment	Responses
Chapter 1	Key comments: - Current report covers description of 11 polders but no recommendation for selection of 5 for further detailing: - Framework of Component 5 is missing in the Introduction to understand how this report fits into this Component; - The report is very much focused on civil works/drainage/flood protection whereas this component is about polder design including consideratins about livelihoods/economic activities/drinking water/water management etc. For this but also next steps a more multi-disciplinary view is expected; - It is unclear how some activities in the TOR under Component 5 will be covered under Deliverables from Component 5 (e.g. activity 1-3 as per TOR); i think this warrants a discussion between BWBD/LTM Consultant (and possibly WB?) to better understand this component and its activities/deliverables;	Addressed in the revised report
Chapter 1	This chapter must provide a better introduction how this deliverable fits into the overall framework of the research program; see e.g the introduction of D5A-2 as example; also explain how the various activities as described per TOR within Component 5 link together and how this report/selection of polders will be used in the next activities; e.g. this report seems to be the first step of activity 4 (i.e. selection of 3-5 polders) under component 5 in the TOR, but what about activity 1-3? Which deliverable will cover those activities?	Addressed under *Steps and activities of Component 5 in Chapter 1*
Chapter 1	"ToR stipulates to refine (Component-5) concept of polder design and management to see in which of the remaining polders in the CEIP-1 project these concepts could be applied." => this is outdated information from the TOR and won't very likely happen since CEIP-1 ends in 2022/2023 (and designs of CEIP-1 have been finished); recommend to formulate this in a more general sense, i.e. that the output of this analysis can inform any future polder rehab project/program in the coastal zone (future phases of CEIP and/or other programs)	Updated
Chapter 1	This chapter must also be consistent in terms of what will be done; the second sentence talks about 3 polders, later on it is 3-5, and ultimately 5 polders are selected based on the text (i realize that the TOR is a bit confusing here but the report should be clear!);	Rewritten
Chapter 2	Please include some rationale on why these 11 polders (out of 139) are representative/have been selected; what has been the basis for these polders? Spread across the coastal zone is	Included

Comments and Suggestions of the World Bank and Responses by the Consultants

Short reference to report text/figure	Comment	Responses
	definitely one of them, but what else? Inner coast/exterior coast? small/large? severe waterlogging issues? etc.?	
Chapter 2	Polder 14/1 and Polder 15 are indeed part of the CEIP-1 program but have been dropped from construction works (detailed designs have been made though)	Noted
Chapter 2	The text in this section (and also other sections) must be edited to make it a more comprehensive story and better readable in terms of contents and structure; now the text is mainly focused on the civil works/flood protection and drainage infra but the text should also provide some sense of the livelihoods, economic activities, spread of population, existince of shelters, water management structure/organization, drinking water facilities etc.etc. see also TOR	Will be covered in the upcoming reports of Component 5
Chapter 2	Polder 15: what seems completely missing here is that this polder was affected severely by cyclone Amphan in 2020? (because the visits were in 2019??)? There was a breach and it was severely flooded.	The information is updated
Section 2.7 and 2.8	These do not fit into the report structure; please include the text where it fits into the polder descriptions;	The report is restructured
Chapter 3	I miss here a recommendaton from the Consultant which 5 would be preferable/suggested to BWBD to be chosen and for what reasons. This can be finetuned following discussions with BWBD and a final choice has been made; one argument to select (at least one) CEIP-1 polder could be that such a polder may be a good candidate for a next program (and thus lessons learned could be implemented).	Added in the last paragraph of Chapter-3