PEOPLE'S REPUBLIC OF BANGLADESH
BANGLADESH WATER DEVELOPMENT BOARD
LOCAL GOVERNMENT ENGINEERING DEPARTMENT

PREPARATORY SURVEY FOR HAOR AREA RESILIENCE AND DEVELOPMENT PROJECT

FINAL REPORT (ADVANCE DISCLOSURE VERSDION)

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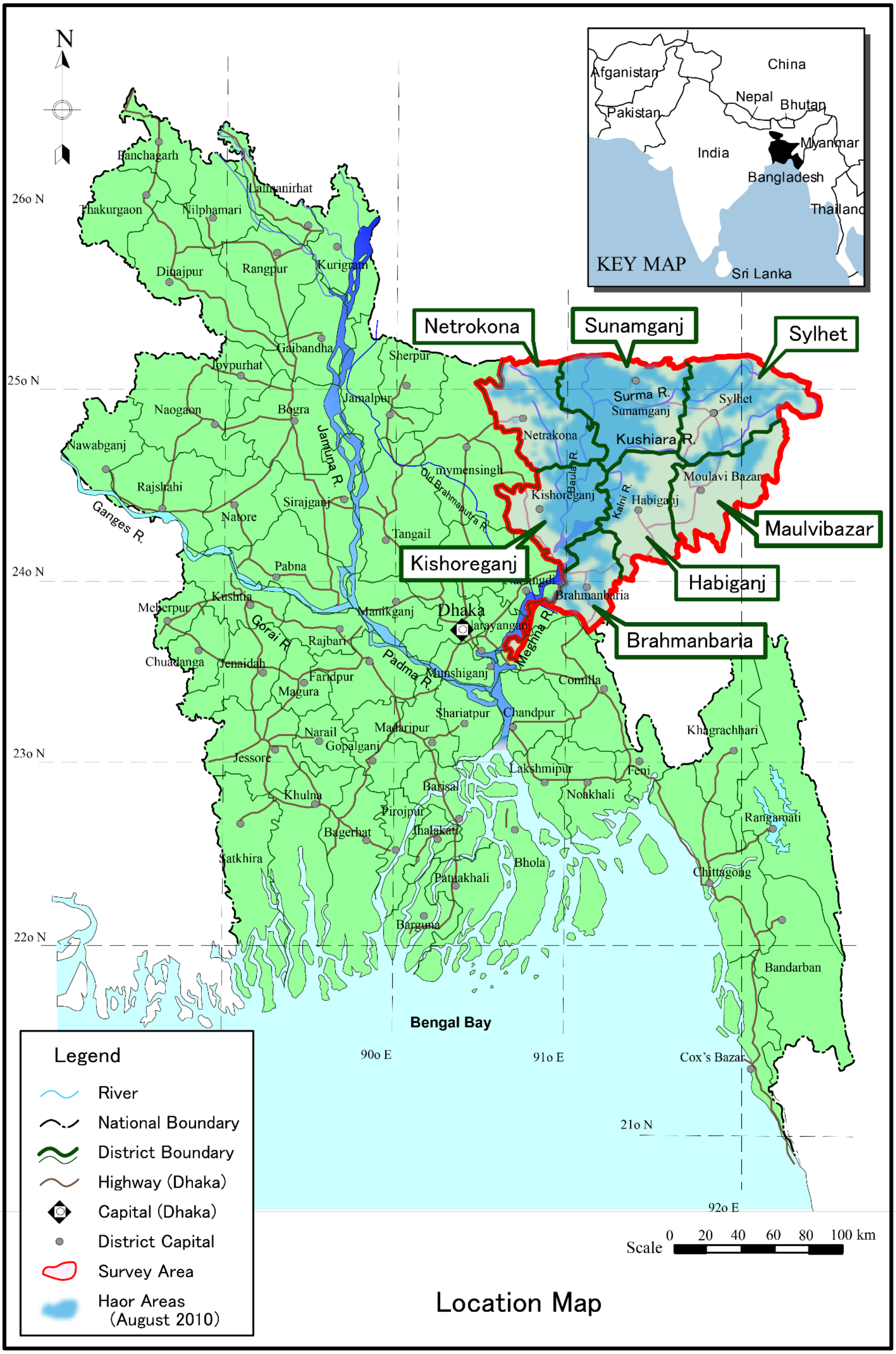

Source: Data Collection Survey on Water Resources Management in Haor of Bangladesh, Final Report, JICA, December 2023

< Summary >

I. INTRODUCTION

1.1 In the Haor region, situated in the northeast of the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh"), much of the area is submerged during the monsoon season, which lasts from around June to November each year. This area is characterized by low-lying wetlands, known as "haors", that are scattered throughout the region. The Haor region is facing severe and escalating climate risk. Observational data and advanced climate model projections indicate a clear direction towards a new climatic regime, characterized by significant warming, a hazardous redistribution of seasonal rainfall, and an increase in intensity of extreme weather events. These changes pose a fundamental threat to the region's socio-ecological stability and the livelihoods of its nearly 20 million residents. The region faces a worsening threat, characterized by intensifying dry-season aridity and escalating wet-season flood risks. Consequently, the two pillars of the haor economy, namely, "dry-season Boro rice" and "wet-season fisheries", are under significant negative impacts due to climate change.

1.2 This project aims to reduce flood damage and improve a) access to basic infrastructure, and b) agricultural and fishery productivity in the haor area, through (i) rehabilitation/construction of flood control facilities (full/submergible embankments, regulator, and others) and rural infrastructures (submergible Village road, market, wharf, and various infrastructure), (ii) agriculture and fisheries promotion activities (practical guidance of agricultural technology, support for sustainable use of fishery resources, and other activities), thereby contributing to stable food supply and climate change adaptation in the country.

II. BACKGROUND OF THE PROJECT

Development Plans in Bangladesh

2.1 The following plans are introduced as the national policies of Bangladesh in close relation to haor area resilience and development.

	Plan	Covered Period	Descriptions Related to Haor Region
1	Bangladesh Delta Plan 2100 (BDP 2100)	2015-2100	The haor area has been identified as one of the food insecure regions in Bangladesh in terms of agricultural production and food supply: a single crop (Boro rice) can be grown due to a longer period of annual flooding, resulting in food insecurity. Hence, the strategies include "protecting agriculture and vulnerable communities from floods, together with alternative livelihood".
2	Perspective Plan of Bangladesh 2021-2041 (PP2041)	2021-2041	The PP2041 focuses mainly on integration of environmental and climate change considerations into growth strategy. The specific strategies include the following: ● Implementing the "Bangladesh Delta Plan 2100 (BDP2100)" to build resilience and reduce vulnerability to climate change.
3	The Eighth Five Year Plan (July 2020-June 2025) (8FYP)	2020-2025	The following themes are incorporated into the strategies, policies, and programs. ● GDP growth acceleration, employment generation, and rapid poverty reduction. ● A sustainable development pathway that is resilient to disaster and climate change.

Source: JICA Survey Team

Current Situation of the Haor Area

2.2 Much of the haor area is submerged during the monsoon season (around June to November), with low-lying wetlands, known as “haors”, scattered throughout the region. In haors, Boro rice, which is positioned as the staple food of the Bangladeshi people, is cultivated as a single crop and serves as the main source of income. Boro rice is harvested by mid-May each year, but occasionally, sudden floods (flash floods) occur before harvest, causing damage to crops and preventing their harvest. It is noted that recently, flash floods have occurred more often than expected. As a result, the livelihoods of people in this region have become unstable, making the region one of the areas with a high poverty rate[1].

The Japan International Cooperation Agency (JICA) has implemented activities which include the following: (i) development of flood control facilities, such as embankments and regulators, and rural infrastructure, such as local roads and (ii) various agricultural and fisheries promotion activities as Yen loan project since 2014 (“Haor Flood Management and Livelihood Improvement Project”, hereinafter referred to as “the Phase 1”).

2.3 The submersible embankments, which are unique globally, are being submerged completely during the rainy season each year and function to prevent water from entering the haor before the harvest of Boro rice. The submersible embankments are subjected to overflow and wave erosion before and after the submersion, causing many sections to be eroded or completely breached. The damaged submersible embankments are repaired by the Bangladesh Water Development Board (BWDB), and the cycle of damage and repair occurs annually.

In Phase 1, various types of slope protection measures were tested as experiments. These types of slope protection measures have been in place for about four (4) years only, and one of the challenges for the next phase is to verify their long-term durability and effectiveness.

2.4 The development of rural infrastructure has been implemented by the Local Government Engineering Department (LGED). In Phase 1, the Project selected and constructed rural roads, markets, and boat landing stations, aiming to enhance synergistic effects with flood control measures and contribute to the promotion of agriculture and fisheries. Notably, many rural roads are constructed on the crests of submersible embankments, which has made flood control measures for these facilities a crucial aspect of rural infrastructure development.

2.5 In Phase 1, many programs were implemented for agriculture and fisheries promotion, such as training on agricultural and fisheries techniques to improve the capacity of agricultural and fisheries workers, provision of livestock to improve livelihoods, and promotion of new crop introductions.

As part of promotion activities, more than300 water users associations (WMGs) were formed by beneficiaries (mainly farmers in the haors) to maintain the facilities constructed for flood control. However, since the handover of the flood control facilities to the WMGs near the end of Phase 1, training for the WMGs during Phase 1 was not sufficiently conducted, and verification of their current operation and maintenance (O&M) capacities remains an issue.

In addition, 139 fishing unions (BUGs) were formed to carry out fishing by using the developed Beels (low-lying areas within the haors). However, when the leases for the Beels with the Government of Bangladesh (GOB) expired, they lost the right to control the Beels and consequently lost their place to operate.

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[1] Some haor districts like Kishoreganj and Netrokona have poverty rates as high as 53.5% and 34.0%, respectively. (POVERTY MAPS OF BANGLADESH 2016: Key Findings, 2020, BBS, World Food Programme and International Fund for Agricultural Development)

The lease for Beel is managed under the Jalmohal System[2] administered by the Ministry of Land (MoL). Application, renewal and operation must follow the procedures of this system. The challenge lies in developing the management capabilities of the BUGs and to maximize the time that they have to save money in preparation for bidding on lease renewals.

Recent Studies Related to Haor Phase 2 Project

Additional Study, Haor Flood Management, and Livelihood Improvement Project (BWDB Part)

2.6 This study was carried out by BWDB with consultants from July 2023 to March 2024 for the Haor Phase 1 Project, based on the following background. The descriptions below summarize the study's objectives, key findings, and recommendations.

2.7 Study Objective: A supplementary study was conducted to evaluate the effectiveness of the pilot program of slope protection works and to consider the applicability of the haor sub-projects proposed in the PDPP to successor projects of Phase 1.

2.8 Main Study Results

- Several changes were made to the planning, design, and construction methods of flood control facilities for Phase 1 from BWDB's technical standards. One major change was the adjustment of the pre-monsoon period for the design flood level (ten-year return flood level), changing the end date from May 31 to May 15[3].
- The BWDB field office completed the handover of facility operations to the newly established WMG and WMA by June 2023. In addition, BWDB conducted demonstrations and training sessions during the first year of operation to familiarize WMG with operational procedures, and practical technology transfer was carried out during this period. From the second year onwards, joint operations were carried out by WMG, WMA, and BWDB local staff, and operational adjustments were made based on the experience gained in the previous year.
- Some of the haor sites proposed in the revised DPP were also found to be included in the list of previous studies. This indicates that the need for projects on these haor sites had been recognized for some time. Compared to those not selected, the proposed haor sites had larger cultivable areas and higher rehabilitation costs per cultivable area, suggesting that more capital investment is required for their operation.
- A preliminary assessment of the haor sites proposed in the revised PDPP was conducted from perspectives which include the following: (1) technical, (2) economic, (3) environmental, (4) social, (5) capacity, and (6) institutional aspects. It was determined that their implementation is feasible and further detailed consideration should be conducted in a feasibility study.

2.9 Recommendations

- The constructed slope protection works are applicable to future similar haor projects. However, their periodic inspection and repair work must be continuously conducted. Further analysis of the mechanisms of flooding and drainage in haor is necessary to more effectively design countermeasures, including slope protection works.
- Evaluation of river water level (RWL) records from March to May revealed that RWLs during

2 Jalmohal System: A scheme under which public waters (lakes, Beels, and rivers) owned by the GOB are administered by the MoL, and usage rights of the waters are granted and renewed periodically through bidding and lease contracts. User entities, such as fishing unions (BUGs), pay lease fees under this system to obtain fishing and management rights.

3 This was decided at a joint meeting between the consultants and the BWDB design section on 26 January 2016. The reasons for this decision were: 1) most farmers are currently cultivating high-yielding varieties (HYV) of Boro rice, and the harvest season usually ends by May 15th; and 2) farmers want to use rivers and Khals (waterways) to transport rice in rural boats and also to draw water into the paddy fields earlier.

pre-monsoon period could potentially indicate dangerous RWLs for submersible embankments from mid-March to mid-April.

- Over the past ten years, pre-monsoon RWLs have exceeded the design crest elevation of submersible embankments two or three times. Future projects require updating the pre-monsoon design high water level (HWL).
- Wind direction during the rainy season (from pre-monsoon to post-monsoon) is important when considering the slope protection works of submersible embankments against wave action. Existing observation data does not clearly capture wind direction trends. Engineers involved in the design of haor sub-projects should collect information on actual wind conditions at each site.
- Further training and follow-up opportunities should be provided until the relevant parties are fully capable of operating the project. Therefore, a capacity development program targeting the WMAs established in Phase 1 should be included in the follow-up project. Operations by the WMGs and WMAs should be monitored closely by the BWDB. Any identified issues should be addressed promptly to minimize their negative impact on the following year's plans. Each organization should immediately begin and continue to maintain appropriate operational records.
- Further monitoring of the submersible dikes is recommended. This will help elucidate the failure mechanisms of submersible embankments in various locations and situations and improve the planning and design of slope linings.
- Runoff and inundation analysis methods have been used to identify weak points in submersible embankments and determine the necessary protective measures, but their accuracy needs further validation.
- Reducing the thickness of the currently used concrete (CC) blocks could potentially lower costs.
- For Type D (soil-cement work), a cement-to-soil ratio of 1:4 has been found to provide better protection for the embankment. Therefore, a higher soil-cement ratio than the current one is recommended.
- Rainfall data within Indian territory was limited and could not be adequately analysed. Hydrological data near the border were also scarce and inaccurate. These observation sites are inaccessible, and flash floods last only a short time, making it difficult for surveyors to measure discharge using current meters during floods. Therefore, only low-flow data are available, making it challenging to improve the accuracy of runoff models in flash-flooded basins. Improving the hydrological observation system is necessary to improve flood management planning.
- Hydrological and hydraulic analyses require longer computation times than analysts anticipated. Trial and error activity is essential for calibrating runoff and inundation models and optimizing structure layouts and reducing computation times remains a key challenge.
- Preliminary review of the revised PDPP: The selection of haor sub-projects involved in the project involved intensive discussions between BWDB and LGED, focusing on key considerations including embankments, village infrastructure, crop damage, flood vulnerability, and the economic status of local people. Additionally, feedback from stakeholders such as farmers, fishers, businesspersons, local dignitaries, and leaders is also being taken into consideration. It is advisable to further quantitatively assess the selected haors across multiple dimensions.
- A preliminary assessment of the proposed haors has been carried out, covering technical,

economic, environmental, social, capacity, and institutional aspects. A more detailed assessment of the similar one will need to be undertaken during the feasibility study stage.

Project Preparation/Pre-Feasibility Study for Haor Flood Management and Livelihood Improvement Project (LGED Part, Phase 2)

2.10 Based on the findings of the Haor Flood Management and Livelihood Improvement Project – HFMLIP (2014) (Phase 1; LGED component) conducted by JICA in 2014, it was revealed that the Haor region is among the poorest areas in the country, requiring urgent measures for socio-economic development. Consequently, the GOB decided to conduct the Haor Phase 2 Feasibility Preparatory Study (LGED). The Feasibility Preparatory Study (LGED) was carried out from 2014 to 2024 in 26 haors, selected through consultations between BWDB and LGED, across five districts of the Haor region: Netrakona, Habiganj, Brahmanbaria, Kishoreganj, and Sunamganj.

2.11 The objective of the Feasibility Preparatory Study (LGED) was to improve living standards and stimulate economic activities in the Haor region through enhanced access to social infrastructure such as education, health, and markets, as well as through increased fishery productivity. To achieve this, the following activities were proposed.

i) Development and rehabilitation of rural roads and infrastructure in the Haor region, including boat landing stations (Ghats), markets (Hats), and village protection walls.

ii) Implementation of fishery promotion activities in the Haor region.

iii) Improvement of living standards and promotion of economic activities in the Haor region.

iv) The priority areas for rural infrastructure development and fishery promotion under the Feasibility Preparatory Study (LGED) were selected to respond to infrastructure needs, which is identified in the Master Plan formulated in 2012 and to expand and sustain the achievements of Phase 1 implemented in 2014. Furthermore, as fisheries constitute one of the principal sources of income for residents in the Haor region, measures to improve fishery productivity were implemented in parallel with infrastructure development in order to contribute to livelihood enhancement for beneficiaries.

2.12 Main Findings and Recommendations

(1) Findings

a) Rural Roads: Among the existing paved rural roads, those requiring rehabilitation and maintenance were included as project targets. The selection criteria prioritized roads where damage was assessed to significantly hinder the mobility of residents within the haor areas. Across the 26 targeted haors, approximately 235 km of existing roads were identified as requiring rehabilitation and maintenance and were consequently included in the project scope.

b) Markets (Hats) and Boat Landing Stations (Ghats): Market development was included in the project scope to provide an environment that enables larger volumes of agricultural products, fish, and other goods to be traded more hygienically and efficiently, thereby reducing losses. The improvement of boat landing stations (Ghats) is also crucial for residents of the haor areas, who mainly rely on river transport for the shipment of harvested rice. These facilities will enable safer and more efficient loading and unloading of passengers and goods, while strengthening the network from harvest to distribution. According to the Benefit Monitoring and Evaluation (BME) survey conducted for Phase 1, market improvements resulted in increased trade volume and visitor numbers, with more frequent participation by women. The survey also indicated a substantial rise in the value of privately owned land surrounding the improved markets. Field data collection identified 41 Hats and 83 Ghats as project targets.

c) Village Protection Walls: As the Haor region consists of low-lying wetlands along rivers, it becomes submerged for several months each year due to monsoon floods and river overflows, with constant wave impact. Recent urbanization, construction activities, vegetation clearing, and changes in cropping patterns to increase agricultural output have further intensified the risk of wave action. Residential areas in the Haor region are generally built on land elevated above the floodwater level, and during Phase 1, some residents attempted countermeasures, such as raising land levels using dredged soil from Beels or sediments from Khals (canals). In other GOB projects, small-scale village protection walls were constructed, demonstrating their effectiveness in protecting settlements and property against wave action.

d) Fishery Promotion and Aquaculture Activities: For fishery promotion in the Haor, the improvement and management of Beels—key hubs for both capture and seasonal aquaculture—were included as project targets. Regarding institutional improvements, Phase 1 introduced and monitored Beel User Groups (BUGs). Phase 2 incorporates measures to ensure sustainability by enabling BUGs to independently manage and lease Beels beyond the project period. Khals, which connect Beels and serve as critical fish migration routes during the dry season, are also essential facilities. Many have been filled with silt due to soil erosion, thereby hampering fishery activities. Consequently, dredging of Beels and Khals was included in the project scope. Field surveys identified 328 Beels and approximately 600 km of Khals as targets.

(2) Recommendations and Considerations

Rural roads targeted under the project are principally those located within haor embankments. However, some roads located outside the haors were also selected. This is because such roads function as arterial routes to other towns or as essential livelihood roads connecting villages, both of which are vital for the daily lives of Haor residents.

Comprehensive Study for Evaluation and Updating of Master Plan for the Haor Area

2.13 The Haor Master Plan (HMP), a 20-year framework plan, was formulated in 2012 by the Department of Bangladesh Haor and Wetlands Development (DBHWD), as an “integrated development plan”, which aims to:

- Optimizing the available resources of the Haor area for the future development of its potentials;
- Expanding eco-friendly settlement areas to ensure housing for the poor; and
- Developing rural livelihood to ensure a healthy liveable environment.

2.14 It has been more than a decade since the inception of HMP, and several critical changes and challenges have emerged in the Haor area, making it essential to update the HMP. Therefore, the comprehensive study (2025) has established the vision and five (5) goals of the updated HMP, which are as framed below.

Vision: To transform the Haor region into a resilient, ecologically balanced, and economically vibrant landscape that safeguards livelihoods, ensures food security, and promotes inclusive and sustainable development, while preserving its unique biodiversity and cultural heritage.

Goals:

Goal-1: Environmental Sustainability: Ensure ecological balance by conserving wetlands, biodiversity, and water resources.

Goal-2: Climate Resilience: Strengthen flood management, erosion control, and early warning systems.

Goal-3: Sustainable Livelihoods: Improve agriculture, fisheries, and alternative income sources to enhance economic well-being.

Goal-4: Infrastructure Development: Expand transportation, energy, and communication networks for better regional connectivity.

Goal-5: Institutional Strengthening: Improve governance, policy frameworks, and stakeholder collaboration for effective implementation.

2.15 This comprehensive study assessed community needs through public meetings, discussions, and household surveys in various areas of the Haor region, mainly to gather community opinions regarding their awareness of the HMP and its impacts on livelihoods, particularly in agricultural and fishing sectors. In accordance with the outcomes of the needs survey, community feedback indicates a strong desire for collaborative approaches between the communities and government agencies to enhance socio-economic resilience in the face of environmental challenges.

2.16 In consideration of the community needs, a "thematic and programmatic approach" has been adopted for the effective implementation and monitoring of the updated HMP. Under this approach, a total of 17 programs, corresponding to the target sectors in the HMP, are classified into three (3) thematic areas: (i) Sustainable Natural Resources (SNR), (ii) Public Services Delivery (PSD), and (iii) Industrial and ICT Development (IID).

The project names "Haor Flood Management and Livelihood Improvement Project (Phase 2), BWDB Part (Implementing Agencies: BWDB, JICA)", and "Haor Flood Management and Livelihood Improvement Project (Phase 2), LGED Part (Implementing Agencies: LGED, JICA)" are included in the programs "T1P1 and T2P4" of the project portfolios of themes (i) and (ii), respectively. The Project is included in the programs of the updated HMP.

Climate Risk Profile in Haor Area

2.17 The foundational causes of climate risk in the Haor area are the measurable shifts in regional climatology. Several analyses of observed data and advanced climate model projections have revealed a system becoming hotter and drier in the winter, while being subject to more intense and concentrated rainfall, resulting in a paradoxical "flood and drought" environment.

2.18 The dependence on a single annual harvest of Boro rice characterizes the haor economy, creating immense systemic risk. The agricultural system is fundamentally misaligned with the current climate reality. The most acute threat is the widespread destruction of the standing crop due to early flash floods, which has now frequently occur before rice can be harvested. The 2017 flood serves as a stark case study of the potential for regional economic collapse from a single climatic event.

In that year, the severe flooding across the seven districts of the Haor region resulted in a loss of 993,332 tons of Boro rice, equivalent to approximately BDT 24.8 billion, through converting this loss at approximately BDT 25,000 per ton of paddy rice. If such severe flooding occurs frequently, the overall local economy would severely decline. This primary threat is compounded (i) by intensifying drought during the growing season, which places stress on irrigation supplies, and (ii) by rising temperatures, which can induce heat stress during the critical grain-filling stage, further diminishing productivity.

2.19 The haor's fisheries, the second pillar of the regional economy, are under severe pressure. Rising water temperatures are pushing aquatic systems beyond the optimal reproductive thresholds for key native fish species, directly disrupting spawning and reducing hatching rates. This thermal stress is exacerbated by altered hydrological cycles. Intense floods, subsequent siltation degrade, and shrink critical fish habitats, while reduced water levels during the extended dry season concentrate pollutants and eliminate vital dry-season refuges for fish.

Therefore, fish stocks and biodiversity, which directly influence the fisheries sector, one of the pillars of the Haor region economy, are declining. For example, in Hakaluki Haor, it has been reported that "approximately 32 out of 107 species" have disappeared or become rare (Aziz et al., Heliyon 2021), and in Tanguar Haor, the proportion of carp species declined from 7.55% in 2021 to 6.50% in 2022 (Akther et al. 2024). Furthermore, an interview survey in Tanguar Haor with 200 residents and fishermen revealed that 95.5% of respondents stated that "fish catches are decreasing day by day" (Environ 2013). This situation is having a significant impact on rural household incomes, employment opportunities, and regional nutritional security.

III. CLIMATE CHANGE IMPACT (CLIMATE HAZARD ANALYSIS)

3.1 Assessment Method

- To assess climate risks associated with the project, the current and projected frequency of climate hazards will first be evaluated.
- For future projections of climate hazards, the assessment will primarily refer to climate projection data based on the Representative Concentration Pathways (RCPs) used in the IPCC Fifth Assessment Report (AR5) and the Shared Socio-economic Pathways (SSPs) used in the Sixth Assessment Report (AR6).
- Key reference documents include:
  1. A Global Report: Reducing Disaster Risk – A Challenge for Development, UNDP, 2004
  2. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP), MOEF, 2009
  3. Bangladesh Delta Plan 2100 (BDP 2100), BOP, 2018
- In this study, the potential impacts of climate change will be assessed with reference to multiple IPCC scenarios. Future climate variables, such as rainfall, temperature, and solar radiation, will be obtained from Global Climate Models (GCMs) and used as a basis for preliminary analysis of potential climate change impacts.
- The selection of GCMs will primarily follow those used in the Coupled Model Intercomparison Project Phase 6 (CMIP6), although models from CMIP5 may also be utilized as necessary.
- The assessment of climate risks and potential adaptation measures to mitigate these risks will be addressed in Chapter 5: Preliminary Design of this report.

3.2 Current Status of Climate Hazards

- Bangladesh is highly susceptible to climate hazards such as floods, cyclones, storm surges, and droughts, and is considered one of the most climate-vulnerable countries in the world. In the study area, flood damage occurs particularly frequent, as shown in Table 3.2.1 of this report. Recent studies have shown that the magnitude and frequency of floods are increasing due to the effects of climate change[4].

- In the project area, flash floods are the most frequently occurring climate hazard. Although less frequent, cyclones have also affected the region and caused significant damage. For example, Cyclone Sidr, which occurred in November 2007, passed through Habiganj and Moulvibazar districts and directly hit the city of Sylhet. Additionally, post-monsoon droughts, due to reduced rainfall, have had a serious impact on farmers, especially in this project area where single-cropping agriculture is predominant.
- Based on the meteorological conditions of the study area, the climate hazards considered for this project are summarized in the table below.

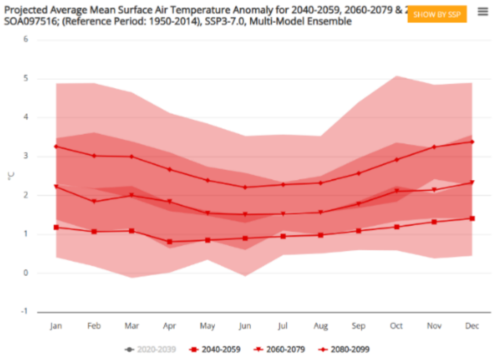
No.	Climate Hazard	Definition
H1	Flood	River flooding, including flash floods, primarily originating from upstream catchments in India.
H2	Heavy Rainfall	Inland flooding caused by intense rainfall within and around the project area
H3	Cyclone	Wind- and water-related damage caused by tropical cyclones originating in the Bay of Bengal.
H4	Drought	Drought conditions due to low rainfall or prolonged dry periods.
H5	Wind	Changes in wind speed and direction, and the occurrence of severe storms.
H6	High Temperature	Rising average temperatures and an increased frequency of heatwaves and extreme heat events.
H7	Cold Wave	Cold waves occurring during the winter season.
H8	Sunshine	Changes in solar radiation.
H9	Sea Level Rise	Poor drainage and habitat changes caused by sea level rise[5].

Source: JICA Survey Team

3.3 Future Projections of Climate Hazards

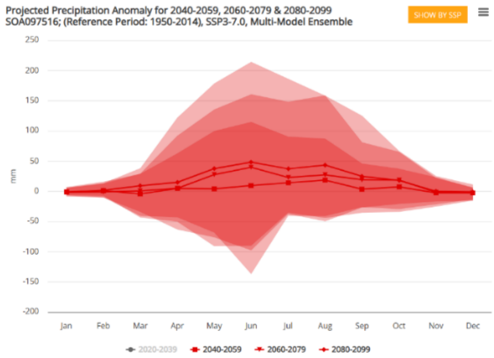
- As part of the literature review on climate variables, information from the IPCC Fourth Assessment Report, the Bangladesh Delta Plan Baseline Studies (2018), and the World Bank's Climate Change Knowledge Portal (CCKP) were compiled. In particular, the World Bank's CCKP organizes the analysis results of the IPCC Sixth Assessment Report based on CMIP6, presenting future climate values (basin-averaged temperature and precipitation) that approximately correspond to the Haor Basin. Figure below illustrates the monthly climate values under the CMIP6 SSP3-7.0 scenario for 2050, 2070, and 2090. The projections indicate an overall increasing trend in mean temperature throughout the year, while precipitation is expected to increase by approximately 50 mm during the monsoon season from May to August.

[4] "Bangladesh Delta Plan 2100" (2018)
[5] The downstream part of the survey area is a tidal zone, where river water levels are affected by tides. Consequently, sea-level rise may make it difficult for river water to flow downstream.



Average Temperature

Source: Climate Change Knowledge Portal HP



Average Rainfall

Source: Climate Change Knowledge Portal HP

- Given that the target rainfall events used for designing flood control facilities, developing flood forecasting systems, and analysing flash flood propagation mechanisms have durations of several days, the impacts of climate change on such events are likely to differ from those on the annual climatological averages. In this study, the dataset developed by Mishra et al., which applies bias correction and downscaling (0.25° resolution) to CMIP6 data, was utilized. Daily rainfall data were input into a river channel model for analysis. The 2004 flood event, equivalent to a ten-year return period rainfall, was selected as the case study. Rainfall data for runoff analysis were prepared under two conditions: one without considering climate change effects and another incorporating them, and the results were compared to evaluate the potential impacts of climate change. The SSP3-7.0 scenario, regarded as more realistic than SSP5-8.5 (which is often considered to produce overly high projections), was adopted. With reference to the 30-year project period (including both construction and operation/maintenance) assumed in the economic analysis of the Haor Phase 1 project, the target year was set as 2060, and data from 2047 to 2073 were used for the analysis.

  The results of the climate change impact assessment are presented below. The findings indicate that, as a result of climate change, the required design water level could increase by up to approximately 70 cm. Taking these calculated results into account, along with the required freeboard, the crest elevation of the submersible embankments was determined.

No.	HAOR_NAME	Nearby River	Pre-monsoon Water Level (mPWD) Without Climate Change	Pre-monsoon Water Level (mPWD) With Climate Change	Difference
1	Ballar Haor (Chegaiya Haor)	RATNASAT 24300	4.86	5.00	0.14
2	Boram Haor	CHAMTI-DARAIN_RIVER 2200	6.70	7.00	0.30
3	Chaptir Haor	KAMARKHALI_NADI 19400	6.74	7.04	0.30
4	Chayer Haor	OLDSURMA 40900	5.58	5.76	0.18
5	Dewghar Haor	DHALESWAR-NE 26700	3.60	3.71	0.11
6	Goradoba Haor	SOMESWARI 17500	6.96	7.17	0.21
7	Gurmar Haor	PATNAIGANG 52000	7.03	7.25	0.22
8	Hail Haor	LUNGLABIJNA 26500	6.35	6.88	0.53
9	Halir Haor	BAULAI 10100	7.04	7.26	0.22
10	Humayerpur Haor	GHORAUTRA 21600	3.29	3.50	0.21
11	Kalaruka Haor	SARIGOWAIN 66200	10.21	10.59	0.38
12	Karchar Haor	GATGOTIA_RIVER 9000	7.44	7.53	0.09
13	Kazirkhola Boro Haor	KALNI 48000	5.41	5.48	0.07
14	Khai Haor	MAHASING 24300	6.77	7.09	0.32
15	Khaliajuri FCD (Polder-3)	BAULAI 59010	5.57	5.68	0.11
16	Khuniyer Haor	DHANU 63680	4.82	5.00	0.18
17	Makalkandi Haor	BIBIYANA 26600	6.07	6.27	0.20
18	Mrigar Haor	LOWER-CHAMTI 9800	5.02	5.18	0.16
19	Muktarpur Haor	KUSHIYARA 77850	9.16	9.56	0.40
20	Naluar Haor (Part 1)	BHATTA-DAHUK 36900	6.77	7.09	0.32
21	Naluar Haor (Part 2)	KUSHIYARA 116850	7.39	7.78	0.39
22	Pathar Chauli Haor (Part 1)	SURMA 111600	9.32	9.91	0.59
23	Pathar Chauli Haor (Part 2)	A_PIYAN 43000	9.57	10.25	0.68
24	Shanir Haor	NANDIAGANG 14450	7.09	7.34	0.25
25	Sonamoral Haor	SOMESWARI 42500	6.88	7.08	0.20
26	Updakhali Haor	SOMESWARI 9300	6.97	7.19	0.22
27	Zilkar Haor (Part 1)	SURMA 78600	10.75	10.95	0.20
28	Zilkar Haor (Part 2)	SURMA 90000	10.34	10.65	0.31

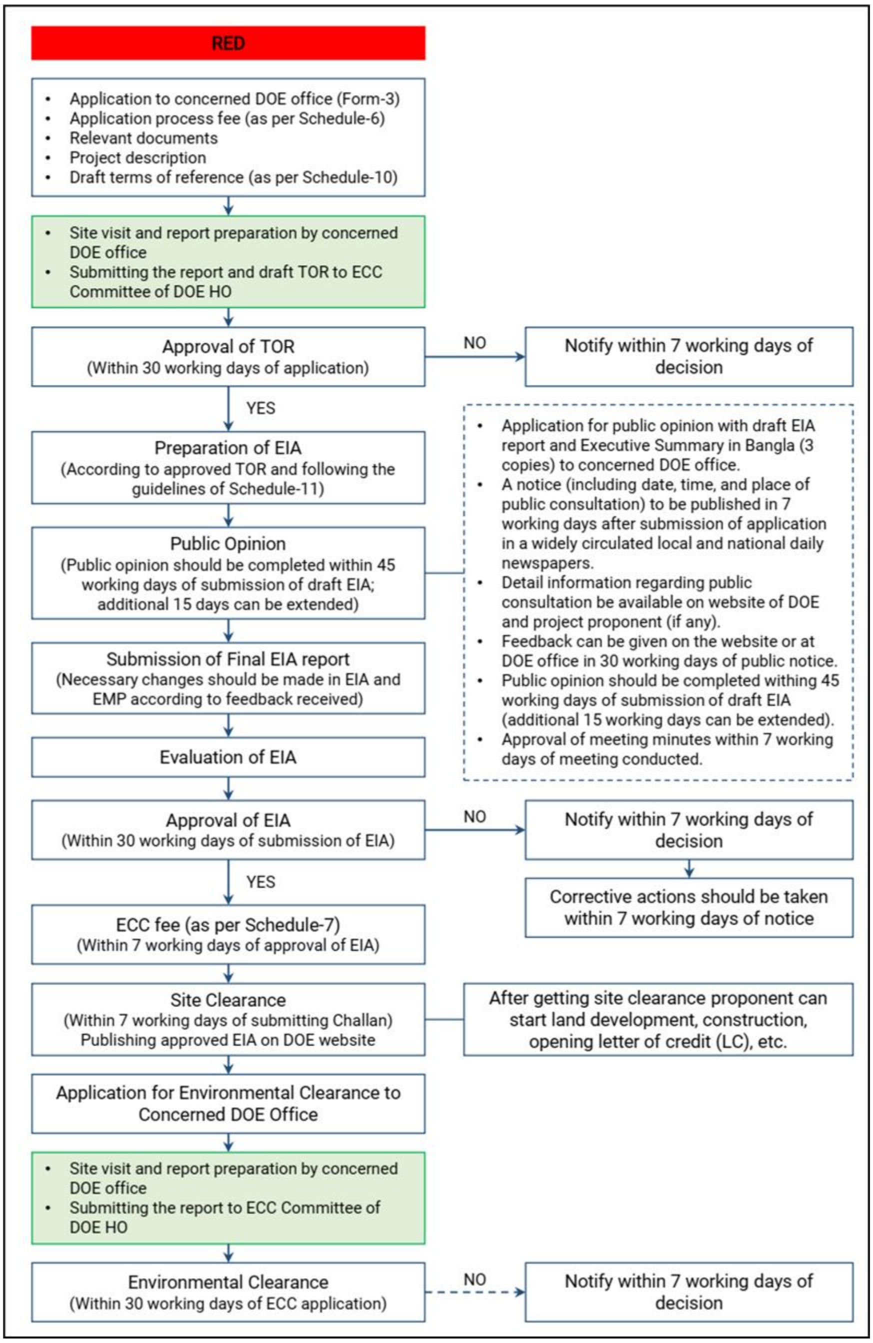
Source: JICA Survey Team

IV. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (PART 1)

Natural Environment

4.1 In this preparatory survey, the potential impacts of the Project on the natural and social environments will be assessed, and measures will be considered to avoid, minimize, or mitigate adverse effects. A draft Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) will also be prepared. Furthermore, an environmental baseline survey will be conducted in the Project area to assess the current environmental conditions, which will serve as a reference for quantitatively evaluating the Project's environmental impacts during the construction and operation phases.

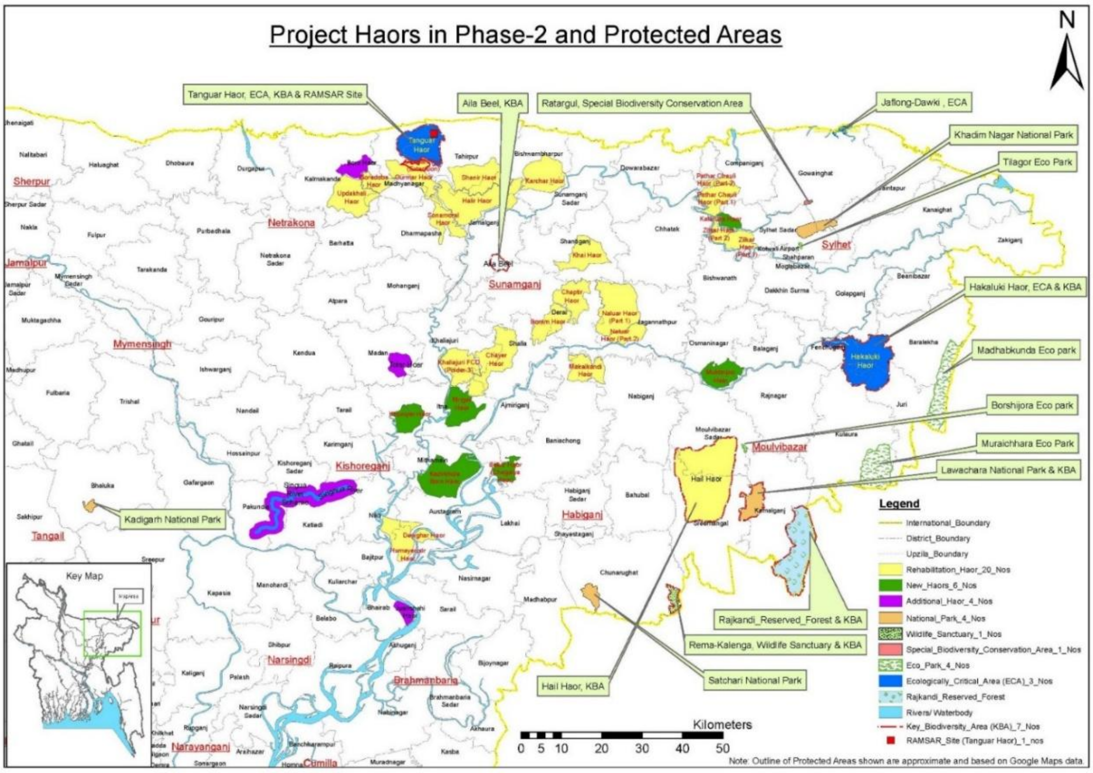
4.2 The national regulations of Bangladesh on Environmental Impact Assessment (EIA) are stipulated in the "Environment Conservation Rules (ECR) 2023". Based on the ECR 2023, every development project or industry specified as Red Category in Schedule 1 requires obtaining a Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from the Department of Environment (DoE). Also, according to Rules 14 and 15 of ECR 2023, a comprehensive EIA study is required to obtain an SCC from the DoE. In this project, the BWDB potion corresponds to "River Basin Development, Irrigation and Flood Control Project" under No. 60 of Schedule 1, and the LGED portion corresponds to "Dredging and Dredged Material Management of Rivers and Canals (including Beel) over 5 km" under No. 34 or "Road Construction or Expansion over 10 km" under No. 38 of Schedule 1. Thus, an EIA study is required for this Project under the Bangladesh legal framework. Detailed procedures to obtain ECC for Red Category are presented below.



Source: JICA Survey Team

4.3 There is no major discrepancy between the environmental regulation of Bangladesh and JICA guidelines for environmental and social considerations, except at the public consultation stage. JICA Guidelines provide for information disclosure both at the planning stage and after the preparation of the draft EIA report, whereas ECR 2023 requires disclosure after the draft EIA report.

4.4 In the selection of candidate haors, an assessment from the perspective of the natural environment was conducted as one of the evaluation criteria. A key environmental consideration in selecting the project haors is their geographical relationship with environmentally sensitive areas, such as protected areas and national parks. With the exception of Hail Haor, none of the candidate project haors fall within environmentally sensitive areas. Migratory birds visit the Haor region extensively during the winter season. In particular, Tanguar Haor is designated as a Ramsar site, while Hakaluki Haor and Hail Haor are recognized as Important Bird Areas (IBAs). From the standpoint of biodiversity conservation, Hail Haor is excluded from the project scope, while Gurm, which is located in close proximity to Tanguar Haor, is also excluded as a precautionary measure. As a result, important habitats and their adjacent areas have been excluded from the project. With the implementation of appropriate environmental protection and mitigation measures at the selected sites, potential impacts on migratory birds and other significant species are considered to be sufficiently minimized.



Source: JICA Survey Team

Social Environment

4.5 The scope of this JICA Preparatory Survey includes the investigation of social considerations of the Project in terms of its positive and negative impacts on the social context, including poverty and income, the mitigation measures for the negative impacts, and the monitoring plan for effective mitigation. The primary source of negative impacts associated with this Project is expected to arise from the land acquisition required for the Project, specifically for submergible embankments and village protection walls.

4.6 For land acquisition, the main law in Bangladesh is the "Acquisition and Requisition of Immovable Property Act (ARIPA) of 2017". The act must be complied with during the acquisition or requisition of land for any development purpose. Affected persons are entitled to receive their compensation for land and other assets in accordance with this law. However, it should be noted that there is no national law in Bangladesh for resettlement.

4.7 The land acquisition law of Bangladesh, namely, the Acquisition and Requisition of Immovable Property Act (ARIPA), 2017, is applied for the acquisition and requisition of properties required for development activities in Bangladesh. However, there is no specific resettlement plan mentioned under the Bangladesh law. Consequently, certain gaps exists between the land acquisition law of Bangladesh and the JICA Guidelines for Environmental and Social Considerations (2022). This survey will be conducted in compliance with both the JICA Guidelines and ARIPA, 2017.

V. PRELIMINARY PROJECT DESIGN

Flood Control Facilities

5.1 The implementing agencies, BWDB and LGED, conducted a joint meeting on 6 August 2023 and selected 26 haors for the Project implementation (the GoB List). Including these haors, a total of 44 haors, as presented below, were considered for selection for project implementation:

i) 26 haors from the GOB List.

ii) 17 haors considered in the JICA Data Collection Survey of Phase 1 (Data Collection Survey on Water Resources Management in Haor of Bangladesh, Final Report, JICA, December 2023), but not implemented yet.

iii) An additional of one (1) haor requested by the BWDB (Khaliajhuri – 1 Haor)

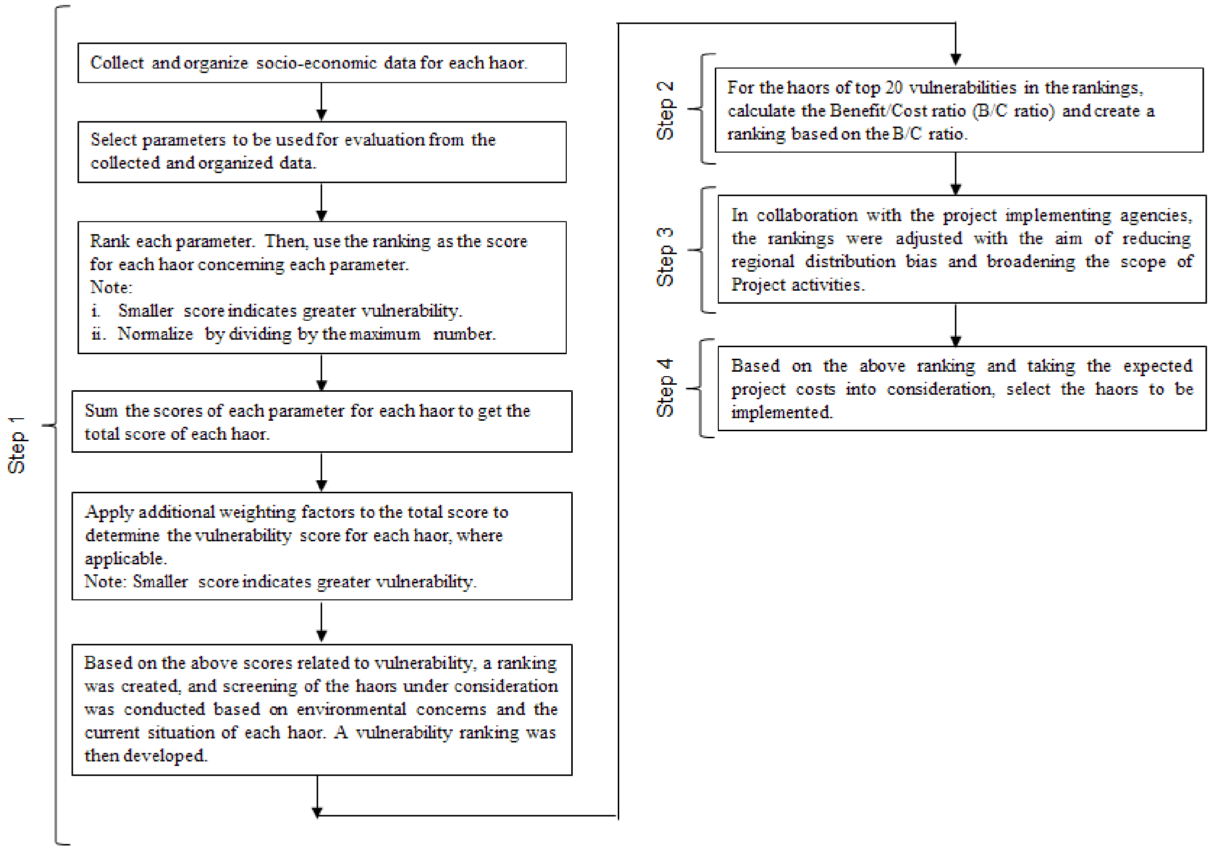
iv) In summary, 26 + 17 + 1 = 44 haors in total.

The selection of haors for project implementation was carried out by considering the vulnerability of each candidate haor, evaluating and ranking their economic viability, taking into account environmental concerns, and reviewing the current conditions of each haor, with due reference to the planned project costs.

No	Parameters		Parameter Available	Used for Selection (Physical Damage)	Used for Selection (Financial Damage)
1	Haor Basic Information	Gross Area of Haor, (ha)	O		
		Cultivable Land, (ha)	O	O	O
		Perimeter of Haor, (km)	O		
		Length of Submersible Embankment, (km)	O	O	O
		Length of Full Embankment, (km)	O		
		Population	O	O	O
		Number of Household	O		
		Average Monthly Income per Household, (BDT/HH/Month)	O		
		Poverty Ratio (%)	O		
		Rice Harvest Yield, (ton)	O	O	O
		Rice Harvest Yield per Area, (ton/ha/yr)	O		
		Catch Rate (Fishery: Capture & Culture), (kg/yr)	O	O	O
		Catch Rate per Water Surface Area (Fishery: Capure&Culture), (kg/ha/yr)	O		
2	Annual Damage without Flash Flood	Average Annual Damage Length of Embankment in Last Several Years (2018-2024), (km)	O	O	
		Average Annual Cost to Repair Flood Management Facilities in Last Several Years (2018-2024), (Lac BDT)	O		O
		Damage Length of Rural Infrastructure (Road) in Last Several Years (2020-2024), (km)	O	O	
		Repair Cost of Rural Infrastructure (Road) Last Several Years (2020-2024), (M BDT)	O		O
3	Damage due to Flash Flood in 2017	Damaged (inundated) Land, (ha)	O	O	
		Damaged Crop, (ton)	O		
		Cost of Damaged Crop (M BDT)	O		O
		Reduction of Fishery Catch Volume, (kg)	O		
		Cost of Damage to Fishery, (M BDT)	O		O

Source: JICA Survey Team

The selection process is summarized in the figure below.



Source: JICA Survey Team

Selection Process of Haor for Project Implementation

The selected haors, identified through the above selection process, are summarized in the following table. It is noted that, after considering the expected project budget, the ten (10) haors listed in the table below were selected after a series of discussions among the implementation agencies, JICA, and the JICA Survey Team. It was also agreed that Khaliajuri FCD-3 would serve as the 11th candidate haor for the Project, in the event that an additional haor can be implemented for any reason during the implementation stage.

	No.	Name of Subproject	Division Name	New Haor/ Rehab Haor
10 Haors selected for the Project	1	Naluar Haor-1	Sunamganj	Rehab
	2	Mrigar Haor	Kishorganj	New
	3	Makalkandi Haor	Habiganj	Rehab
	4	Chaptir Haor	Sunamganj	Rehab
	5	Shanir Haor	Sunamganj	Rehab
	6	Pathar Chawli Haor	Sylhet	Rehab
	7	Karchar Haor	Sunamganj	Rehab
	8	Halir Haor	Sunamganj	Rehab
	9	Humaipur Haor	Kishorganj	Rehab
	10	Khaliajuri FCD-1	Netrokona	Rehab
Next Candidate	11	Khaliajuri FCD-3	Netrokona	Rehab

Source: JICA Survey Team

5.2 The design for flood control facilities under the previous project (HFMLIP Phase 1) was reviewed as part of the Additional Study of HFMLIP Phase 1, as summarized in the following table, in comparison with previous BWDB design practices. Including modifications introduced during the implementation of the Phase 1, these revisions were generally positively received. For this Project, in consideration of the evaluation of climate risks and the assessment of adaptation measures, the basic design approach will be consistent with this previous design policy.

No.	Design	BWDB Design	Previous Project	Difference	Effect	Remarks
1	Protection period for preventing flash flood	31st May	15th May	Protection period was shifted earlier by 15 days.	Effective	Reduced risk of damage by shifting of harvesting time early.
2	Embankment section (top width/side slopes, CS-RS)	2.4 m-3.6 m/2:1-3:1	4.3 m/3:1-3:1	People can use the embankment as a local road.	Effective	Positive functional impact.
3	Embankment crest level	Water level of one-in-ten-year pre-monsoon flood + 0.3 m free board	Water level of one-in-ten-year pre-monsoon flood + 0.3 m free board	No change	N/A	In accordance BWDB Standard Design Manual.
4	Compaction of soil of embankment	Compaction by hand hammer; no test testing conducted.	Mechanical compaction up to 85% of MDD.	Soil compaction testing was introduced.	Partially effective, as damage due to wave action and current occurred at critical locations.	Effectiveness was partial.
5	Slope and crest protection of embankment	Turfing on slopes and crest by grass sods.	Turfing on slope and top by grass sods in general. Some	Slope and top protection with hard materials (CC	Damage occurred at some critical locations due to	Effective, but protection using hard materials

No.	Design	BWDB Design	Previous Project	Difference	Effect	Remarks
			reaches constructed with CC blocks on the crest over sand bedding for use as local roads.	block, sand-cement bags, and geo-bags over geofabric filters) were done at damaged locations.	wave action and currents.	increases project costs.
6	Gated regulators	Standard BWDB steel-gated regulator with standard vent size (1.5 m x 1.8 m).	Standard BWDB steel gated regulator vent size (1.5 m x 1.8 m)	No change in operational procedures.	Operational difficulties remain, as MS gates and hoist rusted early and hindered local navigation at some locations.	Facilitates water retention in canals but restricts local boat navigation.
7	Flood fuse	No structure designed.	Designed as safety structure for embankment protection, emergency flushing/ drainage, and local navigation.	Newly introduced at selected locations for opening during emergencies, improve navigation, and enable rapid post-monsoon drainage.	Effective	Requires yearly soil refilling, resulting maintenance costs and timely closure.
8	Drainage outlet	Used for pocket drainage.	Used for pocket drainage.	No adaptation made.	Effective	Effective
9	Irrigation inlet	Used for inletting irrigation water by LLP.	Used for inlet of irrigation water by LLP.	No adaptation made.	Effective	Effective

Source: Prepared by the JICA Survey Team based on HFMLIP Additional Study Report, BWDB, March 2024.

In addition, the conceptual design of the facilities was carried out with attention to the following points:

- The boundaries of each rehabilitation haor were defined by the location of existing embankments and other facilities. For haors where new projects are being implemented, the boundaries are primarily determined by the required setback distance from rivers, as stipulated in the BWDB Design Manual. Embankments are planned to be constructed along the boundaries of each haor.
- The crest elevation of embankments was determined based on hydraulic analysis, considering a flood with a ten-year return period, in accordance with the policy stated in the above table. The potential effects of climate change were also incorporated into the analysis.
- For flood control facilities, as part of the initial design, information regarding the types, locations, and quantities of flood control measures, based on field observations, was collected from the BWDB local offices. The JICA Survey Team subsequently reviewed this information to confirm its appropriateness and conducted further consultation with the BWDB local offices, as required.

- Among the slope protection methods, both Type A (which covers the embankment body with CC Blocks) and Type D (which covers the embankment body with sand-cement in jute bags) are rigid forms of protection. Type A is considered particularly effective in locations where water flow directly impacts the structure. Although Phase 1 identified concerns regarding the uniformity of Type D's quality, trial construction with increased cement content confirmed the effectiveness and improved quality control. Additionally, Type D is less expensive and relatively easier to maintain, which is expected to support future Haor region development projects by the Bangladeshi government after this project. Given the strong performance of Type A in Phase 1 and the limited record of Type D with increased cement content, it is currently impractical to replace Type A with Type D. Nevertheless, active utilization of Type D is considered desirable.

Based on the above outline design policies and considerations, the layout of the flood management facilities was examined for each haor and designed as shown on the map in Appendix 5.1.4. Major flood management facilities of the ten (10) selected haors are summarized in the table below:

Embankment (Full + Submersible):	322.9 km
Embankment Slope Protection (Types A, B5, C, and D):	80.0 km
Regulators:	7 nos
Flood Fuse:	30 nos
Khal Re-excavation:	49.5 km

5.3 The quantities and cost of flood control facilities for this project were estimated for each candidate Haor area, in accordance with the guidelines described below.

- The quantities for each facility were determined for each haor based on the conceptual design described in the previous section.
- The unit prices for each type of work were primarily derived from those summarized in the Additional Study of prior projects, with some items reviewed and adjusted as necessary. These prices are set at the March 2023 level. Any price increases occurring after that date were separately considered and incorporated into each haor's project cost during the cost estimation process.

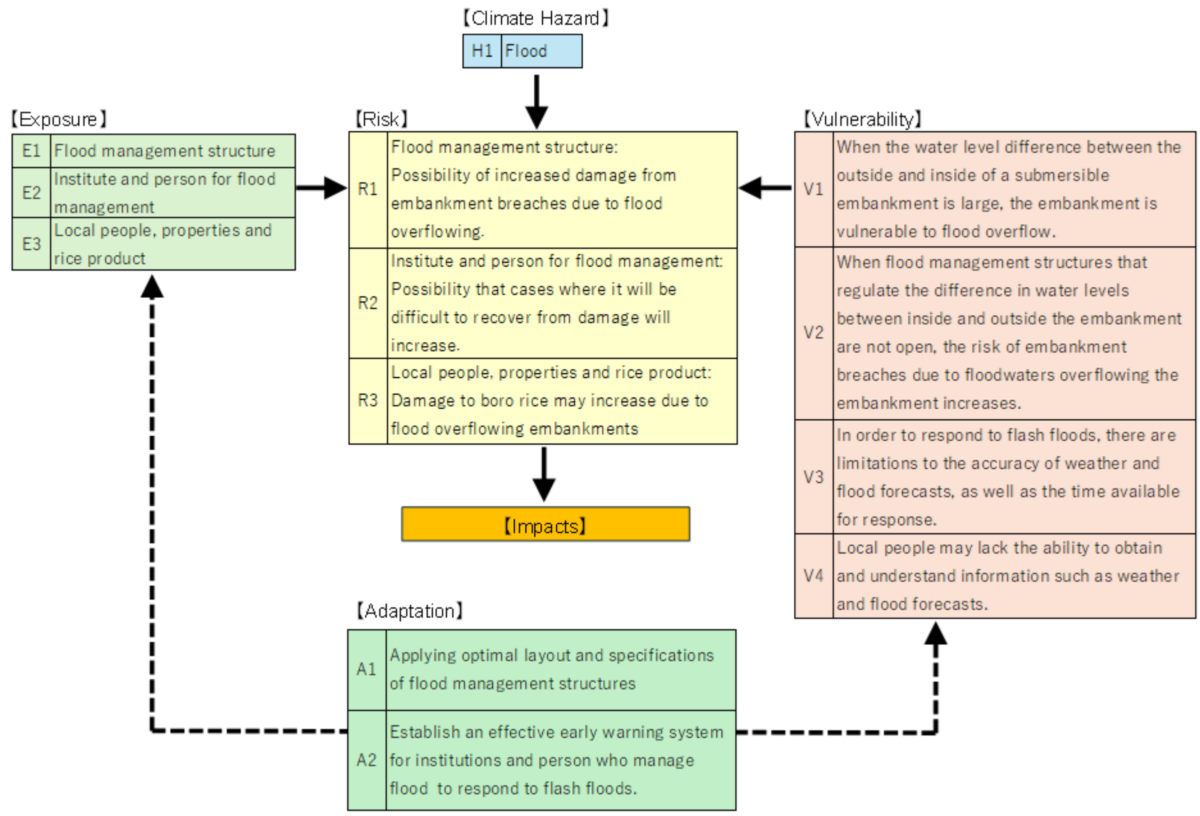
5.4 Climate Risk Assessment and Consideration of Adaptation

- The climate risk of this project was assessed with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).
- The exposure of this project to the above climate hazards is divided into three categories: E1 - Flood management structure, E2 - Institutions and personnel for flood management, and E3 - Local people, properties, and rice product. For each category, the current impact of each hazard is evaluated on a four-point scale from 0 to 3. Taking into account the projected future direction of changes in climate hazards, the hazards that should be monitored in each project activity are circled in red, as shown in the figure below as a climate risk matrix.

		Climate Hazard								
		H1 Flood	H2 Heavy Rainfall	H3 Cyclone	H4 Drought	H5 Wind	H6 High Temperature	H7 Cold Wave	H8 Sunshine	H9 Sea Level Rise
	Frequency	++	++	+	+	+	+	+	-	-
	Future	↗	↗	→	→	→	→	→	→	↗
Exposure	E1 Flood management structure	3	2	1	0	2	0	0	0	1
Exposure	E2 Institute and person for flood management	3	2	1	1	1	1	1	0	0
Exposure	E3 Local people, properties and rice product	3	2	1	1	1	1	1	1	1

Source: Prepared by the JICA Survey Team with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).

- The above climate risks were identified as significant future as "risks", and the factors that were considered to contribute to the occurrence of those climate risks were defined as "vulnerabilities". A climate risk tree was then prepared as shown in the figure below.



Source: Prepared by the JICA Survey Team with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).

- The number of people who will benefit from flood management measures was estimated to be approximately 645,000 for "A1: Applying optimal layout and specifications for flood control facilities, such as construction of slope protection works, to increase resilience against levee overflows," and approximately 9,364,000 for "A2: Building an effective early warning system that enables organizations and individuals involved in flood control measures and local residents to respond to flash floods."

5.5 Improvement of Flood Inundation Analysis for Layout Plan of Flood Management Structures

- There are three current issues with the model construction of the Additional Study: 1) the long time required for calculations, 2) the limited data available for verifying the constructed model, and 3) some of the topographical information being out of date. The following ideas for improving these issues were considered.
- Study of methods to reduce the calculation time for flood analysis: the improvement options of "deleting unnecessary areas (reducing non-flooded/non-examined areas)" and "increasing the mesh size (coarse meshing)" were adopted for improving the calculation model. The results of the speed-up of calculations are as follows:

Previous Calculation Time (As of April 2025)	Current Calculation Time (As of May 2025)	Speed-up Rate	Calculation Period
48 hours	12-15 hours	3-4 times	Mar. to Dec. (ten months)

Source: JICA Survey Team

- Examination of Methods to Verify Flash Flood Models Using Satellite Images: The flash flood model developed in the Additional Study was verified for reproducibility using data obtained by installing new water level gauges and conducting visual observations three times daily, since there was minimal existing water level record in the target area. However, this does not allow verification of major past floods, which remains an issue. In this project, the validity of the model will be verified using satellite images. For satellite images, Sentinel-1, which is available free of charge, will be used for this purpose.
- Application of topography estimation technique using satellite images: Topography data of Bangladesh created by SOB includes a 1960 paper-based map and a 2011 Digital Elevation Map (DEM). The 2011 DEM does not cover areas near the border with India; and therefore several haors are not included in the topographic map (Figure 3.5.1 in ITR). The applicability of the elevation estimation technique was evaluated at Naogaon Haor, where a bathymetry survey was carried out by BWDB in 2023. Lower elevation, for which accuracy is crucial for flood analysis, is well represented, although high elevation section is partially overestimated. Together with the result for Boram Haor, the applicability of this technique is promising. Using satellite imagery, highly accurate topographic maps can be obtained more readily in the Haor region. The generated maps make it possible to take into account for flood storage by haors in flood analysis, even in the areas where officially published topographic maps are not available. Additionally, changes in elevation over the years can be monitored. This technique can be used in lieu of field surveys to obtain elevation information needed for detailed design during the ODA project main stage, thereby reducing survey costs.

Rural Infrastructures

5.6 Scope of Rural Infrastructure Facilities under the Project

The rural infrastructure facilities targeted by this project are proposed to include the improvement and construction of rural roads, markets (Hats), and boat landing stations (Ghats) under the jurisdiction of LGED. These components have been selected from the perspectives of improving the efficiency of agricultural transport—particularly during the pre-monsoon Boro rice harvest season—enhancing access to basic infrastructure such as schools and hospitals and contributing to the revitalization of the local economy and the expansion of income-generating opportunities in haor areas.

Furthermore, although not included in Phase 1, village protection walls (VPW) are also to be incorporated into the scope of the project in response to requests from LGED. These structures are designed to mitigate erosion damage around residential areas caused by wave action during the monsoon season and are essential for protecting the lives and property of the Haor residents.

In addition, based on discussions with LGED, the maintenance and rehabilitation of existing roads with paved surfaces also to be included in the project. However, the costs for maintenance and rehabilitation should be covered by GOB.

No.	Category	Purpose of Improvement	Synergistic Effect with Flood Control
1	Rural Road Improvement	Improvement of Upazila roads, Union roads, and Village roads, including submersible roads, non-submersible roads, bridges, and culverts.	High (Mitigates the impact of flooding by enabling rapid transportation of agricultural and fishery products).
2	Market（Hat）Development	Development of growth centres and rural markets.	High (Facilitates the sale of produce within the Haor area).
3	Boat Landing Station（Ghat）Construction	Construction of new boat landing stations.	High (Enables transportation of produce within the Haor area).
4	Village Protection Wall Construction	Construction of the Village Protection Wall (VPW) to protect villages from wave-induced erosion.	High (Protects the assets and livelihoods of village residents).
5	Rural Road（Rehabilitation）	Maintenance and rehabilitation of existing paved Upazila roads, Union roads, and Village roads—including submersible roads, non-submersible roads, bridges, and culverts—to be implemented under the GOB budget.	High (Mitigates the impact of flooding by enabling rapid transportation of agricultural and fishery products).

Source：JICA Survey Team

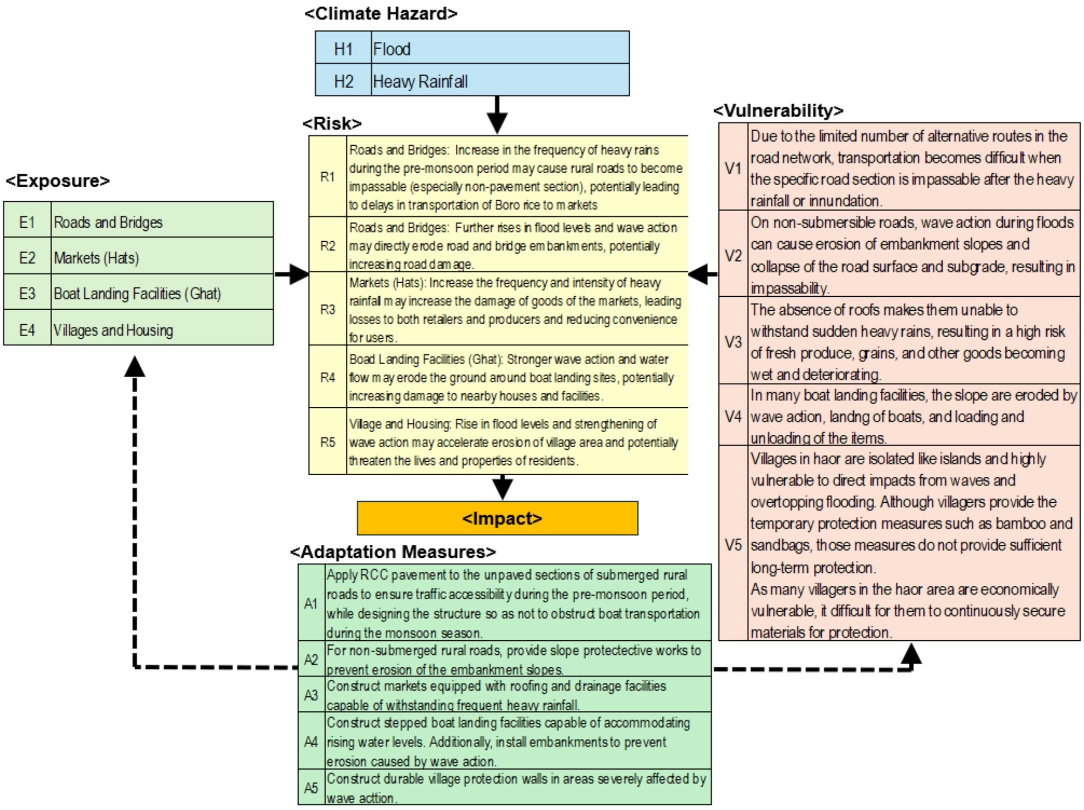
5.7 Climate Risk Assessment and Consideration of Adaptation for Rural Infrastructure

- The climate risk of this project with respect to rural infrastructure was assessed with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).
- The exposure of this project to the climate hazards is divided into four categories: E1 - rural roads and bridges, E2 - markets, E3 - boat landing stations, and E4 - villages and residential areas.

			Climate Hazard								
			H1 Floods	H2 Heavy Rainfall	H3 Cyclone	H4 Droughts	H5 Wind	H6 High Temperture	H7 Cold Waves	H8 Solar Radiation	H9 Rise in Sea-level
	Current Frequency		++	++	+	+	+	+	+	-	-
	Future		↗	↗	→	→	→	→	→	→	↗
Exposure	E1	Rural Roads and Bridges	3	3	2	0	2	1	1	1	1
	E2	Markets (Hat)	2	3	2	1	2	1	1	1	1
	E3	Boat Landing Facilities (Ghat)	3	2	2	1	2	0	0	0	1
	E4	Villages and Housing	3	2	2	1	2	1	1	1	1

Source: Prepared by JICA Survey Team with reference to "JICA Climate-FIT (Adaptation) - Climate Finance Impact Tool for Adaptation (March 2024)"

- The above climate risks were defined as significant in the future as "risks", and the factors that were considered to contribute to the occurrence of those climate risks were defined as "vulnerabilities". A climate risk tree was then prepared, as shown in the figure below.



Source: Prepared by JICA Survey Team with reference to "JICA Climate-FIT (Adaptation) - Climate Finance Impact Tool for Adaptation (March 2024)"

5.8 Challenges of Target Infrastructure

- As a result of the documentation review, the challenges related to rural roads, markets, boat landing stations, and village protection walls were identified as outlined below.

No.	Name	Challenges
1	Rural Road	Within the project target areas, some haor areas have pavement coverage that is lower than the national average. Improving the pavement and related infrastructure, particularly for Union Roads and Village Roads, which serve as the primary daily routes for Haor residents, remains a significant challenge.
2	Market（Hat）	Certain target areas also have fewer market facilities per capita compared with the national average. Developing markets (Hats), which function as important local trading hubs, is the priority.
3	Boat Landing Station（Ghat）	Boat landing stations (Ghats), which serve as critical transport points during the flood season, have been found to be in a deteriorated condition, making their improvement an essential requirement.
4	Village Protection Wall	In the target areas, erosion of embankments caused by wave action during floods has been observed in river-facing.

Source: JICA Survey Team

5.9 Design

Rural Road

- The pavement width and type for each selected rural road are presented in the table below. The road width was determined in accordance with the LGED Standard Road Design Guidelines, based on the assumed Commercial Vehicles per Day (CVD).

Type of Road		Design of Road Width (m)			
		Pavement Width	Total Width	CVD	Improvement Type
Upazila Road	Submergible	3.70	6.70	50-100	RCC Pavement
	Non-submergible	5.50	9.20	201-300	BC Pavement
Union Road	Submergible	3.70	6.70	50-100	RCC Pavement
	Non-submergible	3.70	6.70	50-100	RCC and Uni Block (50:50)
Village Road	Submergible	3.00	5.50	0-50	RCC Pavement
	Non-submergible	3.00	5.50	0-50	RCC and Uni Block (50:50)

Source: Prepared by the JICA Survey Team based on to LGED's "Road Design Standard"

- As a result of discussions with LGED, Uni Block pavement was selected for Union roads and Village roads, considering the characteristics and construction conditions of the Haor area. However, due to constraints related to material procurement and contractor availability, a mixed pavement application was adopted for non-submersible Union roads, with a 50:50 combination of Bituminous Concrete (BC) pavement and Uni Block pavement.
- For non-submerged roads, slope protection works using RCC retaining walls will be provided to prevent erosion and slope failure caused by flooding.
- As paving works are expected to be carried out within the existing road right-of-way, no land acquisition will be required for road construction (the same applies to markets and boat landing stations).

<u>Market（Hat）</u>

- Markets consist of general vending sheds, women's vending sheds, fish and meat vending sheds, toilets, tube wells, and a management building, among other facilities. As markets are often located along rivers or waterways, priority is given to selecting sites on elevated land that are not inundated during the monsoon season, in order to prevent riverbank erosion resulting by wave action during the rainy season.

Item	Number
General Shed	1
Women's Shed	1
Fish and Meat Shed	1
Open Platform	1
Male Toilet	1
Female Toilet	1
Tube Well	1
Management Committee Office	1
Drainage and Waste Management Facilities	1

Source: JICA Survey Team

- As markets requiring land acquisition are excluded from the Project, no land acquisition will be involved.

<u>Boat Landing Station（Ghat）</u>

- Reference was made to the standard drawings established by LGED. The specifications shall be selected from the standards below, in accordance with the scale of the boat landing station.

Type A: Standard specifications applicable to boat landing stations (Ghats).
The step width is 1.5 m. The tread depth is 250 mm, and the riser height is 125 mm.

Type B: Specifications applicable to Ghats associated with growth centers.
The step width is 3.0 m. The tread depth is 400 mm, and the riser height is 200 mm.

Village Protection Wall

- The Village Protection Wall will be implemented along the entire village perimeter, with high-rigidity structures on wave-exposed sections, and nature-based solutions applied to the remaining sections to reduce overall costs.
- The high-rigidity protection measures consist of a toe wall system, which is easy to construct and suitable for long-term service. On the opposite side, where wave action is considered less significant, protection using vegetation and sandbags is applied. In addition, sandbags will be installed at the toe of the wall to prevent scouring at the foundation and subsequent tilting of the retaining structure.

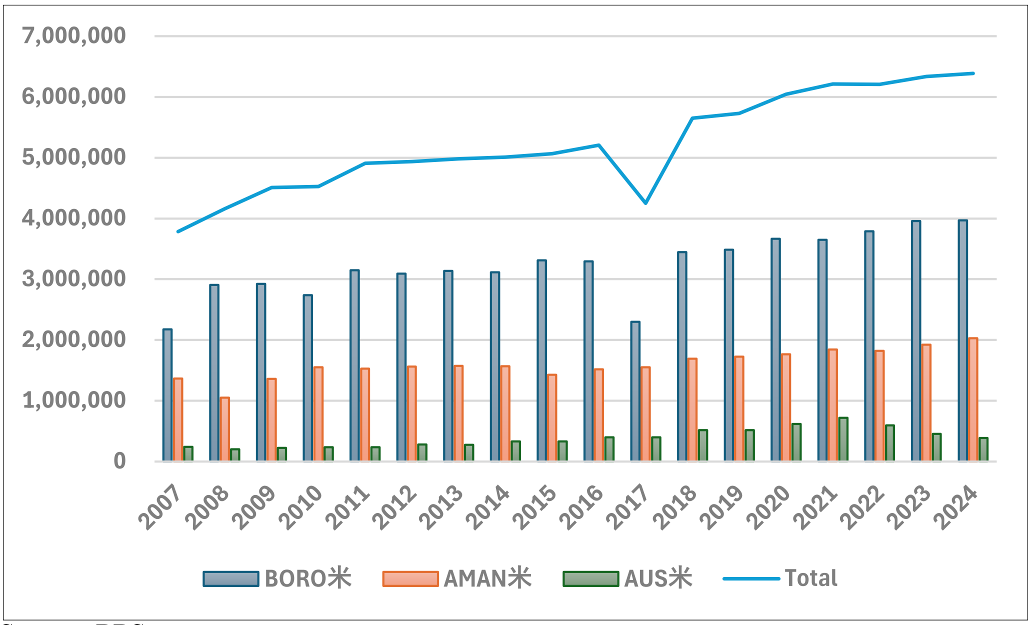
Construction Method	Location	Length (m/village)	Remarks
CC Block and Toe-Wall Protection	Areas exposed to strong wave-induced erosion such as along rivers	260 (10% of total 2,600 m)	Includes toe stabilization using sandbags
Nature-Based Solutions (Vegetation and Sandbag Protection)	Areas not directly exposed to wave action	2,340 (90% of total 2,600 m)	Includes slope protection using sandbags

Source: JICA Survey Team

Agriculture and Fisheries Promotion Activities

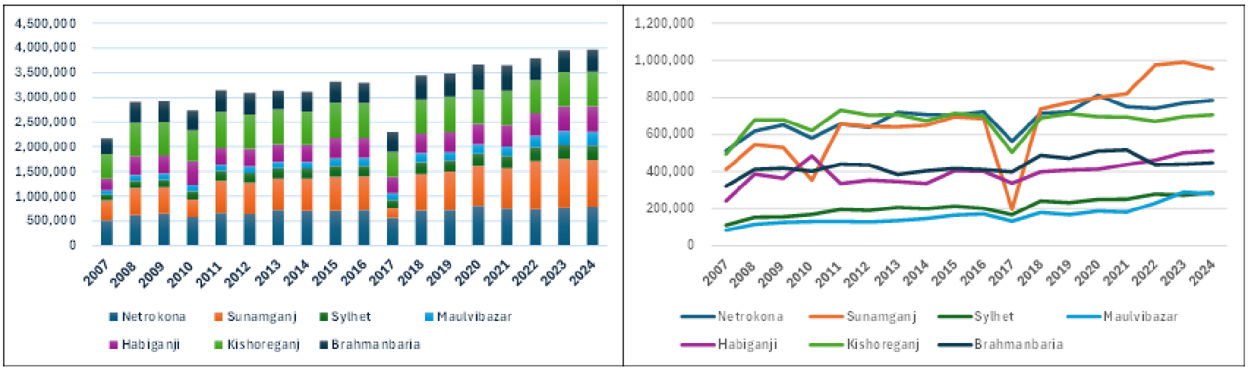
Agriculture Promotion Activities

5.10 According to publicly available data from the Bangladesh Bureau of Statistics (BBS), the total production of Boro, Aman, and Aus rice in the seven haor districts increased from approximately 3.73 million MT in 2007 to approximately 6.39 million MT in 2024, representing an increase of about 1.7 times, as shown in the figure below. The production ratio of the three rice varieties is 60% for Boro rice, 30% for Aman rice, and 10% for Aus rice, with Boro rice accounting for the largest portion of production.



Source：BBS

5.11 The production volume of Boro rice across the seven haor districts has increased by approximately 1.8-fold, rising from approximately 2.17 million MT in 2007 to around 3.97 million MT in 2024, representing an average annual growth rate of 7%. By district, the production volume of Boro rice in Sunamganj, Netrokona, and Kishoreganj districts is higher than in other districts.



Source：BBS

The year 2017 experienced the worst flooding since 2010, and as shown in the figure below, the loss of Boro rice production in these three districts was 843,967 MT compared to the previous year.

Boro Rice Production (MT)	Year 2016	Year 2017	Lost Amounts in 2017
Sunamganj District	685,226	196,500	△488,726
Netrokona District	722,996	563,439	△159,557
Kishoreganj District	699,047	503,363	△195,684
Total	2,107,269	1,263,302	△843,967

Source：BBS

5.12 The results and review of Phase 1's agricultural promotion activities and small-scale livelihood improvement were evaluated on a three-point scale, with ◎ and ○ indicating effectiveness and △ indicating ineffectiveness, as shown in the table below. From the perspective of the review, activities deemed effective were assessed based on the number of times they were implemented, the number of beneficiaries, and their impact on improving agricultural techniques and livelihoods.

Review of Agricultural Promotion Support Sub-Project in Phase						
	Agriculture Promotion Support Sub-Project (APSS)	Contents of Activity	Project number	Number of beneficiaries	Review*	
1	Farmer Field visit program to RDA/BARD	Farmers visit to Rural Development Institute	4 batches	350（Farmers）	◎	Effective in broadening farmers' perspectives
2	Farmer Training Program specially for agricultural promotion	Training farmers (30-45 people/batch) on new technologies such as flash and flood prevention	743 batches	31,579（Farmers）	◎	Training on flood prevention measures for rice cultivation. Rice cultivation is an important livelihood in the haor region and is effective
3	Training on Homestead Vegetable Cultivation (Women)	Home gardening training for women	112 batches	3,890（Housewives）	◎	Home gardening is effective not only for providing nutrition to the table but also for improving livelihoods during the rainy season.
4	WMG member visit to successful projects	Farmers' visits to successful projects	5 batches	234（Farmers）	◎	Effective in broadening farmers' perspectives
5	New Technology Transfer (Rice for BRRI/ Vegetable for BARI)	Training on technology transfer, such as new rice varieties, by BRRI etc.	15 batches	1,000（Farmers）	◎	Training on new cultivation techniques at BRRI etc., including high-yielding varieties and early-harvesting rice, is effective
6	ToT (Training of Trainers) for-IFM (Integrated Farm Management) for FFS (Farmer Field School)	A 20-day training course to learn about comprehensive agricultural management, including rice cultivation, other crops, vegetables, and livestock, with the aim of developing master trainers who will conduct farmer training (farmer field schools)	20 batches	514（Farmers）＋98（Extention workers）	◎	Training for Master trainers who teach the farmers - Effective as an agricultural extension tool for training
7	Farm Machinery					
	a) Harvester/Reaper	Combine and other agricultural machinery training	27 batches	1,273（Farmers）	◎	Training on agricultural machinery such as combine harvesters is effective in increasing efficiency of harvest
8	Demonstration of cultivation					
	a) Winter & Summer Vegetables	Vegetable seeds distributed to homes for cultivation demonstrations		1,300（Housewives）	◎	Home gardening is effective not only for providing nutrition to the table but also for improving livelihoods during the rainy season
	b) Uplandcrop(Mustard)	Mustard seeds distributed to farmers for cultivation demonstrations	125 acre	322（Farmers）	△	Effectiveness is unclear

	c) Uplandcrop(Maize)	Corn seeds distributed to farmers for cultivation demonstrations	95 acre	348（Farmers）	△	Effectiveness is unclear
	d) Uplandcrop(Potate)	Potato seeds distributed to farmers for cultivation demonstrations	125 acre	754（Farmers）	△	Effectiveness is unclear
	e) Adaptive Trial of Rice(IRRI,BRRI,BWDB)	Trial cultivation of early harvest and cold-resistant varieties of rice at farms	5 acre	15（Farmers）	◎	Effective for disseminating cultivation techniques for BRRI varieties, including early harvest rice
9	Demonstration of paddy					
	a) Boro	Distributing rice seeds, fertilizer, technical support, and signboards to farmers for local cultivation demonstrations	5,227 acre	14,876（Farmers）	◎	Rice cultivation is an important livelihood for farmers in the haor region and it is effective
	b) Aman	Distributing rice seeds, fertilizer, technical support, and signboards to farmers for local cultivation demonstrations	428 acre	713（Farmers）	◎	Rice cultivation is an important livelihood for farmers in the haor region and it is effective

10	Nursery Management training & establishment	A 3-day seedling production training course to learn about vegetable and fruit seed production, seedling cultivation, grafting methods, and seedling sales	17 baches	410 （Farmers・Housewives）	◎	The haor areas have no access to vegetable and fruit seeds, so it is also an effective way to improve women's livelihoods
11	Farmer Field School establishment	16-day Farmer Field School on Boro Rice Cultivation conducted by Master Trainers for Farmers	299 baches	8,970（Farmers）	◎	Effective for disseminating Boro rice cultivation techniques to farmers
12	Value Chain Development and Marketing	-	-	-		
13	Research-extension-farmer dialog	BRRI holds rice cultivation training session with farmers	23 baches	1,101（Farmers）	○	Dialogue training on new cultivation techniques at BRRI etc., including early harvest rice (likely overlaps with 5)
14	Training on Poultry and Livestock Rearing	Poultry and livestock rearing training (for women)	123 baches	3,865（Housewives）	◎	Effective as a means to improve women's livelihoods
15	Training on "Paramedical Veterinary"	Veterinarian Assistant Training	9 baches	260（Farmers）	◎	Effective for training personnel with a certain level of veterinary knowledge to promote livestock breeding

16	Afforestation (Sapling of Hijol & Pulm tree)	Afforestation of Nunnir, Naogaon (Part A & B) Haor	Planting 25,000 Hijol and Karoch seedlings over a 13km stretch		○	Although afforestation is limited to certain areas, it is effective as a flood prevention measure.
	Total number of beneficiaries			71,890（WMG members）		
		＊◎ is effective, ○ is somewhat effective, and △ is the effectiveness is unclear				

Source: JICA Survey Team

Review of Small-Scale Income Genertion Sub Project in Phase 1						
	Small-Scale Income Genertion Sub Project (SIGS)	Contents of Activity	Project number	Number of beneficiaries	Review*	
1	Floating Bed Vegeable Cultivation and Support service scheme	This method of growing vegetables on beds on water is not feasible due to the strong water flow in the haor areas.	-	-		
2	Homestead Vegetable Cultivation and Support service scheme	Training for home vegetable gardening		5,845（Family）	◎	Home gardening is effective not only for providing nutrition to the table but also for improving livelihoods during the rainy season
3	Small scale Vegetable Production and Support Service Scheme	Distribution of seeds for vegetable cultivation	492 acre	5,192（Farmers）	○	Effective in areas where there is no way to obtain vegetable seeds
4	Fruit Production and Support Service Scheme	Distribution of saplings for fruites (bananas, papayas, mangoes, etc.) for fruit cultivation	170 acre (24 Nursery)	748（Farmers）	○	Effective in areas where there is no way to obtain fruites sapling
5	Poultry (Duck) rearing and Support Service Scheme	Poultry distribution and training for improving the livelihood of poor women	148,315 ducks distributed	7,612（Poor woman）	◎	Effective in improving the livelihoods of poor women
6	Goat rearing and Suport Service Scheme	Poultry distribution and training for improving the livelihood of poor women	Distribution of 5,029 goats	2,862（Poor woman）	◎	Effective in improving the livelihoods of poor women
7	Mushroom Production and Suport Service Scheme	2-day training course including mushroom cultivation and sales	3 Times	100（Housewives）	△	Effectiveness is unclear
8	Training of Basic Tailoring and Support Service Scheme	Disitribution of sewing machine and 9-day sewing training to improve the livelihoods of poor women	843 sewing machines distributed	843（Poor woman）	◎	Effective in improving the livelihoods of poor women

9	Distribution of Solar Panel for Household Electricity Supply and Support Service Scheme	Distribution of solar panels		82 (Family)	△	Effectiveness is unclear
10	Computer Training and Support Service Scheme	PC Skills Training	Not implemented	-		
11	Biogas Plant development and Support Service Scheme	Biogas Utilization Training	Not implemented	-		
12	Mother and Child Care and Support Service Scheme	Medical support for mothers and children, including medication and medical consultations	36 Times	1,080（Housewives）	△	Effectiveness is unclear
13	Community based sanitary Latrine(only for remote haor area)	Supporting sanitation management in remote haor areas	Not implemented	-		
14	Improved Cooking Stoves	Cooking stove support		1,875 (Family）	△	Effectiveness is unclear
	Total number of beneficiaries			26,239（WMG members）		
		＊◎ is effective, ○ is somewhat effective, and △ is the effectiveness is unclear				

Source: JICA Survey Team

5.13 In Phase 2, the agricultural priorities are protecting Boro rice cultivation from frequent disasters caused by climate change, moving away from Boro rice monoculture and diversifying residents' livelihood. Accordingly, priority in Phase 2 is placed on establishing components that address these issues. During the implementation phase, four components will be implemented per target haor. The core components of the project are: (1) the introduction and dissemination of early-harvesting, cold-tolerant rice to mitigate flash floods risks, (2) the adoption of water-saving Boro rice cultivation to counter drought, coupled with soil improvement measures to enhance rice cultivation that is resistant to blast disease, (3) the introduction of cash crops (field crops) cultivation to diversify cultivation from the monoculture of Boro rice, and (4) the dissemination of home vegetable gardening, livestock rearing, and vermicomposting to improve women's livelihoods.

Four Supporting Components	Specific Component Activities and Expected Effects	Effectiveness Indicators
Introduction and dissemination of early-harvesting, cold-resistant rice varieties	A rice field will be established as a base for producing early-harvest, cold-resistant rice varieties of Boro rice. An NGO will manage the production of rice seeds, and the harvested seeds will be distributed to farmers in the following year. Farmers will learn to cultivate early-harvest rice in the same field. As early-harvest and cold-tolerant varieties become more widespread in Haor, rice cultivation protected from cold-induced sterility and flash floods through early harvesting will become widespread.	Area under cultivation for early-harvesting, cold-resistant rice varieties(ha)

Four Supporting Components	Specific Component Activities and Expected Effects	Effectiveness Indicators
Introduction and promotion of water-saving intermittent cultivation, rice straw composting, and silicate materials	As a measure against drought during the dry season, implement (1) water-saving intermittent cultivation; and as a measure against rice blast disease and soil organic matter deficiency, implement (2) rice straw composting and Boro rice cultivation using silicate acid materials. In cooperation with farmers, conduct comparative verification of these cultivation methods and conventional methods in farmers' rice fields. After verifying the results, effective measures will be promoted to farmers in Haor starting the following year. As a result, the farmers will be able to cultivate drought-resistant Boro rice, reduce rice blast disease, and stabilize Boro rice income.	(1) Number of farmers using water-saving intermittent cultivation and rice straw compost (2) Average annual income stabilized through rice cultivation (BDT)
Introduction and promotion of cash crops	To introduce and promote cash crops, they will be cultivated simultaneously for a certain period before planting Boro rice. The farmland will be prepared for cultivation by improving soil acidity with magnesium lime. In Haor, farmers will also plant Boro rice at the same time after cultivating cash crops. The introduction of field crops cultivation will diversify cropping patterns in Haor and improve farmers' livelihoods.	Area under cultivation for cash crops (ha)
Introduction and promotion of home gardening and animal husbandry for women	To improve women's livelihoods by promoting (1) home gardening and (2) raising livestock such as ducks, chickens, goats, and similar livestock. Manure from livestock will be used as a raw material for earthworm compost, which is then sold to help support livelihoods. As a result, women's livelihoods are enhanced throughout the year.	Number of women who have home gardens and raise livestock; number of women whose livelihoods have improved

Source: JICA Survey Team

5.14 In Hobiganj District, the high-yielding variety BRRI 29 is widely used as a representative variety of Boro rice (average yield: 7.5 MT, average growth period: 160 days). However, depending on the timing of sowing, there is a risk of low temperatures during the panicle formation period and of flash floods during the harvesting period. To address these issues, the Bangladesh Rice Research Institute in Hobiganj recommends sowing seeds at the optimal time, as indicated in the table below.

Sowing Date	Panicle Formation Stage	Harvesting Stage	Risks Encountered
October 15 (Early sowing)	February 14	April 10	If rice is sown early and the young panicle formation period is exposed to temperatures below 20 °C, the risk of sterility increases.
November 15 (Late sowing)	March 3	May 2	Late sowing avoids exposure of the rice panicle formation stage to low temperatures, but the increases the risk of experiencing flash floods during harvesting.
November 1	February 24	April 20	No significant issues.

Source : Share the Planet public document: "Practice and dissemination of disaster-resilient, climate-adaptive agriculture" published date: May 22, 2023

To avoid these risks, BRRI has developed early harvesting varieties that require fewer growing days to harvest, as shown in the table below, and is promoting their use in the haor areas.

Early Harvest Variety	Standard Growing Days	Average Yield (MT/ha)	Rice Grain Appearance
BRRI 67	143 days	6	Medium and Slender

Early Harvest Variety	Standard Growing Days	Average Yield (MT/ha)	Rice Grain Appearance
BRRI 84	141 days	6.5	Medium and Slender
BRRI 88	142 days	7	Medium and Slender
BRRI 96	145 days	6.5-7	Short Grain
BRRI 100	148 days	8.8	Medium and Slender
BRRI 103	145 days	8.15	Medium and Slender
BRRI Hybrid 5	145 days	8.5-9	Long and Slender

Source：ABOUT BRRI 2023

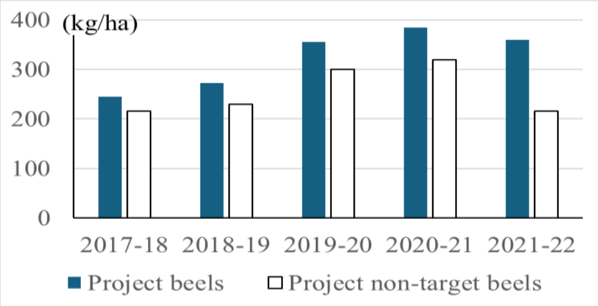
5.15 The most popular rice variety in the area, BRRI 29, exhibits low resistance to blast disease, and blast damage is widespread in the Haor region, making it necessary to take preventative measures. Supplementing rice with silica is essential to prevent blast disease, and applying rice straw or silica materials to supplement the rice is an effective strategy to prevent blast disease.

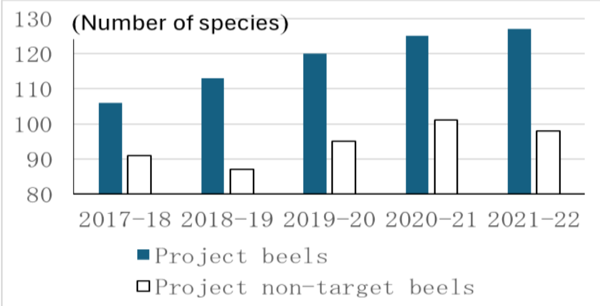
Fisheries Promotion Activities

5.16 Bangladesh's fisheries and aquaculture sector accounts for more than 3.5% of the national gross domestic product (GDP) and employs approximately 11% of the population, making it a strategically important industry of the country. In particular, the northeastern Haor region constitutes a critical water system supporting over 20% of the nation's inland fisheries. However, the region suffers from high poverty levels, and resource degradation has been progressing due to overfishing, sedimentation, and constraints inherent in the lease system. Therefore, interventions are required that can simultaneously achieve sustainable resource utilization and livelihood improvement. In particular, effective interventions should integrate community-based resource management with appropriate dredging and rehabilitation of connecting canals, the establishment of fish sanctuaries (no-fishing zones), and other measures, all premised on maintaining ecosystem integrity and biodiversity within each Beel.

5.17 In Phase 1, the project implemented the establishment of Beel Users Group (BUGs), canal dredging, and the creation of fish sanctuaries. Although results varied by site, notable increases in fish catch and household income, as well as improvements in fish species diversity, were observed. On the other hand, floodplain aquaculture and net-pen culture faced sustainability challenges due to flooding risks and high operational costs. Community-based Alternative Income Generating Activities (CAIGA) demonstrated moderate success in generating supplementary income, but constraints remained in terms of technical skills, market access, and other socio-economic factors. Moving forward, based on these lessons, the project should prioritize interventions with higher effectiveness and long-term sustainability, with a particular focus on strengthening community-based management and conserving aquatic ecosystems.

5.18 According to the monitoring results from Phase 1, as presented in the figures, fish catch in the project's target Beels increased steadily, rising from 1,900 kg per household at the 2018 baseline to 5,400 kg per household in 2023, representing an approximately 2.8-fold increase. Fish species richness also demonstrated an upward trend. While non-target Beels exhibited large substantial fluctuations and instability, the target Beels consistently showed improvements in species diversity.





Source: JICA Survey Team

Changes in Emergent Catch per Hectare Over Time

Source: JICA Survey Team

Changes in the Number of Fish Species Found Over Time

In the regression analysis, the increase in fish species richness in the target Beels showed a strong correlation ($R^2 = 0.963$), whereas the non-target Beels exhibited only a weak correlation ($R^2 = 0.636$). These results indicate that resource management interventions—such as the establishment of BUGs, canal dredging, and the designation of fish sanctuaries—were effective in improving both fish catch and biodiversity.

5.19 The key challenges identified in Phase 1 include: (i) the Beel lease system, which being short term and driven by high-bid auctions, tends to exclude disadvantaged fishers; (ii) the vulnerability of aquaculture activities to flooding, high operational costs, and internal conflicts; (iii) the shortage of technical skills and the vulnerability to natural disasters within CAIGA activities; and (iv) limited financial access and institutional support for women, despite their high levels of participation. These challenges highlight the need for institutional reforms and strengthened support measures in Phase 2.

5.20 Beel selection will begin by generating a long list of candidate Beels exceeding the final target number. This long list will then be screened based on social conflicts, lease conditions (area, price, and renewal timing), and the technical feasibility of interventions such as dredging and aquaculture. The long list will comprise a greater number of Beels than actual target, from which the final development targets will be selected, with the objective of identifying approximately 90 Beels.

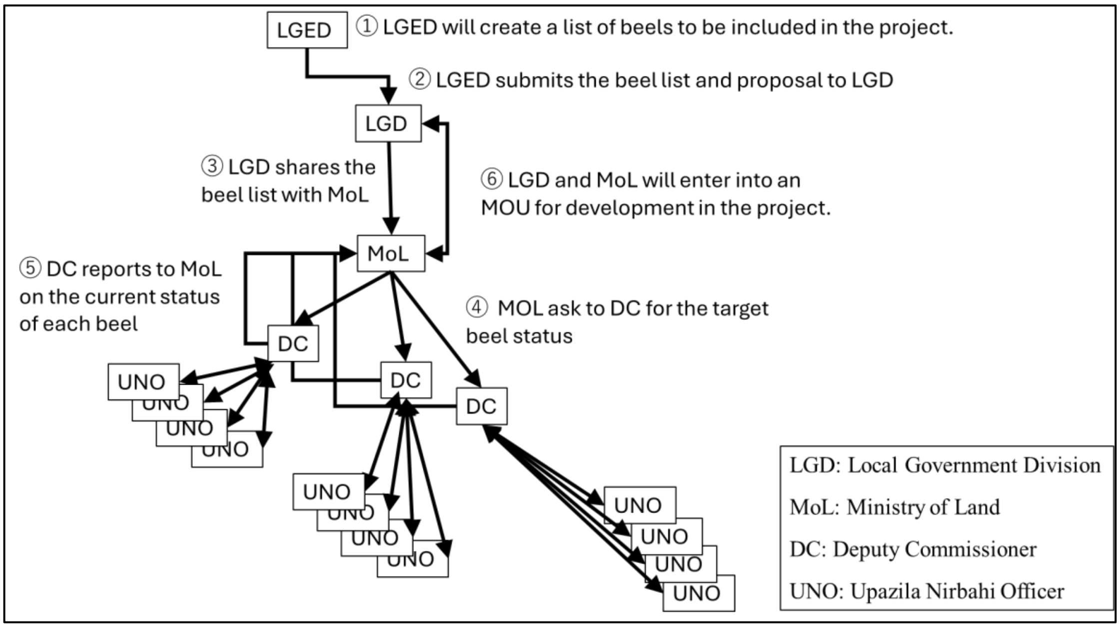
5.21 In Phase 2, activities that contribute to resource conservation and the strengthening of livelihood foundations, such as fisheries management based on BUGs, canal dredging, and the establishment of fish sanctuaries, should be given the highest priority. At the same time, low-cost and highly sustainable activities led primarily by women, including homestead aquaculture (small-scale aquaculture in a domestic pond near the home) and fish processing, should be actively promoted. Conversely, high-cost and flood-prone activities, such as net-pen and cage culture, should be limited to selective, small-scale introduction. In selecting target Beels, it is also essential to consider factors such as Beel area, lease price, renewal timing, and the presence or absence of community conflicts.

Category	Activity (Type)	Reason for Priority	Priority in Phase 2
Community-Based Fisheries	Establishment of Beel User Groups (BUG) and Community-Based Fisheries Management (CBFM)	Effective for ecosystem conservation, biodiversity enhancement, and income generation. Institutional reform has high potential.	Top Priority
Aquaculture	Homestead Aquaculture	Led by women, low-cost, highly profitable, and sustainable.	Top Priority
Aquaculture-Related Activities	Fish Processing (e.g., dried fish)	Low-risk and highly beneficial for women's livelihoods. Viable as an	High

		alternative income source during floods.	
Climate Change Adaptation Measures	Canal dredging, aquatic vegetation restoration, and integrated rice-fish farming	Effective for ecosystem restoration and strengthening climate resilience.	High

Source: JICA Survey Team

5.22 The Beel selection flow shown below illustrates the procedure for determining the target Beels for Phase 2. First, candidate Beels are identified, after which the presence of social conflicts and lease conditions (area, price, and renewal timing) are reviewed. Next, the technical feasibility of proposed interventions, such as dredging and aquaculture, is assessed. Only those Beels that meet these conditions should be selected as final targets.



Beel Selection Flow

Source: JICA Survey Team

5.23 LGED's preliminary estimation projected a larger project scale. However, considering the implementation capacity of local governments, it is desirable to adopt a more realistic scale by narrowing the number of selected Beels. In addition, 'Beel Connectivity Improvement' should not be limited to conventional road construction but designed in a way that allows the use of various methods such as small access structures and raised embankments.

Flood Forecasting and Early Warning System

5.24 Within BWDB, the division responsible for operating the flood forecasting system is the Flood Forecasting and Warning Centre (FFWC). Based on the consultations conducted with FFWC, the current status and challenges of flood forecasting system operations were organized, as summarized in the table below.

System	Challenges	Remarks
1. Observation System	【Difficulty in Obtaining Rainfall Data within India】 The available meteorological and hydrological data from India are limited in both duration and type.	Rainfall data are obtained through the India Meteorological Department (IMD) website, while water level data for the period from 15 May to 31 October are provided via email and WhatsApp.

System	Challenges	Remarks
2. Data Transmission and Reception System	【Real-time Acquisition of Water Level Data Not Yet Implemented】 Observation data from installed AWS※1 are not currently utilized on websites or for water level forecasting.	The frequency of manual water level data acquisition currently in operation is five times per day (at 6:00, 9:00, 12:00, 15:00, and 18:00). FFWC-BWDB plans to publish AWS data on its website and incorporate it into water level forecasts once data accuracy is confirmed.
3. Analysis System	【Difficulty Extending the Forecast Period (Maximum)】 The maximum forecast period of the Northeast Region Model is limited to three days, which is insufficient for applications such as rice harvesting.	FFWC-BWDB recognizes the need to extend the forecast period, considering that rice harvesting typically requires about 15 days, or at minimum 5 to 7 days, but acknowledges challenges in maintaining forecast accuracy over longer periods.
	【Difficulty Editing Flood Forecast Model※2】 The MIKE11 model currently in use has limited user manual support compared to free software, resulting in operational difficulties within Bangladesh.	FFWC-BWDB is considering transitioning to freeware or open-source models; however, as MIKE11 models have been developed nationwide, this transition is not straightforward.
	【Insufficient Discharge Data at Water Level Stations near the Indian Border】 Discharge measurements are infrequent, leading to challenges in accurately determining the H-Q rating curves at water level stations near the border.	Budget constraints and the hazardous conditions during high flows are major obstacles to conducting frequent discharge measurements.
4. Flood Forecast Dissemination System	【Forecast Communication Timing Not Considered】 Forecast dissemination does not currently take into account flood arrival times or necessary lead times.	Different lead times may be required depending on the location within the Haor region, necessitating detailed analysis of flood arrival timings.
	【Early Warning Issuance System Not Yet Established】 The system from the flood forecasts to the issuance of early warnings has not been established.	Staff of FFWC-BWDB currently check the flood forecasting system results and issue early warnings individually.
	【Effective Forecast Communication Methods Not Considered】 The communication pathway from FFWC-BWDB to residents is extensive, making it difficult for evacuation information to reach the population promptly.	Efforts to improve communication include smartphone applications, interactive voice response (IVR) systems, and information dissemination via Google platforms.
5. Community Response and Early Warning System	【Early Response Plans for Residents Not Developed】 Neither FFWC-BWDB nor local governments have defined specific actions that relevant organizations.	Residents belonging to Disaster Management Committees (DMCs) who receive early warning information decide on flood prevention activities; however, limited understanding of flood forecasts and early warning information often results in delayed responses.

※1: AWS: Automated Weather Station
※2: MIKE11 is a one-dimensional river modelling software developed by the Danish Hydraulic Institute (DHI) in Denmark. It is capable of simulating flow, water levels, water quality, and sediment transport in rivers, floodplains, irrigation canals, and reservoirs.
Source: JICA Survey Team

5.25 The results of the needs survey indicated that the number of residents who actively utilize flood early warning information remains limited. While some communities receive warnings through systems such as River Information Management System (RIMS) and SMS, the findings suggest that the dissemination and public awareness of early warning information may be insufficient. In certain areas, it was also confirmed that community-based early warning methods—such as announcements via mosques and loudspeakers (miking)—function effectively.

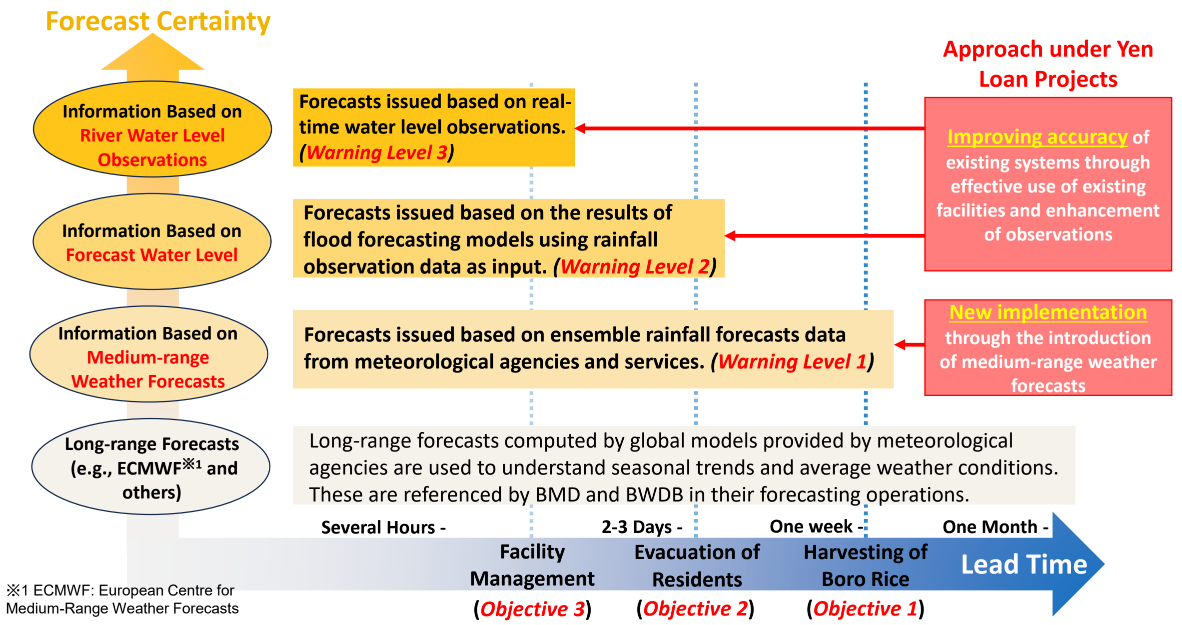
Regarding assets vulnerable to flash floods, respondents identified crops (particularly rice), livestock, and essential household items. Although some communities reported that damages were mitigated thanks to flood early warnings, many others stated that they either do not utilize early warning information or that floods arrive too rapidly for protective actions to be implemented.

5.26 The flood forecasting system currently operated by FFWC-BWDB was developed with the support of various national governments and international aid agencies in the past. A runoff model for each sub-basin and a one-dimensional hydraulic model for the main rivers have been established. In addition, the hearing with the counterparts confirmed that improving the accuracy and lead time of the current flood forecasting system is a higher priority than maintaining multiple flood forecasting models with similar capabilities. Therefore, constructing a similar system again is not considered effective in terms of support efficiency. Instead, based on the previously identified issues of the existing system, the policy is to examine potential improvements.

5.27 In setting the objectives for system development, the livelihoods and socio-economic backgrounds of local residents were taken into consideration, and three objectives were established (Objectives 1-3 in the figure below).

In addition, the forecast information to be developed or enhanced to achieve each objective was organized along the vertical axis of the figure below. In the current flood forecasting system, both observed and forecasted river water levels up to three days in advance are utilized. By effectively utilizing existing facilities and upgrading observation technologies, further improvements in forecasting accuracy are planned.

Although river water level forecasts beyond three days are not currently in operation, extending the lead time is necessary to support the early harvesting of Boro rice. Therefore, the introduction of medium-range weather forecasts will facilitate the implementation of new forecasting capabilities.



Source: JICA Survey Team

5.28 The project implementation items corresponding to each identified issue are summarized in the table below. The target alert levels (1-3) addressed by each project are also indicated in the table. For detailed descriptions of each project implementation item, refer to Section 5.4.3 of the main report, as it is described therein.

System	Challenges	Project Implementation Items	Warning Level		
			1	2	3
1. Observation System	Difficulty in obtaining rainfall data from India	Application of satellite-based rainfall data in India (real-time rainfall data)	-	●	-
2. Data Transmission and Reception System	Real-time acquisition of water level data not yet implemented	Real-time acquisition of water level data	-	●	●
3. Analysis System	Difficulty extending the forecast period (maximum)	Utilization of ensemble rainfall forecasts	●	-	-
	Difficulty in editing flood forecast model	Update of the flood forecasting model	-	●	-
	Insufficient discharge data at water level stations near the India Border	Enhancement of discharge measurement	●	●	-
4. Flood Forecast Dissemination System	Forecast communication timing not considered	Application of satellite-based rainfall data in India (historical rainfall data)	●	●	●
		Assessment of lead time considering flood arrival time	●	●	●
	Early warning issuance system not yet established	Update of the decision support system	●	●	●
	Effective forecast communication methods not considered	Introduction of an early response timeline	●	●	●
5. Community Response and Early Warning System	Early response plans for residents not yet developed				

Source: JICA Survey Team

（Remarks）

Warning Level 1： Information Based on Medium-Range Weather Forecasts（Lead Time: Several days–weeks）

Warning Level 2： Information Based on Rainfall Observations for Flood Forecast（Lead Time: Several days）

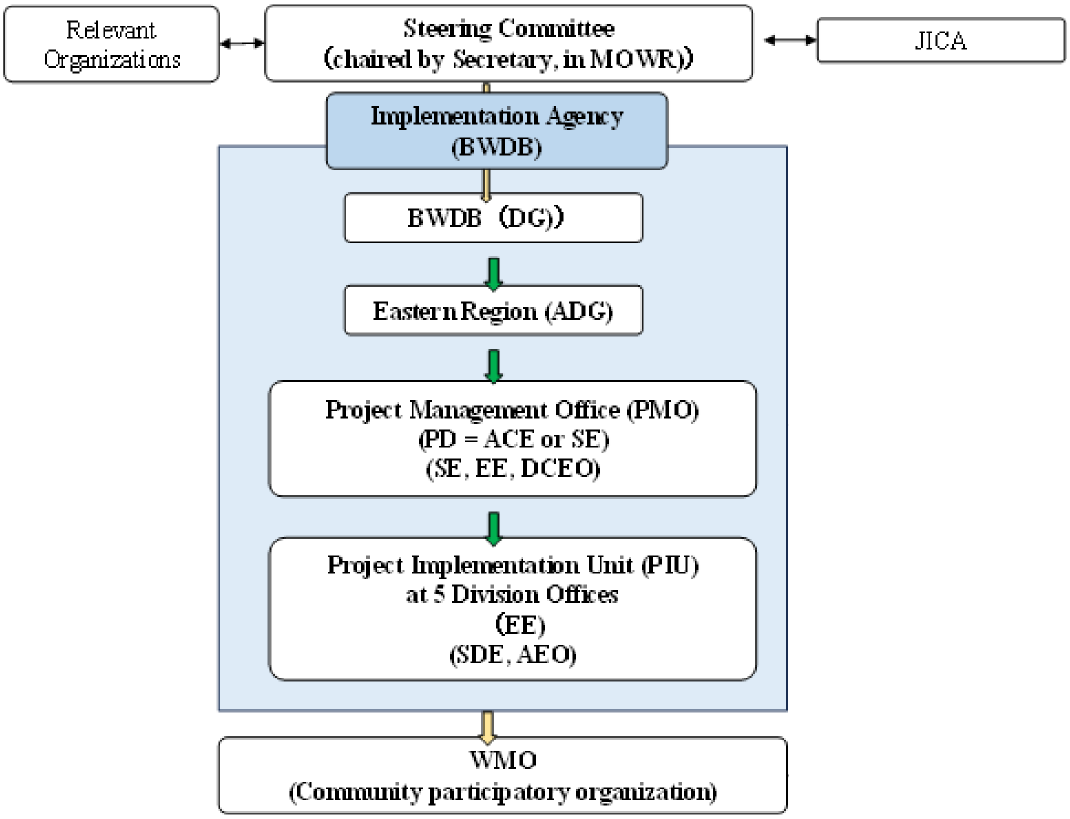
Warning Level 3： Information Based on River Water Level Observations（Lead Time: 1–2 days）

VII. PROJECT IMPLEMENTATON AND OPERATION AND MAINTENANCE SYSTEM

Flood Control Facilities and Agriculture Promotion Activities

7.1 This section outlines the current situation of implementation, as well as the operation and maintenance (O&M) systems for flood control facilities and agricultural promotion activities in the Haor region. It includes institutional arrangements, financial and technical support, and community-based management. Additionally, it also highlights key challenges and proposes future directions.

The primary implementing agency of the Project is the Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources. As in Phase 1, BWDB will continue to take a prominent role in Phase 2, with the main objective of developing flood control facilities. Phase 2 is expected to be implemented in coordination with relevant agencies, under the organizational structure illustrated below.



Notes: DG = Director General, ADG = Additional Director General, ACE = Additional Chief Engineer, SE = Superintending Engineer, DCEO = Deputy Chief Extension Officer, PD = Project Director, EE = Executive Engineer, SDE = Sub-Divisional Engineer, and AEO = Assistant Extension Officer.

Source: JICA Survey Team

BWDB employs over 13,000 staff members and operates more than 200 field offices nationwide, covering activities ranging from planning and design to operation and maintenance. The Office of Community Water Management (OCWM) oversees the establishment, auditing, and capacity building of community-based Water Management Organizations (WMOs) and promotes participatory water resources management in collaboration with the Department of Agricultural Extension (DAE) and the Department of Fisheries (DoF).

The O&M of flood control facilities follows a two-tier institutional structure involving both BWDB and community-based organizations (WMOs). Major repairs and emergency responses are undertaken by BWDB using government budget allocations and donor funding, while routine preventive maintenance is carried out by WMOs using accumulated savings from membership fees and agricultural income. WMOs are organized into three levels: Water Management Groups (WMG; 305 groups), Water Management Associations (WMA; 29 groups), and Water Management Federations (WMF). These organizations are responsible for facility inspection, policy advocacy, and coordination, with particular emphasis on the participation of women and the disadvantaged groups.

Between 2017 and 2023, WMG financial reserves totalled BDT 56.2 million, which were allocated for routine inspections and minor repairs. However, these reserves alone are insufficient to cover the entire cost of preventive maintenance, making complementary public-sector and external financial support indispensable. BWDB provides limited financial assistance for major repairs and emergency responses; for example, approximately BDT 150 million per year is allocated to the Kishoreganj area.

From a technical perspective, BWDB engineers have provided training to WMG and WMA members, promoting maintenance practices consistent with O&M manuals. Progress has been made in the introduction of GIS and ICT tools, the distribution of simple inspection equipment, and the consideration of drone technology for wide-area inspections. Nevertheless, further capacity building and digital transformation are required to strengthen preventive maintenance practices.

Key challenges identified for establishing a sustainable O&M system include: 1) strengthening the organizational capacity and leadership of WMGs, particularly by promoting the participation of women and youth, 2) increasing savings and improving transparency in fund management, 3) continuing regular O&M training and enhancing technical capacity, 4) clarifying the division of responsibilities between BWDB and WMOs, 5) improving management efficiency through the wider application of ICT and GIS, 6) deepening community-based management and designing effective incentive mechanisms, and 7) standardizing and digitizing inspection records and strengthening data accumulation.

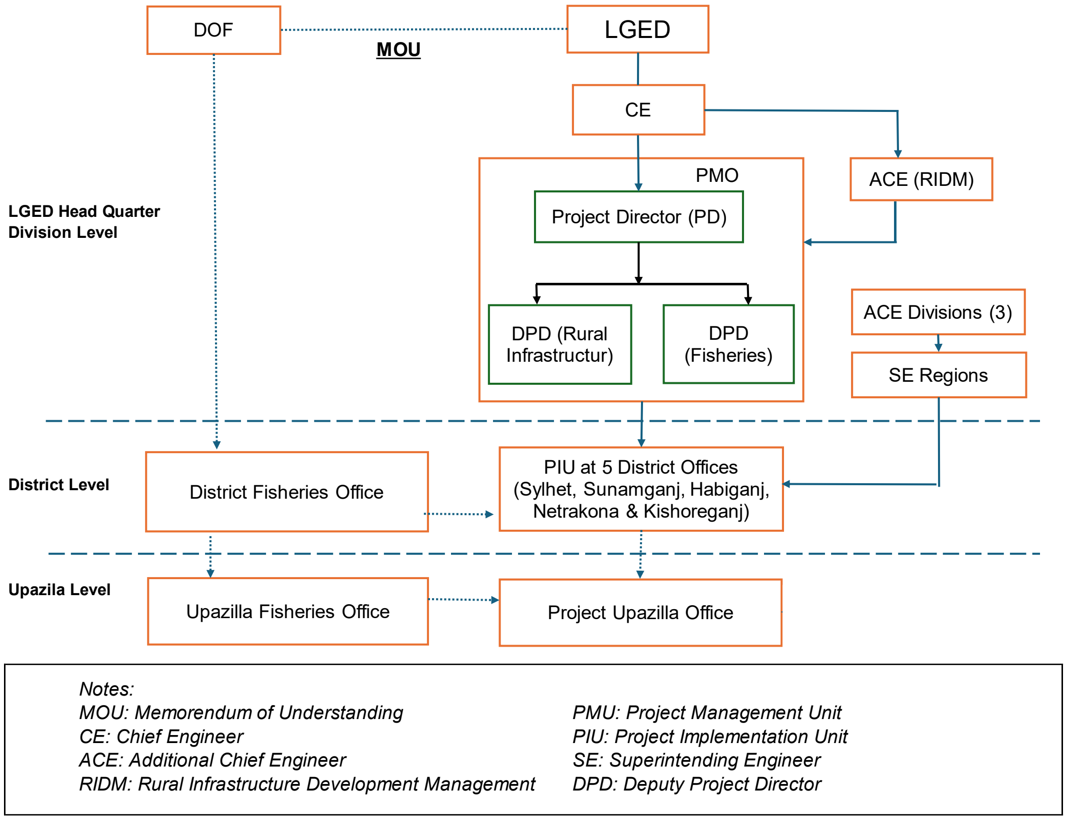
Addressing these challenges through ongoing JICA technical cooperation will be essential for the establishment of a sustainable, community-rooted maintenance system.

7.2 As in Phase 1, BWDB will play a leading role in agricultural promotion and small-scale livelihood improvement activities. A Project Implementation Office (PIO) will be established within BWDB, and each district's Project Implementation Unit (PIU) will support the agricultural promotion and small-scale livelihood improvement activities WMG members. To provide technical and specialized guidance, BWDB will conclude Letters of Agreement with the Bangladesh Rice Research Institute, the Bangladesh Agricultural Research Institute, and the Bangladesh Agricultural University, as well as a Memorandum of Understanding with the Department of Agriculture Extension, to obtain technical and expert support for CCRS and SIGS activities. Approximately two Executive Engineers will be assigned to each PIU, and Extension Overseas staff will be assigned to each of them, with each staff responsible for three to five WMGs. They will support the CCRS and SIGS activities of WMG members in the field.

Rural Infrastructures and Fisheries Promotion Activities

Rural Infrastructures

7.3 To implement rural infrastructures development and fishery promotion activities, a Project Management Office (PMO), headed by a Project Director (PD), will be established at the headquarters of Local Government Engineering Department (LGED), as presented in the following figure. Project Implementation Units (PIUs) will be established within existing LGED district offices in Netrokona, Kishoreganj, Habiganj, Sylhet, and Sunamganj districts, where the target haors are located. Project Upazila Offices under LGED are planned to be established within existing Upazila offices. The district offices of the Department of Fisheries, which are responsible for implementing Fishery Promotion activities, will coordinate with LGED's PIUs.



Source: Prepared by the JICA Survey Team based on the discussion with LGED

7.4 Maintenance of Upazila roads, Union roads, and main Village roads will be carried out by LGED's Road Management and Road Safety Unit (RMRSU) and regional offices, under the supervision of LGED district and Upazila offices. Maintenance of other Village roads, excluding key Village roads within rural infrastructure, will be conducted by local government institutions (LGIs), such as Upazila Parishads and Union Parishads, under the technical guidance from LGED.

7.5 Maintenance of growth centres, rural markets (Hats), and boat landing stations (Ghats) will be undertaken by lessees, Market Management Committees (MMCs), and Upazila Market Management Committees (UMMCs), utilizing a portion of the rental income.

7.6 Maintenance of the village protection walls proposed as part of this project is expected to be carried out by the villagers, similar to the maintenance practices for existing protection walls, including routine inspections and minor repairs. During the construction phase, villagers are expected to participate in the part of construction works (e.g., manual earthworks) through employment by contractors or Labour Contracting Societies (LCS) which will help them gain an understanding of the structure and acquire basic skills for construction and repair. In cases where medium- to large-scale repairs are required, the villagers may need to request support from LGIs.

Fisheries Promotion Activities

7.7 To ensure the sustainable implementation of fisheries promotion activities, it is a key priority to enhance the operational capacity and institutional compliance of Beel Users' Groups (BUGs), while maintaining the existing Beel-leasing system. In particular, it is necessary to establish arrangements that enable BUGs to remain competitive under the current institutional framework through measures such as registration as cooperatives with the Department of Cooperatives, improved financial transparency, and systematic advance savings mechanisms in preparation for lease renewal. While women's participation rates were relatively high in Phase 1, constraints were observed in their access to finance and institutional support. Accordingly, in Phase 2, it is important to strengthen financial and institutional support for women-led aquaculture and processing activities by utilizing internal BUG savings mechanisms and linking these with existing microfinance schemes. Furthermore, to enhance the effectiveness of fisheries resource management and facility operation and maintenance, the strengthening local governance through collaboration among relevant institutions at the Upazila level is required. Through such arrangements, fisheries promotion activities, including disaster risk reduction and climate change adaptation, are expected to be continuously implemented in a manner that is responsive to local conditions.

7.8 Building on the framework used in Phase 1, the implementation structure for fisheries development in Phase 2 positions the Upazila Fisheries Officer (UFO), the local technical officer of DoF, as the central actor responsible for daily operations and technical management. LGED will serve as the secretariat for joint Upazila-level reviews, including organizing quarterly reviews and consolidating KPIs. At the implementation level, BUGs will have a core role, undertaking community fisheries management, aquaculture activities, sanctuary management, financial management, and related tasks. Universities and NGOs will provide limited and supplementary support, such as initial training on record-keeping, standardization, and quality assurance. Dredging and canal rehabilitation will fall under LGED's mandate, implemented in coordination with relevant departments, whereas flood-control structures such as embankment reinforcement fall under the jurisdiction of the flood-control sector (e.g., BWDB) and therefore are not included as core components of the fisheries development implementation structure.

7.9 In terms of the operational framework for fisheries development, the management of fisheries resources and related facilities will be delegated to BUGs after the infrastructure completion, with DoF leading technical operations and LGED serving as the secretariat for joint reviews and being responsible for consolidating and publicly disclosing monitoring results. Since the special extension of the lease system expired in April 2023, and general competitive bidding has become the standard practice, BUGs must strengthen for lease renewal by securing cooperative registration, obtaining approval of their membership lists, and formalizing financial discipline measures such as the full T-3 savings (i.e., savings accumulated three months before to the renewal deadline). Technical training will be led by DoF and complemented by universities and NGOs in specific thematic areas such as aquaculture techniques, fisheries management, processing and marketing, and climate change adaptation. Monitoring will track and publish key indicators on a monthly or quarterly basis, including CPUE, compliance with fishing bans, disclosure rates of meeting minutes of T-3 achievement, and the status of women's participation. Women's participation will remain voluntary under existing institutional frameworks and will be implemented together in conjunction with measures such as baseline assessments of role-sharing and time burdens, as well as childcare considerations.

VIII. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (PART 2)

Environmental Impact Assessment

8.1 In this study, environmental impact assessments were carried out for the top 15 candidate haors for the project (hereinafter referred to as the "15 EIA Target Haors"), based on the results of the baseline survey. For each haor, an EIA was conducted and an Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) were prepared. Items that are common to all 15 haors are marked as [Common to All Haors], while items applicable only to specific haors are clearly indicated as [Only for ~ Haor].

8.2 In the baseline survey, the 26 candidate haors for the project were classified into nine clusters based on their spatial distribution. Baseline environmental conditions for the overall target area were identified by conducting field surveys in the representative haors of each cluster. The target haors and survey scope of the baseline study are as follows. Considering the feasibility of fieldwork during flood conditions, the scope of the wet-season baseline survey was limited to the following components: river-bottom sediment, surface water, macro-benthos, phytoplankton, zooplankton, and fish and other nekton species.

Cluster	Candidate Project Haors	Haors Where Field Surveys were Conducted	District
SN1	Updakhali Haor	Gurmar Haor	Sunamganj
	Goradoba Haor		
	Gurmar Haor		
	Sonamoral Haor		
SN2	Karchar Haor	Halir Haor	
	Halir Haor		
	Shanir Haor		
SN3	Chaptir Haor	Chaptir Haor	
	Khai Haor		
	Boram Haor		
SN4	Naluar Haor (Part 1)	Naluar Haor (Part 1)	
	Naluar Haor (Part 2)		
	Makalkandi Haor		
SN5	Mrigar Haor	Mrigar Haor	Kishorganj
	Khuniyer Haor		
	Khaliajuri Haor		
	Chayer Haor		
SN6	Kazurkhola Boro Haor	Kazir Kola Boro Haor	
	Dewghar Haor		
	Humayerpur Haor		
	Ballar Haor		
SN7	Pathar Chawli Haor (Part 1)	Pathor Chauli Haor (Part 2)	Sylhet
	Pathar Chawli Haor (Part 2)		
	Kalaruka Haor		
	Zikar Haor (Part 1)		
	Zikar Haor (Part 2)		
SN8	Muktarpur Haor	Muktarpur Haor	
SN9	Hail Haor	Hail Haor	Moulvibazar

Source: JICA Survey Team

Items	Sampling Points/Survey Area	Frequency	Parameters
River Bottom Sediment	9 points Survey area: River/tributary bottom around the project site (interventions).	One time/ Dry season	Temperature, Sulfide, (OM), Hg, Cd, Pb, Organic-P, N, Cr^{6+}, As, CN, Cu, Zn, F, Na, K, Cl, Ca, and Mg.
Surface Water	9 points Survey area: Tributaries around the project site/Haor waterbody.	One time/ Dry season	Parameters in accordance with National Surface Water Quality Standards, including Temperature, Turbidity, pH, DO, BOD_5, COD, TDS, EC, TSS, NH_3, NO_3, Total Coliform, and Cl.

Items	Sampling Points/Survey Area	Frequency	Parameters
Ground Water	9 points Survey area: Shallow/deep wells near the project sites.	One time/ Dry season	Temperature, Turbidity, Total Hardness, pH, TDS, EC, sulphate, chlorides, As, Fe, Mn, NO_3, PO_3, F, Total Coliform, Faecal Coliform
Air Quality	9 points Along the entire project sites.	One time/ Dry season	Parameter in accordance with National Ambient Air Quality Standards, such as SO_2, NO_2, SPM, PM_{10}, $PM_{2.5}$, CO, and O_3 24 hour-continuous for 1 day.
Noise			Noise Level (Leq: dBA) 24 hour-continuous for 1 day, recording noise events or noise source (e.g. passing vehicle, construction works, and other noise sources).
Soil Quality	9 points Along the entire project sites.	One time/ Dry season	pH, soil texture, TOC, Total N, Total P, and Total K.
Macro benthos (1) (Floodplain and River Bottom)	9 points *Same as "River bottom sediment"	One time/ Dry season	Species name, number, wet weight (Method) Sampling by Grub sampler, followed by analysis. Keep collecting samples for three years (e.g., formalin fixation) ensuring proper labelling and classification.
Phytoplankton			Species name and number (Method) Water Sampling (1 L), followed by relevant analysis.
Zooplankton	9 points *Same as "River bottom sediment" (Sampling :1 to 2 layers, depending on the depth) - 0 ~ - 2 m - 2 ~ - 10 m Survey area: Same as above		Species name and number (Method) Sampling using a plankton net (50 -100 µm), followed by analysis.
Fish and Other Nektons	- Fish market - Local fisheries office - Documents and hearing from experts/scientist Survey area: Same as above - Important locations (e.g., catching, spawning, breeding and other key zones for river aquatic ecosystem) of inland fishery activity in and around the Haor area - Fish migration patterns in and around the Haor area and nearby rivers		Species name and number (Note) Both natural and cultured fish are considered.
Vegetation	Survey area: 9 clusters In and around the sampling cluster areas for vegetation survey	One time/ Dry season	- Species and number - Vegetation maps during the pre-monsoon/ dry season were developed within relevant study, including: Upland vegetation map Emergent vegetation map Aquatic vegetation map (Subject to change on conditions) Based on this developed vegetation map, relevant map information (e.g., floral inventory) shall be updated or revised as needed.

Items	Sampling Points/Survey Area	Frequency	Parameters
Mammal	Survey area: 9 clusters Identifying important zones for river dolphins, birds, reptiles, and amphibians (their availability and any other issues) through field observation and local-level consultation in and around the sampling cluster (Note: Subject to change on conditions)	- One time/ Dry season * Day time and Nighttime	Species and number (Method) In and around the cluster, data are collected by visual observation, interviews with local residents, secondary data, among other approaches.
Birds		- One time/ Dry season * Day time only	Species and number (Method) Cluster census, point census, visual observation, mist nets, interviews with local residents and others, and secondary data.
Reptile and Amphibians		- One time/ Dry season * Day time only	Species and number (Method) Visual observation and secondary data.
Insects		One time/ Dry season * Day time and Nighttime	Species and number (Method) Visual observation and secondary data.

Source: JICA Survey Team

8.3 Biological surveys indicated that important species are widely distributed throughout the Haor region, including the Eurasian otter (CR), Fishing cat (EN), Bengal fox (VU) among mammals; the Indian peacock softshell turtle among reptiles; and the Baer's pochard (CR), Pallas's fish eagle (EN), Rufous-rumped Grassbird (EN), Black-necked Stork (EN), Bristled Grassbird (EN), Eastern Imperial Eagle (VU), Greater Spotted Eagle (VU), Lesser White-fronted Goose (VU), Oriental Darter (NT), Ferruginous Duck (NT), and Falcated Duck (NT) among birds. However, the target haors of this project, do not encompass important habitats for these species, and it is considered that potential impacts on species of conservation importance can be effectively minimized through the implementation of appropriate environmental protection and mitigation measures. Regarding fish, endangered species listed in the Bangladesh Red List (eight EN species and five VU species) were recorded, although only one species is categorized as VU in the global Red List. The main construction works of the project will be conducted exclusively during the dry season and on terrestrial areas. In addition, dredging works will be limited to the conservation and restoration of deep-water zones and will be conducted spot-wise during the low-water period. As a result, disturbance to important habitats such as spawning and nursery grounds and littoral vegetation zones, will be avoided, and the direct modification area of the project is not considered to correspond to critical habitats of the above-mentioned threatened species. Furthermore, by implementing appropriate environmental protection and mitigation measures, construction-related impacts will be minimized. Ecosystem conservation will also be promoted through fishery enhancement activities (e.g., establishment of sanctuaries and securing migration routes through dredging). Therefore, potential impacts on important species are considered to be adequately mitigable.

8.4 As part of the analysis of alternatives, four options were examined for both the BWDB portion and the LGED portion: (i) the "no-project scenario", (ii) the "non-submersible embankment/non-submersible road construction scenario", (iii) the "limited infrastructure development scenario", and (iv) the "integrated approach." These alternatives were comparatively evaluated in terms of their perspectives of advantages, disadvantages, and environmental impacts. As a result of the analysis, the "integrated approach" was determined to be the most recommended option for both portions.

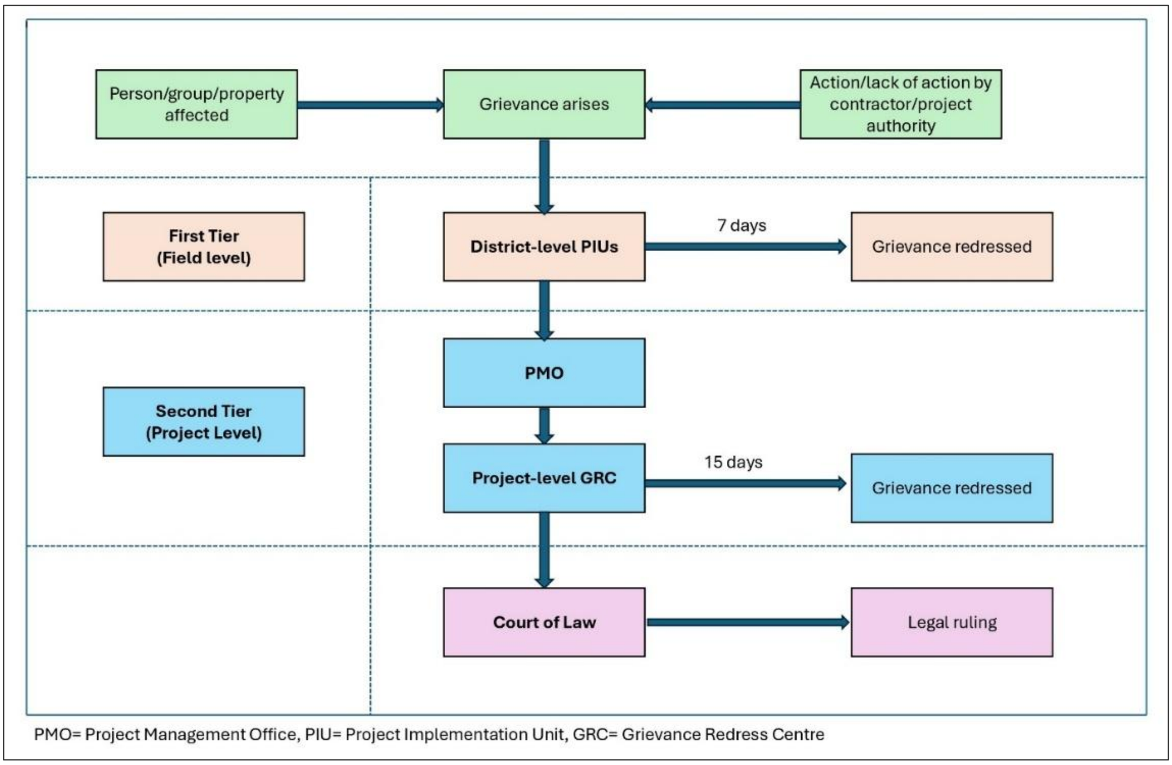
8.5 Based on the results of the baseline surveys, environmental impact assessments were conducted for each haor, and the Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) were prepared. Although Shanir Haor is not located within a protected area, it is located in close proximity to Tanguar Haor (a protected area), and the baseline findings suggested that it may serve as potential habitat for important species, including migratory birds that visit Tanguar Haor during the winter season. In consideration of the potential impacts on these important species, it was determined, based on the results of the environmental impact assessment, that additional baseline surveys will be conducted in Shanir Haor during the detailed design (DD) stage to assess potential impacts on migratory birds. If necessary, additional measures will be examined, including the possibility of excluding Shanir Haor from the project target area.

8.6 For the BWDB portion, a Project Management Office (PMO) will be established at the BWDB headquarters in Dhaka to oversee coordination, environmental management, and supervision of the implementation of the EMP. At the district level, Project Implementation Units (PIUs) will be established, and Subproject Management Offices (SMOs) will be deployed for each haor. Under the guidance of the PMO, the PIUs will operate at the district level and oversee multiple SMOs. The SMOs will operate at the field level and will be responsible for day-to-day site implementation, supervision of contractors, and management of local issues. During the operation phase, facilities with an irrigated area of less than 5,000 ha will be managed by the WMOs, which will receive training after construction and carry out EMP-related activities with technical support from the SMOs and the PMO.

8.7 For the LGED portion, a Project Management Office (PMO) will be established at the LGED headquarters, and Project Implementation Units (PIUs) will be established at the district level. Field offices will be set up within existing LGED Upazila offices. The PMO will be responsible for planning, management, and supervision, while the PIUs will be responsible for implementing rural infrastructure development and fisheries promotion activities in the target haors and Upazilas.

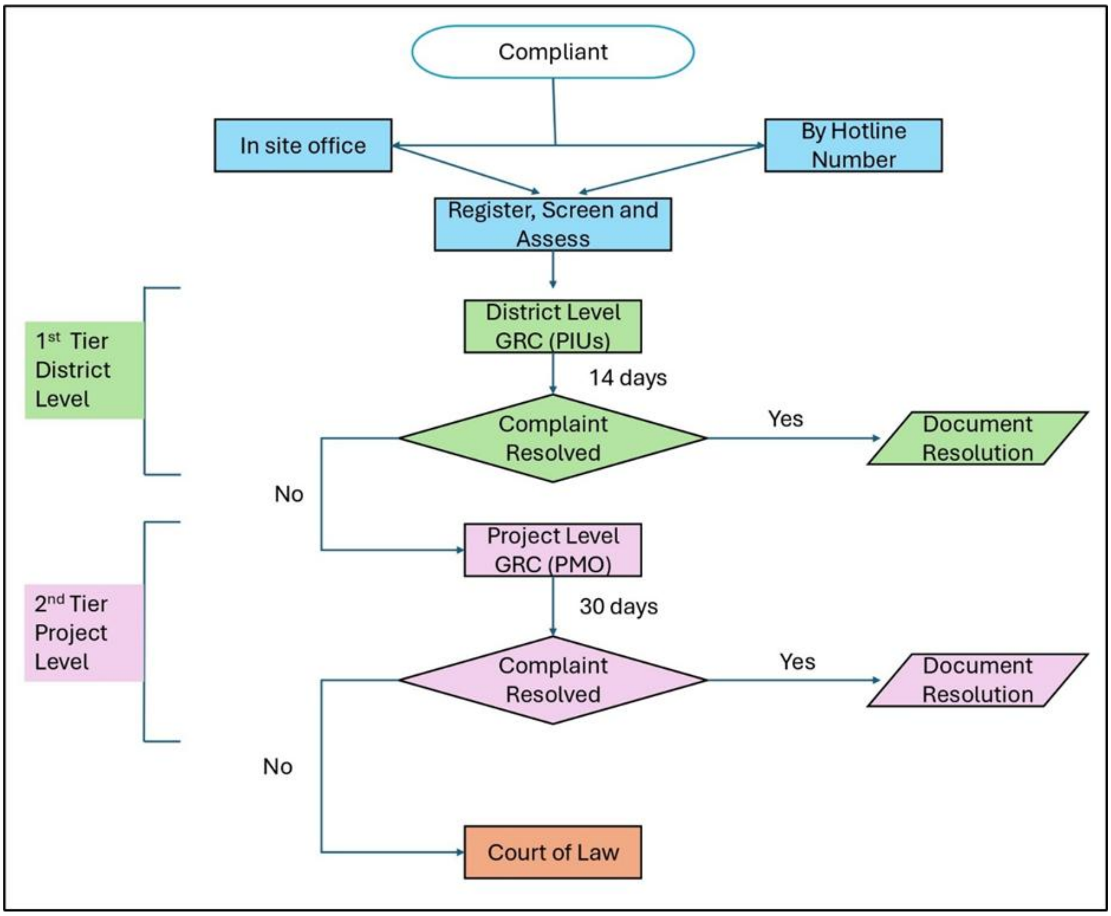
8.8 In this study, consultations were held with the Department of Environment (DoE), which is responsible for EIA approval and it was decided to conduct Public Consultation Meetings (PCMs) in three Divisions: Dhaka, Sylhet, and Mymensingh. Considering the distribution of the 15 target haors and accessibility for participants, PCMs were conducted at four locations. Prior to the PCMs, the draft EIA was submitted to the DoE and public notification was carried out through newspaper announcements and the distribution of invitation letters. At each PCM, the project outline, the results of the environmental impact assessment, and the EMP and EMoP were presented, followed by open discussions with local communities. During the discussions, opinions were raised regarding potential impacts on fisheries and the effective utilization of dredged materials; however, the importance of the project was acknowledged, and it was confirmed that there was no significant opposition to the project.

8.9 The grievance redress mechanism was designed separately for BWDB and LGED portions, with each consisting of two tiers. In the first tier, grievance handling will be carried out by the PIUs established within the BWDB/LGED district-level offices. If the issue remains unresolved, the second tier involves grievance handling by the PMO established at the BWDB/LGED headquarters. The grievance redress mechanisms for each portion are described below.



Source: JICA Study Team

Grievance Redress Mechanism for BWDB Portion



Source: JICA Study Team

Grievance Redress Mechanism for LGED Portion

Land Acquisition Plan

8.10 As the detailed design of the facilities is excluded in the scope of this Preparatory Survey, exact land acquisition locations will need to be finalized during the detailed design stage. Additionally, the RAP survey was planned during the monsoon season, and since the project area was flooded during that period, it was impossible to conduct field surveys until November, which marks the beginning of the dry season. Therefore, the project locations were tentatively fixed and the simplified Resettlement Action Plan (RAP) was prepared based on the tentative land acquisition areas, the secondary data such as mouza maps (cadastral maps) and the census and socio-economic statistics data of Bangladesh Bureau of Statistics (BBS), and the qualitative data obtained from stakeholder meetings at the Haor level and Focus Group Discussions (FGDs) at the village level. The detailed land acquisition areas will be finalized in the detailed design stage.

8.11 For the BWDB portion, the planned land acquisition for 13 submergible embankment rehabilitation sites and two new construction sites (Mrigar Haor and Ballar Haor) are approximately 1,737,600 m^2 (429,187 acres). The number of affected households was estimated based on the assumption that one household owns one land plot as a provisional condition and the approximate number of PAPs was estimated by using the average family size per household from the BBS 2022 census data. As a result, 9,393 land plots across 15 haors were subject to land acquisition, impacting 9,393 households and an estimated 46,133 PAPs. In accordance with the land acquisition and resettlement policy of the Project, houses and other primary structures will be avoided, and no physical displacement of PAHs is expected.

8.12 For the LGED portion, the planned land acquisition for village protection walls at 17 villages will be 213,333.30 m^2 (52.6933 acres). Provisionally, 1,661 land plots in 17 villages will be subject to land acquisition, and 1,661 households and an estimated 8,063 PAPs are affected.

8.13 The 13 stakeholder meetings covering 15 haors were conducted jointly by BWDB and LGED, 15 FGDs were organized at the village level for BWDB, 17 FGDs were organized at the village level for LGED, and four (4) FGDs targeting women were conducted for jointly for BWDB and LGED. Although the project involves the acquisition of farmland, local communities, including affected households, expressed support for the project during the stakeholder meetings and FGDs, recognizing the anticipated socio-economic benefits. However, since the land acquisition impacts and scale were identified provisionally with the secondary data, the exact land acquisition impact and landowners need to be determined during the detailed design stage. The simplified RAP will need to be updated based on the field survey outcomes. Consultation meetings with affected households should continue throughout the RAP updating and implementation period during the detailed design.

Planning from Gender Perspective

8.14 The gender survey was conducted with the secondary data collection and FGDs with women’s groups. From the perspective of promoting gender equality and women's empowerment, the national legislation, executing agencies’ policies and FGD outcomes were analysed.

8.15 The number of stakeholder attending the meeting shows that women's participation in public consultation meetings is limited. Therefore, it is necessary to organize smaller meetings/FGDs specifically targeted for women to allow them to express their views and provide feedback. Even in FGDs targeting general PAHs (mostly male participants) and community leaders, some male participants mentioned that women's involvement in decision-making is limited. In the FGDs targeting women, female participants described that, while decisions within the family are made collaboratively by both men and women, women's opinions are less valued in decision-making outside the household.

8.16 It is found that gender-related laws and policies are relatively well-established in Bangladesh. However, because the project site is in a rural area, traditional division of roles between men and women remains strong.

IX. STUDY ON PROJECT EFFECTS

Quantitative Effect

Economic Analysis

9.1 An economic analysis was conducted to assess the project's economic feasibility by evaluating its impact on society as a whole, calculating the difference in economic benefits between the “with-project” case and the “without project” case, and considering the project’s funding plan. The Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (B/C), and Economic Net Present Value (ENPV) were calculated based on the base-case scenario and multiple hypothetical cases in the sensitivity analysis. The calculations followed various guidelines issued by JICA and the Government of Bangladesh. The evaluation period adhered to relevant guidelines and aligned with the project life commonly adopted in the sector. It is known to be 30 years after construction commencement for the BWDB-managed portion and 20 years after construction commencement for the LGED-managed portion.

9.2 For the BWDB-managed portion, the flood damage reduction benefits for Boro rice cultivation were calculated as economic benefits. For the LGED-managed portion, the following benefits were each calculated as economic benefits: the reduction in vehicle operating costs (VOC) due to road improvements, the reduction in travel time costs (TTC) due to road improvements, the reduction in losses due to market improvements, the reduction in erosion damage due to village protection wall works, and the benefits from fisheries promotion activities.

9.3 The cost-benefit flow analysis based on the above assumptions resulted in an overall EIRR of 21.4% and ENPV of BDT 8,445.5 million, calculated at a social discount rate of 12%. The EIRR exceeded the social discount rate of 12%, indicating that the project was economically justified.

	EIRR	ENPV
BWDB Part	19.1%	BDT 3,264.1 mil. (JPY 4,040.0 mil.)
LGED Part	23.5%	BDT 5,181.4 mil. (JPY 6,413.0 mil.)
Whole Project	21.4%	BDT 8,445.5 mil. (JPY 10,453.0 mil.)

Source: JICA Survey Team

Operational and Effectiveness Indicators

9.4 The operational and effectiveness indicators for the BWDB part are outlined below.

Indicator	Baseline Value	Target Value
Lead time ensured by the constructed flood forecasting system.	Up to 72 hours	Improvement in actual values. (More than 72 hours)
Forecast accuracy ensured by the constructed flood forecasting system.	-	Improvement from baseline values.
Frequency of flooding in the project haor due to external water (flash floods) during the pre-monsoon season.	Three times in the last 15 years (2010, 2017, and 2022)	One time or less
Area affected by pre-monsoon floods (%).	15%	0% (in case of flush floods with the size of less than a ten-year flood)
Percentage or number of beneficiaries covered by the flood forecast who	-	Improvement from baseline values.

Indicator	Baseline Value	Target Value
were able to obtain and utilize flood forecast information.		
Area dedicated to growing early-harvesting, cold-resistant rice varieties in introduced areas.	0 ha	More than half the total area.
Average income of farmers involved in the introduction and promotion of water-saving intermittent cultivation, rice straw composting, and silicate materials.	Approx. BDT 150,000	BDT 200,000
Cultivated area where field crops are cultivated in the haor where field cash crops are introduced.	0 ha	More than half the total area.
In haors where the introduction and promotion of home gardening and animal husbandry for women is practiced: 1. Number of women practicing home gardening; and 2. Women with increased income.	1. 0 2. 0	1. More than half 2. More than half

Source: JICA Survey Team

9.5 The operational and effectiveness indicators for the LGED part are presented below.

Indicator	Baseline Value	Target Value
Average Annual Daily Traffic	980 vehicles/day	1300 vehicles/day
Average Annual Daily Traffic	980 vehicles/day	1300 vehicles/day
Increased market sales due to market improvements.	BDT 1,670,000/market	BDT 2,500,000/market
Number of houses and utilities whose erosion risk was reduced by village protection walls.	0	1,400
Increased fish catch.	230 kg/ha/year	660 kg/ha/year
Household income and assets derived from fishing activities.	BDT 70,000/household/year	BDT 150,000/household/year
Fish diversity.	90 ～ 100 species	120 ～ 130 species
Percentage of women participating in alternative livelihood and income-generating activities (e.g., home pond aquaculture, small-scale fish processing and dry fish production, household-based petty trading, poultry rearing).	15 ～ 20%	35%
Percentage of women in positions and in the BUG minutes.	Positions: less than 5% Minutes reflection: almost 0%	Positions: 30% Minutes reflection: 25%

Source: JICA Survey Team

Intangible Effect

9.6 "Establishment of the methodology for planning the layout of flood control facilities in the Haor area", "establishment of topography estimation method using satellite images in the Haor area", "reduction of large-scale flood damage through the introduction of flood forecasting and early warning systems", "damage reduction on fisheries output", and "reduction in human dislocation" were considered as intangible effects of the BWDB part of the Project.

9.7 "Increase in job opportunities in the area", "increase in trade activities", "better access to social services such as NGOs, farmers organizations, schools, and hospitals", and "increase in electricity accessibility" were considered as intangible effects of the LGED part of the Project.

Abbreviations and Acronyms

AA	:	Animal Attendant
AADT	:	Annual Average Daily Traffic
AAEO	:	Assistant Agriculture Extension Officer
AC	:	Assistant Chief
ACE	:	Additional Chief Engineer
ADB	:	Asian Development Bank
ADG	:	Additional Director General
ADLO	:	Additional District Livestock Officer
ADP	:	Annual Development Program
AE	:	Assistant Engineer
AEO	:	Agriculture Extension Officer
AE	:	Assistant Engineer
AIDS	:	Acquired Immune Deficiency Syndrome
AI	:	Artificial Intelligence
AIGA	:	Alternate Income Generating Activity
ALOC	:	Activities for the Landless Organized with Consciousness
AO	:	Accounts Officer
AP	:	Affected Person
APSS	:	Agriculture Promotion Support Sub-project
ARP	:	Abbreviated Resettlement Plan
ASA	:	Caritas Bangladesh; Association for Social Advancement
AWP	:	Annual Work Plan
B.C	:	Bituminous Carpeting
BADC	:	Bangladesh Agriculture Development Corporation
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agriculture Research Institute
BBS	:	Bangladesh Bureau of Statistics
B/C	:	Benefit Cost Ratio
BD	:	Bangladesh
BDP2100	:	Bangladesh Delta Plan 2100
BFDC	:	Bangladesh Fisheries Development Corporation
BFRI	:	Bangladesh Fisheries Research Institute
BHWDB	:	Bangladesh Haor and Wetland Development Board
BKB	:	Bangladesh Krishi Bank
BLRI	:	Bangladesh Livestock Research Institute
BMC	:	Beel Management Committee
BMD	:	Bangladesh Meteorological Department
BPC	:	Bangladesh Planning Commission
BRAC	:	Bangladesh Rural Advancement Committee
BRDB	:	Bangladesh Rural Development Board
BRRI	:	Bangladesh Rice Research Institute
BRTA	:	Bangladesh Road Transport Authority
BRTC	:	Bureau of Research Testing and Consultation
BSD	:	Bangladesh Standard Datum
BSD	:	Bangladesh Statistic Department
BUET	:	Bangladesh University of Engineering & Technology

BUG	:	Beel Users Group
BWDB	:	Bangladesh Water Development Board
C/S	:	Construction Supervision
CaMa-Flood	:	Catchment-based Macro-scale Floodplain Model
CARE	:	Cooperative for Assistance & Relief Everywhere
CBN	:	Cost of Basic Needs
CBO	:	Community Based Organization
CBRMP	:	Community Based Resource Management Project
CC	:	Community Clinic
CCDB	:	Christian Commission for Development in Bangladesh
CCL	:	Cash Compensation under Law
CDSP	:	Char Development and Settlement Project
CE	:	Chief Engineer
CEGIS	:	Center for Environmental and Geographic Information Services
CFRM	:	Community Fishery Resource Management
CIC	:	Community Infrastructure Coordinator
CIG	:	Common Interest Group
CNG	:	Compressed Natural Gas
COD	:	Cut-Off Date
CPR	:	Common Properties Resources
CPS	:	Crop Specialist
CPTU	:	Central Procurement Technical Unit
CPUA	:	Catch Per Unit Area
CRP	:	Common Resource Properties
CRM	:	Community Resource Management
CS	:	Certified Seed
CTU	:	Central Training Unit
CUL	:	Compensation Under Law
CVD	:	Commercial Vehicle per Day
CWM	:	Chief Water Management
D/D	:	Detail Design
DAE	:	Department of Agriculture Extension
DANIDA	:	Danish International Development Agency
DAO	:	District Agriculture Office
DAWP	:	District Annual Work Plan
DC	:	Deputy Commissioner
DC	:	Deputy Chief
DC	:	Deputy Commissioner
DCE	:	Deputy Chief Extension Office
DDM	:	Department of Disaster Management
DICT	:	Dutch Cone Test
DEID	:	Department For International Development
DEM	:	Digital Elevation Model
DFO	:	District Fisheries Office
DFO	:	District Fisheries Officer
DFS	:	Directorate Field Services
DG	:	Director General

DLO	:	District Livestock Office
DLS	:	Department of Livestock Services
DMC		Disaster Management Committee
DO	:	Division Office
DOA	:	Department of Agriculture
DOE	:	Department of Environment
DOF	:	Department of Fisheries
DPD	:	Deputy Project Director
DPHE	:	Department of Public Health Engineering
DPP	:	Development Project Proforma
DPP	:	Development Project Proposal
DPP	:	Developing Project Profile
DSC	:	Design Supervision Consultant
DTO	:	District Training Officer
DTW	:	Deep Tube Well
DX	:	Digital transformation
EA	:	Executing Agency
EC	:	Executive Committee
ECA	:	Environment Conservation Act
ECA	:	Ecologically Critical Area
ECC	:	Environmental Clearance Certificate
ECNEC	:	Executive Committee of National Economic Council
ECR	:	Environmental Conservation Rule
EE	:	Executive Engineer
EMoP	:	Environmental Monitoring Plan
ERD	:	Economic Relations Division
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Ratio of Return
EMA	:	External Monitoring Agency
EME	:	Effect Monitoring and Evaluation
EMP	:	Environmental Management Plan
ENPV	:	Economic Net Present Value
EO	:	Extension Overseas
ESC	:	Engineering Services Consultant
ETP	:	Effluent Treatment Plant
F&A	:	Finance and Accounting
F/S	:	Feasibility Study
FA	:	Field Assistant
FAP	:	Flood Action Plan
FC	:	Foreign Currency
FCD	:	Flood Control and Drainage
FCD/I	:	Flood Control, Drainage and Irrigation
FCDI	:	Flood Control, Drainage and Irrigation
FDAP	:	Fisheries Development Area Plan
FFS	:	Farmer Field School
FFW	:	Food For Works
FFWC	:	Flood Forecasting and Warning Centre
FGD	:	Focus Groups Discussion

FIVDB	:	Friends in Village Development, Bangladesh
FLID	:	Fisheries and Livestock Information Department
FTA	:	Fault Tree Analysis
FWC	:	Family Welfare Center
FWMA	:	Federation of Water Management Association
FWUA	:	Federation of Water Users Association
FY	:	Fiscal Year
GCM	:	Growth Center Market
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
GK	:	Ganges-Kobadak
GO	:	Governmental Organization
GOB	:	Government of Bangladesh
GPWM	:	Guidelines for Participatory Water Management
GR	:	Grievance Redress Committee
GSMaP	:	Global Satellite Mapping of Precipitation
GTZ	:	German Technical Cooperation Agency
HACCP	:	Hazard Analysis and Critical Control Point
H-ADCP	:	Horizontal Acoustic Doppler Current Profiler
HED	:	Health Engineering Department
HH	:	Household
HIES	:	Household Income and Expenditure Survey
HILIP	:	Haor Infrastructure and Livelihood Improvement Project
HISAL	:	Haor Initiatives for Sustainable Alternative Livelihood
HIV	:	Human Immunodeficiency Virus
HMP	:	Haor Master Plan
HP	:	High Priority
HQ	:	Headquarters
HS	:	Highly Significance
HWL	:	High Water Level
HYV	:	High Yielding Variety
IA	:	Implementing Agency
IAPP	:	Integrated Agricultural Productivity Project
ICM	:	Integrated Crop Management
ICMG	:	Integrated Crop Management Group
ICUN	:	International Union for Conservation of Nature
ID	:	Identity Card
IEE	:	Initial Environmental Examination
IFAD	:	International Fund for Agricultural Development
IGA	:	Income Generation Activity
ILRP	:	Income and Livelihood Restoration Program
IMC	:	Implementation Monitoring Committee
IMD	:	India Meteorological Department
IMR	:	Infant Mortality Rate
IMSC	:	Inter-Ministerial Steering Committee
IPM	:	Integrated Pest Management
IPMG	:	Integrated Pest Management Group

IRI	:	International Roughness Index
IWM	:	Institute of Water Modelling
IWMP	:	Integrated Water Management Plan
IWRM	:	Integrated Water Resources Management
IWT	:	Inland Water Transport
JAXA	:	Japan Aerospace Exploration Agency
JDCF	:	Japan Debt Cancellation Fund
JICA	:	Japan International Cooperation Agency
JMC	:	Joint Management Committee
JVS	:	Joint Verification Survey
JVT	:	Joint Verification Team
KKRM	:	Kalni-Kushiyara River Management
KSS	:	Krishok Sarnabaya Samity
L	:	lowland
L&R	:	Land and Revenue
L/A	:	Loan Agreement
LA&R	:	Land Acquisition and Resettlement
LAP	:	Land Acquisition Plan
LC	:	Local Currency
LCB	:	Local Competitive Bidding
LCS	:	Labor Contracting Societies
LEAF	:	Local Extension Agents for Fisheries
LGD	:	Local Government Division
LGEB	:	Local Government Engineering Bureau
LGED	:	Local Government Engineering Department
LGI	:	Local Government Institution
LGSP	:	Local Governance Support project
LGRD	:	Local Government, Rural Development
LGRD&C	:	Local Government, Rural Development and Cooperative
LH	:	Lease Holder
LLP	:	Low Lift Pump
LMS	:	Land Market Survey
LOA	:	Letter of Agreement
LPL	:	Lower Poverty Line
M&E	:	Monitoring and Evaluation
M/M	:	Man/Month
MC	:	Management Committee
MDGs	:	Millennium Development Goals
MH	:	Medium Highland
MICS	:	Multiple Indicator Cluster Survey
MIS	:	Management Information System
ML	:	Medium Lowland
MLGRD&C	:	Ministry of Local Government, Rural Development and Cooperative
MM	:	Man/Month
MMC	:	Market Management Committee
MMT	:	Mobile Maintenance Team
MOA	:	Ministry of Agriculture

MOE	:	Ministry of Education
MOF	:	Ministry of Finance
MOEF	:	Ministry of Environment and Forests
MOFL	:	Ministry of Fisheries and Livestock
MOL	:	Ministry of Land
MOU	:	Memorandum of Understanding
MOWR	:	Ministry of Water Resources
MP	:	Master Plan
MP	:	Medium Priority
MVC	:	Multipurpose Village Center
NARS	:	National Agricultural Research System
NASA	:	National Aeronautics and Space Administration
NATP	:	National Agricultural Technology Project
NCA	:	Net Cultivated Areas
NCB	:	National Competitive Bidding
NEP	:	National Fisheries Policy
NERM	:	North East Region Model
NGO	:	Non-Governmental Organization
NOAA	:	National Oceanic and Atmospheric Administration
NOBIDEP	:	Northern Bangladesh Integrated Development Project
NOC	:	No Objection Certificate
NSAPR II	:	National Strategy for Accelerated Poverty Reduction II
NWMP	:	National Water Management Plan
NWP	:	National Water Policy
O&M	:	Operation and Maintenance
OAWP	:	Overall Annual Work Plan
ODA	:	Official Development Assistance
OFRD	:	On-farm Research Division
OP	:	Operational Procedure
OWP	:	Overall Work Plan
PAP	:	Project Affect Person
PC	:	Planning Commission
PD	:	Project Director
PEC	:	Project Evaluation Committee
PEO	:	Principal Extension Officer
PIU	:	Project Implementation Unit
PMO	:	Project Management Office
PMU	:	Project Monitoring Unit
POPI	:	People's Oriented Program Implementation
PPR	:	Public Procurement Regulation
PQ	:	Pre-Qualification
PRA	:	Participatory Research Activities
PSM	:	Participatory Scheme Management
PSO	:	Principal Scientific Officer
PSSWRSP	:	Participatory Small Scale Water Resources Sector Project
PUO	:	Project Upazila Office
PVAT	:	Property Valuation Advisory Team

PWD	:	Public Works Datum
PWD	:	Public Work Department
QCBS	:	Quality and Cost Based Selection
RAC	:	Resettlement Advisory Committee
RADP	:	Revised Annual Development Program
RAO	:	Regional Agriculture Office
RAP	:	Resettlement Action Plan
RCC	:	Reinforced Cement Concrete
RCC	:	Roller Compacted Concrete
RCF	:	Resettlement and Compensation Framework
RD	:	Rural Dispensary
RDP	:	Rural Development Project
RDRS	:	Rangpur Dinajpur Rural Service
REA	:	RAP Executing Agency
REB	:	Rural Electrification Board
RF	:	Resettlement Framework
RHD	:	Roads and Highways Department
RIIP	:	Rural Infrastructure Improvement Project
RIMES	:	Regional Integrated Multi-hazard Early Warning System
RM	:	Rural Market
RMRSU	:	Road Maintenance and Road Safety Unit
RO	:	Research Officer
ROW	:	Right of Way
RSDMS	:	Road and Structure Database Management System
RTC	:	Regional Training Centers
RTIP	:	Rural Transport Improvement Project
RU	:	Resettlement Unit
RV	:	Replacement Value
RWL	:	River Water Level
SAAO	:	Sub-assistant Agricultural Officer
SAE	:	Sub-assistant Engineer
SAIWRPM	:	Southwest Area Integrated Water Resources Planning and Management
SAP	:	South Asia Partnership- Bangladesh
SAPPO	:	Sub-assistant Plant Protection Officer
SCA	:	Seed Certification Agency
SCBRMP	:	Sunamganj Community Based Resource Management Project
SDE	:	Sub-divisional Engineer
SDO	:	Sub-division Office
SCF	:	Standard Conversion Factor
SE	:	Superintending Engineer
SFYP	:	Sixth Five Year Plan
SIA	:	Social Impact Assessment
SIGS	:	Small-scale Income Generation Sub-project
SO	:	Section Officer
SO	:	Section Office
SOB	:	Survey of Bangladesh
SR	:	Spoilage Reduction

SRDI	:	Soil Resources Development Institute
SSWRDP	:	Small Scale Water Resources Development Project
SSWRDS	:	Small Scale Water Resources Development and Support
STW	:	Shallow Tube Well
SU Samity	:	Samaj Unnoyan Samity
SW	:	Shallow Well
SW	:	Southwest
SWAIWRP&MP	:	Southwest Area Integrated Water Resources Planning and Management Project
TARD	:	Technical Assistance for Rural Development
TCCA	:	Thana Central Cooperative Association
TOR	:	Terms of Reference
TSD	:	Training and Staff Development
UCS	:	User’s Cost Saving
U5MR	:	Under-5 Child Mortality Rate
UAO	:	Upazila Agriculture Offices
UAWP	:	Upazila Annual Work Plan
UCCA	:	Upazila Central Cooperative Association
UE	:	Upazila Engineer
UFO	:	Upazila Fisheries Office
UHC	:	Upazila Health Complex
ULAO	:	Upazila Livestock Assistant Office
ULO	:	Upazila Livestock Office
UMMC	:	Upazila Market Management Committee
UNESCAP	:	United Nations Economic and Social Commission for Asia and the Pacific
UNICEF	:	United Nations International Children’s Emergency Fund
UNO	:	Upazila Nirbahi Officer
UNR	:	Union Road
UP	:	Union Parishad
UPL	:	Upper Poverty Line
UZR	:	Upazila Road
VAT	:	Value Added Tax
VC	:	Veterinary Compounder
VFA	:	Veterinary Field Assistant
VGD	:	Vulnerable Group Development
VGF	:	Vulnerable Group Feeding
VHP	:	Very High Priority
VHS	:	Very Highly Significance
VL	:	Very Lowland
VLR	:	Village Road
VOC	:	Vehicle Operating Cost
VOSD	:	Voluntary Organization for Social development
VR	:	Village Road
VS	:	Veterinary Surgeon
WARPO	:	Water Resources Planning Organization
WB	:	World Bank
WM	:	Water Management

WMA	:	Water Management Association
WMC	:	Water Management Committee
WMCA	:	Water Management Cooperative Association
WMF	:	Water Management Federation
WMG	:	Water Management Group
WMIP	:	Water Management Improvement Project
WMO	:	Water Management Organization
WP	:	Works Program
WPW	:	Works Program Wing
WUA	:	Water Users Association
WUC	:	Water Users Committee
WUG	:	Water Users Group
XEN	:	Executive Engineer

PREPARATORY SURVEY

FOR

HAOR AREA RESILIENCE AND DEVELOPMENT PROJECT

FINAL REPORT

LOCATION MAP

SUMMARY (UNDER PREPARATION)

ABBREVIATIONS

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CHAPTER 1 INTRODUCTION

1.1 Overview of the Project

In the haor region situated in the northeast of the People's Republic of Bangladesh (hereinafter referred to as “Bangladesh”), much of the area is submerged during the monsoon season from around June to November each year, with low-lying wetlands, known as “haors”, scattered throughout. The haor region is facing a severe and escalating climate risk. Observational data and advanced climate model projections have revealed a clear shift towards a new climatic regime characterized by significant warming, a hazardous redistribution of seasonal rainfall, and an increase in the intensity of extreme weather events (as referred to in “Section 2.5”). These changes pose a fundamental threat to the region's socio-ecological stability and the livelihoods of its nearly 20 million residents[1], as the region faces a worsening threat marked by intensifying dry-season aridity and escalating wet-season flood risks. Consequently, the two pillars of the haor economy, namely “dry-season Boro rice” and “wet-season fisheries”, are under serious negative impacts due to the climate change.

(1) Project Objective

This project aims to reduce flood damage and improve a) access to basic infrastructure and b) agricultural and fishery productivity in the Haor area, through (i) rehabilitation/construction of flood control facilities and rural infrastructures, and (ii) agriculture and fisheries promotion activities, thereby contributing to stable food supply and climate change adaptation in the country.

(2) Project Contents

① Rehabilitation/construction of flood control facilities (full/submergible embankments, drainage canals, regulators, and associated hydraulic structures),

② Improvement/construction of rural infrastructures (submergible Village roads, markets, wharves, and related community facilities),

③ Agriculture and fisheries promotion activities (practical guidance of agricultural technologies, support for sustainable use of fishery resources, and management of fishery resources), and

④ Consulting services

(3) Project Implementing Agencies/Institutional Arrangements

- Bangladesh Water Development Board (BWDB)
- Local Government Engineering Department (LGED)

Close coordination will be ensured with the Ministry of Agriculture, the Bangladesh Meteorological Department (BMD), and the Department of Fisheries (DOF).

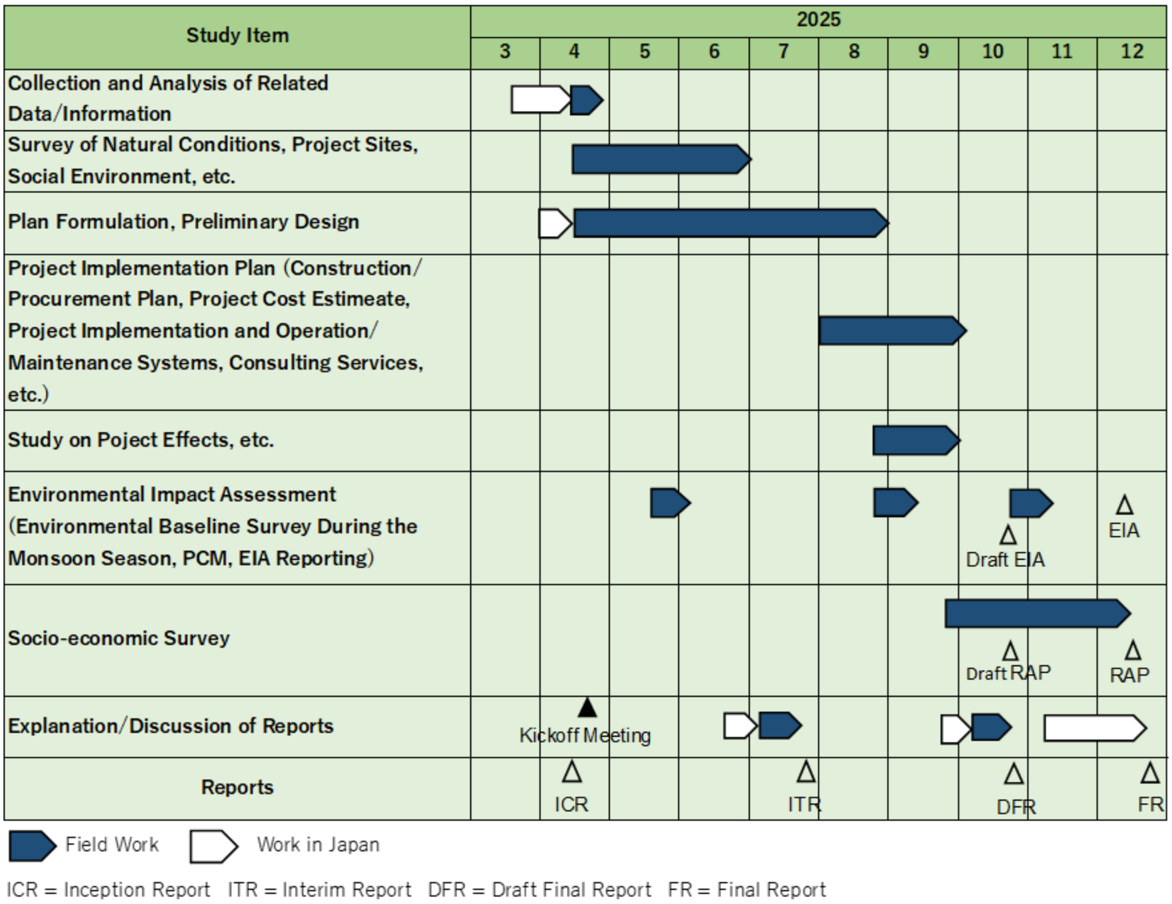
1.2 Survey Objective

The "Preparatory Survey for Haor Area Resilience and Development Project (hereinafter referred to as “the Survey”)” aims to conduct the survey necessary to examine the project contents related to the implementation of the Project as a Japan official development assistance (ODA) loan project.

[1] Source: “Master Plan of Haor Area, April 2012, Bangladesh Haor and Wetland Development Board, Ministry of Water Resources” (projected from BBS, 2001 census)

1.3 Survey Schedule

The survey schedule is presented in Figure 1.3.1.



Source: JICA Survey Team

Figure 1.3.1 Survey Schedule

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Development Plans in Bangladesh

The following plans are introduced as national policies of Bangladesh, closely related to Haor area resilience and development.

2.1.1 Bangladesh Delta Plan 2100 (BDP 2100)

The Bangladesh Delta Plan 2100 (BDP 2100) is envisaged as a long-term, integrated, and holistic plan that deals with a long-term view on water resources management, climate change, and environmental challenges, aiming to support long-term development of Bangladesh. The BDP 2100 has developed a broad-based, long-term vision regarding the likely changes in the Bangladesh Delta by the end of the 21st Century and the goals for implementing this vision, which are framed below.

Vision: Achieving a Safe, Climate-Resilient and Prosperous Delta

Goals:

Higher-Level goals:

Goal 1: Eliminate extreme poverty by 2030.
Goal 2: Achieve upper middle-income status by 2030.
Goal 3: Being a prosperous country beyond 2041.

Specific goals:

Goal 1: Ensure safety from floods and climate change-related disasters.
Goal 2: Enhance water security and efficiency of water usage.
Goal 3: Ensure sustainable and integrated management of river systems and estuaries.
Goal 4: Conserve and preserve wetlands and ecosystems, promoting their wise use.
Goal 5: Develop effective institutions and equitable governance for in-country and transboundary water resources management.
Goal 6: Achieve optimal and integrated use of land and water resources.

In BDP2100, the water challenges and strategies are built, (a) addressing the fundamental problem of flooding, which is a nationwide challenge and (b) addressing specific challenges in six hotspots[2], which are: 1) water shortage in drought-prone Barind Region[3]; 2) river erosion problems in the river and estuary regions; 3) coastal inundation and salinity problems of the coastal region; 4) flash flooding and wetland management issues in the Haor region; 5) water shortage, sanitation, and drainage problems in urban areas; and 6) water shortage problem in the Chittagong Hill Tracts (CHT) Region.

Regarding hotspot-specific strategies for Haor and flash-flood areas, the Haor region has been identified as one of the food-insecure regions in Bangladesh in terms of agricultural production and food supply. A single crop (Boro rice) is grown due to the prolonged period of annual flooding, resulting in food insecurity. Hence, the strategies include "protecting agriculture and vulnerable communities from floods, along with promoting alternative livelihoods".

The Project will provide the Haor area with safety from flash floods under climate change and livelihood improvement through agriculture and fisheries promotion. Thus, it will contribute particularly to Goal 1 of the Higher-Level Goals, as well as Goals 1 and 6 of the Specific Goals.

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2 "Hotspot" simply defines a broad grouping of districts and areas facing similar natural hazards and climate change risks.
3 A geographically and climatically unique region situated in the northwest of Bangladesh, the Barind Region is a highland plateau with elevations ranging from 15 to 30 meters. It is characterized by lower annual rainfall compared to the surrounding lowland areas, dry conditions, and soil with poor water retention capacity, resulting in high dependence on groundwater irrigation for agriculture.

2.1.2 Perspective Plan of Bangladesh 2021-2041 (PP2041)

"Vision 2041" (Bangladesh's long-term national goals) attempts to eliminate extreme poverty and reach Upper Middle-Income Country (UMIC) status by 2031, and High-Income Country (HIC) status by 2041 with poverty nearing eradication. To translate "Vision 2041" into a development strategy, 'Making Vision 2041 a Reality: Perspective Plan of Bangladesh 2021-2041' (PP2041) has been issued.

The strategic goals of the PP2041 are set up as framed below.

- Eradication of Extreme Poverty by 2031, with poverty reduced to less than 3% by 2041.
- Achieving Upper Middle-Income Country by FY 2031 and High-Income Country status by 2041.
- Industrialization, with export-oriented manufacturing, will drive structural transformation into the future.
- Paradigm shifts in Agriculture will enhance productivity and ensure nutrition and food security for the future.
- A service sector of the future will bridge the transformation of the rural agrarian economy to a primarily industrial and digital economy.
- The urban transition will be an essential component of the strategy for moving towards a high-income economy.

The PP2041 focuses mainly on integrating environmental and climate change considerations into growth strategy, in alignment to the Project objective of "Haor Area Resilience and Development". The specific strategies under the PP2041include, among others:

"Implementing the "Bangladesh Delta Plan 2100 (BDP2100)" to build resilience and reduce vulnerability to climate change."

2.1.3 The Eighth Five Year Plan (July 2020 – June 2025) (8FYP)

The implementation of the Perspective Plan of Bangladesh 2021-2041 (PP2041) is envisaged in four (4) 'Five Year Plans'. The first five (5)-year period begins with the Eighth Five-Year Plan (8FYP). Therefore, the main objective of the 8FYP is to initiate the implementation of the PP2041 in a manner that brings Bangladesh closer to the goals of achieving UMIC status by 2031, attaining Sustainable Development Goal (SDG) targets through managing the challenges of LDC graduation, and eliminating extreme poverty by 2031.

The 8FYP focusses on six core themes, as framed below.

- Rapid recovery from COVID-19.
- GDP growth acceleration, employment generation, and rapid poverty reduction.
- A broad-based strategy of inclusiveness.
- A sustainable development pathway that is resilient to disasters and climate change.
- Improvement of critical institutions necessary to lead the economy to UMIC status by 2031.
- Attaining SDG targets and mitigating the impacts of LDC graduation.

These six core themes are incorporated into the macroeconomic and sectoral strategies, policies, and programmes of the 8FYP.

2.2 Current Situation of the Haor Area

In haors, Boro rice is cultivated as a single crop and serves as the main source of income. According to data from the Bangladesh Bureau of Statistics (BBS), the country's rice production in 2023, on an unhulled rice basis, consisted of 21,068 thousand tons of Boro rice (52% of the total), 16,656 thousand tons of Aman rice (41%), and 2,973 thousand tons of Aus rice (7%). In the same year, the Boro rice production in the seven districts of the Haor region amounted to 3,969 thousand tons (19% of the national Boro rice production). The annual rice consumption in the country, on a polished rice basis, has ranged from 37 to 38 million tons in recent years based on data from the United States Department of Agriculture, and most of the rice produced in the country is consumed domestically. In this context, Boro rice is positioned as the staple food of the Bangladeshi people.

Boro rice is harvested by mid-May each year; however, sudden floods (flash floods) occasionally occur before harvest, causing damage to crops and preventing harvests. As a result, the livelihoods of people in this region become unstable, making the region one of the areas with a high poverty rate[4]. It has been observed that flash floods have recently occurred more frequently than expected (see "Section 2.5"), raising concerns about the impacts of climate change on local livelihoods.

Since 2014, the Japan International Cooperation Agency (JICA) has implemented (i) the development of flood control facilities, such as embankments and regulators, and rural infrastructure, such as local roads and (ii) various agriculture and fisheries promotion activities as yen loan project ("Haor Flood Management and Livelihood Improvement Project", hereinafter referred to as "the Phase 1"). In the Phase 1, new facilities were constructed in 13 haors and existing facilities were rehabilitated in 14 haors out of approximately 370 haors in the haor region, as shown in Figure 2.3.1.

Flood Control Facilities

The submersible embankments, which are unique globally, submerge completely during the rainy season each year and function to prevent water from entering the haor before the harvest of Boro rice. The submersible embankments are subject to overflow and wave erosion both before and after the submersion, causing many sections to be eroded or completely breached. Damaged submersible embankments are repaired by the BWDB, and the cycle of damage and repair occurs annually.

The submersible embankments constructed in the Phase 1 were made more resilient against overflow-induced damage by (i) introducing mechanical compaction (ii) constructing the embankment slopes relatively gentler compared to the existing ones. However, some sections of the embankments were still damaged, and various types of slope protection measures were tried as experiments. These types of slope protection measures have been in place for about four (4) years, and one of the challenges for the next phase is to verify their long-term durability and effectiveness.

Additionally, the need for an early warning system for flash floods has been identified, which would increase the lead time, reduce damage to Boro rice crops before harvest, and ensure the timely evacuation of personnel and machinery in and around the haors.

Rural Infrastructure

The development of rural infrastructure has been implemented by the Local Government Engineering Department (LGED). In the Phase 1, the Project selected and constructed rural roads, markets, and boat landing stations, aiming to enhance synergy effects with flood control measures and contribute to the promotion of agriculture and fisheries.

Given the large number of haors, there remains a high demand for rural infrastructure development. Notably, many rural roads are constructed on the crests of submersible embankments, which makes flood control measures for these facilities a crucial aspect of rural infrastructure development.

Agriculture and Fisheries Development

In the Phase 1, many programs were implemented for agriculture and fisheries promotion, including training on agricultural and fisheries techniques to enhance the capacity of agricultural and fisheries workers, provision of livestock to improve livelihoods, and promotion introducing of new crops. However, the need for agriculture and fisheries promotion activities remains significantly high due to the high poverty rate in the haor areas, climate change impacts, and the large number of haors.

As part of the promotion activities, more than 300 water users associations (WUAs) were formed by the beneficiaries (mainly farmers in the haors) to maintain the facilities constructed for flood control. However, since the handover of the flood control facilities to the WMGs occurred toward the end of the

[4] Some haor districts like Kishoreganj and Netrokona have rates as high as 53.5% and 34.0% respectively. (POVERTY MAPS OF BANGLADESH 2016: Key Findings, 2020, BBS, World Food Programme and International Fund for Agricultural Development)

Phase 1, training for the WMGs in the Phase 1 insufficiently conducted, and verification of their current capacities remains an issue.

In addition, 139 fishing unions (BUGs) were formed to carry out fishing activities in the developed Beels (low-lying areas within the haors). However, when the leases for the Beels with the Government of Bangladesh (GOB) expired, the unions lost their rights to control the Beels, resulting in the loss of their operational areas.

The lease for Beels is managed under the Jalmohal System,[5] administered by the Ministry of Land (MoL), and applications, renewals, and operations must follow the procedures of this system. The challenge is to develop management capabilities of the BUGs and to maximize the time they have to save money in preparation for bidding on lease renewals. This could be achieved by introducing a system in which a portion of Beel revenue is set aside to fund the next lease payment.

2.3 Preliminary Development Project Proposal (DPP) of Haor Phase 2 Project

BWDB prepared a preliminary development project proposal (PDPP) in November 2021 for the "Haor Flood Management and Livelihood Improvement Project, BWDB Part (2nd Phase)", for possible JICA financing.

A JICA Project Review Meeting for the 2nd Phase project was held on 27 August 2023, where JICA expressed interest in implementing the 2nd Phase project in collaboration with LGED to maximize synergies through the development of rural infrastructure and fisheries. As a result, JICA requested BWDB and LGED to work together and finalize a sub-project list for the 2nd Phase for potential JICA financing.

Therefore, BWDB and LGED, held two joint meetings on 2 and 6 August 2023, resulting in selection of 26 sub-haor projects (20 and 6 haors for "rehabilitation" and "new development", respectively), as compiled in Table 2.3.1. The locations of these 26 haors are shown in Figure 1.3.1.

The definitions of rehabilitation and new haors used in Table 2.3.1 are explained below.

- Rehabilitation Haor: A haor where the project was previously formulated and undertaken through study/design and implementation using development funds.
- New Haor: Although referred to as new, some facilities may already exist. These facilities were constructed with the "Non-Development Budget", which is basically intended for repair and emergency works.

[5] Jalmohal System: a scheme under which public waters (lakes, Beels, and rivers) owned by the GOB are administered by the MoL. Usage rights for these waters are granted and renewed periodically through bidding and lease contracts. User entities, such as fishing unions (BUGs), pay lease fees under this system to obtain fishing and management rights.

Table 2.3.1 List of 26 Haors Selected for Haor Second Phase Project

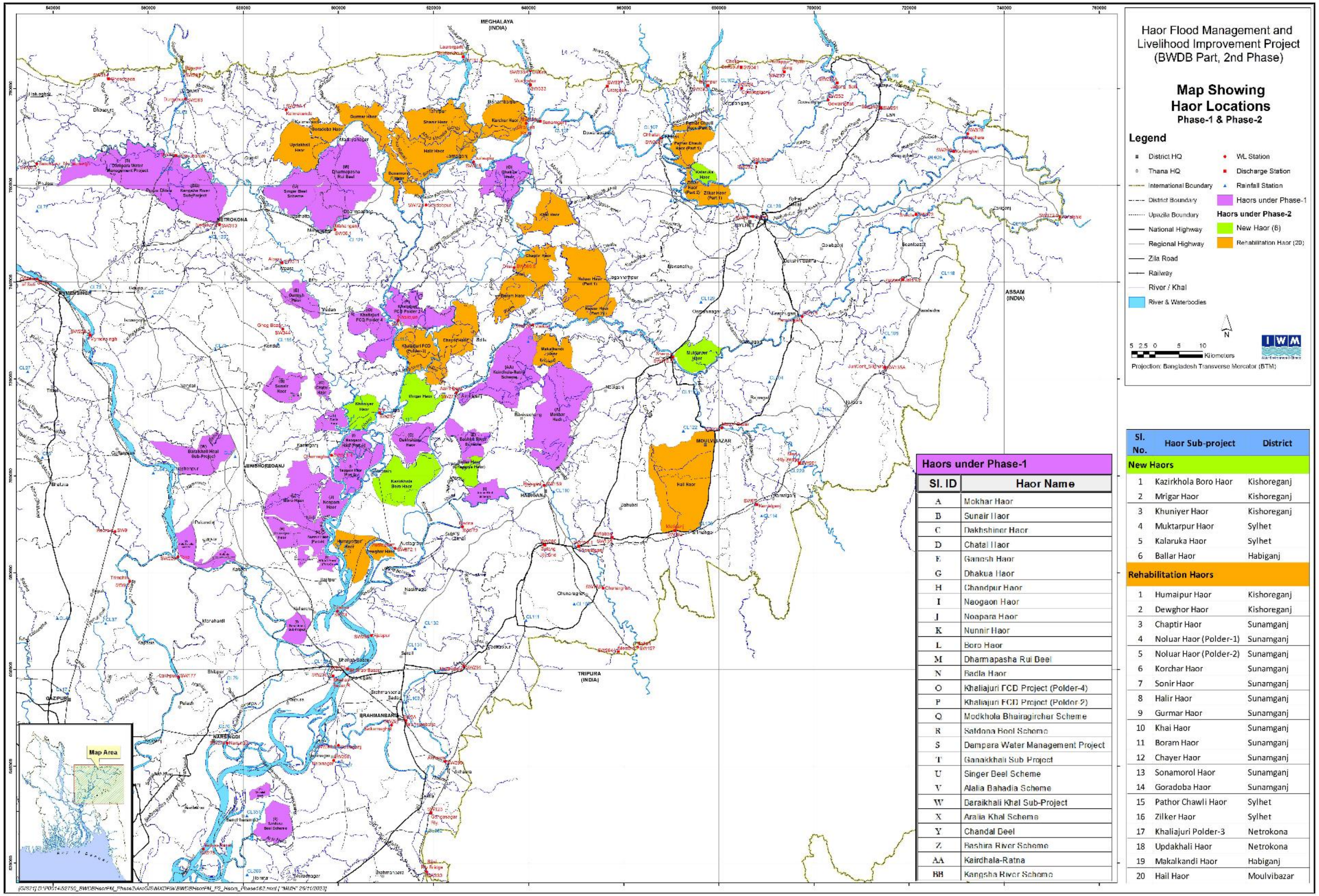
List of 26 nos. selected Haors for Haor 2nd Phase Project

Sl. No.	Haor Sub-project	District	Upazila	Command Area in Ha.
1	Kazirkhola Boro Haor	Kishoreganj	Mithamoin, Austogram	4000
2	Mrigar Haor	Kishoreganj	Itna	5500
3	Khuniyer Haor	Kishoreganj	Itna	2297
4	Muktarpur Haor	Sylhet	Osmaninagar	5089
5	Kalaruka Haor	Sylhet	Sylhet Sadar	1433
6	Ballar Haor	Habiganj	Baniachang	2500
Total Command Area for New Haors				**20819**

Sl. No.	Haor Sub-project	District	Upazila	Command Area in Ha.
1	Humaipur Haor	Kishoreganj	Bajitpur, Nikli, Austogram	5395
2	Dewghor Haor	Kishoreganj	Austagram	1450
3	Chaptir Haor	Sunamganj	Derai	4622
4	Noluar Haor (Polder-1)	Sunamganj	Jagannathpur	8940
5	Noluar Haor (Polder-2)	Sunamganj	Jagannathpur	3200
6	Korchar Haor	Sunamganj	Sunamganj Sadar, Bishwamvarpur	6017
7	Sonir Haor	Sunamganj	Bishwamvarpur, Tahirpur, Jamalganj	8298
8	Halir Haor	Sunamganj	Jamalganj, Bishwamvarpur, Tahirpur	9429
9	Gurmar Haor	Sunamganj	Dharmapasha, Moddhyanagar, Tahirpur	5186
10	Khai Haor	Sunamganj	Shantiganj	3400
11	Boram Haor	Sunamganj	Derai, Shulla	4497
12	Chayer Haor	Sunamganj	Shulla	9981
13	Sonamorol Haor	Sunamganj	Dharmapasha	3275
14	Goradoba Haor	Sunamganj	Chhatak	850
15	Pathor Chawli Haor	Sylhet	Companiganj	6500
16	Zilker Haor	Sylhet	Sylhet Sadar	2400
17	Khaliajuri Polder-3	Netrokona	Mohanganj	3024
18	Updakhali Haor	Netrokona	Madan	2325
19	Makalkandi Haor	Habiganj	Baniachang, Nabiganj	9500
20	Hail Haor	Moulvibazar	Moulvibazar Sadar	18414
Total Command Area for Rehabilitation Haors				116703

Total Haor for 2nd Phase: 26 nos. (Rehabilitation 20 nos. & New 06 nos.)
Total Command Area in Haor 2nd Phase = 20819+116703 = 137522 Ha

Source: BWDB letter to JICA Bangladesh Office, Memo No: PD/HFMLIP/2023-3024/C-1(g)/, Date: 26.09.2023



Haors under Phase-1	
Sl. ID	Haor Name
A	Mokhar Haor
B	Sunair Haor
C	Dakhshiner Haor
D	Chatal Haor
E	Ganesh Haor
G	Dhakua Haor
H	Chandpur Haor
I	Naogaon Haor
J	Noapara Haor
K	Nunnir Haor
L	Boro Haor
M	Dharmapasha Rui Beel
N	Badla Haor
O	Khaliajuri FCD Project (Polder-4)
P	Khaliajuri FCD Project (Polder-2)
Q	Modkhola Bhairagirchar Scheme
R	Satdona Beel Scheme
S	Dampara Water Management Project
T	Ganakkhali Sub Project
U	Singer Beel Scheme
V	Alalia Bahadia Scheme
W	Baraikhali Khal Sub-Project
X	Aralia Khal Scheme
Y	Chandal Beel
Z	Bashira River Scheme
AA	Kairdhala-Ratna
BB	Kangsha River Scheme

Sl. No.	Haor Sub-project	District
New Haors		
1	Kazirkhola Boro Haor	Kishoreganj
2	Mrigar Haor	Kishoreganj
3	Khuniyer Haor	Kishoreganj
4	Muktarpur Haor	Sylhet
5	Kalaruka Haor	Sylhet
6	Ballar Haor	Habiganj
Rehabilitation Haors		
1	Humaipur Haor	Kishoreganj
2	Dewghor Haor	Kishoreganj
3	Chaptir Haor	Sunamganj
4	Noluar Haor (Polder-1)	Sunamganj
5	Noluar Haor (Polder-2)	Sunamganj
6	Korchar Haor	Sunamganj
7	Sonir Haor	Sunamganj
8	Halir Haor	Sunamganj
9	Gurmar Haor	Sunamganj
10	Khai Haor	Sunamganj
11	Boram Haor	Sunamganj
12	Chayer Haor	Sunamganj
13	Sonamorol Haor	Sunamganj
14	Goradoba Haor	Sunamganj
15	Pathor Chawli Haor	Sylhet
16	Zilker Haor	Sylhet
17	Khaliajuri Polder-3	Netrokona
18	Updakhali Haor	Netrokona
19	Makalkandi Haor	Habiganj
20	Hail Haor	Moulvibazar

Source: JICA Survey Team

Figure 2.3.1 Location Map of Haors Under Phase-1 Project and 26 Haors Selected for Phase-2 Project

2.4 Recent Studies Related to Haor Phase 2 Project

2.4.1 Additional Study, Haor Flood Management and Livelihood Improvement Project (BWDB Part)

(1) Objective of the Study

This additional study was conducted from July 2023 to March 2024 as part of the Haor Project Phase 1, as instructed by the Bangladesh Water Development Board (BWDB) to the consultants, based on the following background. The following is an excerpt from the report, which includes the objectives of the study, key findings, and recommendations.

In the construction of flood management structures in Phase 1, the durability of the embankments was improved compared to conventional submersible embankments by compacting the embankments with heavy machinery and introducing flood fuses[6]. However, damage was confirmed in some of the newly constructed submersible embankments, prompting the construction of various types of slope protection works were as a pilot program during the construction period from FY2020 to FY2023, their effectiveness was evaluated[7]. However, at this point, it was determined that the effectiveness evaluation was insufficient due to the short duration since construction. Moreover, a preliminary review of the haor sub-projects listed in the Preliminary Development Project Proforma (PDPP, November 2021) was deemed necessary for the haor sub-projects that had not yet been implemented[8]. Furthermore, the study was requested to summarize the lessons learned from various activities related to livelihood improvement in Phase 1 and provide recommendations for future projects. For the background of the above, an additional study was conducted to evaluate the effectiveness of the slope protection pilot program and to consider the applicability of the haor sub-projects proposed in the PDPP to the successor projects of Phase 1.

(2) Key Findings and Recommendations

(a) Key Findings

i. Design and Effectiveness of Phase 1: Several changes were made to the standard BWDB methodology for planning, designing and constructing of flood control facilities. One of the major changes was modifying the end of the pre-monsoon period for the design flood (10-year return flood) from 31st May to 15th May[9]. The effect of this design change was evaluated as generally appropriate.

ii. Hydrological Conditions during Phase 1: River Water Level or High-Water Level (HWL) hydrographs from 17 gauging stations for the past ten years (2013 to 2022) revealed that the river water level (RWL) at several points exceeded the design crest level of the submersible embankment before 15th May. It is necessary to update the HWL of the submersible embankment accordingly.

iii. Operational Aspects of Phase 1: The BWDB field office completed the handover of facility operations to the established WMGs and WMAs by June 2023. Additionally, BWDB conducted demonstrations and training during the first year of operation to familiarize WMGs with operation procedures, and practical technology transfer to WMGs was conducted during this overlapping

[6] This flood control facility was created by excavating a part of a submersible embankment to allow water to flow in and out of the haor and the surrounding area. It is approximately 40 to 60 m wide. The facility is opened on May 16th, at the end of the pre-monsoon season, and closed around February during the dry season. By repeating this process every year, the difference in water levels inside and outside the haor is reduced, thereby (1) preventing damage to the embankment due to overflow, and (2) enabling boat navigation within and around the haor during the rainy season.

[7] The evaluation results were reported in the "Consultancy Services Completion Report (June 2023), Nippon Koei, BETS, CNRS."

[8] Reference: "2.3 Preliminary Development Proposal for Haor Phase 2 Project"

[9] This was decided at a joint meeting between the consultants and the BWDB design section on 26 January 2016. The reasons were: 1) most farmers are currently cultivating high-yielding varieties (HYV) of Boro rice, and the harvest season usually ends by May 15th, and 2) farmers prefer to use rivers and khals (waterways) for transporting rice in rural boats and also to draw water into the paddy fields earlier.

period. From the second year onwards, joint operations were conducted by the WMGs and WMAs with BWDB field staff, and operational adjustments were made based on the experience gained in the previous year.

iv. Assessment of Embankment Damage: Damage tended to occur repeatedly at the same points along the embankment. It is judged that a more detailed analysis of the damage mechanism would enable the development of technically and economically effective slope protection works. With the implementation of slope protection measures, the extent of severe damage to the submersible embankment in FY2023 has been significantly reduced compared to FY2020.

v. Site Visit to Slope Protection Works: A site visit confirmed that the slope protection works and flood fuses installed generally functioned well, and damage to submersible embankments was significantly reduced.

vi. Hydrological and Hydraulic Analysis: The developed runoff and inundation analysis models largely reproduced the flood phenomena in certain haors. This numerical analysis model is considered to be useful for the basic design of the haor subprojects.

vii. Preliminary Review of the Revised PDPP[10]: It was found that some of the haors proposed in the revised PDPP were also included in the list of previous studies. In other words, the need for work in these haors had been recognized for some time. The proposed haors have larger cultivable areas and higher repair costs per cultivable area compared to those not selected, suggesting that more capital investment is required for the operation[11] of the haors. However, it is possible that these haors were selected for reasons beyond than their vulnerability to floods, such as damage to village infrastructure and regional economic development. Therefore, further research into the background of the selected haors is recommended.

viii. Preliminary Study of the Haors Proposed in the Revised PDPP: The haors proposed in the revised PDPP were assessed through (i) site visits, (ii) preliminary technical studies and basic design, and (iii) cost estimates. These haors have similar hydraulic conditions with those implemented in Phase 1, and it was determined that the technology used in Phase 1 would be effective. The cost estimates and benefits of some haors were analysed, and investment was deemed appropriate.

ix. Preliminary Assessment of Suitability of the Haors Proposed in the Revised PDPP for Follow-on Projects: The haors proposed in the revised PDPP were assessed as feasible from a preliminary perspective in terms of (i) technical, (ii) economic, (iii) environmental, (iv) social, (v) capacity, and (vi) institutional aspects. Further detailed assessment should be carried out through a feasibility study.

(b) Recommendations

i. Evaluation of Effectiveness of Slope Protection Works of Submersible Embankments: The constructed slope protection works are applicable to similar haor projects in the future. However, regular inspection and maintenance needs to be continuously carried out. Further analysis of the flooding and drainage mechanisms of haors is needed to design countermeasures, including slope protection works. Monitoring of flooded and drained haors over a wider area and in a shorter period is required, and drone technology is considered to be one of the most useful tools to carry out such monitoring.

ii. Lessons Learned in Hydrology and Hydraulics (River Water Level):

① From the evaluation of RWL data from March to May, indications of dangerous RWLs for submersible embankments during the pre-monsoon season could be inferred from the water levels from mid-March to mid-April. For example, RWL at Sunamganj station exceeded the design crest elevation of the submersible embankment by 15 May in both 2017 and 2022. In both years, the river water level rose sharply around the end of March. Based on these

[10] This refers to the version revised in December 2020.
[11] This includes inspection of embankments and other structures, and repair work in the event of damage.

observation results, a river water level between El. 4.0 m and El. 5.0 m at this location can be considered the pre-monsoon warning water level. Further evaluation using longer records is required to establish a warning water level.

② It was revealed that RWL during the pre-monsoon period exceeded the design crest elevation of the submersible embankment two or three times in the past 10 years. It is considered necessary to update HWL during the pre-monsoon period in future projects. Furthermore, multi-layered measures are required to increase the resilience of the submersible embankment against flooding.

③ Since the crest of the submersible embankment repeatedly appears above the water surface from the pre-monsoon to the post-monsoon periods, understanding the wind direction during the period is important for implementing wave countermeasures.

④ There were long periods of missing data from four water level observation stations[12] [3] between 2018 to 2019. Continuous RWL observation is extremely important for future water resource development. Strengthening the observation system, including adequate budgetary measures, is required.

iii. Lessons Learned in Hydrology (Rainfall): Approximately 70% of the haor basins are located within the Indian territory. Moreover, the Meghalaya mountain range receives extremely high rainfall, so real-time rainfall information in this region is essential for forecasting floods with longer lead times. Advanced approaches are required to develop forecasting systems[13].

iv. Lessons Learned in Hydrology (Wind): Wind direction during the rainy season (pre-monsoon to post-monsoon) is important for considering the protection of embankments against wave action. Generally, the monsoon wind blows from the southwest across the country, but winds from the northeast are sometimes observed in Sylhet. It is considered that the existing observation data do not clearly indicate the prevailing wind direction tendency. Engineers involved in the design of the haor sub-projects should collect information on actual wind conditions at each site. Interview surveys with local people are an important method for grasping the actual wind conditions.

v. Operational Aspects of Flood Management Structures: Further training and follow-up opportunities should be provided until the stakeholders are fully capable of operating the structures. Therefore, the follow-up activities should include a capacity-building programme for WMAs established in Phase 1. Operations by WMGs and WMAs should be monitored by BWDB. Operational records are crucial for fine-tuning the operational plan for the following year. Identified problems should be addressed to minimise the negative impact on the next year's plan. For this reason, each organisation should immediately start and continue proper operational records. Some operational records have already been confirmed.

vi. Assessment of Embankment Damage: In order to analyse the details of the failure mechanism of submersible embankments, it is recommended to use drones to survey a wider area in a shorter timeframe during flooding and dewatering.

vii. Slope Protection Works:

① Further real-time monitoring of submersible embankments is recommended. This will elucidate the collapse mechanisms of submersible embankments in various locations and situations, and improve the planning and design of slope protection works.

② Runoff and inundation analyses have been used to identify weak points of submersible embankments and the type of protection required, but their accuracy requires further

[12] Four stations: Chhatak, Derai, Durlovpur, and Sukdevpur.

[13] The Indian government does not disclose information such as hourly rainfall or topographical information within Indian territory, so the necessary data must be obtained through alternative means (for example, by analysing satellite images) and a forecasting system must be developed.

verification.

③ Costs could be reduced by decreasing the thickness of the concrete blocks currently used.

④ For Type D (soil-cement work), a cement to soil ratio of 1:4 was found to perform better. Therefore, it is recommended to adopt a higher soil-cement ratio than the current ratio.

viii. Lessons Learned from Hydrological and Hydraulic Analysis:

① Rainfall data within Indian territory could not be fully analysed due to limited availability. Hydrological data near the border also suffer from problems of scarcity and accuracy issues. This is because these observation points are not easily accessible, and the duration of flash floods is short, making it difficult for investigators to use current meters to measure flow rate during floods. As a result, the only available flow data are those obtained during relatively low flows, making it difficult to improve the accuracy of runoff models in basins prone to flash floods. It is desirable to improve hydrological observation systems to enable more effective flood management planning.

② Hydrological and hydraulic analyses require longer calculation times than analysts typically anticipate[14]. Trial and error activity is essential for calibrating (identifying) runoff and inundation models and optimising structural layout plans, Reducing calculation times remains a significant challenge.

ix. Preliminary Review of the Revised PDPP:

① The selection of haor sub-projects was conducted through in-depth discussions between the BWDB and LGED local representatives, based on major considerations such as embankments, village infrastructure, crop damage, vulnerability to floods, and economic status of the local people. Moreover, feedback from stakeholders such as farmers, fishermen, businessmen, local dignitaries and leaders was also taken into account. It is advisable to perform further quantitative evaluation of the selected haors on various aspects.

② A preliminary evaluation of the proposed haors was carried out on technical, economic, environmental, social, capacity, and institutional aspects. Further detailed evaluation of the same aspects should be executed at the feasibility study stage. It is further recommended that the implementing agencies initiate relevant activities and collect pertinent information prior to the feasibility study.

③ During the Phase 1, 16 agricultural promotion support sub-projects and 15 small income generation sub-projects were implemented. As the livelihood improvement activities were completed very successfully, it is recommended to continue the same activities in the follow-on projects. In order to maximize the impact of the livelihood improvement programmes, 13 additional programmes have been proposed. However, their suitability, local acceptability, and cost should be considered before incorporating them into the livelihood improvement component of subsequent projects.

2.4.2 Project Preparation/Pre-Feasibility Study for Haor Flood Management and Livelihood Improvement Project (LGED Part, Phase 2)

(1) Objective of the Survey

The Haor Phase 2 Project Pre-Feasibility Study (Pre-Feasibility Report for Haor Flood Management and Livelihood Improvement Project – Phase 2, 2023; hereinafter "Pre-F/S") was conducted as a preliminary study for the implementation of Phase 2, following the successful outcomes of the "Haor Flood Management and Livelihood Improvement Project – HFMLIP (2014)" previously implemented by JICA.

The target area was determined through consultations between the LGED and BWDB and comprises 26

[14] BWDB has commissioned the consultant to carry out the analysis.

haors located across five districts in the Haor region: Netrakona, Habiganj, Brahmanbaria, Kishoreganj, and Sunamganj (see Table 2.4.1).

Table 2.4.1 Target Areas of the Pre-Feasibility Study (LGED Component)

SL No	District	Proposed Haor Name	Upazila
1	Sunamganj	Boram Haor	Derai, Shulla
2		Halir Haor	Jamalganj, Bishwamvarpur, Tahirpur
3		Karchar Haor	Sunamganj Sadar, Bishwamvarpur
4		Shanir Haor	Jamalganj, Bishwamvarpur, Tahirpur
5		Gurmar Haor	Dharmapasha, Moddhyanagar, Tahirpur
6		khair Haor	Shantiganj, Jangannathpur
7		Chaptir Haor	Derai
8		Sonamoral Haor	Dharmapasha
9		Goradoba Haor	Moddhyanaga
10		Naluar Haor (Polder-1)	Jangannathpur
11		Naluar Haor (Polder- 2)	Jangannathpur
12		Chayar Haor	Shulla, Khaliajuri, Itna, Azmiriganj
1	Sylhet, Moulvibazar, Hobiganj	Pathor Chawli Haor	Sylhet Companyganj
2		Zilkar Haor	Sylhet Sadar
3		Muktarpur Haor	Osmany Nagar, Balaganj
4		Kalaruka Haor	Sylhet Sadar
5		Hail Haor	Moulvibazar Sadar
6		Makalkandi Haor	Baniachang, Nabiganj
7		Ballar Haor/Chegaiya Haor	Baniachang
1	Netrakona. Kishoreganj	Ubdhkhali Haor	Kolmakanda, Madhyanagar
2		Khaliajuri (Polder-3)	Khaliajuri, Itna
3		Dewghar Haor	Austagram
4		Humaipur Haor	Bajitpur, Nikli, Austagram
5		Kazirkhola Boro Haor	Mithamoin, Austagram
6		Mrigar Haor	Itna
7		Khuniyer Haor	Itna

Source: Pre-F/S Report for Haor Flood Management and Livelihood Improvement Project (HFMLIP) Phase 2 (LGED, 2024)

The Pre-F/S aimed to expand efforts for the comprehensive development of agricultural infrastructure and the more effective utilization of fisheries promotion measures in the Haor region, building on the Phase 1 project. To support the implementation of Phase 2, the study conducted the following investigations:

i) Development and rehabilitation of rural roads and infrastructure in the Haor region, including boat landing stations (ghats), markets (hats), and village protection walls;

ii) Implementation of fishery promotion activities in the Haor region;

iii) Improvement of living standards and stimulation of economic activities in the Haor region; and

iv) Priority areas for rural infrastructure development and fishery promotion of this project were selected with the aim of addressing the infrastructure needs identified in “Haor Master Plan (2012)”, and of scaling up and sustaining the outcomes of HFMLIP Phase1 (2014). As fishery is a significant source of income for residents of the Haor region, measures to enhance fishery productivity were implemented in parallel with infrastructure development in order to contribute to improved livelihoods for beneficiaries.

(2) Key Findings and Recommendations

(a) Survey Findings

In order to expand upon the initiatives implemented under the preceding HFMLIP Phase1, the study examined the development of rural roads (Upazila roads, Union roads, and Village roads), rural markets (hats), boat landing stations (ghats), and village protection walls in 26 Haors, along with fishery promotion activities (development of Beels).

(b) Findings and Proposal for Rural Infrastructure

1) Proposal for New Rural Roads

For the new roads proposed under Phase 2, Upazila roads, Union roads, and Village roads were examined. Roads subject to submergence were designed exclusively for dry-season access, whereas non-submersible roads were designed as all-weather roads to ensure accessibility even during the monsoon season.

The road sections also include bridges and culverts (structures that provide space beneath roads or bridges; in this case, intended for vehicular traffic). These components were included in the project scope to ensure adequate drainage capacity, which is essential for vehicular movement, particularly considering the increased floodwater levels during the monsoon season. Additionally, protective structures for road shoulders were also included to mitigate wave-induced erosion. However, the quantity of protective structures was uniformly estimated as 5 km per haor, and no cost basis for unit rates was provided.

The total length of rural roads selected under the project exceeds 900 km, of which approximately 950 m are bridges, 4,180 m are culverts, and 130 km are protective structures. The selection criteria prioritised roads that residents use to access economic, social, and administrative services within the Haor, as well as roads with high connectivity to main roads.

2) Proposal for Rural Road Rehabilitation

Among the existing paved rural roads, those in need of rehabilitation and maintenance were included in the project scope. The selection was based on the extent of damage that significantly hampers the mobility of residents in Haor area. Within the 26 targeted Haors, approximately 235 km of existing roads were identified as necessitating rehabilitation and maintenance.

3) Proposal for Markets (Hat) and Boat Landing Stations (Ghat)

The development of rural markets (hat) was included in the project to provide improved environments for the trade of agricultural products, fish, and other goods in a more hygienic and efficient manner, contributing to the reduction of post-harvest losses. The improvement of boat landing stations (ghat) was also deemed critical, particularly for Haor residents who transport harvested paddy through water routes. These interventions aim to enhance the safety and efficiency of passenger and cargo loading and unloading operations, thereby strengthening the supply chain from harvest to distribution.

According to the Benefit Monitoring and Evaluation (BME) survey of Phase 1, improvements to markets led to increased trade volume, higher footfall, and greater participation by women. The survey also reported a significant increase in the value of privately owned land surrounding the upgraded markets.

Based on the data collection survey, 41 hats and 83 ghats were identified as potential project targets.

4) Proposal for Village Protection Walls

The Haor region, being a low-lying area along riverbanks, experiences prolonged submergence during the annual monsoon due to heavy rainfall and flash flood, which often result in strong wave action. In recent years, risks associated with wave damage have been intensified by urbanization, construction activities, vegetation clearance, and changes in cropping patterns aimed at increasing agricultural productivity.

Most residential areas in the Haor are constructed on elevated land above typical flood levels. In Phase 1, some residents attempted to raise land elevation using excavated soil from Beels and khals. Additionally, small-scale village protection walls were constructed under other GoB projects, which established their effectiveness in protecting homes and properties from wave action.

In response to this growing need, the current project plans to construct approximately 13,000 m of village protection walls. A uniform length of 500 m per haor was provisionally allocated, although the basis for unit cost estimation has not been provided.

(c) Findings and Proposal for Fishery and Aquaculture Promotion

The fishery promotion component includes both the improvement of institutional arrangements and the development of Beels, which are vital for both capture and seasonal aquaculture in the Haor region. In Phase 1, Beel User Groups (BUGs) were established and monitored. In Phase 2, emphasis is placed on ensuring the sustainability of BUGs so that they may manage and lease Beels independently after the completion of the project.

Khals, which serve as canals connecting Beels, are also critical for fish migration during the dry season. Many of these canals have been filled with silt due to soil erosion, severely hampering fishery activities. Therefore, the dredging of Beels and khals is included in the project scope. Field surveys identified 328 Beels and approximately 600 km of khals for inclusion.

In terms of aquaculture activities, the project had built upon and expand the initiatives from Phase 1, targeting backyard homestead aquaculture, fish processing, floodplain community-based aquaculture, net-pen aquaculture, and sacrificial fish farming. These activities aim to promote sustainable production and processing practices while contributing to poverty reduction and women's empowerment.

(d) Recommendations and Considerations

Most of the rural roads selected for the project are located within embankment-protected areas of the Haor, but some roads lie outside these zones. These roads were selected because of their importance to the daily lives of local residents, either serving as trunk roads to neighbouring towns or as essential links connecting villages.

2.4.3 Comprehensive Study for Evaluation and Updating of Master Plan for the Haor Area

The Haor Master Plan (HMP), a 20-year framework plan, was formulated in 2012 by the Department of Bangladesh Haor and Wetlands Development (DBHWD), as an "integrated development plan", with the aim of optimizing available resources of the Haor area for future development, expanding of eco-friendly settlement areas to ensure housing for the poor, and developing rural livelihood to ensure a healthy livable environment. The HMP is being implemented through the multifaceted development interventions including flood management, environmental sustainability, crop production, fisheries and livestock, expansion of education, settlement and health facilities, road communication, navigation, water supply and sanitation, industry, afforestation, and generation of power and energy.

It has been more than a decade since the inception of the HMP and several critical changes and challenges have emerged in the Haor area, which make it important to update the HMP. Therefore, the comprehensive study has set up the vision and five (5) goals of the updated HMP, which are as framed below.

Vision : To transform the Haor region into a resilient, ecologically balanced, and economically vibrant landscape that safeguards livelihoods, ensures food security, and promotes inclusive and sustainable development while preserving its unique biodiversity and cultural heritage.

Goals :

Goal-1: Environmental Sustainability: Ensure ecological balance by conserving wetlands, biodiversity, and water resources.
Goal-2: Climate Resilience: Strengthen flood management, erosion control, and early warning systems.
Goal-3: Sustainable Livelihoods: Improve agriculture, fisheries, and alternative income sources to enhance economic well-being.
Goal-4: Infrastructure Development: Expand transportation, energy, and communication networks for better regional connectivity.
Goal-5: Institutional Strengthening: Improve governance, policy frameworks, and stakeholder collaboration for effective implementation.

Besides, this comprehensive study evaluated the community needs through public meetings/discussions and household surveys in various areas of the Haor region, mainly to gather community opinions regarding their awareness of the HMP and its impacts on livelihoods, specifically in agricultural and fishing sectors.

In accordance with the outcomes of the need survey, the community opinions are found to indicate that the community has a strong desire for collaborative approaches to enhance socioeconomic resilience in the face of environmental challenges, through the following summaries:

i) The main conclusions drawn from the discussions include the urgent need for (i) infrastructural improvements, such as elevated roads and flood management structures, and (ii) support for sustainable practices in both fisheries and agriculture.

ii) Recommendations highlight community-managed resources, stricter regulations against detrimental fishing practices, and enhanced government support for agriculture and alternative livelihoods, particularly for women.

iii) The need for active engagement in preserving local ecosystems, such as fish sanctuaries, is emphasized, reflecting the community's commitment to reclaiming their traditional livelihoods while ensuring environmental sustainability.

In consideration of the community needs, a Thematic and Programmatic approach has been adopted for the effective implementation and monitoring of the updated HMP. In this approach, a total of 17 programs, corresponding to the target sectors in the HMP, are divided into three (3) thematic areas, namely (i) Sustainable Natural Resources (SNR), (ii) Public Services Delivery (PSD), and (iii) Industrial and ICT Development (IID), as outlined below.

The project names of "Haor Flood Management and Livelihood Improvement Project (Phase 2), BWDB Part (Implementing Agencies: BWDB, JICA)", and "Haor Flood Management and Livelihood Improvement Project (Phase 2), LGED Part (Implementing Agencies: LGED, JICA)" are contained in the programs: "T1P1 and T2P4" within the project portfolios of various programs of the three themes, respectively. The Project is included in the programs of the updated HMP.

T1: Sustainable Natural Resources (SNR)

- T1P1: Water Resources
- T1P2: Agriculture
- T1P3: Fisheries
- T1P4: Livestock

T2: Public Services Delivery (PSD)

- T2P1: Education
- T2P2: Health
- T2P3: Water Supply and Sanitation
- T2P4: Transportation and Urban Services
- T2P5: Social Protection and Services
- T2P6: Housing and Settlement

T3: Industrial and ICT Development (IID)

- T3P1: Industry
- T3P2: Energy and Power
- T3P3: Mineral Resources
- T3P4: Eco-tourism
- T3P5: ICT Development

2.5 Climate Risk Profile in Haor Area

The Haor region, a complex of wetland ecosystems covering approximately 15% of Bangladesh, is a critical breadbasket and protein source for the country. Its socio-economy is closely linked to a dynamic seasonal hydrology. For six to seven months of the year, the land is submerged, transforming into a vast inland sea. As the water recedes during the dry season, fertile lands come out, which allow for the cultivation of a single and crucial crop of Boro rice, timed to be harvested just before the onset of the flash floods in the pre-monsoon season. This delicate balance is being fundamentally altered by climate change, exacerbating existing vulnerabilities and posing a threat to the indigenous ecosystem and the sustainability of livelihoods dependent on it.

(1) Climatic shifts and hydrological consequences

The foundational causes of climate risk in the Haor area stem from measurable shifts in regional climatology. Several analyses have revealed that the system becomes hotter and drier during winter, while experiencing more intense and concentrated rainfall. This has resulted in a paradoxical "flood and drought" environment, as stated below (see Appendix 2.5.1).

- **Temperature Rise:** The Haor region has been experiencing a definitive warming trend. The observed increase of up to 1.2 °C in maximum temperature is compounded by a significant rise in minimum temperatures. Projections indicate that minimum temperatures will rise faster than maximum, leading to a narrowing diurnal temperature range. This shift disrupts the normal physiological cycles of crops such as Boro rice, which are sensitive to nighttime temperatures, and intensifies overall heat stress on the ecosystem.

- **Altered precipitation regimes:** While the total annual rainfall may increase, its seasonal distribution is becoming more hazardous. Intensified pre-monsoon and monsoon rainfalls directly heightens the risk of catastrophic flash floods. A study by Akter et al. (2023) explains that if the average rainfall exceeds 250 mm in Meghalaya and Assam and 400 mm in Sylhet, severe flash floods may occur in the Sylhet haor region. Conversely, a noticeable decline in winter precipitation creates a significant water deficit during the Boro rice cultivation period, intensifying competition for scarce irrigation resources.

- **Intensification of extreme events:** Flash floods are a primary hazard in the Haor area, and they are becoming more frequent and severe. The 2022 floods were considered the worst in the area's 120-year history, engulf approximately 90% of the Sylhet division. Furthermore, the indirect impact of more intense tropical cyclones in the Bay of Bengal cannot be overstated. These storms bring large amounts of sediment into the river systems, leading to Haor riverbed siltation. This results in a reduction in the natural drainage capacity of the area, and even a moderate local rainfall could trigger severely prolonged flooding.

- **Prolonged drought conditions:** The decrease in winter rainfall is directly linked to an increase of the number of consecutive dry days, which are projected to increase in the future under various climate change scenarios. According to a study by the Asian Development Bank (ADB), models show a slight increasing trend in consecutive dry days across South Asian countries, including Bangladesh, up to the 2080s under the A1B emissions scenario. This extended drought is amplified by higher temperatures and increased evapotranspiration, leading to severe agricultural and hydrological drought. It delays the planting of Boro rice, stresses the crop during its growth phase, and depletes the perennial wetlands (Beels) that serve as essential dry-season refuges for fish.

- **Rise in river water temperature:** The warming of the Haor's aquatic systems is a direct consequence of rising air temperatures and intensified by reduced dry-season water flows and increased turbidity from sedimentation. As river water temperatures rise, they are projected to surpass the 32 °C threshold, which is critical for the reproduction of many native fish species. This thermal stress directly impairs spawning, reduces egg viability, and threatens the collapse of the region's capture fisheries, a fundamental part of local nutrition and economy.

(2) Aggravation of vulnerability in socio-economy

(a) Impact on Agriculture: Boro Rice Dilemma

The Haor economy is characterised by its dependence on a single annual harvest of Boro rice, which creates immense systemic risk. The agricultural system is fundamentally misaligned with the new climate reality. The most acute threat is the widespread destruction of the standing crop by early flash floods, which now frequently strike before the rice can be harvested. The 2017 flood serves as a stark case study of the potential for regional economic collapse from a single climatic event.

In that year, the severe flooding in the seven (7) districts of the Haor region resulted in a loss of 993,332 tons of Boro rice, amounting to approximately 24.8 billion BDT, based on an average price of 25,000 BDT per ton of paddy rice. If such damage occur frequently due to such severe flooding, the overall local economy will significantly decline. This primary threat is compounded by: (i) the intensification of drought during the growing season, which sets stress on irrigation supplies, and (ii)rising temperatures, which can induce heat stress during the critical grain-filling stage, further diminishing productivity.

(b) Impact on Fisheries and Aquatic Ecosystems

The Haor's fisheries, which are the second pillar of the regional economy, are under severe pressure. Rise in water temperatures is leading to aquatic systems beyond the optimal reproductive thresholds for native fish species, directly disrupting spawning and reducing hatching rates. This thermal stress is heightened by the altered hydrological cycle. Intense floods and subsequent siltation degrade and shrink critical fish habitats, while reduced water levels during the prolonged dry season concentrate pollutants and eliminate essential refuges for fish.

Consequently, fish stocks and biodiversity, which are critical for fisheries, the second economic pillar of the Haor region, are in decline. For example, in Hakaluki Haor, it has been reported that "approximately 32 out of 107 species" have either disappeared or become rare (Aziz et al., Heliyon 2021). In Tanguar Haor, the proportion of carp species has decreased from 7.55% in 2021 to 6.50% in 2022 (Akther et al. 2024). Furthermore, an interview survey in Tanguar Haor, involving 200 residents and fishermen, revealed that 95.5% of respondents stated that "fish catches are decreasing day by day" (Environ 2013). This decline is having a serious impact on rural household income, employment opportunities, and regional nutritional security.

CHAPTER 3 CURRENT CONDITIONS OF THE PROJET AREA

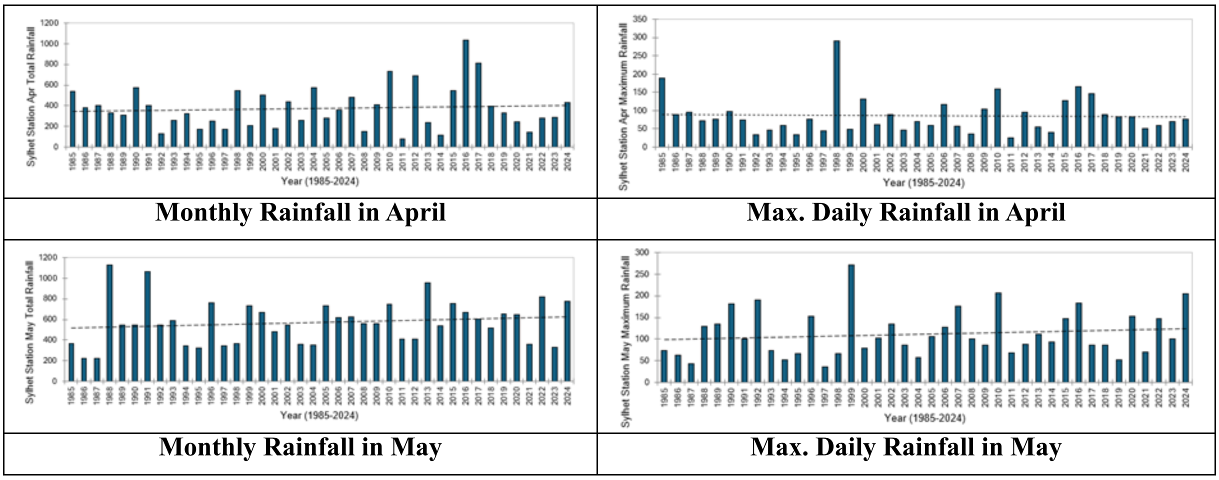
3.1 Climate and Wind

The survey assessed and analysed trends in climate variables, i.e. temperature, rainfall, sunshine, humidity, wind speed and direction, observed at BMD's five meteorological stations in the survey area namely Sylhet, Srimangal, Mymensingh, Comila, and Dhaka. It also examined rainfall and its patterns in relation to climate change by collecting 40 years of data, from 1985 to the present, as well as observed rainfall data from India. The main results are as follows:

(a) **Temperature**: An increasing trend was observed for the maximum temperatures in Sylhet, Srimangal, and Comila. There was also a slight increasing trend in the other two locations. During the dry season, an increasing trend was observed in Sylhet and Srimangal. The minimum temperatures generally showed an increasing or stable trend throughout the year at all five locations.

(b) **Rainfall**: In the pre-monsoon period, no clear increasing trend in rainfall was observed at three locations, except Dhaka and Srimangal, where an increasing trend was noted. A decreasing trend was observed at Mymensingh and Comila. In the monsoon period, no clear increasing trend in rainfall was observed at four locations, except in Dhaka, where an increasing trend was observed. A decreasing trend was noted at Srimangal and Mymensingh. During the post-monsoon period, no clear increasing trend in rainfall was observed at three locations except Dhaka and Sylhet, where an increasing trend was recorded. A decreasing trend was observed at Mymensingh. In the dry season, a decreasing trend in rainfall was observed at four locations except Dhaka, where an increasing trend was noted.

(c) **Pre-monsoon rainfall**: As shown in Figure 3.1.1, the monthly rainfall and maximum daily rainfall for the pre-monsoon period at Sylhet were generally constant or slightly decreasing in April, while a slight increasing trend can be observed in May.



Monthly Rainfall in April | **Max. Daily Rainfall in April**

Monthly Rainfall in May | **Max. Daily Rainfall in May**

Source: JICA Survey Team

Figure 3.1.1 Rainfall Trend During Pre-Monsoon Period（Sylhet, 1985-2024）

(d) Rainfall in the Indian Haor Basin: Rainfall data were available for three locations in the Indian Haor Basin from 2014 to 2022. No discernible time-series trends were observed in the data.

(e) Sunshine: A decreasing trend in sunshine hours was observed in Srimangal and Dhaka. During the dry season, a decreasing trend was detected in all five locations.

(f) Humidity: A decreasing trend in humidity was observed in Sylhet, Comila, and Dhaka.

(g) Wind Speed and Direction: In Dhaka, southerly winds predominate from the pre-monsoon to monsoon periods, while northerly winds predominated in the post-monsoon period.

An overview of meteorological and wind conditions is provided in Appendix 3.1.1.

3.2 Natural Disasters

In Bangladesh, the water level rises gradually during monsoon floods but increases suddenly during flash floods. However, these floods rarely cause significant damage or results in substantial loss of lives.

In the Haor areas, pre-monsoon flash floods cause the greatest damage to Boro rice. They also lead to direct damage, such as the destruction of embankments themselves due to overtopping of submersible embankments and inundation above and below the floor. Additionally, indirect damage occurs, such as roads being submerged and blocked off.

Table 3.2.1 shows an overview of the major natural disasters in the survey area.

Table 3.2.1 Overview of Major Natural Disasters in the Survey Area

Year of Natural Disaster (Flood)	Overview
1988	Torrential rains caused severe damage across the country, particularly in the northern and northeastern regions. The flooded area in Bangladesh was 120,973 km^2 (the largest ever recorded), with damage amounting to BDT 100,000 million, and 73 million people were affected.
1998	Flooding occurred nationwide in early July. At Bhrairab Bazar on the Meghna River, the river level remained above the danger level for 79 days. High waves and backwaters were also prominent, and El Niño is thought to have also played a role. The flooded area in Bangladesh was 100,000 km^2, the damage amounted to BDT 100,000 million, and 15 million people were affected.
2004	Monsoon rains occurred in the Ganges, Brahmaputra, and Meghna river basins, with the northeastern region in particular receiving 1.5 times the normal amount of rainfall. The rainfall that occurred on 11th April caused river levels in the Surma, Kushiyara, and other rivers to exceed dangerous levels for a period of two to ten days, causing significant damage to crop. The total number of people affected in Bangladesh was 74.7 million.
2007	Two floods occurred on 24th June and 5th September. In the June flood, Sylhet, Sunamganj, and other areas along the Surma River were affected. In the September flood, Sunamganj was affected by 15-30% of its land area, while other areas were only 0-15% submerged. The total number of people affected in Bangladesh was 28.5 million.
2010	Heavy rainfalls persisted from 30th March to 10th April in Sylhet and Sunamganj districts, causing heavy flood inundation in the Kushiyara, SariGowain, Piyain and Rubachora river basins. Flash floods in June also severely affected Netrakona, Sunamganj, and Kishoreganj, as floodwaters from the Assam and Meghalaya mountains in India continued for two weeks.
2017	Heavy rainfalls and flash floods from the Meghalaya Mountains in India caused the water levels in several rivers in the north, northeast, and south to rise, inundating low-lying areas. Following the devastating floods in mid-April, a second flood occurred on 27th June, causing damage in the northeastern districts of Sylhet and Moulvibazar. Rising RWLs caused embankments to breach in various locations, resulting in harm to local residents. In the northeast alone, approximately 330,000 households were affected, around 310,000 ha of farmland were flooded, about 300 houses were completely destroyed. Nearly 400 educational institutions were temporarily suspended from operation. Approximately 220,000 ha of Boro rice paddy fields were affected, of which around 150,000 ha were flooded in Sunamganj district, resulting in the loss of about 394,000 tons of Boro rice.
2022	In May, continuous rains in the Meghalaya Mountains in India caused widespread flooding in low-lying areas of Sylhet and Sunamganj districts. Approximately two million people were affected and around 205 km^2 were flooded, with approximately 1,137 ha of farmland was inundated. In Sylhet and Sunamganj districts, about 150,000 households lost power for several days from 17th May due to flooding at a power plant. More than 873 educational institutions, primarily public primary schools, were closed. According to the district offices of the Agricultural Extension Department, 1,421 ha of nurseries and 1,704 ha of Boro rice paddy fields were flooded, resulting in the loss of approximately 79,000 tons of Boro rice. Additionally, 13,340 ha of summer vegetables were severely damaged. According to the district office of the Department of Agriculture Extension, there was severe damage to 1,421 ha of nurseries, 1,704 ha of Boro crops, and 13,340 ha of summer vegetables. According to the Department of Public Health Engineering (DPHE), 370 tube wells and 3,659 toilets were damaged.

Year of Natural Disaster (Flood)	Overview
	In June, heavy rainfall in the upstream basin caused record flooding in the northeast. According to the FFWC, Cherrapunji district in the northeastern Indian state of Meghalaya recorded the third-highest rainfall in the past 122 years on 16th June, triggering devastating flash floods in the northeast. These floods submerged about 94% of Sunamganj and over 84% of Sylhet. More than 7.2 million people were affected and hundreds of thousands of families were isolated by the floods. Some families took refuge in open spaces, nearby houses, higher ground or in designated flood shelters. According to the Ministry of Disaster Management, Management and Relief (MoDMR), the army, navy, fire service, and local authorities evacuated about 500,000 people to shelters. The floods disproportionately affected vulnerable groups in society, especially women, girls, children and people with disabilities.
2024	A series of floods have affected the north, northeast, and southeast since mid-June, affecting around 14.6 million people, displacing millions and causing widespread damage. At the peak of the floods, 723,331 people were evacuated, with approximately 600,000 in evacuation centres and 120,000 along roads and levees. The floods caused extensive damage to infrastructure. According to DPHE, 86% of water supply facilities and 84% of sanitation facilities were damaged, with around 60,000 water supply facilities and 120,000 toilets destroyed. Schools were also damaged. Damage to livestock was estimated at USD 34 million, while the damage to fishing industry was estimated at USD 121.6 million. More than 7,000 schools were closed, and outbreaks of waterborne diseases also occurred. In Sylhet prefecture, more than half of the paddy fields were flooded in June. According to the Ministry of Agriculture, the floods, which continued intermittently until October, caused USD 282 million in damage to the rice crop.

Source: Prepared by the JICA Survey Team based on information from "Data Collection and Verification Survey on Water Resources Management in Haor Areas in Bangladesh: Final Report" JICA, Nippon Koei Co., Ltd., December 2013 and websites (e.g. reliefweb).

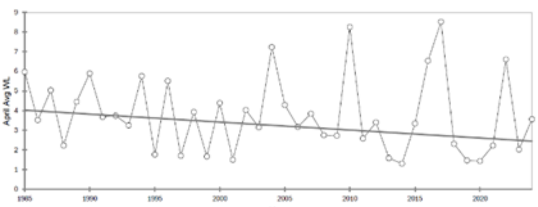
3.3 Hydrology

The data collected from 12 BWDB hydrological stations across the survey area (Sunamganj, Sylhet, Kanairghat, Amalshid, Fenchuganj, Moulovibazar, Hobiganj, Khaliajuri, Itna, Bhairababazar, Narshingdi, and Chandpur) included information related to river management, such as rainfall, river cross-sections, flood occurrence, salt wedge estuaries, discharge data, river water level, and discharge observations, and planned high-water levels, as well as the impact of changes in river discharge and water levels due to climate change. The data were collected over a 40-year period, from 1985 to the present, and the trends of these changes were evaluated and analyzed. The main results are as follows:

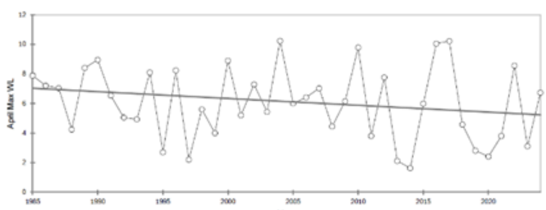
(a) **Rainfall**: As mentioned in Section 3.1 (Weather and Wind Conditions) of this report, no clear increasing trend in rainfall was observed during the pre-monsoon season at the three locations, except for Dhaka and Srimangal, where an increasing trend was observed.

(b) **River Water Levels**: During the pre-monsoon period, a decreasing trend was observed in Chandpur and Habiganj. During the monsoon season, a decreasing trend is observed in Narshingdi and Chandpur. During the post-monsoon period, a decreasing trend was identified in Sylhet, Dirai-on-Kalni, Narshingdi, Chandpur, Dilalpur, and Itna. During the dry season, a decreasing trend is noted in Chandpur and Habiganj.

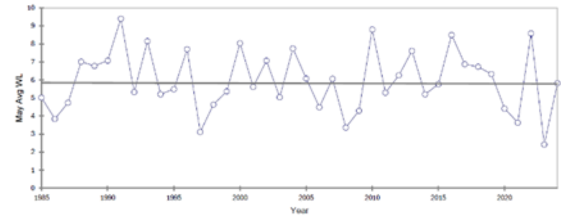
(c) **River Water Levels During Pre-monsoon Period**: As shown in Figure 3.3.1, the monthly average river water levels and maximum daily river water levels during the pre-monsoon period at Sylhet (as a representative point) show a decreasing trend in both April and May, with a roughly flat trend.



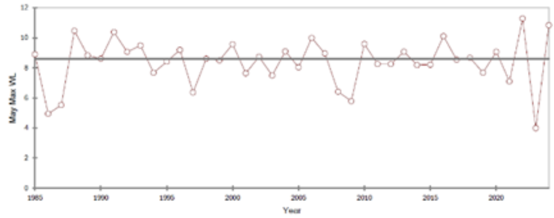
Monthly Average RWL in April



Max. Daily RWL in April



Monthly Average RWL in May



Max. Daily RWL in May

Source: JICA Survey Team

Figure 3.3.1 River Water Level Trend During Pre-monsoon Period（Sylhet, 1985-2024）

An overview of the hydrological conditions is shown in Appendix 3.3.1.

3.4 Geology

(1) Outline of the Survey

The purpose of this geological survey was to obtain the necessary geological information for the planning and design of flood control facilities, such as submerged embankments, submerged roads, and Village roads, which were to be rehabilitated or newly constructed in the priority project areas.

In addition, an investigation on the suitability of locally available materials for embankment construction was conducted to ensure the stability and constructability of the embankment structures.

The investigation items, quantities, and implementation progress are summarized in Table 3.2.1. The locations and coordinates of the borehole surveys, the test pits, and sampling points are presented in Table 3.4.2. The investigation items and quantities that had been contracted but not yet implemented were cancelled due to inundation in the target Haor areas. The laboratory tests were conducted in accordance with ASTM standards.

Table 3.4.1 Investigation Items and Quantities

No.	Location	Quantity (nos.)		
		Contracted	Completed	Not Implemented
A) Borehole Survey (three locations, with a total drilling depth of 90 meters)				
1	Sunamganj (Korchar Haor)	1	1	0
2	Sylhet (Pathor Chawli Haor)	1	1	0
3	Kishoreganj (Humaipur Haor)	1	1	0
B) Test Pit and Sampling （27 locations in total）				
1	Sunamganj	12	2	10
2	Kishoreganj	5	5	0
3	Sylhet	5	3	2
4	Nabiganj	2	2	0
5	Netrokona	2	0	2
6	Moulvibazar	1	0	1
Total		27	12	15

Source: JICA Survey Team

Table 3.4.2 List of Locations and Coordinates of Borehole Surveys and Test Pits

No.	Location	Latitude	Longitude
A) Borehole Survey (three boreholes)			
BH-01	Karchar Haor, Sunamganj	25° 5' 22.95" N	91° 17' 39.55" E
BH-02	Pathor Chawli Haor, Sylhet	25° 3' 7.99" N	91° 44' 31.00" E
BH-03	Humaipur Haor, Kishoreganj	24° 14' 51.27" N	91° 0' 39.48" E
B) Test Pit and Sampling （12 locations in total）			
TP-01	Karchar Haor, Sunamganj	25° 4'9.00"N	91°17'34.00"E
TP-02	Halir Haor, Sunamganj	25° 4'17.00"N	91° 6'9.00"E
TP-03	Humaipur Haor, Kishoreganj	24°14'49.00"N	91° 0'36.00"E
TP-04	Dewghar Haor, Kishoreganj	24°17'10.00"N	91° 4'10.00"E
TP-05	Khuniyer Haor, Kishoreganj	24°30'1.00"N	90°59'20.88"E
TP-06	Kazirkhola Boro Haor, Kishoreganj	24°24'3.00"N	91° 2'1.00"E

No.	Location	Latitude	Longitude
TP-07	Kalaruka Haor, Sylhet	24°57'59.00"N	91°43'27.00"E
TP-08	Pathor Chawli Haor, Sylhet	24°59'38.00"N	91°43'45.00"E
TP-09	Makalkandi Haor, Habiganj	24°37'7.00"N	91°27'2.00"E
TP-10	Zikar Haor, Sylhet	24°57'54.00"N	91°43'20.00"E
TP-11	Ballar Haor, Habiganj	24°26'45.00"N	91°16'60.00"E
TP-12	Mrigar Haor, Kishoreganj	24°32'57.00"N	91° 7'45.00"E

Source: JICA Survey Team

(2) Outcomes of the Survey

(a) Overview of Topography and Geology

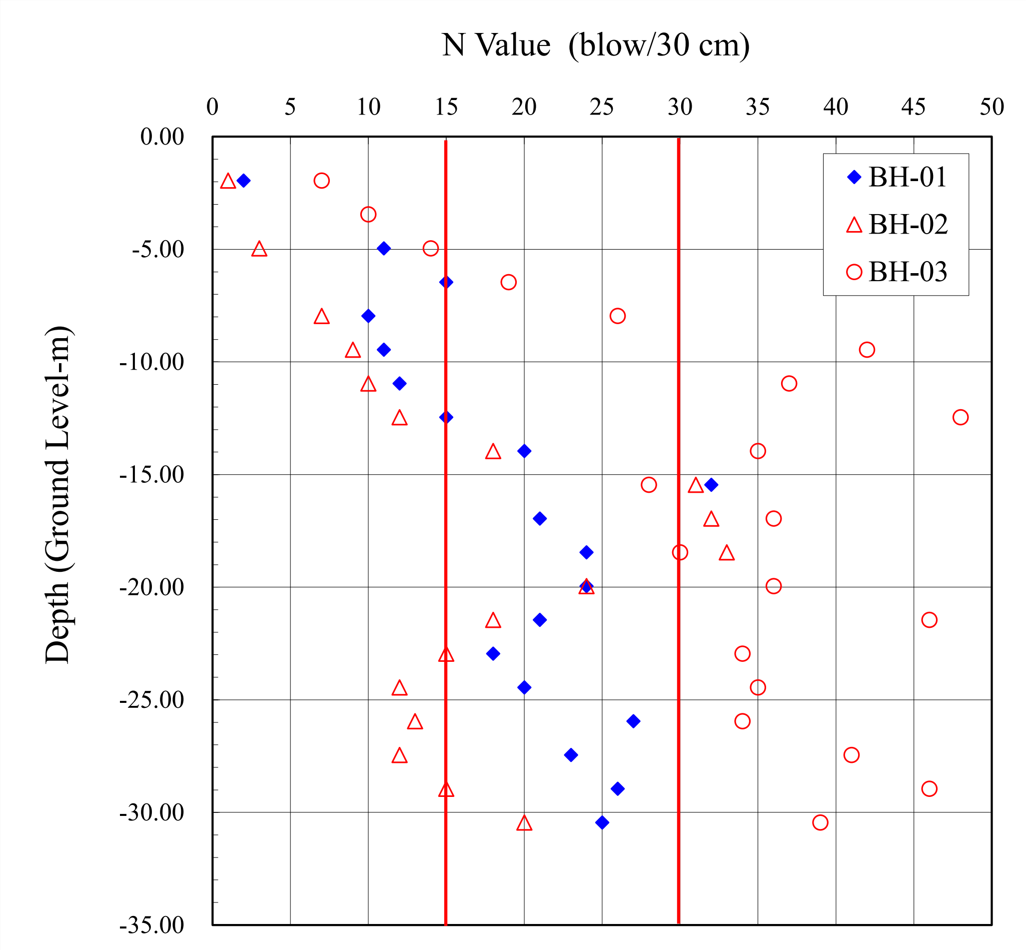
The project area forms part of the Sylhet Basin, a sedimentary landform, and is geologically classified as a broad sedimentary basin. Topographically, the area is characterized by seasonally inundated low-lying wetlands, known as haors, which form bowl-shaped depressions. Surrounding these haors are slightly elevated areas called chals, which serve as the foundation for human settlements and agricultural activities.

Geologically, the area is mainly composed of Quaternary sediments. Alluvial deposits are widely distributed in the surface layer, consisting of alternating strata of clay, silt, fine sand, and peat. These sediments are predominantly derived from rivers such as the Brahmaputra, Meghna, and Surma, having been formed during a recent geological period.

(b) Soil Characteristics at the Borehole Survey Locations

At BH-01 and BH-02, the subsurface strata are predominantly composed of cohesive soils (CL, ML), with an interbedded sandy soils (SM) layer approximately 2 to 7 meters thick. In contrast, the strata at BH-03 consist solely of sandy soils (SM). All three boreholes were drilled to a depth of 30 meters from the ground surface, and no bedrock was encountered within this depth.

Figure 3.4.1 presents the SPT N-values measured at various depths across the three boreholes. The N-value serves as an index of soil hardness and compactness, with higher values indicating denser and stronger ground conditions. The following trends have been further identified based on the data presented in Figure 3.4.1.



Source: JICA Survey Team

Figure 3.4.1 SPT N-Values vs. Depth

- As a general trend, the SPT N-values increase with depth, indicating a gradual densification of the subsurface soils. However, variations in this pattern are observed across the three survey locations.
- At BH-01, soft soil layers with N-values below 15 are dominate to a depth approximately 20 meters from the ground surface. Below this depth, the N-values increase slightly, reaching up to around 30. Overall, the site is characterized by relatively soft soil layers, which are likely to extend continuously to deeper strata.
- At BH-02, very soft layers with N-values below 10 are present within the upper 10 meters. While N-values increase modestly below this depth, they generally remain within the range of 10 to 20. The overall ground condition is assessed as soft, thereby indicating a potential risk of differential or excessive settlement during the construction of structures.
- At BH-03, significantly higher N-values are recorded compared to the other two locations. In particular, values exceeding 30 are frequently observed below a depth of 15 meters. Even in the upper layers, N-values generally range from 15 to 20. The ground at this location is therefore evaluated as being dense to firm throughout.

(c) Evaluation of the Suitability of Embankment Materials

The Haor region is subject to widespread inundation during the monsoon season. Accordingly, when developing infrastructure such as roads and embankments, it is essential to ensure that embankment structures are durable and capable of maintaining stability under flooding and submerged conditions.

The evaluation of material suitability for embankment construction has been conducted with reference to the BWDB Standard Design Manual (Volume I: Standard Design Criteria) and the Manual for Highway Earth Works, published by the Japan Road Association (1989), using the following technical indicators:

- **Plasticity Index (PI) ≤ 15%**: Soils with high PI values are prone to significant swelling and shrinkage, which may adversely affect embankment stability and are therefore considered unsuitable.
- **Liquid Limit (LL) ≤ 50**: Soils with a high LL are highly sensitive to changes in moisture content, resulting in poor stability when used as a foundation material.
- **CBR ≥ 80%**: The California Bearing Ratio (CBR) is an index of ground bearing capacity. For road embankments, a CBR value of 80% or higher is considered desirable.
- **Priority given to locally available cohesive soils**: Utilizing local materials can reduce transportation costs and construction periods. In many cases, these local materials also possess favorable properties for embankments, such as appropriate compressibility and permeability.
- **Other factors (grain size distribution, compaction properties, and moisture content, among others)**: Factors such as the suitability of particle size distribution suitability, compaction behavior during construction activities, and deviations from the optimum moisture content were also evaluated comprehensively.

Table 3.4.3 presents the results of the laboratory tests conducted for each sample (TP-01 to TP-12). Based on indicators such as the Liquid Limit (LL), Plastic Limit (PL), and Plasticity Index (PI), the following construction considerations are required from the perspectives of embankment stability and constructability:

- **Conditionally Suitable (TP-06, TP-07, TP-09 to TP-12): These samples meet the standard criterion for LL (≤ 50). However, their PI values are slightly high. Therefore, the following considerations are required:**
    - Adjustment of the water content in the field to approach the Optimum Moisture Content (OMC).
    - Provision of a layer thickness of 15–20 cm and a compaction degree of at least 85% or higher.
- **Unsuitable (TP-01, TP-02, TP-03 to TP-05, and TP-08): High-plasticity soils (CH, MH) and non-plastic soils (NP) require improvement treatment before being used as embankment materials:**
    - High-plasticity soils: Lime stabilization is recommended to reduce swelling and shrinkage.
    - Non-plasticity soils: Construction control is required, considering gradation and compaction characteristics.
    - In particular, for TP-01, TP-02, and TP-08, careful control of moisture content and layer thickness is essential.

For construction planning that utilizes locally available materials, it is essential to apply appropriate improvement measures and ensure strict construction control in accordance with the material properties. These efforts will enhance the stability and durability of embankments and improve resilience against floods and inundation.

In Phase 1, the embankment material investigations were conducted at multiple sites. In Phase 2, the suitability of these sites should be evaluated, and a suitability distribution map should be prepared to identify potential borrow areas. This will support sustainable use of materials and strengthen regional resilience to natural hazards.

Table 3.4.3 Summary of Laboratory Test Results for Embankment Materials

Trial Pit ID	Unified Soil Classification System (Group Symbols)		Grain Size Analysis: Sand 0.075 - 4.75 (%)	Silt 0.005 - 0.075 (%)	Clay < 0.005 (%)	Fines < 0.075 (%)	Atterberg Limit: Liquid Limit LL (%)	Plastic Limit PL (%)	Liquidity Index LI (%)	Water Content Wt (%)	Specific Gravity Gs	Modified Proctor Test: Maximum Dry Density MDD (g/cm^3)	Dry Density (90% MDD) 90% (g/cm^3)	Optimum Water Content OMC (%)
TP-01	High Plastic Silt	MH	14.6	68.6	16.9	85.4	53.79	31.76	22.03	32.70	2.68	1.71	1.54	21.30
TP-02	Fat Clay	CH	14.9	46.1	39.0	85.1	54.21	27.07	27.14	27.56	2.74	1.66	1.50	19.39
TP-03	Silt	ML	14.0	62.9	23.1	86.0	0	NP	NP	33.75	2.68	1.61	1.45	20.85
TP-04	Silt with sand	ML	15.1	70.2	14.7	84.9	0	NP	NP	29.74	2.68	1.76	1.58	16.81
TP-05	Silt	ML	13.5	69.2	17.3	86.5	0	NP	NP	30.59	2.68	1.66	1.50	16.25
TP-06	Silt	ML	13.2	66.4	20.4	86.8	48.55	28.64	19.91	29.30	2.68	1.66	1.49	21.55
TP-07	Lean Clay	CL	14.0	57.7	28.3	86.0	39.10	22.62	16.48	31.78	2.73	1.70	1.53	19.05
TP-08	Fat Clay	CH	9.7	55.1	35.2	90.3	54.36	25.01	29.36	38.12	2.74	1.64	1.47	22.35
TP-09	Lean Clay	CL	12.9	57.4	29.7	87.1	40.37	22.71	17.66	34.78	2.72	1.67	1.50	17.08
TP-10	Lean Clay	CL	3.3	64.4	32.3	96.7	40.64	21.69	18.96	24.03	2.72	1.68	1.51	19.33
TP-11	Lean Clay	CL	14.8	48.3	36.9	85.2	40.88	22.73	18.15	27.89	2.73	1.73	1.56	17.04
TP-12	Lean Clay	CL	12.7	53.2	34.0	87.3	39.14	19.99	19.15	27.82	2.72	1.78	1.61	17.30

Source: JICA Survey Team

3.5 Topography

(1) Outline of the Survey

Topographical surveys were conducted at the proposed project haors to understand the topographical conditions necessary for facility design, construction planning, and cost estimation. The implementing agencies, BWDB and LGED, held a joint meeting on 6 August 2023, and selected 26 haors as the next project implementation targets (GOB 2nd phase list). In this study, those 26 haors were surveyed.

The following activities were carried out as part of the topographical surveys:

i. For areas where a digital elevation model (DEM) is not available (one new haor: Kalaruka Haor, and three rehabilitation haors: Karchar, Shanir, and Hail Haors): full longitudinal and cross-sectional surveys were conducted (cross-sections at 1 km intervals and crest levels at 100 m intervals).

ii. For areas where a DEM is available: calibration of the DEM was undertaken by conducting cross-sectional surveys along the haor perimeter (approximately 20 cross-sections per haor).

iii. For each haor, one cross-section will be surveyed across the entire width.

Table 3.5.1 summarized the final status of the topographic survey.

Table 3.5.1 Final Status of the Topographic Survey

No.	Name of Haor	District	New/ Rehabilitation	Included in 15 Haors in Table 5.1.4	ii. Limited Survey for Available DEM	i. Full Survey without DEM
2nd Phase GOB List						
1	Kazirkhola Boro Haor	Kishoreganj	New		**	

No.	Name of Haor	District	New/ Rehabilitation	Included in 15 Haors in Table 5.1.4	ii. Limited Survey for Available DEM	i. Full Survey without DEM
2	Mrigar Haor	Kishoreganj	New	○		○
3	Khuniyer Haor	Kishoreganj	New			○
4	Muktarpur Haor	Sylet	New		○	
5	Kalaruka Haor	Sylet	New			○
6	Ballar Haor	Habigonj	New	○		○
7	Humaipur Haor	Kishoreganj	Rehab	○		○
8	Dewghor Haor	Kishoreganj	Rehab			○
9	Chaptir Haor	Sunamganj	Rehab	○	○	
10	Naluar Haor (Polder-1)	Sunamganj	Rehab	○	○	
11	Naluar Haor (Polder-2)	Sunamganj	Rehab		○	
12	Karchar Haor	Sunamganj	Rehab	○		○
13	Shanir Haor	Sunamganj	Rehab	○		○
14	Halir Haor	Sunamganj	Rehab	○		○
15	Gurmar Haor	Sunamganj	Rehab		○	
16	Khai Haor	Sunamganj	Rehab	○	○	
17	Baram Haor	Sunamganj	Rehab	○	○	
18	Chayer Haor	Sunamganj	Rehab		○	
19	Sonamorol Haor	Sunamganj	Rehab		○	
20	Goradoba Haor	Sunamganj	Rehab		○	
21	Pathar Chawli Haor	Sylhet	Rehab	○		○
22	Zilker Haor	Sylhet	Rehab			○
23	Khaliajuri Polder-3	Netrokona	Rehab	○		○
24	Updakhali Haor	Netrokona	Rehab	○	○	
25	Makalkandi Haor	Habiganj	Rehab	○		○
26	Hail Haor	Moulvibazar	Rehab			○
Haors Implemented in the 1st Phase						
1	Dhrmapasha Rui Beel	Sunamganj and Netrokona			○*	
2	Dakhshiner Haor	Kishoreganj and Habiganj			○*	
3	Naogaon Haor (Part-A)	Kishoreganj			○*	
4	Naogaon Haor (Part-B)	Kishoreganj			○*	

Source: JICA Survey Team

*: Survey for investigating the current condition of areas where slope protection work was applied in previous projects.

**: Only cross-sectional surveys covering the entire width of haors were conducted.

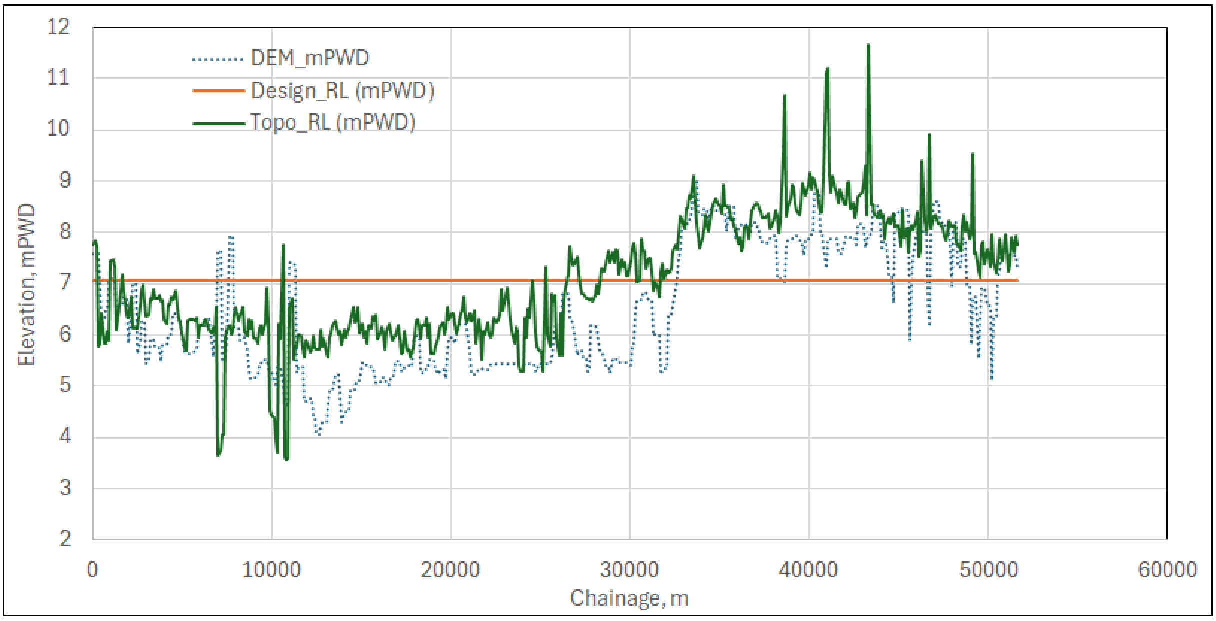
(2) Outcomes of the Survey: Project Candidate Haors

There are some areas where the topographical data obtained from the DEM and from this survey exhibited a poor correlation. The following trends were observed regarding these differences:

i. The DEM was published by the Survey of Bangladesh in 2011, indicating that 14 years have elapsed since its release. The discrepancies between the current topographical survey and the DEM are believed to reflect changes in the terrain resulting from both natural and artificial factors during this period. In particular, significant differences were observed in Halir Haor, which are likely attributable to embankment construction undertaken during this period.

ii. No clear regional trends have been identified at this stage (under review).

iii. The differences in elevation along the Haor boundary line, as determined from the DEM and the current topographic survey, are illustrated in Figure 3.5.1 using Naluar Haor (Polder-1) as an example. Additionally, Table 3.5.2 summarizes these differences for the 15 candidate haors proposed for project implementation, as described in Chapter 5.



Source: JICA Survey Team

Figure 3.5.1 DEM and Topographic Survey: Differences Along the Haor Boundary Line (Naluar Haor [Polder-1])

Table 3.5.2 Difference in Average Elevation on Haor Boundaries between the DEM and the Topographical Survey

No.	Name of Haor	District	New/ Rehabilitation	Mean Ground Elevation at Haor Boundary (DEM from Topographic Survey) (m)
1	Naluar Haor (Polder-1)	Sunamganj	Rehab	0.56
2	Mrigar Haor	Kishoreganj	New	-0.01
3	Makalkandi Haor	Habiganj	Rehab	-0.43
4	Chaptir Haor	Sunamganj	Rehab	0.65
5	Shanir Haor	Sunamganj	Rehab	DEM data not available
6	Pathar Chawli Haor	Sylhet	Rehab	DEM data not available

No.	Name of Haor	District	New/ Rehabilitation	Mean Ground Elevation at Haor Boundary (DEM from Topographic Survey) (m)
7	Karchar Haor	Sunamganj	Rehab	DEM data not available
8	Halir Haor	Sunamganj	Rehab	2.64
9	Khai Haor	Sunamganj	Rehab	0.92
10	Humaipur Haor	Kishoreganj	Rehab	0.52
11	Updakhali Haor	Netrokona	Rehab	0.99
12	Khaliajuri Polder-1	Netrokona	Rehab	Topo data not available *
13	Khaliajuri Polder-3	Netrokona	Rehab	0.85
14	Ballar Haor	Habiganj	New	0.41
15	Baram Haor	Sunamganj	Rehab	0.12

*: Topography survey could not be conducted, as the BWDB requested that the haor considered only after the onset of the monsoon season.

Source: JICA Survey Team

Based on the topographical survey results, adjustments have been made to the quantities used for cost estimation, and these adjustments are reflected in the preliminary design in Chapter 5.

3.6 Infrastructures/Obstacles Survey

(1) Outline of the Survey

Infrastructures and obstacles survey was conducted to identify any structures or obstacles that may impede project implementation in the candidate haors. The survey was undertaken by UAVs to capture the current conditions along the boundaries of the candidate haors. The 26 haors listed in the GOB 2nd phase list were surveyed as candidate haors.

Additionally, to assess damage to flood control facilities constructed during the Phase 1, specifically, Naogaon Haor A and B, Dakshiner Haor, and Dharmapasha Rui Beel, videos documenting the current conditions of these haors were also captured using UAVs prior to the 2025 monsoon season. Table 3.6.1 summarizes the final status of these investigations.

Table 3.6.1 Final Status of the Structures and Obstacles Survey

No.	Name of Haor	District	New/ Rehabilitation	UAV Survey Carried Out
2nd Phase GOB List				
1	Kazirkhola Boro Haor	Kishoreganj	New	No*
2	Mrigar Haor	Kishoreganj	New	○
3	Khuniyer Haor	Kishoreganj	New	○
4	Muktarpur Haor	Sylhet	New	○
5	Kalaruka Haor	Sylhet	New	○
6	Ballar Haor	Habiganj	New	○
7	Humaipur Haor	Kishoreganj	Rehab	○
8	Dewghor Haor	Kishoreganj	Rehab	○

No.	Name of Haor	District	New/ Rehabilitation	UAV Survey Carried Out
9	Chaptir Haor	Sunamganj	Rehab	○
10	Naluar Haor (Polder-1)	Sunamganj	Rehab	○
11	Naluar Haor (Polder-2)	Sunamganj	Rehab	○
12	Karchar Haor	Sunamganj	Rehab	○
13	Shanir Haor	Sunamganj	Rehab	○
14	Halir Haor	Sunamganj	Rehab	○
15	Gurmar Haor	Sunamganj	Rehab	○
16	Khai Haor	Sunamganj	Rehab	○
17	Baram Haor	Sunamganj	Rehab	○
18	Chayer Haor	Sunamganj	Rehab	○
19	Sonamorol Haor	Sunamganj	Rehab	○
20	Goradoba Haor	Sunamganj	Rehab	○
21	Pathar Chawli Haor	Sylhet	Rehab	○
22	Zilker Haor	Sylhet	Rehab	○
23	Khaliajuri Polder-3	Netrokona	Rehab	○
24	Updakhali Haor	Netrokona	Rehab	No*
25	Makalkandi Haor	Habiganj	Rehab	○
26	Hail Haor	Moulvibazar	Rehab	○
Haors Implemented in the 1st Phase				
1	Dharmapasha Rui Beel	Sunamganj and Netrokona		○**
2	Dakhshiner Haor	Kishoreganj and Habiganj		○**
3	Naogaon Haor (Part-A)	Kishoreganj		○**
4	Naogaon Haor (Part-B)	Kishoreganj		○**

*: Inundated prior to the survey

**: Survey carried out to assess the current condition of embankments where slope protection was applied.

Source：JICA Survey Team

(2) Outcomes of the Survey: Structures and Obstacles

According to the UAV footage along the boundary lines of the above-mentioned haors, the following points were made.

- While minor structures, such as concrete-buried pipes, are generally present along the haor boundary line, no structures that would interfere with the project have been identified. The structures confirmed by this survey are shown on the maps summarized in Appendix 3.6.1 for each haor.
- Among the ten haors selected as project targets, a total of nine high-voltage transmission network towers were identified near the borders of both Mrigar Haor and Chaptir Haor. When designing

the embankment, it may be necessary to consider these towers when determining embankment alignment.

(3) Outcomes of the Survey: Flood Control Facilities

Based on the UAV footage of Naogaon Haor A and B during overflow in the 2025 monsoon season, the following observations were confirmed:

i. Overflow does not occur uniformly along the crest of the submersible embankment but tends to be concentrated in specific localized areas.

ii. Regarding embankment erosion, in sections where Slope Protection Types A and Type D have not been applied, both wave-induced erosion of the slope and crest, as well as overflow-induced erosion of the crest and the embankment body, were observed.

iii. In locations where strong overflow was present, the footage suggests that the embankment body has been significantly eroded. However, since the eroded sections are submerged, it is recommended that on-site inspections be conducted during the post-monsoon season. This is considered to be one of the main failure mechanisms of submersible embankments.

iv. Slope Protection Type A effectively resists both wave action and overtopping, preventing embankment erosion.

v. For Slope Protection Type D, the sand-cement bags generally provide good resistance against waves. However, erosion was observed in areas where protection near the crest was not installed. In some places, significant damage to the embankment body caused by strong water flow was also observed.

vi. As for the effectiveness of Type B5, it is difficult to assess the condition of the nonwoven fabric beneath the cover soil from the UAV footage; therefore, on-site inspections and other methods are recommended for confirmation.

3.7 Socio-Economic Conditions

This section analyzes the socio-economic conditions of Bangladesh and the target survey area, as well as the needs faced by the target survey area, based on social statistical data, materials published by other public institutions, and needs assessments conducted by subcontractors.

(1) Population and Households

According to census data from the Bangladesh Bureau of Statistics[1] (hereinafter referred to as "BBS"), Bangladesh has a total of 41,010,051 households and a population of approximately 165,158,616 in 2022. The Sylhet District, which occupies the majority of the study area, accounts for 6.7% of the total population, with annual growth rates in recent years of 17.4% from 1991 to 2001, 23.5% from 2001 to 2011, and 11.3% from 2011 to 2022.

(2) Economic Situation

The total nominal GDP of Bangladesh in 2023 is USD 467.2 billion, of which agriculture accounts for 11.6%, manufacturing 35.3%, and the service industry 58.2%. The agriculture sector's share of total GDP shows a decreasing trend due to its slower growth compared with other sectors, with a growth rate of 13.9% in 2013 and 13.0% in 2023. The annual growth rate of GDP has been around 6%.

(3) Agriculture and Fishery

As of 2022, in Sylhet District, 34.2% of households are engaged in agriculture, of which 20.8% are self-employed and 13.4% are wage-employed. The average percentage of agricultural employment in Bangladesh as a whole is 20.1%, indicating a high degree of dependence on agriculture in the region.

[1] "Population & Housing Census 2022 Preliminary Report", 2022, BBS

As of 2022, grain production (including rice, wheat, corn, millet, barley, and other grains) in Sylhet District accounts for 8.0% of the country's total production, and when compared to the 8.2% share of cultivated land area, it can be inferred that the region is less productive than other regions. When limited to the Haor region, grain production and cultivated land area account for 12.6% and 12.9% of the national total, respectively.

As for the fishing industry, the catch in the Sylhet District accounted for 7.1% of the national total, which is almost equal to the population share of 7.0%. In the Haor area, the catch from Beels (ponds where water from the monsoon season remains in dry season hollows) and floodplains (during the monsoon season) accounted for a large share of the total catch.

(4) Household Income and Expenditures

According to the Household Income and Expenditure Survey[2] (hereinafter referred to as "HIES"), household income has been increasing, with a national average of BDT 32,444/month and average expenditure of BDT 31,500/month as of 2022. The Gini coefficient, which indicates inequality in economic conditions, was 0.499, showing no significant improvement since 2000. The agricultural sector accounted for 16.6% of income, while remittances from domestic and foreign sources accounted for 10.5%. The Sylhet division, which accounts for the majority of the study area, has an income of BDT 22,861/month, which is low compared to the national average.

(5) Poverty

A survey by the Bangladesh Bureau of Statistics shows that the percentage of people living below the two high and low poverty lines is high, but has declined, from 32% and 18% in 2010 to 19% and 6% in 2022, indicating that living standards have improved nationwide. However, as of 2022, the proportion of people living below the upper and lower poverty lines in Sylhet Division is roughly equivalent to the national average (18% and 5%), while in Mymensingh Division, the proportion of people living below the upper and lower poverty lines exceeds the national average (24% and 10%). Further improvement is needed through appropriate development planning and the provision of adequate public services.

(6) Other Significant Needs

A needs assessment survey to determine the social needs of the Haor area was conducted from July to August 2025. The following are the notable findings of the survey worth mentioning.

- Destructiveness and frequency of flash floods: In one notable past case, 880,000 tons of Boro rice were lost in the 2017 floods alone. In the worst case, 80% to 90% of crops can be damaged, directly affecting farm income and local food security.
- Lack of early warning: Institutional communication of weather and flood warnings is virtually absent, with residents relying on loudspeaker announcements and individual intuition. In some cases, floods arrive within hours, leaving insufficient time for pre-harvest evacuation and asset protection.
- Over-dependence on monoculture and single season: Approximately 98.9% of cultivating households are engaged in Boro rice cultivation, while other crops are highly under-diversified at only 7.8%.
- Irrigation vulnerability (energy and equipment dependence): Dependence on LLPs (low-head pump) is extremely high at 96.5%. It is vulnerable to shocks in fuel and electricity prices and equipment supply, and the irrigated area per household varies considerably.
- Weak financial resilience: Savings holdings are only 14.3%, and the main response to income shocks is borrowing from shopkeepers and loan sharks (46.3%) and from relatives (30.9%). Self-help buffers during emergencies are scarce.

[2] "Final Report Household Income and Expenditure Survey", 2023, BBS

- Potable water safety risks (manifested during rainy season): Dependence on shallow wells rises to 58.9% during the rainy season, thereby increasing the risk of contamination from flooding and sewage backflow.
- Vulnerability of sanitation facilities: About 74.3% of households use pit latrines, 12.6% use septic tanks, and 12.6% practice open defecation. Many facilities are damaged, leaking, or flooded, and sanitation risks are particularly pronounced during flood periods.
- Transportation and logistics bottlenecks: Boat transport serves as the lifeline during the rainy season. However, significant congestion occurs, with waiting times for berthing ranging from 30 minutes to 2 hours, and there is a widespread lack of jetties and mooring facilities.
- Road network disruption: Many roads in the Haor area are unpaved, and these roads become impassable during the monsoon season, leading to isolation of settlements.
- Degradation of open water resources: Sedimentation, overfishing, and inequitable leasing have degraded open water ecosystems. The introduction of co-management and improved access to seed, feed, and finance is considered important for sustainable aquaculture expansion.
- Constraints on women and schooling vulnerable groups: Gaps in education and service access for girls remain, and the burden of domestic work during the flood season is unevenly distributed among women. Inclusive service delivery design is therefore necessary.

3.8 Climate Change Impact (Climate Hazard Analysis)

(1) Assessment Method

To assess climate risks associated with the project, the current and future frequency of climate hazards will first to be evaluated. For future projections of climate hazards, the assessment will primarily refer to climate projection data based on the Representative Concentration Pathways (RCPs) used in the IPCC Fifth Assessment Report (AR5) and the Shared Socioeconomic Pathways (SSPs) used in the Sixth Assessment Report (AR6).

Key reference documents include:

① A Global Report: Reducing Disaster Risk – A Challenge for Development, UNDP, 2004

② The Bangladesh Climate Change Strategy and Action Plan (BCCSAP), MOEF, 2009

③ Bangladesh Delta Plan 2100 (BDP 2100), BOP, 2018

In this study, the potential impacts of climate change will be assessed with reference to multiple IPCC scenarios. Future climate variables such as rainfall, temperature, and solar radiation, will be obtained from Global Climate Models (GCMs) and used as a basis for a preliminary analysis of potential climate change impacts. The selection of GCMs will primarily follow those used in the Coupled Model Intercomparison Project Phase 6 (CMIP6). The assessment of climate risks and potential adaptation measures to reduce those risks will be addressed in Chapter 5 (Preliminary Project Design) of this report.

(2) Current Status of Climate Hazards

Bangladesh is susceptible to climate hazards such as floods, cyclones, storm surges, and droughts, and is considered one of the most climate-vulnerable countries in the world. In the study area, flood damage occurs particularly frequent[3], as shown in Table 3.2.1. Recent studies indicate that the magnitude and frequency of floods are increasing due to the effects of climate change.

In the project area, flash floods represent the most frequently occurring climate hazard. Although less frequent, cyclones have also affected the region and caused significant damage. For example, Cyclone Sidr, which occurred in November 2007, passed through Habiganj and Moulvibazar districts and directly

[3] Source: ”Bangladesh Delta Plan 2100” (2018)

hit the city of Sylhet. Additionally, post-monsoon droughts due to reduced rainfall, have severely impacted on farmers, particularly in this project area where single-cropping agriculture is predominant.

Based on the meteorological conditions of the study area, the climate hazards considered relevant to this project are summarized in Table 3.8.1.

Table 3.8.1 Climate Hazards in the Project Area

No.	Climate Hazard	Definition
H1	Flood	River flooding, including flash floods, primarily originating from upstream catchments in Indian territory.
H2	Heavy Rainfall	Inland flooding caused by heavy rainfall within and around the project area.
H3	Cyclone	Wind- and water-related damage caused by tropical cyclones originating in the Bay of Bengal.
H4	Drought	Drought conditions due to low rainfall or prolonged dry periods.
H5	Wind	Changes in wind speed and direction, including the occurrence of severe storms.
H6	High Temperature	Rising average temperatures, with increased frequency of heatwaves and extreme heat events.
H7	Cold Wave	Occurrence of cold waves during the winter season.
H8	Sunshine	Variations in solar radiation.
H9	Sea Level Rise	Poor drainage and habitat changes caused by sea level rise.

Source: JICA Survey Team

(3) Future Projections of Climate Hazards

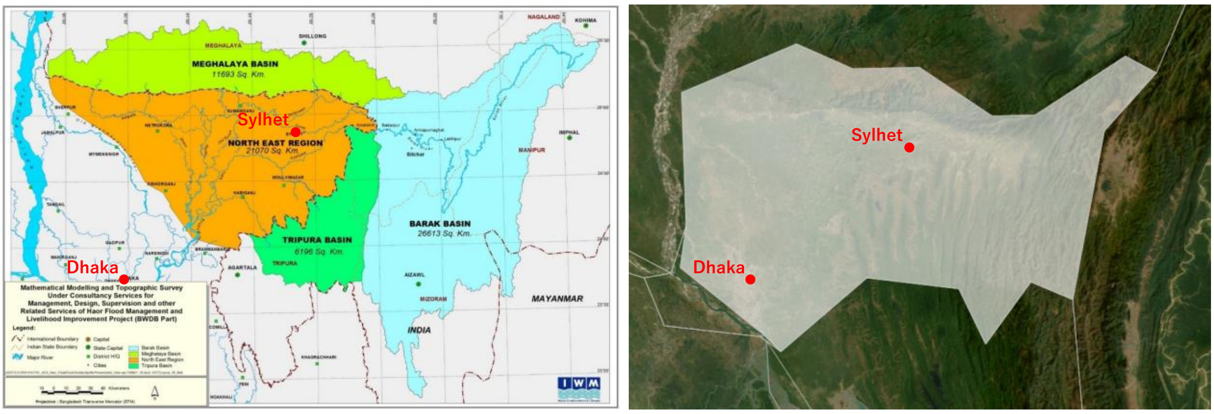
(a) Reference Review on Climatological Value

The IPCC Fourth Assessment Report projects that in South Asia, monsoonal rainfall will increase, leading to higher river flood discharges. It also anticipates that global warming will cause a sea-level rise of 0.18 to 0.79 meters in the region, which may result in saltwater intrusion into rivers and aquifers. Rainfall is expected not only to increase but also to become more erratic, white the frequency and severity of droughts are projected to rise. These impacts are expected to be particularly anticipated in the northern and western regions of Bangladesh.

Furthermore, the Bangladesh Delta Plan Baseline Studies (June 2018) analysed the impacts of climate change on rainfall and other factors using CMIP5 projections. The findings indicate that in the North East Region, where the Haor wetlands are located, annual rainfall could increase by up to approximately 800 mm under the RCP 8.5 scenario.

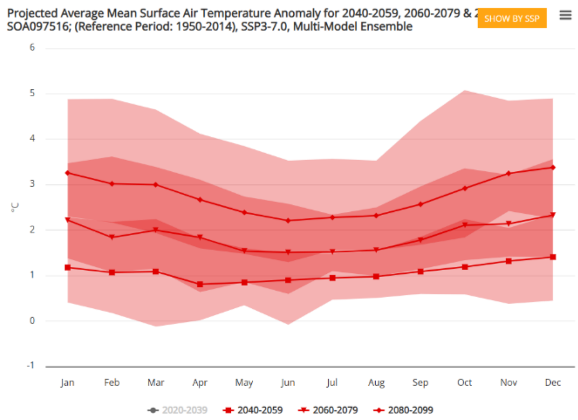
In addition, the Climate Change Knowledge Portal (CCKP), published by the World Bank, provides analysis results based on CMIP6 projects used in the IPCC Sixth Assessment Report. Future climate values averaged over the basin where the Haor region is located are also organized. Figure 3.8.1 presents the basin location map: the left panel displays the Haor basin (highlighted by four different colours, which together comprise the entire Haor basin), while the right panel shows the basin area from the CCKP where Haor is situated. Although the CCKP includes an extended basin area along the southwest Jamuna River that is not part of the Haor region, the basin boundaries on the Indian side are found to be relatively consistent.

Figure 3.8.2 and Figure 3.8.3 present excerpts of future changes in basin-averaged temperature and precipitation under SSP3-7.0. Monthly climate values are shown for the years 2050 (average of 2040-2059), 2070 (2060-2079), and 2090 (2080-2099). The solid line represents the model ensemble mean, while the red shaded areas indicate the range of inter-model variability. The left panel illustrates changes in average temperature, and the right panel shows changes in monthly precipitation.



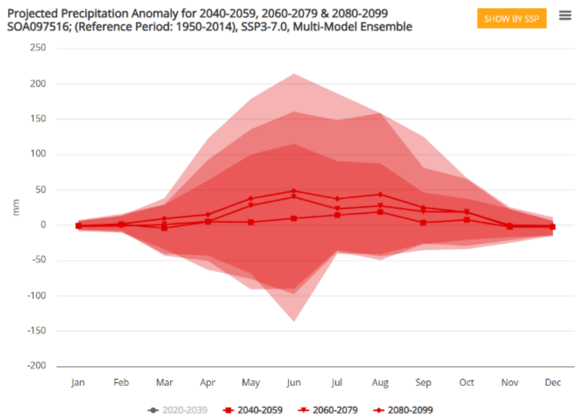
Source: JICA Survey Team

Figure 3.8.1 Haor Basin (left) and the Basin Including the Haor Region as Defined in the CCKP (Right)



Source: Climate Change Knowledge Portal HP

Figure 3.8.2 Projected Changes in Basin-Averaged Temperature for the Haor Region (CMIP6 SSP3-7.0)



Source: Climate Change Knowledge Portal HP

Figure 3.8.3 Projected Changes in Basin-Averaged Precipitation for the Haor Region (CMIP6 SSP3-7.0)

As shown in the figures, the average temperature is projected to increase throughout the year, while precipitation is expected to rise by approximately 50 mm during the monsoon season, from May to August.

(b) Impact Assessment on the Design of Flood Control Structures (High Floods)

1) Study Approach

Given that the target rainfall events used for designing flood control facilities, developing flood forecasting systems, and studying flash flood propagation mechanisms have durations of several days, the impacts of climate change on such events are likely to differ from those on the annual climatological values described above. Therefore, this study adopts an approach in which daily rainfall data—organized based on CMIP6 simulation results—are used as input to a one-dimensional river channel model to assess climate change impacts.

While direct use of CMIP6 data is possible, this study employs a bias-corrected and downscaled CMIP6 dataset developed by Mishra et al., which offers a higher spatial resolution of 0.25° than standard CMIP6 datasets[4].

For the design of flood control facilities, the rainfall change analysis focused on the 2004 flood, which

[4] Bias-corrected climate projections for South Asia from Coupled Model Intercomparison Project-6, Vimal Mishra, October 2020, Scientific data, 7(1), p.338

corresponds to the 10-year return period rainfall event used in the design of Haor submersible embankments. Two scenarios were examined—one excluding climate change effects and another incorporating them—and the results were compared to evaluate the potential impacts of climate change.

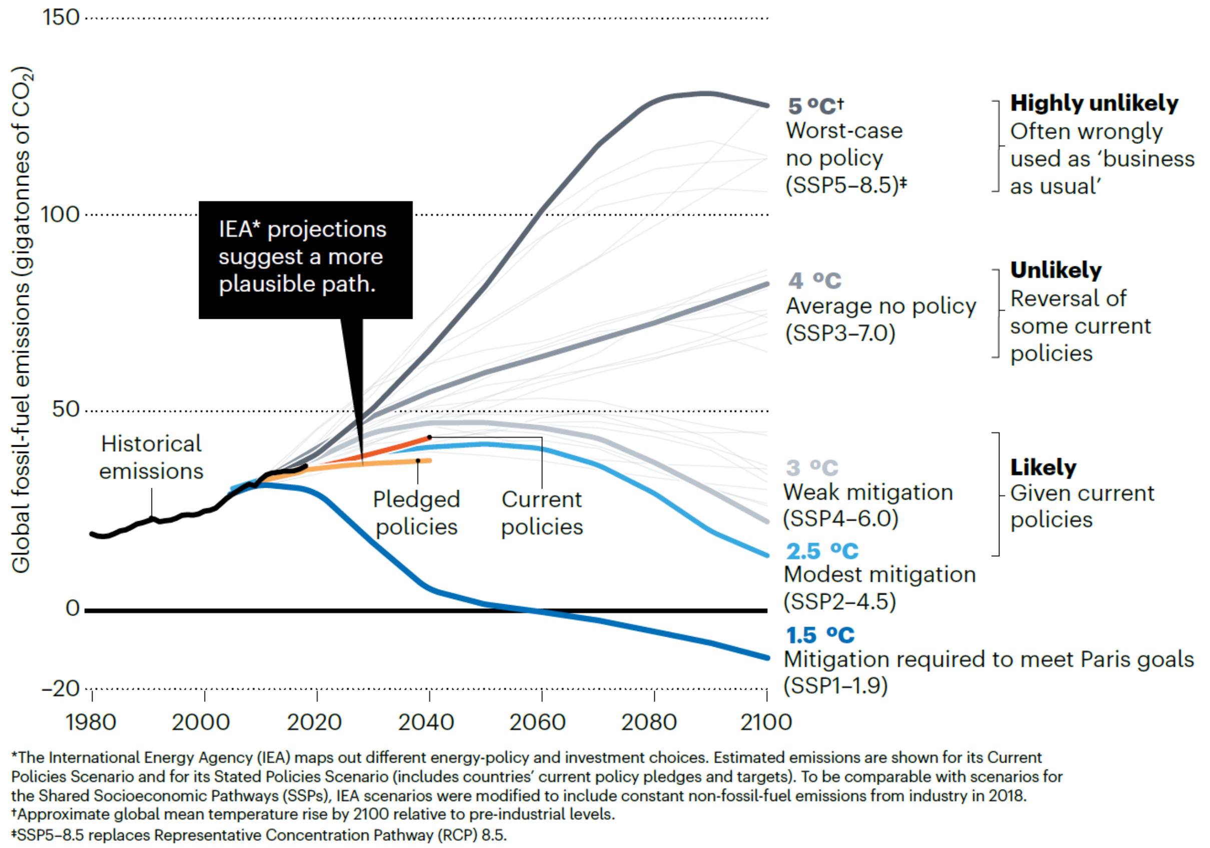
In examining river channel planning, it is generally possible to consider policies aimed at mitigating an increase in the design water level by evaluating a combination of measures, such as riverbed excavation and channel widening, in response to increased discharge. However, riverbed excavation in the target area is likely to be only a temporary measure due to the continuous supply of sediment from upstream. In addition, given the large scale of the river basin, it would be difficult to monitor and implement longitudinal riverbed level management and countermeasures from downstream, making such measures challenging to carry out. Furthermore, potential adverse environmental impacts are also a concern. Similarly, measures involving channel widening are considered difficult, taking into account land use conditions around the river channel as well as potential environmental impacts. Therefore, after conducting an assessment of climate change impacts on the design water level, the corresponding increase in the embankment height was examined.

It should be noted that, according to the BWDB Design Guidelines, when considering the impacts of climate change in the design of river embankments in Bangladesh, an additional height of 30 cm is uniformly applied, regardless of the design flood discharge or the level of flood protection. Similarly, under the ADB-supported FREAP currently being implemented in the Haor area, embankment designs adopt an approach in which an additional height of 30 cm is added to the conventional H.W.L.
During the implementation stage of this project, it will therefore be necessary to re-examine this issue, taking into account both the BWDB design guidance and the assumed climate change scenarios.

2) Scenario Setting

First, the selection of the target SSP scenario was examined. Among the five CMIP6 scenarios, SSP5-8.5 represents the most extreme case, while SSP3-7.0 is the second most severe. SSP5-8.5 assumes rapid economic growth heavily dependent on fossil fuels, resulting in very high greenhouse gas emissions, with radiative forcing reaching 8.5 W/m² by 2100—representing the worst-case projection. In contrast, SSP3-7.0 assumes limited international cooperation, continued regional conflicts, and moderate economic growth, leading to high emissions with radiative forcing reaching 7.0 W/m² by 2100. Both scenarios project substantial climate change impacts, but SSP5-8.5 generally indicates more pronounced effects.

The reference review found no documented cases within Bangladesh in which the design of flood control facilities explicitly adopted a specific SSP scenario. While selecting SSP5-8.5 could be justified as precautionary measure to ensure safety, recent studies suggest that, considering energy transitions and current policy trends, this scenario may be unrealistic and could overestimate emissions (see Figure 3.8.4). By contrast, SSP3-7.0 reflects a moderate level of future emissions growth and global warming while incorporating more realistic elements such as moderate socio-economic development and limited international cooperation, reflecting recent policy trends. Therefore, SSP3-7.0 was deemed the most appropriate high-emission scenario for climate change impact assessment in this study.



Source: Emissions – the 'business as usual' story is misleading, Zeke Hausfather & Glen P. Peters, January 2020, Nature 577, 618-620

Figure 3.8.4 Concept of the SSP Scenarios

Next, the target design year for the facilities was considered. In the economic analysis for the Haor Phase 1 project, a service life of 30 years (including both construction and operation/maintenance) was assumed. This study adopts the same approach. To ensure safety margin, it is assumed that construction will commence in 2030, with the target year set at 2060, i.e., 30 years later. Using the Mishra et al. dataset, data for the period 2047–2073 (centred on 2060) were extracted and utilised for the analysis.

3) Result

The results of the climate change impact assessment are presented below. The findings indicate that, as a consequence of climate change, the required design water level could increase by up to approximately 70 cm. Taking these calculated results into account, together with the required freeboard, the crest elevation of the submersible embankments was determined.

Table 3.8.2 Climate Change Impacts on the Design Water Level of Submersible Embankments of Haors

No.	HAOR_NAME	Nearby River	Pre-monsoon Water Level (mPWD) Without Climate Change	Pre-monsoon Water Level (mPWD) With Climate Change	Difference
1	Ballar Haor (Chegaiya Haor)	RATNASAT 24300	4.86	5.00	0.14
2	Boram Haor	CHAMTI-DARAIN_RIVER 2200	6.70	7.00	0.30
3	Chaptir Haor	KAMARKHALI_NADI 19400	6.74	7.04	0.30
4	Chayer Haor	OLDSURMA 40900	5.58	5.76	0.18
5	Dewghar Haor	DHALESWAR-NE 26700	3.60	3.71	0.11
6	Goradoba Haor	SOMESWARI 17500	6.96	7.17	0.21
7	Gurmar Haor	PATNAIGANG 52000	7.03	7.25	0.22
8	Hail Haor	LUNGLABIJNA 26500	6.35	6.88	0.53
9	Halir Haor	BAULAI 10100	7.04	7.26	0.22
10	Humayerpur Haor	GHORAUTRA 21600	3.29	3.50	0.21
11	Kalaruka Haor	SARIGOWAIN 66200	10.21	10.59	0.38
12	Karchar Haor	GATGOTIA_RIVER 9000	7.44	7.53	0.09
13	Kazirkhola Boro Haor	KALNI 48000	5.41	5.48	0.07
14	Khai Haor	MAHASING 24300	6.77	7.09	0.32
15	Khaliajuri FCD (Polder-3)	BAULAI 59010	5.57	5.68	0.11
16	Khuniyer Haor	DHANU 63680	4.82	5.00	0.18
17	Makalkandi Haor	BIBIYANA 26600	6.07	6.27	0.20
18	Mrigar Haor	LOWER-CHAMTI 9800	5.02	5.18	0.16
19	Muktarpur Haor	KUSHIYARA 77850	9.16	9.56	0.40
20	Naluar Haor (Part 1)	BHATTA-DAHUK 36900	6.77	7.09	0.32
21	Naluar Haor (Part 2)	KUSHIYARA 116850	7.39	7.78	0.39
22	Pathar Chauli Haor (Part 1)	SURMA 111600	9.32	9.91	0.59
23	Pathar Chauli Haor (Part 2)	A_PIYAN 43000	9.57	10.25	0.68
24	Shanir Haor	NANDIAGANG 14450	7.09	7.34	0.25
25	Sonamoral Haor	SOMESWARI 42500	6.88	7.08	0.20
26	Updakhali Haor	SOMESWARI 9300	6.97	7.19	0.22
27	Zilkar Haor (Part 1)	SURMA 78600	10.75	10.95	0.20
28	Zilkar Haor (Part 2)	SURMA 90000	10.34	10.65	0.31

Source: JICA Survey Team

It is noted that an increase in the embankment crest level of up to approximately 70 cm may result in a maximum increase in the required land acquisition width of about 2 m within the construction sections in the target Haor area, assuming a horizontal ground surface on the landward side. However, in most sections, the increase in land acquisition width is expected to be less than this maximum value. In addition, as this project mainly involves rehabilitation works, such an increase will not occur continuously along the entire embankment alignment. Although the detailed extent of the increase will be calculated during the detailed design phase, mitigating adverse impacts from climate change–induced water level rise is considered more critical than the potential impacts associated with additional land acquisition. This is particularly important for securing Boro rice production and ensuring stable livelihoods for farmers. Accordingly, a climate change–adaptive crest height for the submersible embankment has been adopted in this study.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (RELEVANT LAWS AND REGULATIONS, GAP ANALYSIS)

4.1 Natural Environment

4.1.1 Introduction

The scope of this Japan International Cooperation Agency (JICA) Preparatory Survey requires the investigation of the environmental considerations of the Project in terms of its positive and negative impacts on the environment, the identification of mitigation measures for the adverse impacts, the preparation of management plan for the mitigation measures, and the development of a monitoring plan to ensure effective mitigation.

The main purpose of the environmental study is to identify, evaluate, and report on the environmental and socio-economic effects of a project. Another important element is the formulation of an Environmental Management Plan (EMP) outlining the mitigation activities to be conducted during both the implementation and operation phases. This also includes an Environmental Monitoring Plan (EMoP) for the effective supervision and reporting of EMP execution. Another purpose of the environmental study is to establish the baseline environmental condition of the project location, including different parameters across multiple environment components. These baseline values are later compared with corresponding values of the respective parameters sampled during construction and operation stages in order to quantify the impact trends.

This study is conducted in accordance with the requirements of the legal framework of Bangladesh. However, as the Bangladesh Water Development Board (BWDB) and Local Government Engineering Department (LGED) intend to seek JICA finance for this Project, the environmental study also considers JICA's Environmental and Social Guidelines.

4.1.2 Legal and Institutional Framework of Bangladesh

(1) Legal Requirements

According to Section 12 of the Environment Conservation Act 1995, no project can be established or undertaken without obtaining permission from the Department of Environment (DoE). As per the latest "Environment Conservation Rules (ECR) 2023" of DoE, different industries and projects are divided into four categories under Schedule 1. In this project, the BWDB portion corresponds to "River Basin Development, Irrigation and Flood Control Project" under Item No. 60 of that table, and the LGED portion corresponds to "Dredging and Dredged Material Management of Rivers and Canals (including Beel) over 5 km" under Item No. 34 of the table or "Road Construction or Expansion over 10 km" under Item No. 38 of the same table. Every development project or industry, which is specified under Red Category of Schedule 1 of the ECR 2023 requires the acquisition of a Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from DoE. Furthermore, according to Rules 14 and 15 of the ECR 2023, a comprehensive Environmental Impact Assessment (EIA) study is required for obtaining a Site Clearance Certificate (SCC) from the DoE. Thus, an EIA study is required for this Project as per Bangladesh legal framework.

(2) Laws and Regulations

This section outlines the regulatory context directly related to environmental compliance, which must be adhered to by all parties involved in the project throughout the planning, construction, and operation phases.

(a) The Bangladesh Environment Conservation Act (BECA), 1995 (as amended in 2000, 2002, and 2010)

This is the main legislation in Bangladesh governing environmental protection. The aim of this Act is to provide for the conservation of the environment, the improvement of environmental standards, and the control and mitigation of environmental pollution. The purpose of this Act is to establish the Department of Environment, headed by a Director General (DG); to set the power and function of the Director General; to declare Ecologically Critical Areas; to mandate the obtaining an Environmental Clearance Certificate (ECC) from DG prior to the establishment of any industry or project; and to provide for the formulation of environmental guidelines and authority to promulgate rules.

(b) The Environmental Conservation Rules (ECR), 2023

- The implementation details of the Environmental Act are described in the Rules, and the latest such Rules are the Environmental Conservation Rules (ECR) of 2023. The Rules stipulate the following:
- The procedures for obtaining a Location Clearance Certificate (LCC) followed by an Environmental Clearance Certificate (ECC), in accordance with the categorization (Green, Yellow, Orange, and Red) of industries and other development projects as specified in the Schedule.
- The National Environmental Quality Standards for inland surface water and coastal water according to designated use, drinking water standards, sewage discharge standards, and standard of effluent discharge from industry or project.
- The guidelines for the selection of locations for industries and projects, including requirements for documentation related to the approval of effluent treatment plant for ECC application.
- The prescribed formats for the EIA Terms of Reference (TOR) preparation, EIA reports, and EMP, as well as the formats of various forms for ECC application to DoE and the applicable application processing and testing fees in DoE etc.

(c) Environment Court Act, 2010

This Act establishes Environmental Courts and Special Magistrate Courts related to environmental issues. Also, the Act defines the jurisdiction of the Environmental Courts; prescribes penalties for violations of court orders; sets out trial procedure in Special Magistrate Court; confers powers of entry, search, and procedure for investigations; specifies the procedures and powers of the Environmental Courts; and provides for the authority of the Environment Court to conduct inspections, appeal procedure, and the formation of the Environmental Appeal Court.

(d) Air Pollution Control Rules, 2022

The rules set the standards for ambient air quality and odour, vehicular emissions, industrial emissions (stack emissions and fugitive emissions), municipal solid waste incineration emissions, and standards for construction dust control.

(e) Noise Pollution (Control) Rules, 2006

The Rules have been established to manage noise-generating activities, which have the potential to impact the health and well-being of workers and the surrounding communities. Schedule 1 of the Rules specifies the acceptable noise levels for different zones, while Schedule 2 of this rule sets standards for motor vehicles and water vessels. In addition, the Rules require prior authorisation for the use of high-noise devices, including workplace and construction-related noise-generating appliances.

(f) Ecologically Critical Areas (ECAs) Management Rules, 2016

The Rules outline the procedure for declaring environmentally endangered areas and specify activities that are prohibited within such areas.

(g) Biodiversity Act, 2017

The objective of this act is to provide for the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the utilisation of biological resources and associated knowledge, as well as matters incidental thereto.

(h) Forests Act, 1927 and its amendments in 1982, 1989, 2000, and 2018

Under this Act, the Government may declare any forest land as the property of the Government to be reserved as forest land. No rights shall be acquired in reserved forest land other than those acquired by succession or by government grant or contract, and no clearing of cultivation shall be carried out other than in accordance with rules made by the Government for the reserved area.

(i) Wildlife (Conservation and Security) Act, 2012

This Act is to provide for the conservation and protection of biodiversity, forests, and wildlife of the country. The Act depicts ten new types of protected areas. Prohibitions relate to capturing, killing, shooting, or trapping wildlife. The determination of threatened flora and fauna set out in four (4) schedules. Also, the Act stipulates strict actions for violations of the law.

(j) Protected Area Management Rules, 2017

This Act is the legal basis for the management and co-management of protected areas. The Rules specify provisions for financial benefits and income incentives to stakeholders through participatory social forestry programmes, which are to be implemented in buffer zones and landscape areas, and promote eco-tourism.

(k) Bangladesh Water Act, 2013

An Act to make provisions for integrated development, management, abstraction, distribution, use, protection, and conservation of water resources. The purposes of this Act are: the right to potable water and water for hygiene and sanitation shall be treated as the highest-priority right; to constitute the "National Water Resources Council"; to adopt National Water Policy, prohibiting the construction of any structure or creating obstacles for ensuring a normal flow of water, protection of aquifers by establishing the lowest safe yield level for groundwater abstraction; protection of flood control embankments; conservation and management of water sources like dighi, pond, haor, baor, water pollution control; prescribing punishment, fines, and compensation for violating the law; and conferring the power to make rules.

(l) Bangladesh Water Rules, 2018

This Rule mentions provision of No Objection Certificate (NOC) for the establishment of projects related to flood control and management; surface water extraction, supply and use related project ; irrigation projects using surface water; construction of hydraulic structures; water conservation projects; flood-affected plain land and wetland development projects; groundwater use for industrial purposes; riverbank protection and river control; river excavation and dredging project; canal excavation and re-excavation projects; fisheries development in surface water projects; groundwater extraction, supply and use related projects; and other projects. According to Clause 16 of the Rules, a NOC should be taken from the DG of WARPO, Deputy Commissioner (DC), Upazila Nirbahi Officer (UNO), and Union Committee/Chairman based on the total investment of the specific project.

(m) National River Protection Commission Act, 2013

This Act is to establish a Commission for preventing the illegal occupation of rivers, pollution of water and the environment, pollution of rivers caused by industrial factories, illegal constructions, and various irregularities, and for ensuring multidimensional use of rivers for socio-economic development including restoration of the normal flow of rivers, their proper maintenance, and making them navigable.

(n) Protection and Conservation of Fish Act, 1950, and its amendment in 1982 and the Rules of 1985

The Act was enacted to provide for the protection and conservation of fish. Under the Act, the Protection and Conservation of Fish Rules were adopted in 1985.

(o) National Environment Policy, 2018

The vision of this policy is environmental conservation, pollution control, biodiversity conservation, and mitigation of the adverse effects of climate change to ensure sustainable development.

(p) National Water Policy, 1999

The main objective of this Policy is to minimize disruption to the natural aquatic environment in streams and water channels.

(q) National Fisheries Policy, 1999

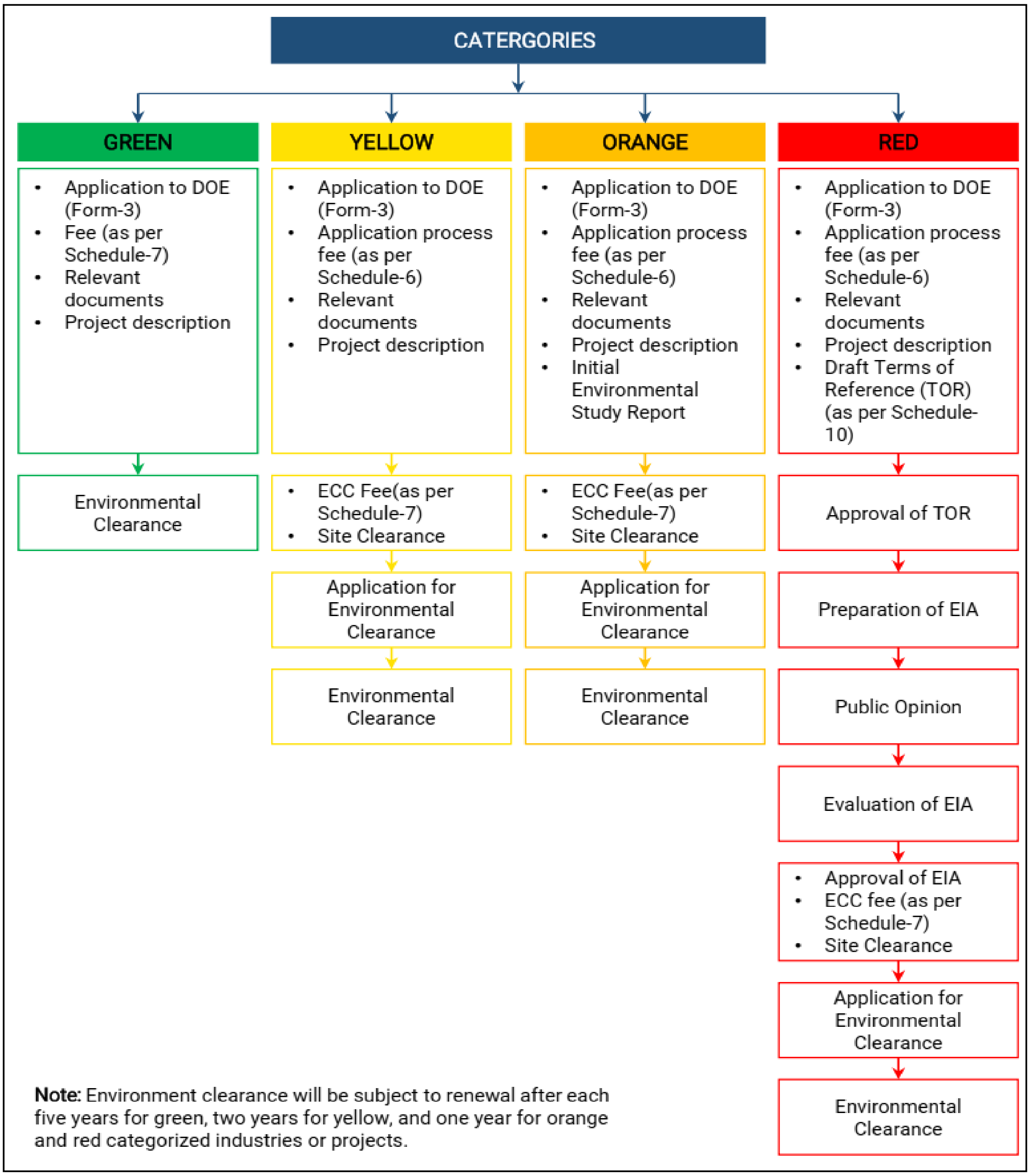
This Policy provides provisions for the protection and conservation of fish in freshwater and brackish water bodies, as well as for the preservation, management, and exploitation of fisheries resources in inland open water, fish cultivation, and management in inland closed water, among others.

(r) National Agriculture Policy, 2018

This Policy is to ensure food security and socio-economic development through the enhancement of crop productivity, boosting production, raising farmers' income, diversifying crops, producing safe foods, and developing a marketing system, promoting profitable agriculture, and use of natural resources.

(3) Procedure to Obtain Approval from DOE

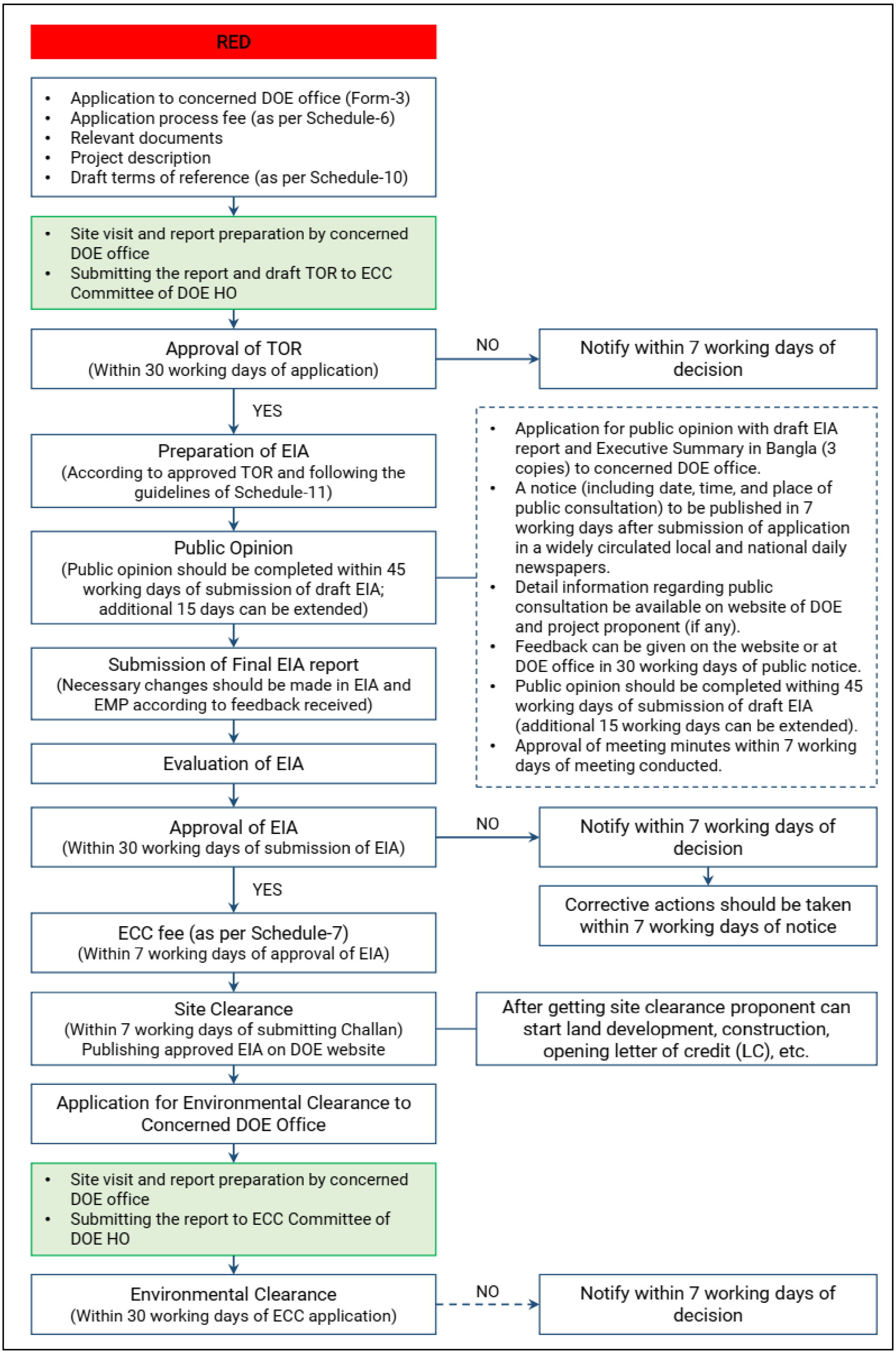
A schematic outline of the procedure to obtain approval from the DoE is given below based on ECR 2023.



Source: JICA Survey Team based on ECR 2023

Figure 4.1.1 Procedure for Obtaining Environmental Clearance for Different Categories Project

Further details of the procedures for Red Category projects are shown below.



Source: JICA Survey Team based on ECR 2023

Figure 4.1.2 Procedure of Obtaining Environmental Clearance for Red Category Project

4.1.3 Legal and Institutional Framework of JICA

In the case of potential JICA financing, the JICA Guidelines will be applied to the Project, which is the "Guidelines for Environmental and Social Considerations". The latest JICA Guidelines were published in 2022.

The basic principles are as follows:

- Environmental and social impacts caused by projects must be assessed and examined at the earliest possible stage of planning. Alternatives or mitigation measures should be considered to avoid such impacts wherever feasible, and to minimise, reduce, or mitigate them when avoidance is not possible.
- Appropriate plans and systems for measures, such as monitoring plans and environmental management plans, must be prepared.
- The impacts to be assessed include impacts on human health and safety, air, water, soil, waste, accidents, water use, climate change, biodiversity, and ecosystem services, including transboundary or global-scale impacts. These also include social considerations such as: migration of population including involuntary resettlement; local economy, including employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions; existing social infrastructures and services, vulnerable social groups including poor people and indigenous peoples, equality of benefits and losses and equality in the development process; gender; children's rights; cultural heritage; local conflicts of interest, infectious diseases such as HIV/AIDS; and working conditions including occupational safety.
- In addition to the direct and immediate impacts of projects, derivative, secondary, and cumulative impacts, as well as impacts associated with indivisible projects are also to be examined and assessed to a reasonable extent.
- Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by the host country government, including relevant local governments.
- In principle, Projects should be undertaken outside areas that are specifically designated for the conservation of nature or cultural heritages by the host country governments, unless the main purpose of the Projects is to promote or restore the protection of such areas. Also, projects should not cause significant adverse impacts on these designated conservation areas.
- Sufficient consultations with local stakeholders, including local residents, must be conducted through disclosure of information at an early stage.
- For projects that are expected to generate more than a significant amount of greenhouse gas emissions, the total amount of greenhouse gas emissions shall be estimated and disclosed before the project implementation.
- Projects must not involve significant conversion or degradation of critical habitats or critical forests.
- Any adverse impacts that a project may have on indigenous peoples are to be avoided whenever feasible by exploring all viable alternatives. If avoidance is not possible even after such examination, effective measures for indigenous peoples must be implemented to minimize the impacts and compensate for losses.
- Measures for the affected indigenous peoples must be prepared as an Indigenous Peoples Plan (IPP), which may constitute part of other documents for environmental and social considerations, and must be disclosed publicly in compliance with the relevant laws and ordinances of the host country.
- During the project implementation, project proponents must monitor whether any unforeseeable situations occur, as well as the performance and effectiveness of the planned mitigation measures. Project proponents shall take appropriate actions based on the results of such monitoring.

- In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects requiring mitigation measures whose effectiveness must be verified, project proponents must ensure that the project plans include feasible monitoring arrangements.
- Project proponents should make efforts to make the monitoring results available to local stakeholders involved in the project.

JICA Guidelines classify projects into four categories, based on the extent of environmental and social impacts, considering the project's characteristics, scale, site condition, and other relevant factors. These are category A, B, C, and FI, where A to C are the categories in descending order of likely impacts, and FI refers to a sector program of small subprojects. As per JICA, this Project falls under Category B. Generally, for this category, the impacts are site-specific, with few irreversible impacts, and can be addressed by general mitigation measures in most cases. The scope of environmental reviews for Category B projects may vary from project to project, but it is narrower than that of Category A projects. Usually, an IEE level study is required for Category B projects.

Since this Project may involve land acquisition, a separate Resettlement Action Plan (RAP) must also be prepared by the BWDB and LGED separately.

4.1.4 Gap Analysis between Bangladesh Regulations and JICA Guidelines

There is no major gap between the environmental regulations of Bangladesh and JICA guidelines for environmental and social consideration except the public consultation stage. JICA guidelines have a provision for information disclosure both at planning stage and after draft EIA report preparation, whereas ECR 2023 requires discloser after the draft EIA report. The following Table 4.1.1 shows the comparison.

Table 4.1.1 Gap Assessments Between Environmental Regulations of GOB and the JICA Guidelines

Aspect of Operational Framework	JICA	GOB	Harmonized Operational Framework
Environmental Policy and Regulations	JICA Guidelines for Environmental and Social Consideration, 2010	Environment Conservation Act, 1995 Environment Conservation Rules, 2023	No gap
Analysis of Alternative	The environmental impact must be assessed and examined from the earliest possible planning stage. Alternative studies shall be conducted to avoid or minimize adverse impacts and must be examined and incorporated into the project plan.	Schedule 10 of ECR 2023 demonstrated that the EIA report shall include the justification of selected project options and the cancellation of other options.	No gap
Public Consultation Meeting & KII	For projects with potentially adverse effects, information about the project needs to be disclosed at an early stage, and stakeholders, such as local communities, should be adequately consulted. The consultation results must be considered in project planning. (Holding consultations is highly desirable, especially at the scoping stage and when the draft report is being prepared).	In the ECR 2023, public consultation at the scoping stage is not required; but public consultation after draft EIA is mandatory.	JICA guidelines provide for public consultation both at the planning stage and after draft EIA report preparation whereas ECR 2023 has been emphasizes to consultation after the draft EIA. Public consultation shall be implemented throughout the preparation and implementation stages of the Project. During the preparation of the EIA report, consultations are conducted at the scoping

Aspect of Operational Framework	JICA	GOB	Harmonized Operational Framework
			stage and when the draft report is prepared.
Disclosure of EIA report	According to the Guidelines, the EIA report shall be disclosed 120 days before the loan agreement, and stakeholders should have access to the report.	Rule 16 of ECR 2023 outlines the public opinion on environmental impact assessments. These rules clearly presented the steps for disclosure of the draft EIA report disclosure. According to Sub-rule 16 (2) of ECR 2023, the concerned project proponent shall fix the date, time, and place for public opinion verification within seven working days of receiving the application and publish a notice in a widely circulated local and a national daily newspaper. Detailed information regarding public opinion shall be published on the website of the DoE, and if applicable, the website of the proponent of the said project. Regarding the Environmental Impact Assessment (EIA) report, stakeholders may submit their opinions at the concerned office or through the website of the Directorate within 30 working days of publication of the notification. Public consultation shall be completed within 45 working days following the preparation of the EIA report.	No gap

Source: JICA Survey Team

4.1.5 Evaluation from the Perspective of Natural Environment in the Selection of Candidate Haors for the Project

At the onset of this JICA Preparatory Survey (PS), one of the primary tasks within the Survey scope was to select the target haors. The selection process considered various parameters including average annual damage length of embankment, inundated land, vulnerability, and others. The detailed selection process is described part in this report (Section 5.1.1). One of the evaluation criteria was the assessment from the natural environmental aspect.

The main environmental factor important to target haor selection is their geographical relationship with environmentally sensitive areas. In the northeast Bangladesh, there are many such environmentally sensitive areas. A list of such areas is provided below, and the relative positions of the haors under preliminary study with respect to these areas are shown in Figure 4.1.3.

Table 4.1.2 Environmentally Sensitive Areas in Northeast Bangladesh

Sl. No.	Name	District	Division	Area (Hector)	Coordinate	Declaration	Remark
National Park							
1.	Lawachara National Park	Moulvibazar	Sylhet	1250	24° 19′ 11″ N 91°47′1″E	7 Jul 1996	
2.	Satchari National Park	Habiganj	Sylhet	242.91	24°07′12″N 91°27′03″E	10 Oct 2005	
3.	Khadim Nagar National Park	Sylhet	Sylhet	678.8	24°53′52″N 91°52′17″E	13 Apr 2006	Habitat or species management area
4.	Kadigarh National Park	Kachina, Bhaluka, Mymensingh	Mymensingh	344.13	24°20′18″N 90°19′42″E	24 Oct 2010	Habitat or species management area
Wildlife Sanctuary							
1.	Rema-Kalenga Wildlife Sanctuary	Chunarughat, Habiganj	Sylhet	1795.54		7 Jul 1996	National Park
Special Biodiversity Conservation Area							
1.	Special Biodiversity Conservation Area (Ratargul)	Sylhet	Sylhet	204.25	25°01′03″N 91°55′54″E	31 May 15	
Eco Park							
1.	Madhabkunda Eco Park	Dakshinvag, Barlekha, Moulvibazar	Sylhet	204.25	24°37′47″N 92°13′16″E	2001	
2.	Muraichhara Eco Park	Kulaura, Moulvibazar	Sylhet	335.889	24°43′314″ N 92°08′581″E		
3.	Tilagor Eco Park	Sylhet	Sylhet	45.34	24°55′02″N 91°54′24″E	2006	
4.	Borshijora Eco Park	Moulvibazar	Sylhet	326.07	21°48′44″N 90°08′15″E	2006	
Ecologically Critical Areas (ECA)							
1.	Hakaluki Haor	Sylhet and Moulvibazar	Sylhet	40,466		1999	Inland Freshwater Wetland
2.	Tanguar Haor	Tahirpur, Sunamganj	Sylhet	9,727		1999	Inland Freshwater Wetland
3.	Jaflong-Dawki	Jaflong, Sylhet	Sylhet	1493		2015	River

Sl. No.	Name	District	Division	Area (Hector)	Coordinate	Declaration	Remark
Key Biodiversity Area (KBA)							
1.	Hakaluki Haor	Sylhet and Moulvibazar	Sylhet	40,466		1999	Inland Freshwater Wetland
2.	Tanguar Haor	Tahirpur, Sunamganj	Sylhet	9,727		1999	Inland Freshwater Wetland
3.	Lawachara National Park	Moulvibazar	Sylhet	1250	24°19′11″N 91°47′1″E	7 Jul 1996	National Park
4.	Rema-Kalenga Wildlife Sanctuary	Chunarughat, Habiganj	Sylhet	1795.54		7 Jul 1996	National Park
5.	Rajkandi Reserved Forest	Kamalganj, Moulvibazar	Sylhet				
6.	Hail Haor	Moulvibazar Sadar, Sreemangal	Sylhet	21,600.71			Haor
7.	Aila Beel	Jamalganj, Sunamganj	Sylhet	75.59			Beel
Reserved Forest							
1.	Rajkandi Reserved Forest	Kamalganj, Moulvibazar	Sylhet				
RAMSAR Site							
1.	Tanguar Haor	Tahirpur, Sunamganj	Sylhet	9,727		1999	Inland Freshwater Wetland

Source: JICA Survey Team based on secondary data

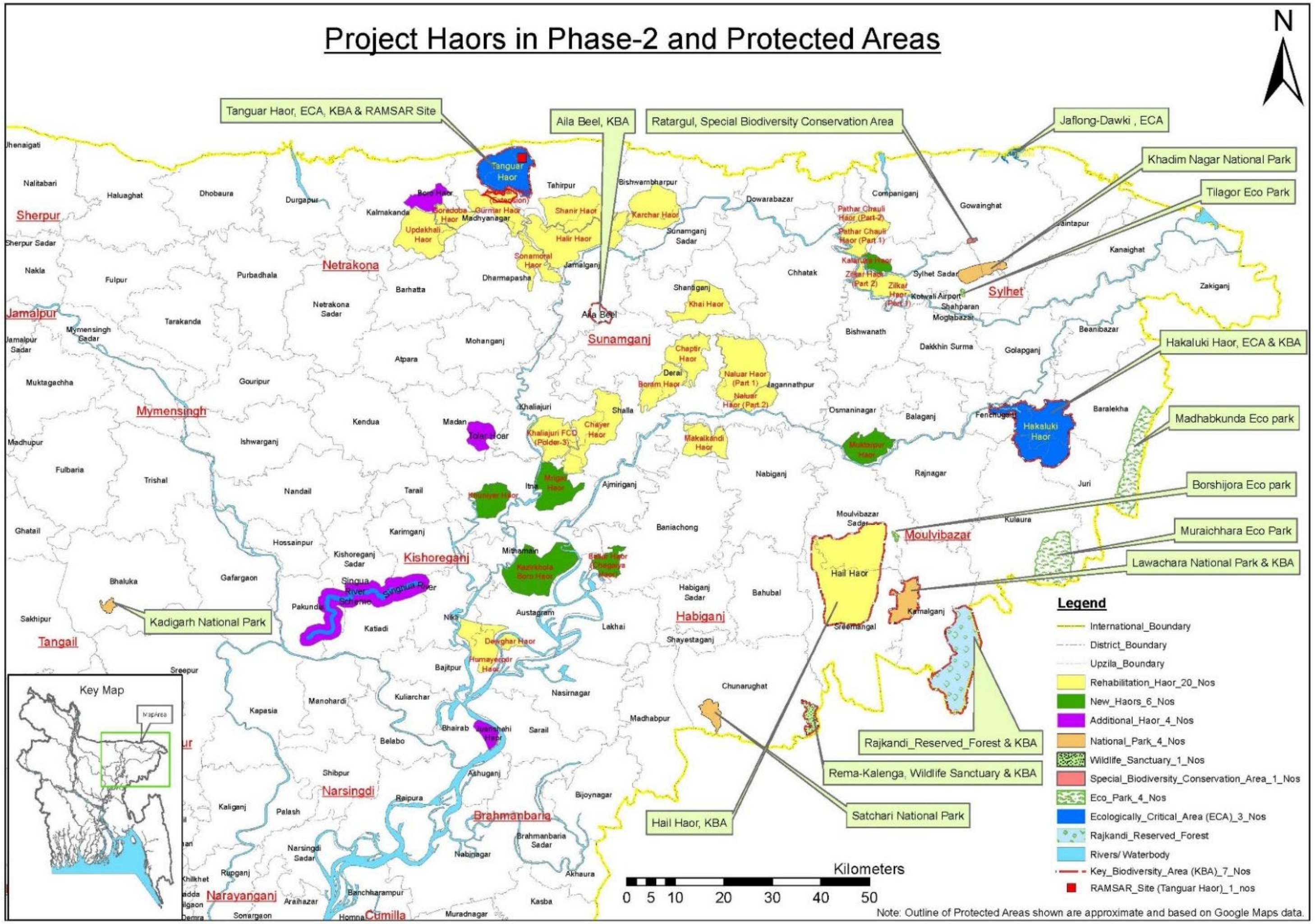
As shown in Figure 4.1.3, most of the target haors, with the exception of Hail Haor, are relatively distant from any of the sites.

The haor region is visited by a large number of migratory birds every winter (dry season) and functions as an important feeding and resting ground. According to the Bangladesh Red List, Tanguar Haor, Hakaluki Haor, and Gurmar Haor are identified as major migratory bird sites, including species of conservation concern. In particular, Tanguar Haor is designated as a Ramsar wetland, while Hakaluki Haor and Hail Haor are recognized as Important Bird Areas (IBAs). Accordingly, these haors are internationally recognised as environmentally significant areas from a biodiversity conservation perspective. Based on these considerations, Hail Haor has been excluded from the project target areas.

With regard to Gurmar Haor, although it does not have an official designation such as a protected area, it is located in close proximity to Tanguar Haor, a Ramsar wetland. While the two haors are topographically separated by Gurmar Extension Haor and are not directly connected hydrologically, Gurmar Haor is the closest haor to Tanguar Haor among the project candidate sites. Furthermore, the Bangladesh Red List also identifies Gurmar Haor as an important migratory bird site, encompassing species of conservation concern. Therefore, as a precautionary and conservative measure, Gurmar Haor has also been excluded from the project target areas.

Although the Bangladesh Red List indicates that some species of conservation concern inhabit or visit the haor region more broadly, the project has excluded the above-mentioned critical habitats and adjacent haors from its target areas. In addition, by implementing appropriate environmental protection and mitigation measures in the remaining project areas, potential impacts on migratory birds and other important biological species are considered to be sufficiently minimized (see Chapter 8 for details).

In conclusion, from the perspective of natural environment conservation, Gurmar Haor and Hail Haor have been excluded from the project's target haors.



Source: JICA Survey Team

Figure 4.1.3 Project Haors in Phase 2 and Environmentally Sensitive Areas in Northeast Bangladesh

4.2 Social Environment

4.2.1 Introduction

The scope of this JICA Preparatory Survey requires an investigation into the social considerations of the Project in terms of its positive and negative impacts on the social context, poverty, income, and the mitigation measures for the negative impacts, management plan for these mitigation measures, and monitoring plan for effective mitigation.

The main factor for negative impacts from this Project is expected to arise from the land acquisition required for the Project. It is widely accepted that the preparation of a proper RAP and its effective implementation is the key tools to mitigate social negative impacts. The RAP document also contains an implementation plan as well as a monitoring plan.

This study has been conducted in accordance with the requirements of Bangladesh legal framework. However, as the BWDB and LGED intend to seek JICA financing for this Project, the social study also considers JICA's Environmental and Social Guidelines. Therefore, a RAP for the project will be prepared in compliance with the JICA Guidelines for Environmental and Social Considerations.

4.2.2 Legal and Institutional Framework of Bangladesh

For land acquisition, the principal law in Bangladesh is the "Acquisition and Requisition of Immovable Property Act (ARIPA) of 2017". The Act must be adhered during the acquisition or requisition of land for any development purpose. The affected persons receive their compensation for land and other assets in accordance with this law. Under the law, the affected person is entitled to an additional 200% of the assessed value for land and an additional 100% for structures, trees, crops, and other assets. Further details are provided below. However, it should be noted that there is no national law in Bangladesh providing for resettlement benefit.

Major steps of the land acquisition process, as conducted by the District Commissioner (DC) office, are presented below according to ARIPA 2017 law for easy reference.

Table 4.2.1 Steps of Land Acquisition Process as per ARIPA 2017

Step	Description
Administrative approval from line ministry	The requiring body (in this case BWDB and LGED) must obtain administrative approval from the line ministry (Ministry of Water Resources and Ministry of Local Government).
LA proposal submission by Project owner to respective DC office	The land acquisition (LA) proposal document includes: - Facilities layout plan Proposed acquisition area shown on Mouza maps - List of affected plots (known as Plot Index) - Amount of land in each plot and land required for acquisition (Land Schedule) - General running video of the affected area - Filled up "CHA" Form showing names of the owners as per Khatians (ownership records - Administrative approval from the Line Ministry - Other relevant documents as per Item 1 of "LA Instructions Set" (issued by Land Ministry in 2017) The first six items constitute the Land Acquisition Plan (LAP).
Document check and Reconnaissance Survey	The DC office will verify submission of all required documents. A representative of the DC office will conduct a preliminary reconnaissance survey, including video documentation.
Meeting of District Land Acquisition Committee (DLAC) and allocation of case number by DC office	Submitted documents are sent to the DLAC to allocate an LA case number (within 21 working days of LA proposal submission). This marks the official recognition of the LA proposal.
Notice of Acquisition under Sec. 4	Marks the official start of the LA process and acts as the legal "Cutoff Date".
Joint Verification Survey (JVS) as per Sec. 4 (3) (Kha)	A joint verification survey must commence within seven (7) working days of Sec 4 notice, jointly conducted by the acquiring body (DC office) and the requiring body (BWDB and LGED). The survey must be completed prior to the issuance of Sec 7 notice. Joint video documentation is conducted to confirm assets.

Step	Description
Objection against JVS as per Sec. 4 (8)	To be submitted to the Divisional Commissioner within seven (7) working days following publication of the JVS report.
Decision on objection as per Sec. 4 (9)	To be solved by the Divisional Commissioner within 15 working days after Sec 4 (8).
Objection against acquisition (Sec. 5-1)	To be submitted to DC office within 15 working days under Sec 4 (8) notice.
Decision on objection (Sec. 5-2)	To be resolved by the DC office within 30 working days after Sec 5-1 submission.
Submission for final approval (Sec. 5-3)	Depending on acquisition amount, the LA proposal is submitted to either Divisional Commissioner or the Central Land Acquisition Committee (CLAC), within 30 working days after Sec 5-2 decision.
Final approval by Divisional Commissioner or CLAC (Sec. 6)	To be granted within a maximum 60 working days following Sec 5-3 submission.
Final notice of acquisition to persons of interest (Sec. 7)	Official recognition of Project Affected Persons (PAPs). PAPs must submit all required documents within 15 working days of notice issuance.
Estimation of Cash Compensation under Law (CUL)	DC office prepares the compensation amount estimates within 30 working days of issuing the Sec. 7 notice. Land register determines the land value; the PWD assesses the value of structures; the DAE evaluates agricultural crops values; Forestry Department prepares tree values, and other relevant assets. The DC office complies the individual estimates and requests the requiring body to deposit the total amount to the DC office.
DC office will ask project owner to deposit the money (under Sec. 8-4)	Within 120 days after the award preparation under the Sec. 8.
Notice of compensation amount (Sec. 8)	Once the requiring body has made the full payment, the notice shall be served within seven (7) working days.
Payment of compensation (Sec. 11)	Payment shall commence within 60 working days after notice under Sec 8.
Acquisition of possession (Sec. 13-1)	Land will be taken over by the DC office on payments under Sec 11.
Gazette Notification (Sec. 13-2)	Within 90 working days after Sec. 13-1, the DC issues a Gazette Notification formally declaring the end of the LA process. Vacant land is then handover over to the requiring body (BWDB/LGED) by the DC.
Arbitration (Sec 30)	Within 45 working days after Sec. 8 notice, an application can be submitted regarding the compensation amount to a nominated arbitrator, which is not below the rank of Joint District Judge.
Arbitration hearing (Sec 31)	The arbitrator must issue a verdict within 90 working days from application submission. Additional compensation cannot exceed 10% of Sec. 8 amount.
Appeal to Arbitration (Sec 36)	An appeal can be made against the arbitration decision to the Arbitration Appellate Tribunal, which is not below the rank of District Judge. Additional amount cannot be more than 10% of Arbitration amount. Verdict must be issued within 60 working days from application submission.

Source: JICA Survey Team Based on ARIPA, 2017.

It can be said from the above table that completing a Land Acquisition (LA) case typically requires between 12 and 18 months, measured from the issuance of Notice under Sec 4 to Gazette Notification under Sec. 13. Following the award by the DC, additional payments in accordance with RAP entitlements may proceed to the title holders.

4.2.3 Legal and Institutional Framework of JICA

With regard to involuntary resettlement, the JICA Guidelines for Environmental and Social Considerations of 2022 are broadly equivalent to the World Bank ESS5 on Land Acquisition, Restrictions on Land Use and Involuntary Resettlement. The guidelines recognize and address the involuntary resettlement and relocation impacts on all affected persons, irrespective of their legal titles, and requires the preparation of RAP or ARAP in all instances where involuntary resettlement occurs, depending on the number of affected persons. The JICA policy requirements are as follows:

- Involuntary resettlement and loss of means of livelihood are to be avoided whenever feasible by exploring all viable alternatives. If avoidance is not possible even after such examination, effective measures to minimize impacts and compensate for losses must be taken in consultation with the affected persons.

- Project affected people, such as people to be resettled involuntarily and/or people those who may lose their livelihoods due to the project, must be provided with sufficient compensation and support by the project proponents in a timely manner. Compensation must be calculated at full replacement cost as much as possible and provided in advance. Project proponents must endeavour to enable the affected people to improve or at least restore their standards of living, income opportunities, and production levels to pre-project conditions.
- Compensation standards are disclosed and consistently applied. The project-affected persons need to be aware of these compensation standards. In principle, the contents of the individual compensation to be agreed must be explained to the project affected persons in writing, and the project-affected persons can confirm the contents at any time.
- Appropriate participation of the project affected people, and their communities must be promoted in the planning, implementation, and monitoring of measures addressing involuntary resettlement and loss of livelihood.
- For projects that result in large-scale involuntary resettlement, a RAP must be prepared and made available to the public prior to the resettlement and provision of compensation and support. In preparing the RAP, consultations must be held with the project affected people and communities, based on adequate information provided to them in advance. During consultations, explanations must be provided in languages and forms that are understandable to the project-affected people. It is desirable that the RAP includes elements outlined in the Environmental and Social Standard (ESS) 5 of the World Bank's environmental and social policies.
- Migration of population including involuntary resettlement, local economy, such as employment and livelihood; utilization of land and local resources; social institutions such as social capital and local decision-making institutions; existing social infrastructures and services, vulnerable social groups, such as poor people and indigenous peoples; equality of benefits and losses and equality in the development process; gender; children's rights; cultural heritage; local conflicts of interest, infectious diseases such as Human Immunodeficiency Virus (HIV)/ Acquired Immune Deficiency Syndrome (AIDS); and working conditions including occupational safety.
- A mechanism for handling concerns and grievances from people and communities affected by the project's environmental and social impacts must be in place.
- The grievance redress mechanism needs to be easily accessible for the project-affected people and communities.
- Project proponents should make efforts to respond promptly to the grievances they receive.
- Appropriate considerations must be given to vulnerable social groups, such as women, children, elderly people, people in poverty, indigenous peoples, persons with disabilities, refugees, internally displaced persons, and minorities.

4.2.4 Gap Analysis between Bangladesh Regulations and JICA Guidelines

The land acquisition law of Bangladesh, the Acquisition and Requisition of Immovable Property Act (ARIPA), 2017, is applied for the acquisition and requisition of properties required for development activities in Bangladesh. However, the Bangladesh law does not specifically mention a resettlement plan. There are certain gaps between the land acquisition law of Bangladesh and the JICA Guidelines for Environmental and Social Considerations (2022). Below presents the comparative analysis between the GOB laws (ARIPA, 2017) related to land acquisition, compensation, and involuntary resettlement and JICA's requirements as prescribed in the JICA Guidelines for Environmental and Social Considerations 2022. Table 4.2.2 provides the detailed comparison.

Table 4.2.2 Comparison between the Government of Bangladesh and JICA Guidelines for Environment and Social Consideration - Land Acquisition and Resettlement

Sl.	JICA Environmental Guidelines	GOB's Laws (ARIPA, 2017)	Gaps Between ARIPA, 2017, and JICA's Guidelines	Proposed Gap Filling Measures
1	Involuntary resettlement should be avoided wherever possible.	Not specified.	The JICA Environmental Guidelines require avoiding or minimising resettlement or loss of livelihood.	Like other donor-funded projects in Bangladesh, the approach of avoiding involuntary resettlement has already been taken into account during the preparation of this project. This will be further practiced during the design and implementation stage.
2.	When population displacement is unavoidable, effective measures to minimize impact and compensate for losses should be taken.	Not specified for non-titled people.	JICA Environmental Guidelines acknowledge all affected persons whether legally residing or not, as eligible for compensation.	Compensations shall be proposed even if non-titled affected people, including: - Compensation for structures, trees - Structure transfer assistance - Structure reconstruction assistance - Moving assistance for residential house owner - Tenant moving allowance
3.	People who must be settled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities, and production levels to pre-project levels	Not specific about maintaining the living standard of affected people same or above pre-project levels.	JICA Environmental Guidelines require that no one is worse off as a result of resettlement and that their living level is maintained at least at original levels.	Additional assistance can be proposed in the form of: - Grant for business loss - Compensation for loss of plant and fish stock - Grant for loss of wage employment - Rental fee loss for displaced rented house owner - One-time moving assistance for tenant business owners - Introduction of micro-credit - Provision of job training - Provision of priority employment, etc.

Sl.	JICA Environmental Guidelines	GOB's Laws (ARIPA, 2017)	Gaps Between ARIPA, 2017, and JICA's Guidelines	Proposed Gap Filling Measures
4.	Compensation must be based on the full replacement cost as much as possible.	Compensation is made based on pre-determined government prices, which may be cheaper than the market prices.	JICA Guidelines demonstrate that compensation must be based on full replacement cost, whereas according to ARIPA, compensation is made based on the pre-determined government prices, which may be lower than replacement cost.	The resettlement plan shall address all these issues and spell out a mechanism to determine the replacement cost through an independent evaluator (committee), who will be responsible for deciding the replacement costs.
5.	Compensation and other kinds of assistance must be provided prior to displacement.	Payment is made at a predetermined time, regardless of whether it is before or after the construction starts.	JICA Environmental Guidelines require payment prior to relocation, whereas ARIPA payment is made after completion of all legal steps.	The resettlement plan shall address all these issues and spell out a mechanism for all compensation to be paid prior to possession of the acquired land or prior to displacement.
6.	For projects that entail large-scale involuntary resettlement, RAPs must be prepared and made available to the public	There is no provision for the formulation of RAP or public hearings. The Deputy Commissioner contacts the landowner through the land Acquisition Officer (LO), and if the landowner has no objection, confirmation of the compensation amount, and others, will proceed.	JICA Guidelines require RAP preparation, whereas GOB law does not specify such provision.	The RAP needs to be prepared for all features of resettlement requirements and the mechanism of disclosure to the public is an integral part of the RAP. This will be further practiced during the design and implementation stages.
7.	In preparing a RAP, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	The 2017 Act has provisions to notify only the owners of the property to be acquired.	JICA Guidelines mandate consultation with the affected people and their communities, whereas ARIPA only requires notification of the owner as per records.	The RAP/resettlement plan for the project will be prepared following a consultation process that involves all stakeholders (affected persons, government department/line agencies, local community, NGO, and other stakeholders). The consultation will be a continuous process at all stages of the project development, including project formulation, feasibility study, design, implementation, and post-implementation, including the monitoring phase.
8.	When consultation is held, an explanation must be given in a form, manner, and language that is understandable to the affected people.	There are no provisions.	JICA guidelines demonstrated that an explanation must be given in an easily understandable manner, whereas GOB law has no such provision .	The resettlement plan for the project will be prepared following a consultation process with all stakeholders in the local language and by following a participatory process, with questions and explanations on the components of the RAP through the participation of all the stakeholders representing different groups, and the consultation will be a continuous process at all stages of the project development such as project formulation, feasibility study, design,

Sl.	JICA Environmental Guidelines	GOB's Laws (ARIPA, 2017)	Gaps Between ARIPA, 2017, and JICA's Guidelines	Proposed Gap Filling Measures
				implementation, and post-implementation, including the monitoring phase.
9.	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans.	There is no provision for monitoring related activities with the participation of affected persons.	JICA Environmental Guidelines recommend the participation of affected persons in the planning, implementation, and monitoring of RAP, whereas no such provision in the GOB law.	The resettlement plan for the project will be prepared following a consultation process with all stakeholders, and the consultation will be a continuous process at all stages of project development, such as project formulation, feasibility studies, design, implementation, and post-implementation, including the monitoring phase.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	PAPs have the right to object to the compensation amount. A PAP may lodge an appeal to the Arbitrator.	The laws of Bangladesh states appeal to Arbitrators and court cases, whereas JICA Environmental Guidelines recommend establishing appropriate grievance redress mechanism.	The RAP shall be prepared with a provision for the establishment of a grievance redress mechanism accessible to all the affected people, including non-titled affected people.
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including a population census that serves as an eligibility cut-off date, an asset inventory, and a socio-economic survey), preferably at the project identification stage, to prevent a subsequent influx of unauthorised occupants or others who may seek to take advantage of such benefits.	No such activity required.	There is no provision in the Bangladesh Acts, whereas JICA Environmental Guidelines recommend the identifying affected persons at the latest possible stage, preferably during the project identification stage.	This RAP needs to be prepared based on the data collected through the conduct of a census, and socio-economic survey for the displaced persons, and the preparation of an inventory of losses. Video recording has also been undertaken for the affected properties.
12.	Eligibility of benefits includes the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), PAPs who do not have formal legal rights to land at the time of census but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying.	There is no provision.	There is no provision in Bangladesh Acts, whereas JICA Environmental Guidelines recommend eligibility for benefits for PAPs who have formal legal rights to land, and for PAPs who do not have formal legal rights to land at the time of census but have a claim to such land, as well as for PAPs who have no recognizable legal rights to the land they are occupying.	The RAP shall ensure compensation and assistance to all affected persons, whether physically displaced or economically displaced, irrespective of their legal status. The completion of the census survey will be considered as the cutoff date, and affected persons listed before the cutoff date will be eligible for assistance.
13.	Preference should be accorded to land-based resettlement strategies	There is no provision.	There is no provision in Bangladesh Acts, whereas JICA guidelines have recommend	Although this option may be a difficult proposition given the lack of government land and the difficulties associated with the

Sl.	JICA Environmental Guidelines	GOB's Laws (ARIPA, 2017)	Gaps Between ARIPA, 2017, and JICA's Guidelines	Proposed Gap Filling Measures
	for displaced persons whose livelihoods depend on land.		prioritising land-based resettlement strategies for displaced persons.	acquisition of private lands, the RAP proposes land-for-land compensation as its priority, where feasible. Attempts will be made to find alternative land to compensate for the loss of land, where available and if it is feasible, taking into account the concurrence of the host community and land value.
14.	Provide support for the transition period (between displacement and livelihood restoration)	There is no provision for support during the transition period.	There is no provision in the Bangladesh Acts, while JICA Environmental Guidelines require the provision of support for the transition period.	The following shall be provided in the RAP: - Moving assistance for residential house owners - Moving assistance for tenants.
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, the landless, elderly, women, children, ethnic minorities, and other disadvantaged groups.	There is no provision for either acknowledgment of or compensation for vulnerable groups.	There is no provision in the Bangladesh Acts, while JICA Environmental Guidelines require special attention to vulnerable people and groups.	Vulnerable allowances shall be proposed for poor, old, disabled, and female-headed households such as Special Assistance for Vulnerable households
16.	For a project that entails land acquisition or involuntary resettlement of more than 200 people, a RAP is to be prepared	There is no provision.	There is no provision in the Bangladesh Acts, while JICA Environmental Guidelines require the preparation of a resettlement action plan (RAP) study if there is any land acquisition or involuntary resettlement of more than 200 people.	A RAP needs to be prepared if the number of displaced people is estimated to exceed 200.

Source: JICA Survey Team

CHAPTER 5 PRELIMINARY PROJECT DESIGN

5.1 Flood Control Facilities

5.1.1 Project Candidate Sites (Haors)

This section discusses the method of selecting haors for the project implementation and the results thereof.

(1) Haors to be Considered for the Selection

On August 6, 2023, the Bangladesh Water Development Board (BWDB) and the Local Government Engineering Department (LGED) held a joint meeting and selected 26 haors as candidates for the project implementation (the GoB List). The executing agencies indicated that the selection was based on criteria such as vulnerability, length of submersible embankment, the number of beneficiaries, and Boro rice harvest yield, among others. Including these 26 haors, a total of 44 haors, as described below, were considered for selection using the methodology described in this section.

i. 26 haors from the GoB List.

ii. 17 haors considered in the Japan International Cooperation Agency (JICA) Data Collection Survey of Phase 1 (Data Collection Survey on Water Resources Management in Haor of Bangladesh, Final Report, JICA, December 2023) that have not yet been implemented. In Phase 1, projects proposed in the "Master Plan of Haor Area, April 2012" were prioritized mainly based on their economic efficiency, and the haors selected for implementation were ultimately determined based on total project cost ("Preparatory Survey on Upper Meghna River Basin Watershed Management Improvement Project in the People’s Republic of Bangladesh", Final Report, JICA, February 2014).

iii. One additional haor requested by BWDB (Khaliajhuri-1 Haor). This haor was suggested by BWDB as an alternative during discussions regarding environmental impacts in the haor selection process, as described later. Although it is not included in the GoB list, it was proposed during this study’s haor selection as one that is particularly in need of project implementation due to its vulnerability.

iv. Total: 44 haors (26 + 17 + 1).

(2) Parameters Considered for the Selection of Haors

The parameters listed below and summarized in Table 5.1.1 were collected from BWDB, LGED, and statistical sources, and organized and calculated as necessary, and used in the haor selection process for project implementation.

1. Haor Basic Information:

- Gross Area of Haor (ha),
- Cultivable Land (ha),
- Perimeter of Haor (km),
- Length of Submersible Embankment (km),
- Length of Full Embankment (km),
- Population,
- Number of Household,
- Average Monthly Income per Household (BDT/HH/Month),
- Poverty Ratio (%),
- Rice Harvest Yield (ton),
- Rice Harvest Yield per Area (ton/ha/yr),
- Catch Rate (Fishery: Capture & Culture) (kg/yr),
- Catch Rate per Water Surface Area (Fishery: Capure & Culture) (kg/ha/yr).

2. Annual Damage without Flash Flood:

- Average Annual Damage Length of Embankment in the Last Several Years (2018–2024) (km),
- Average Annual Cost to Repair Flood Management Facilities in the Last Several Years (2018–2024) (BDT in lakh),
- Damage Length of Rural Infrastructure (Road) in the Last Several Years (2020–2024), (km),
- Repair Cost of Rural Infrastructure (Road) in the Last Several Years (2020–2024) (BDT in M).

3. Damage due to Flash Flood in 2017:

- Damaged (inundated) Land (ha),
- Damaged Crop (ton),
- Cost of Damaged Crop (BDT in M),
- Reduction of Fishery Catch Volume (kg),
- Cost of Damage to Fishery (BDT in M).

Table 5.1.1 List of Socioeconomic Parameters for Selections of Haors

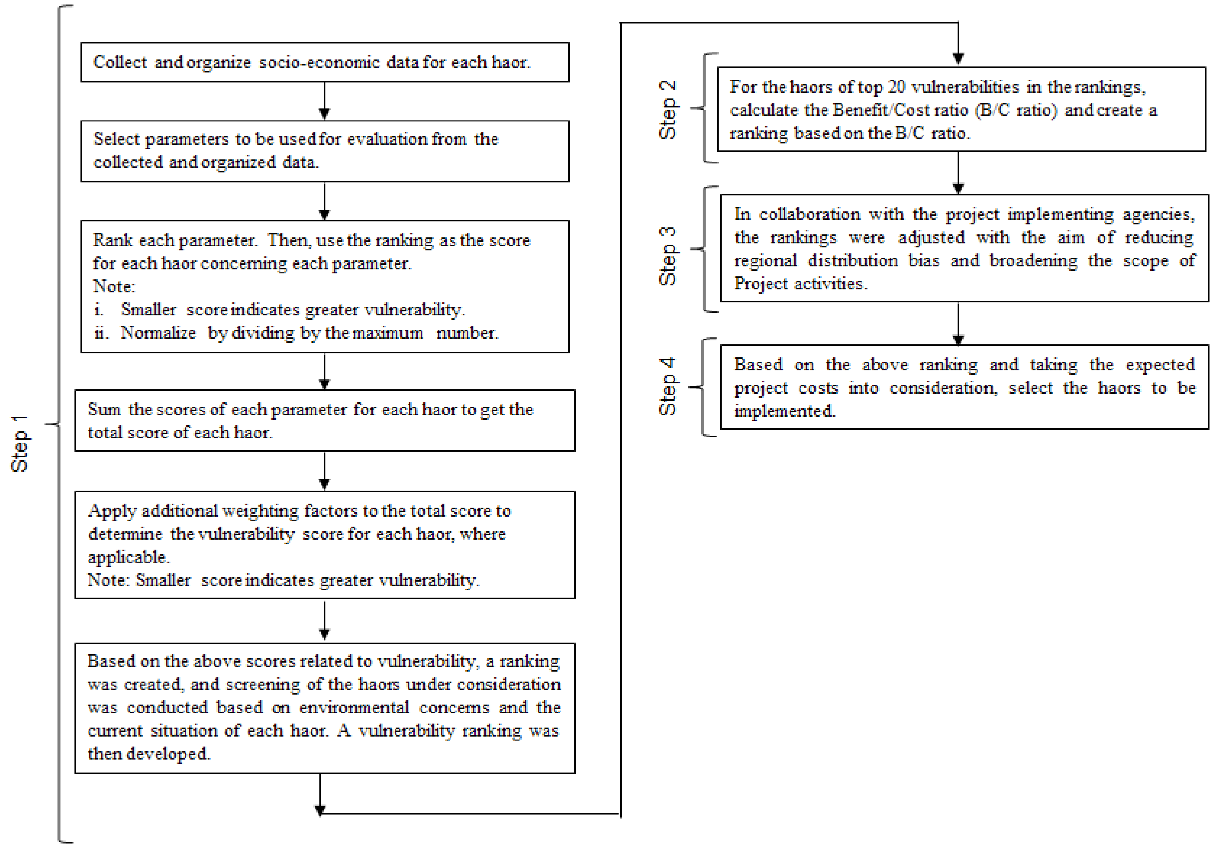
No	Parameters		Parameter Available	Used for Selection (Physical Damage)	Used for Selection (Financial Damage)
1	Haor Basic Information	Gross Area of Haor, (ha)	O		
		Cultivable Land, (ha)	O	O	O
		Perimeter of Haor, (km)	O		
		Length of Submersible Embankment, (km)	O	O	O
		Length of Full Embankment, (km)	O		
		Population	O	O	O
		Number of Household	O		
		Average Monthly Income per Household, (BDT/HH/Month)	O		
		Poverty Ratio (%)	O		
		Rice Harvest Yield, (ton)	O	O	O
		Rice Harvest Yield per Area, (ton/ha/yr)	O		
		Catch Rate (Fishery: Capture & Culture), (kg/yr)	O	O	O
		Catch Rate per Water Surface Area (Fishery: Capure&Culture), (kg/ha/yr)	O		
2	Annual Damage without Flash Flood	Average Annual Damage Length of Embankment in Last Several Years (2018-2024), (km)	O	O	
		Average Annual Cost to Repair Flood Management Facilities in Last Several Years (2018-2024), (Lac BDT)	O		O
		Damage Length of Rural Infrastructure (Road) in Last Several Years (2020-2024), (km)	O	O	
		Repair Cost of Rural Infrastructure (Road) Last Several Years (2020-2024), (M BDT)	O		O
3	Damage due to Flash Flood in 2017	Damaged (inundated) Land, (ha)	O	O	
		Damaged Crop, (ton)	O		
		Cost of Damaged Crop (M BDT)	O		O
		Reduction of Fishery Catch Volume, (kg)	O		
		Cost of Damage to Fishery, (M BDT)	O		O

Source: JICA Survey Team

(3) Selection Process and Methodology

(a) Selection Procedure

The selection of haors for project implementation was carried out by considering the vulnerability of each candidate haor, evaluating and ranking their economic viability, taking into account environmental concerns, and reviewing the current conditions of each haor and project components, with reference to the planned project costs. This selection procedure is summarized in Figure 5.1.1.



Source: JICA Survey Team

Figure 5.1.1 Selection Process of Haor for Project Implementation

First, in Step 1, a vulnerability-based ranking was established, and haors with higher vulnerability were prioritized for project implementation. As the ranking is scored-based, a lower score indicates greater vulnerability and, consequently, a higher necessity for project implementation. The focus on vulnerability as a key policy consideration is based on the following reasons:

1. **Hope of the implementing agency to strengthen the resilience of haors that are currently more vulnerable.**
   When looking at the agency's previous efforts and coordination with relevant government organizations, it is clear that the implementing agency considers it more necessary to apply new technologies introduced in Phase 1—such as slope protection for submersible embankments—to haors that are currently highly vulnerable and therefore more likely to suffer severe damage. In contrast, further reinforcement of haors with relatively low vulnerability and already high resilience is considered less urgent. By enhancing the resilience of the more vulnerable haors, especially against flash floods whose impacts are expected to intensify under future climate change conditions, the Project can have a greater positive effect.
   For example, as indicated in Section 5.3.1(3) of this report, reductions in harvest yields due to the 2017 flash flood were particularly significant in the haor areas of Sunamgonj District. The GoB List also includes a relatively high number of haors in Sunamganj District, reflecting their higher vulnerability compared with other districts.

2. **Promotion of autonomous development of haor areas by the Government of Bangladesh after the Project**
   One of the key objectives of this Project is to enable the GoB to continue the development of haor regions independently after project completion. This includes consolidating the knowledge and experience gained in Phase 1—such as essential technologies and implementation systems—and supplementing or building upon them as necessary. Haors with higher vulnerability are more likely to suffer significant damage to flood control infrastructure, such as embankment breaches, making them technically more challenging to address. Moreover, these highly vulnerable haors have greater potential for improving resilience against climate change. By selecting such haors for implementation under this Project, the continuation of autonomous development efforts by the GoB beyond the project period is expected to be further promoted.
   It should also be noted that, based on internal discussions to date, haors that are considered unsuitable for project implementation from an environmental perspective—such as those inhabited by rare animals—will be discussed separately with the implementing agency, regardless of their vulnerability rating. Additional countermeasures required for implementation will also be considered as needed.

(b) Cases Considered

The vulnerability of each haor was evaluated following the process described in Figure 5.1.1 under the three cases described below. Differences among the results of the three cases were examined, and the vulnerability of the haors was ultimately evaluated based on the most suitable case, as explained herein.

Case 1: Assessment focusing on physical damage. Parameters marked "◯” in the pink column of Table 5.1.1 were considered. All parameters were assigned equal weight (Weight = 1).

Case 2: Assessment focusing on financial damage. Parameters marked " ◯" in the blue column of Table 5.1.1 were considered. All parameters were assigned equal weight (Weight = 1).

Case 3: Assessment with the same conditions of Case 2. However, for the 26 haors included in the GoB List, the following weighting factor was applied:

Weight = 1 / (Number of haors considered this time / Number of haors on the GoB List) = Number of haors on the GoB List / Number of haors studied this time
= 26 / 44 = 0.590

The parameters used to assess vulnerability, as outlined in the examination case above and summarized in Table 5.1.1 as socio-economic indicators, are as follows:

1. Haor Basic Information

- Cultivable Land,
- Length of Submersible Embankments,
- Population,
- Rice Harvest Yield,
- Catch Rate (Fishery: Capture & Culture).

2. Annual Damage in an Ordinary Year without Flash Flood

- Physical damage to flood control facilities and rural infrastructure, as well as repair costs, during ordinary years without flash floods.

3. Damages from Flash Floods

- Area inundated by flash floods in 2017, along with the estimated value of crop and fishery losses.

The parameters under Item 1 represent the socio-economic scale of each haor and reflect underlying factors contributing to vulnerability. The parameters under Items 2 and 3 represent actual damages conditions and therefore serve as direct indicators of vulnerability. These parameters were collectively used to assess the vulnerability of each haor.

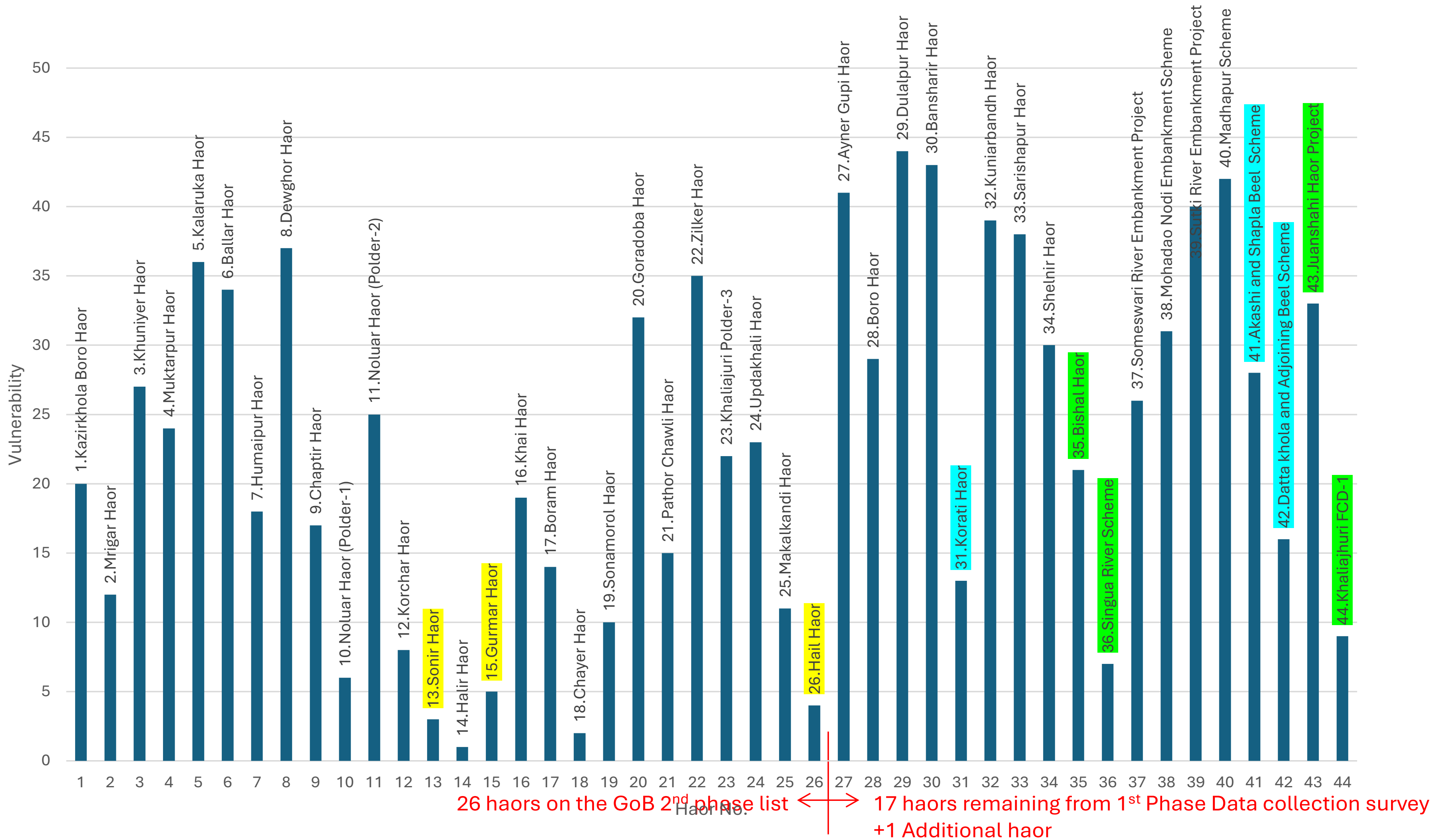
In addition, by applying a weight of 0.59 to the 26 haors included in the GoB List, their vulnerability is assessed as relatively higher. This calculation is considered appropriate for the following reasons.

Interviews with engineers at local BWDB offices indicated that the selection of the 26 haors by the GoB considered factors not fully captured by the socio-economic indicators collected in this study, such as local topography and actual operational conditions of the haors. Some examples learned through these interviews include:

- For haors located at relatively higher elevations, the lead time—from when a rise in river water level is predicted to when the water actually rises and inundation begins within the haor—is longer than for other haors.
- Haors situated farther from major rivers, with other haors located between them and the river, benefit from longer lead times due to distance from the river, as well as the water retention effect of nearby haors.
- Decisions on annual repair priorities are made collaboratively between the local BWDB office and local government based on urgency and the extent of vulnerability, such as the scale of damage incurred. The GoB List is therefore considered to more rightly reflect the current local circumstances.

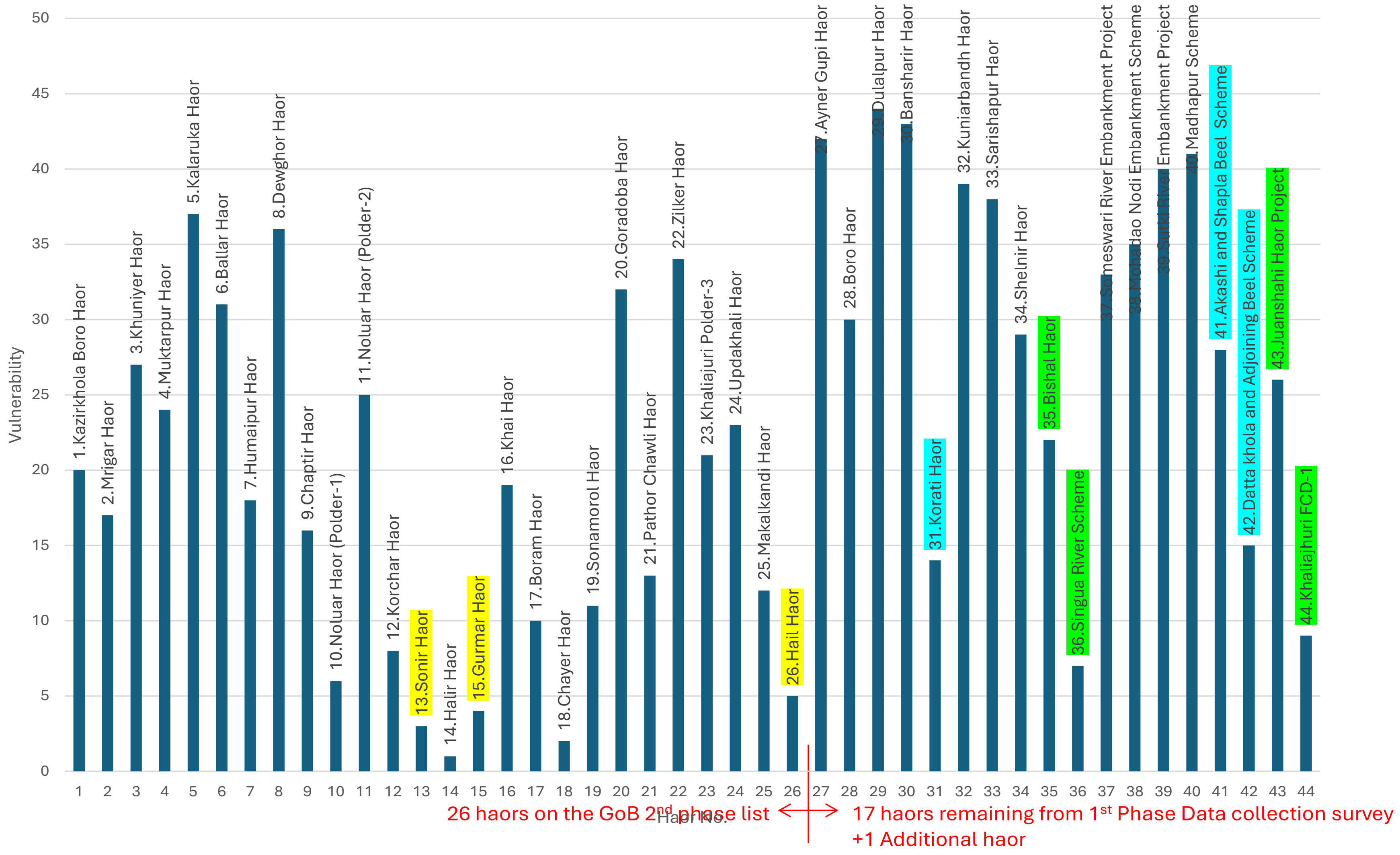
(4) Outcomes of Step 1

Based on the above policy and methodology, the vulnerability ranking of each haor was evaluated, as shown in Figure 5.1.2 for Case 1, Figure 5.1.3 for Case 2, and Figure 5.1.4 for Case 3. The vulnerability rankings developed in Step 1 and shown in these figures reflect the comments from BWDB. In these figures, haors with a higher ranking (represented by shorter bars in the graph) are evaluated as having higher vulnerability and are thus considered to have a greater necessity for project implementation.



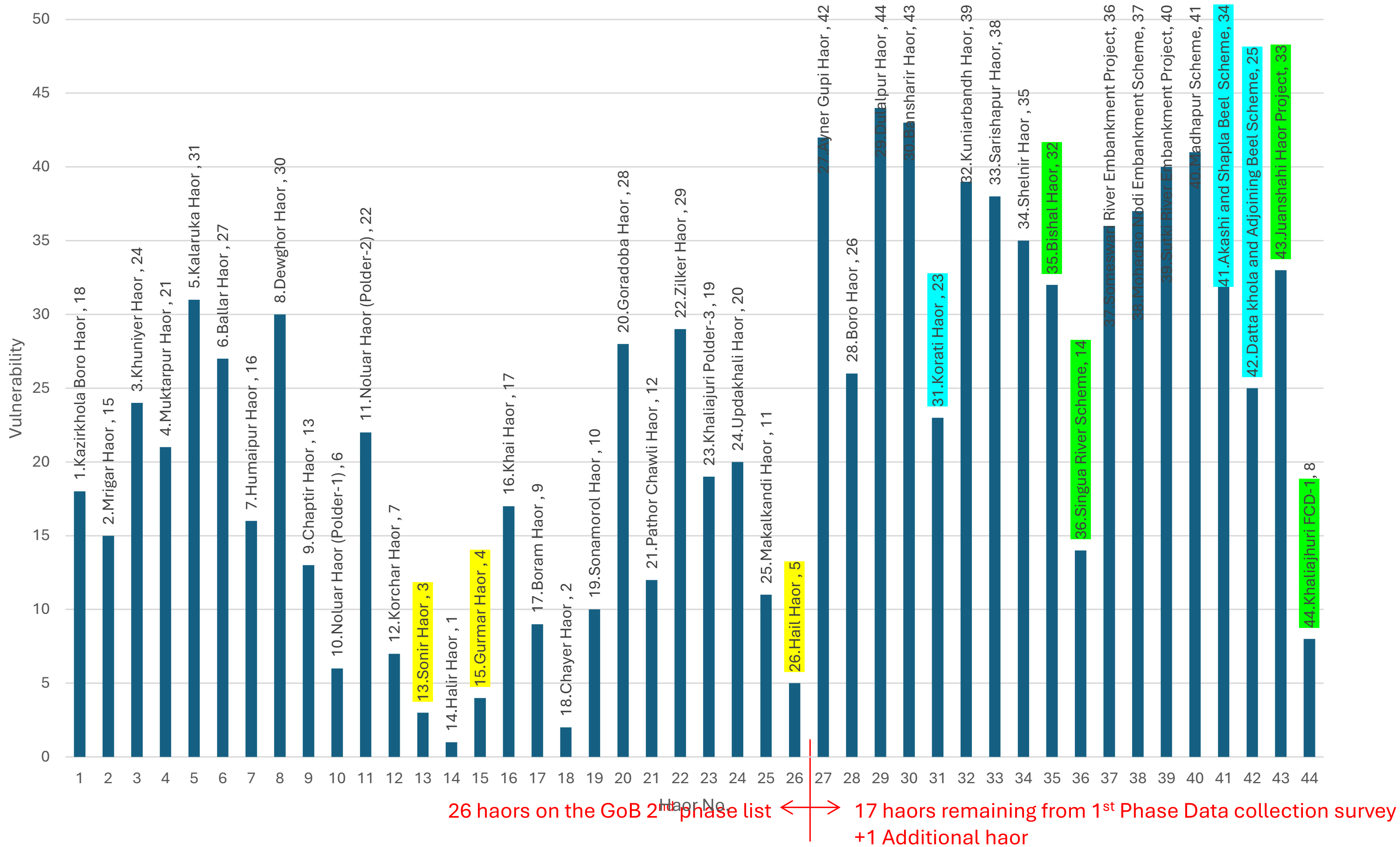
Source: JICA Survey Team

Figure 5.1.2 Haor Vulnerability Ranking (Case 1)



Source: JICA Survey Team

Figure 5.1.3 Haor Vulnerability Ranking (Case 2)



Source: JICA Survey Team

Figure 5.1.4 Haor Vulnerability Ranking (Case 3)

The key findings from these evaluations are as follows:

1. In all three cases (Cases 1, 2, and 3), the 26 haors listed in the GoB List generally show higher vulnerability compared to the other haors. From a socio-economic perspective, the selection of haors on the GoB List can be considered relatively reasonable.

2. This trend is especially evident in Case 3, where greater weighting is given to the haors on the GoB List.

3. Based on the evaluation results, among the 43 haors examined, the survey team believes that all but three haors with environmental concerns from the GoB List can be endorsed.

4. The three haors marked in blue in the figures were confirmed by the local BWDB offices as having lower priority or no immediate need for implementation. Specifically, Korati haor (No. 31) is considered to have low vulnerability because of its relatively high elevation, while Nos. 41 (Akashi and Shapla Beel Scheme) and 42 (Datta Khola and Adjoining Beel Scheme) require only re-excavation of khals, according to the latest BWDB study.

5. The haors adjacent to Hail Haor and Tangurar Haor, which are greatly affected by environmental factors, as described in section 4.1.8 (namely Gurmar Haor and Sonir Haor), are shown in yellow in Figure 5.1.2, Figure 5.1.3, and Figure 5.1.4. These haors were found to be relatively highly vulnerable.

6. As alternatives to the three haors excluded, Nos. 35 (Bishal Haor), 36 (Singua River Scheme), and 43 (Juanshahi Haor Project) were proposed to the implementing agencies from outside the GoB List due to their high vulnerability.

Based on the above findings, the following outcomes were agreed upon during discussions with the implementing agencies:

7. The implementing agencies agreed to remove Hail Haor from the 26 haors on the GoB List due to environmental concerns

8. As replacements for Hail Haor, four haors not included in the GoB List—namely Nos. 35 (Bishal Haor), 36 (Singua River Scheme), 28 (Boro Haor), and 44 (Khaliahjuri-1)—were requested for project implementation.

The JICA survey team considers it reasonable to accept the results of these discussions with the implementing agency, as it has been confirmed that the four additional haors requested by the agency are relatively vulnerable.

Taking into account the vulnerability evaluation results of each haor, discussions with the implementing agencies, and the specification in this preparatory survey that approximately 30 haors are to be selected, a total of 29 haors were finalized and are listed in Table 5.1.2 according to their ranking.

Table 5.1.2 Candidate Haors Ranking

Ranking	Haor ID. Haor Name	Included in the GoB 2nd Phase List ?	New/Rehab ?
1	14.Halir Haor	Yes	Rehab
2	18.Chayer Haor	Yes	Rehab
3	13.Sonir Haor	Yes	Rehab
4	15.Gurmar Haor	Yes	Rehab
5	10.Noluar Haor (Polder-1)	Yes	Rehab
6	12.Korchar Haor	Yes	Rehab
7	17.Boram Haor	Yes	Rehab
8	44.Khaliajhuri FCD-1	No	Rehab
9	21.Pathor Chawli Haor	Yes	Rehab
10	25.Makalkandi Haor	Yes	Rehab
11	19.Sonamorol Haor	Yes	Rehab
12	9.Chaptir Haor	Yes	Rehab
13	2.Mrigar Haor	Yes	New
14	36.Singua River Scheme	No	Rehab
15	7.Humaipur Haor	Yes	Rehab
16	16.Khai Haor	Yes	Rehab
17	1.Kazirkhola Boro Haor	Yes	New
18	23.Khaliajuri Polder-3	Yes	Rehab
19	24.Updakhali Haor	Yes	Rehab
20	4.Muktarpur Haor	Yes	New
21	11.Noluar Haor (Polder-2)	Yes	Rehab
22	3.Khuniyer Haor	Yes	New
23	28.Boro Haor	No	New
24	6.Ballar Haor	Yes	New
25	20.Goradoba Haor	Yes	Rehab
26	22.Zilker Haor	Yes	Rehab
27	8.Dewghor Haor	Yes	Rehab
28	5.Kalaruka Haor	Yes	New
29	35.Bishal Haor	No	New

Source: JICA Survey Team

(5) Outcomes of Step 2

The top 20 haors listed in Table 5.1.2 were ranked based on their benefit-cost ratio (B/C) ratios using the methodology described below.

Benefit = Expected annual reduction in losses from damaged Boro rice = unit price of Boro rice × rice yield × damaged area × average annual damage rate

Cost = Construction cost of flood control facilities (estimated in this survey; it is noted that the cost used for calculating B/C ratio was preliminary without considering the outcomes of the topographic survey carried out by this survey)

For the benefit calculation, it was assumed that the unit price of Boro rice and the rice yield are uniform across the entire Haor region. It was also assumed that the damaged area is proportional to the cultivable area of each haor. Based on these assumptions, a benefit-cost ratio indicator was calculated using the following formula and applied to rank the haors:

Benefit-cost ratio indicator = (Cultivable area of each haor × Average annual damage rate) / Construction cost of flood control facilities

The average annual damage rate was set at 15%, as determined by a BWDB survey, and this value was used in the calculation.

Please note that the benefit-cost ratio indicator defined here is intended specifically for selecting target haors for the project and is defined differently from the benefit discussed in Chapter 9, which analyzes the economic efficiency of the overall Project.

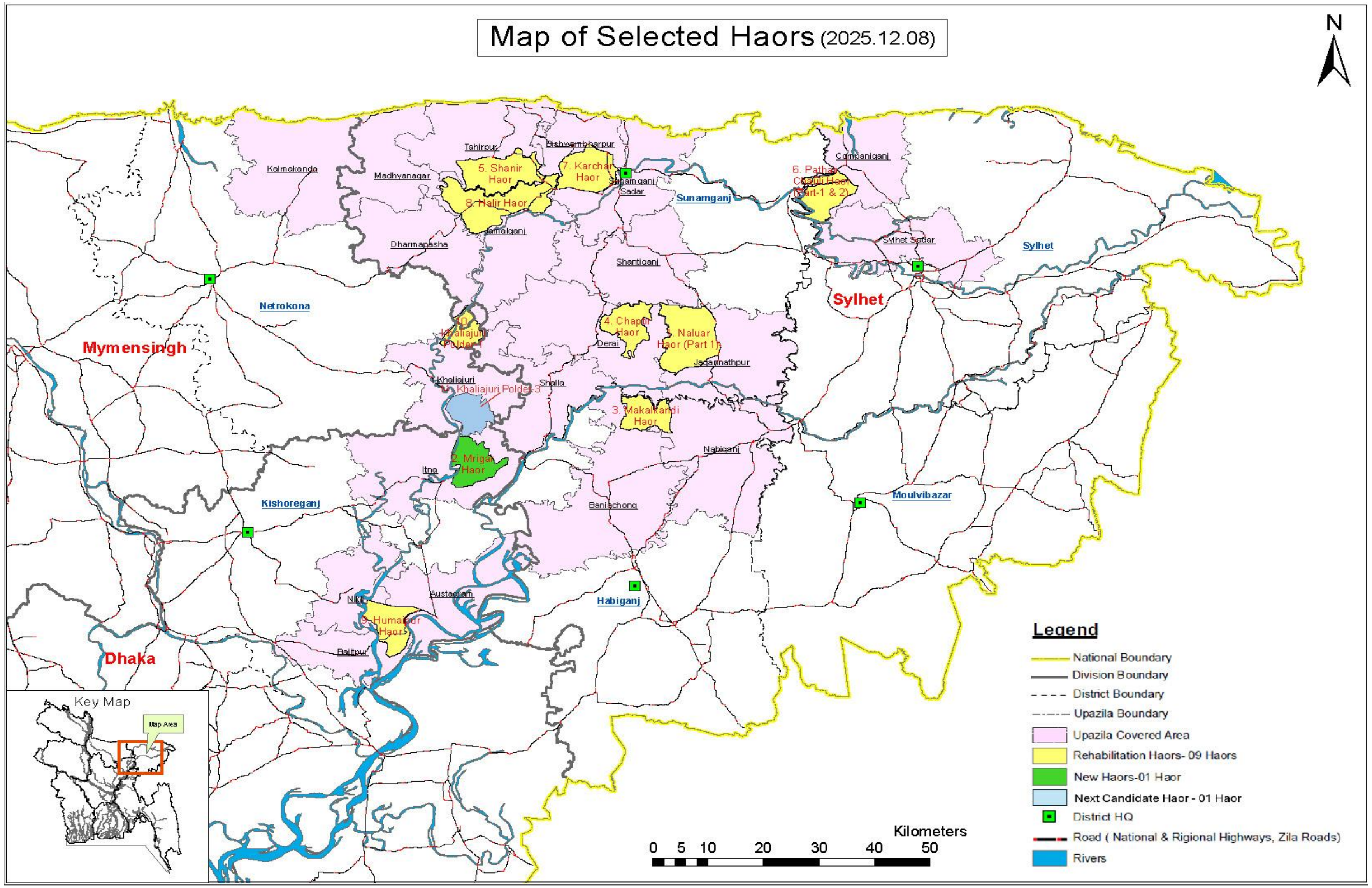
(6) Outcomes of Step 3 and Step 4

Regarding the ranking of benefit-cost ratios obtained in Step 2, a series of discussion among BWDB and LGED's representatives and the JICA Survey Team were held. It was eventually agreed among the parties that 10 haors to be implemented, as compiled in the table below.

Table 5.1.3 List of the Haors to be Implemented for the Project (agreed among execution agencies on December 8, 2025)

	No.	Name of Subproject	Division Name	New Haor/ Rehab Haor
10 Haors selected for the Project	1	Naluar Haor-1	Sunamganj	Rehab
	2	Mrigar Haor	Kishorganj	New
	3	Makalkandi Haor	Habiganj	Rehab
	4	Chaptir Haor	Sunamganj	Rehab
	5	Shanir Haor	Sunamganj	Rehab
	6	Pathar Chawli Haor	Sylhet	Rehab
	7	Karchar Haor	Sunamganj	Rehab
	8	Halir Haor	Sunamganj	Rehab
	9	Humaipur Haor	Kishorganj	Rehab
	10	Khaliajuri FCD-1	Netrokona	Rehab
Next Candidate	11	Khaliajuri FCD-3	Netrokona	Rehab

Source: JICA Survey Team



Source: JICA Survey Team

Figure 5.1.5 Map of Haors Selected for Project Implementation

5.1.2 Basic Layout Plan of Flood Control Facilities

(1) Climate Risk Assessment and Consideration of Adaptation

(a) Method of Climate Risk Assessment

The climate risk of the Project was assessed with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024). Climate risk refers to the potential occurrence of adverse events resulting from climate hazards—such as high temperatures, low rainfall, heavy rainfall, storms, drought, floods, and sea level rise—that could prevent the Project from delivering its planned value at the planning stage and the functions and effects that were expected to be realized.

In this assessment, climate risk is considered to manifest in the following forms:

- ✓ Structural inability of the target facilities and assets to perform their intended functions (physical functional failure);
- ✓ Deterioration of the target facilities and assets due to excessive demand caused by climate change or operation under conditions exceeding original design assumptions, making it impossible to provide the services and functions that were intended in advance (deterioration in service level); and
- ✓ Increased maintenance and repair costs (deterioration in economic viability when used).

(b) Climate Hazards in Flood Control Facilities

Considering the climate hazards listed in "Table 42 Examples of Climate Hazards in Disaster Prevention (Weather- and Water-Related Disaster Countermeasures) Projects" on page 54 of "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation", it was deemed desirable to consider all nine hazards in Table 3.8.1.

(c) Climate Risk Matrix

The exposure of the Project to the above climate hazards is divided into three categories:

E1: Flood management structure,

E2: Institute and person for flood management, and

E3: Local people, properties and rice product.

For each exposure category, the current impact of each hazard is evaluated on a four-point scale from 0 to 3. Taking into account the future direction of changes in climate hazards, the hazards that should be watched in each project activity are circled in red in the climate risk matrix, as shown in Figure 5.1.6.

			Climate Hazard								
			H1 Flood	H2 Heavy Rainfall	H3 Cyclone	H4 Drought	H5 Wind	H6 High Temperature	H7 Cold Wave	H8 Sunshine	H9 Sea Level Rise
	Frequency		++	++	+	+	+	+	+	-	-
	Future		↗	↗	→	→	→	→	→	→	↗
Exposure	E1	Flood management structure	3	2	1	0	2	0	0	0	1
	E2	Institute and person for flood management	3	2	1	1	1	1	1	0	0
	E3	Local people, properties and rice product	3	2	1	1	1	1	1	1	1

Source: Prepared by the JICA Survey Team with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).

Figure 5.1.6 Climate Risk Matrix for the Project (Flood Control Facilities)

(d) Climate Risks Considered to be Significant in Future

For the combinations of "climate hazards" and "exposures" that should be monitored in the selected businesses, "vulnerabilities" that are considered to contribute to—or have already contributed to—the occurrence of "climate risks" likely to become significant in the future was examined. The results of this assessment are summarized in Table 5.1.4.

Table 5.1.4 Narrowing Down of Climate Risks That May Become Significant in Future for the Project (Flood Control Facilities)

(A)	(B)	(C)
Combination of "Climate Hazards" and "Exposures" to be Considered	**Vulnerabilities Assessment Contributing to Climate Risks (Susceptibility to and Capacity to Cope with Impacts)**	**Possible Major Future Climate Risks**
H1（Flood）+ E1（Flood Management Structure） Flash floods during the first half of the rainy season overtopped the submersible dike, causing it to breach.	As recent flood history shows, past events such as flash floods and their impacts have been too difficult to deal with and manage.	H1（Flood）+ E1（Flood management structure） As extreme phenomena, such as increased precipitation and changes in the timing of precipitation, are expected to become more severe and occur more frequently in the future, there is a possibility that the type of damage described on the left side will increase.
H1（Flood）+ E2（Institute and Person for Flood Management） Flash floods in the early rainy season overtop submersible embankments causing damage from breaches. This creates a burden in dealing with the damage.	There are limitations to flood-fighting measures for protecting embankments during flood events. Furthermore, if the water-passing capacity of flood management structures is insufficient to accommodate the difference in water levels between the areas inside and outside the embankments, the risk of embankment overtopping and subsequent breaching increases.	H1（Flood）+ E2（Institute and person for flood management） As extreme phenomena—such as increased rainfall and changes in the timing of rainfall—are expected to become more severe and occur more frequently in the future, there is a possibility that cases, such as those described on the left, will become more difficult to deal with.
H1（Flood）+ E3（Local People, Properties, and Rice Product） Flash floods in the early rainy season overtopped the submersible embankments, causing them to breach, allowing outside water to flow into the land inside the embankment and causing damage to unharvested Boro rice.	There are limitations to the accuracy of weather and flood forecasts of flash floods and the time available to respond. There may also be a lack of capacity to obtain and understand this information.	H1（Flood）+ E3（Local People, Properties and Rice Product） As extreme phenomena—such as increased rainfall and changes in the timing of rainfall—are expected to become more severe and occur more frequently in the future, there is a possibility that the type of damage, as described on left, will increase.

Source: Prepared by the JICA Survey Team with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).

(e) Consideration of Adaptation Measures

Table 5.1.5 shows possible adaptation measures to reduce the climate risks related to the flood control facilities selected above.

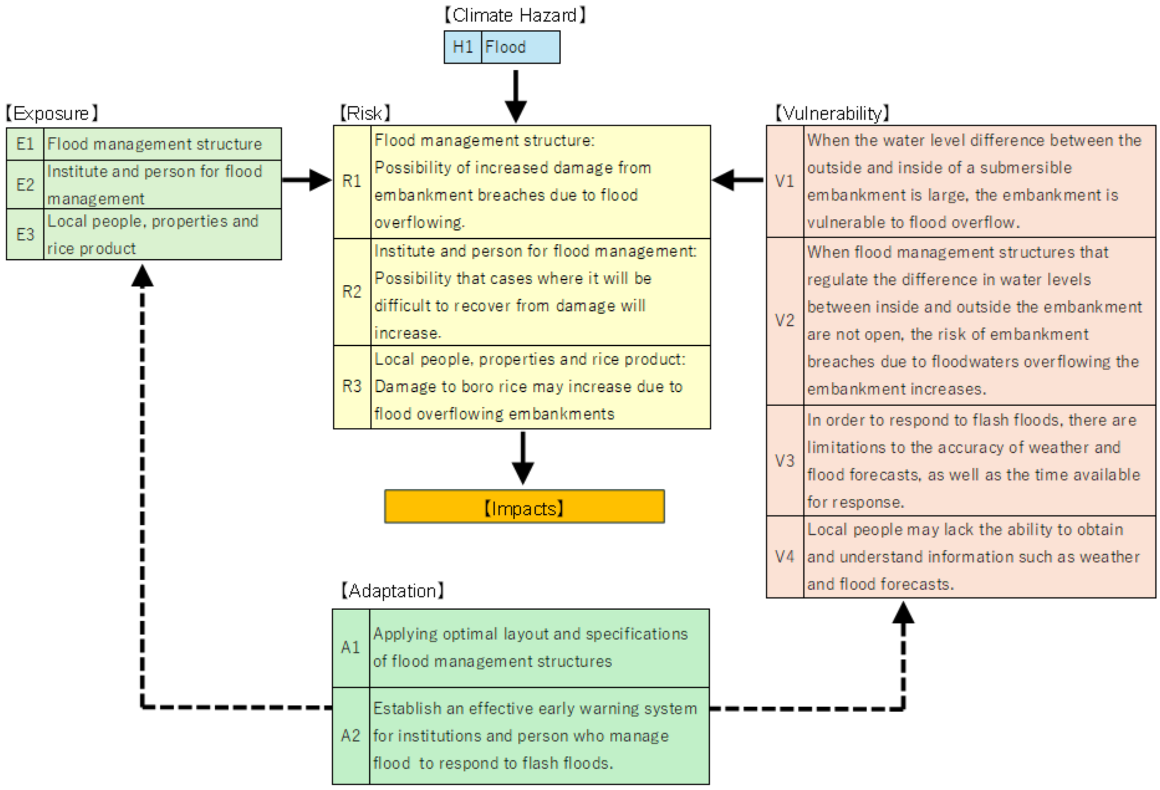
Table 5.1.5 Consideration of Adaptation Measures

Risk #	Impact Climate Risks (Ultimately Selected) that are Likely to be Significant in the Future	Adaptation Measures for Climate Risk	Corresponding SDG Item No.
1	As extreme phenomena—such as increased precipitation and changes in the timing of precipitation—are expected to become more severe and occur more frequently in the future, there is a possibility that the type of damage previously discussed will increase.	Adaptation Measure 1 Applying optimal flood protection facility layout and specifications.	9
2	As extreme phenomena—such as increased rainfall and changes in the timing of rainfall—are expected to become more severe and occur more frequently in the future, there is a possibility that cases previously discussed will become more difficult to deal with.	Adaptation Measure 1 Applying optimal flood protection facility layout and specifications.	9
		Adaptation Measure 2 Develop an effective early warning system for flood-related organizations and local people to respond to flash floods.	9, 11
3	As extreme phenomena—such as increased rainfall and changes in the timing of rainfall—are expected to become more severe and occur more frequently in the future, there is a possibility that the type of damage previously discussed will increase.	Adaptation Measure 1 Applying optimal flood protection facility layout and specifications.	9
		Adaptation Measure 2 Develop an effective early warning system for flood-related organizations and local people to respond to flash floods.	9, 11

Source: Prepared by the JICA Survey Team with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).

(f) Climate risk tree

The above climate risks were defined as significant future "risks", and the factors considered to contribute to their occurrence were defined as "vulnerabilities". Based on this classification, a climate risk tree was developed, as shown in Figure 5.1.7.



Source: Prepared by the JICA Survey Team with reference to "JICA Climate-FIT (Adaptation), Climate Finance Impact Tool for Adaptation" (March 2024).

Figure 5.1.7 Climate Risk Tree for the Project

(g) Estimated Beneficiary Population

Among the flood control measures, the JICA Survey Team conducted a union-based survey and estimated the population benefitting from "A1: Optimizing the layout and specifications of flood control facilities, such as slope protection, to enhance resilience against overflowing embankments" to be approximately 645,000 people across the ten target haors.

As for "A2: Establishing an effective early warning system for flood control organizations, personnel, and local residents to respond to flash floods", it is estimated that all farmers and their household members in the study area will benefit. According to the Bangladesh Bureau of Statistics (BBS) Census 2022, the populations of Sylhet Division and Mymensingh Division are approximately 11,035,000 and 12,225,000, respectively. The population of Kishoregonj District is approximately 3,268,000. The total population is 26,528,000. It is said that 35.3% of Bangladesh's workforce is engaged in agriculture[1], so the beneficiary population is estimated to be 26,528,000 x 35.3% ≈ 9,364,000 people.

(2) Improvement of Flood Inundation Analysis for Layout Plan of Flood Management Structures

This Project considers using approximately ten haors as project sites. During the detailed design stage of flood control facilities, flood inundation analysis will be conducted to predict potential overflow locations within these haors and to optimize the design of slope protection works for submersible embankments. Under this survey work, approaches to conducting such analyses effectively and efficiently were examined. There are three current issues with the model construction of the Additional Study: 1) the long time required for calculations, 2) the limited data available for verifying the constructed model, and 3) some of the topographical information is out of date.

5.1.3 Facility Design

[1]Source: World Bank (ILO estimation model estimates) statistics (2023) (https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?end=2023&locations=BD&start=2019&utm_source=chatgpt.com)

(1) Design Policy and Facility Design

The design for flood control facilities during the previous project (HFMLIP Phase 1) was reviewed in the Additional Study of HFMLIP Phase 1, as summarized in Table 5.1.6, in comparison with previous BWDB design practices. Including changes made during the implementation of the previous project, these revisions were generally positively received. For this Project, in consideration of the evaluation of climate risks and the study of adaptation measures, the basic approach will follow this previous design policy.

Table 5.1.6 Comparison Between Design of Previous Project and BWDB Design

No.	Design	BWDB Design	Previous Project	Difference	Effect	Remarks
1	Protection period for preventing flash flood	31st May	15th May	Protection period shifted earlier by 15 days.	Effective	Reduced risk of damage through earlier harvesting.
2	Embankment section(top width/side slopes (CS-RS)	2.4 m–3.6 m /2:1–3:1	4.3 m/3:1–3:1	People can use embankment as local road.	Effective	Positive impact.
3	Embankment Crest Level	Water Level of 1-in-10-year pre-monsoon flood + 0.3 m free board	Water Level of 1-in-10-year pre-monsoon flood + 0.3 m free board	None	N/A	BWDB standard design manual.
4	Compaction of soil of embankment	Compaction by hand hammer. No tests were done.	Mechanical compaction introduced up to 85% of MDD.	Compaction test of soil was introduced.	Partially effective, though damage due to wave/ current occurred at critical locations.	Partially effective.
5	Slope & top protection of embankment	Turfing on slope and top by grass sods.	Turfing on slope and top by grass sods. Some reaches were constructed with CC blocks on top over sand bedding for use as local roads.	Slope and top protection using hard materials (CC block, sand-cement bags, and geobags over geofabric filter) implemented at five damaged locations.	Damage occurred at some critical locations due to waves and currents.	Effective, but involves higher cost due to the use of protection with hard materials.
6	Gated regulators	Standard BWDB steel-gated regulator with standard vent size (1.5 m x 1.8 m)	Standard BWDB steel-gated regulator vent size (1.5 m x 1.8 m)	No change in operation procedure.	Operational difficulties remain as early as MS gates and hoists rusted early. Hinder local navigation at some locations.	Help with easy water retention in canal. Hinder local boat navigation.
7	Flood Fuse	No structure was designed	Designed as safety structures for embankment for emergency use of flushing/drain	Newly introduced at selected location for opening during necessity / help navigation and quick drainage	Effective.	Yearly filling with soil demands maintenance cost and timely closing.

No.	Design	BWDB Design	Previous Project	Difference	Effect	Remarks
			age and local navigation.	in post-monsoon.		
8	Drainage outlet	Used for pocket drainage.	Used for pocket drainage.	No adaptation done.	Effective.	Effective.
9	Irrigation inlet	Used for inletting irrigation water by LLP.	Used for inlet to irrigation water by LLP.	No adaptation.	Effective.	Effective.

Source: JICA Survey Team

Drawings of the typical designs are summarized in Appendix 5.1.3.

In addition, the conceptual design of the facilities was carried out with attention to the following points:

- The boundaries of each rehabilitation haor are determined by the location of existing embankments and other facilities. For haors where new projects are being implemented, the boundaries are primarily determined by the required setback distance from rivers, as stipulated in the BWDB Design Manual. Embankments are to be constructed along the boundaries of each haor.

- The crest elevation of embankments was determined based on hydraulic analysis considering a flood with a 10-year return period, in line with the policy stated in Table 5.1.6. The effects of climate change were also taken into account, and details regarding the consideration of climate change impacts are explained in Section 3.8.

- For flood control facilities, as part of the initial design, information regarding the types and locations (quantities) of flood control measures based on field observations was collected from the BWDB local offices. The survey team then reviewed this information to confirm its appropriateness and further discussed it with the BWDB local offices as required.

- Among the slope protection methods, both Type A (which covers the embankment body with CC Blocks) and Type D (which covers the embankment body with sand-cement in jute bags) are rigid forms of protection. Type A is considered particularly effective in locations where water flow directly impacts the structure. Although Phase 1 raised concerns regarding the uniformity of Type D's quality, trial construction with increased cement content confirmed the effectiveness for better quality control. Additionally, Type D is less expensive and relatively easier to maintain, which is expected to facilitate future Haor region development projects by the Bangladeshi government after this Project. Given the strong performance of Type A in Phase 1 and the limited record of Type D with increased cement content, it is currently impractical to replace Type A with Type D. Nevertheless, active utilization of Type D is considered desirable. Typical cross section of each type of slope protection is included in Appendix 5.1.3.

(2) Scenarios for Cost Estimation

In addition, while establishing the content of the Project, several options have been considered for both the BWDB and LGED components. The project cost was examined for various scenarios. The options of the BWDB and LGED components and scenarios examined for the estimation of the project cost are presented below:

Table 5.1.7 BWDB Component Options under Consideration[2]

Option	Slope Protection Types (Type A : Type D*)
Original**	1 : 0.53**

[2] *: In this Project, the cost of slope protection works is expected to be high. Both Type A (CC block) and Type D (sand-cement) slope protection are considered rigid structures. Type D has a lower unit price and is relatively easier to maintain,

Option	Slope Protection Types (Type A : Type D*)
Option 1	1 : 2
Option 2	1 : 4

Source: JICA Survey Team

Table 5.1.8 Options Considered in the LGED Component

Option	Target Facilities
Option 1	1) Rural Roads (after First Screening) - Including bridges and culverts 2) Rural Markets and Ghats 3) Village Protection Works
Option 2	1) Rural Roads (High-Priority Roads under Option 1 — LGED Priority Rank 1 and 2) - Including bridges and culverts 2) Rural Markets and Ghats 3) Village Protection Works
Option 3	1) Rural Roads (Highest-Priority Roads Only — LGED Priority Rank 1) - Including bridges and culverts 2) Rural Markets and Ghats 3) Village Protection Works

Source: JICA Survey Team

As described in Section 5.2.2, for the rural infrastructure component under the LGED scope, the priority ranking of rural roads was established after the first screening based on the following criteria:

① Roads with high user traffic.

② Roads of high urgency, providing access to schools and hospitals.

③ Priority given to unpaved submerged Village roads and Union roads.

No fixed benchmark values were set for the above criteria; instead, a relative assessment was conducted among facilities within each target haor.

Based on the target road list, interviews were held with the LGED and district-level engineers to assign priority rankings (Rank 1, Rank 2, and Rank 3).

In the table above, Option 1 corresponds to the results of the first screening; Option 2 includes rural roads ranked as Priority 1 and Priority 2; Option 3 includes only rural roads ranked as Priority 1.

Considering the above, the project cost was examined for the nine scenarios listed in the table below.

Table 5.1.9 Scenarios for Project Cost Estimation

Scenario	BWDB Part	LGED Part
Scenario 1	Original	Option 1
Scenario 2	Original	Option 2
Scenario 3	Original	Option 3
Scenario 4	Option 1	Option 1
Scenario 5	Option 1	Option 2
Scenario 6	Option 1	Option 3
Scenario 7	Option 2	Option 1
Scenario 8	Option 2	Option 2
Scenario 9	Option 2	Option 3

Source: JICA Survey Team

making it more advantageous for future haor area development projects by the Bangladeshi government after the completion of this Project. Therefore, active use of Type D is considered desirable. Based on this, options will be set regarding the usage ratio of Type A and Type D.
**: The quantities requested by the BWDB local offices were reviewed by the survey team. The ratio of Type A to Type D (1:0.53) is based on this review.

After discussions with the implementing agencies regarding the project costs derived from each scenario, it was decided to proceed with Scenario 7, where the BWDB portion of the costs is lower and the scope of work for the LGED portion is broader. Therefore, the project cost considered in this report is calculated based on the conditions of Scenario 7.

(3) Recommendations Regarding Flood Control Facilities During Project Implementation

The following matters are proposed for consideration regarding flood control facilities during the implementation of this Project.

- In the detailed design phase, it is desirable to estimate potential overflow locations of submersible embankments and consider the layout of flood management facilities, including slope protection works, based on the following information:
  i. Estimation of areas prone to overflow and the required types of slope protection works based on observations and experience from BWDB local offices (Initial Design).
  ii. Estimation of areas prone to overflow through numerical analysis.
  iii. Observation of rising water levels and overflow conditions along boundaries of the target haor areas at the beginning of the monsoon season using Unmanned Aerial Vehicles (UAVs).
- At the ends of rigid slope protection structures (e.g. ones constructed with CC blocks), severe erosion of the embankment body tends to occur. Similar to practice in Japan, it is recommended to install gabion-like structures (e.g., using bricks instead of rocks) to help reduce this erosion.
- Long-term changes in river channel topography are difficult to predict, so it is considered necessary to examine future trends through continuous monitoring utilizing various methods such as satellite imagery, UAVs, and field surveys. To ensure the long-term soundness of flood management facilities, it is desirable to consider monitoring during both the project implementation stage and its subsequent operation. Due to topographical deformation over extended operation period, the overflow section may shift from its original location, and additional slope protection works may be required in the future by the implementing agency. It is recommended that the agency allocate a budget in advance to address such situations.
- During the monsoon season, breaches of submersible embankments caused by overtopping can be reduced by minimizing the difference in water levels inside and outside the haor. At the beginning of the monsoon period, the "Flood Fuse" structure introduced from Phase 1 facilitates the inflow of water into the haor, raising its internal water level. However, as water levels approach the crest, overtopping may occur at the crest, and it is difficult to predict where this will happen. In particular, overtopping may occur and lead to breaches at locations other than those with rigid slope protection. Lowering the embankment crest by about 30 cm at certain sections to designate fixed overtopping points (flood spillways) can help control where overtopping occurs when internal and external water levels approach the crest, thereby reducing the risk of breaches. On the other hand, in the event of a flood with a probability greater than once in ten years, damage may increase downstream of the overtopping section. In light of the above, it is proposed that the attempt to fix overtopping points (flood spillways) be discussed with the implementing agency during the project implementation phase, considering aspects such as cost and operation.

5.1.4 Study on Possibility of Utilizing Japanese Technology

The following Japanese Technology may be considered for Improving Inundation Analysis Methods.

- *Build a computing environment to study ways to speed up flood inundation calculations*. As previously mentioned (see 5.1.2 Basic Facility Layout Plan (2)(a) of this report), software and hardware, such as PCs and GPUs, that mimic the computing environment in Bangladesh in a Japanese private company's computing environment were established and computational experiments to accelerate flood inundation calculations are conducted. This leverages Japan's accumulated technology sharing and advantages in PC equipment procurement, enabling efficient speed-up studies.

- As previously mentioned (see 5.1.2 Basic Facility Layout Plan (2), (c) of this report), satellite imagery allows for a highly accurate and easy understanding of the topography of haor areas. The resulting topographical maps can be applied to flood inundation analysis and allow for the understanding of changes in topography over time. This eliminates the need for some on-site surveys around the target haor areas, leading to reduced survey costs. This technology was developed by the JICA Survey Team member while he was dispatched as a JICA Long-Term Expert and was then transferred to Bangladesh.

5.2 Rural Infrastructures

5.2.1 Review of the Preceding Project (HFMLIP Phase 1)

The LGED implemented the "Haor Flood Management and Livelihood Improvement Project (HFMLIP Phase1)" (hereinafter referred to as "Phase 1") from August 2014 to June 2024. The target area of Phase 1, the Haor area, frequently suffers significant damage to pre-harvest Boro rice due to flash floods during the pre-monsoon season, posing a severe threat to agricultural activities, which form the mainstay of local livelihoods. Additionally, insufficient development of transport and distribution infrastructure, including rural roads, has hindered the region's economic development and improvement of living conditions. In response to these challenges, Phase 1 was implemented by BWDB and LGED, with the objective of strengthening flood control measures, improving rural infrastructure, and promoting agricultural and fishery activities.

(1) Objective of Phase 1

The LGED component of Phase 1 aimed to improve access to social infrastructure such as education, healthcare, markets, and growth centers through the development and rehabilitation of rural roads and rural infrastructure, along with fishery promotion activities. Ultimately, the objective was to enhance livelihoods and revitalize economic activities in the Haor area.

(2) Project Area

The Project was implemented in 27 Haors and 34 Upazilas across five districts: Habiganj, Kishoreganj, Netrokona, Sunamganj, and Brahmanbaria.

(3) Scope of Works

(a) Improvement and Rehabilitation of Rural Infrastructure (Component 2)

- Development of rural roads, including bridges and culverts
- Rehabilitation and maintenance of existing rural roads
- Development of rural markets (Hat)
- Development of boat landing stations (Ghat)

(b) Fishery Promotion Activities (Component 3-2)

- Community-based management of Beels.
  - Management by Beel User Groups (BUGs).
  - Excavation of Beels and connecting canals (khals).
  - Establishment of fish sanctuaries and wetland tree plantations.
- Implementation of Community-Based Alternative Income Generation Activities (CAIGA).
- Aquaculture activities: household ponds, net enclosures, fish cages, floodplain aquaculture, and processing (drying and fermentation).
- Enforcement of fisheries regulations.

(c) Effects

According to the "Project Completion Report (LGED, 2024)", the results of the benefit monitoring and evaluation of rural infrastructure facilities conducted in 2023 indicated the following project impacts:

- Increase in land prices along project roads: From BDT 21,765 / decimal to BDT 34,678 / decimal
- Reduction in travel time (non-motorized): From 7.7 min/km to 7.33 min/km.
- Reduction in travel time (vehicle): From 6.53 min/km to 4.13 min/km.
- Increase in traffic volume (vehicles): From an average of 804 vehicles/day to 1,901 vehicles/day.

5.2.2 Project Candidate Sites

(1) Facility Selection Policy for the Current Project

(a) Selection Policy for Target Facilities

The selection of target rural infrastructure was based on those proposed in "Project Preparation / Pre-Feasibility Study Report for Haor Flood Management and Livelihood Improvement Project – LGED Part (Phase 2) (LGED, 2024)" (hereinafter referred to as the Pre-FS Report). The study focused on facilities located within the 26 Haors identified in the Pre-FS Report.

Considering the Project's objectives, the following criteria were applied in selecting the target rural infrastructure:

- Contribution to enhancing resilience to climate hazards by promoting agriculture and fishery activities.
- High level of synergy with flood control measures.

(b) Target Rural Infrastructure

The Planning Commission of Bangladesh classifies its road networks into six types: national highways, regional highways, Zila roads, Upazila roads, Union roads, and Village roads. Among these, the Project targets roads under LGED's jurisdiction—specifically Upazila roads, Union roads, and Village roads—that remain unpaved and result in reduced transport efficiency during the monsoon season due to heavy rainfall and flooding.

Each of these rural roads is categorized as either submersible or non-submersible, depending on its vulnerability to flooding during the monsoon season. Bridges and culverts included within the road lengths are also covered under the project scope as they are essential for ensuring drainage and safe road use during floods.

Additionally, it is proposed to include Village Protection Walls (VPWs) in the project scope, which were not covered under Phase 1. VPWs are structures designed to reduce erosion and flooding damage to residential areas caused by waves during the rainy season in the haor area. In recent years, wave-induced erosion along village perimeters has increased due to the impact of climate change. Given that it is a facility of critical importance for protecting the lives and properties of residents, it is proposed to include the VPW as a project component and to model the series of activities required when administrative agencies, such as LGED, implement it. The proposed model assumes the selection of target villages, consensus-building with residents, procedures such as land acquisition, determination of construction methods and design, construction, and sustainable maintenance by the residents. Further details are provided in Section 5.2.2(2).

Furthermore, the project also considers the rehabilitation of paved roads (Upazila, Union, and Village roads) identified in the Pre-FS Report as requiring maintenance.

Village Protection Walls (Kishoreganj District)

Source: JICA Survey Team

Table 5.2.1 Target Rural Infrastructures

No	Category	Purpose of Improvement	Synergistic Effect with Flood Control
1	Rural Road Improvement	Improvement of Upazila roads, Union roads, and Village roads—including submersible roads, non-submersible roads, bridges, and culverts.	High: Mitigates the impact of flooding by enabling rapid transportation of agricultural and fishery products.
2	Market（Hat）Development	Development of growth centers and rural markets.	High: Facilitates the sale of produce within the Haor area.
3	Boat Landing Station（Ghat）Construction	Construction of new boat landing stations.	High: Enables transportation of produce within the Haor area.
4	Village Protection Wall Construction	Construction of VPWs to protect the village from wave-induced erosion.	High; Protects the assets and livelihoods of village residents.
5	Rural Road (Rehabilitation)	Maintenance and rehabilitation of existing paved Upazila roads, Union roads, and Village roads—including submersible roads, non-submersible roads, bridges, and culverts—to be implemented under the GoB budget.	High; Mitigates the impact of flooding by enabling rapid transportation of agricultural and fishery products.

Source：JICA Survey Team based on the latest data from the "Road and Market Database (February 2025)" published on the LGED website.

(2) Current Situation of Target Facilities

(a) Upazila Road

In the haor area, Upazila roads are primarily used to transport harvested crops rapidly to higher-level road networks—such as Zila roads and regional and national highways—thereby making a significant contribution to sustaining the economic activities of the local population. According to the LGED road database, as of 2025, the total length of Upazila roads nationwide is 36,773 km, with a paved ratio of 93.3%. In the 26 haor areas targeted in LGED’s Pre-FS report, the total road length was 1,456 km, with a paving rate of 78.4%, which was below the national average.

Results from the impact assessment of Phase 1 confirmed that paved roads, compared with unpaved roads, resulted in increased traffic volume and reduced travel time. Therefore, addressing unpaved roads—which contribute to reduced efficiency in transporting agricultural products—is essential. Field observations for the Project further confirmed that during the monsoon season, unpaved roads become muddy due to rainfall and flooding, hindering vehicle passage and the transportation of goods.

Unpaved Upazila Road (Submersible) – Requires Improvement

Paved Upazila Road (Non-Submersible) – Asphalt Pavement, Width: 5.5 m

Table 5.2.2 Pavement Ratio of the Rural Road in Target Haor Area

Name	Length (km)		Pavement Ratio	
	Target Haor in Pre-FS Report (26 Haor)	National	Target Haor in Pre-FS Report (26 Haor)	National
Upazila Road	1,456	36,773	78.4% (Pavement length 1,142 km)	93.3% (Pavement length 34,337 km)
Union Road	1,504	42,102	69.0% (Pavement length 1,038 km)	79.7% (Pavement length 33,560 km)
Village Road (A)	4,743	182,355	27.3% (Pavement length 1,296 km)	30.1% (Pavement length 54,921 km)
Village Road (B)	6,133	149,906	10.9% (Pavement length 668 km)	25.7% (Pavement length 38,503 km)

Source: Prepared by JICA Survey Team based on the latest data from LGED's 'Road and Market Database' website as of February 2025.

(b) Union Road

In the haor area, Union roads are primarily used to transport harvested crops, such as Boro rice, to core roads—including Upazila roads—thereby significantly contributing to the economic activities of the residents.

According to the LGED road database, the total length of Union roads nationwide is 42,102 km, with a paved road ratio of 79.7% as of 2025, meaning that 8,542 km still require paving. In the 26 haor areas targeted in the LGED’s Pre-FS report, the total road length was 1,504 km, with a paving rate of 69.0%, which was below the national average. Similar to Upazila roads, paving works are necessary to improve the efficiency of crop transportation.

Furthermore, field observations under this Project confirmed that submerged-type roads, which are completely inundated during the monsoon season, are heavily affected by wave action, and in an unpaved condition, they are highly susceptible to scouring and erosion. The necessity of paving to maintain structural soundness and improve transportation efficiency was thus confirmed (see Table 5.2.2).

Union Road (Submersible) – Condition during Submersion (Reinforced Concrete Pavement, Carriageway Width: 3.0 m)

Union Road (Submersible) – Condition during Non-Submersion (Reinforced Concrete Pavement, Carriageway Width: 3.0 m)

Paved Union Road (Non-Submersible) – Condition (Asphalt Pavement)

(c) Village Roads (Category A)

These roads mainly connect Union centers with villages and markets. In the haor area, they play a key role in transporting harvested agricultural products between haors and villages. Improvements in transport efficiency through paving are expected to substantially enhance villagers' livelihoods. According to LGED's database, the total length of Village roads (Category A) nationwide is 182,355 km, but their paved ratio remains low at only 30.1% as of 2025. In the 26 haor areas targeted in LGED's Pre-FS report, the total road length was 4,743 km, with a paving rate of 27.3 %, which was below the national average. As with Upazila roads and Union roads, pavement works are necessary to improve the efficiency of crop transportation. Field observations conducted for the Project confirmed that, similar to Union roads, these roads are affected by wave action during submersion, reaffirming the necessity of pavement works (see Table 5.2.2).

(d) Village Roads (Category B)

Village roads (Category B) represent the lowest classification among roads managed and maintained by the LGED and local government authorities, primarily consisting of intra-Village roads. In the haor area, these roads mainly serve to transport harvested crops out of villages. Paving these roads to improve transport efficiency is also anticipated to benefit significantly the villagers' livelihoods. The LGED's database indicates a total length of 149,906 km for Village roads (Category B) nationwide, with a pavement ratio of only 25.7% as of 2025. In the 26 haor areas targeted in LGED's Pre-FS report, the total length is 6,133 km, but the paved ratio is a mere 10.9%, significantly below the national average, indicating an urgent need for improvement (see Table 5.2.2).

Village Road (Submersible) – Condition during Submersion (Reinforced Concrete Pavement)

Village Road (Submersible) – Condition during Non-Submersion (Reinforced Concrete Pavement, Road Constructed under Phase 1)

(e) Growth Center / Rural Market (Hat)

The main products within the haor area are Boro rice and fisheries, making markets essential for gathering these products and facilitating transactions at fair prices. Additionally, during the monsoon season, flooding hampers consumers in the haor from easily reaching markets outside the area. As a result, local markets within the haor are vital for the residents.

Markets are broadly categorized into growth centers and rural markets. Growth centers have a large capacity and serve as the principal markets within the haor area; rural markets are smaller in scale.

Based on the field survey conducted under the Project, it was observed that even markets developed with GoB funding suffer from insufficient road paving, drainage systems, and roofing, which impede their usability during the rainy season.

Existing Growth Centers (with Roofing, but Lacking Adequate Paving and Drainage Facilities)

Existing Rural Markets (No Covered Sales Buildings to Protect from Rain; Sales are Conducted in Open Alleyways)

(f) Boat Landing Station (Ghat)

In the haor areas, which are surrounded by rivers and become inundated during the monsoon season, landing stations serve as essential infrastructure for transporting food, daily necessities, and construction materials. It is desirable that these landing stations be located along the rivers near marketplaces. To improve the efficiency of transporting Boro rice and fish catches, facilities that can accommodate fluctuating water levels are required.

The Pre-FS completion report notes that some existing landing stations become muddy during the rainy season, resulting in unstable footing, reduced loading and unloading efficiency, and lower safety. It also points out that the absence of landing stations near marketplaces has led to decreased efficiency in transporting Boro rice.

Proposed Landing Station Construction Sites (Kawarjor Bazar, Kazirkhola Boro Haor, Kishoreganj) (Planned to be Constructed Adjacent to the Market)

Existing Boat Landing Stations (Reinforced Concrete Structures, Approximately 5.0 meters in Width)

(g) Village Protection Walls

Villages and houses within the haor areas are built on elevated ground above the flood levels experienced during the monsoon season. In Phase 1, some villages implemented initiatives to raise homestead land using soil excavated from the Beels, and local residents, government agencies, and NGOs have been experimenting with various construction methods to cope with increasing wave-induced damage. Among these efforts, the construction of village protection works has been demonstrated to be an effective measure for safeguarding residential areas from wave action and protecting the lives of residents.

In the Haor region, several village protection methods have been implemented and evaluated under projects, such as the Haor Infrastructure and Livelihood Improvement Project (HILIP, IFAD, 2011–2023). Under HILIP, a total of 11 village protection works were constructed and monitored across five districts—Brahmanbaria, Habiganj, Kishoreganj, Netrokona, and Sunamganj. The protection measures included the following:

- Brick-mount protection combined with vegetation protection of riverbanks.
- RCC retaining walls for riverbank protection.
- Toe walls with supporting piles combined with hollow blocks and vegetation for bank protection.

The VPWs were not considered as project target facilities in Phase 1. However, LGED strongly requested to include them in the Project following particularly strong requests from local residents. Field inspections revealed that some protective structures, consisting of wooden frame frameworks installed by residents around certain villages, were in place. However, these offered low resistance against wave action, resulting in bank erosion.

Village Protection Walls Constructed under other Donor Projects (Bank Protection using CC Blocks, HILIP)

Village Protection Walls Constructed by the Villagers Themselves (Defenses Consisting of Wooden Fences and Vegetation)

Village Protection Walls Constructed by the Villagers Themselves (Defenses using Sandbags and Vegetation)

Perimeters of Villages without VPWs (Erosion Observed)

5.2.3 Basic Layout Plan of Rural Infrastructures

(1) Climate Risk Assessment and Consideration of Adaptation for Rural Infrastructure

(a) Climate Hazards Affecting Rural Infrastructure Facilities

For rural infrastructures, climate hazards are identified based on the "JICA Climate-FIT (Adaptation) – Climate Finance Impact Tool for Adaptation", specifically referring to “Table 42: Examples of Climate Hazards for Disaster Prevention / Risk Reduction Projects (Weather-Related Disasters, Water-Related Disasters)” and “Table 62: Examples of Climate Hazards for a Project in the Road Sector”.

Considering this guidance, it is deemed appropriate to examine all nine climate hazards listed in Chapter 3, Section 3.8, and Table 3.8.1.

(b) Climate Risk Matrix

The exposure to the above climate hazards under this Project is categorized into four infrastructure elements:

E1: Rural Roads and Bridges;
E2: Markets (Hat);
E3: Boat Landing Facilities (Ghat);
E4: Villages and Housing.

For each of these elements, the current level of impact from each hazard is assessed using a four-level scale ranging from 0 to 3. Additionally, by incorporating the projected future trends of climate hazards, key hazards to be monitored under each project activity are highlighted with red circles.

These results are summarized in the climate risk matrix shown below.

		Climate Hazard								
		H1 Floods	H2 Heavy Rainfall	H3 Cyclone	H4 Droughts	H5 Wind	H6 High Temperture	H7 Cold Waves	H8 Solar Radiation	H9 Rise in Sea-level
	Current Frequency	++	++	+	+	+	+	+	-	-
	Future	↗	↗	→	→	→	→	→	→	↗
Exposure	E1 Rural Roads and Bridges	3	3	2	0	2	1	1	1	1
	E2 Markets (Hat)	2	3	2	1	2	1	1	1	1
	E3 Boat Landing Facilities (Ghat)	3	2	2	1	2	0	0	0	1
	E4 Villages and Housing	3	2	2	1	2	1	1	1	1

Source: JICA Survey Team with reference to "JICA Climate-FIT (Adaptation) - Climate Finance Impact Tool for Adaptation"

Figure 5.2.1 Climate Risk Matrix for the Project（Rural Infrastructures）

(c) Potentially Significant Future Climate Risks

For each selected project activity, combinations of relevant "climate hazard" and "exposure" elements that require close attention were analyzed in terms of the "vulnerabilities" that may contribute to, or are already contributing to, the occurrence of "climate risks" that are expected to become significant in the future.

The results of this assessment are summarized in the table below.

Table 5.2.3 Identification of Vulnerabilities Contributing to Climate Risk Generation and Possible Major Future Climate Risks (Rural Infrastructure)

(A) Combination of "climate hazards" and "exposures" to be considered	(B) Vulnerabilities assessment contributing to climate risks (susceptibility to and capacity to cope with impacts)	(C) Possible major future climate risks
H1 (Flood) + E1 (Rural Roads and Bridges) In the case of non-submersible rural roads and bridges, rising water levels during floods often expose the road embankments to wind and wave action, leading to erosion and scouring. This poses a significant threat to the safety and stability of the roads and bridges.	Many rural roads lack adequate pavement, slope protection, and drainage facilities, resulting in frequent slope erosion, road surface and embankment collapse, and loss of accessibility during flood events. In addition, the road base materials are often rudimentary and have low resistance to repeated inundation.	H1 (Flood) + E1 (Rural Roads and Bridges) In addition to further rises in flood levels, strong winds may generate wind waves that could intensify erosion and scouring around road embankments, bridge piers, and abutments.
H2 (Heavy Rain) + E1 (Rural Roads and Bridges) Heavy rains occurring during the pre-monsoon Aman rice harvest season cause unpaved road sections to become muddy and impassable. This hinders transportation during the Aman rice harvest period as well as the delivery of agricultural machinery such as harvesters.	There are few alternative routes in the road network, so when certain road sections become impassable, transportation options become limited.	H2 (Heavy Rain) + E1 (Rural Roads and Bridges) If the frequency of heavy rains during the pre-monsoon period increases, rural roads may become impassable almost every year, resulting in delays in Aman rice harvesting and transportation to markets, which could lead to increased damages.
H2 (Heavy Rain) + E2 (Markets (Hats)) In markets with inadequate roofing, sudden heavy rains frequently expose goods directly to rainfall, resulting in quality deterioration. Additionally, in markets with poor	As structural vulnerabilities, the lack of roofing or the use of simple structures make it difficult to withstand sudden heavy rains, resulting in a high risk of damage	H2 (Heavy Rain) + E2 (Markets (Hats)) As the frequency and intensity of heavy rains increase in the future, the number of markets frequently suffering damage to goods is expected to rise, resulting in losses

(A) Combination of "climate hazards" and "exposures" to be considered	(B) Vulnerabilities assessment contributing to climate risks (susceptibility to and capacity to cope with impacts)	(C) Possible major future climate risks
drainage facilities, muddy conditions after heavy rains hinder both customer access and the loading and unloading of goods.	and spoilage, particularly for perishable goods and grains. Insufficient paving of floors and inadequate drainage facilities (such as gutters and slope grading) cause muddy and slippery conditions during heavy rains, making walking difficult.	for both retailers and producers, as well as decreased convenience for users.
H1 (Flood) + E3 (Boat Landing Facilities (Ghat)) In the haor areas, prolonged flooding during the monsoon season results in boat landing facilities being constantly submerged or exposed to strong waves. Cases of erosion and collapse of embankments and boarding areas have also been observed, leading to a decline in the functionality of boat landings as a means of transportation during the flood season.	As a structural vulnerability, many boat landing facilities still have simple structures, and their embankments remain inadequate. Consequently, erosion and damage to embankments and surrounding ground are likely to occur due to waves, vessel berth, and cargo loading and unloading activities.	H1 (Flood) + E3 (Boat Landing Facilities (Ghat)) Increased wave action and stronger currents may cause erosion of the ground surrounding boat landing facilities, potentially leading to greater damage to nearby residences and structures.
H1 (Flood) + E4 (Villages and Houses) In the haor areas, residents live on elevated highlands above the monsoon flood levels, forming villages. To prevent erosion caused by waves during the monsoon season, measures such as bamboo barriers and sandbags are used. However, in recent years, rising flood levels and increased wave action have accelerated erosion, threatening the safety of houses and residents.	As a topographical vulnerability, although villages are located on elevated highlands, they exist as isolated islands and are thus directly exposed to waves and overtopping from the surrounding areas. A major vulnerability factor is that the height and area of these highlands are approaching their limits in response to the steadily rising flood levels each year. As a structural vulnerability, emergency measures such as bamboo barriers and sandbags are the predominant means of village protection, with few permanent structures in place. These measures have low durability against repeated high waves and erosion, thus cannot provide adequate long-term protection. Moreover, many residents of the haor areas belong to economically vulnerable groups, making it difficult to continuously secure resources for housing reconstruction and protective materials. Evacuation and relocation options are limited, hindering rapid response during disasters.	H1 (Flooding) + E4 (Villages and Houses) Due to the impacts of climate change, rising flood levels and increased wave intensity may exceed the protective capacity of existing village defense measures, posing serious threats to the lives and properties of residents.

Source: JICA Survey Team with reference to “JICA Climate-FIT (Adaptation) - Climate Finance Impact Tool for Adaptation (March 2024)”

(d) Consideration of Adaptation Measures

For the climate risks associated with the selected rural infrastructure affected by climate hazards, potential adaptation measures to reduce these risks are presented in the table below:

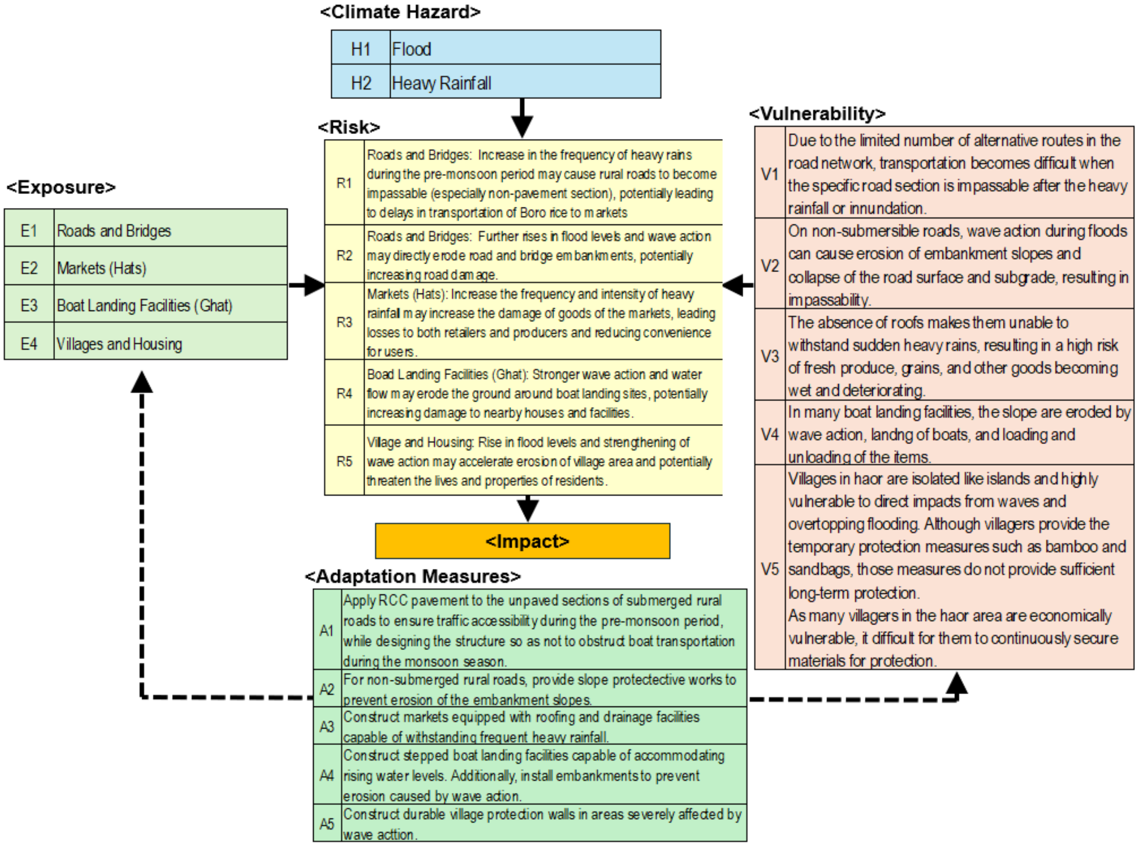
Table 5.2.4 Adaptation Measures Review Table

Risk	Impact Climate Risks that are Likely to be Significant in the Future for the Target Project	Adaptation Measures for Climate Risk	Corresponding SDG Item No.
1	In addition to further rises in flood levels, strong winds may generate wind wave action, which could intensify erosion and scouring around road embankments, bridge piers, and abutments.	<u>Adaptation Measure 1</u> For non-submersible rural roads, slope protection structures should be installed to prevent erosion of embankment slopes. In addition, more bridges and culverts with appropriate openings need to be constructed.	9
2	If the frequency of heavy rains during the pre-monsoon period increases, rural roads may become impassable almost every year, potentially leading to delays in the harvesting and transportation of Boro rice to markets, resulting in increased losses.	<u>Adaptation Measure 2</u> Apply concrete pavement to the unpaved sections of submerged rural roads to ensure traffic accessibility during the pre-monsoon period, while maintaining a structure that does not obstruct waterway transportation during the monsoon season.	9
3	As the frequency and intensity of heavy rainfall are expected to increase in the future, the number of markets where goods are frequently damaged is likely to rise, causing losses for both retailers and producers, as well as reducing convenience for users.	<u>Adaptation Measure 3</u> Construct markets equipped with roofing and drainage facilities that can withstand frequent heavy rainfall.	9
4	Stronger wave action and currents may lead to erosion of the ground surrounding boat landing facilities, potentially increasing damage to nearby houses and infrastructure.	<u>Adaptation Measure 4</u> Construct stepped boat landing facilities capable of accommodating rising water levels. Additionally, install embankments to prevent erosion caused by wave action.	9
5	Rising flood levels and increased wave action may exceed the capacity of existing village protection measures, potentially threatening the lives and properties of residents.	<u>Adaptation Measure 5</u> Construct durable VPWs in areas severely affected by wave erosion.	11

Source: JICA Survey Team with reference to “JICA Climate-FIT (Adaptation) - Climate Finance Impact Tool for Adaptation (March 2024)”

(e) Climate Risk Tree

The abovementioned climate risks, considered potentially significant in the future, are defined as “Risks”, and the factors believed to contribute to the occurrence of these climate risks are identified as “Vulnerabilities”. The climate risk tree has been created as shown in the figure below.



Source: JICA Survey Team with reference to "JICA Climate-FIT (Adaptation) - Climate Finance Impact Tool for Adaptation (March 2024)"

Figure 5.2.2 Climate Risk Tree including Adaptation Measures for the Project（Rural Infrastructures）

5.2.4 Facility Design

(1) Basic Design

(a) Basic Design Policy

For the basic design of rural roads, LGED's design standards were applied. For growth centers (Hat) and boat landing stations (Ghat), design standards and implementation experiences from HMFLIP Phase 1, as well as examples from the HILIP implemented in the haor area, were utilized. The planned horizontal alignment of rural roads was basically maintained according to the existing alignment. The planned road surface elevation was set at the existing level without embankment raising, in line with the approach adopted in Phase 1, while considering flood drainage impacts and cost-effectiveness.

VPWs are to be implemented around the entire perimeter of the village. The half exposed to incoming waves during flooding will be constructed with rigid protection works, while the other half will employ natural protection methods.

(b) Rural Roads

The design widths of the selected rural roads are shown in the table below. The design assumes full pavement surfacing for all types of roads along entire lengths. Road widths are based on LGED's standard road design, adopting road types according to the anticipated Commercial Vehicle Daily (CVD).

Based on empirical knowledge from Phase 1 and other projects, the CVD in haor areas is expected to be less than 100. Accordingly, the design in this Project assumes a CVD of 100 or less as a baseline. For roads expected to carry relatively higher traffic volume within the haor—such as submerged Upazila roads and both submerged and non-submerged Union roads—a baseline CVD of 50 to 100 is assumed.

Village roads, both submerged and non-submerged, which are expected to have lower traffic volumes, are designed with a baseline CVD of 0 to 50.

However, non-submerged Upazila roads are classified as high-standard roads and are expected to accommodate the highest traffic volumes among the target roads, including large vehicles. Therefore, a conservative design approach is adopted. The non-submerged Upazila roads are anticipated to have a CVD exceeding 200, with a pavement width of 5.5 m, corresponding to Type 5 in the LGED standard design.

Furthermore, for non-submersible roads, due to concerns about slope erosion or collapse caused by floodwater forces during inundation, slope protection works (protective works) will be installed. The protection type follows LGED's "Typical Design for Protection Wall", using reinforced cement concrete (RCC) retaining walls for slope protection.

As it is difficult to investigate the exact extent of protection works required along the target roads, the length of protection works per haor for non-submersible roads (Upazila roads, Union roads, Village roads) was estimated using the following formula based on Phase 1 achievements. It is assumed that the protection works will cover 15% of the total road length, calculated using the following formula:

Protection work length
= Total length of non-submersible roads (km) × 15% (assumed coverage)
× 2 (both sides of the road) + Number of bridges within the length (10–100 m span)
× 2 sides × 100 m (construction length on both sides of each bridge)

Table 5.2.5 Pavement Widths of Rural Roads

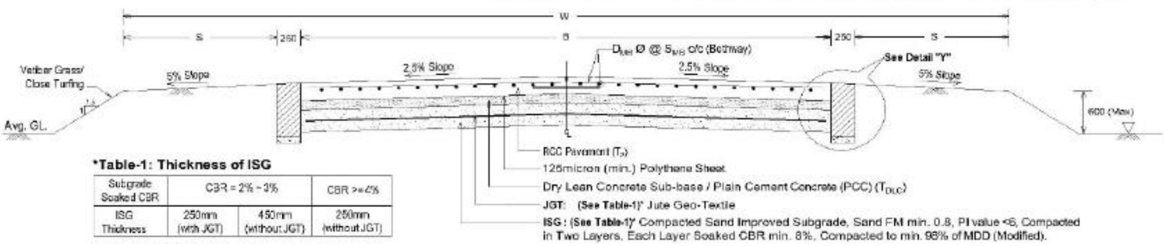
Type of Road		Design of Road Width (m)			
		Pavement Width	Total Width	CVD	Improvement Type
Upazila Road	Submersible	3.70	6.70	50-100	RCC Pavement
	Non-submersible	5.50	9.20	201-300	BC Pavement
Union Road	Submersible	3.70	6.70	50-100	RCC Pavement
	Non-submersible	3.70	6.70	50-100	RCC and Uni Block (50:50)
Village Road	Submersible	3.00	5.50	0-50	RCC Pavement
	Non-submersible	3.00	5.50	0-50	RCC and Uni Block (50:50)

Source: JICA Survey Team based on to LGED's "Road Design Standard".

1. Upazila Roads (Submersible):

Bituminous Carpeting (BC) pavement is unsuitable for submerged conditions. Therefore, for submerged Upazila roads, Reinforced Cement Concrete (RCC pavement has been selected in accordance with LGED's road design standards. To accommodate temporary increases in traffic volume—such as during the dry season for Boro rice transportation—the road width will be periodically widened to provide passing bays (bus bays). These passing bays sections, measuring 5.5 m in width and 15–16 m in length, are planned to be installed at an interval of every 200 m.

The standard cross-section of the Upazila roads is shown below. Other drawings are provided in the attached documents.

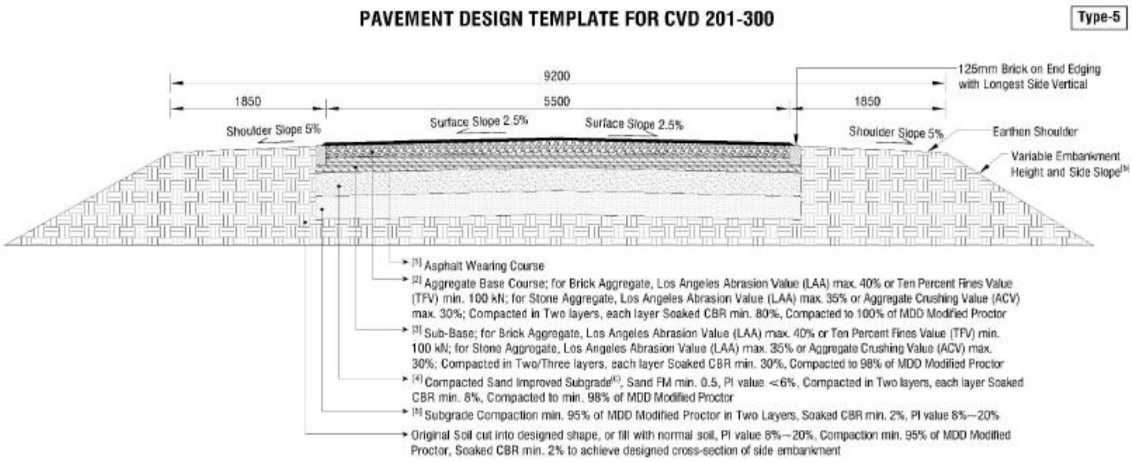


Source: JICA Survey Team based on to LGED's "Road Design Standard"

Figure 5.2.3 Standard Cross-section of Upazila Road (Submersible)

2. Upazila Roads (Non-submersible):

Non-submerged Upazila roads are primary roads in rural areas with high traffic volumes, including large vehicle traffic. They comply with LGED's standard road design and adopt Bituminous Carpeting (BC) pavement, which is more cost-effective than RCC pavement. However, the construction method will continue to be reviewed, taking into account economic efficiency and constructability.



Source: JICA Survey Team based on LGED's "Road Design Standard"

Figure 5.2.4 Standard Cross-section of Upazila Road (Non-submersible)

3. Union Roads (Submersible):

As with Upazila roads, BC pavement is deemed unsuitable under submersible conditions. Accordingly, RCC pavement is adopted.

4. Union Roads (Non-submersible):

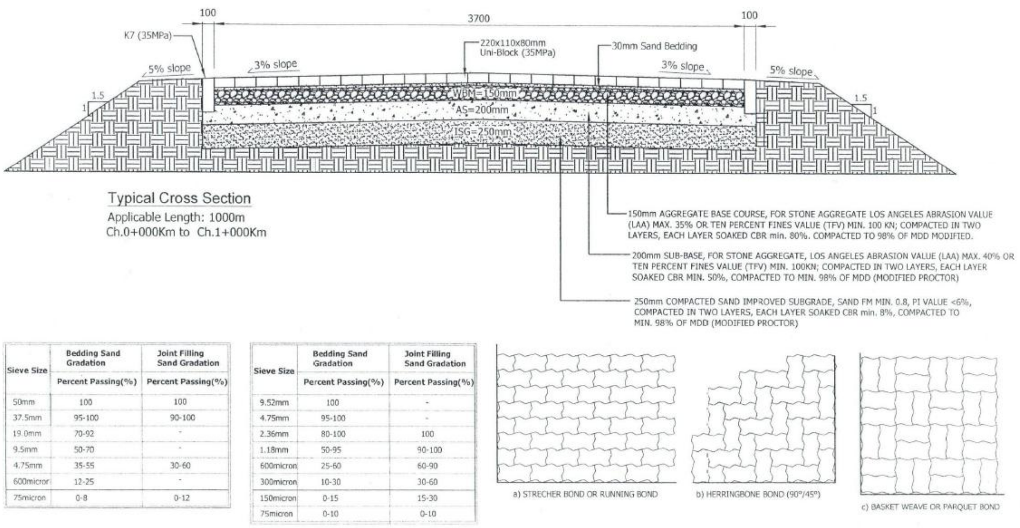
Non-submerged Union roads experience relatively high traffic volumes, including trucks and agricultural machinery. Although BC pavement was proposed in the Pre-FS Report, considering the characteristics of the haor area, climate, and environmental conditions, the adoption of Uni-block pavement is proposed.

Example of Uni-block Pavement Construction by LGED (Mymensingh Office)

Example of Uni-block Pavement Construction by LGED (Rajshahi Office)

Source: JICA Survey Team based on LGED's "Preparation and Incorporation of Alternative Pavement Section (Interlocking Concrete Block Pavement) into Road Design Manual"

Figure 5.2.5 Overview of Uni-block Roads



Sieve Size	Bedding Sand Gradation	Joint Filling Sand Gradation
	Percent Passing(%)	Percent Passing(%)
50mm	100	100
37.5mm	95-100	90-100
19.0mm	70-92	-
9.5mm	50-70	-
4.75mm	35-55	30-60
600micron	12-25	-
75micron	0-8	0-12

Sieve Size	Bedding Sand Gradation	Joint Filling Sand Gradation
	Percent Passing(%)	Percent Passing(%)
9.52mm	100	-
4.75mm	95-100	-
2.36mm	80-100	100
1.18mm	50-95	90-100
600micron	25-60	60-90
300micron	10-30	30-60
150micron	0-15	15-30
75micron	0-10	0-10

Source: JICA Survey Team based on to LGED's "Preparation and Incorporation of Alternative Pavement Section (Interlocking Concrete Block Pavement) into Road Design Manual"

Figure 5.2.6 Standard Cross Section of Uni-block Roads

Uni-block has recently been promoted as an environmentally friendly building material alternative to fired bricks. Its application for road pavements in Bangladesh began in 2020, and in 2023, LGED established a standard design for its use. Below is a comparison between BC pavement and Uni-block pavement.

Table 5.2.6 Comparison of Bituminous Carpeting (BC) Pavement and Uni-block Pavement

Item	BC Pavement	Uni-block Pavement
Constructability	Aggregates and bitumen are heated at high temperatures and mixed, then compacted with a road roller. Requires delicate temperature control during construction, making it technically challenging.	Rapid construction is possible under favorable weather conditions. Uses precast interlocking concrete blocks produced in factories. Constructed by laying sand and aggregates and interlocking the blocks. Usable immediately after installation.
Maintenance and Durability	Requires frequent maintenance (potholes, rutting). Rutting occurs under extreme weather conditions (high temperature, flooding, heavy rain). Lifespan is 10–15 years, but maintenance is needed after about 3 years, often requiring full or partial resurfacing.	High maintainability as individual blocks can be replaced. Resistant to deformation with a minimum strength of 30 MPa. The lifespan is 20–30 years, with minimal maintenance required.
Climate Change Resilience	Deforms under high temperatures. Slippage occurs due to flooding and heavy rain. Deterioration progresses if shoulders loosen, sometimes requiring mechanical repair. Absorbs heat, raising surrounding temperatures.	Resistant to deformation even under high temperatures. Permeable to water, reducing flood risk. Shoulder deterioration can be easily repaired manually. Reflects sunlight, lowering surface temperature.
Environmental Impact	Harmful (requires heating of bitumen). Potential health hazards.	Environmentally friendly (low CO_2 emissions). No heating required.
Life Cycle Cost (LCC)	Low initial cost but high maintenance costs. Initial cost: approximately BDT 150 lakh /km.	Higher initial cost but lower LCC due to high durability. Initial cost: approximately BDT 220 lakh /km.
Experience and Technical Requirements	Requires skilled workers.	Proven construction experience with local residents.
Quality	Smooth ride quality.	Slightly inferior ride quality compared to BC pavement.
Recommended Usage	Recommended where machinery mobilization is easy, in warm climates, and where rapid construction is required.	Recommended for areas with high traffic volumes, prone to flooding or high temperatures, and for projects prioritizing sustainability.

Source: JICA Survey Team

BC pavement requires heating the asphalt material to high temperatures during construction, resulting in a high level of technical difficulty. Furthermore, construction is challenging during rainy weather, which imposes timing constraints in the haor area where prolonged rainfall is expected during the monsoon season.

In contrast, although Uni-block pavement has a higher construction unit cost compared to BC pavement, it involves simply laying blocks on the sub-base without the need for skilled operations—such as temperature control—and is less affected by weather conditions. Additionally, maintenance is easier. In other projects conducted by LGED, there is proven experience of construction carried out by residents.

Following consultations with the LGED PD regarding the above, agreement was reached on the use of Uni-block. However, it was noted that, due to the innovative nature of the method, it would be difficult to procure materials and engage contractors to construct the entire length. Consequently, it was decided that Union roads (non-submerged) will be paved using a 50:50 split between BC pavement and Uni-block pavement.

5. Village Roads (Submersible):

In line with the considerations mentioned above, BC pavement is unsuitable; hence, RCC pavement is adopted.

6. Village Roads (Non-submersible):

Non-submerged Village roads often serve as the terminal segments of the road network within the haor, typically experiencing low traffic volumes and no passage of large vehicles; therefore, block pavement could be considered. However, as these roads have the longest total length and the highest usage by residents among the project targets, Uni-block pavement is adopted similarly to Union roads. However, the availability of a Uni-block can sometimes delay implementation in the haor area. In such cases, BC design may be used, but the ratio of BC to Uni-block should be maintained at 50:50.

(c) Land Acquisition

As the paving works under this Project are anticipated to be conducted within the existing road, no land acquisition will be required for road construction.

(d) Markets (Hat)

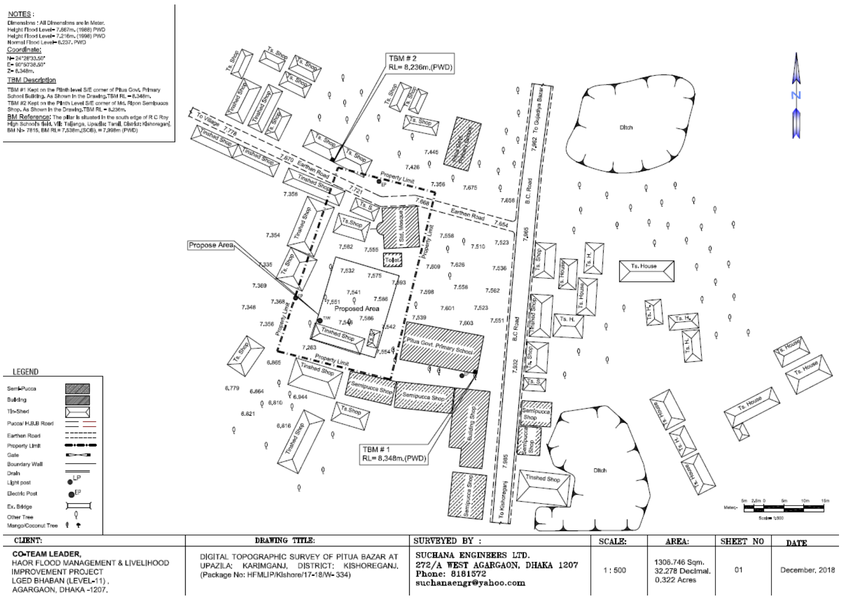
As there are no established design standards for markets (Hat), the layout and structural components have been developed with reference to examples from HILIP and Phase 1 of HFMLIP projects. A standard market typically comprises general sales sheds, women's sales sheds, fish and meat sheds, toilets, tube wells, and a management building.

Hats are often located along rivers or canals, and therefore, slope protection measures are included in the design to prevent riverbank erosion caused by wave action during the rainy season. According to the interviews with LGED, it was confirmed that some of the Hats constructed in Phase 1 are used as shelters during floods. The largest shed measures 18 m × 12 m, while the smallest measures 18 m × 6 m.

Table 5.2.7 Design Components of Hat

Item	Number
General Shed	1
Women’s Shed	1
Fish and Meat Shed	1
Open Platform	1
Male Toilet	1
Female Toilet	1
Tube Well	1
Management Committee Office	1
Drainage and Waste Management Facilities	1

Source: JICA Survey Team



Source：Haor Flood Management and Livelihood Improvement Project (LGED、2024)

Figure 5.2.7 Example of Standard Drawing of Hat

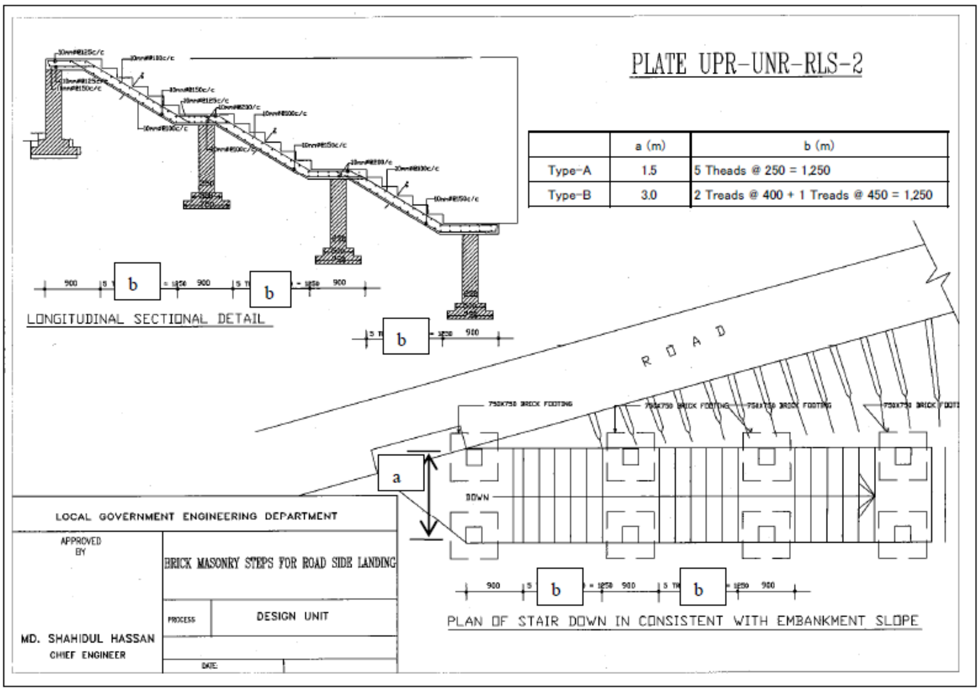
In this study, any Hat that would require land acquisition or resettlement required was excluded from the project scope. Therefore, no land acquisition or resettlement will be necessary.

(e) Boat Landing Stations (Ghat)

Standard drawings for boat landing stations (Ghats) have been developed by LGED, which provides three types of standard designs. Based on the design applied in Phase 1 of HFMLIP, the following types have been adopted. As with the markets, any facility requiring land acquisition has been excluded from consideration in this study. As a result, no land acquisition or resettlement will be necessary.

Type A:
This is the standard specification applied to general Ghats. The step width is 1.5 m, with a tread depth of 250 mm and a step height of 12 mm.

Type B:
This type is applied to Ghats associated with growth centers. The step width is 3.0 m, the tread depth is 400 mm, and the step height is 200 mm.



Source: Road Design Standards rural road (LGED and JICA, 2005)

Figure 5.2.8 Standard Drawings of Ghat (Type A and Type B)

(f) Village protection walls

As described in Section 5.2.2(2)(b), the VPWs are designed to select appropriate construction methods based on the wave exposure and terrain surrounding each target village. The methods were reviewed based on LGED's standard designs for slope protection, and VPWs are planned to be constructed around the entire perimeter of each village.

Sections exposed to strong waves during the flood season, such as areas adjacent to rivers where significant erosion or collapse is likely, will be constructed using rigid protection structures. Sections that are inundated but not expected to experience major wave-induced damage will use cost-effective, nature-based protection measures.

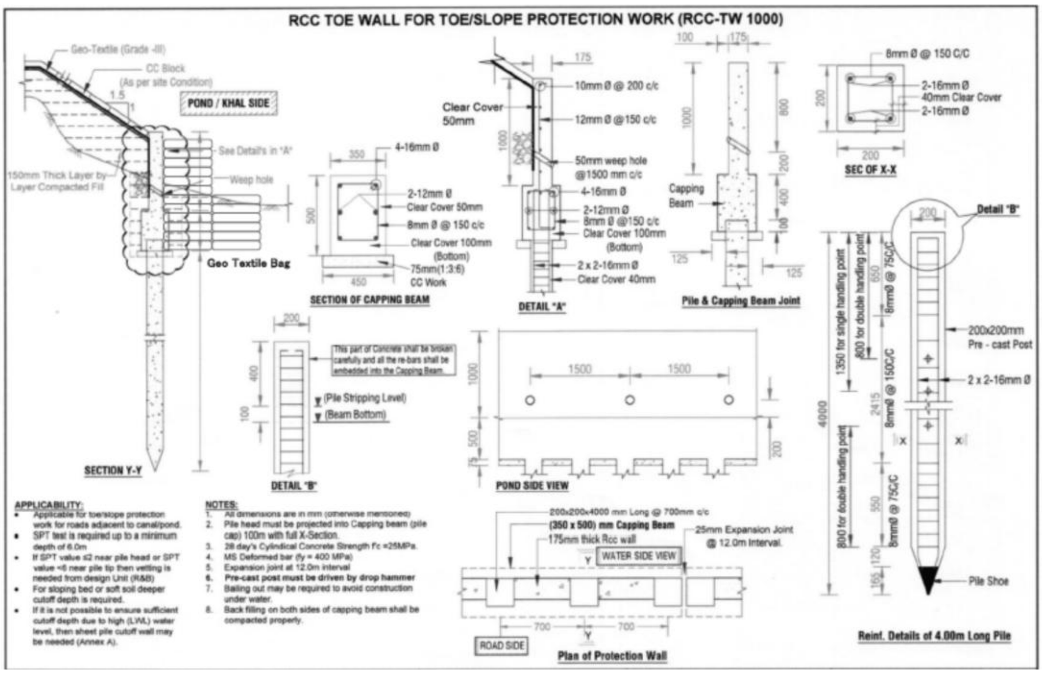
For the high-rigidity measures, a toe-wall construction method—expected to be durable and relatively easy to construct—will be employed, while the opposite side, less affected by waves, will be protected using vegetation and sandbags. Note that sandbags will be installed at the toe of the wall, which is not included in the referenced standard design. This is intended to protect the base of the toe-wall from scouring and tilting caused by wave impact.

Regarding the construction length per village, based on village perimeter measurements and field surveys, it is planned that 10% of the total 2,600 m perimeter will use high-rigidity protection, while the remaining 90% will be implemented with nature-based protection measures.

Table 5.2.8 Proposed Design for Village Protection Walls

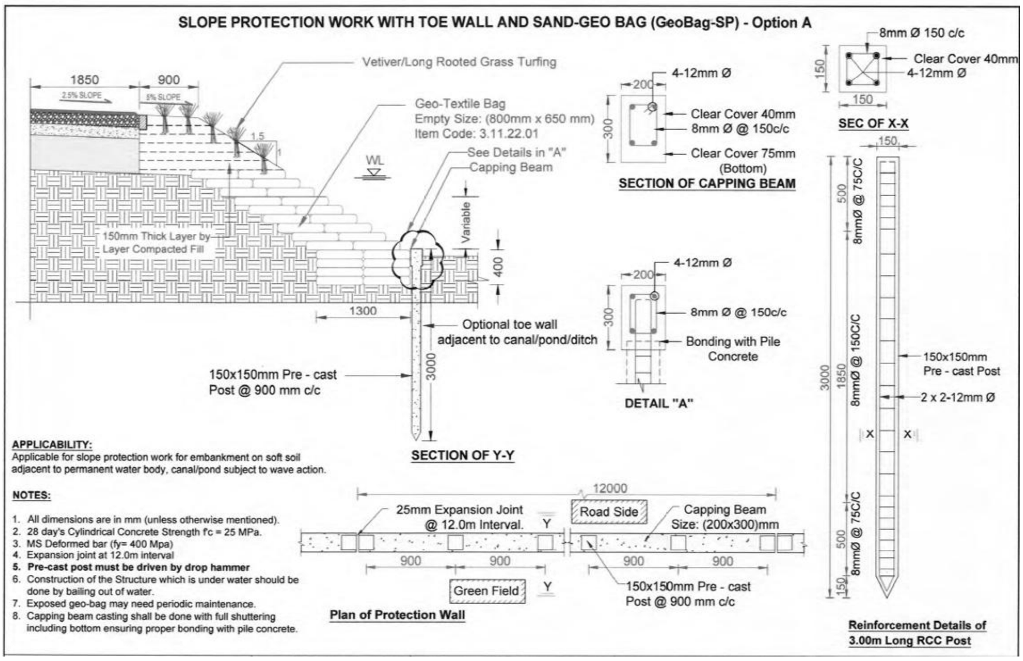
Construction Method	Location	Length (m/village)	Remarks
CC Block and Toe-Wall Protection	Areas exposed to strong wave-induced erosion (e.g., along rivers)	260 (10% of total 2,600 m)	Includes toe stabilization using sandbags
Nature-based Solution (Vegetation and Sandbag Protection)	Areas not directly exposed to waves	2,340 (90% of total 2,600 m)	Includes slope protection using sandbags

Source: JICA Survey Team



Source: Typical Design for Protection Wall (LGED, 2014)

Figure 5.2.9 Standard Drawings of Village Protection Walls (CC Block and Toe-wall Protection)



Source: Typical Design for Protection Wall (LGED, 2014)

Figure 5.2.10 Standard Drawings of Village Protection Walls (Nature-based Solution)

(g) Drawings

Based on the design policy, standard drawings were prepared for rural roads (Upazila roads, Union roads, Village roads), markets (Hat), boat landing stations (Ghat), and VPWs. The prepared drawings are presented in the attached documents.

(h) Quantities

For rural roads (Upazila roads, Union roads, and Village roads), markets (Hats), boat landing stations

(Ghats), and VPWs, the target quantities were determined based on the project target facility list proposed in the Pre-FS Report. Selection was carried out using the established selection criteria, and facilities were ranked according to their importance and the number of haors adopted for the Project.

5.3 Agriculture and Fisheries Promotion Activities

5.3.1 Agriculture Promotion Activities

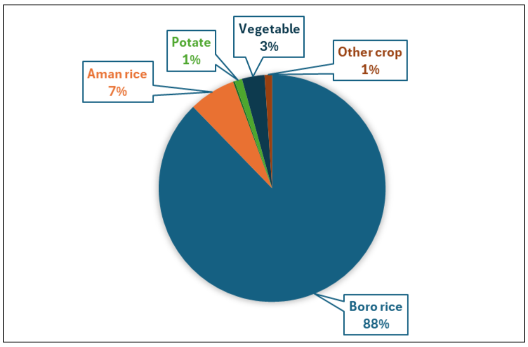
(1) Overview of Agriculture in Haor Region

In the Haor region, agriculture is carried out on low, humid land surrounded by rivers. During the rainy season (June to November), the amount of water in the rivers increases, limiting agricultural activities due to the shrinkage of cultivated land, and farmers' livelihoods mainly depend on income from Boro rice cultivation of the dry season (December to May). According to the 2024 Agricultural Census by BBS, the irrigated planted area by crop in the seven haor districts is 2,274,000 acres (approximately 926,000 ha) for Boro rice, accounting for 88% of the total irrigated planted area in the seven haor districts. In Bangladesh as a whole, the irrigated planted area for Boro rice accounts for 55%, and it can be said that agriculture in the seven haor districts depends on the monoculture of Boro rice.

Table 5.3.1 Irrigated Planted Area in Seven Haor Districts and Across the Country (in Thousand Acre)

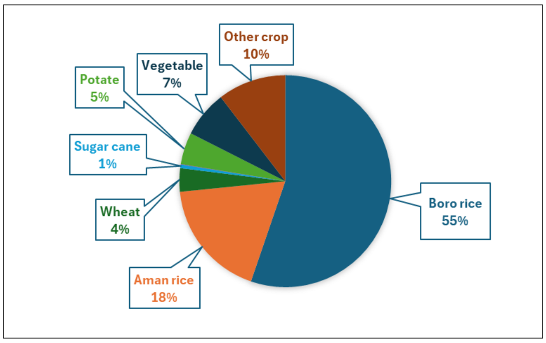
Irrigted planted area (Thousand acre)	Boro rice	Aman rice	Wheat	Sugar cane	Cotton	Potate	Vegetables	Other crop
Netrokona	446	260	1	0	0	2	5	3
Sunamganj	515	13	1	0	0	3	18	3
Sylhet	194	49	1	0	0	2	18	3
Maulvibazar	140	1	0	0	0	5	8	6
Habiganji	298	26	0	0	0	5	11	5
Kishoreganj	406	33	2	0	0	8	14	7
Brahmanbaria	275	25	1	0	0	3	9	1
Haor 7 district total	2,274	407	6	0	0	28	83	28
Percentage	88%	7%	-	-	-	1%	3%	1%
Bangladesh total	11,897	3,905	771	119	13	1,047	1,532	2,246
Percentatge	55%	18%	4%	1%	-	5%	7%	19%

Source：BBS Yearbook of Agricultural Statistics 2024



Source：BBS Yearbook of Agricultural Statistics

Figure 5.3.1 Percentage of Irrigated Planted Area in Seven Haor Districts



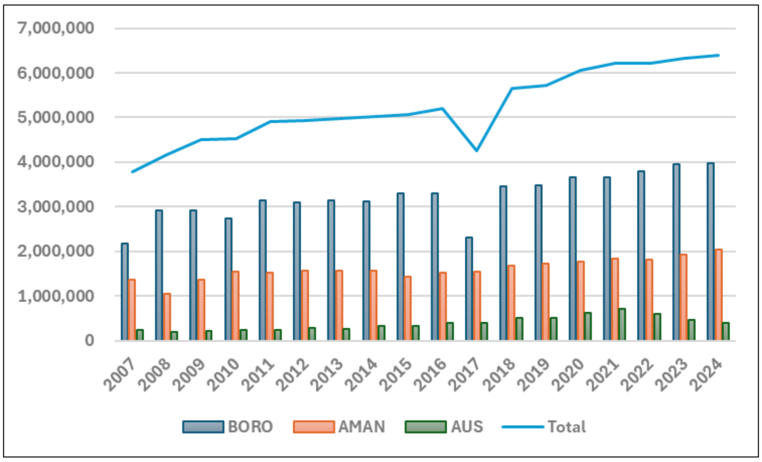
Source：BBS Yearbook of Agricultural Statistics

Figure 5.3.2 Percentage of Irrigated Planted Area Nationwide

According to documents from the Bangladesh Council for Agricultural Research, the main problems with crop production in the haor regions are pointed out by flash floods, the distribution of highly acidic soil, soil hardness, poor soil nutrition, and the difficulty of distributing agricultural products due to weak rural infrastructure. Due to these problems, field crop cultivation has not become widespread besides Boro rice, and although Aman rice accounts for 7% and vegetables for 3%, agriculture in the region remains dominated by Boro rice cultivation as a monoculture. Meanwhile, there has been little progress in agricultural mechanization to make Boro rice harvesting more efficient, and post-harvest work, including harvesting, drying and threshing, are almost entirely done by the hand of farmers. There are no rice storage facilities, so farmers sell the rice immediately after harvesting. During the study team's site visit, the team learned that "blast" disease is widely spreading in Boro rice cultivation in the region. Blast is a disease that occurs in low-temperature, high-humidity environments. Although it is unclear whether it is related to the effects of climate change, to maintain the productivity of Boro rice in this region, it is necessary to take measures against flash floods as well as develop techniques to prevent soil diseases such as blast.

(2) Changes in Rice Production in the Seven Haor Districts

According to the public data on rice harvest by the BBS, the total production of Boro, Aman and Aus rice in the seven haor districts was increased from about 3.73 million MT in 2007 to about 6.39 million MT in 2024, an increase of about 1.7 times. The total paddy rice production in the seven districts in 2024 was about 6.39 million MT, which is about 16% of the total paddy rice production of 400 million MT in Bangladesh. In addition, the average annual growth rate of rice production in the seven haor districts is 4.6%, which is higher than the national average of 2.2%. In the region, the proportion of the three types of paddy rice production is 60% Boro rice, 30% Aman rice, and 10% Aus rice, with Boro rice accounting for a large proportion.



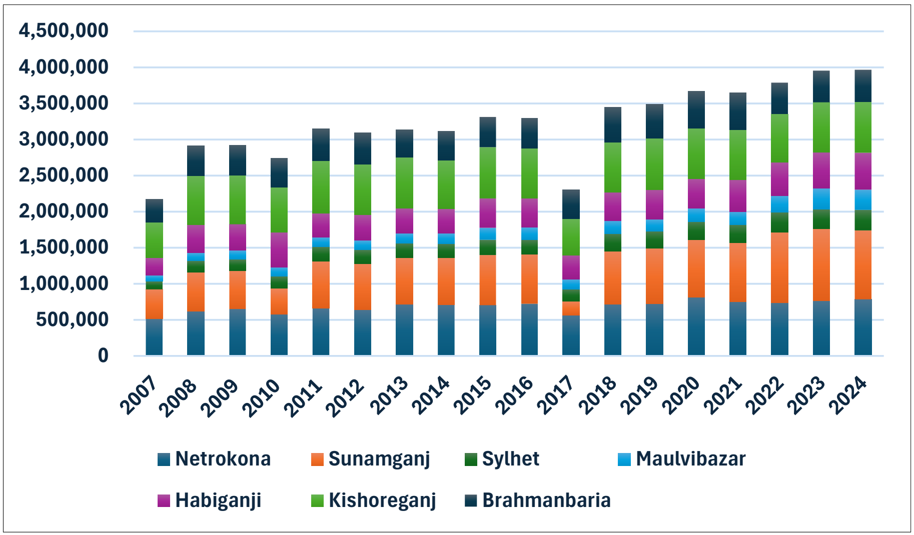
Source：BBS Yearbook of Agricultural Statistics

Figure 5.3.3 Changes in Rice Production (Paddy Rice MT) in Seven Haor Districts

Looking at the trends in rice production in the seven haor districts, the increase in production has been remarkable, but major flood damage occurs in some years. Recently, in 2017, the loss of Boro rice was large (down about 30% from the previous year: loss of about 1 million MT). However, production recovered the year after the major flood and has been increasing since then (see Figure 5.3.3). In the major flood of 2017, the loss of Aman rice and Aus rice was not large compared to the loss of Boro rice. As a measure to maintain rice production in the Haor region, the focus should be on maintaining and improving the production of Boro rice by taking measures against flash floods even in normal years, while being cautious about floods that occur in some years.

(3) Trends in Boro Rice Production in the Seven Haor Districts and Factors Behind the Increase in Production

The Boro rice production in the seven districts increased by 1.8 times from 2.17 million MT in 2007 to 3.97 million MT in 2024, with an average annual growth rate of 7% (see Figure 5.3.4).



Source：BBS Yearbook of Agricultural Statistics

Figure 5.3.4 Trends in Total Production of Boro Rice (Paddy Rice: MT) in Seven Haor Districts

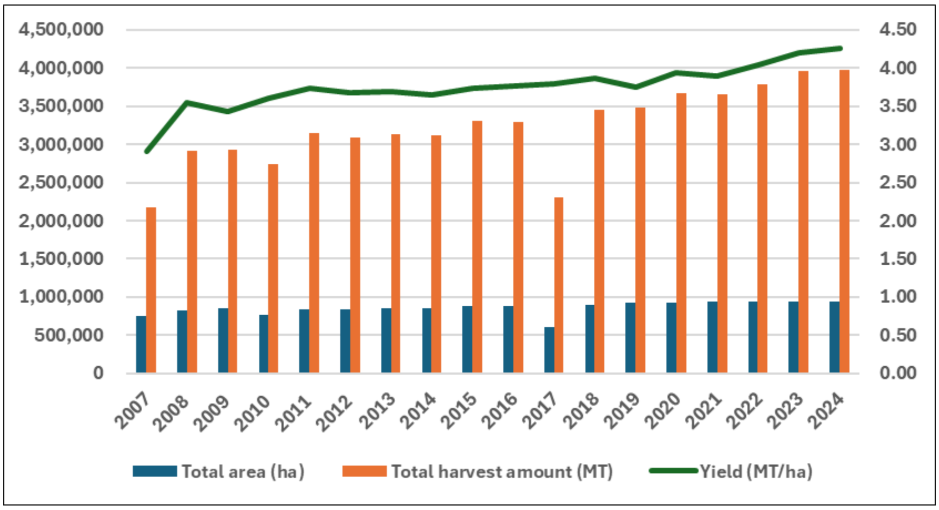
By district, the Boro rice production in Sunamganj, Netrokona, and Kishoreganj districts is higher than that in other districts, and in particular, the production in Sunamganj District was increased by 2.5 times from 400,000 MT in 2007 to around 1 million MT in 2024. However, as mentioned above, 2017 was the year of the largest flood since 2010, and the loss of Boro rice production in these three districts was 843,967 MT compared to the previous year. Sunamganj District was the most damaged, with a loss of 490,000 MT (see Table 5.3.2 and Figure 5.3.5). However, the year after the flood, the production of Boro rice in all three districts recovered and has been increasing every year since then.

Table 5.3.2 Damage and Loss of Boro Rice in Three Districts in 2017 (MT)

Boro Rice Production (MT)	Year 2016	Year 2017	Lost Amounts in 2017
Sunamganj District	685,226	196,500	△488,726
Netrokona District	722,996	563,439	△159,557
Kishoreganj District	699,047	503,363	△195,684
Total	2,107,269	1,263,302	△843,967

Source：BBS Yearbook of Agricultural Statistics

The harvested area of Boro rice in the seven districts increased by about 180,000 hectares in 16 years, from about 750,000 hectares in 2007 to about 930,000 hectares in 2024 (an increase of about 24%). The increase in harvested area is low compared to the increase in production volume (2.17 million MT to 3.97 million MT: an increase of about 82%) (see Figure 5.3.5).



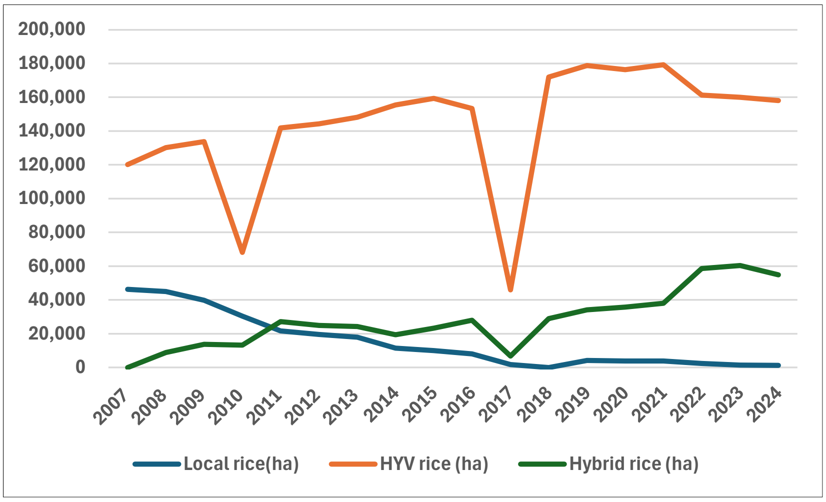
Source：BBS Yearbook of Agricultural Statistics

Figure 5.3.5 Trends in Boro Rice Harvested Area (ha), Yield (MT), and Yield per unit Area in Seven Haor Districts

The yield per unit area of Boro rice (rice production in MT per hectare) increased dramatically from 2.91 MT/ha in 2007 to 4.26 MT/ha in 2024. This indicates that the increase in production volume has not been due to the expansion of the harvested area, but rather due to an increase in "yield per unit area" in cultivated land area.

One of the factors behind the increase in yield per unit area is the improvement of Boro rice varieties. Figure 5.3.6 shows the planting ratio of Boro rice varieties in Sunamganj District, where the area planted with high-yield varieties (HYV) increased from 120,000 ha in 2007 to about 160,000 ha in 2024. HYV varieties—developed primarily by BRRI (Bangladesh Rice Research Institute)—currently account for approximately 70% of the planted area in Sunamganj District.

However, the increase in hybrid varieties (first generation hybrids), which did not exist in 2007, planted approximately 60,000 hectares in 2024, has also had a major impact on yield improvement. According to a needs survey conducted in July 2025 in the surveyed haor areas in Sunamganj District, hybrid varieties account for 90–95% of the rice varieties used by farmers for rice cultivation, while HYV varieties account for 5–10%, with hybrid varieties being overwhelmingly popular. This shows that hybrid varieties, which save farmers the time and effort of storing seed rice, and have high yields, are being rapidly adopted. The reason hybrid varieties are becoming popular is that they are preferred by farmers because they eliminate the time and effort required for seed rice preservation and can ensure a certain level of yield even in flooded areas.



Source：BBS Yearbook of Agricultural Statistics

Figure 5.3.6 Trends in Harvested Area (ha) by Boro Rice Variety in Sunamganj District

(4) Review of Agricultural Promotion Activities and Lessons in Phase 1

In Phase 1, the Agricultural Promotion Support Services (APSS) implemented a number of programs, including training in agricultural techniques to improve farmers' capacity in rice cultivation techniques, providing livestock for livelihood improvement, and promoting the adoption of new crops. While these programs were well received by beneficiaries, the wide-ranging nature of the programs made it difficult to grasp the impact of the program implementation. It is believed that a clearer understanding of the impacts of each program is necessary for future learning.

Poverty rate in haor areas remains higher than the national average. While the national poverty rate stood at 18.7% in 2022 (BBS), poverty rates in the haor districts were recorded at 27.2% in Sunamganj, 35.2% in Kishoreganj, and 33.9% in Netrokona. Furthermore, given the large number of haor areas, there is still a significant need for agricultural promotion activities.

The results and review of Phase 1 agricultural promotion activities and small-scale livelihood improvement are summarized in Table 5.3.3 and Table 5.3.4. Effectiveness was evaluated using a three-level scale, where ◎ and ○ indicate effectiveness, while △ indicates that effectiveness could not be clearly determined. Because there were no clear indicators for measuring the effectiveness of Phase 1 agricultural promotion and small-scale livelihood improvement activities, the review interviewed the implementing agencies for details of the activities. Activities were evaluated as effective based on the frequency of implementation, the number of beneficiaries, and whether they were deemed effective in improving agricultural techniques and livelihoods.

Overall, the subprojects focused on training to improve the agricultural techniques of beneficiary farmers and were deemed effective in terms of technology dissemination. The Farmer Field School (FFS) was deemed highly effective, as it provided practical content that allowed farmers to apply what they learned in the training to their own cultivation practices. Small-scale livelihood improvement (SIGS) included many small-scale training programs, such as home gardening, animal husbandry, and sewing, even during the rainy season, which contributed to improving women's livelihoods. Some positive effects were confirmed, such as women who make a living by sewing becoming independent.

On the other hand, the distribution of seeds to promote the cultivation of cash crops such as vegetables and fruit during the dry season was difficult to assess, as there was no evidence of widespread cultivation in the area. However, the promotion of crop cultivation other than Boro rice in this region is necessary to break away from the monoculture of Boro rice and introduce a more diverse agricultural model. Based on field surveys and interviews with stakeholders, reasons cited for the lack of expansion of cash crop cultivation in Phase 1 included farmers' unfamiliarity with cash crop cultivation, cultivation difficulties due to soil issues under different upland conditions than rice cultivation (e.g., high soil acidity: pH 4–5, soil nutrient deficiency: low phosphorus and potassium content, soil hardness), a lack of irrigation water due to recent droughts, the lack of suitable markets for harvested crops, and difficulty in accessing markets due to poor rural infrastructure.

To address these issues, a draft implementation manual will be prepared at the detailed design stage. The manual will focus on practical measures that farmers can implement themselves on the ground, including improving soil acidity with dolomitic lime (which is available in Bangladesh and has immediate effect in improving soil acidity in the highly acidic soil with a pH of around 4, which is common in haors), enriching the soil with nutrients and improving its physical properties through the application of organic matter such as rice straw, cow dung, or green manure, incorporating soil mulching to prevent drought, and selecting crops based on an understanding of market needs.

Monitoring will be conducted one year after the project is implemented to check whether the content has been incorporated into the training, and the content of the farmer training program in Phase 2 will be carefully examined in advance.

Table 5.3.3 Haor Phase 1: Review of Agricultural Promotion Activities

Agriculture Promotion Support Subproject (APSS)		Contents of Activity	Project Number	Total Number of Beneficiaries	Review*	
Training aimed at spreading agricultural techniques and improving livelihoods						
1	Farmer Training Program (specially for agricultural promotion)	Training for farmers (30–45 people/batch) on new technologies such as flash and flood prevention.	743 batches	31,579 people (farmers)	◎	Training in flood prevention measures for rice cultivation. Rice cultivation is an important livelihood in the Haor region and is effective.
2	Training on Homestead Vegetable Cultivation (Women)	Home gardening training for women.	112 batches	3,890 people (women)	◎	Home gardening is effective not only for providing nutrition to the table but also for improving livelihoods during the rainy season.
3	New Technology Transfer (Rice for BRRI/ Vegetable for BARI)	Training in technology transfer, such as new rice varieties, by BRRI and other organizations.	15 batches	1,000 people (farmers)	◎	Effective for acquiring new cultivation techniques for BRRI, including HYV variety and early-harvest rice.
4	Research-Extension-Farmer Dialogue	BRRI rice cultivation training session with farmers.	23 batches	1,101 people (farmers)	◎	Interactive training on new cultivation techniques at BRRI, including early harvest rice. Effective for acquiring new techniques.
5	Farm Machinery					
	a) Harvester/Reaper	Combine and other agricultural machinery training	27 batches	1,273 people (farmers)	◎	Training on agricultural machinery such as combine harvesters is effective in increasing harvest efficiency
6	Nursery Management Training and Establishment	A three-day seedling production training course to learn about vegetable and fruit seed production, seedling cultivation, grafting methods, and seedling sales.	17 batches	410 people (farmers・women)	◎	The Haor region has no means of obtaining vegetable and fruit seeds, so it aims to move away from monoculture of Boro rice and obtain seeds steadily. It is also effective as a means of improving livelihoods as it places a relatively small burden on

Agriculture Promotion Support Subproject (APSS)		Contents of Activity	Project Number	Total Number of Beneficiaries	Review*	
						women's housework and care work
7	Farmer Field School Establishment	16-day Farmer Field School on Boro Rice Cultivation conducted by master trainers for farmers	299 batches	8,970 people (farmers)	◎	Effective for spreading Boro rice cultivation techniques to farmers
8	Training on Poultry and Livestock Rearing	Poultry and livestock farming training (for women)	123 batches	3,865 people (women)	◎	Housework and care work is relatively less of a burden on women, making it an effective way to improve livelihoods
Developing leadership talent						
9	Training of Trainers (ToT) for-IFM (Integrated Farm Management) for FFS (Farmer Field School)	A 20-day training course to learn about comprehensive agricultural management, including rice cultivation, other crops, vegetables, and livestock, with the aim of developing master trainers who will conduct farmer training (farmer field schools).	20 batches	514 people (farmers) +98 people (extension workers)	◎	Effective in developing human resources who can lead other farmers.
10	Training on "Paramedical Veterinary"	Veterinarian assistant training	9 batches	260 people (farmers)	◎	Effective in developing human resources with a certain level of veterinary knowledge to promote livestock breeding.
Visits to external organizations to understand the agricultural environment						
11	Farmer Field visit program to RDA/BARD	Farmers visit the Rural Development Institute	4 batches	350 people (farmers)	◎	Although there are few beneficiaries, it is effective for farmers to understand local agricultural issues.
12	WMG member visit to successful projects	Farmers visit successful projects	5 batches	234 people (farmers)	◎	For farmers who have few beneficiaries, learning about successful cases is effective for them to adopt useful technologies in their own fields.
Distribution of seeds to promote rice and vegetable cultivation						
13	Demonstration of Cultivation					
	a) Winter and Summer Vegetables	Vegetable seeds distributed to homes for cultivation demonstrations		1,300 people (families)	◎	Home gardening is not only beneficial for providing nutrition to the table, but also for improving livelihoods during the rainy season, as farmers can earn an average of BDT 1,130 per 1 decimal (40 m^2) of land.
	b) Upland Crop (Mustard)	Mustard seeds distributed to farmers for cultivation demonstrations	125 acres	322people (farmers)	△	Mustard seeds are hardly grown as a cash crop during the dry season. Selection of market-friendly crops such as Cucurbitaceae and cultivation of vegetables in jute bags in farmers'

Agriculture Promotion Support Subproject (APSS)		Contents of Activity	Project Number	Total Number of Beneficiaries	Review*	
						yards are also worth considering.
	c) Upland Crop (Maize)	Corn seeds distributed to farmers for cultivation demonstrations	95 acres	348 people (farmers)	△	Maize is rarely grown as a cash crop during the dry season.
	d) Upland Crop (Potato)	Potato seeds distributed to farmers for cultivation demonstrations	125 acres	754 people (farmers)	△	Potato is rarely grown as a cash crop during the dry season.
	e) Adaptive Trial of Rice (IRRI, BRRI, BWDB)	Trial cultivation of early harvest and cold-resistant rice varieties at farms	5 acres	15 people (farmers)	◎	Effective for spreading cultivation techniques for BRRI varieties, including early-harvest rice.
14	Demonstration of Paddy					
	a) Boro	Distributing Boro rice seeds, fertilizer, technical support, and signboards to farmers for local cultivation demonstrations	5,227 acres	14,876 people (farmers)	◎	Rice cultivation is an important livelihood for farmers in the Haor region and is effective.
	b) Aman	Distributing Aman rice seeds, fertilizer, technical support, and signboards to farmers for local cultivation demonstrations	428 acres	713 people (farmers)	◎	Rice cultivation is an important livelihood for farmers in the Haor region and is effective.
Tree-planting activities						
15	Afforestation (Sapling of Hijol and Pulm tree)	Nunnir, Naogaon (Part A & B) Afforestation in Haor	13 km (25,000 Hijol and Karoch trees planted)		○	Although afforestation is limited to certain areas, it is effective as a flood prevention measure.
Other activities						
16	Value Chain Development and Marketing	-	-	-		
	Total beneficiaries	71,890 people (WMG members)				

*◎ is effective, ○ is somewhat effective, △ is effectiveness is unknown

Source: JICA Survey Team

Table 5.3.4 Haor Phase 1: Small-scale Livelihood Improvement Review

Small-scale Income Generation Sub Project (SIGS)		Contents of Activity	Project Number	Total Number of Beneficiaries	Review*	
Training aimed at improving livelihoods, primarily for women						
1	Homestead Vegetable Cultivation and Support Service Scheme	Training for home gardening		5,845 people (families)	◎	Home gardening is not only beneficial for providing nutrition to the table, but also for improving livelihoods during the rainy season, as farmers can earn an average of BDT 1,130 per 1 decimal (40 m^2) of land.
2	Poultry (Duck) Rearing and Support Service Scheme	Poultry farming training to improve the livelihoods of poor women	148,315 ducks distributed	7,612 people (poor women)	◎	The burden on poor women in terms of housework and care work is relatively light, making it effective in

Small-scale Income Generation Sub Project (SIGS)		Contents of Activity	Project Number	Total Number of Beneficiaries	Review*	
						improving their livelihoods.
3	Goat Rearing and Support Service Scheme	Goat-raising training to improve the livelihoods of poor women	Distribution of 5,029 goats	2,862 people (poor women)	◎	The burden on poor women in terms of housework and care work is relatively light, making it effective in improving their livelihoods.
4	Mushroom Production and Support Service Scheme	Two-day training session including mushroom cultivation and sales	3 times	100 people (women)	△	It places relatively little burden on women's housework and care work, and is effective in improving livelihoods, but it is difficult to obtain seed cultures.
5	Training in Basic Tailoring and Support Service Scheme	Nine-day sewing training to improve the livelihoods of poor women	843 sewing machines distributed	843 people (poor women)	◎	The burden on poor women in terms of housework and care work is relatively light, making it effective in improving their livelihoods.
Seed distribution activities to promote vegetable and fruit cultivation						
6	Small- scale Vegetable Production and Support Service Scheme	Distribution of seeds for vegetable cultivation	492 acres	5,192 people (farmer)	○	Vegetable cultivation generates an average profit of BDT 1,130 per 1 decimal (40 m^2) of farmland, making it effective.
7	Fruit Production and Support Service Scheme	Distribution of seeds for fruit cultivation (banana, papaya, mango, etc.)	170 acres (24 farms)	748 people (farmer)	○	Fruit consumption is low in the region, so it is effective as a means of inoculating vitamins and minerals and as a means of reproducing the seeds.
Other Activities						
8	Distribution of Solar Panel for Household Electricity Supply and Support Service Scheme	Distribution of solar panels		82 (families)	△	Support targeted at poor households and not effective in improving livelihoods.
9	Mother and Child Care and Support Service Scheme	Medical support for mothers and children, including medication and medical consultations	36 times	1,080 people (women)	△	Support targeted at mothers and children, not effective in improving livelihoods.
10	Improved Cooking Stoves	Support for cooking stoves with chimneys		1,875 people (families)	△	Support targeted at poor households and not effective in improving livelihoods.
	Total beneficiaries	26,239 people (WMG members)				

*◎ is effective, ○ is somewhat effective, △ is effectiveness is unknown

Source: JICA Survey Team

(5) Proposals for Agricultural Promotion and Livelihood Improvement Activities in Phase 2

The agricultural promotion and livelihood improvement activities in Phase 1 targeted farmers and women throughout the target haor area and involved various activities to improve rice cultivation and other crop cultivation techniques and livelihoods. As a result, individual rice cultivation techniques improved, and an increase in women engaged in sewing and retail work contributed to livelihood improvements. However, it was difficult to see any significant impacts that would resolve the region's overall issues.

The agricultural priorities in the haor area are protecting Boro rice cultivation from frequent disasters caused by climate change, moving away from Boro rice monoculture and diversifying residents' livelihoods. Therefore, in Phase 2, priority is placed on establishing components that address these issues.

Table 5.3.5 Proposed Agricultural Promotion Activities in Phase 2

Climate Change Resilient Agriculture Sub Projects (CCRS)		Contents of Activity
1. Activities to introduce and promote early-harvest, cold-tolerant rice		
1	Extension of rice (early-harvest variety) and seed production in demonstration farm	Utilizing NGOs to cultivate rice and produce seed rice in demonstration fields for early-harvest and cold-resistant varieties.
2	Adaptive trial of rice (early harvest variety) by collaboration with IRRI, BRRI in five districts	In collaboration with IRRI and BRRI, early-harvest varieties will be cultivated experimentally to identify varieties suitable for haor area.
3	Seed distribution of early-harvest rice	Distribute early-harvest rice seeds, fertilizer, signboards, etc. to farmers and provide technical support (from the second year onwards)
4	New technology transfer (rice for BRRI)	BRRI conducts training for farmers to transfer technology for cultivating new varieties.
5	Research-extension-farmer dialogue	BRRI provides rice cultivation technology training for farmers through dialogue with them.
2. ① Water-saving intermittent cultivation ② Activities for the introduction and dissemination of rice straw compost and silica materials		
1	Boro rice cultivation under AWD, trial for using compost, SiCaO4, carbon emission experiment	Distribute Boro rice seeds, fertilizer, signboards to farmers; promote rice cultivation using water-saving and intermittent cultivation; apply rice straw compost/silica materials; and provide technical support in cooperation with agricultural universities.
2	Irrigation through solar pump	Introducing solar panel irrigation to promote water-saving intermittent cultivation.
Small-scale Income Generation Sub Project (SIGS)		**Contents of Activity**
3. Activities for the introduction of cash crop cultivation		
1	Upland Cash Crop Cultivation	Distribute cash crop seeds, fertilizer, and signboards to farmers and provide technical support. After that, hold a preliminary meeting with farmers to start Boro rice cultivation all at once.
2	Value-chain Development and Marketing	Train farmers on how to select and sell markets for cash crops.
3	Small scale Vegetable Production and Support Service Scheme	Distribution of vegetable seeds.
4	Fruit Production and Support Service Scheme	Distribution of fruit cultivation seeds (e.g., banana, papaya, mango).
4. Small-scale livelihood activities for women		
1	Training on Poultry and Livestock Rearing	Poultry and livestock farming training (for women).
2	Poultry (Duck) rearing and Support Service Scheme	Distribution of poultry (ducks) to improve women's livelihoods.
3	Sheep rearing and Support Service Scheme	Distributing sheep to improve women's livelihoods.
4	Training on "Paramedical Veterinary"	Veterinarian assistant training.
5	Training of Basic Tailoring and Support Service Scheme	Nine-day sewing training and sewing machine provision to improve the livelihoods of poor women.
6	Training on Homestead Vegetable Cultivation (Women)	Home gardening training for women.
7	Training on how to make vermicompost	Vermicomposting training + provision of a vermicompost hatch.

Climate Change Resilient Agriculture Sub Projects (CCRS)		Contents of Activity
8	Mushroom cultivation training	Mushroom cultivation training.
5. Mainly training-related		
1	Farmer Training Program specially for agricultural promotion	Train farmers (30 people/batch) on new technologies such as flash flood prevention (including the promotion of early harvest rice and flood warning response).
2	Farmer Field School establishment (30 person)	A 16-day field school training course for farmers on Boro rice cultivation led by master trainers (including the promotion of early harvest rice and flood warning response).
3	ToT (Training of Trainers) for-IFM (Integrated Farm Management) for FFS (Farmer Field School)	A 20-day training course to learn about comprehensive agricultural management, including rice cultivation, other crops, vegetables, and livestock, with the aim of developing master trainers who will conduct farmer training (farmer field schools).
4	Nursery Management training & establishment	A three-day seedling production training course to learn about vegetable and fruit seed production, seedling cultivation, grafting methods, and seedling sales.
5	Homestead Vegetable Cultivation and Support service scheme	Home vegetable gardening training.
6	Farmer Field visit program to RDA/BARD	Farmers visit to Rural Development Institution.
7	WMG member visit to successful projects	Farmers visit successful projects.
6. Tree planting activities		
1	Afforestation (Sapling of Hijol & Pulm tree)	Planting trees in Haor.
7. WMO Formation		
1	Targeting 11 Haor	

Source：JICA Survey Team

(6) Climate Risk Assessment and Adaptation Measures

Climate risk assessments for agricultural promotion activities in haor areas predict increased risks, primarily from floods and heavy rains. The Project's target population is estimated at approximately 25,000 farmers and 25,000 women. In 2017, severe floods devastated rice crops in Sunamganj, Netrokona, and Kishoreganj districts. The climate risk assessment for the region, presented in Chapter 5 (Flood Mitigation) (Figure 5.1.1), highlights the possibility of increased flood damage to Boro rice in the future and calls for adaptation measures to address flash floods. Because most farmers in haor areas rely solely on the Boro rice harvest for their livelihoods, measures to counter sudden flash floods that occur during the Boro rice harvest are crucial.

Boro rice is harvested by mid-May each year, but sudden flash floods occurring before harvest can sometimes damage the Boro rice and prevent harvesting. In recent years, the effects of climate change have led to the occurrence of larger-than-expected flash floods during the pre-monsoon season (mid-March to mid-May), and a needs assessment has revealed frequent damage to immature Boro rice before harvest in Kishoreganj, Sunamganj, Habiganj, and Sylhet districts. This calls for urgent countermeasures. In Habiganj District, the high-yielding variety BRRI 29 is widely used as the representative Boro rice variety (average yield 7.5 MT, average maturity 160 days). However, depending on the sowing time, there is a risk of low temperatures during the panicle formation stage and of flash floods during the harvesting period. To address these issues, the Habiganj Rice Research Institute recommends sowing seeds at the appropriate time (see Table 5.3.6).

Table 5.3.6 Relations Between Time of Sowing of Boro Rice and Disaster Risk

Sowing Date	Panicle Formation Stage	Harvesting Stage	Risks Encountered
October 15 (Early sowing)	February 14	April 10	If rice is sown early and the young panicle formation period is exposed to temperatures below 20°C, the risk of sterility increases.
November 15 (Late sowing)	March 3	May 2	Late sowing means that the rice panicle formation stage is not exposed to low temperatures, but the risk of experiencing flash floods during harvesting increases.
November 1	February 24	April 20	No problem.

Source : Share the Planet document: "Practice and dissemination of disaster-resilient, climate-adaptive agriculture" published date: May 22, 2023

In addition to BRRI 29, farmers in the region tend to cultivate HYV varieties (yielding 8 MT/ha or more) such as BRRI 89 and 92, which have higher yields. However, these varieties all have a long growing period of 150–160 days, and if care is not taken with the sowing period, the risk of encountering the risks listed in Table 5.3.6 increases. To mitigate these risks, BRRI has developed early harvesting varieties with shorter growth periods (see Table 5.3.7) and is promoting their adoption in the Haor region.

Table 5.3.7 Examples of Early-harvest Varieties Developed by BRRI

Early-harvest Variety	Standard Growing Days	Average Yield （MT/ha）	Appearance of a Grain of Rice
BRRI 67	143 days	6	Medium and Slender
BRRI 84	141 days	6.5	Medium and Slender
BRRI 88	142 days	7	Medium and Slender
BRRI 96	145 days	6.5-7	Short Grain
BRRI 100	148 days	8.8	Medium and Slender
BRRI 103	143 days	8.15	Medium and Slender
BRRI Hybrid 5	145 days	8.5-9	Long and Slender
BRRI 29 (reference)	160 days	7.5	Medium and Slender

Source：ABOUT BRRI 2023

Therefore, the promotion of these early-harvest varieties could potentially have a certain effect as a flood countermeasure, and it is necessary to explore means of promoting their adoption.

(7) Measures Against Rice Blast Disease

The most popular rice variety in the area, BRRI 29, has low resistance to blast disease, which is increasingly spreading and causing. Therefore, control measures are necessary. Basic measures against blast disease are preventing the spread of infection by not taking infected rice straw outside the affected area, and disinfecting seeds by agricultural chemicals. Excessive fertilization is also related to the disease. Since the local area generally relies on urea fertilization, excessive nitrogen fertilization promotes the spread of blast disease. Farmers need to be instructed on proper fertilization practices.

In addition, supplementing rice with “Silica” is essential to prevent blast disease. Rice is called a silica plant and absorbs more than ten times as much silica as nitrogen. The silica absorbed by the plant strengthens the rice cell tissue, prevents the invasion of pathogens, and provides resistance to the disease. Supplementing with silica by applying silicic acid materials is an effective measure against blast disease. Silica is much contained in rice straw, and in Japan, rice straw is returned to rice fields after harvest to help supply silica to the following year's crop. However, in Bangladesh, rice straw is piled up as feed for livestock such as cows; thus, silica is continuously taken out from rice fields, and the cycle of supplying silica to rice fields has been interrupted. In addition, in Bangladesh, agricultural extension does not teach the use of silica materials in the fertilization system for rice cultivation, and the use of silica materials is not generally recognized. Under these circumstances, it is necessary to educate the concerned people and disseminate the use of silica materials, such as by mixing silica materials into the soil at the same time of fertilization before planting.

(8) Examination of the Possible Use of Japanese Technology

As mentioned above, the effectiveness of silicate additives in rice cultivation has been discussed. In Japan, with the increase in crude steel production, research and dissemination of the agricultural use of slag—a by-product of iron extraction from iron ore—has been promoted since the 1950s. Specifically, research and dissemination of calcium silicate derived from slag in rice cultivation have been promoted. Experimental studies in Japan have shown that rice plants absorb approximately 110 kg of silica per 1,000 m^2 per year, of which 56 kg comes from the soil (including silica provided by rice straw plowed into the soil) and approximately 13 kg from irrigation water, leaving a deficit of approximately 41 kg. This deficit must be compensated for with silicate additives, and calcium silicate has traditionally been applied to rice cultivation in Japan. In recent years, the need for silicate additives has increased to improve rice plant tolerance to high summer temperatures due to climate change.

Meanwhile, fertilization of rice crops in Asia, as seen in the fertilization system in Bangladesh, primarily involves the application of nitrogen, phosphate, and potassium. Silica, which is said to be required at approximately ten times the rate of nitrogen application for rice cultivation, is completely unheard of. In this context, the application of calcium silicate, which Japan has promoted for rice cultivation, could potentially be utilized in Bangladesh as a Japanese technology. Furthermore, converter slag—derived from slag—is also effective in improving the highly acidic soils widespread in Bangladesh, and its effectiveness has been demonstrated in Japan. To obtain calcium silicate, the location of a nearby steelworks that generates slag is essential. However, in Bangladesh, iron is extracted from scrap iron products, so no slag is generated as a by-product. Importing calcium silicate from neighboring India, which actively produces crude steel, is therefore promising. As of 2024, India's crude steel production volume was approximately 150 million tons. The country aims to increase this to approximately 300 million tons by 2030, which is expected to result in the generation of a large amount of by-product slag. Producing approximately 1 ton of crude steel generates approximately 150 kg of slag, the source of calcium silicate. Therefore, producing 100 million tons of crude steel would generate approximately 15 million tons of slag annually, making its utilization a challenge. The Konoike Group, a Japanese company that has long been commercializing slag in Japan, is focusing on the expansion of crude steel production in India. Starting in 2025, the group began promoting the use and dissemination of slag in India and has already demonstrated the effectiveness of using calcium silicate in rice cultivation on Indian farms.[3]

5.3.2 Fisheries Promotion Activities

(1) Fisheries in the Haor Region

The fisheries and aquaculture sector in Bangladesh plays a critical role in the national economy, food security, and employment generation, contributing more than 3.5% of the national GDP. About 11% of the population is engaged in this sector, making it an indispensable part of rural livelihoods.

Among the main ecosystems that support this sector, the Haor region, an extensive floodplain mainly located in the northeastern part of the country, stands out for its rich aquatic biodiversity and seasonal productivity. The Haor region comprises bowl-shaped lowland basins (floodplains) that become large, continuous water bodies during the monsoon season, while shrinking considerably in the dry season. Within the haor system are numerous small, relatively deep natural depressions known as Beels, which connect to surrounding water bodies during the rainy season and function as isolated water bodies during the dry season. Due to these geomorphological and hydrological characteristics, haors serve as important sites for both capture fisheries and seasonal aquaculture. These dynamic topographic and climatic conditions make haors a critical hub for capture fisheries as well as seasonal aquaculture practices, such as short-term enclosure-based fattening in isolated dry-season Beels or off-season aquaculture during non-rice periods. Natural depressions and wetlands within the haor, which retain water throughout the year or nearly year-round, are referred to as Beels. During the monsoon season, they form part of vast interconnected water systems, while in the dry season, they become isolated ponds or lakes. As such, they play an important role as habitats for fish and other aquatic organisms and contribute significantly to regional biodiversity. It is estimated that the Haor region contains approximately 4,500 Beels,

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[3] Source Konoike group web page: "The research and development is being conducted in collaboration with an Indian startup company for the manufacturing and sales of soil improvement agents utilizing steel slag"

accounting for more than 20% of the country's inland water bodies used for fisheries, thereby making substantial contributions to Bangladesh's inland fisheries.

On the other hand, haors are one of the poorest regions in Bangladesh. Concerns are rising over the decline in the fisheries and aquaculture sector due to overfishing in Beels, habitat degradation from siltation, insufficient conservation measures, and restrictive leasing systems. Although many households in haors rely on fisheries for their livelihoods, they face the constraints mentioned above, and there is a pressing need for appropriate interventions to support sustainable fisheries development. From an environmental standpoint, it is also crucial to preserve Beel ecosystems to maintain biodiversity, including fish species.

(2) Fisheries Promotion Activities under the Haor Flood Management and Livelihood Improvement Project (HFMLIP)

This section reviews the content, effects, and challenges of fisheries promotion activities under the predecessor project to the current "Haor Region Resilience Enhancement and Development Project", the "Haor Flood Management and Livelihood Improvement Project (HFMLIP)", (hereafter referred to as Phase 1) to support more effective fisheries and aquaculture development strategies.

Phase 1 implemented fisheries development and aquaculture promotion activities based on the Haor Master Plan (2012), aiming to improve productivity in the Haor region, restore biodiversity, and enhance community resilience. The Haor Master Plan is currently undergoing an evaluation and revision process, with a draft published for public comments. The proposals in this chapter take into account the direction indicated in the draft revision.

An overview of Phase 1 is presented below.

(2.1) Community-based Fisheries Development

(a) Activities

The fisheries development under Phase 1 aimed to empower local communities, restore ecological balance, and sustainably increase fish catch. A community-based fisheries management (CBFM) approach was adopted, based on a MOU between the Ministry of Land and the Local Government Division (LGD). Through LGED, 139 Beels were transferred to the Project, and the following initiatives were carried out:

- Formation and capacity building of community-based organizations for sustainable fisheries management.
  - ✓ BUGs (Beel User Groups) were established in the 139 transferred Beels, and capacity development training was provided on organizational management, resource management (compliance with closed seasons, establishment and management of sanctuaries, understanding of fisheries regulations), leadership, aquaculture techniques, and hygienic management of drying and fermentation processing.
- Restoration of water bodies, including rivers and canals, to improve fish habitats and migration routes.
  - ✓ A total of 118 Beels were excavated, improving the aquatic environment.
  - ✓ A total of 90,000 wetland trees were planted around embankments to prevent erosion and provide habitat (including hiding and feeding places) for aquatic life.
- Establishment and enforcement of community-based management for fishing regulations and seasonal closed seasons to protect broodstock and juvenile fish.
  - ✓ Sanctuaries were established in 102 Beels by BUGs. These sanctuaries consist of deepened areas within the Beel to secure perennial water zones, functioning as community-managed no-fishing zones to protect broodfish and juveniles. They were operated in combination with

boundary markers, tree planting, compliance with closed seasons, and restrictions on harmful fishing gear to maintain or restore species diversity and productivity.

- Installation of boundary pillars to clarify the borders of each Beel.

(b) Effects of Community-based Fisheries Development

According to the Project Preparation Study by LGED[4] and research conducted by WorldFish[5], the following activities significantly contributed to both livelihood improvement and ecological restoration:

- According to the Services Completion Report (SCR), the total fish production in the BUG-managed target Beels under Phase 1 in 2023 was approximately 1,260 tons, with total sales reaching around BDT 2.20 billion. In comparison, sales in 2016 were only about BDT 0.069 billion, indicating an approximate 32-fold increase. Similarly, according to the WorldFish 5th Round Survey and the Pre-Feasibility Study conducted by LGED, total fish production in the 25 monitored Beels increased from 106 tons in 2017–2018 to 165 tons in 2020–2021 (+56%), and productivity improved from 245 kg/ha/year (2017–2018) to 360 kg/ha/year (2020–2021).

- According to SCR, cumulative profit distribution reached approximately BDT 54.07 million, with 3,971 beneficiaries (27% women). These activities undertaken by BUGs were not implemented before the Project; therefore, the outcomes can be considered newly created by the Project.

- Similarly, SCR reported that BUG members collectively saved about BDT 8.1 million (approximately JPY 9.3 million) as funds for future activities.

- In addition to shared profits, local male beneficiaries earned more than BDT 50 million (about JPY 57 million) in wages from Beel maintenance, fish harvesting, and sales.

Furthermore, changes in the livelihoods of individual BUGs and residents are summarized below (Table 5.3.8) based on the results of a WorldFish report investigating and comparing the effects of fisheries promotion in Phase 1 on improving livelihoods and the Phase 1 Completion Report.

Table 5.3.8 Ratio of BUG Beneficiaries' Income and Catch Volume

Items	2018 (Baseline)	2023 (3rd Survey)	Rate of Change
Average annual fish catch per BUG household (kg)	1,900 kg	5,400 kg (Note 1)	+184%
Average fishing income of BUG households	BDT 66,400	BDT 111,440 (Note 2)	+68%
Average monthly income by CAIGA	None	BDT 2,833	+100%
Average annual total income of BUG households	BDT 111,450	BDT 243,321	+118%
Average unit price of fish sales (BDT/kg)	BDT 142	BDT 191	+34%

Source: JICA Survey Team

The values “Annual Fish Catch per Household” and “Average Fisheries Income” require careful interpretation.

With regard to Note 1, annual catch values represent fish catches aggregated at the household level under BUG-based collective management, not the daily individual catches of fishers. In the Haor Beel management system, in addition to daily individual catches (typically 1–4 kg/person/day), major harvests (large-scale collective harvesting events) are carried out once or several times a year. Depending on the size of the Beel, a single major harvest can produce several hundred kilograms to several tons of fish. These collective harvests are distributed among BUG member households, resulting

4 Project Preparation/Pre-Feasibility Study Report for Haor Flood Management and Livelihood Improvement Project (HFMLIP)-LGED Part (Phase-2)
5 Final Report of Fish Catch Monitoring and Bio-diversity Impact. Study of HFMLIP-LGED/WorldFish. 2023.

in large household-level annual catch volumes. Household-level annual catch volumes ranging from 1.5 to 7 tons were observed in WorldFish's 5th Round Survey and SCR data, and the average value of 5.4 tons reflects the distribution influenced by these collective harvests. Thus, the figures do not represent "individual fishing capacity", but rather the total catch distributed to households under collective management of Beel resources.

With regard to Note 2, the "Average Fisheries Income (BDT 111,440)" represents the net income received by households after deducting collective management expenses, annual lease fees, and fishing operational costs, and after allocating shares of collective harvests to each household. In contrast, the reference value "BDT/kg = 191" is a gross sales price, calculated by dividing total sales revenue by sales volume without deducting expenses. Additionally, catch volumes include self-consumed fish, which are not reflected in cash income. Therefore, dividing net income by catch volume will not match the gross sales price per kilogram—these two indicators measure different concepts.

In addition, based on the results of surveys conducted by World Fish from 2017 to 2022 to evaluate the catch and fish diversity in Phase 1, the changes in the number of fish species occurring over time in 25 project-targeted Beels and five non-project-targeted Beels (control areas) among the target haors were monitored (Table 5.3.9).

Table 5.3.9 Number of Beels Surveyed in each Haor

District	Name of Haor	Number of Beels Targeted by the Project	Number of Beels not Covered by the Project
Sunamganj	Tanguar Haor	9	2
Netrokona	Mohanganj Haor	4	1
Kishoreganj	Itna Haor	4	1
	Austogram Haor	2	0
Brahmanbaria	Meghna Basin Haor	1	0
Habiganj	Khowai Haor	5	1
Total		25	5

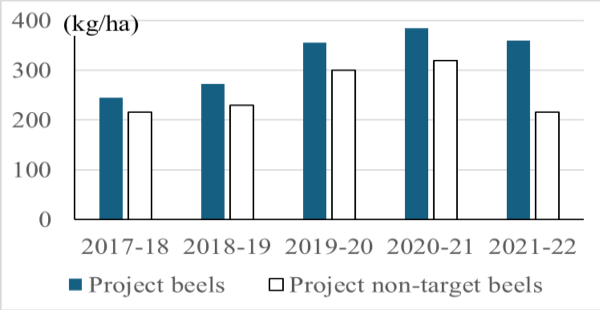
Source: JICA Survey Team

Figure 5.3.7 shows the changes in fishery production per hectare in project-targeted and non-project-targeted Beels from 2017–2018 to 2021–2022.

In project-targeted Beels, catch per hectare increased from 245 kg/ha/year to 384 kg/ha/year in 2020–2021, taking 2017–2018 as the baseline. It decreased in 2021–2022 (360 kg/ha/year) but still increased by 47% compared to the baseline. A regression analysis using annual average values (dependent variable: production per hectare; independent variable: intervention-period dummy variable = 1 for 2018–2019 onward) showed a high coefficient of determination ($R^2 = 0.7869$), suggesting the project intervention contributed to increased productivity.

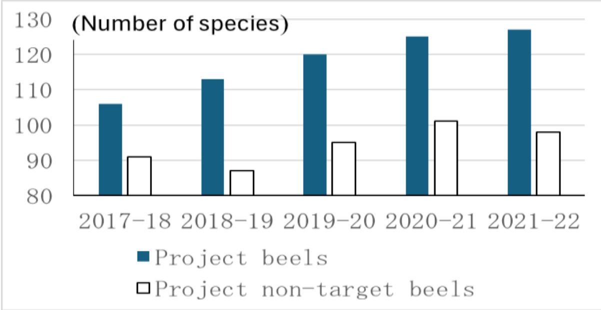
In non-project Beels, productivity increased temporarily from 215 kg/ha/year to 320 kg/ha/year in 2020–2021, but returned to near-baseline levels (216 kg/ha/year) in 2021–2022. The regression analysis yielded $R^2 = 0.0847$, indicating no sustained trend, and changes were likely due to external factors such as environmental variability.

Figure 5.3.8 also shows the total number of fish species that appeared in project-targeted and non-targeted Beels. Because the number of Beels surveyed differs, a simple comparison of the number of species that appeared is not appropriate. For this reason, a regression analysis of the obtained data showed a consistent increasing trend for project-targeted Beels with $R^2 = 0.963$, while the increasing trend was relatively weak for non-project-targeted Beels with $R^2 = 0.636$. Therefore, it can be interpreted that the number of species that appeared tends to increase year by year in project-targeted Beels, while the number of species that appeared in non-project-targeted Beels fluctuates from year to year, with no consistent increasing trend being observed.



Source: JICA Survey Team

Figure 5.3.7 Changes in Emergent catch per Hectare over Time



Source: JICA Survey Team

Figure 5.3.8 Changes in the Number of Fish Species Found over Time

(c) Challenges Identified in Phase 1 – Restrictive Beel Leasing System

Bangladesh's Beel leasing system is based on the "Jalmohal" policy. This policy aims to conserve fishery resources and improve the livelihoods of fishers by giving priority to allocating fishing rights in state-owned water resources (e.g., lakes, rivers, Beels) to "real fishers." It was revised in 2009 to include preferential leasing to fishermen's cooperatives and the establishment of permanent protected areas, in an effort to promote sustainable resource use. The main mechanisms are as shown in Table 5.3.10.

Table 5.3.10 Key Mechanisms of the Jalmohal Policy

Item	Contents
Purpose	Ensuring profits through management of national waters, sustainable use of fishing resources, and livelihood support for the poor.
Responsible Authority	Mainly Ministry of Land.
Eligible Entities	Small-scale fishing groups and Fishermen Cooperative Societies (FCS). Only formally registered cooperatives are eligible. Groups including non-fishers are excluded.
Lease Allocation Methods	Competitive tender (auction-based lease) or direct lease to registered FCS.
Lease Duration	Three to six years. Long-term use is possible through repeated re-bidding.

Source: JICA Survey Team

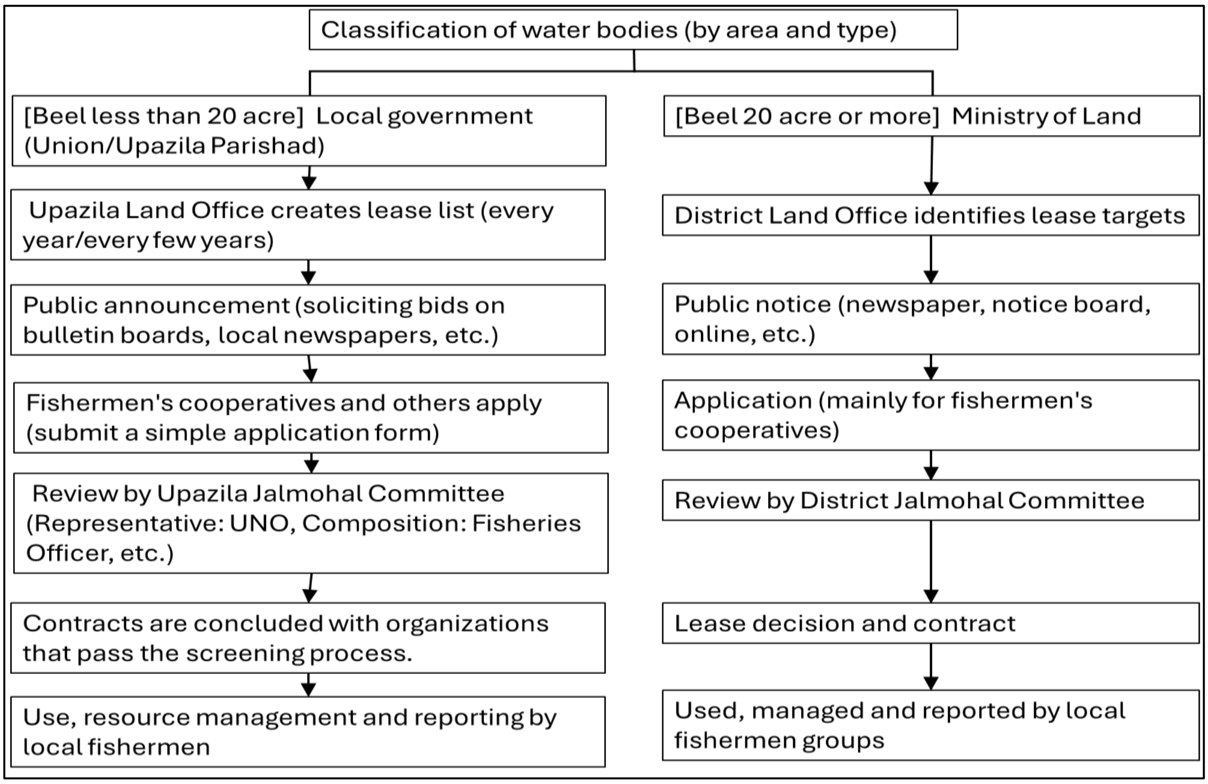
The management system is as shown in Table 5.3.11.

Table 5.3.11 Management Authority by Area Under the Beel Leasing System

Water area	Management agency	Supervisor	Remarks
Less than 20 acres (approximately 8.1 hectares)	Upazila	Upazila Nirbahi Officer (UNO)	Bidding is done at the local level.
20 acres or more (approximately 8.1 hectares or more)	District	Deputy Commissioner (DC)	Targeted at relatively large Beels. Bidding prices tend to be high.

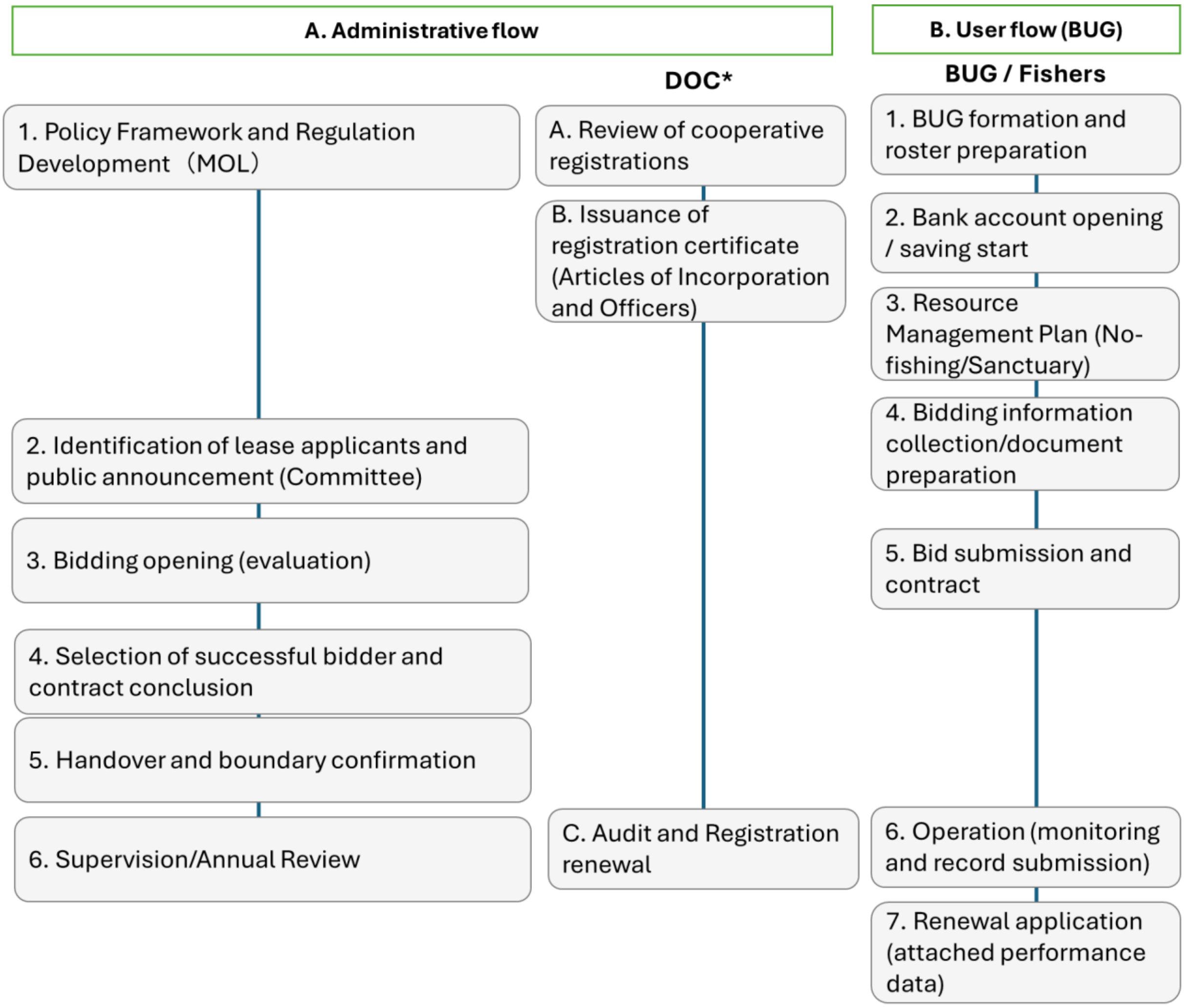
Source: JICA Survey Team

The flow of the above system overview is shown in the Figure 5.3.9, and the implementation flow for the administration and users is shown in Figure 5.3.10.



Source: JICA Survey Team

Figure 5.3.9 Jalmohal Management System



Source: JICA Survey Team

Figure 5.3.10 Jalmohar System (Administrative / User Flow)

Although the system aims to encourage ordinary residents and communities to manage the Beel, there are some serious problems that are causing the depletion of fisheries and marine resources and hindering poverty reduction. The main issues are as follows.

① Inaccessibility for Poor Local Fishers

The institutional requirements—such ascooperative registration by the Department of Cooperatives (DOC), approval by the Jalmohal Committee, bidding procedures, and security deposits—create barriers for poor local fishers. Because bidding requires substantial initial capital, leases tend to be won by wealthy individuals or influential local elites. Local fishers often must pay high fishing access fees to the leaseholder, leaving them with minimal profits. As a result, the system's intended purpose (providing opportunities for local fishers) is undermined.

② Lack of Investment Incentives

The real obstacles to investment are thought to be institutional issues, such as (1) uncertainty about when the next renewal will be, (2) vague rules for dividing profits and saving, and (3) a lack of formal registration as a cooperative. Without these in place, there is a strong tendency to prioritize immediate catches and catch as much as possible that year, making it difficult to make progress in efforts to increase future resources, such as protecting spawning grounds and planting trees.

③ Limited Incentives for Conservation Activities

Wealthy lessees often do not actually live near the target Beels or the target Beel is not directly involved in their primary livelihood, so they have little incentive to implement fishery management practices in the target Beels, such as establishing protected areas or closed season during breeding season.

These challenges hinder the promotion of the above-mentioned community-based management approach. Although the Jalmohal management policy was revised in 2009 to provide preferential leases to local fisher groups, there have been reports that it has not functioned adequately in some areas. The background factors include variations in the interpretation of priority criteria, insufficient establishment of systems for screening and monitoring, the procedural and financial burden required for cooperative registration and participation in bidding, difficulties in coordination among relevant agencies, and the fact that procedures for filing objections have not sufficiently penetrated the field. In order for local residents to protect the Beels and use them fairly, it is necessary to organize local fishers, improve their livelihoods, obtain lease rights, and establish a management system that enables sustainable management of the Beels. When implementing fisheries development measures in Phase 2, a management system that can substantially improve the abovementioned challenges will be essential.

(2.2) Aquaculture Promotion Activities

(a) Activities

Aquaculture plays an important role in improving the livelihoods of rural residents in Bangladesh. The country possesses some of the richest inland water resources in the world, and the potential for further development in this sector, especially in the Haor region, is considerable. In Phase 1, aquaculture activities directly supported by the Project reached several hundred households, such as 210 cases of homestead aquaculture. On the other hand, according to the Pre-Feasibility Study conducted by LGED, the five target districts contain an even larger number of household ponds and seasonal water bodies, many of which remain underutilized for household consumption or low-input extensive use. This indicates that significant opportunities remain for income improvement and nutritional improvement through proper site selection, stocking of seed and feed inputs, and improvement of post-harvest handling and distribution. However, floodplains (haor) are not uniformly suitable for aquaculture, and determination of site suitability is required, considering water-level fluctuations, duration of inundation, micro-topography, embankment stability, feeding, and access conditions. In addition, in the haor, due to seasonal bias in fish catch and the weakness of cold-chain systems, opportunities for value addition beyond household consumption tend to be limited. Participation by women is particularly well suited to hygienic, home-based processing (e.g., drying, smoking, salting, simple cooking / hygienic packaging), and is considered rational in terms of both livelihood diversification and reduction of post-harvest loss.

Based on this context, Phase 1 implemented five types of aquaculture and fish processing activities targeting poor households and women:

- **Homestead Aquaculture:**

Small-scale fish farming typically carried out in household ponds near homes.

- ✓ A total of 210 units were established across five target districts, with 87 men and 153 women (240 total beneficiaries) participating.

- **Daudkandi Model Floodplain Aquaculture:**

Community-based seasonal aquaculture conducted in floodplains, a model originally developed in Daudkandi, Bangladesh.

- ✓ Five floodplain aquaculture units were set up in Habiganj, Sunamganj, and Netrokona districts, with 103 men and 36 women (139 total beneficiaries) participating.

- Net Pen Aquaculture:

Open-water aquaculture using large enclosures (nets) installed in natural water bodies such as rivers and lakes. Water flows freely through the pens, allowing fish to grow in near-natural conditions.

- ✓ Eight net pen units were installed in Sunamganj, Netrokona, Kishoreganj, and Brahmanbaria districts, with 129 men and 43 women (172 total beneficiaries) participating.

- Cage Culture:

Similar to net pen culture but with cages floating on the surface of the water and fixed in place to prevent drifting.

✓ Five cage units were set up in Brahmanbaria and Kishoreganj, with 44 men and 6 women (50 total beneficiaries) participating.

- Fish Processing:

Traditional and low-cost fish preservation methods in Bangladesh, especially useful in remote or flood-prone areas. Enables long-term storage without refrigeration, adds value to fish catches, and provides year-round income.

✓ Women's groups were formed, consisting of nine members in Habiganj and 11 in Sunamganj.

(b) Effects of Aquaculture Promotion Activities

According to the project preparation study by LGED, the above activities contributed to improving livelihoods in the project areas as follows:

- Homestead Aquaculture

In homestead aquaculture, a total of BDT 8,749,951 was provided as financial support to 210 ponds of beneficiary households (BUG members) through LGED from the project budget. Comparing baseline data from FY 2019–2020 with production (total volume), production value (total), productivity per unit area, and annual household income at project completion (FY 2021–2022), the results are shown in Table 5.3.12.

Table 5.3.12 Changes in Homestead Aquaculture Activity Data in Phase 1

Items	2019–20 data (baseline)	At the end of the project (FY2021–22)	Increase/change
Production volume (total amount)	5,205 tons (5,205 kg)	268.64 tons (268,640 kg)	Approx. 51.6-fold increase
Production value (total amount)	BDT 390,375	BDT 31,630,000	Approx. 81-fold increase
Average production volume per unit area	510 kg/ha	2,611 kg/ha	Approx. 5.1-fold improvement
Average annual income per household	BDT 16,265	BDT 36,458	Approx. 2.24-fold increase

Source: JICA Survey Team

Through this activity, total production volume and total production value increased significantly. However, these figures are totals, and increases due to scale factors—such as the expansion of participating households/ponds and the number of cycles—are also included. Therefore, they do not directly represent productivity improvement for the same households. Productivity per unit area improved approximately five-fold (e.g., 510 → 2,611 kg/ha/year). This “five-fold” increase is not an average, but an example observed in ponds where initial production in Phase 1 homestead aquaculture had been extremely low. Because many household ponds had previously been managed for home consumption with low inputs, substantial improvement was possible through basic management such as pond preparation before stocking, improved seed size, proper stocking density, polyculture combinations, standardized feeding and fertilization, and measures against predation and escape. Consequently, the improvement ratio appears large. In contrast, in floodplain aquaculture, even with similar interventions, productivity improvement is generally around 1.8 times, because the water bodies are large, and controlling water quality, feeding, and escape prevention is more difficult. This difference arises from structural differences between small, manageable household ponds and extensive, difficult-to-manage floodplain environments. Meanwhile, large increases in total production also include the expansion of participation and improvement in record-keeping. Annual household income more than doubled, contributing significantly to livelihood improvement. As noted above, women accounted for about 64% of participants (153 out of 240), indicating a positive effect on women's economic support.

- **Daudkandi Model Floodplain Aquaculture**

The Daudkandi model floodplain aquaculture activity received BDT 2.77 million (JPY 3.19 million) from the project as operating expenses. Table 5.3.13 shows the results of a comparison of production volume (total volume), production value (total amount), production volume per unit area, and annual income per household at the end of the project (2021-22) using data from 2019-20 as the baseline.

Table 5.3.13 Changes in data on Daudkandi model floodplain aquaculture activities in the first phase

Items	2019–2020 Data (Baseline)	At the End of the Project (FY 2021–2022)	Increase/Change
Production volume (total amount)	52.2 tons	162.3 tons	Approx. 3.1-fold increase
Production value (total amount)	BDT 3,920,000	BDT 13,590,000	Approx. 3.5-fold increase
Average production volume per unit area	1,435 kg/ha	2,670 kg/ha	Approx. 1.86-fold increase
Average annual income per household	BDT 15,680 /year	BDT 35,250/year	Approx. 2.25-fold increase

Source: JICA Survey Team

As mentioned above, the model has been effective in terms of both productivity (kg/ha) and livelihood improvement (BDT/household). Total production increased approximately 3.1 times. However, this is a total comparison, and increases in participating areas, households, and cycles are also aggregated. Yield per unit area improved due to a combination of operational improvements, such as timely stocking, proper density, water management, reduced escape and predation through enclosure, use of fertilization and partial feeding, joint surveillance, partial harvesting and market-timing adjustment, and simple hygienic handling. Annual household income increased approximately 2.25 times, attributable to (i) an approximately 1.86-fold increase in unit-area yield, (ii) an increase in sales price due to partial harvesting and market-timing adjustment and improved seed composition (total production value increased approximately 3.5 times), and (iii) reduced post-harvest losses through simple hygienic handling, resulting in increased saleable volume and sales value. It should be noted that "annual household income" in the table is an indicator of cash income from floodplain aquaculture and does not directly represent net profit after deducting additional costs such as fertilization and feeding. Moreover, because this model is based on "joint contribution" and "resource sharing", participation is limited for the economically vulnerable, and mainly those able to invest capital and labor can take part. In addition, constraints in group coordination and land conditions during activity introduction and management exist. Therefore, technical support and institutional arrangements are required for wider dissemination.

- **Net Pen Aquaculture**

For net pen aquaculture, the data from 2019–2020, for which the Project provided a total of BDT 4.69 million (JPY 5.4 million) for operating expenses, was used as the baseline to compare production volume (total volume), production value (total volume), production volume per unit area, and annual income per household at the end of the Project (2021–2022), as shown in Table 5.3.14.

Table 5.3.14 Changes in Net Pen Aquaculture Activity Data in Phase 1

Items	Data from 2019–2020 (baseline)	At the end of the Project (2021–2022)	Increase/change
Total production	2.5 tons	7.5 tons	3x increase
Total sales	BDT 250,000	BDT 1,050,000	4.2x increase
Production per unit area	1,200 kg/ha	2,350 kg/ha	1.96x increase
Annual income per household	BDT 12,500	BDT 31,750	Approximately 2.54x increase

Source: JICA Survey Team

However, net pen installation requires initial investment in materials and aquaculture techniques, making implementation and dissemination among the poor difficult. Annual household income increased approximately 2.54 times because unit-area productivity increased by about 1.96 times and because sales price increased through partial harvesting and market-timing adjustment. Indeed, total production increased about threefold, while total sales increased about 4.2 times; thus, increased price (about 1.4 times) and reduced post-harvest loss increased saleable volume, contributing to income growth. It should be noted that “annual household income” reflects cash income from the activity and does not indicate net profit after deducting additional costs.

- **Cage Culture**

For fish cage aquaculture, the Project provided a total of BDT 2.05 million (JPY 2.36 million) for operating expenses. As with each of the aquaculture activities mentioned above, the data from 2019–2020 was used as the baseline to compare the production volume (total volume), production value (total volume), production volume per unit area, and annual income per household at the end of the Project (2021–2022) (Table 5.3.15).

Table 5.3.15 Changes in Fish Cage Aquaculture Activity Data in the First Phase

Items	Data from 2019–2020 (baseline)	At the End of the Project (2021–22)	Increase/Change
Total production	1.8 tons	6.8 tons	Increased 3.8 times
Total sales	BDT 180,000	BDT 950,000	Increased 5.3 times
Production per unit area	1,800 kg/ha	3,100 kg/ha	Increased 1.72 times
Annual income per household	BDT 12,000	BDT 30,000	Increased 2.5 times

Source: JICA Survey Team

Cage aquaculture showed increases in unit-area production and household income; however, because it is a feeding-based system, the cost of formulated feed and the feed conversion ratio (FCR) constitute major constraints on profitability. In Phase 1, subsidies for feed and materials were provided, resulting in short-term income increases. However, profitability estimates assuming the absence of subsidies indicate that gross profit level—after accounting for feed cost-to-sales ratios and equipment depreciation—are insufficient, suggesting limited long-term profitability. Therefore, this activity is considered to have only “confirmed certain potential for improvement” and has not reached the level of generating stable profit on a commercial basis. Since initial investment (e.g., floats, nets, frames) is relatively high and suitable sites are limited due to flow and water-quality conditions, it is assessed as unsuitable for continuation solely by economically vulnerable groups or for widespread dissemination under Phase 2.

- **Fish Processing**

20 women who participated in the fish processing activity were each provided with BDT 10,000 from the Project. As with each of the aquaculture activities mentioned above, the data from 2019–2020 was used as the baseline to compare production volume (total volume), production value (total amount), production volume per unit area, and annual income per household at the end of the Project (2021–2022), as shown in Table 5.3.16.

Table 5.3.16 Changes in Fish Processing Activity Data in the First Phase

Item	2019–2020 Data (Baseline)	At the End of the Project (2021–2022)	Changes and Results
Activity details	N/A	Dried fish, fermented fish, small fish products	New diversification
Sales amount (2021–2022)	N/A	Approx. BDT 1,900,000 (Approx. JPY 2.2 million)	New creation
Average annual income per person	N/A	Approx. BDT 17,273 (= 1,900,000 ÷ 110 people)	-

Source: JICA Survey Team

- **Promotion of women's participation:**

Most of the participants were women, and the activity contributed to gender mainstreaming. Annual cash income was BDT 17,000 per person, confirming effectiveness as a cash income source for poor households. This figure is based on sales and does not represent net profit. The processing activities in Phase 1 were household-based, small-scale, supplementary livelihood activities, and because the methods of recording costs (e.g., raw materials, supplies, fuel, labor) varied greatly among households, no unified data existed from which representative net profit levels could be calculated. On the other hand, common effects were confirmed, such as reduction of wastage and spoilage losses, stable small-scale cash income, and expansion of income opportunities for women. The primary objective of the processing activities is not the maximization of profit margins, but rather loss reduction and diversification of women's income sources. In addition, value-added processing such as drying and fermentation is expected to extend shelf life and expand marketability. Fish processing is a relatively new initiative newly introduced in Phase 1, and certain effects were confirmed in terms of increased cash income for women (sales-based) and improved regional income. To promote commercialization, standardization of work procedures (hygiene and quality control) for drying, smoking, and salting, as well as proper labelling, storage, and simple packaging, are required.

In addition, basic accounting management to track costs, inventory, and yield is necessary.

Homestead aquaculture and fish processing was assessed as the most effective of these activities because of its high female participation rate, low cost, ease of implementation by individuals or small groups, and its sustainability beyond the project period.

(c) Challenges in Aquaculture Activities Revealed in Phase 1

In the aquaculture activities implemented under Phase 1, although certain improvements in productivity and household income were confirmed, the following issues were identified from the perspectives of dissemination, scaling-up, and sustainability.

① **Vulnerability to Flooding and Natural Disasters**

Net pen, cage culture, and floodplain aquaculture suffered from flash floods, storm surges, and strong currents, which destroyed infrastructure and reduced participant motivation.

② **High Operational and Implementation Costs**

Cage culture required significant initial investment (e.g., materials, feed, facilities) resulting in costs exceeding profits.

③ **Poor Group Management and Internal Conflict**

Group-based activities like net pen and floodplain aquaculture experienced internal disputes over profit sharing, roles, and decision making due to weak leadership and coordination.

④ **Technical and Environmental Issues**

Water quality in haor varies seasonally, affecting fish health and growth. Inexperience with new methods led to overstocking, poor feeding practices, and frequent losses from predation and theft.

⑤ **Dropout and Low Participation Rates**

Some community members were reluctant to engage in cage culture or unfamiliar techniques such as fermentation. Due to social factors—such as the need for family approval, local customs, gender-based division of roles, relations with neighbors, religious and hygiene norms, security concerns, and seasonal migration—there were cases in which beneficiaries dropped out.

These lessons suggest that Phase 2 should cautiously reconsider activities with profitability or sustainability issues in Phase 1.

(2.3) Alternative Income Generation Activities

(a) Activities

In order to reduce excessive fishing (overfishing) on aquatic resources in the haor and to support livelihood improvement of BUG members—particularly women—HFMLIP Phase 1 introduced alternative income generation activities (CAIGA) suited to the community as follows.

- Training for income improvement in non-fishing occupations such as poultry rearing, tailoring, and handicrafts.
- Support for the establishment and operating capital of micro-enterprises at the household scale through microfinance and a revolving fund. Examples of micro-enterprises include poultry raising, home-based processing/retail, and tailoring/handicrafts.
- Acquisition of financial literacy and micro-enterprise management skills (e.g., cost calculation, inventory management, pricing, simple bookkeeping, sales management) to strengthen the stability of household income.

These initiatives are aimed at enhancing the socioeconomic resilience of communities, particularly during seasons with low fish catch.

(b) Effects of CAIGA Activities

During Phase 1, a total of BDT 41.74 million (approx. JPY 48 million) was distributed to 4,065 BUG members, 27.6% of whom were women. Participants contributed some of their own capital in addition to project funds to start their businesses. The breakdowns are as follows:

- 2,860 participants contributed a total of BDT 25.798 million.
- By June 2023, 2,997 individuals had earned a total profit of BDT 84.578 million from their income-generating activities.
- The combined current value of business assets for 3,994 members was recorded at BDT 125.152 million (approx. JPY 143.93 million).
- Some beneficiaries expanded their businesses by reinvesting part of their income into additional income-generating activities.

These outcomes demonstrate that CAIGA activities were effective in improving the livelihoods of poor BUG members.

(c) Challenges in Phase 1 CAIGA Activities

① Lack of Business and Technical Skills among Beneficiaries

Many CAIGA beneficiaries, especially the poor and women, lacked basic business operation skills such as financial management and marketing. Among some beneficiaries, insufficient basic knowledge in household budgeting, cost calculation, sales, and husbandry management (e.g., hygiene, disease prevention) led to decreased productivity or failure of initial investments. A prerequisite for introducing CAIGA should include completion of basic training beforehand, stepwise provision of materials after training, and standardized short-term accompaniment (visits/consultation) after introduction.

Additionally, it was confirmed that systems were weak in ensuring the sustainability of operation and maintenance (O&M) costs after project completion, reducing dependence on external sources for materials and fingerlings, internalizing operation and accounting within women's groups, strengthening BUG's financial circulation (including savings and renewal funds), and establishing mechanisms for continuous technical support and submission of monitoring and evaluation (M&E) records.

② Limited Market Access

Many haor areas are far from markets and become isolated during the monsoon. As a result, timely sales of products became difficult, reducing profitability.

③ Low Profitability of Certain Activities

Some supported activities (e.g., mat weaving, mushroom cultivation) were piloted because they were low-cost and could be conducted at home; however, some cases showed low profit margins or slow return on investment. Therefore, in the future, selection criteria must be clarified and high-profit activities should be prioritized.

Based on the above experiences of Phase 1, the following considerations and recommendations for Phase 2 are summarized below.

Considerations:

- The poorest and most vulnerable groups are more likely to participate in and continue activities that have low initial costs and can be started easily at home and on a small scale.
- Targeting women contributes to increased ownership of assets and income by women; however, it requires careful consideration of the additional time burden placed on them.
- The presence or absence of basic training, continuous monitoring, and minimal technical support affects the outcomes.

Recommendations for Phase 2:

- **Targeting:** Prioritize the poorest and most vulnerable groups and focus on activities with low initial cost.
- **Gender:** Promote women's participation, while requiring measures to balance household responsibilities and childcare burdens.
- **Operation:** Make completion of basic training beforehand a prerequisite for participation, and standardize simple monitoring mechanisms and pinpoint technical support after introduction.

(3) Climate Risk Assessment and Adaptation Strategies

Fisheries in the Haor region are vulnerable to climate-related risks such as irregular rainfall, prolonged droughts, early floods, and siltation of water bodies. The following table (Table 5.3.17) summarizes the expected climate risks and their impact on fisheries.

Table 5.3.17 Climate Change Risks and Their Effects on the Haor Fisheries Sector

Extreme Weather Event	Impacts
Early floods / Abnormal rainfall	Washout and burial of spawning and nursery grounds. Increased failure of hatching and recruitment. Disturbance during breeding season. Increase in days with inability to fish / inability to access fishing grounds.
Strong winds / High waves	Damage to aquaculture facilities (e.g., nets, cages).
Droughts / Declining water levels	Drying of wetlands, oxygen depletion, failure of aquaculture ponds.
Rising temperatures	Increased competition and predation pressure on indigenous species due to the rise of exotic cultured species under high-temperature / low-oxygen conditions.

Source: JICA survey team

To respond to these extreme weather events, the following adaptive strategies can be considered:

- Strengthening buffer functions through restoration and conservation of habitats (e.g., restoration of vegetated zones and wetlands, vegetated banks, conservation of spawning and nursery grounds to mitigate flood peaks, reduce turbidity, and prevent washout)
- Promotion of climate change-adaptive aquaculture (adaptive aquaculture) (e.g., adjustment of aquaculture schedules, advancing/distributing stocking and harvesting, lowering stocking density, securing deepwater refuges, feed management, selection of species/strains). Strengthening community capacity through training and institutionalization of practices related to disaster preparedness and adaptive resource management.

(3.1) Strengthening Buffer Functions through Restoration and Conservation of Habitats

(a) Restoration of natural water bodies and conservation of spawning grounds

Early flooding and abnormal heavy rainfall can cause washout and mortality of eggs and larvae. Mitigation of these effects can strengthen species survival and reproductive capacity.

- **Securing Depth in Beels Through Dredging**

Ecologically considerate functional recovery through dredging. It is said that sediment deposition has caused the Beel depth to become shallower year by year. In areas where Beels or khaals have become shallow, selective and minimal dredging is conducted, limited to (1) restoring water flow in major khaals and channels; and (2) conserving/restoring deep-water refuges useful for fish during the dry season. Disturbance of spawning/nursery grounds and shoreline vegetation belts is avoided, and construction is carried out in spots during the low-water season.

- **Restoration of Aquatic and Submerged Vegetation**

Underwater plants provide covers and nursery grounds for juveniles, reducing their exposure to strong currents.

- **Protection of Broodstock During the Spawning Season (Closed Season / Conservation of Spawning Grounds)**

Establish short-term fishing closure periods during the spawning season to protect spawning and migration routes/spawning beds (e.g., temporary closure of fishing in specific areas, suspension of nighttime fishing operations, temporary removal of fish-attracting gear and fixed equipment).

- **Protection of Juveniles and Recruits (Nursery Ground Protection / Selective Fishing)**

Mesh size restrictions, release of small fish, conservation of nursery and breeding areas (shallow waters and vegetation zones), securing of waterways.

(b) Securing Fish Migration Pathways

To restore and maintain the hydrological connectivity between rivers, tributaries, Beels, khaals, floodplains, and spawning and nursery grounds, ensure flow paths and remove sediment and deposits so that migration of broodfish during the spawning season and movement of juvenile fish during the recruitment period can be secured.

- **Dredging of Khals (canals)**

Ensures navigable water depth between connected Beels.

(c) Bank Protection of Beels and Canals

By reducing shoreline erosion caused by strong winds and high waves and by mitigating wave impact, this contributes to the protection of aquaculture facilities installed along the shore, as well as villages and farmland. In addition, by using vegetated belts, soil-retaining structures, and permeable structures, it also contributes to reducing the inflow of sediment, pesticides, and nutrients contained in surface runoff, thereby supporting water quality conservation.

- **Tree Planting**

Planting and conserving native trees along the banks of Beels and canals.

(d) Beel Management During the Dry Season

Maintaining residual water and fish populations even during droughts contributes to resource recovery in the following year.

- **Conservation of the Deepest Sections of Beels**

Creating deeper areas through dredging ensures habitats for broodstock during dry periods.

(3.2) Promotion of Climate-resilient and Adaptive Aquaculture

(a) Integrated Rice-fish Farming

To address the vulnerability of monocropping (e.g., single-season Boro rice), maximize farmland use, diversify income, and enhance resource efficiency.

- **Simultaneous Aquaculture in Rice Fields**

Introduce native species such as Mola (Amblypharyngodon mola) and Kholisha/Karalsha (Trichogaster fasciata), which thrive in shallow, low-oxygen environments. These species improve soil nutrient cycling and benefit rice yields.

(b) Presentation of Candidate Species for Climate-adaptive Aquaculture and Stepwise Introduction

Fish species that have tolerance to washout risks during floods and to high-temperature / low-oxygen conditions can become "candidates" for aquaculture species. Table 5.3.18 organizes representative examples as candidates. However, introduction requires attention to:

- **Aquaculture of Native Fish Species with Strong Environmental Tolerance**

Examples of fish species with strong environmental tolerance in the local area are presented in Table 5.3.18.

Table 5.3.18 Examples of Fish Species Highly Resistant to Environmental Changes

Local Name	Scientific Name	Traits / Climate Adaptation
Magur	*Clarias batrachus*	Can move on land, survive drought and low-oxygen conditions, and hide in mud during floods.
Shing	*Heteropneustes fossilis*	Air-breathing, survive in shallow/temporary pools, and are resistant to flood currents.
Pabda	*Ompok pabda*	Inhabit aquatic vegetation, prefer still water, and are not strong swimmers
Mola	*Amblypharyngodon mola*	Small, hide in aquatic vegetation, and are less likely to be swept away by floods.
Rui	*Labeo rohita*	Tolerant to water currents and tends to stay within water bodies post-flood.
Native carps	*Catla catla,* *Labeo rohita*	Often escape floods by hiding in bottom layers or trenches.

Source: Introduction to Fish Species Diversity (World Fish) 2013.

(3.3) Community Capacity Development

The reasons why community capacity building is necessary are summarized below in Table 5.3.19.

Table 5.3.19 Reasons for the Need to Strengthen Community Capacity

Reason	Explanation
Increased frequency and intensity of climate disasters	Unpredictable floods and droughts exceed the capacity of individual coping strategies.
Delays and limitations in public support	Community-level rapid response becomes critical when external aid is delayed or insufficient.
Shared nature of fishery resources (Commons problem)	Sustainable management by local communities is essential to prevent depletion.
Coexistence of multiple stakeholders	Collaboration and consensus-building are needed among farmers, fishers, women, and youth.

Source: JICA Survey Team

Key Capacity Building Areas:

① Community-based Resource Management

- ✓ Establishment and strengthening of fishery cooperatives and committees.
- ✓ Setting rules for local Beel and paddy field usage (e.g., fishing bans, size limits).
- ✓ Joint fish stocking (stock enhancement) and monitoring.

② Disaster Response Capability

- ✓ Weather communication training (via SMS, radio, and disaster boards).
- ✓ Emergency evacuation drills during floods, and establishment of elevated storage and fish holding facilities.
- ✓ "Alternative income plans during disasters" (e.g., dried fish processing, home gardening).

③ Livelihood Diversification and Skills Training

- ✓ Support for side businesses such as aquaculture, processing, fish sales, tourism, and crafts.
- ✓ Technical training for women and youth (e.g., dried fish production, bio-block construction).
- ✓ Promotion of integrated farming models combining rice and fish.

④ Education and Awareness Activities

- ✓ Workshops on water conservation, climate change impacts, and sustainable fisheries.
- ✓ Introduction of environmental education in schools and Madrasas.
- ✓ Community dialogue involving local leaders and religious figures.

⑤ Strengthening Local Governance and Policy Linkages

- ✓ Collaborate with Union Parishads (village councils) to develop climate adaptation plans.
- ✓ Foster tripartite collaboration among NGOs, local governments, and research institutions.
- ✓ Ensure the participation of women and minorities in decision-making processes.

5.4 Flood Forecasting and Early Warning System

5.4.1 Current Status and Challenges of the Flood Forecasting System

(1) Overview of Challenges in the Flood Forecasting and Early Warning System

A hearing was conducted with the Flood Forecasting and Warning Centre (FFWC)—the agency responsible for operating the flood forecasting system within the BWDB—to understand the current status and challenges of the system. For detailed information on the current situation and challenges, please refer to Appendix 5.4.1. Additionally, interviews were conducted with the Bangladesh Meteorological Department (BMD) and other relevant stakeholders responsible for weather forecasting, and the results are summarized in Appendix 5.4.1.

Table 5.4.1 Challenges in the Flood Forecasting and Early Warning System

System	Challenges	Remarks
1. Observation System	【Difficulty in Obtaining Rainfall Data within India】 The available meteorological and hydrological data from India are limited in both duration and type.	Rainfall data are obtained through the India Meteorological Department (IMD) website, while water level data from May 15 to October 31 are provided via email and WhatsApp.
2. Data Transmission and Reception System	【Real-Time Acquisition of Water Level Data Not Yet Implemented】 Observation data from installed AWS※1 are not currently utilized on websites or for water level forecasting.	The frequency of manual water level data acquisition currently in operation is five times per day (at 6:00, 9:00, 12:00, 15:00, and 18:00). FFWC-BWDB plans to publish AWS data on their website and incorporate it into water level forecasts once data accuracy is confirmed.
3. Analysis System	【Difficulty Extending the Forecast Period (Maximum)】 The maximum forecast period of the Northeast Region Model is limited to three days, which is insufficient for uses such as rice harvesting.	FFWC-BWDB recognizes the need to extend the forecast period, considering that rice harvesting typically requires about 15 days—or at minimum 5 to 7 days—but acknowledges challenges in maintaining forecast accuracy over longer periods.
	【Difficulty Editing Flood Forecast Model※2】	FFWC-BWDB is considering switching to freeware or open-source models; however, since

System	Challenges	Remarks
	The MIKE 11 model currently in use has limited user manual support compared to free software, resulting in operational difficulties within Bangladesh.	MIKE 11 models have been developed nationwide, transitioning will not be straightforward.
	【Insufficient Discharge Data at Water Level Stations near the Indian Border】 Discharge measurements are infrequent, leading to challenges in accurately determining the H-Q rating curves at water level stations near the border.	Budget constraints and hazardous conditions during high flows are major obstacles to conducting frequent discharge measurements.
4. Flood Forecast Dissemination System	【Forecast Communication Timing Not Considered】 Forecast communication does not currently take into account flood arrival times or necessary lead times.	Different lead times may be required depending on the location within the Haor region, necessitating detailed analysis of flood arrival timings.
	【Early Warning Issuance System Not Yet Established】 The system from the flood forecasting system to the issuance of early warnings has not been established.	Staff of FFWC-BWDB check the results of the flood forecasting system and individually issue early warnings.
	【Effective Forecast Communication Methods Not Considered】 The communication pathway from FFWC-BWDB to residents is lengthy, making it difficult for evacuation information to reach the population promptly.	Efforts to improve communication include the use of smartphone applications, interactive voice response (IVR) systems, and information dissemination via Google platforms.
5. Community Response and Early Warning System	【Early Response Plans for Residents Not Developed】 Neither FFWC-BWDB nor local governments have defined specific actions that relevant organizations should take.	Residents belonging to Disaster Management Committees (DMCs) receiving early warning information decide on early response and flood prevention activities; however, limited understanding of flood forecasts and early warning information often results in delayed response.

※1: AWS: Automated Weather Station

※2: MIKE 11 is a one-dimensional river modelling software developed by the Danish Hydraulic Institute (DHI) in Denmark. It is capable of simulating flow, water levels, water quality, and sediment transport in rivers, floodplains, irrigation canals, and reservoirs.

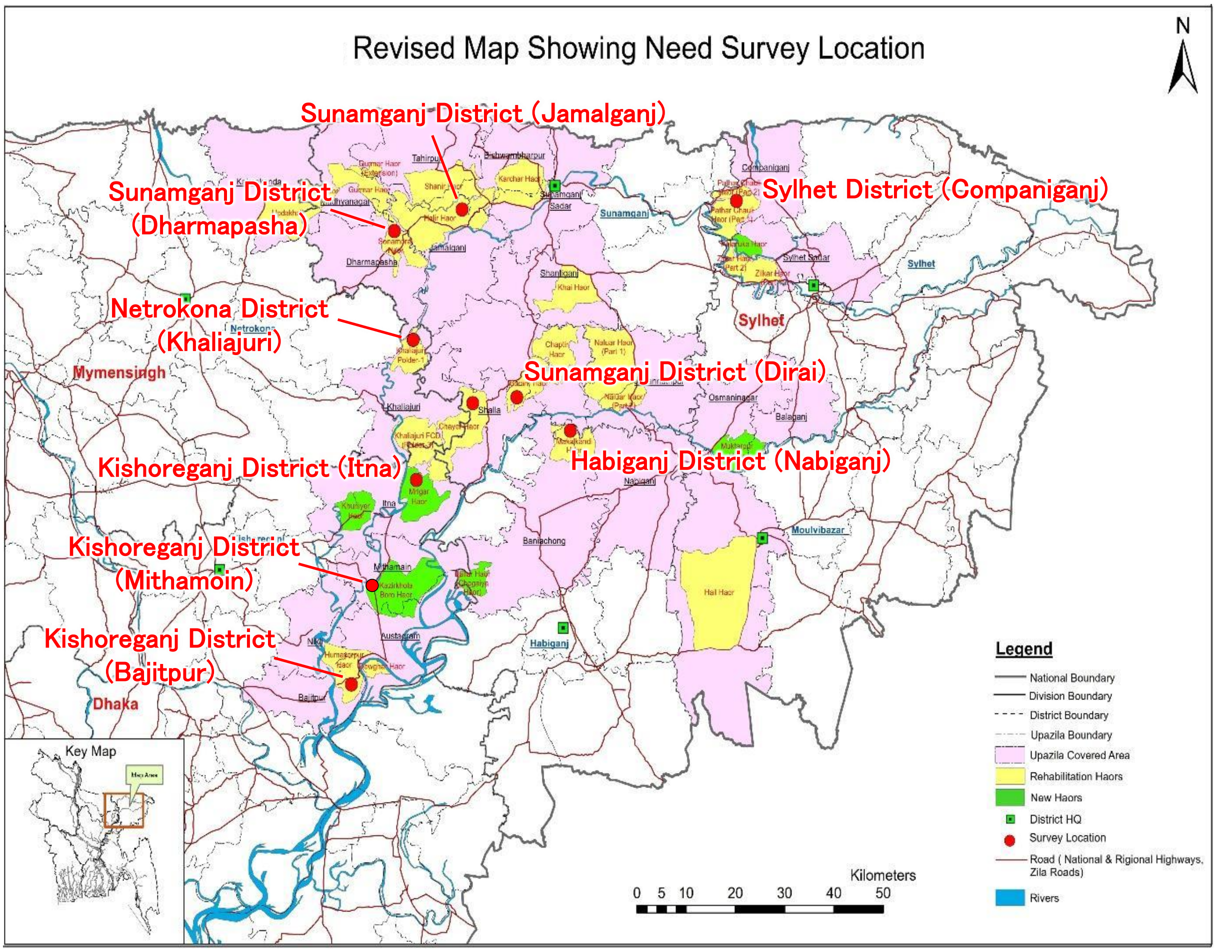
Source: JICA Survey Team

(2) Overview of Needs Survey for the Flood Forecasting and Early Warning System

A needs survey was conducted in ten haor areas covering 17 Upazilas in five districts of Northeastern Bangladesh (Kishoreganj, Sunamganj, Habiganj, Netrokona, Sylhet). From the survey results, the following summarizes the findings related to the flood forecasting and early warning system.

(a) Summary of Survey Results

The locations where the needs assessment were conducted and the corresponding findings are summarized below.



Source: JICA Survey Team

Figure 5.4.1 Location Map of the Needs Survey (Flood Forecasting and Early Warning System)

Table 5.4.2 Summary of the Results of the Needs Survey (Flood Forecasting and Early Warning System)

District	Utilization of Early Warning and the Achievable Lead Time	Assets at Risk from Flash Floods	Damages Reduced by Flood Early Warning
Kishoreganj District (Bajitpur, Itna, Mithamoin)	Very limited utilization: Early warning is minimal or non-existent. Even when issued, the lead time is very short or absent.	Agricultural crops (rice), livestock (cattle), essential household items (e.g., food)	No reduction: early warning is minimal or absent, and floods arrive too quickly for protective measures to be taken.
Sunamganj District (Dirai, Dharmapasha, Jamalganj)	Low to moderate utilization: In certain areas, such as Dirai, early warnings are disseminated through loudspeakers (miking) or local authorities, while other areas have none. Lead times are inconsistent—sometimes sufficient—but no specific duration is reported.	Agricultural crops (rice), livestock (cattle, livestock feed), essential household items (e.g., food, fuel)	No to partial reduction: In some areas where early warnings were received, actions such as early harvesting were carried out.
Habiganj District (Nabiganj)	Moderate utilization: In certain areas, early warnings are issued by the DC/UNO or through loudspeakers (miking), but others have none. Lead times range from 2–6 hours, occasionally extending to 2–4 days.	Agricultural crops, livestock, essential household items	Partial reduction: In certain areas, early warnings allowed early harvesting and relocation.
Netrokona District (Khaliajuri)	Very limited to almost no utilization: No early warning system has been reported.	Agricultural crops, livestock, essential household items	No reduction: Neither early warning nor early action was reported.
Sylhet District (Companiganj)	Low to moderate utilization: Some early warnings are provided through River Information Management System (RIMS), SMS, or mosques, but many areas have none. Where available, the lead times are around 2–4 days, but in many areas no warnings are received at all.	Agricultural crops (rice), livestock, essential household items	Partial reduction: In areas with 2–4 days of lead times, communities carried out early harvesting and relocation of assets.

Source: JICA Survey Team

(b) Key Findings of the Survey

The survey confirmed that the utilization of flood early warnings among residents is limited. While in some areas residents receive early warnings through RIMS, SMS, and other similar channels, the results suggest that dissemination and awareness of early warnings are still insufficient. In certain areas, community-based early warning through mosques and loudspeakers (miking) was also found to be functioning.

Assets identified as being at risk from flash floods include not only agricultural crops (rice) but also livestock and essential household items. In some areas, early warnings helped reduce damages—for example, through early harvesting or relocation—but in many locations, warnings were either not utilized or the floods arrived too quickly for protective measures to be implemented.

5.4.2 Outline of Flood Forecasting and Early Warning System

(1) Consideration Policy

The flood forecasting system currently operated by FFWC-BWDB was developed with support from various national governments and international aid agencies in the past. For example, under the HILIP funded by IFAD, a flood forecasting model currently used in the Haor region was developed. In addition, Regional Integrated Multi-Hazard Early Warning System (RIMES) has advanced the introduction of updated meteorological and hydrological data as well as decision-support systems for the national model of Bangladesh. Through these initiatives, runoff models for individual small catchments and one-dimensional channel models for major rivers have already been developed within the existing flood forecasting system.

Given this situation, establishing another system of a similar type would not be effective from the perspective of support efficiency. Furthermore, interviews with the counterparts confirmed that there is a stronger need to improve the accuracy, lead time, and other aspects of the current flood forecasting system, rather than maintaining multiple similar forecasting models. Therefore, based on the challenges identified in the existing system, it was decided that the Project will focus on examining possible improvements to the current system.

In defining the objectives of system development, consideration was given to the livelihoods and social background of local residents, with a focus on the three aspects outlined below. For details on the specific characteristics of the Haor region relevant to flood forecasting and early warning system development, see Appendix 5.4.1, Chapter 1.

- Objective 1: Inform residents of the appropriate timing for Boro rice harvesting (Early harvesting of Boro rice)

In the Haor region, Boro rice is extensively cultivated from the end of the dry season through the pre-monsoon period (March to May). When flash floods occur during this period—coinciding with the harvest season—the rice crops become submerged, resulting in severe damage. This poses serious risks to farmers' livelihoods and food security. Therefore, it is crucial for the flood forecast and early warning system to ensure sufficient lead time. With adequate warning, farmers can take preemptive measures such as advancing the harvest or accelerating reaping activities, thereby minimizing potential losses.

Since the lead time required for such agricultural measures differs from that required for community evacuation, it is necessary to consider issuing flood forecasts at different timings according to their specific purposes.

- Objective 2: Ensure resident safety and facilitate evacuation of agricultural machinery and livestock (Evacuation of People, Equipment, and Livestock)

When a flash flood occurs, communities may become temporarily isolated, leading to the risk of severe impacts such as loss of life, destruction of houses, and the washout of livestock and agricultural machinery. Therefore, within a flood forecasting and early warning system, it is crucial to prioritize the safety of residents and ensure sufficient lead time to facilitate smooth evacuation. In particular, agricultural machinery and livestock constitute major household assets, and providing accurate information—such as the timing, magnitude, and arrival time of flooding—is essential for supporting appropriate evacuation decisions. Such information enables residents to take voluntary and well-planned evacuation actions, which is expected to significantly reduce both human and economic losses.

- Objective 3: Manage infrastructure such as sluice gate operations (Facility management)

In the Haor region, various hydraulic structures—including fuse dikes and regulators—have been installed across the area to temporarily protect paddy fields from flooding. Fuse dikes are designed to breach intentionally when flood discharge exceeds a certain threshold, thereby preventing excessive inundation in other areas while protecting agricultural land and distributing river flows. Regulators, on the other hand, are used for water level control, drainage, and intake operations, playing a vital role in both agricultural water management and flood mitigation.

The proper timing of operation and regular maintenance of these facilities are essential. Therefore, the flood forecast and early warning system should be designed to support decision-making related to the operation of such structures. This approach is expected to reduce overall flood risk in the region while also contributing to the stability of agricultural production.

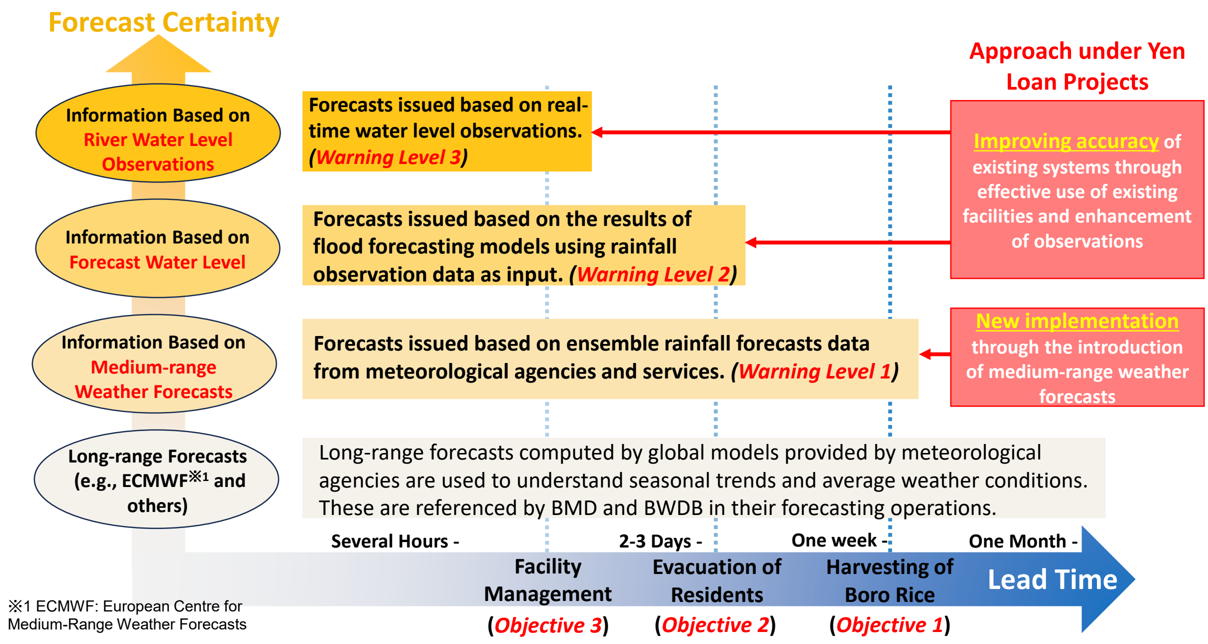
To achieve the above objectives, it was considered appropriate to utilize various meteorological and hydrological information in an integrated and stepwise manner. Based on this approach, the issuance of the following three warning levels was proposed.

Table 5.4.3 Warning Level Setting for Flood Forecasting and Early Warning System

Warning Level	Lead Time	Information	Dissemination Methods
Warning Level 1: Information Based on River Water Level Observations	Several days–weeks	Forecasts by Meteorological Agencies (e.g., Ensemble Forecasts)	Internet and Related Communication Lines
Warning Level 2: Information Based on Rainfall Observations for Flood Forecast	Several days	Radar and Satellite-based Rainfall	Ditto
Warning Level 3: Information Based on Medium-Range Weather Forecasts	1–2 days	Real-Time River Water Level Observations	Ditto

Source: JICA Survey Team

Considering that the required lead time differs depending on the purpose, the concept for developing a flood forecasting and early warning system is summarized in the figure below.



Source: JICA Survey Team

Figure 5.4.2 Approach to the Development and Implementation of Flood Forecasting and Early Warning Systems

In the current flood forecasting system, observed river water levels and forecasted river water levels up to three days in advance are utilized. To improve accuracy, effective use of existing facilities and enhancement of observation methods will be pursued. At present, forecasts for river water levels beyond three days are not in operation. Since extending the current lead time is necessary to enable early harvesting of Boro rice, new implementation will be pursued through the introduction of medium-range weather forecasts.

(2) Project Implementation Items

The project implementation items have been organized in response to the identified challenges. The corresponding warning levels (Levels 1 to 3) addressed by each activity are indicated in the table below.

Table 5.4.4 Summary of System Challenges and Proposed Measures

System	Challenges	Project Implementation Items	Warning Level 1	Warning Level 2	Warning Level 3
1. Observation System	Difficulty in Obtaining Rainfall Data within India	Application of Satellite-Based Rainfall Data in India (Real-Time Rainfall Data)	-	●	-
2. Data Transmission and Reception System	Real-Time Acquisition of Water Level Data Not Yet Implemented	Real-Time Acquisition of Water Level Data※1	-	●	●
3. Analysis System	Difficulty Extending the Forecast Period (Maximum)	Utilization of Ensemble Rainfall Forecasts	●	-	-
	Difficulty Editing Flood Forecast Model	Update of Flood Forecasting Model※2	-	●	-
	Insufficient Discharge Data at Water Level Stations Near the Indian Border	Enhancement of Discharge Measurement	●	●	-
4. Flood Forecast Dissemination System	Forecast Communication Timing Not Considered	Application of Satellite-Based Rainfall Data in India (Historical Rainfall Data)	●	●	●
		Assessment of Lead Time Considering Flood Arrival Time	●	●	●

System	Challenges	Project Implementation Items	Warning Level 1	Warning Level 2	Warning Level 3
	Early Warning Issuance System Not Yet Established	Update of the Decision Support System	●	●	●
	Effective Forecast Communication Methods Not Considered	Introduction of an Early Response Timeline	●	●	●
5. Community Response and Early Warning System	Early Response Plans for Residents Not Developed				

Source: JICA Survey Team

（Remarks）

Warning Level 1： Information Based on Medium-Range Weather Forecasts（Lead Time: Several days–weeks）

Warning Level 2： Information Based on Rainfall Observations for Flood Forecast（Lead Time: Several days）

Warning Level 3： Information Based on River Water Level Observations（Lead Time: 1–2 days）

※1 Although AWS have already been installed under a World Bank project, the FFWC-BWDB plans to incorporate the data from these AWS into the flood forecasting system once it is confirmed that the stations are capable of accurately observing water levels and rainfall. Accordingly, there is a recognized need for system updates to enable future integration of AWS data into the operational flood forecasting system.

※2 While the MIKE 11 model has been developed across Bangladesh, there is growing concern about the difficulty of updating the system. Many of the flood forecast systems implemented by various agencies are also based on MIKE 11.

CHAPTER 6 PROJECT SUMMARY

6.1 Project of Phase 1

The project of Phase 1, covering 27 haors in total (14 haors for rehabilitation and 13 haors for new development), is presented in Table 6.1.1 below.

Table 6.1.1 Project of Phase 1

Item	BWDB Part	LGED Part
Component	1) Component 1: Flood management infrastructure 2) Component 3-1: Agriculture production improvement (including small-scale income generation)	1) Component 2: Construction and rehabilitation of rural development infrastructures 2) Component 3-2 Fishery production improvement
Period	99 months (2014-2023)	120 months (2014-2024)

Source: JICA Survey Team

6.2 Project of Phase 2

6.2.1 Project Summary

The main components of Phase 2 are the same as those of Phase 1, namely: 1) Flood management infrastructure, 2) Agriculture production improvement; and 1) Construction and rehabilitation of rural development infrastructures, 2) Fishery production improvement, respectively.

In addition, the target haors of Phase 2 consists of ten haors, including nine rehabilitation haors and one new haor.

Table 6.2.1 Target Haors of Phase 2

Rank	Name of subproject	Division name	Rehab/New Haor
1	Naluar Haor-1	Sunamganj	Rehab
2	Mrigar Haor	Kishorganj	New
3	Makalkandi Haor	Habiganj	Rehab
4	Chaptir Haor	Sunamganj	Rehab
5	Shanir Haor	Sunamganj	Rehab
6	Pathar Chawli Haor	Sylhet	Rehab
7	Karchar Haor	Sunamganj	Rehab
8	Halir Haor	Sunamganj	Rehab
9	Humaipur Haor	Kishorganj	Rehab
10	Khaliajuri FCD-1	Netrokona	Rehab

Source: JICA Survey Team

6.2.2 Implementation Schedule

Table 6.2.2 Expected Schedule

Item	Expected Schedule
1. Consultant Procurement	Total 9 months
2. Detail Design	Total 10 months
3. Tendering	Total 5 months

Source: JICA Survey Team

CHAPTER 7 PROJECT IMPLEMENTATON AND OPERATION/ MAINTENANCE SYSTEM

7.1 Flood Control Facilities and Agriculture Promotion Activities

7.1.1 Current Organization of BWDB

(1) Organisational Structure and Personal

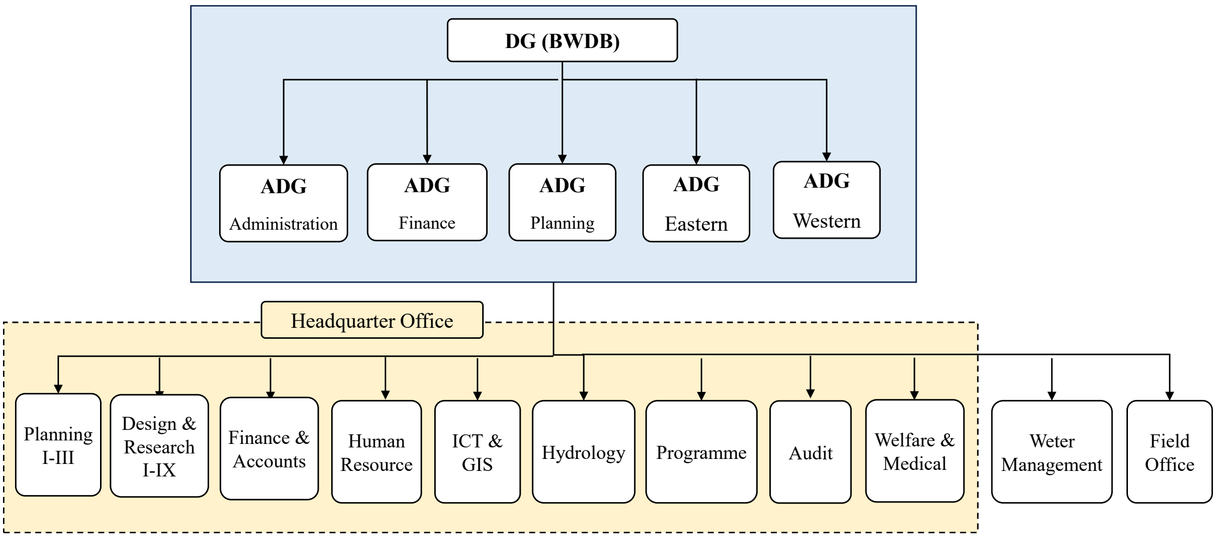
The Bangladesh Water Development Board (BWDB) is a governmental agency established in 1959 under the Ministry of Water Resources (MOWR). It was subsequently reorganised in 2000 as a core agency responsible for the development, management, and conservation of the country’s water resources with the enactment of the BWDB Act 2000.

BWDB has been designated as the implementing agency for this project. The following section provides an outline of its organisational structure, as well as the roles and responsibilities of its major divisions and departments.

(a) Headquarter Office Structure

The highest authority of the BWDB is the Director General (DG), who holds ultimate responsibility for the overall management of the organisation. This authority is shared with five Additional Director Generals (ADGs).

As illustrated in Figure 7.1.1, the organisational structure of BWDB comprises nine key divisions located within the headquarter office—namely: Planning, Design & Research, Finance & Accounts, Human Resource Development, information and communications technology (ICT) and geographic information system (GIS), Hydrology, Program, Audit, and Welfare & Medical Services—as well as the Office of the Chief Water Management (OCWM) and field offices across the country. According to the official BWDB website, as of June 2025, the organisation employs over 13,000 personnel across its headquarter and field offices nationwide.



Notes: DG = Director General, ADG = Additional Director General

Source: Prepared by JICA Survey Team based on information available on BWDB website

Figure 7.1.1 BWDB Organisational Structure

In accordance with the BWDB Act 2002, the core responsibilities of the BWDB are defined as follows:

a) Planning, design, construction, and management of irrigation systems, embankments, and drainage infrastructure at both national and local levels.

b) Mitigation of flood damage and management of water scarcity through appropriate structural and non-structural measures.

c) Collection, analysis, and management of water resources data, including hydrological and topographical surveys.

d) Research and development (R&D) activities related to the effective utilisation of irrigation and drainage systems.

e) Land acquisition and land use management in accordance with relevant laws and regulations.

Table 7.1.1 categorises these core responsibilities by functional domain.

Table 7.1.1 Core Responsibilities of BWDB

Functional Domains	Key Responsibilities
1) Development and Management of Water Resources	● Development of water resources including rivers, lakes, wetlands, and groundwater. ● Design, construction, and operation of flood control, drainage, and irrigation infrastructures/facilities. ● Formulation and implementation of policies for the sustainable utilisation of water resources.
2) Flood Management and Disaster Risk Reduction	● Operation and improvement of flood forecasting systems. ● Development of infrastructures such as embankments, drainage channels, and retention basins. ● Implementation of region-specific flood mitigation measures. ● Post-flood recovery assistance and impact assessment.
3) Promotion of Irrigation Projects	● Supply and management of agricultural water. ● Design, construction, and maintenance of irrigation facilities, including pumps, canals, and weirs. ● Optimisation of water use to enhance agricultural productivity.
4) River and Wetland Conservation and Dredging	● Dredging of rivers to secure flow capacity and prevent flooding. ● Water management and ecological conservation of wetlands (e.g., haor and Beel areas). ● Stabilisation of river courses and prevention of bank erosion.
5) Regional Response through Field Offices	● Deployment and management of 8 zones, 33 circles, 86 divisions, and over 200 sub-divisions nationwide. ● Implementation of projects tailored to regional and local water management needs. ● Support for WMOs through collaboration with local communities.
6) Application of Technology, Research, and ICT	● Utilisation of hydrological surveys and design & research, and integration of GIS and ICT tools. ● Promotion of digitalisation through e-Tendering and electronic document management (D-Nothi). ● Advancement of technical innovation based on long-term strategies such as the Delta Plan 2100.
7) Environmental and Social Considerations	● Implementation of Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA). ● Introduction of Resettlement Action Plans (RAP) and participatory decision-making processes. ● Harmonisation of sustainable water resource management with regional development

Source: Prepared by the JICA Survey Team based on information available on the BWDB website

BWDB is composed of both technical and administrative personnel deployed nationwide. Its organisational and staffing structure is arranged in a multi-tiered system as follows:

a) Chief Engineer / Additional Chief Engineer
b) Superintending Engineer / Senior System Analyst / Director
c) Executive Engineer / System Analyst / Deputy Director
d) Sub-divisional Engineer / Programmer
e) Assistant Engineer / Assistant Programmer / Assistant Director

These positions are further distributed across multiple specialised domains.

a) Technical (design, construction, supervision)
b) Administrative (finance, human resource, audit)
c) ICT (information systems, GIS, software development)
d) Hydrology (data collection and analysis)
e) Project Management (planning, progress monitoring)
f) Field Office Personnel (responsible for regional/local project and O&M)
g) R&D (river morphology, groundwater, flood forecasting)

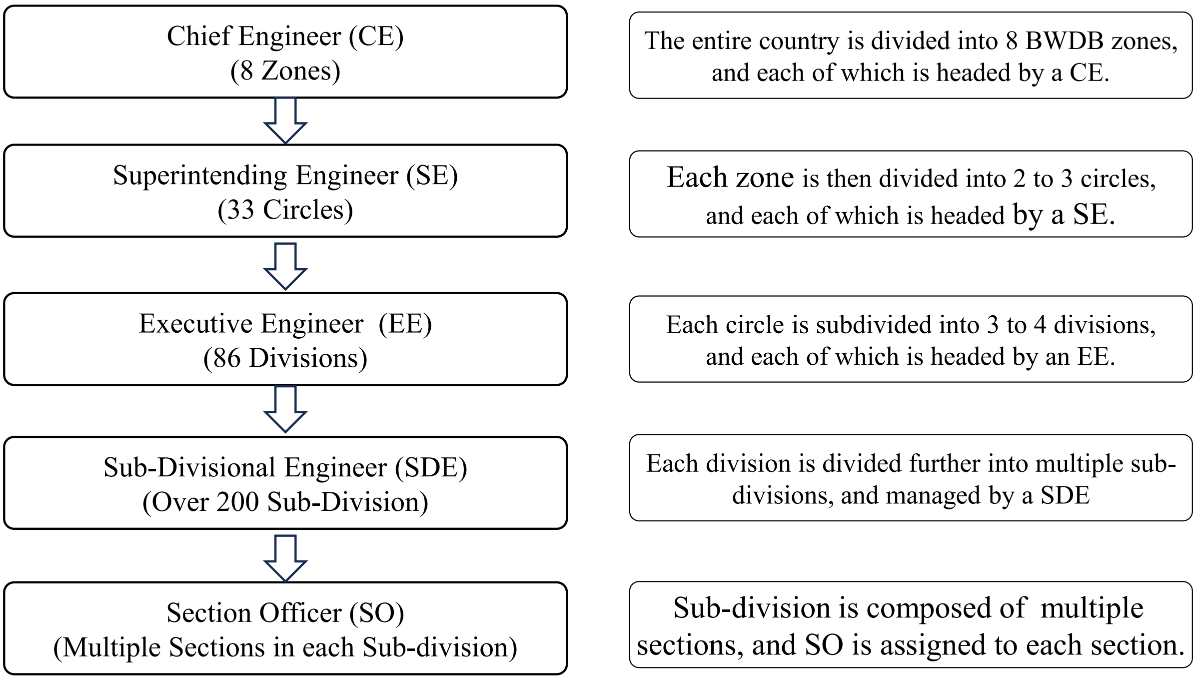
This staffing structure forms the foundation for BWDB's functional and decentralised operations, with clearly defined responsibilities at each level.

(b) Field Offices

BWDB implements water resources management and various project activities on the ground through its field offices across the country. As illustrated in Figure 7.1.2, the organisational structure is hierarchical, with technical staff assigned at each level.

Key responsibilities of BWDB field offices include the following:

a) Design, construction, and supervision of infrastructures, (e.g., embankments, drainage canals, irrigation systems) tailored to local topographic and hydrological conditions.
b) Coordination with the OCWM to support community-based O&M activities and provide technical assistance to WMOs.
c) Implementation of land acquisition and resettlement (RAP) in coordination with local administration (DC offices).
d) Identification and response to local needs through engagement with communities and local governments.



Source: Prepared by the JICA Survey Team based on information available on the BWDB website

Figure 7.1.2 Organisational Hierarchy of BWDB Field Offices

Staffing varies depending on project scale and scope; however, typically 60–70% of personnel are technical staff (e.g., EEs, SAEs, GIS/MIS officers), with the remainder assigned to administrative and managerial roles. Table 7.1.2 presents a typical staffing composition, while Table 7.1.3 outlines the technical qualifications of field office staff.

Table 7.1.2 Standard Staffing Structure of BWDB Field Offices

Field Offices	Roles and Responsibilities
Upazila Level	● Executive Engineer: 1 person ● Sub-Assistant Engineer: 2 to 3 persons ● Administrative and Management Staff: 3 to 5 persons ● Field Supervisors and Laborers: 10 to 20 persons（depending on the scale of the project）
District Level	● Superintending Engineer: 1 person ● Technical Staff (including EEs, Designers, Surveyors, etc.): 10 to 15 persons ● Administrative, Financial, and Procurement Officers: 5 to 10 persons

Source: Prepared by the JICA Survey Team based on the Final Report (February 2014), Preparatory Survey on the Upper Meghna River Basin Watershed Management Improvement Project.

Table 7.1.3 Technical Levels of BWDB Field Offices

Position	Required Technical Level	Remarks
Superintending Engineer	Master's degree or higher in engineering	Overall supervision of the project
Executive Engineer	Bachelor's degree in civil or water resources engineering	Responsible for design and construction management
Sub-Assistant Engineer	Diploma or associate degree from a technical institute	Field supervision and surveying
GIS/MIS Specialist	Expertise in IT and geographic information systems	Flood forecasting and data management
Community Liaison Officer	Background in social development or agriculture	Coordination with local communities and public awareness

Source: Prepared by the JICA Survey Team based on Final Report (February 2014), Preparatory Survey on the Upper Meghna River Basin Watershed Management Improvement Project.

(c) Office of the Chief Water Management (OCWM)

The OCWM is the designated division responsible for the formation, registration, and auditing of WMOs within BWDB, in accordance with the Participatory Water Management Rules (2014). OCWM provides institutional and technical support for WMO development and works closely with BWDB offices to promote field-level water resource management. OCWM also collaborates with relevant agencies, such as the Department of Agricultural Extension (DAE) and Department of Fisheries (DOF), to promote sustainable water use and infrastructure O&M through community participation.

Key personnel include:

a) Principal Extension Officer (PEO)
b) Deputy Chief Extension Officer (DCEO)
c) Assistant Extension Officer (AEO)

Key responsibilities are as follows:

a) Establishment and support of community-based WMO: Support for the formation of WMOs, and their organisational management and decision-making, as well as training on maintenance.
b) Coordination with agriculture and fisheries sectors: Support for irrigation and aquatic resource management in coordination with DAE and DOF.
c) Promotion of O&M activities: Implementation of O&M for embankments, drainage canals, irrigation facilities, etc., in collaboration with community-based WMOs, including the preparation of annual plans and progress reporting.
d) Awareness-raising and education activities: Conducting awareness campaigns on the sustainable use of water resources and organising community-based training programs for disaster preparedness, such as floods and droughts.

OCWM plans to deploy approximately 600 community facilitators (Extension Overseers) across more than 600 projects nationwide. In addition, around 316 technical staff and 415 support staff will be assigned to BWDB zonal, circle, and divisional offices. Training programs for WMO members are expected to reach over 36,000 participants annually.

(2) Financial and Budgetary Aspects

Annual budget information for BWDB is published in its official annual reports. Budget summaries for FY2021 to FY2024 are presented in Table 7.1.4 and Table 7.1.5.

BWDB's budget prioritises new development projects, with limited allocation for post-project maintenance. According to the Consultancy Service Completion Report (June 2023) and the Additional Study Report (Volume 1: Main Report, March 2024) prepared for the Haor Flood Management and Livelihood Improvement Project (BWDB Part), BWDB's financial resources are primarily directed toward corrective maintenance (major repairs) and emergency response and maintenance. In contrast, the costs of preventive maintenance—including routine maintenance, periodic maintenance, and minor repairs for submersible embankments and other flood control facilities—are currently covered entirely by WMG savings.

Table 7.1.4 BWDB Budget Implementation Status

Fiscal Year	Total Budget (BDT in Billion)	Actual Expenditure (BDT in Billion)	Execution Rate (%)	Major Budget Items
2022-2023	2,062	1, 988	95.07	Priority placed on flood control and water resources management projects
2023-2024	2,243	2,149	95.80	Focus on flood control, irrigation, and embankment construction projects

Source: Prepared by the JICA Survey Team based on BWDB Annual Reports

Table 7.1.5 BWDB Budget Execution Status for FY2023-2024 (Excerpt)

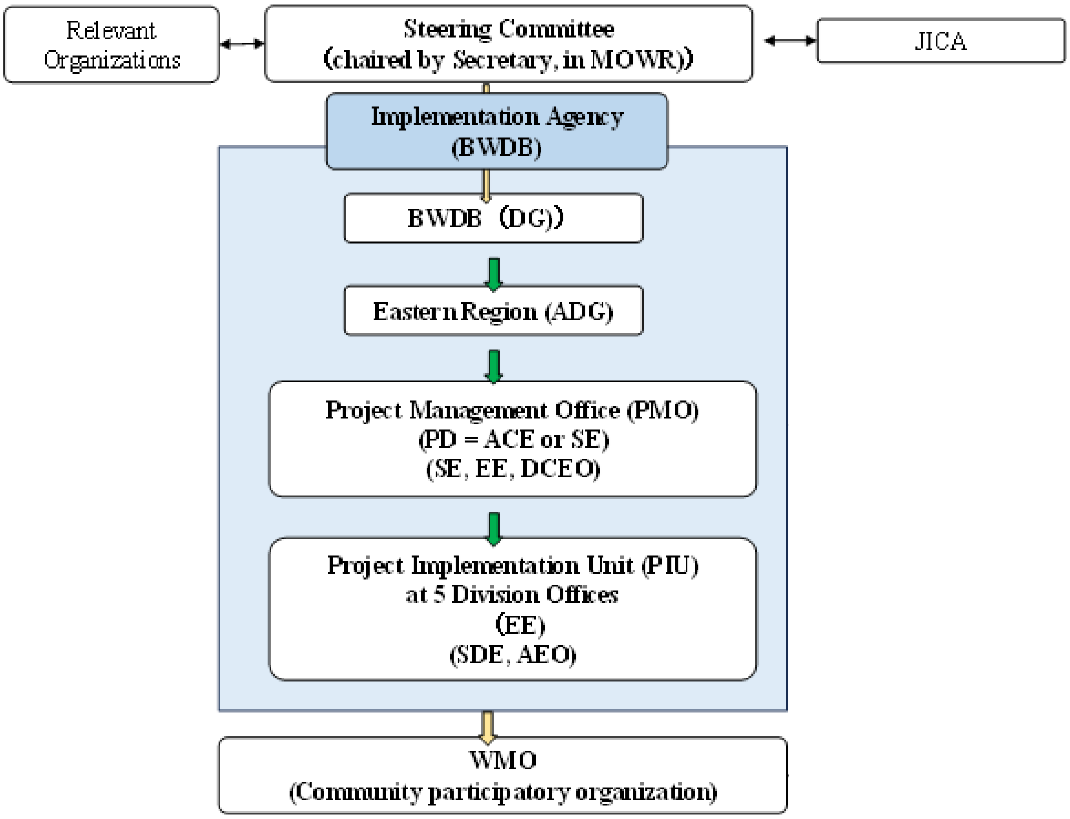
Projects	Total Budget (BDT in Billion)	Actual Expenditure (BDT in Billion)	Execution Rate (%)
FRERMIP	1350.4	893.3	66.1%
Urban Drainage Development	448.3	316.7	70.6%
River Stabilisation (Multiple Areas)	480.4	342.6	71.3%
Irrigation Development (Nationwide)	595.0	234.3	39.4%

Source: Prepared by the JICA Survey Team based on BWDB Annual Reports

7.1.2 Implementation and Operation/Maintenance Systems for Flood Control Facilities

(1) Project Implementation System

Similar to Phase 1, Phase 2 of the Project is expected to be implemented under the leadership of BWDB, with the objective of developing flood management infrastructure in the haor region. BWDB will serve as the main implementing agency, and the Project will be implemented in accordance with the institutional framework illustrated in Figure 7.1.3.



Notes: DG = Director General, ADG = Additional Director General, ACE = Additional Chief Engineer, SE = Superintending Engineer, DCEO = Deputy Chief Extension Officer, PD = Project Director, EE = Executive Engineer, SDE = Sub-divisional Engineer, AEO = Assistant Extension Officer.

Source: JICA Survey Team

Figure 7.1.3 Tentative Structure of Project Implementation for BWDB

The main responsibilities of the relevant agencies and organisations are outlined below.

Steering Committee (SC)

A Steering Committee has been established under the chairmanship of the Secretary of the MOWR, comprising representatives from BWDB, Local Government Engineering Department (LGED), Bangladesh Haor and Wetland Development Board (BHWDB), Department of Agriculture Extension (DAE), DFF, Ministry of Land (MOL), and the Japan International Cooperation Agency (JICA) (as observer).

The Committee is expected to convene regularly to:

a) Share information on the implementation status of flood control facilities among relevant agencies.
b) Facilitate inter-ministerial coordination to ensure achievement of Project objectives.
c) Monitor and evaluate the progress and effectiveness of the Project implementation.

Project Management Office (PMO)

The PMO is established at the BWDB headquarters, with an Additional Chief Engineer (ACE) or Superintending Engineer (SE) appointed as the Project Director (PD). The PD is supported by SEs, EEs, and DCEOs.

The PMO is responsible for the overall technical management of the Project, including design, construction supervision, and procurement.

Its key functions include the following:

a) Preparation of the overall project implementation schedule

b) Procurement and management of consultants
c) Review of detailed designs and bidding documents
d) Monitoring of land acquisition progress
e) Oversight of construction activities, including progress, budget, quality
f) Supervision of environmental compliance
g) Coordination with relevant agencies and reporting of Project progress

Project Implementation Unit (PIU)

PIUs are planned to be set up under BWDB at the Division Offices in each of the target district (Netrokona, Kishoreganj, Habiganj, Brahmanbaria, and Sunamganj) to oversee the field-level implementation. Each PIU will be headed by the Executive Engineer (EE) of the respective Division Office, with support from Sub-Divisional Engineers (SDEs) and Assistant Extension Officers (AEOs).

The PIUs will be responsible for field-level implementation and will carry out the following key tasks:

a) Preparation of construction implementation plans
b) Execution of surveys and investigations
c) Preparation of bidding documents and tendering
d) Execution of land acquisition
e) Construction supervision and verification of physical progress
f) Reporting and coordination with relevant agencies

(2) Operation and Maintenance (O&M) System

Current O&M Arrangement

Since the completion of Phase 1 in May 2023, the O&M activities for flood control facilities in the Haor region have been jointly undertaken by BWDB and local WMOs. According to the Consultancy Service Completion Report (June 2023) and the Additional Study Report (Volume 1: Main Report, March 2024) prepared for the Haor Flood Management and Livelihood Improvement Project (BWDB Part), notable achievements have been observed in organisational, financial, and technical aspects; however, challenges remain in ensuring financial sustainability, strengthening local technical capacity, and advancing digitalisation.

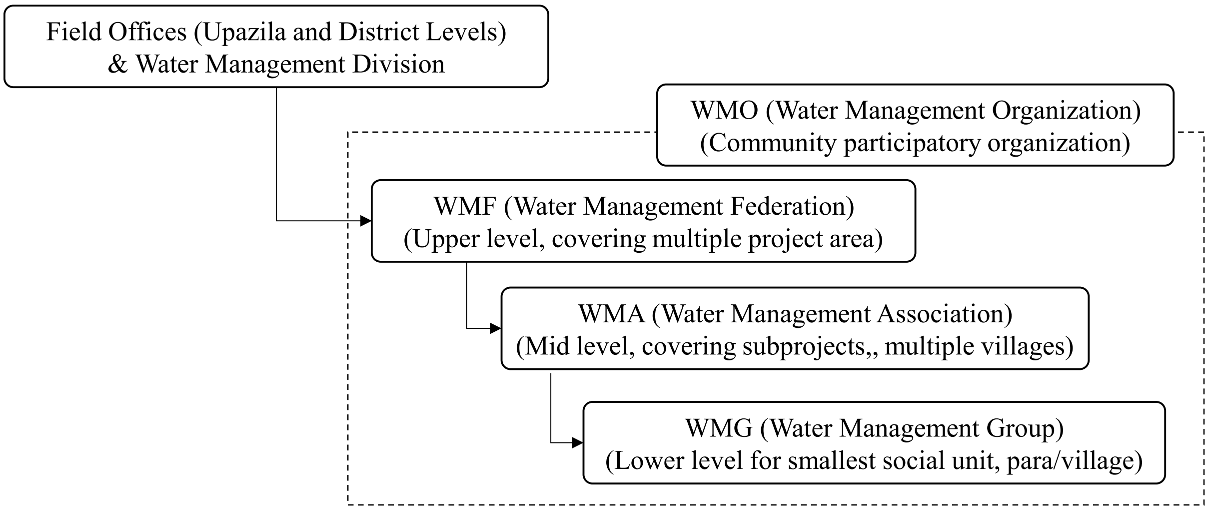
This section outlines the current O&M situation and ongoing initiatives based on the review of the above-mentioned reports and preliminary interview surveys. The analysis is organised around three key aspects: (i) organisational structure, (ii) financial and budgetary systems, and (iii) technical capacity. Accordingly, recommendations for future improvements are presented.

(a) Organisational Aspect

The O&M of flood control facilities—including embankments, drainage canals, retention basins, and sluice gates—is primarily managed by BWDB, through coordination between its headquarter and field offices. Field-level O&M activities are implemented via the division and sub-divisional offices. The OCWM provides institutional and technical support for the formation, operation, auditing, and capacity development of WMOs, in coordination with BWDB field offices.

Routine inspection, maintenance (routine and periodic), minor repairs, and daily monitoring are carried out by WMOs in collaboration with BWDB field offices. These community-based WMOs play a critical role in ensuring the sustainability of fold control facilities through participatory maintenance.

A conceptual diagram of the O&M institutional structure is presented below.



Source: JICA Survey Team

Figure 7.1.4 Current Operation and Maintenance Arrangement for Flood Control Facilities

The BWDB serves as the core agency for the planning, development, operation, and maintenance of flood control facilities in the Haor region, including submersible embankments and drainage structures. It plays a leading role in preparing O&M manuals and implementing corrective maintenance and emergency repairs. According to the Consultancy Service Completion Report (June 2023) for the Haor Flood Management and Livelihood Improvement Project (BWDB Part), many technical staff assigned to field offices were assessed to have attained a satisfactory level of technical capacity and skills through various training programs conducted during Phase 1. These included training in O&M techniques, community coordination, and basic repairs. However, some staff members continue to face challenges in applying advanced technical knowledge, fulfilling their duties effectively, and utilising ICT tools—skills that are essential for managing extensive infrastructure and implementing preventive O&M practices. In addition, although some trained technical personnel regularly participated in meetings with WMOs to share O&M information and provide technical guidance on minor repairs, budgetary and staffing constraints have limited their ability to provide adequate outreach and supervision across all project sites.

On the other hand, WMOs are community-based groups established under the Participatory Water Management Regulation (PWMR) 2014, with the aim of enabling local residents to sustainably manage flood control facilities in the Haor region. As outlined in Table 7.1.6, WMOs operate within a three-tier structure and are actively engaged in routine inspection, minor repairs, and daily monitoring in coordination with BWDB field offices.

Furthermore, interviews with local WMOs revealed that some organisations do not possess an O&M manual. Although they conduct inspections, their record-keeping and management remain insufficient.

Table 7.1.6 Organisational Structure and Roles of WMO

WMO	Roles and Composition	
WMF	Role	● Serves as the apex body overseeing multiple WMAs. ● Engages in policy advocacy and coordination with government agencies and development partners at the district or basin level. ● Facilitates technical training and promotes large-scale project implementation. ● Functions as a platform for inter-WMA collaboration and the resolution of cross-cutting issues.
	Composition	● Composed of representatives elected from each WMA. ● Covers a wide geographical area, such as a district or river basin.
WMA (29 associations registered)	Role	● Acts as an intermediary organisation overseeing multiple WMGs. ● Coordinates and manages flood control facilities across multiple villages or broader catchment areas. ● Responsible for major facility repairs, resource mobilisation, and liaison with government agencies and BWDB. ● Facilitates information sharing and technical support among WMGs.

WMO	Roles and Composition	
	Composition	● Formed by representatives (typically Executive Committee members) from each WMG within its jurisdiction. ● Generally composed of 10 to 20 WMGs. ● Operates under its own Executive Committee, which is responsible for organisational governance.
WMG (305 groups registered)	Role	● The smallest unit of the WMO structure, established at the village or sub-village level. ● Responsible for the daily O&M of flood control facilities, including inspections, minor repairs, and vegetation management. ● Manages membership fees and savings and conducts awareness-raising activities among residents. ● Implements agricultural and livelihood improvement programs.
	Composition	● Typically consists of 20 to 50 households. ● Comprised of local residents—farmers, fishers, women, and vulnerable groups—with a strong emphasis on women's participation. ● Governed by an elected Executive Committee (Chairperson, Vice Chairperson, Treasurer, Secretary).

Source: Prepared by the JICA Survey Team based on the Consultancy Service Completion Report (June 2023), Haor Flood Management and Livelihood Improvement Project (BWDB Part).

(b) Financial and Budgetary Aspect

The financial structure for the O&M of flood control facilities in the Haor region is organised under a two-tier system:

a) Preventive Maintenance: This category of maintenance is primarily implemented by local WMGs, which manage and operate maintenance funds sourced from community-based contributions, including monthly membership fees, a portion of agricultural income, and SIGS. The funds are used to support daily inspections, minor repairs, weeding, and other preventive maintenance activities.

b) Major Repairs and Emergency Response/Maintenance: The BWDB allocates budgets for major repairs and emergency maintenance, utilising both government funding and donor assistance—including support from JICA and other development partners. Major repair works and emergency responses during disaster events are mainly financed through these sources.

WMGs mobilise funds independently, primarily through monthly member contributions averaging BDT 20 per member, membership fees, monthly savings (also averaging BDT 20 per member), and O&M contributions. From 2017 to March 2023, a total of BDT 56.2 million was mobilised by 297 WMGs, averaging approximately BDT 189,000 per WMG. These funds were mainly utilised for preventive maintenance activities, including routine inspections, minor repairs, and the weeding of flood control facilities.

On the other hand, the BWDB's financial support is mainly limited to major repairs and emergency responses. For example, the annual repair budget in Kishoreganj District is approximately BDT 150 million, of which about BDT 10 million (BDT 400,000 × 25 units) is allocated for the operation of flood fuses, accounting for approximately 6.7% of the total.

(c) Technical Aspect

The status of technical personnel deployment, technical standards, training systems, and equipment provision is summarised as follows:

a) Deployment of Technical Personnel: Specialised engineers in civil engineering, hydraulics, and agriculture are deployed at both BWDB headquarters and filed offices. At the community level, WMGs appoint trained local members to help ensure an adequate level of local technical capacity.

b) Development of Technical Standards: Standard design manuals developed by BWDB provide clear technical standards for the design and maintenance of key infrastructure, such as embankments, sluice gates, and flood fuses.

c) Preparation of O&M Manuals: During Phase 1 of the Project, O&M manuals were jointly developed by the consultant team and BWDB. These manuals outline key activities and implementation procedures for both BWDB and WMOs and have been used as training materials. To further promote community-based O&M activities, the preparation of simplified WMG versions—written in plain local language and supplemented with illustrations and photographs—is recommended.

d) Training System: O&M training based on the manuals were conducted for WMGs during the project period. In addition, BWDB technical staff received periodic training to strengthen their capacity and update their technical knowledge.

e) Equipment Provision: Basic equipment for inspection and minor repairs is available at BWDB field offices. In addition, simplified tools have been distributed to WMGs to facilitate community-led preventive maintenance activities.

O&M Framework Post-Phase 2

Following the completion of Phase 2, the O&M of both existing and newly developed flood control facilities is expected to continue under the two-tier structure involving BWDB and WMOs, as established in Phase 1.

Further efforts will focus on strengthening the existing O&M system by identifying specific challenges through field surveys and interview-based assessments, with the objective of ensuring sustainable and effective O&M activities during the implementation period of the Project.

7.1.3 Implementation and Management System for Agricultural Promotion Activities

The priority items for agricultural promotion activities and the associated implementation and management system are outlined below.

(1) Priority Items for Agricultural Promotional Activities

Climate Change Resilient Agriculture Sub-projects (CCRS) and Small-scale Livelihood Improvement Sub-projects (SIGS) are primarily implemented through training programs aimed at improving the livelihoods of WMG member farmers and women. In the Haor region, agricultural production is largely unavailable during the rainy season, and Boro rice cultivation is the primary agricultural activity during the dry season. Therefore, increasing Boro rice production is the top priority. However, the region needs to reduce its dependence on Boro rice monoculture. Accordingly, training in the cultivation of other crops—such as those grown during the dry season before Boro rice planting—is also important. Furthermore, to secure income sources during the rainy season, when agricultural activities are limited, small-scale livelihood improvement activities are necessary. These activities primarily target women in households and aim to support household livelihoods. They cover a wide range of areas, including home gardening and animal husbandry.

(2) Implementation Structure for Agricultural Promotion Activities

As in Phase 1, the BWDB will play a leading role in agricultural promotion and small-scale livelihood improvement activities. A Project Implementation Office (PIO) will be established within BWDB, while Project Implementation Units (PIUs) in each district will support WMG members' agricultural promotion and small-scale livelihood improvement activities. To provide technical and expert guidance, BWDB has signed Letters of Agreement (LOA) with the Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI), and Bangladesh Agriculture University, as well as a Memorandum of Understanding (MOU) with the Department of Agricultural Extension (DAE). Two Executive Engineers will be assigned to each PIU, and Extension Overseas will be deployed to support the PIUs. Each Extension Officer will be responsible for three to five WMGs and will support WMG members in implementing CCRS and SIGS activities in the field.

7.2 Rural Infrastructures and Fisheries Promotion Activities

7.2.1 Current Organization of LGED

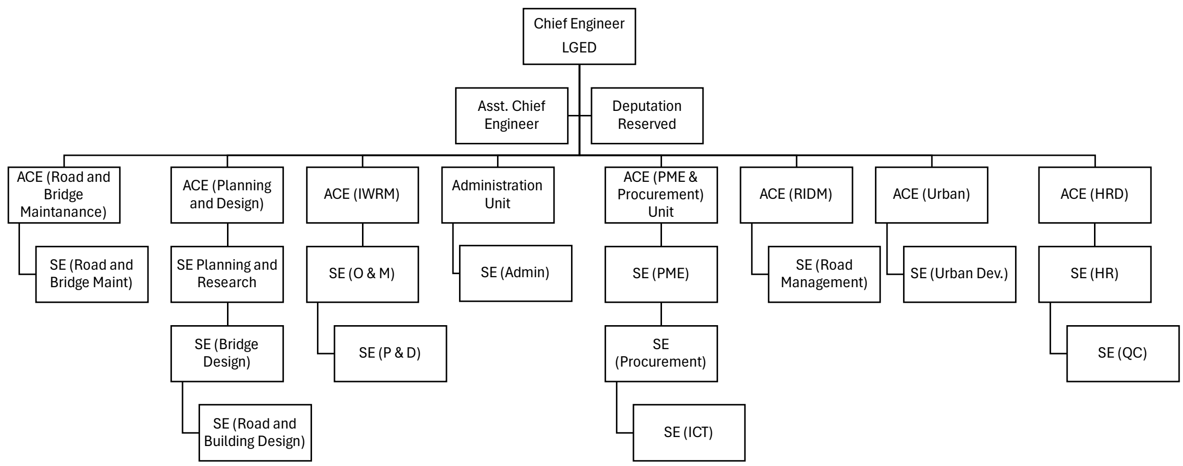
(1) Organisational Structure and Staffing

The Local Government Engineering Department (LGED), a public sector engineering organisation of Bangladesh under the Local Government Division (LGD), operates under a decentralised and hierarchical organisational structure designed to efficiently manage extensive rural, urban, and water sector infrastructure projects and programs. A brief overview of its organisational framework and the function of each office is provided below.

(a) Headquarters Structure

LGED is led by the Chief Engineer and supported by 7 Additional Chief Engineers and 15 Superintending Engineers. These officials supervise specialised units, such as Planning and Design, Project Monitoring, Evaluation and Procurement (PME & Procurement), Road and Bridge Maintenance, Integrated Water Resources Management (IWRM), Urban Management, Human Resource Development (HRD), and Administration. In addition to the revenue setup, Project Directors of GOB and donor-financed projects operate under the direct supervision of the Chief Engineer. As of December 2020, 13,394 personnel work under the revenue head, of which about 60% are technical staff, while the rest are involved in accounts, social development, and other support functions. Only 2.4% of the workforce is stationed at headquarters, with the majority deployed in the field.

The organisational chart of the LGED headquarters is shown in Figure 7.2.1 below.



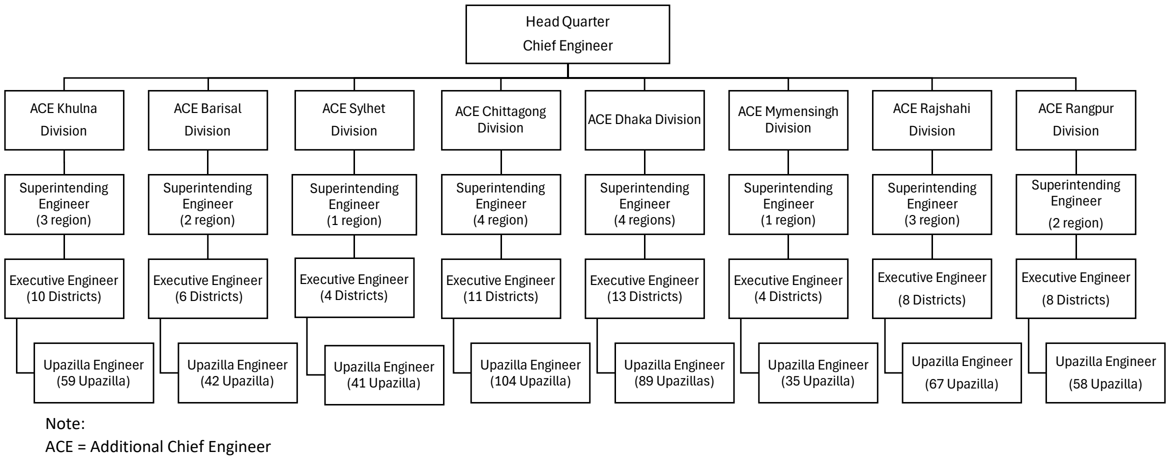
Note:
Asst = Assistant
ACE = Additional Chief Engineer
SE = Superintending Engineer
IWRM = Integrated Water Resource Management
P & D = Planning and Design
PMU = Project Monitoring and Evaluation
RIDM = Rural Infrastructure Development and Management
HRD = Human Resource Development
QC = Quality Control

Source: LGED Website (December 2020)

Figure 7.2.1 Organisation Chart of LGED Headquarter

(b) Divisional, Regional, Field Structure

LGED's operations are highly decentralised, with 97.6% of its workforce stationed at the field level across divisional (0.8%), regional (2.2%), district/zilla (16%), and sub-district/upazila (76.9%) levels. This structure is the main strength of LGED, as it enables rapid decision-making and community-centred planning. The organisational chart of the field offices is presented in Figure 7.2.2 below, along with the overview of the structure and roles of each office.



Source: LGED Website (December 2020)

Figure 7.2.2 LGED Divisional, Regional, and Field Structure

Table 7.2.1 Overview of the Structure and Roles of LGED Field Offices

Office	No. of Offices	Staffing	Roles
Additional Chief Engineer's Offices	8 divisional offices in each division	Managed by an Additional Chief Engineer and supported by three Executive Engineers	Administrative and technical assistance services, contact management, procurement, monitoring, and quality control of all the regional, district, and upazila engineers' offices activities within the division.
Superintending Engineer's Offices	20 regional offices	Managed by a Superintending Engineer and supported by two Executive Engineers	Administrative and technical assistance services, contact management, procurement management, monitoring, and quality control of all the district and upazila engineers' offices' activities within the region.
Executive Engineer's Offices	64 district offices in each district	Managed by an Executive Engineer with a Senior Assistant Engineer and an Assistant Engineer	Executing LGED's activities and maintain close communication with the headquarters, divisional and regional offices. The Executive Engineer is responsible for providing administrative and technical assistance services, managing contacts, overseeing procurement, monitoring activities, and ensuring quality control of the district's and upazila engineers' offices' functions within the district.
Upazila Engineer's Office	495 upazila office in each upazila	Upazila Engineer with supporting staff	Focusing on grassroots execution, community engagement, and maintenance of local infrastructure, such as roads, bridges, and water systems at the upazila level.

Source: LGED

(2) Roles of LGED

LGED is a public sector agency responsible for the planning and development of rural, urban, and small-scale water sector-related infrastructure in Bangladesh. Its primary functions include the construction and maintenance of rural roads, bridges, and culverts to enhance connectivity. LGED also provides technical support to local government institutions, such as unions, upazilas, and zilla parishads. In the urban sector, LGED implements urban infrastructure projects like roads and drainage facilities and capacity-building training for city corporations and pourashavas employees to improve institutional governance. In addition, LGED contributes to the implementation and maintenance of small-scale water sector projects financed by the Government of Bangladesh and other partner organisations.

The following Table 7.2.2 shows the primary functions of LGED.

Table 7.2.2 Primary Function of LGED

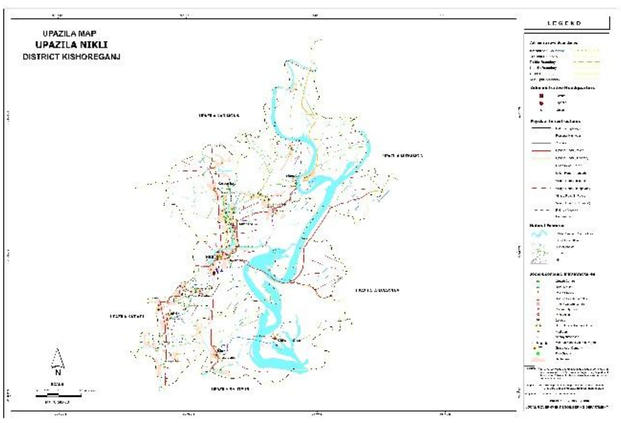
Rural Infrastructure	Urban Infrastructure	Small-scale Water Resource Development
Construction, rehabilitation, and maintenance of rural roads, bridges, and culverts; growth centres and rural markets; boat landing stations; Union and Upazila Parishad complexes; and multipurpose cyclone centres	Construction of roads and footpaths; drainage facilities; bus and truck terminals; solid waste management; sanitary and community latrines; microcredit programs; and income-generating activities (IGA) activities.	Construction and maintenance of sluice gates and rubber dams; excavation and re-excavation of canal; construction and reconstruction of embankments; formation of Water Management Cooperative Association (WMCA); excavation of Beels, water bodies, and ponds; and IGA-related capacity-building training.

Source: LGED

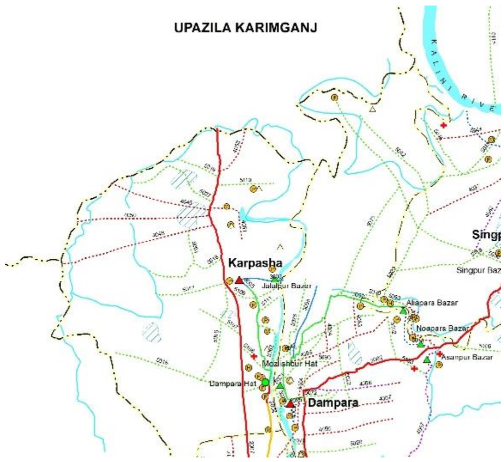
For the implementation of the project, the departments of LGED with which close collaboration is expected are described below.

(a) GIS Unit

LGED has established a GIS Unit with the objective of preparing GIS-based maps for project planning in the rural, urban, and small-scale water resources sectors. On the LGED website, Upazila maps and rural road network maps prepared by the GIS unit are available. These maps show rural roads, rural infrastructure facilities, and public facilities such as schools and hospitals for each Upazila. Effective utilisation of these GIS data will facilitate project implementation, particularly in identifying the locations of target rural roads. In addition, this unit provides services not only within LGED but also to other public agencies and private organisations.



Upazila Map
(Example of Nikli Upazila, Kishoreganj District)



Rural Road Network Map
（Road ID numbers are presented）

Source: LGED Website GIS Portal (https://oldweb.lged.gov.bd/ViewMap.aspx)

Figure 7.2.3 Upazila Maps and Rural Road Network Maps Prepared by the GIS Unit

LGED requires technical support for the capacity building of its personnel, utilising the latest technologies and updated software, in order to enhance and strengthen the functions of the GIS Unit.

(b) Training Unit

The Training Unit of LGED operates continuous training programs aimed at enhancing the capacities of technical staff, other employees, and beneficiaries. The unit regularly updates a comprehensive training plan based on available funds from the revenue budget and development project budgets supported by donor funding.

Table 7.2.3 Budget Allocation for Training (2022-2023 to 2024-2025)

Sl No.	Financial Year	Revenue Fund (BDT Lakhs)	Development Project Fund (BDT Lakhs)	Total Fund for Training (BDT Lakhs)
1.	2022-2023	434.50	5,437.36	5,871.86
2	2023-2024	490.35	5,320.23	5,807.42
3	2024-2025	601.71	6,306.84	6,908.63

Source: Training Unit of LGED

(3) Financial Status and Budget Allocation of LGED for Project Implementation

LGED implements a large number of rural, urban, and small-scale water resources infrastructure projects based on the government's Annual Development Programme (ADP). The financial resources for these projects include both government funding and external donor funding sources such as JICA, Asian Development Bank (ADB), the World Bank, and International Fund for Agricultural Development (IFAD).

Budget allocation are distributed across the following key areas:

① Infrastructure construction costs (e.g., roads, bridges, culverts)
② Operation and maintenance costs
③ Human resource development (e.g., training, technical assistance)
④ Environmental and social safeguard-related costs
⑤ Project management costs (e.g., operation of PMU/PIU)

Table 7.2.4 below shows the budget allocation and expenditure status related to LGED's project implementation over the past five years.

Table 7.2.4 Project Budget Allocation and Expenditure Status

Fiscal Year	Project Budget Allocation (BDT Crores)	Actual Expenditure (BDT Crores)	Ratio (%)
2019-2020	14,957.6	13,146.7	87.9
2020-2021	17,000.2	14,865.4	87.4
2021-2022	15,512.7	15,077.6	97.2
2022-2023	19,910.9	17,508.5	87.9
2023-2024	21,951.3	21,204.1	96.6

Source： LGED

In the Project, training will be required for field office engineers in particular, covering design work, bidding and contract management, construction supervision, operation and maintenance, and the implementation and continuation of fisheries promotion activities. Accordingly, it is anticipated that the PMO may request training support from the Training Unit. The necessary training costs are planned to be covered under the capacity development subcomponent and the fisheries promotion activities of the Project.

(4) Technical Capacity for Project Implementation

LGED possesses a strong, decentralised organisational structure and a wealth of human resources across the country, enabling it to implement large-scale and diverse infrastructure projects. Its headquarters, located in Dhaka, is responsible for strategic planning, project formulation, development of technical standards, and coordination with donor agencies and central ministries.

LGED's field offices, deployed at divisional, regional, district, and upazila levels, facilitate timely decision-making on the ground and support community-based project implementation.

In addition, LGED has established specialised units in areas such as GIS, design and planning, quality control, environmental and social safeguards, information management, and training, ensuring a robust technical and managerial support.

To ensure the quality and efficient maintenance of roads and bridges, LGED has developed design standards, guidelines, manuals for rural roads and bridges, as well as maintenance manuals. Furthermore, to effectively plan, develop, and maintain the rural road network, LGED has built an integrated Road Database.

This database systematically collects and stores detailed information—including road names, numbers, lengths, pavement types, number of bridges and culverts, and maintenance history—for Upazila, Union, and Village roads across the country. It is integrated with GIS through the Road and Structure Database Management System (RSDMS), allowing visualisation and analysis of road asset data.

By utilising the RSDMS, LGED promotes sustainable and strategic road management while also contributing to the qualitative improvement of regional transport infrastructure.

(5) Operation and Maintenance System for Rural Infrastructure

(a) Organisation for Operation and Maintenance

LGED has a systematically organised structure for the O&M of rural infrastructure, aimed at ensuring efficient and continuous functionality. O&M activities are primarily carried out by the upazila offices at the local level, in coordination with District and Regional Engineer offices. The roles of each office are as follows:

① Upazila Office:
Responsible for on-site infrastructure management, routine maintenance and inspections, and emergency response. It also serves as the main liaison with local communities.

② District Office:
Provides technical support, supervises major maintenance works, and manages procurement of materials.

③ Regional Office:
Formulates overall O&M strategies, ensures quality control, and monitors progress.

(b) Budget Allocation for O&M

LGED secures the necessary financial resources for the O&M of rural infrastructure. The budget for O&M activities is funded through a combination of government expenditures and allocations from individual projects.

Recent budget allocation trends reflect the increasing importance of O&M expenditures in achieving sustainable infrastructure management. Appropriate funding enables timely maintenance work and regular inspections at the field level.

Table 7.2.5 below summarises the total road length and corresponding budget allocations over the past ten years.

Table 7.2.5 Budget Allocation for Road Maintenance

Financial Year	Road Length (km)		Maint. Need (Cr. Tk.)	Allocation (BDT Crores)			Maintenance Type-wise Expenditure (BDT Crores)			
	Total Length	Paved Length		GoBM	Other Projects	Total	RM (On)	RM (Off)	PM	EM
2014-2015	321,462	95,977	8282	975	402	1377	3.70	25.37	1339.67	8.26
2015-2016	346,286	101,093	12555	1075	450	1525	3.94	25.46	1479.30	16.30
2016-2017	352,943	106,275	14244	1258	889	2147	4.49	26.08	2098.28	18.15
2017-2018	352,943	111,433	16889	1730	963	2693	4.56	42.09	2618.30	28.25
2018-2019	353,332	116,919	18486	1800	1495	3295	7.62	42.38	3225.00	20.00
2019-2020	353,353	122,556	20905	1767	1422	3189	13.93	62.32	3087.42	25.00

Financial Year	Road Length (km)		Maint. Need (Cr. Tk.)	Allocation (BDT Crores)			Maintenance Type-wise Expenditure (BDT Crores)			
	Total Length	Paved Length		GoBM	Other Projects	Total	RM (On)	RM (Off)	PM	EM
2020-2021	353,353	128,528	19514	2276	2000	4276	17.90	119.69	4108.22	30.00
2021-2022	338,922	115,243	20412	2363	2723	5086	20.08	146.22	4873.05	46.75
2022-2023	338,922	150,583	17464	2791	2977	5768	22.50	165.43	5550.22	29.63
2023-2024	372,753	156,347	21310	2884	2891	5775	31.51	206.68	5513.92	22.75

Notes:
RM(On) : Routine Maintenance (On Pavement)
RM(Off) : Routine Maintenance (Off Pavement)
PM : Periodic Maintenance (Reseal, Overlay, Rehabilitation & Widening)
EM : Emergency Maintenance
GoBM : Rural Road, Bridge and Culvert Maintenance Program (Revenue Budget)

Source: Maintenance Unit, LGED

As shown in the table above, the need for maintenance and management costs has increased with the expansion of paved road length. Although budget allocations for required maintenance costs remain insufficient, the budget per kilometre of road has increased significantly over the past decade: from approximately BDT 42,800 per km (BDT 1,377 Cr./ 321,000 km) in 2014–2015 to approximately BDT 155,000 per km (BDT 5,775 Cr./ 373,000 km) in 2023–2024, representing roughly three times the maintenance costs over ten years.

7.2.2 Project Implementation and Operation and Maintenance Structure for Rural Infrastructure

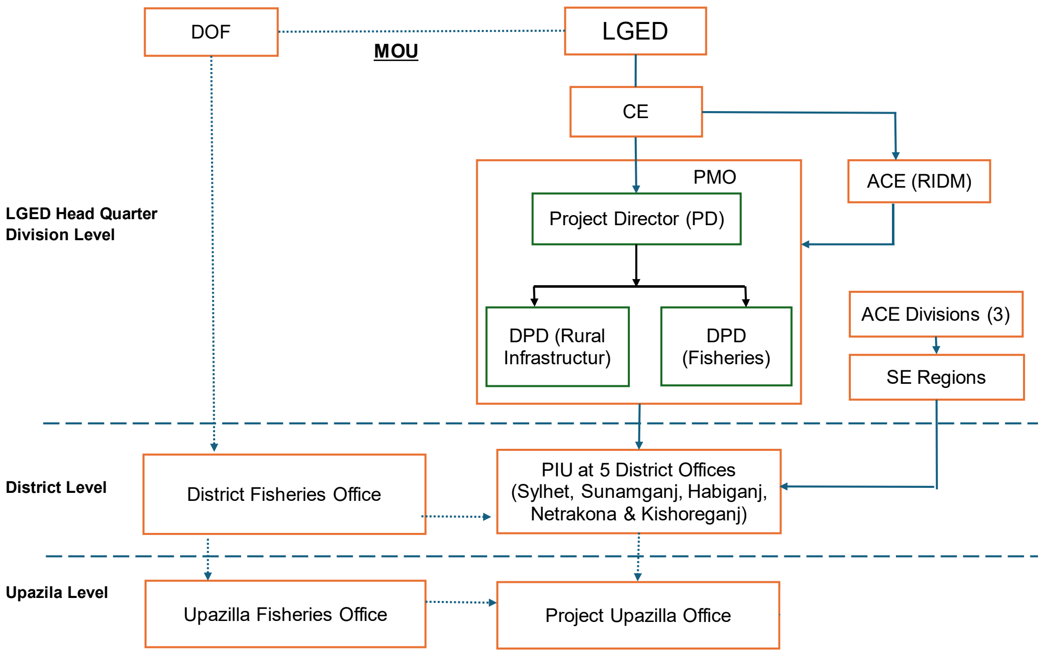
(1) Project Implementation Structure

For the implementation structure of rural infrastructure and fisheries promotion activities, a Project Management Office (PMO) will be established at the LGED headquarters, headed by a Project Director (PD).

Project Implementation Units (PIUs) will be set up within the existing LGED district offices located in the targeted districts—Netrokona, Kishoreganj, Habiganj, Sylhet, and Sunamganj. LGED project upazila offices are planned to be established within the existing LGED upazila offices.

District offices of the Department of Fisheries (DOF) are expected to coordinate with LGED's PIUs to implement fisheries promotion activities.

The organisational chart of the implementation structure is presented in Figure 7.2.4 below.



Notes:
MOU: Memorendum of Understanding
CE: Chief Engineer
ACE: Additional Chief Engineer
RIDM: Rural Infrastructure Development Management
PMU: Project Management Unit
PIU: Project Implementation Unit
SE: Superintending Engineer
DPD: Deputy Project Director

Source: JICA Survey Team, based on the discussion with LGED

Figure 7.2.4 Project Implementation Structure (Proposed)（LGED）

(2) Project Management Office (PMO)

(a) Roles of PMO

The PMO of LGED will be established at LGED headquarter and will be responsible for the overall management of rural infrastructure development and fisheries promotion activities, aiming to efficiently achieve project outputs. To implement the project, the PMO will carry out the following roles and responsibilities.

a) Formulate the overall implementation plan.
b) Procure and manage consultants and project staff, and closely monitor their performance based on their Terms of Reference (TOR), utilising appropriate monitoring and evaluation (M&E) tools and human capital development systems.
c) Prepare the Annual Work Plan and Budget (AWPB) and procurement plan for both the PMO and PIUs and obtain approval from the Chief Engineer of LGED.
d) Conduct detailed design.
e) Monitor progress of land acquisition.
f) Supervise activities and monitor implementation progress.
g) Coordinate rural infrastructure development with fisheries promotion activities.
h) Provide guidance to the PIUs.
i) Review and approve invoices from consultants and contractors.
j) Ensure compliance with environmental and social safeguard requirements.
k) Report to and coordinate with relevant agencies.
l) Organise stakeholder workshops at each stage of implementation.
m) Prepare knowledge management documents and share them with stakeholders.
n) Draft and ensure implementation of the following Memorandums of Understanding (MOUs):
    1) MOU between LGED and the Department of Fisheries (DOF)
    2) MOU between the Local Government Division (LGD) and the Ministry of Land (MOL)
o) Establish an internal control mechanism (including internal audit and audit by FAFD) and respond

to audit recommendations.

(b) Staff of PMO

To operate PMO effectively, the following staff are required.

Table 7.2.6 Staff of LGED PMO

No.	Position	Quantity
1	Project Director	1
2	Deputy Project Director	2*
3	Senior Assistant Engineer	1
4	Assistant Engineer	1
5	Account Office	1
6	Sub-Assistant Engineer	3
7	Administrative / Human Resources Manager	1
8	Office Assistance cum Computer Operator	1
9	Driver	1
10	Office Helper	1
11	Guard / Cleaner	1
	Total	14

Note: *) Rural Infrastructure x 1, Fishery Promotion Activities x 1

Source: prepared by JICA Survey Team based on the discussion with LGED

(3) Project Implementation Unit (PIU)

(a) Roles of PIU

A PIU of LGED will be established in each of the five districts and will be responsible for implementing rural infrastructure development and fisheries promotion activities in the target haor and upazila areas. The PIU will undertake the following roles and responsibilities:

a) Prepare subproject and scheme implementation plans.
b) Conduct surveys and measurements.
c) Prepare bidding documents, issue bid invitations, and award and sign contracts (bid evaluation will be conducted by the Evaluation Committee, and the evaluation results will be approved by officials designated under government regulations).
d) Review and verify design specifications.
e) Carry out land acquisition.
f) Supervise the construction of rural infrastructure and the implementation of fisheries-related activities.
g) Review contractors' invoices.
h) Prepare progress reports.

(b) Staff of PIU

To ensure the proper operation of the PIUs, it is necessary to secure the following staff in each PIU established in the respective districts.

Table 7.2.7 Staff of LGED PIU (Each District)

No.	Position	Quantity
1	Executive Engineer*	1
2	Senior Assistant Engineer	1
3	Assistant Engineer	1
4	District Project Coordinator	1
5	District M&E Officer	1
6	Subject Matter Specialist (Fisheries)	1
7	District Training Coordinator	1
8	Accountant	1
9	Office Assistance cum Computer Operator	1
10	Speed Boat Driver	1
11	Driver	1

No.	Position	Quantity
12	Office Helper	1
	Total	12

Note: *) Concurrent roles of the LGED District Office

Source: prepared by JICA Survey Team based on the discussion with LGED

(4) Operation and Maintenance Structure

The PIU of LGED will be responsible for implementing rural infrastructure development and fisheries promotion activities in the targeted haor areas and upazilas. The PIU will undertake the following tasks and responsibilities.

(a) Rural Roads

Maintenance of Upazila roads, Union roads, and important Village roads is carried out by LGED's district and upazila offices under the supervision of the Road Management and Road Safety Unit (RMRSU) and LGED regional offices.

For Village roads not categorised as important, maintenance activities are implemented by Local Government Institutions (LGIs), such as Upazila Parishads and Union Parishads, under the technical guidance of LGED.

(b) Markets and Boat Landing Stations

Maintenance of growth centres, rural markets, and boat landing stations (Ghats) is carried out by tenants, Market Management Committees (MMC), and Upazila Market Management Committees (UMMC), utilising a portion of the rental income.

(c) Village Protection Walls

For the proposed village protection wall, routine inspections and minor repairs are expected to be carried out by villagers, similar to existing protection walls. During the construction period, villagers are expected to participate in parts of the construction works (such as manual earthworks) through employment by contractors or Labour Contracting Societies (LCS), helping them gain an understanding of the structure and acquire basic skills for construction and repair.

In cases where medium- to large-scale repairs are required, villagers may need to request support from LGIs.

(5) Cost Estimate for Maintenance of Rural Infrastructures

The expected annual costs for maintenance of each rural infrastructure, which are to be constructed in the Project, were estimated as below:

Table 7.2.8 Unit Cost for Maintenance of Rural Road

Rural Road	Category	Pavement Type	Annual Maintenance Cost (Lakh BDT/km)
Upazila Road	Submergible	RCC	18.87
	Non-submergible	BC	17.68
Union Road	Submergible	RCC	15.75
	Non-submergible	Uni-block	13.86
Village Road	Submergible	RCC	13.55
	Non-submergible	Uni-block	8.82

Source: estimated by JICA Survey Team based on LGED Annual Report

Table 7.2.9 Unit Cost for Maintenance of Bridge and Culvert

Structure	Annual Maintenance Cost (Lakh BDT/m)
Bridge	0.42
Culvert	0.39

Source: estimated by JICA Survey Team based on LGED Annual Report

Table 7.2.10 Unit Cost for Maintenance of Market, Boat Landing Station and Village Protection Wall

Structure	Unit	Annual Maintenance Cost (Lakh BDT/unit)
Market	Per location	4.40
Boat Landing Station	Per location	1.60
Village Protection Wall	Per km	6.80

Source: estimated by JICA Survey Team assuming a service life of 25 years

7.2.3 Implementation and Operational Structure for Fisheries Promotion Activities

This section specifies the procedures for institutionalisation and clarifies the roles and responsibilities of relevant institutions, aiming to ensure autonomous operation after project completion. The focus is on legal positioning, financial discipline, Upazila-level collaborative mechanisms, and the internalisation of training functions.

(1) Basic Policy and Target Outcomes

(a) On the Structure of Beel User Group (BUG)

1) Implementation Structure of the Fisheries Promotion Component in Phase 1

- Design and Implementation of Fisheries Promotion (Component 3-2):
  - ✓ LGED promoted community-based fisheries resource management (CbFRM). Within this CbFRM, WorldFish (NGO) was responsible for catch monitoring and biodiversity impact assessment of the target Beels and provided technical support on fish species identification and conservation. Furthermore, follow-up surveys conducted from 2017–2022 confirmed that the number of fish species increased from 106 to 127, with results shared at workshops in four districts in 2023.
  - ✓ In each Beel, a BUG was established. Based on an MOU with the Ministry of Land (MOL), community leasing arrangements covering 139 Beels were adopted. Under this framework, activities such as dredging, excavation of connecting canals, establishment of fish sanctuaries, wetland tree planting, alternative livelihood activities (CAIGA), and aquaculture support were implemented.
  - ✓ The Department of Fisheries (DOF) collaborated in these activities from both technical and institutional perspectives.
- Field-level activities:
  - ✓ Formation of BUGs/BMCs, opening of bank accounts, and operational training were carried out.
  - ✓ Progress was monitored jointly by LGED and the consultant.

2) Situation at the End of Phase 1

Since a clear nationwide system for financial arrangements and implementation procedures for the maintenance and management of Beels and canals had not been established, the O&M Manual and the CbFRM Guidelines developed in Phase 1 proposed operational and maintenance procedures. These procedures and formats have not been enacted as uniform national laws or official notices. However, in the target districts, they have continued to be referenced and used as operational guidelines (practical manuals) by LGED, DOF, and BUGs. If the contents are to be updated in Phase 2, a realistic procedure would be to conduct consultations and pilot implementation with relevant institutions (LGED, MOL, Department of Cooperatives, etc.), obtain approval from the technical committee, and then disseminate the updates nationwide through an update of DOF internal circulars. Matters related to the leasing system and similar issues would be complemented through joint circulars or memoranda issued together with the MOL.

- Community management: At project completion, out of 139 target Beels, 130 BUGs had been formed, 126 leases obtained, and 121 reached effective management.
- Based on agreement with MOL, the lease period during the project was extended (2016–June 2022, with a special extension due to project extension from 2022–April 2023). However, after April 2023, acquisition of Beel lease rights was expected to return to normal open competitive bidding.
- Before the special lease arrangement ended, the PD requested Upazila and District Cooperative Offices to accelerate BUG registration to obtain legal personality and strengthen competitiveness in bidding. However, due to lack of time, some BUGs remained unregistered.
- Similar to legal personality, approval of BUG membership lists by Jalmohal Committees—required for bidding—was completed for only 85 out of 139 (61.2%), resulting in BUGs being unable to complete or prepare bidding documents in time.

3) Issues Identified When Attempting to Reacquire Lease Rights After Project Completion

- Disadvantages and Increased Failures in Competitive Bidding (Re-leasing)

  BUGs without cooperative registration were less likely to be treated as "formal organisations" in procedures. The PD instructed districts at the end of the project to accelerate BUG cooperative registration—granting legal personality—was found to strengthen legitimacy in bidding qualification, contract procedures, and external relations. Details on timing and procedures are indicated in "4. Activities Necessary to Enhance BUG Sustainability."

  BUGs with delayed registration found it difficult to prove organisational legitimacy, increasing the risk of disadvantage in bid qualification screening.

- Stagnation in Submission of Membership Lists to Jalmohal Committees

  Approval of BUG membership lists by Upazila/District Jalmohal Committees—a prerequisite for bidding and management—took time. This process should have proceeded in parallel with cooperative registration. Delays resulted in more cases where BUGs had incomplete documents or could not meet deadlines, leading to disadvantages in bidding.

- Insufficient Financial Capacity

  Although guidance on individual small-scale savings was provided for CAIGA activities and some guidance on BUG financial management was given, many BUGs were unable to accumulate sufficient funds to cover security deposits, annual lease fees, legal fees, and other expenses. Furthermore, external factors such as floods and the COVID-19 pandemic during the project period damaged their savings. Specific policies and procedures related to this matter are organised in "4. Activities Necessary to Enhance BUG Sustainability."

- Insufficient Capacity to Handle Conflicts and Vested Rights

  At the local level, conflicts over leasing arise due to occupation by influential persons, litigation, or discrepancies in registration. If the legal backing of a cooperative is weak or incomplete, BUGs become disadvantaged in administrative or judicial responses and negotiations, leading to more cases where they fail to secure management rights.

CHAPTER 8 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (EIA AND RAP SURVEY)

8.1 Natural Environment

8.1.1 Approach and Methodology Adopted for this Study

As explained in Chapter 4, although this project is classified as Category B under the Japan International Cooperation Agency (JICA) assessment, according to Schedule 1 (Category Classification) of Bangladesh's Environmental Conservation Rules, the Bangladesh Water Development Board (BWDB) component involving the installation of submersible embankments and the Local Government Engineering Department (LGED) component involving road widening of more than 10 km fall under the Red Category. Therefore, both BWDB and LGED are required to conduct an Environmental Impact Assessment (EIA) study and obtain EIA approval from the Department of Environment (DoE).

The study included environmental baseline surveys for both the monsoon and dry seasons. Stakeholder consultations (PCM: Public Consultation Meetings) were conducted after the submission of the draft EIA report to the DoE, in accordance with ECR 2023. The EIA report was finalized by incorporating comments and feedback from PCMs and stakeholders and was subsequently submitted to the DoE. The EIA study was implemented through local subcontracting.

This preparatory survey began in April 2025. As the dry season ended in late May and the selection of local subcontractors required some time, the subcontracted work was divided into two phases. First, to urgently address the dry season field survey, one subcontractor was selected by mid-May 2025, and that contractor completed the dry season survey by the end of May 2025. Subsequently, tasks including the monsoon season field survey, stakeholder consultations (PCM), impact assessment, and the preparation of the Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) were carried out under a separate subcontract agreement, starting with the monsoon baseline survey in August 2025. By October 2025, a draft EIA report had been prepared. Public consultation meetings were then held, after which the EIA report was finalized.

In this study, the top 15 candidate haors for the project (EIA target 15 haors) were selected, and an EIA was conducted for each haor, along with the preparation of EMP and EMoP. Based on the results of the haor-by-haor evaluation, items common to all 15 haors are indicated as [Common to all Haors], while items applicable only to specific haors are clearly identified as [Applicable Only to ~ Haor] in the compiled documentation.

8.1.2 Environmental Baseline Survey

As described above, baseline surveys were conducted during the dry season in May 2025 and the rainy season in August 2025. The key points of both surveys are summarized below.

(1) Outline of the Environmental Baseline Survey

The purpose of the surveys was to understand the current environmental and social conditions of the haor areas through the following investigations.

- Detail information on site locations;
- Visual survey of the sites;
- Collection of the required primary data;
- Understanding and assessment of general environmental conditions;
- Understanding of existing ecosystem and biodiversity; and
- Conducting focus group discussions (FGDs) and discussions with stakeholders to obtain feedback.

The scope of dry season environmental baseline survey is shown in Table 8.1.1 below.

Table 8.1.1 Scope of Fieldwork for Dry Season Environmental Baseline Investigations

Items	Sampling Points and Survey Area	Frequency	Parameters
River Bottom Sediment	Nine points Survey area: River and tributaries bed around the project site (interventions)	One time (dry season)	Temperature, sulfide, organic matter (OM), Hg, Cd, Pb, Org-P, N, Cr^{6+}, As, CN, Cu, Zn, F, Na, K, Cl, Ca, and Mg
Surface Water	Nine points Survey area: Tributaries around the project site and haor waterbody	One time (dry season)	Parameters of National Surface Water Quality Standards, such as temperature, turbidity, pH, DO, BOD_5, COD, TDS, EC, TSS, NH_3, NO_3, total coliform, Cl
Ground Water	Nine points Survey area: Shallow and deep wells near the project sites	One time (dry season)	Temperature, turbidity, total hardness, pH, TDS, EC, sulphate, chlorides, As, Fe, Mn, NO_3, PO_3, F, total coliform, faecal coliform
Air Quality	Nine points Along the entire project sites	One (1) time (dry season)	Parameter of National Ambient Air Quality Standards, such as SO_2, NO_2, SPM, PM_{10}, $PM_{2.5}$, CO and O_3 24 hour-continuous for one day.
Noise			Noise Level (Leq: dBA) 24 hour-continuous for one day, with recording noise events or sources (e.g., passing vehicle, construction works, etc.).
Soil Quality	Nine points along the entire project sites	One time (dry season)	pH, soil texture, TOC, total N, total P, and total K
Macrobenthos (1) (Floodplain and river bottom)	Nine points *Same as “River bottom sediment”	One time (dry season)	Species name, number, wet weight (Method) Sampling by grub sampler and analysis. Keep collecting samples for three years (e.g., formalin fixation) with proper labelling and classification.
Phytoplankton			Species name and number (Method) Water sampling (1 L) and relevant analysis
Zooplankton	Nine points *Same as “River bottom sediment” (Sampling :1 to 2 layers, depending on the depth) - 0 ~ - 2 m - 2 ~ - 10 m Survey area: same as above		Species name and number (Method) Sampling by plankton net (50 -100 μm) and analysis
Fish and Other Nektons	- Fish markets - Local fisheries offices -Documents and hearing from experts /scientist Survey area: same as above -Important places (e.g., catching, spawning breeding and other important zones for river aquatic ecosystem) of inland fishery activity in and around the Haor area - Fish migration patterns in and around the Haor area and nearby rivers		Species name and number (Note) Both natural and cultured fish are of concerns.

Items	Sampling Points and Survey Area	Frequency	Parameters
Vegetation	Survey area: Nine clusters In and around the sampling cluster area for vegetation survey	One time (dry season)	- Species and number - Vegetation maps during the pre-monsoon/dry season were developed within relevant study Upland vegetation map Emergent vegetation map Aquatic vegetation map (subject to change on condition) Based on this developed vegetation map, relevant map information (e.g., floral inventory)/ revising shall be conducted.
Mammal	Survey area: Nine clusters Identification of the important zones for river dolphins, birds, reptiles and amphibians (availability and any other issues) by field observation and local-level consultations in and around the sampling cluster (Note: subject to change on conditions)	Once (dry season) * Day time and nighttime	Species and number (Method) Visual observation in and around the clusters; interviews with local residents and other stakeholders; review of secondary data.
Birds		Once (dry season) * Day time only	Species and number (Method) Cluster census, point census, visual observation, mist net, interviews with local residents and other stakeholders, secondary data
Reptile and Amphibians		Once (dry season) * Day time only	Species and number (Method) Visual observation and review of secondary data
Insects		Once (dry season) * Day time and nighttime	Species and number (Method) Visual observation and review of secondary data

Source: JICA Survey Team

(2) Execution of Field Work

The dry-season baseline survey was conducted from May 24 to June 1, 2025, by four survey teams. In this preparatory survey, 26 candidate project haors were grouped into nine clusters by classifying haors that are adjacent or located relatively close to one another into the same cluster. Field surveys were then carried out at representative haors within each cluster to understand the baseline environmental conditions of the entire project area. The reasons for adopting this clustering approach are described below.

1. Environmental Considerations

The main factors influencing environmental conditions include topographic characteristics, watershed structure, regional climate, and vegetation distribution. Among these, watershed structure and vegetation distribution exhibit limited spatial variability across groups of haors, with relatively homogeneous patterns observed over wide areas. Therefore, environmental characteristics derived from these factors are considered broadly common among nearby haors. In contrast, topography (such as elevation differences, inundation depth, and basin morphology) and local meteorological conditions (including rainfall, the influence of seasonal monsoons, and wind speed) show local variations, which creates regional differences in hydrological characteristics and ecosystem structure. Accordingly, clustering based on geographic distribution, while taking these factors into account, is scientifically and hydrologically sound.

2. Social Considerations

The main factors influencing social conditions include population distribution, the location of administrative functions and political and economic centres, and industries—primarily agriculture and fisheries—that are affected by environmental conditions. Because regional spatial structure is highly correlated with socio-economic accessibility, establishing social clusters based on geographic distance and locational relationships is considered sufficiently rational. In particular, in haor areas, seasonal isolation, access to distribution networks and markets, accessibility to administrative services, and the production structure of agriculture and fisheries are strongly dependent on geographic conditions, making spatial clustering appropriate. It should be noted that this clustering was conducted solely for the purpose of selecting survey locations for the environmental baseline survey. As described later, the social survey (Resettlement Action Plan (RAP) survey) under this study was conducted individually for each target haor.

Table 8.1.2 Name of Investigation Haors

Cluster	Candidate Project Haors	Haors Where Field Surveys Were Conducted	District
SN1	Updakhali Haor	Gurmar Haor	Sunamganj
	Goradoba Haor		
	Gurmar Haor		
	Sonamoral Haor		
SN2	Karchar Haor	Halir Haor	
	Hailr Haor		
	Shanir Haor		
SN3	Chaptir Haor	Chaptir Haor	
	Khai Haor		
	Boram Haor		
SN4	Naluar Haor (Part 1)	Naluar Haor (Part 1)	
	Naluar Haor (Part 2)		
	Makalkandi Haor		
SN5	Mrigar Haor	Mrigar Haor	Kishorganj
	Khuniyer Haor		
	Khaliajuri Haor		
	Chayer Haor		
SN6	Kazurkhola Boro Haor	Kazir Kola Boro Haor	
	Dewghar Haor		
	Humayerpur Haor		
	Ballar Haor		
SN7	Pathar Chawli Haor (Part 1)	Pathor Chauli Haor (Part 2)	Sylhet
	Pathar Chawli Haor (Part 2)		
	Kalaruka Haor		
	Zikar Haor (Part 1)		
	Zikar Haor (Part 2)		
SN8	Muktapur Haor	Muktarpur Haor	
SN9	Hail Haor	Hail Haor	Moulvibazar

Source: JICA Survey Team

(3) Results of Analytical Monitoring

To determine baseline environmental quality during the dry season, analytical monitoring was conducted for various parameters of air, noise, surface water, ground water, soil and river bottom sediment. The results are presented in the following subsections. Photographs of testing and sampling are given below.

Ambient Air Quality Monitoring

Ambient Noise Level Monitoring (Daytime)

Surface Water Quality Sampling

Ground Water Quality Sampling

Soil Sampling

River Bottom Sediment Sampling

Photographs of Analytical Parameters Sampling

Source: JICA Survey Team

(a) Ambient Air Quality

The sampling period was between 24 May and 1 June 2025. The air quality data at the project site shows that all the parameters remain within the allowable limits as per the Environmental Quality Standards of Bangladesh. The table below presents the highest concentration recorded for each parameter tested. Among the sites, it can be said that the air quality of Kazir Kola Boro Haor was comparatively worse than in other locations.

Table 8.1.3 Ambient Air Quality

Sl	Parameters	Unit	Highest Concentration	Location	Standards	
					APCR2022 *1	WHO2021 AQG Level *2
1.	PM2.5	(µg/m3)	36.19	Kazir Kola Boro Haor	65	15
2.	PM10	(µg/m3)	68.55	Kazir Kola Boro Haor	150	45
3.	SPM	(µg/m3)	108.93	Kazir Kola Boro Haor	-	-
4.	SO2	(µg/m3)	1.52	Naluar Haor	80	40
5.	NOx	(µg/m3)	1.37	Gurmar Haor, Chaptir Haor	80 *3	25 *3
6.	CO	(ppm)	1	Halir Haor, Kazir Kola Boro Haor, Chaptir Haor, Naluar Haor, Pathor Chauli Haor, Muktarpur Haor	17.16 *4	-
7.	O3	(µg/m3)	22.17	Naluar Haor	100	100

*1 Air Pollution Control Rules, 2022

*2 WHO global air quality guidelines, 2021

*3 The reference value is for NO2

*4 The reference value is 20 mg/m³, and the calculation is based on WHO (2021), using a conversion factor of 1 mg/m³ = 0.858 ppm (at 1 atm and 20°C)

Source: JICA Survey Team

(b) Ambient Noise

The sampling period was from 24 May and 1 June 2025. All the ambient noise level data were within the standard limits. The table below shows the highest values obtained for day and night. Among the sites, it can be said that the noise level at Halir Haor was comparatively higher than in other locations, considering both the day and night.

Table 8.1.4 Ambient Noise Quality

Sl. No.	Location	Concentration Present (dBA)	
		Daytime (LAeq)	Nighttime (LAeq)
1.	Gurmar Haor	44.2	40.1
2.	Halir Haor	45.2	42.5
3.	Chaptir Haor	43.3	41.4
4.	Naluar Haor	42.4	39.8
5.	Mrigar Haor	45.3	41.1
6.	Kazir Kola Boro Haor	44.7	41.7
7.	Pathor Chauli Haor	43.2	40.9
8.	Muktarpur Haor	45.2	40.2
9.	Hail Haor	42.1	41.3
Bangladesh Standard for Residential Area Noise Pollution Control Rules, 2006		55	45
Standard for Residential Area Guidelines for Community Noise, World Health Organization (WHO), 1999		55	45

Source: JICA Survey Team

(c) Surface Water

The sampling period was from 24 May and 1 June 2025. The results are given in Table 8.1.5 below. For surface water quality, all parameters complied with the Bangladesh Environmental Quality Standards for both drinking water and fisheries.

Table 8.1.5 Surface Water Quality

Parameters	Unit	Concentration																		Bangladesh Standard*	
		Gurmar Haor		Halir Haor		Chaptir Haor		Naluar Haor		Mrigar Haor		Kazir Kola Boro Haor		Pathor Chauli Haor		Muktarpur Haor		Hail Haor		D**	F***
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet		
Temperature (T)	°C	22.3	25.6	20.2	25.4	22.8	25.4	21.6	25.4	20.8	25.6	21.1	25.6	21.8	25.3	22.4	25.4	22.5	25.5	-	-
Turbidity	NTU	13.5	11.1	7.71	23	1.52	19.2	3.29	7.6	4.79	1.2	14.4	3.6	7.85	3.5	1.28	13.3	27.4	11.7	-	-
pH	-	7.05	6.03	7.09	6.04	6.91	6.05	7.12	6.01	7.03	5.98	7.18	6.15	7	6.2	6.87	6.1	7.11	6.08	6.0-9.0	6.5-8.5
Dissolved Oxygen (DO)	mg/L	5.23	6.4	6.19	6.6	5.55	6.5	5.98	6.2	6.28	6.2	6.11	6.6	6.27	6.6	5.98	6.4	5.42	6.3	≥ 5	-
BOD5	mg/L	1.5	< 0.2	4.5	< 0.2	2	< 0.2	2	< 0.2	2.5	< 0.2	1	< 0.2	2	0.24	2	0.4	2	< 0.2	≤ 6	≤ 12
COD	mg/L	27	0.9	36	0.7	32	0.8	38	0.7	27	1.1	21	1	25	0.9	30	1.4	26	0.6	50	100
Total Dissolved Solids (TDS)	mg/L	70	30	84	30	69	30	77	30	81	30	92	30	111	30	102	30	89	30	1000	1000
Total Suspended Solids (TSS)	mg/L	16	8	7	6.5	< 5	6.8	9	5.2	7	6.8	36	6	17	6.5	5	7.2	18	9	-	-
Electric Conductivity (EC)	µS/cm	110	50	88	60	96	50	106	60	114	50	124	50	122	60	119	60	88	50	-	-
Ammonia (NH3)	mg/L	0.38	0.02	0.22	0.01	0.27	0.01	2.77	0.01	0.27	0.08	0.33	0.06	0.31	0.44	0.36	0.24	0.92	0.18	-	-
Nitrate (NO3)	mg/L	1.77	1.3	1.77	1.1	1.77	1.2	1.77	1.3	1.77	1.2	2.21	1.1	1.77	0.8	1.33	0.6	2.66	0.9	-	-
Coliform (total)	CFU/ 100 mL	340	< 1.8*	390	2	280	< 1.8*	240	< 1.8*	200	< 1.8*	190	< 1.8*	1110	4	1260	9.3	1370	2	≤ 5000	≤ 50000
Chloride (Cl-)	mg/L	7	1.89	6	1.22	7	3.18	7	2.15	8	2.38	8	19.7	6	8.71	8	1.6	2	6.16	-	-

* ECR, 2023 (Appendix Table 2-Ka-1, Schedule 2-Ka-1-4, Inland surface water for fisheries purpose)

** Water usable for fisheries

*** Water usable for irrigation

Source: JICA Survey Team

(d) Ground Water

Groundwater sampling was conducted from 24 May to 1 June 2025. At Hail Haor, Pathor Chauli Haor, and Muktarpur Haor, some parameters exceeded the Bangladesh drinking water standards. With respect to the World Health Organization (WHO) Guidelines for Drinking-water Quality (4th edition), guideline values were exceeded at five locations for arsenic and at one location for fluoride. As the sampling data are limited, it is not possible to conclude, based solely on these data, that the aquifers across the haor areas are contaminated.

Table 8.1.6 Ground Water Quality

Parameters	Unit	Groundwater Quality									Bangladesh Standard	WHO Guideline
		Gurmar Haor	Halir Haor	Chaptir Haor	Naluar Haor	Mrigar Haor	Kazir Kola Boro Haor	Pathor Chauli Haor	Muktarpur Haor	Hail Haor		
Temperature	°C	25.6	24.3	25.5	23.6	26.1	25.7	24.8	26.4	23.9	20-30	-
Turbidity	NTU	2.74	0.32	0.83	1.99	0.38	0.71	22	5.11	17.2	5	-
Total Hardness	mg/L	90	162	44	26	20	24	32	60	28	500	-
pH	-	6.89	7.11	7.07	6.92	7.18	7.04	6.97	6.52	7.04	6.5 - 8.5	-
TDS	ppm	113	93	124	111	177	152	175	148	140	1,000	-
EC	µS/cm	178	155	207	189	267	259	302	291	275	-	-
Sulfate (SO_4)	mg/L	< 7	< 7	< 7	15	< 7	< 7	< 7	< 7	< 7	250	-
Chloride (Cl^-)	mg/L	11	90	10	8	26	23	18	5	9	250	-
Arsenic (AS)	mg/L	0.016	0.005	0.035	0.002	0.009	0.029	0.002	0.069	0.069	0.05	0.01
Iron	mg/L	0.17	0.18	0.39	0.22	0.21	0.33	3.95	0.38	4.81	0.3-1.0	-
Manganese (Mn)	mg/L	0.1	0.9	0.11	0.11	0.1	0.1	0.11	0.12	0.14	0.4	-
Nitrate (NO_3)	mg/L	25.45	2.98	3.54	1.33	3.67	26.78	1.77	13.72	24.35	45	50
Phosphate (PO_4)	mg/L	4.7	0.21	0.1	26	1.21	5.3	0.72	4.5	0.1	-	-
Fluoride (F)	mg/L	0.4	0.74	2.05	0.07	0.83	0.96	0.14	0.24	0.59	1	1.5
Total Coliform (TC)	n/100	0	0	0	0	0	0	0	0	0	0	-
Faecal Coliform (FC)	n/100	0	0	0	0	0	0	0	0	0	0	-

*1 ECR, 2023 (Appendix Table 2-B)

*2 World Health Organization. (2017). Guidelines for Drinking-water Quality: Fourth Edition incorporating the First Addendum.

Source: JICA Survey Team

(e) Soil Quality

Soil samples were collected following the USEPA sampling procedures. Tests were conducted for soil texture, TOC, T-N, T-P, and T-K.

The soil quality analysis across nine haor locations show slightly acidic pH levels, which are acceptable for most wetland crops. Soil textures vary from sandy loam to loam, providing good drainage, aeration, and root development. Loam is particularly ideal due to its balanced sand, silt, and clay content. High TOC levels in Gurmar Haor indicate better organic matter content. Some areas, like Halir Haor and Gurmar Haor, have high phosphorus, which are beneficial for plant growth. Total nitrogen content indicates limited natural fertility and crop productivity. Potassium levels are very low in Pathor Chauli and Muktarpur Haor, indicating reduced fertility. Overall, while the soils are physically suitable (in terms of texture and pH), their chemical fertility is low, making them nutrient-poor and requiring improvement. Without proper soil fertility management, the soils are unlikely to support high crop yields.

Table 8.1.7 Soil Quality

Parameters		Unit	Gurmar Haor	Halir Haor	Chaptir Haor	Naluar Haor	Mrigar Haor	Kazir Kola Boro Haor	Pathor Chauli Haor	Muktarpur Haor	Hail Haor
pH		-	5.5	6.2	5.6	5.8	6.2	5.9	6.3	6.4	5.7
Soil Texture	Type	-	Sandy Loam	Loamy Sandy	Loam	Loam	Sandy Loam	Loamy Sandy	Loam	Loam	Loamy Sandy
	Sand	%	48.82	80.98	43.80	37.73	56.73	81.66	35.21	40.69	80.59
	Silt	%	23.67	15.10	43.00	42.94	28.28	14.55	38.93	37.23	10.64
	Clay	%	27.51	3.93	13.20	19.33	14.99	3.79	25.86	22.08	8.77
TOC		mg/kg	40868	30210	20034	48016	15817	11081	17256	17980	15919
Total N		%	0.16	0.13	0.12	0.21	0.10	0.11	0.09	0.07	0.07
Total P		mg/kg	1670	2280	1711	3.37	3.29	1517	774	3.82	3.78
Total K		mg/kg	757	710	403	305	890	1066	156	160	206

Source: JICA Survey Team

(f) River Bottom Sediment

River Bottom Sediment sampling was conducted during the dry season from 24 May to 1 June 2025, and the rainy season from 20 to 30 August 2025. Based on sediment quality analyses at the nine sampling locations, environmental conditions are generally good. Sulfide was not detected, indicating that recent anaerobic decomposition has not occurred. Organic matter (OM) content ranged from low to moderate, which is within the normal range for haor wetlands. Organic phosphorus (Org-P) concentrations were very high at all sites except Hail Haor, indicating high fertility while also raising concerns about the risk of eutrophication.

Hail Haor shows the best riverbed sediment conditions, with no indication of excessive heavy metals or nutrient enrichment. In contrast, Gurmar Haor, Halir Haor, and Pathor Chauli Haor show signs of heavy metal contamination and excessive phosphorus.

Table 8.1.8 River Bottom Sediment Quality

Parameters	Unit	Concentration																	
		Gurmar Haor		Halir Haor		Chaptir Haor		Naluar Haor		Mrigar Haor		Kazir Kola Boro Haor		Pathor Chauli Haor		Muktarpur Haor		Hail Haor	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Temperature	°C	24.8	24.7	25	25.2	25.2	25	24.7	24.8	25.1	25.1	24.7	24.7	25.3	24.8	25.2	25.3	24.7	25
Sulfide	mg/kg	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0
Organic Matter	%	0.52	3.023	0.72	1.838	1.65	2.522	1.86	3.283	1.14	2.783	0.62	1.685	0.56	2.588	0.62	5.988	0.41	5.926
Mercury (Hg)	mg/kg	0.56	<0.001	0.22	<0.001	0.28	<0.001	0.52	<0.001	1.02	<0.001	0.9	<0.001	0.97	<0.001	0.66	<0.001	0.35	<0.001
Cadmium (Cd)	ppm	0.3	<0.001	0.48	<0.001	0.48	<0.001	0.37	<0.001	0.17	<0.001	0.15	<0.001	0.65	<0.001	0.03	<0.001	0.61	<0.001
Lead (Pb)	ppm	20.03	7.29	32.26	4.15	16.7	5.99	20.03	22.2	17.81	10.2	17.81	3.07	25.59	7.44	22.26	6.92	6.68	7.5
Organic Phosphorus	mg/kg	2253	<0.002	3254	<0.002	2884	<0.002	2717	<0.002	1899	<0.002	1938	<0.002	2179	<0.002	1785	<0.002	241	59267
Nitrogen (N)	%	0.03	0.13	0.04	ND	0.09	ND	0.1	0.74	0.06	0.56	0.04	ND	0.03	ND	0.03	0.58	0.02	0.46
Chromium (Cr6+)	ppm	51.95	12.1	61.27	12.7	43.66	13.5	45.61	179	55.87	15.4	50.98	12.6	56.85	16.7	52.93	10.6	28.18	8.94
Arsenic (As)	mg/kg	2.32	2.69	4.75	2.57	1.38	4.53	2.19	23.7	3.06	1.96	1.11	3.41	1.68	1.51	1.11	0.73	1.68	1
Copper (Cu)	ppm	1.67	11.9	1.84	13	1.72	11.3	1.82	17.9	1.94	20.8	2.1	11.2	2.08	12.5	1.37	12	0.27	30
Zinc (Zn)	ppm	2.04	28.7	1.6	33.6	4.71	34.9	5.61	34.8	1.66	38.3	0.57	31.3	0.84	31.1	0.59	34.9	0.54	35.8
Fluorine (F)	mg/kg	<0.5	5.06	0.88	6.5	0.93	10.7	0.95	2.69	1.06	4.8	0.94	6.51	1.15	3.75	1.03	6.38	1.47	<0.5
Sodium (Na)	mg/kg	302	77.8	119	105	155	94.5	227	170	131	159	122	122	150	113	169	93.3	81.6	58.8
Potassium (K)	meq/100 g soil	0.19	1.77	0.28	2.14	0.54	1.83	0.55	4.57	0.25	2.15	0.33	2.55	0.19	2.69	0.17	1.71	0.1	1.49
Chlorine (Cl)	mg/kg	48.7	639	2.27	22.4	10.3	17.6	4.06	39	6.48	29.4	1.23	30.6	4.42	32.1	7.93	50.8	1.89	11.7
Calcium (Ca)	meq/100 g soil	4.69	5.27	10.27	3.75	6.55	1.41	5.99	2.83	2.78	2.8	3.64	4.97	5.06	2.62	2.39	3.29	0.54	102.61
Magnesium (Mg)	meq/100 g soil	1.83	2.31	2.31	15.65	1.09	6.92	1.03	5.14	1.24	7.64	1.14	23.01	2.62	8.87	2.8	7.19	0.92	12.2

Source: JICA Survey Team

(4) Ecological and Biodiversity Survey

Ecological surveys were conducted for the dry season in nine selected haors. Some photographs of field sampling are shown below. Following sampling, tests were conducted at Jahangirnagar University. Brief results are given below, while detailed findings can be found in the Dry Season Environmental Baseline Report.

Phytoplankton Sampling

Zooplankton Sampling

Macrobenthos Sampling

Vegetation Sampling

Fisheries Survey

Ecological Survey Pictures

Source: JICA Survey Team

(a) Benthos

The benthic fauna survey was conducted by collecting sediment samples from the bottom of the haors using an Ekman grab sampler. The collected sediment were placed in trays under well-lit conditions and left undisturbed for 24 hours to allow settling, after which the sample volume was measured.

A total of 23 benthic species were recorded across both the dry and rainy seasons. During the dry season, the benthic community comprised 19 species belonging to five major groups: Platyhelminthes, Nematoda, Annelida, Arthropoda, and Mollusca. Annelids were consistently dominant, followed by arthropods and molluscs, indicating their important ecological roles in sediment processes and nutrient cycling. Kazir Kola Boro Haor exhibited the highest benthic biodiversity, while Naluar Haor and Gurmar

Haor showed lower diversity. In the rainy season, the benthic community consisted of 13 species representing the same five major groups as in the dry season. The gastropod *Pila globosa* (a freshwater snail species) showed high densities in Muktarpur Haor, Pathor Chauli Haor, and Kazir Kola Boro Haor.

(b) Phytoplankton

Phytoplankton samples were collected using a standard plankton net with an approximate mesh size of 60 µm. Horizontal and vertical tows were conducted at multiple locations in each haor to obtain representative samples.

A total of 23 phytoplankton species were recorded across both the dry and rainy seasons. Phytoplankton diversity varied among haors and was influenced by hydrological conditions, nutrient availability, seasonal variation, and land use. During the dry season, 17 species belonging to the major groups—Cyanobacteria (blue-green algae), Chlorophyta (green algae), Bacillariophyta (diatoms), Euglenophyta, and Dinophyta—were identified. High species richness was observed in Halir Haor and Kazir Kola Boro Haor, suggesting nutrient-rich and well-balanced environmental conditions. In contrast, lower diversity in some haors, such as Chaptir Haor and Muktarpur Haor, suggests environmental stress or unstable hydrological conditions. During the rainy season, 13 phytoplankton species belonging to Chlorophyta, Bacillariophyta, Euglenophyta, and Dinophyta were recorded.

(c) Zooplankton

Zooplankton samples were collected using a standard plankton net with an approximate mesh size of 60 µm at water depths of 2 m and 10 m.

A total of 30 zooplankton species were recorded across both the dry and rainy seasons, indicating moderate to high zooplankton diversity. During the dry season, 25 species belonging to five major groups—Protozoa, Rotifera, Copepoda, Ostracoda, and Cladocera—were identified, with Kazir Kola Boro Haor showing the highest species richness. Healthy zooplankton communities were also observed in Halir Haor and Hail Haor, whereas Chaptir Haor exhibited lower diversity, suggesting potential ecological stress. During the rainy season, 19 zooplankton species belonging to the major groups Copepoda, Rotifera, and Cladocera were recorded.

(d) Fishes

The fish survey was conducted by collecting samples from local fish markets in the early morning and evening to maximize species detection and assess the status of both indigenous and cultured fish within the project impact area. Data were also collected through interviews with fishermen and FGDs with fishing communities. A pre-designed questionnaire was used for data recording, and key informant interviews (KIIs) and FGDs were conducted at multiple local fish markets.

A total of 56 fish species were recorded across both the dry and rainy seasons. During the dry season, 27 species were documented. In the dry season, Kazir Kola Boro Haor, Hail Haor, and Halir Haor exhibited the highest fish diversity, whereas lower diversity was observed in Mriga, Pathor Chauli, Muktarpur, Chaptir, Naluar, and Gurmar. During the rainy season, a total of 51 species of fish and shrimp were recorded across the surveyed haor areas. Higher species diversity was observed in Gurmar Haor, Halir Haor, Mrigar Haor, and Hail Haor, while relatively lower diversity was recorded in Chaptir Haor and Pathor Chauli Haor.

Based on the Bangladesh National Red List, threatened species were recorded, including eight endangered (EN) species and five vulnerable (VU) species. However, under the global Red List, only one species—the Mrigal carp (*Cirrhinus mrigala*), classified as vulnerable (VU)—was identified. Construction activities under the main project will be carried out only during the dry season and on land, while dredging works will be limited to conservation and restoration of deep-water areas and implemented on a spot basis during the low-water period. As a result, disturbance to critical habitats such as spawning and nursery grounds and riparian vegetation zones will be avoided. Therefore, the areas directly modified by the project do not constitute important habitats for the above-mentioned threatened species.

(e) Vegetation

Vegetation is comprised of 23 species including emergent, free-floating, and upland plants. Dominant families, like Poaceae and Oxalidaceae, were prevalent in Halir and Gurmar Haors. Free-floating species indicated eutrophic conditions at some sites, while upland grasses contributed to soil stabilization and grazing resources. Shallow water areas supported emergent species, while floating species thrived in nutrient-rich haors. Vegetation surveys were performed through quadrat sampling across emergent, floating, and upland zones. This multi-tiered biological sampling approach provided an integrated understanding of haor ecosystem health. Data collected were analysed to evaluate both biodiversity richness and ecological stress.

(f) Mammals, Birds, Amphibians, Reptiles, and Butterflies

The ecological survey (Mammals, Birds, Amphibians, Reptiles, and Butterflies) of nine selected Haors involved assessing the unique wetland ecosystem characterized by seasonal flooding and diverse aquatic life. This included mapping the extent and characteristics of haors and Beels, identifying fauna, and understanding the impacts of human activities and natural processes.

The baseline survey employed a system-wide, detailed, and participatory approach. The consultant used line transect sampling, visual survey, interviews with local residents, and secondary sources to gather information on fauna, including mammals, dolphins, birds, amphibians, reptiles, fish and nektons, butterfly and other aquatic organisms within the Area of Influence (AoI). Observations were made within 500 m in and around the project boundary. Photographs of some common species are given below.

<table>
<tr><td></td><td></td></tr>
<tr><td>Bandicota bengalensis</td><td>Cynopterus sphinx</td></tr>
<tr><td colspan="2">Mammals</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Anthus rufulus</td><td>Dicrurus macrocercus</td></tr>
<tr><td colspan="2">Birds</td></tr>
</table>

	
Euphlyctis hexadactylus	***Duttaphrynus melanostictus***
Amphibians	
	
Xenochrophis piscator	***Hemidactylus frenatus***
Reptiles	
	
Graphium doson	***Moduza procris***
Butterfly	

Examples of Mammals, Birds, Amphibians, Reptiles, and Butterflies Recorded

● **Mammals:** Commonly recorded species include mongooses, house mice, and various species of bats and shrews, most of which are classified as "Least Concern (LC)." According to Professor M.A. Aziz of Jahangirnagar University, the Eurasian otter (CR) and the Fishing cat (EN) are widely distributed in the haor region. In addition, the presence of the Bengal fox (VU) has been confirmed based on secondary information. Considering that these species are primarily nocturnal, mitigation measures such as restrictions on nighttime construction activities are considered necessary.

The Eurasian otter feeds mainly on fish and crustaceans in aquatic environments and also consumes small animals and plant matter on land. However, areas to be modified by the project are primarily semi-artificial environments, such as existing roads, drainage channels, and deep-water areas of Beels, which do not constitute the otter's primary foraging habitats and therefore do not overlap with important habitats. In the BWDB portion, submerged embankments will be constructed, while in the LGED portion, roads will be developed as linear structures. Although these may intersect potential movement routes of otters, the submerged embankments will have gentle slopes of approximately 1:3 and will not obstruct the movement of medium-sized mammals such as otters. In addition, road works will involve improvement of existing roads and therefore will not alter pre-existing conditions or create new habitat fragmentation.

The fishing cat inhabits a wide range of environments, including rural areas near river systems, green spaces, wetlands, marshes, and shrublands. It is nocturnal and primarily feeds on fish but also preys on small animals and poultry. In the haor region, areas with abundant prey resources (fish, crustaceans, small animals) and dense shrub cover along water bodies are considered important habitats. Under this project, submerged embankments will be constructed at a certain distance from rivers, and dredging will be limited to the conservation and restoration of deep-water areas, conducted on a spot basis in artificial drainage channels for drainage purposes. As a result, no direct modification will occur in the important habitats of this species. Furthermore, the gently sloping BWDB embankments and the LGED roads (planar structures) are not expected to obstruct movement routes or hinder the movement of the species between the important habitats. Therefore, areas directly modified by the project are not considered important habitats for this species.

The Bengal fox primarily preys on small mammals and also feeds on reptiles, insects, and crabs. It prefers habitats such as flat to gently undulating terrain, scrubland, and grasslands, where hunting and den excavation are relatively easy. As the areas directly modified by the project consist mainly of semi-artificial environments—such as existing roads, embankments, and drainage channels—they do not correspond to habitats suitable for hunting or den excavation as described above and are therefore not considered important habitats for this species. Similar to the two species discussed above, the gently sloping BWDB embankments and LGED roads (planar structures) are not expected to obstruct movement routes. Accordingly, areas directly modified by the project are not considered important habitats for the Bengal fox.

● **Birds:** Each haor supports approximately 30–37 bird species, including herons, kingfishers, egrets, pigeons, and the common myna. All recorded bird species are classified as “Least Concern (LC)” except for the Oriental Darter, which is listed as Near Threatened (NT). According to the Bangladesh Red List, the Oriental Darter is widely distributed within the country, although its population is declining. In addition, the haor region is known to support several important species, including the Baer’s Pochard (CR), Pallas’s Fish Eagle (EN), Rufous-rumped Grassbird (EN), Black-necked Stork (EN), Bristled Grassbird (EN), Eastern Imperial Eagle (VU), Greater Spotted Eagle (VU), Lesser White-fronted Goose (VU), Ferruginous Duck (NT), and Falcated Duck (NT). As described in Section 4.1.5, this project excludes habitats within the target haors that are important for birds in the haor region, including migratory species. With the implementation of appropriate mitigation measures, potential impacts on bird species are therefore expected to be minimized.

Among the threatened species, waterfowl—including Baer’s Pochard, Lesser White-fronted Goose, Ferruginous Duck, and Falcated Duck—migrate widely to the haor region for overwintering. These species are associated with aquatic environments, and their foraging habitats are located in water bodies. In contrast, areas directly modified by this project include, in the BWDB portion, submerged embankments on land and dredging of drainage channels, and in the LGED portion, road improvement works, village protection retaining walls, and dredging associated with fisheries enhancement. While dredging activities may spatially overlap with the general distribution of waterfowl, the project drainage channels are semi-artificial environments and, based on ecological information, differ from the species’ preferred foraging habitats, which are characterized by shallow waters rich in aquatic vegetation and small organisms. Therefore, areas directly modified by the project are not considered important habitats for these species.

In Bangladesh, the Rufous-rumped Grassbird and the Bristled Grassbird have been recorded only in Tanguar Haor, and sightings are considered extremely rare. Since Tanguar Haor is not included among the target haors of this project, areas directly modified by the project are not considered important habitats for these species.

The Oriental Darter is a resident species widely distributed in wetlands throughout the country. It relies on fish-rich aquatic environments, such as rivers and lakes with relatively intact natural conditions for foraging and breeds in trees and shrubs located near water bodies. Dredging under this project is conducted for the improvement of drainage in artificial channels and the conservation and restoration of deep-water areas, implemented on a spot basis during the low-water period. As a result, disturbance to important habitats, such as fish spawning and nursery grounds and riparian vegetation zones, is avoided. Trees near water bodies that could serve as breeding sites will not be cleared. Therefore, areas directly modified by the project are not considered to constitute important habitats for these species.

The Black-necked Stork migrates to the haor region during the winter season and forages in wetlands, rivers, Beels, and paddy fields. It primarily feeds on fish—particularly eels and catfish—but also consumes frogs, lizards, snakes, crustaceans, and insects. It typically forages by probing with its bill in shallow waters and among aquatic vegetation. Under this project, construction of structures will be carried out on land, and dredging activities will be limited to the conservation and restoration of deep-water areas and conducted on a spot basis during the low-water period. Consequently, disturbance to important habitats, such as spawning and nursery grounds and riparian vegetation zones, will be avoided. Therefore, areas directly modified by the project are not considered important habitats for this species.

Raptors, such as the Pallas's Fish Eagle, Greater Spotted Eagle, and Eastern Imperial Eagle, nest in trees, and some species breed locally. The project will not involve the clearing of tall trees that could serve as nesting sites, with vegetation removal limited to shrubs and small bushes. In addition, the foraging habitats of these raptors consist mainly of large water bodies where they capture fish and small animals, which do not overlap with areas directly modified by the project. Therefore, areas directly modified by the project are not considered important habitats for these raptor species.

- **Amphibians:** Amphibian species were consistently found across the sites, primarily various frogs and toads. All recorded species were listed as LC. Their habitats include paddy fields, ditches, and homestead forests.

- **Reptiles:** Reptiles were identified at most sites, including skinks, geckos, and snakes like the banded krait and checkered keelback. All species recorded during the survey are classified as LC under the Bangladesh National Red List. However, only the Peacock Softshell Turtle is assessed as EN under the global Red List. This nocturnal freshwater reptile inhabits rivers, ponds, and other freshwater bodies, primarily feeding on fish, aquatic insects, shrimp, and molluscs. It prefers shallow, muddy freshwater habitats, particularly areas with abundant aquatic vegetation and surrounding shrubs.

Dredging activities under this project are limited to ensuring drainage capacity and conserving or restoring deep-water areas. Disturbance to fish spawning and nursery grounds, which provide abundant food resources, as well as riparian and littoral vegetation zones that support aquatic insects, shrimp, and molluscs, will be avoided. Therefore, areas directly modified by the project are considered to avoid the habitat types preferred by this species and are not regarded as important habitats for it.

- **Butterflies:** Between 15 and 20 butterfly species were recorded in each haor, including the Common Grass Yellow, Oak blue, Grey Pansy, Yellow Pansy, Common Emigrant, among others. All recorded species are classifies as LC.

- **Gangetic Dolphin:** The Ganga River dolphin (*Platanista gangetica*), locally known as *Shushuk*, is a pure freshwater species historically abundant in the perennial water bodies of the Padma, Jamuna, Meghna, Surma, Kushiyara river systems, and their tributaries. The population of the Gangetic Dolphin is decreasing day by day. In 2015, the IUCN assessed the Ganges River dolphin as VU in Bangladesh. According to Professor M.A. Aziz of Jahangirnagar University, the Ganges River dolphin primarily inhabits deeper sections of the upper Meghna River and the Old Brahmaputra River. It may occasionally be observed in haor areas during the rainy season when water levels are high but is rarely seen during the dry season when water levels recede. In addition, local fishermen and boatmen reported sightings in adjacent rivers nine to ten years ago, but dolphins are now rarely visible.

(5) Stakeholders' Consultations on Biodiversity

To gather feedback from the local community regarding biodiversity, two types of consultations were conducted: FGD and KII.

(a) Focus Group Discussion

A total of nine FGDs were conducted at the same nine haors where ecological sampling took place. During these discussions, local participants listed the types of fishes, insects, birds, reptiles and mammals usually observed by them. Pictures are given below.

Gunmar Haor **Chaptir Haor**

Kazir Kola Boro Haor **Hail Haor**

Pictures of Focus Group Discussion (FGD)

Source: JICA Survey Team

(b) Key Informant Interviews

Interviews of 13 experts were conducted during the dry season survey for feedback on biodiversity. The key informants included ten Upazila Fisheries Officers and three Executive Engineers from BWDB. The major information and observations obtained are listed below:

- Development activities should be examined critically for fish breeding zones.
- Fishing using harmful pesticides continues and must be stop immediately. This harmful method has led to the disappearance of certain fish species.
- Some traditional fish species, like the Bou Rani fish, have disappeared.
- Previously, turtles, tortoises, gui shap (monitor lizard), and *Shushuk* (dolphin) were seen in the area, but their numbers have drastically dropped and they are now completely absent in many locations.
- Snakes are more visible during flood times.
- Due to reduced navigability in the haor area, excavation might be necessary to improve water flow.
- Embankments should be opened in certain places to restore natural water flow and connectivity.

Some pictures are given below.

Upazila Fisheries Office, Dhormopasha, Sunamganj

Upazila Fisheries Office, Mithamoin, Kishoreganj

BWDB, Moulvibazar

BWDB, Sylhet

Key Informant Interview

Source: JICA Survey Team

8.1.3 Alternative Analysis

Several options were examined at the pre-feasibility stage to identify the most effective and sustainable strategy for flood management in the Haor Basin.

(1) BWDB Portion

(a) Alternative 1: No-Project Scenario

This scenario assumes the continuation of current conditions without additional investment in embankments, regulators, or drainage improvement.

Pros: Avoids construction-related environmental disturbance.

Cons: Haor remain vulnerability; recurrent crop losses from flash floods; declining agricultural productivity; and worsening river siltation.

Environmental Implications: Accelerated sedimentation; reduced fish habitats; increased soil erosion; and biodiversity degradation.

Conclusion: This option contradicts the priorities outlined in the Haor Master Plan, which aims to improve welfare, public services, and livelihoods of local residents, as well as ensuring national food security. It also conflicts with the Delta Plan 2100, which addresses flood and climate change risks. Therefore, this option is considered unacceptable.

(b) Alternative 2: Full Flood Embankment

Description: A continuous full flood embankment encircling the haor area to prevent flooding.

Pros: Provides strong physical protection against floods in the short term.

Cons: Significantly alters natural hydrology; blocks fish migration; disrupts sediment distribution; and reduces ecosystem services; maintenance costs are very high.

Environmental Implications: Degradation of wetlands; threats to biodiversity; and undermining of long-term ecological balance.

Conclusion: This option was dropped as full flood embankments would harm the environment and biodiversity. It is not aligned with sustainable haor management, which aims to balance livelihood improvement for local residents with ecosystem conservation, as outlined in the Haor Master Plan.

(c) Alternative 3: Flood Management Infrastructure Only

This option prioritizes submersible embankment rehabilitation/construction without implementing a comprehensive water management strategy or participatory approach.

Pros: Requires lower financial outlay; offers localized protection to crop fields.

Cons: Does not ensure sustainable operation and maintenance; fails to introduce ownership; agricultural benefits remain partial.

Environmental Implications: Poorly managed embankments may fail, leading to habitat loss and drainage congestion.

Conclusion: This option is not recommended as benefits remain limited, and the risks of maladaptation are high.

(d) Alternative 4: Integrated Flood Management and Agricultural Resilience (Preferred Option)

This option integrates multiple measures, including submersible embankment and regulator/flood fuse rehabilitation/construction, drainage canal re-excavation, wave protection works, community-based O&M, agricultural synergic extension, and income generation incentive.

Key Components:

- Rehabilitation and construction of submersible embankments.
- Construction and repair of regulators, sluices, and flood fuse to improve water retention and controlled drainage.
- Khal re-excavation to restore conveyance capacity and support proper drainage.
- Wave protection works along vulnerable sections of the embankments.
- Formation of Water Management Groups for community ownership and participatory O&M.
- Agricultural extension activities to tap synergic benefit of flood management works
- Income generation incentives
- Flood forecasting and warning system

Pros: Protects crops and livelihoods; reduces flood losses; restores hydrological balance; safeguards communities; provides passage through flood fuses; and contributes directly to national food security.

Cons: Higher upfront cost; and requires more complex management.

Environmental Implications: Net positive if safeguards are applied; restores water flow; reduces sedimentation; and prevents land erosion.

Conclusion: This is preferred option as it offers sustainable benefits, integrates with agriculture and livelihoods, and ensures resilience under climate change.

Table 8.1.9 Alternative Options for BWDB Portion

Item	Option 1 :	Option 2 :	Option 3 :	Option 4 :
Outline	Scenario without project implementation	Scenario of constructing non-submersible embankments designed to remain above water even during the monsoon	Scenario of limited infrastructure development (only rehabilitation and construction of submersible embankments and related infrastructure)	Integrated approach combining rehabilitation and construction of submersible embankments and regulating structures/flood fuses, re-excavation of canals, wave protection works, community-based O&M, synergistic agricultural extension activities, and income-generating initiatives.
Natural Environment				
Ecosystem	△ : Concerns include accelerated sedimentation, reduced fish habitats, increased soil erosion, and biodiversity degradation.	△ : Significantly alters natural hydrology, obstructs fish migration, disrupts sediment distribution, and diminishes ecosystem services.	○ : May lead to wetland degradation, biodiversity threats, and long-term collapse of ecological balance. Compared to Alternative 2, it does not cause major hydrological changes; however, if embankment maintenance is inadequate, embankment failure could negatively impact the ecosystem.	◎ : Compared to Alternative 2, no major hydrological changes occur. With proper maintenance, environmental impacts, such as embankment failure, can be prevented.
Living Environment				
Flood Risk	△ : Recurrent crop damage from flash floods reduces agricultural productivity and worsen river sedimentation.	◎ : Provides strong physical protection against floods in the short term.	△ : Without proper maintenance, there is a risk of structural deterioration leading to malfunction and failure.	◎ : Prevents flash floods, ensures long-term effectiveness, and enhances climate resilience.
Social				
Land Acquisition and Resettlement	NA	△ : Embankment widening is the largest, and the land acquisition area will be larger than other plans.	○ : Embankment widening will result in land acquisition, but the impact will be more limited than that of Alternative 2. Level of the land acquisition is similar to Alternative 4.	○ : Embankment widening will result in land acquisition, but the impact will be more limited than that of Alternative 2. Level of the land acquisition is similar to Alternative 3.
Construction and Overall Project				
Construction Cost	NA	△ : It is the most expensive compared to other options	◎ : It is the lowest price compared to other proposals	○ : It will be lower than Alternative 2, but more expensive than Alternative 3.
Project Impact (effect on reducing flash flood occurrence)	NA	△ : While flash floods can be prevented, crops can be protected, and farmers' livelihoods can be prevented, but ecosystem services such as fisheries may be damaged and the	△ : Compared to Alternative 4, the sustainability of the business effect is low, and the effect on agriculture is limited.	◎ : It prevents the occurrence of flash floods, helps protect crops and protects farmers' livelihoods. Maintenance can provide sustainable benefits and ensure

Item	Option 1 :	Option 2 :	Option 3 :	Option 4 :
		livelihoods of residents may be affected.		resilience to climate change.
Overall Evaluation	△ : Not recommended. The vulnerability of the population of the Haor region continues. Crop damage caused by sudden floods is repeated, agricultural productivity decreases, and river sedimentation worsens. There are concerns about accelerated sedimentation, reduced fish habitat, increased soil erosion, and degradation of biodiversity.	△ : Not recommended. It is effective in reducing flood risk, but has a negative impact on the environment and biodiversity. Ecosystem services such as fisheries will be damaged, and the livelihoods of residents may be affected.	△ : Not recommended. While it has a low financial burden and can provide localized protection for farmland, it does not ensure the sustainability of ongoing operation and maintenance, and the benefits to agriculture are limited.	◎ : Most recommended. It is recommended because it provides sustainable benefits, integrates with agriculture and livelihoods, and ensures resilience to climate change.

Source: JICA Study Team

Notes: △ = Not recommended, ○ = (Relatively) recommended, ◎ = Highly recommended

(2) LGED portion

(a) Alternative 1: No-Project Scenario

This scenario assumes that no additional interventions are undertaken beyond existing infrastructure and natural resource management practices.

Pros: Avoids new construction-related environmental impacts.

Cons: Continues the current vulnerability of haor villages; limits economic growth; exacerbates climate vulnerability; and fails to address declining fisheries productivity.

Environmental Implications: Continued siltation of Beels and khals, biodiversity loss, and soil erosion due to lack of protective measures.

Conclusion: Not acceptable, as it contradicts national development priorities and Sustainable Development Goals (SDGs).

(b) Alternative 2: All Weather Road

Description: Construction of high-elevation, all-weather roads across haor areas to ensure year-round connectivity.

Pros: Provides uninterrupted transport access and reduces seasonal isolation.

Cons: Elevated road embankments obstruct natural flood flow; change hydrology; fragment aquatic habitats; restrict fisheries migration; and increase localized flood risk.

Environmental Implications: Disruption of water flow and local hydrology; alteration of wetland ecosystems; and potential biodiversity loss.

Conclusion: Dropped, as all-weather roads are unsuitable for the haor ecosystem and conflict with natural floodplain dynamics.

(c) Alternative 3: Limited Infrastructure Development Only

This option focuses solely on improving submergible roads and related infrastructures without fisheries or livelihood components.

Pros: Improves seasonal connectivity; requires relatively lower investment compared to full-scale intervention.

Cons: Fails to address declining fish production and socio-economic vulnerability; benefits remain seasonal and localized.

Environmental Implications: Lack of integrated water management may disrupt fish stock patterns.

Conclusion: Not recommended, as it offers limited socio-economic and environmental benefits compared to an integrated approach.

(d) Alternative 4: Integrated Approach (Rural Infrastructure + Fisheries Promotion + Livelihood Support)

This option combines rural infrastructure development, fisheries management, and alternative income generation to maximize benefits.

Components:

- Improvement of upazila, union, and Village roads (submersible) with appropriate drainage and protective works.
- Rehabilitation of damaged roads.
- Development of Beels under Community-Based Fisheries Resource Management (CbFRM).
- Re-excavation of connecting khals for fish migration.
- Aquaculture initiatives such as backyard pond culture and climate-resilient models.
- Construction of markets, Ghats, and village protection walls.
- Construction of village protection walls.

Pros: Enhances connectivity; strengthens climate resilience; increases fish production; improves household income; and promotes gender inclusion.

Cons: Requires higher initial investment and more complex implementation structure.

Environmental Implications: Positive net impact if mitigation measures are adopted; includes biodiversity restoration, improved water flow, and soil protection through swamp tree plantation.

Conclusion: Preferred option, as it balances holistic and sustainable impact.

Table 8.1.10 Alternative Options for LGED Portion

Item	Option 1：	Option 2：	Option 3：	Option 4：
Outline	Scenario without project implementation	Scenario of building a non-submersible road (designed to remain above even in the rainy season)	Limited infrastructure development scenario (only development of submersible roads and related infrastructure)	Integrated approach combining development of the Upazila Union and Village roads (submersible) including drainage and protection works, road renovation, renovation of beer (wetlands) through community-based fisheries resource management (CbFRM), re-excavation of curls (canals), aquaculture activities, markets, docks (Ghats), and construction of village barriers.

Item	Option 1：	Option 2：	Option 3：	Option 4：
Natural Environment				
Ecosystem	△: As the deposition of beer (wetlands) and curls (canals) progresses, the habitat of aquatic organisms will continue to deteriorate.	△: Non-submersible roads act as embankments and change the hydrological environment. It can divide ecosystems in water bodies and limit fish migration.	△: As the deposition of Beel (wetlands) and Khaals (canals) progress, the habitat of aquatic organisms will continue to deteriorate.	◎: The development of Beel using CbFRM and the re-excavation of Khaals that support fish migration are expected to improve water flow and restore biodiversity.
Living Environment				
Flood Risk	NA	△：Changes in the hydrological environment may increase the risk of localized flooding.	○：No impact on flood risk is expected.	○：No impact on flood risk is expected.
Social				
Land Acquisition and Resettlement	NA	◎：Land acquisition is not expected	◎：Land acquisition is not expected	△：When constructing Village Protection Walls, it may be necessary to acquire some land.
Construction and Overall Project				
Construction Cost	NA	△：It will be the most expensive compared to other plans.	◎：It will be the lowest price compared to other plans.	○：It will be lower than Alternative 2, but more expensive than Alternative 3.
Project impact (effect on reducing flash flood occurrence)	NA	△：Non-submersible roads can be built to ensure year-round access to transportation, but it is expected to change the local hydrological environment, reduce biodiversity, and have a negative impact on fisheries.	△：Seasonal transportation access can be improved, but it cannot cope with declining catches of fisheries.	◎：It is expected to improve transportation access, strengthen resilience to climate change, increase fish production, improve household income, and promote gender inclusion.
Overall Evaluation	△：Not recommended. The fragility of the haor region will continue, limiting economic growth. The deposition of Beel (wetlands) and khaals (canals) will continue, biodiversity will deteriorate, and fisheries productivity will decline.	△：Not recommended. Transportation access improves, but negative impacts on the environment and fisheries are expected.	△：Not recommended. Transportation access improves, but the catch is not expected to improve, and the project effects are limited compared to Alternative 4.	◎：Most recommended. Supports improved fisheries productivity, enhanced biodiversity, and the greater socio-economic benefits than the other alternatives.

Source: JICA Study Team

Notes: △ = Not recommended, ○ = (Relatively) recommended, ◎ = Highly recommended

8.1.4 Potential Environmental Impacts

Based on the results of the baseline survey, this study conducted an environmental impact assessment for each of the 15 EIA-target haors.

The assessment of potential impacts is based on activities involved in the implementation of the project, the nature and extent of the proposed activities, and the present environmental setting of the project area. Impacts due to the project activities across different phases have been identified and assessed during the EIA study.

- Construction Phase (Before/During Construction): Temporary or short-term impacts. In particular, construction activities in the BWDB portion will occur only for four months each year.

- Operation and Maintenance Phase (During Service): Long-term impacts. Physical impacts associated with the BWDB portion are limited to a six-week period each year, from 1 April to 15 May.

(1) Scoping

Preliminarily, possible environmental and social impacts were identified through a scoping exercise. The tentative scoping matrix for both BWDB and LGED portions are given below.

Table 8.1.11 Scoping Matrix for BWDB Portion

S/N	Items of Impact	Forecasted Impact		Reason of Assessment
		Before/ During Construction Stage	Operation and Maintenance Stage	
Pollution Measures				
1	Air pollution 【Common to all haors】	✓	-	**During Construction:** Impacts on air quality are expected due to the operation of construction machinery and the movement of vehicles. Increased dust and particulate matter may be generated from aggregate production, transportation routes, and construction sites where diesel-powered equipment is used for earthmoving and excavation. **Operation and Maintenance:** No impact is expected.
2	Water quality 【Common to all haors】	✓	-	**During Construction:** Impacts on water quality from accidental spillage of toxic chemicals such as fuel, lubricants, and solvents are expected. **Operation and Maintenance:** No impact is expected.
3	Soil contamination 【Common to all haors】	✓	-	**During Construction:** Accidental spillage of gasoline, chemicals, liquid waste, disposal of dredged spoils etc. may pollute soil quality. **Operation and Maintenance:** No impact is expected.
4	Wastes 【Common to all haors】	✓	-	**During Construction:** Construction waste and garbage from labour camp are expected. **Operation and Maintenance:** No impact is expected.
5	Noise/ vibration 【Common to all haors】	✓	-	**During Construction:** Noise and vibration levels are expected to increase temporarily due to the operation of machinery, particularly stone crushing units, generators, and the movement of construction vehicles. **Operation and Maintenance:** No impact is expected.
6	Ground subsidence 【Common to all haors】	-	-	**During Construction:** Groundwater usage may be very limited so there will be very minimum impact. **Operation and Maintenance:** No impact is expected.
7	Offensive odour 【Common to all haors】	✓	-	**During Construction:** Construction work are not expected to generate significant odours. Temporary unpleasant odours may occur due to fuel or oil leakages and the use of sanitation facilities for construction workers, potentially causing localized discomfort. **Operation and Maintenance:** No impact is expected.

S/N	Items of Impact	Forecasted Impact: Before/ During Construction Stage	Forecasted Impact: Operation and Maintenance Stage	Reason of Assessment
8	Bottom sediment 【Common to all haors】	✓	-	**During Construction:** Construction of embankments and other structures may temporarily disturb the bottom sediment profile of water bodies. **Operation and Maintenance:** No impact is expected.
Natural Environment				
9	Protected areas 【Common to all haors】	-	-	**During Construction:** No protected areas are located in the project intervention haors. **Operation and Maintenance:** No impact is expected.
10	Biodiversity 【Common to all haors】	✓	✓	**During Construction:** Some negative impact may be anticipated as mostly agricultural land is used for construction of new embankments. Interventions can cause change in wetland characteristics. **Operation and Maintenance:** Embankments may alter water flow and sediment patterns, affecting aquatic plants, plankton, benthos, and fish breeding areas, while having minimal long-term impact on terrestrial wildlife movement.
11	Hydrology 【Common to all haors】	-	✓	**During Construction:** No impact is expected. **Operation and Maintenance:** Project interventions may affect regional hydrology by restricting/ controlling natural water flow, although for a short period for producing/saving crop.
12	Topography/ Geology 【Common to all haors】	✓	-	**During Construction:** Improper excavation during construction/ reconstruction of embankments and canals may degrade existing topography. **Operation and Maintenance:** No additional impact is expected.
Social Environment				
13	Land acquisition and resettlement 【Common to all haors】	✓	-	**During Construction:** New embankment may require land acquisition, potentially impacting the livelihoods of landowners and land users in the affected areas. **Operation and Maintenance:** There is no additional land acquisition.
14	Socially vulnerable 【Common to all haors】	✓	✓	**Before/During Construction:** The construction of the embankment is expected to create jobs and commercial opportunities for local residents, including vulnerable groups. **Operation and Maintenance:** The crops and homestead structures of local residents, including vulnerable groups, will be protected from flash floods.
15	Ethnic minorities/ indigenous people 【Common to all haors】	✓	-	**Before/During Construction:** Not clear at this stage. **Operation and Maintenance:** No impact is expected.
16	Livelihood 【Common to all haors】	✓	✓	**During Construction:** Project-Affected Households (PAHs) who earn income from the acquired land may lose their source of income, either permanently or temporarily. **Operation and Maintenance:**

S/N	Items of Impact	Forecasted Impact: Before/ During Construction Stage	Forecasted Impact: Operation and Maintenance Stage	Reason of Assessment
				Implementation of the project will protect crops from flash floods, thereby improving the livelihood of local people.
17	Land use and utilization of local resources 【Common to all haors】	✓	-	**During Construction:** The major physical components of the new submergible embankment projects include construction of new embankments along with regulators and excavation of canals. Improper excavation for construction/ reconstruction of embankments and canals may degrade existing topography. **Operation and Maintenance:** No impact is expected.
18	Water use 【Common to all haors】	✓	-	**During Construction:** Surface water from nearby rivers or groundwater will be used during the construction phase. **Operation and Maintenance:** No impact is expected.
19	Existing social infrastructure and services 【Common to all haors】	-	✓	**Before/During Construction:** Impact on social infrastructure/service are expected to be limited and/or negligible. **Operation and Maintenance:** Social infrastructure will be protected from flash floods, and relevant services will continue even during the flood season.
20	Social institutions such as social capital and local decision-making bodies 【Common to all haors】	✓	-	**Before/During Construction:** Social and local decision-making institutions of the project area may be impacted. **Operation and Maintenance:** No impact is expected.
21	Uneven distribution of damage and benefits 【Common to all haors】	✓	-	**Before/During Construction:** Only landowners and affected laborers will be eligible for compensation and rehabilitation. **Operation and Maintenance:** No impact is expected.
22	Conflicts of interest within the region 【Common to all haors】	✓	-	**Before/During Construction:** Employment opportunities during construction may lead to some conflicts between local communities. **Operation and Maintenance:** No impact is expected.
23	Cultural heritages 【Common to all haors】	✓	✓	**Before/During Construction:** Not clear at this stage. **Operation and Maintenance:** Ditto.
24	Land scape 【Common to all haors】	✓	-	**Before/During Construction:** Temporary visual alteration of the natural wetland landscape due to embankment construction, machinery, and material stockpiles. **Operation and Maintenance:** Submersible embankments have minimal long-term visual impact, as they are submerged during the monsoon and blend with the natural haor environment.
25	Gender	✓	✓	**During Construction:**

S/N	Items of Impact	Forecasted Impact		Reason of Assessment
		Before/ During Construction Stage	Operation and Maintenance Stage	
	【Common to all haors】			The magnitude of impact is not clear at this stage. **Operation and Maintenance:** Positive impact is expected.
26	Children's rights 【Common to all haors】	✓	✓	**During Construction:** Not clear at this stage. **Operation and Maintenance:** Positive impact is expected.
27	Infectious diseases such as HIV/AIDS 【Common to all haors】	✓	-	**During Construction:** The influx of workers may increase the risk of infectious disease transmission in the project area. **Operation and Maintenance:** No impact is expected.
28	Health, safety and security of local communities 【Common to all haors】	✓	-	**During Construction:** Construction workers may be exposed to occupational health hazards arising from the materials handled and working conditions. **Operation and Maintenance:** No impact is expected.
29	Working environment (work safety) 【Common to all haors】	✓	-	**During Construction:** There is a possibility of accidents and incidents during construction works for the implementation of the project. Physical trouble, noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dusts, fumes, vapours, and liquids are the major hazards which are harmful to workers health. **Operation and Maintenance:** No impact is expected.
Others				
30	Transboundary impacts and climate change 【Common to all haors】	✓	✓	**During Construction:** The operation of construction machines and vehicles will produce greenhouse gases, particularly CO_2. **Operation and Maintenance:** Inappropriate height of embankments and inadequate numbers of drainage facilities may have impact on climate change.
31	Accident 【Common to all haors】	✓	-	**During Construction:** The operation of heavy vehicles and machinery may cause traffic accidents in and around the proposed project sites. In addition, workers may be exposed to accidents during the construction. **Operation and Maintenance:** No impact is expected.

Source: JICA Study Team

Table 8.1.12 Scoping Matrix for LGED Portion

S/N	Items of Impact	Forecasted Impact		Reason of Assessment
		Before/During Construction Stage	Operation and Maintenance Stage	
Pollution Measures				
1	Air pollution 【Common to all haors】	✓	✓	**During Construction:** Impacts on air quality are expected due to the operation of construction machinery and the movement of vehicles. Increased dust and particulate matter may be generated from aggregate production, transportation routes,

S/N	Items of Impact	Forecasted Impact: Before/During Construction Stage	Forecasted Impact: Operation and Maintenance Stage	Reason of Assessment
				and construction sites where diesel-powered equipment is used for earthmoving and excavation. **Operation and Maintenance:** Improved connectivity may increase traffic volumes, leading to more emissions. However, paved roads will reduce resuspension compared to existing earthen roads.
2	Water quality 【Common to all haors】	✓	-	**During Construction:** Impacts on water quality are expected due to accidental spillage of construction materials and toxic chemicals such as fuel, lubricants, and solvents is expected. In addition, runoff from construction camps, including domestic sewage and kitchen waste may pollute surface water. **Operation and Maintenance:** No impact is expected.
3	Soil contamination 【Common to all haors】	✓	-	**During Construction:** Accidental spillage of fuel, chemicals, liquid waste, disposal of dredged spoils may pollute soil quality. **Operation and Maintenance:** No impact is expected.
4	Wastes 【Common to all haors】	✓	-	**During Construction:** Construction waste and garbage from labour camp are expected. **Operation and Maintenance:** No impact is expected.
5	Noise/vibration 【Common to all haors】	✓	✓	**During Construction:** Noise and vibration levels are expected to increase temporarily due to the operation of machinery, particularly stone crushing units, generators, and the movement of construction vehicles. **Operation and Maintenance:** Increased traffic on the completed road may lead to persistent noise and low-level vibrations, potentially affecting nearby settlements and sensitive habitats.
6	Ground subsidence 【Common to all haors】	-	-	**During Construction:** Groundwater usage may be very limited; therefore, impacts on groundwater resources are expected to be very minimal. **Operation and Maintenance:** No impact is expected.
7	Offensive odour 【Common to all haors】	✓	-	**During Construction:** Temporary odours may arise from fuel or oil leaks and from construction workers' sanitation facilities, potentially causing local discomfort. **Operation and Maintenance:** No impact is expected.
8	Bottom sediment 【Common to all haors】	✓	-	**During Construction:** The development of structures and construction of roads may disturb the bottom sediment profile of nearby water bodies. **Operation and Maintenance:** No impact is expected.
Natural Environment				
9	Protected areas 【Common to all haors】	-	-	**During Construction:** There is no protected area in the project intervention haors. **Operation and Maintenance:**

S/N	Items of Impact	Forecasted Impact		Reason of Assessment
		Before/During Construction Stage	Operation and Maintenance Stage	
				No impact is expected.
10	Biodiversity 【Common to all haors】	✓	✓	**During Construction:** Road construction may cause habitat fragmentation, loss of natural habitats, and increased water pollution, sedimentation, and habitat disturbance. These disturbances can collectively reduce ecological integrity and hamper the resilience of plankton and benthic communities. **Operation and Maintenance:** Submersible roads may alter water flow and sediment patterns, affecting aquatic plants, plankton, benthos, and fish spawning and breeding areas, while having minimal long-term impact on terrestrial wildlife movement.
11	Hydrology 【Common to all haors】	-	✓	**During Construction:** No impact is expected. **Operation and Maintenance:** Project interventions may affect regional hydrology by restricting/controlling natural water flow.
12	Topography/ Geology 【Common to all haors】	✓	-	**During construction:** Earth filling and levelling for road embankments may locally alter natural land contours and micro-topography. **Operation and Maintenance:** Submersible roads generally maintain seasonal water flow; therefore, long-term changes to topography are minimal, limited to minor embankment-induced modifications.
Social Environment				
13	Land acquisition and resettlement 【Common to all haors】	✓	-	**During Construction:** Construction of new roads may require land acquisition, potentially impacting the livelihoods of the people who own or use the affected land. **Operation and Maintenance:** There is no additional land acquisition.
14	Socially vulnerable 【Common to all haors】	✓	✓	**Before/During Construction:** Road construction is expected to create job and commercial opportunities for local residents, including vulnerable groups. **Operation and Maintenance:** Crops and homestead structures of local residents, including vulnerable groups, will be protected from flash floods.
15	Ethnic minorities/ indigenous people 【Common to all haors】	✓	-	**Before/During Construction:** Not clear at this stage. **Operation and Maintenance:** No impact is expected.
16	Livelihood 【Common to all haors】	✓	✓	**During Construction:** Project-Affected Households (PAHs) who earn income from the acquired land may lose their source of income, either permanently or temporarily. **Operation and Maintenance:** Implementation of the project will improve the livelihood of local people.
17	Land use and utilization of local resources	✓	-	**During Construction:** Improper excavation during the construction or reconstruction of roads and canals may degrade existing topography.

S/N	Items of Impact	Forecasted Impact		Reason of Assessment
		Before/During Construction Stage	Operation and Maintenance Stage	
	【Common to all haors】			**Operation and Maintenance:** No impact is expected.
18	Water use 【Common to all haors】	✓	-	**During Construction:** Surface water from nearby rivers or groundwater will be used during the construction phase. **Operation and Maintenance:** No impact is expected.
19	Existing social infrastructure and services 【Common to all haors】	-	-	**Before/During Construction:** Impact on social infrastructure and services are expected to be limited and/or negligible. **Operation and Maintenance:** No impact is expected.
20	Social institutions such as social capital and local decision-making bodies 【Common to all haors】	✓	-	**Before/During Construction:** Social institutions and local decision-making institutions in the project area may be impacted. **Operation and Maintenance:** No impact is expected.
21	Uneven distribution of damage and benefits 【Common to all haors】	✓	-	**Before/During Construction:** Only landowners and affected labourers will be eligible for compensation and rehabilitation. **Operation and Maintenance:** No impact is expected.
22	Conflicts of interest within the region 【Common to all haors】	✓	-	**Before/During Construction:** Increase in employment opportunities during construction may lead to potential conflicts between local communities. **Operation and Maintenance:** No impact is expected.
23	Cultural heritages 【Common to all haors】	✓	✓	**Before/During Construction:** Not clear at this stage. **Operation and Maintenance:** Ditto.
24	Land scape 【Common to all haors】	✓	-	**Before/During Construction:** Temporary visual alteration of the natural wetland landscape may occur due to road construction, machinery, and material stockpiles. **Operation and Maintenance:** Submersible roads have minimal long-term visual impact, as they are submerged during the monsoon and blend with the natural haor environment.
25	Gender 【Common to all haors】	✓	✓	**During Construction:** The magnitude of impact is not clear at this stage. **Operation and Maintenance:** Positive impact is expected.
26	Children's rights 【Common to all haors】	✓	✓	**During Construction:** Not clear at this stage. **Operation and Maintenance:** Positive impact is expected.
27	Infectious diseases such as HIV/AIDS	✓	-	**During Construction:** Influx of workers may increase the risk of infectious diseases. **Operation and Maintenance:**

S/N	Items of Impact	Forecasted Impact: Before/During Construction Stage	Forecasted Impact: Operation and Maintenance Stage	Reason of Assessment
	【Common to all haors】			No impact is expected.
28	Health, safety and security of local communities 【Common to all haors】	✓	-	**During Construction:** The construction workers may be at risk for occupational health hazards due to the materials handled and working conditions. **Operation and Maintenance:** No impact is expected.
29	Working environment (work safety) 【Common to all haors】	✓	-	**During Construction:** There is a possibility of accidents and incidents during construction works for project implementation. Physical trouble, noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dusts, fumes, vapours, and liquids are the major hazards which are harmful to workers health. **Operation and Maintenance:** No impact is expected.
Others				
30	Transboundary impacts and climate change 【Common to all haors】	✓	✓	**During Construction:** The operation of construction machines and vehicles will produce greenhouse gases, particularly CO_2. **Operation and Maintenance:** Submersible roads have minimal direct GHG impact. However, improved access may indirectly increase vehicle use in dry season, slightly raising emissions. Proper design enhances climate resilience by maintaining natural flood flow and reducing vulnerability to extreme weather.
31	Accident 【Common to all haors】	✓	✓	**During Construction:** The operation of heavy vehicles and machinery may cause traffic accidents in and around the proposed project sites. Construction workers are also at risk of accidents during the construction. **Operation and Maintenance:** The incidence of road accidents may increase with the rising volume of vehicles on the road.

Source: JICA Study Team

(2) Impact Assessment

Based on the results of baseline surveys conducted during both the dry and wet seasons, the impact assessment is organized as follows.

Table 8.1.13 Summary of Impact Assessment on BWDB Portion

S/N	Items of Impact	Evaluation in Scoping: PCP/CP	Evaluation in Scoping: OP	Evaluation based on EIA: PCP/CP	Evaluation based on EIA: OP	Identified Impacts
Pollution Measures						
1	Air pollution 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Impacts on air quality are expected due to the operation of construction machinery and circulation of construction vehicles. **Operation Phase:**

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
						• No impact is expected.
2	Water quality【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Runoff from construction sites may carry higher quantity of sediments, construction waste, and hazardous parameters, polluting surface water, and impact the aquatic life. • Changes to the groundwater quality within the study area may arise from chemical and waste storage and handling during the construction stage. **Operation Phase:** • No impact is expected.
3	Soil contamination【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Fuel leaks, tank spillages, and machinery emissions may pollute subsoil and groundwater. • Dredged soil handling, filling, and compacting can change soil's physical and chemical properties. • Improper hazardous waste management may cause long-term degradation of soil quality. **Operation Phase:** • No impact is expected.
4	Waste【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Generation of construction debris: excavated soil, concrete, timber, metal, and packaging materials. • Domestic waste from labour camps, such as food scraps, plastics, and general refuse. • Poor waste management may cause localized soil contamination. • Waste can obstruct drainage channels and increase runoff into nearby water bodies, affecting water quality. **Operation Phase:** • No impact is expected.
5	Noise and vibration【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Temporary increase in noise and vibration levels is expected due to the operation of construction machinery and movement of construction vehicles. **Operation Phase:** • No impact is expected.
6	Ground subsidence【Common to all haors】	-	-	D	D	**Construction Phase:** • Groundwater extraction and excavation will be minimal, so the risk of ground subsidence is negligible. **Operation Phase:** • No impact is expected.
7	Offensive odor【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Temporary unpleasant odours may occur due to fuel or oil leakage and sanitation facilities for construction workers, causing localized discomfort. **Operation Phase:** • No odour-related impacts are expected.
8	Bottom sediment【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Bottom sediment disturbance from embankment construction, dredging, and excavation. • Increased turbidity reduces light penetration and affects aquatic plants and animals. • Suspended sediments may clog fish gills, smother benthic organisms, and lower dissolved oxygen. • Temporary degradation of aquatic habitats and disruption of fishing activities. **Operation Phase:** • No impacts on bottom sediment are expected.
Natural Environment						
9	Protected area	-	-	D	D	**Construction Phase:**

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
	【Common to all haors】					• The project haor areas do not include any protected areas, and therefore no impacts on protected areas are anticipated. **Operation Phase:** • No impacts are expected
10	Biodiversity 【Except Shanir Haor】	✓	✓	B-	B-	**Construction Phase:** • Increased turbidity and sedimentation resulting from construction-related runoff may adversely affect aquatic organisms, including fish spawning and nursery grounds. **Operation Phase:** • Embankments may alter water flow and sediment transport patterns, potentially affecting aquatic vegetation, plankton, benthic organisms, and fish breeding habitats.
	Biodiversity 【Shanir Haor】	✓	✓	B-	B-	**Construction Phase:** • Although Shanir Haor is not a designated protected area, its proximity to Tanguar Haor, a protected area, may serve as habitat for migratory birds and other species of conservation concern that visit Tanguar Haor during the winter season. Therefore, potential impacts on these bird species may occur. • Increased turbidity and sedimentation resulting from construction-related runoff may adversely affect aquatic organisms, including fish spawning and nursery grounds. **Operation Phase:** • Embankments may alter water flow and sediment transport patterns, potentially affecting the breeding habitats of aquatic vegetation, plankton, benthic organisms, and fish. • Increased boat traffic and navigation activities may disturb bird habitats.
11	Hydrology 【Common to all haors】	-	✓	D	B+/-	**Construction Phase:** • As construction is scheduled for the dry season, major environmental impacts are not expected. **Operation Phase:** • The structures are expected to cause minimal changes in flood levels and improve flood control; however, they may alter natural drainage, water flow, and sediment transport, potentially leading to localized drainage congestion or gradual siltation if not properly maintained.
12	Topography/ Geology 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Construction activities, including embankment works, regulator installations, dredging, and foundation excavation, may slightly modify local landforms and micro-topography within the project footprint, potentially affecting natural drainage and causing temporary water stagnation if dredged materials and earth stockpiles are not properly managed. **Operation Phase:** • No additional impact is expected.
Social Environment						
13	Land acquisition and resettlement 【Common to all haors】	✓	-	A-	D	**During Construction:** • New embankment may require land acquisition, potentially impacting the livelihoods of landowners and users of the affected land. **Operation and Maintenance:** • There is no additional land acquisition.
14	Poor people (including	✓	✓	B+/-	B+	**Before/During Construction:**

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
	socially vulnerable) 【Common to all haors】					• The poor people who worked in the acquired land may be affected. The construction of the embankment is expected to create job and commercial opportunities for local residents, including vulnerable groups. **Operation and Maintenance:** • The crops and homestead structures of local residents, including poor people will be protected from flash floods.
15	Ethnic minorities/ indigenous people 【Common to all haors】	✓	✓	D	D	**Construction Phase:** • No impact is expected, as no indigenous/ethnic people have been identified. **Operation Phase:** • No impact is expected.
16	Local economy, employment and livelihood 【Common to all haors】	✓	✓	B+/-	A+	**During Construction:** • Project-Affected Households (PAHs) who earn income from the acquired land may lose their source of income, either permanently or temporarily. • Local transport operators, skilled and semi-skilled workers, and nearby businesses (such as restaurants, shops, and mobile banking services) are expected to benefit economically from the activities. **Operation and Maintenance:** • Implementation of the project will protect the crops from flash floods, thereby improving the livelihood of the local people.
17	Land use and utilization of local resources 【Common to all haors】	✓	-	B-	B+	**Construction Phase:** • Reduction of agriculture land may result in a shift in agricultural practices of some people. Moreover, flood protection can facilitate cropping diversification with dynamics cropping pattern. **Operation Phase:** • Diversified cropping pattern.
18	Water use 【Common to all haors】	✓	-	D	B+	**During Construction:** • Water used during construction is extremely limited, so no significant impacts are anticipated. **Operation and Maintenance:** • Retained water can be used for irrigation and fish breeding and production.
19	Existing social infrastructure and services 【Common to all haors】	-	✓	D	B+	**Before/During Construction:** • During the harvest season from April to May, when transportation of harvested rice is required, major construction works will be completed, making the impact will be negligible. **Operation and Maintenance:** • Access to social infrastructure may increase due to improved roads and connectivity.
20	Social institutions such as social capital and local decision-making bodies	✓	✓	B-	B+	**Before/During Construction:** • Social institutions and local decision-making bodies may experience temporary disruption. **Operation and Maintenance:** • Local bodies, like WMG, will be involved in operational activities which allow them gain skill and increase capacities.

S/N	Items of Impact	Evaluation in Scoping PCP/CP	Evaluation in Scoping OP	Evaluation based on EIA PCP/CP	Evaluation based on EIA OP	Identified Impacts
	【Common to all haors】					
21	Uneven distribution of damage and benefits 【Common to all haors】	✓	-	B-	D	**Before/During Construction:** • Only landowners and affected labourers will be eligible for compensation and rehabilitation. **Operation and Maintenance:** • No impact is expected.
22	Conflicts of interest within the region 【Common to all haors】	✓	-	B-	D	**Before/During Construction:** • Increased employment opportunities during construction may lead to occasional conflicts between construction workers and local communities. **Operation and Maintenance:** • No impact is expected.
23	Cultural heritages 【Common to all haors】	✓	✓	D	D	**Before/During Construction:** • No impact is expected **Operation and Maintenance:** • No impact is expected
24	Land scape 【Common to all haors】	✓	-	D	D	**Before/During Construction:** • No impact is expected **Operation and Maintenance:** • No impact is expected
25	Gender 【Common to all haors】	✓	✓	B-	B+	**During Construction:** • Women may face difficulties in participating in community consultations and may have limited decision-making power. **Operation and Maintenance:** • Positive impacts are expected, as women will be included in operational activities and other promotional activities.
26	Children's rights 【Common to all haors】	✓	✓	B-	B+	**Construction Phase:** • Construction activities may impact school-going children who travel on the roads twice a day. **Operation Phase:** • Children will benefit from improved access to schools and reduced risks by flood protection. Support to female household members will also bring some benefits to the children.
27	Infectious diseases such as HIV/AIDS 【Common to all haors】	✓	-	B-	D	**During Construction:** • Influx of workers may increase the risk of infectious diseases. **Operation and Maintenance:** • No impact is expected.
28	Community health and safety 【Common to all haors】	✓	-	B-	D	**During Construction:** • Construction workers may be exposed to occupational health risks depending on the materials handled and the working conditions. **Operation and Maintenance:** • No impact is expected.
29	Working environment (work safety)	✓	-	B-	D	**During Construction:** • There would be the possibility to accidents and incidents occurring during construction works for the implementation of the project.

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
	【Common to all haors】					**Operation and Maintenance:** • No impact is expected.
Others						
30	Transboundary impacts and climate change 【Common to all haors】	✓	✓	B-	D	**Construction Phase:** • The use of construction machinery and vehicles will generate greenhouse gases, primarily carbon dioxide (CO_2); however, the impact is expected to be minimal. **Operation Phase:** • No transboundary impacts or effects on global warming are anticipated.
31	Accident 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • The movement of heavy vehicles and machinery around the project sites may increase the risk of traffic accidents, while construction activities could also pose safety hazards to workers. **Operation Phase:** • No impact is expected.

Source: JICA Study Team

Table 8.1.14 Summary of Impact Assessment on LGED Portion

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
Pollution Measures						
1	Air pollution 【Common to all haors】	✓	✓	B-	B-	**Construction Phase:** • Emissions from construction machinery and vehicles. • Dust from aggregate production and transport routes. • Exhaust and particulates from diesel-powered earthmoving and excavation. • Localized deterioration of air quality at construction sites. **Operation Phase:** • Improved connectivity may raise traffic volumes, potentially raising emissions.
2	Water quality 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Accidental spillage of fuel, lubricants, solvents, and other construction materials may contaminate water. • Runoff from construction camps, carrying domestic sewage and kitchen waste may pollute surface water. **Operation Phase:** • No impact is expected.
3	Soil contamination 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Accidental spillage of fuel, chemicals, and liquid waste may contaminate soil. • Improper disposal of dredged spoils may degrade soil quality. **Operation Phase:** • No impact is expected.
4	Waste 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Generation of construction debris, including excavated soil, concrete, timber, metal, and packaging materials. • Domestic waste from labour camps, such as food scraps, plastics, and general refuse.

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
						Operation Phase: • No impact is expected.
5	Noise and vibration 【Common to all haors】	✓	✓	B-	D	**Construction Phase:** • Temporary increase in noise and vibration levels due to construction machinery and the movement of construction vehicles. **Operation Phase:** • No impact is expected.
6	Ground subsidence 【Common to all haors】	-	-	D	D	**Construction Phase:** • Groundwater use and excavation will be minimal, so the risk of ground subsidence is negligible. **Operation Phase:** • No impact is expected.
7	Offensive odour 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Temporary odours from fuel and oil leaks. • Odors from workers' sanitation facilities may cause local discomfort. **Operation Phase:** • No odour-related impacts are expected.
8	Bottom sediment 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • The construction of roads and related infrastructure may disturb the bottom sediment profile of water bodies. **Operation Phase:** • No impacts on bottom sediment are expected.
Natural Environment						
9	Protected area and eco-sensitive zones 【Common to all haors】	-	-	D	D	**Construction Phase:** • The project haor areas do not include any protected areas, so no impacts on protected areas are anticipated. **Operation Phase:** • No impacts are expected
10	Biodiversity 【Except Shanir Haor】	✓	✓	B-	B-	**Construction Phase:** • Road construction may cause habitat fragmentation and loss of natural habitats, increased water pollution and sedimentation, as well as intensified habitat disturbance. These combined effects may degrade ecosystem integrity and reduce the resilience of plankton and benthic communities. **Operation Phase:** • Submersible roads may alter water flow and sediment transport patterns, potentially affecting aquatic vegetation, plankton, benthic organisms, and fish spawning and breeding habitats; however, long-term impacts on terrestrial wildlife movement are expected to be minimal • Increased boat traffic and navigation activities may cause disturbance to bird habitats.
	Biodiversity 【Shanir Haor】	✓	✓	B-	B-	**Construction Phase:** • Although Shanir Haor is not designated as a protected area, it is located in close proximity to Tanguar Haor, which is protected. It may serve as habitat for migratory birds and other species of conservation concern that visit Tanguar Haor during the winter season. Therefore, potential impacts on these birds may occur. • Increased turbidity and sedimentation resulting from construction-related runoff may adversely affect aquatic organisms, including fish spawning and nursery grounds. **Operation Phase:**

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
						• Submersible roads may alter water flow and sediment transport patterns, potentially affecting aquatic vegetation, plankton, benthic organisms, and fish spawning and breeding habitats; however, long-term impacts on terrestrial wildlife movement are expected to be minimal • Increased boat traffic and navigation activities may disturb bird habitats.
11	Hydrology 【Common to all haors】	-	✓	D	B-	**Construction Phase:** • No significant impact on natural hydrological patterns is expected. **Operation Phase:** • Submerged roads, although intended to minimize disruption by allowing seasonal submergence, can still alter micro-hydrology. Changes in water velocity and flow direction may lead to sediment accumulation in some pockets and erosion in others.
12	Topography/ Geology 【Common to all haors】	✓	-	B-	D	**Construction Phase:** • Construction of submerged roads in haor areas modifies the natural topography through earth filling and embankment works. Although designed to remain underwater during the monsoon, the raised alignment still alters the otherwise flat, basin-like terrain of the haor. **Operation Phase:** • As submerged roads largely maintain seasonal water flows, long-term topographic changes are expected to be minimal, limited to minor embankment-type modifications.
Social Environment						
13	Land acquisition and resettlement 【Common to all haors】	✓	-	A-	D	**During Construction:** • Construction of village protection walls and other related works may require land acquisition, potentially impacting the livelihoods of people who own or use the affected land. **Operation and Maintenance:** • There is no additional land acquisition.
14	Poor people 【Common to all haors】	✓	✓	B-/+	B+	**Before/During Construction:** • Poor people who previously worked on the acquired land may be affected. However, construction of the embankment is expected to create job and commercial opportunities for local residents, including vulnerable groups. **Operation and Maintenance:** • Poor people/household members will benefit from alternative income-generating activities and livelihood support. Road development will enable timely crop harvesting with increased agricultural work opportunities for poor people. Fishery development and other activities will also benefit them in multiple ways.
15	Ethnic minorities/ indigenous people 【Common to all haors】	✓	✓	D	D	**Construction Phase:** • No impact is expected, as no indigenous/ethnic people have been identified. **Operation Phase:** • No impact is expected.
16	Local Economy, Employment	✓	✓	B+/-	A+	**During Construction:** • Project-Affected Households (PAHs) who earn income from the acquired land or other areas

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
	and Livelihood 【Common to all haors】					designated for development may lose their source of income, either permanently or temporarily. • Some affected households and local residents will gain employment through construction-related activities. **Operation and Maintenance:** • Implementation of the project will help timely crop harvesting, enhance fishing activities, and create opportunities for economic activities by other interventions. Therefore, it will improve the livelihood of the local people.
17	Land use and utilization of local resources 【Common to all haors】	✓	-	B-	B+	**Construction Phase:** • Reduction of agricultural land may result in a shift in agricultural practices of some people. Moreover, improved farming capacities may facilitate cropping diversification and the adoption of dynamics cropping pattern. **Operation Phase:** • Diversified cropping pattern.
18	Water use 【Common to all haors】	✓	-	D	B+	**During Construction:** • As water use during construction will be extremely limited, no impacts are anticipated. **Operation and Maintenance:** • Re-excavation of khals and Beel development will support irrigation for agricultural production.
19	Existing social infrastructure and services 【Common to all haors】	-	-	D	B+	**Before/During Construction:** • Impact on social infrastructure/service will be limited and/or negligible. **Operation and Maintenance:** • Access to social infrastructure may increase due to improved roads and connectivity.
20	Social institutions such as social capital and local decision-making bodies 【Common to all haors】	✓	✓	B-	B+	**Before/During Construction:** • Social and local decision-making institutions in the project area may be affected. **Operation and Maintenance:** • Positive impacts are expected on locally formed groups (like BUG) who will be involved in operational activities.
21	Unequal Distribution of Damage and Benefit 【Common to all haors】	✓	-	B-	D	**Before/During Construction:** • Only landowners and affected labourers will be eligible for compensation and rehabilitation. **Operation and Maintenance:** • No impact is expected.
22	Conflicts of interest within the region 【Common to all haors】	✓	-	B-	D	**Before/During Construction:** • Increased employment opportunities during construction, during construction may lead to conflicts between local communities. **Operation and Maintenance:** • No impact is expected.
23	Cultural heritages	✓	✓	D	D	**Before/During Construction:** • No impact is expected **Operation and Maintenance:**

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP /CP	OP	PCP /CP	OP	
	【Common to all haors】					• No impact is expected
24	Landscape 【Common to all haors】	✓	-	D	D	**Before/During Construction:** • No impact is expected **Operation and Maintenance:** • No impact is expected
25	Gender 【Common to all haors】	✓	✓	B+/-	B+	**During Construction:** • There is a risk of gender-based violence. However, women will benefit from women-led agricultural activities. **Operation and Maintenance:** • Positive impact are expected, as women will participate in operational activities and other promotional activities.
26	Children's rights 【Common to all haors】	✓	✓	B-	B+	**Construction Phase:** • Construction activities may affect school-going children who travel on the roads twice daily. **Operation Phase:** • Children will benefit from improved access to schools and reduced flood-related risks. Additionally, support provided to female household members will indirectly benefits to the children.
27	Infectious diseases such as HIV/AIDS 【Common to all haors】	✓	-	B-	D	**During Construction:** • Influx of workers may increase the risk of infectious diseases. **Operation and Maintenance:** • No impact is expected.
28	Community health and safety 【Common to all haors】	✓	-	B-	D	**During Construction:** • Construction workers may be exposed to occupational health risks depending on the materials handled and working conditions. **Operation and Maintenance:** • No impact is expected.
29	Working environment (work safety) 【Common to all haors】	✓	-	B-	D	**During Construction:** • There is a possibility of accidents and incidents occurring during construction works for the implementation of the project. **Operation and Maintenance:** • No impact is expected.
Others						
30	Transboundary impacts and climate change 【Common to all haors】	✓	✓	B-	B-	**Construction Phase:** • Construction machinery, diesel-powered equipment, and transport vehicles will emit greenhouse gases, mainly CO_2, contributing to climate change. Sources include engines of earthmoving machinery, generators, and material transport trucks. **Operation Phase:** • Submersible roads are expected to produce minimal direct greenhouse gas emissions. • A slight increase in emissions may occur due to higher vehicle use during the dry season.
31	Accident 【Common to all haors】	✓	✓	B-	D	**Construction Phase:** • Construction and road accidents may occur in and around the project site due to ongoing construction activities, posing potential safety risks to workers and the local community.

S/N	Items of Impact	Evaluation in Scoping		Evaluation based on EIA		Identified Impacts
		PCP/CP	OP	PCP/CP	OP	
						Operation Phase: • Vehicle use may increase during the dry season; however, this increase is not expected to result in significant accidents.

Source: JICA Study Team

8.1.5 Mitigation Measures, Environmental Management Plan and Environmental Monitoring Plan

(1) Mitigation Measures

For items rated A- and B- in the impact assessment, the following tables present the recommended mitigation measures during construction and operation, respectively.

Table 8.1.15 Environmental Mitigation Plan for BWDB Portion During the Construction Phase

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Air pollution 【Common to all haors】	Dust emissions	• Use water spraying for excavation, earth handling, and material storage areas. • Store soil and sand in designated areas; cover stockpiles with tarpaulin, keep below 2 m, and maintain distance from receptors. • Re-vegetate exposed ground promptly. • Maintain and clean access roads and nearby streets; enforce vehicle speed limits. • Educate communities on dust hazards and preventive measures. • Keep a grievance register on site. • Conduct periodic ambient air quality monitoring.
	Vehicular emissions	• Maintain machinery to prevent smoke emissions and ensure compliance. • Regularly check vehicle emissions. • Use electric or battery-powered equipment where possible; maintain diesel equipment properly. • Avoid idling of vehicles and equipment to reduce exhaust emissions. • Prohibit open burning of waste at or near the site. • Conduct periodic ambient air quality monitoring.
Water quality 【Common to all haors】	Surface water contamination	• Store fuels, oils, and chemicals safely with spill containment. • Treat construction camp wastewater before discharge. • Limit earthworks near watercourses and schedule dredging/excavation during low-flow periods. • Monitor surface water quality regularly during construction. • Train workers on safe material handling to prevent spills.
	Groundwater contamination	• Store fuels, oils, and chemicals with proper containment. • Treat construction camp wastewater; avoid direct soil infiltration. • Manage solid waste properly to prevent leaching. • Monitor groundwater quality regularly near construction sites.
Soil 【Common to all haors】	Soil contamination	• Maintain equipment regularly to prevent fuel leaks. • Manage spills of soil contaminants and handle dredged or excavated waste properly. • Store fuels, chemicals, and lubricants with appropriate containment measures. • Treat and safely dispose of liquid and hazardous waste. • Minimize soil disturbance during construction. • Monitor soil quality periodically and train staff on safe material handling.
Waste 【Common to all haors】	Generation of construction waste and general waste due to the increase in workers	• Treat and dispose of waste properly in compliance with the Solid Waste Management Rules, 2021 and the National 3R Strategy for Waste Management, 2010. Hazardous waste is not expected; however, if generated, it will be managed and disposed of in accordance with the Hazardous Wastes and Ship Breaking Waste Management Rules, 2011. • Prioritize the 3R (Reduce, Reuse, Recycle) approach wherever possible, ensuring disposal is carried out through authorized waste management contractors. • Prepare and implement a Construction Waste Management Plan that includes segregation, collection, and safe disposal of materials. • Provide training and guidance to workers to prevent littering and improper disposal of waste at construction sites. • Regularly monitor waste management practices to ensure compliance with national regulations and the project EMP.
Noise 【Common to all haors】	Increased ambient noise	• Schedule the noisiest construction activities to minimize disturbance and limit operation times of noisy equipment. • Regularly maintain and service all equipment, including mufflers; promptly replace damaged components. • Use quieter equipment models, acoustic covers, or erect acoustic barriers along site boundaries if practicable. • Train workers on noise-reducing practices and provide ear protection in high-noise areas; include reminders in daily toolbox briefings. • Reduce the number of simultaneously operating equipment and route mobile noise sources to minimize disturbance. • Prohibit vehicle movement at night on access roads. • Conduct daily inspections and noise monitoring to ensure compliance with Noise Pollution (Control) Rules, 2025.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Vibration 【Common to all haors】	Vibration generation	• Operate machinery per manufacturer guidelines to reduce vibration. • Limit heavy equipment use near sensitive structures. • Schedule high-vibration activities to minimize exposure. • Periodically monitor vibration levels near sensitive structures.
Odour 【Common to all haors】	Occurrence of unpleasant odours from sanitation facilities for workers.	• Sanitation facilities within the construction camp shall be properly maintained, with regular cleaning and safe disposal of waste.
Bottom sediment 【Common to all haors】	Bottom sediment contamination	• Schedule dredging during dry or low-flow periods to minimize turbidity. • Limit dredging/excavation area and duration to reduce sediment resuspension. • Dispose of dredged material at designated sites, avoiding direct disposal into water bodies. • Monitor turbidity and suspended sediment levels during construction. • Train contractors and workers on responsible practices near aquatic habitats.
Biodiversity	Terrestrial ecosystems and biota 【Common to all haors】	• Restrict tree felling to the minimum required and implement compensatory plantation. • Apply dust suppression measures (water spraying, covering stockpiles) to protect vegetation and fauna. • Limit noisy activities to daylight hours. • Relocate topsoil from cleared areas for later use in revegetation. • Prohibit hunting, capturing, or disturbing wildlife by construction workers.
	Fisheries and aquatic resources 【Common to all haors】	• Dispose of dredged spoil in approved upland areas. • Limit night-time works near major bird habitats to minimize disturbance. • Limit noisy activities to daylight hours. • Prohibit hunting, capturing, or disturbing wildlife by construction workers. • Prepare the construction plan in consultation with local fishermen, taking fish sanctuaries into consideration.
	Impact on birds (important species) [Shanir Haor only]	• Conduct a baseline survey in Shanir Haor during the DD stage to assess potential impacts on migratory birds. If necessary, consider additional measures, including the option of excluding Shanir Haor from the project area.
Topography/ geology 【Common to all haors】	Topographical changes	• Designate specific sites for dredged spoil stockpiling, away from flood-prone and ecologically sensitive areas. • Stabilize stockpiles by turfing, compaction, or protective covering to prevent erosion and uneven surface formation. • Ensure controlled excavation with proper slope stabilization to avoid irregular depressions or mounds. • Backfill temporary borrow pits and level disturbed areas after construction is completed. • Adequately compact newly constructed embankments to reduce settlement. • Maintain natural drainage pathways when altering ground levels. • Provide adequate culverts and regulators in embankments to prevent water stagnation and restore natural flow.
Loss of land 【Common to all haors】	New embankment may require land acquisition, potentially impacting the livelihoods of the people who own or use the affected land.	• The project should aim to minimize land acquisition, avoid physical displacement, and prevent the takeover of productive land. • When avoidance or minimization is not possible, a comprehensive Resettlement Action Plan (RAP) should be prepared, with provisions for cash compensation for acquired land. • Proper monitoring of the RAP implementation should be carried out.
Sharecroppers 【Common to all haors】	May lose access to the agricultural land	• If required, an ILRP will be prepared to minimize adverse impacts on livelihoods.
Socially vulnerable	The poor people who worked in the	• Pay particular attention to the needs of the poor and vulnerable and adapt the engagement process accordingly.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
【Common to all haors】	acquired land may be affected by losing access to the land	• Prepare a context-specific ILRP, ensuring that women have a role in decision-making. • Ensure proper implementation of the ILRP should to minimize livelihood impacts.
Loss of livelihood 【Common to all haors】	Affected people will lose livelihood due to land acquisition and restriction during construction	• Identify both titled and non-titled vulnerable households during the RAP and a context-specific ILRP should be prepared. • Ensure proper implementation of ILRP to minimize livelihood impacts. • Project Affected Persons (PAPs) should be prioritized during any employment opportunities related to this project. • Follow measures to avoid disturbance to adjacent lands.
Land use and utilization of local source 【Common to all haors】	Reduction of agriculture land may result in a shift in agricultural practices of some people.	• Provide fair compensation to affected individuals. • Prepare a context-specific ILRP and ensure its proper implementation. • Offer training and financial support for farmers to transition to alternative employment or modern agricultural techniques.
Local communities and decision-making institutions 【Common to all haors】	Social institutions and local decision-making institutions of the project area may be impacted.	• The land acquisition process should be conducted through the enforcement of Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA), and landowners will be duly compensated as per the provisions mentioned in the Entitlement Matrix of Resettlement Action Plan. • Coordinate with relevant institutions, like Union Parishad and the DC office. • Ensure participatory consultations with affected people.
Uneven distribution of damage and benefit 【Common to all haors】	Only landowners and affected labourers will be eligible for compensation and rehabilitation; others will be excluded from the criteria.	• Cover affected individuals under the agriculture promotional activities like training for the farmers. • Encourage contractors to prioritize hiring local workers, including unskilled labour, to ensure more equitable distribution of job opportunities. • Conduct consultations with affected communities to identify vulnerable groups and ensure their concerns are addressed in compensation and employment strategies. • Implement a context-oriented LRP. • Establish a transparent grievance redress system to allow affected individuals to voice concerns and seek fair resolution regarding compensation and employment.
Conflicts of interest within the region 【Common to all haors】	Due to increased employment opportunities during construction, conflicts may arise between construction workers and local communities.	• Ensure that contractors implement fair recruitment practices that prioritize local workers for unskilled or semi-skilled labour positions. • Conduct regular consultations with local communities to understand their concerns regarding employment opportunities and ensure transparency in the hiring process. • Establish a clear grievance redress system where local workers can raise concerns about employment opportunities and resolve issues amicably.
Gender 【Common to all haors】	There may be risks of gender-based violence.	• Resident women should be closely informed about the days during which the works will occur in the areas they used to move or for other activities. • EPC contractors should alert the labour and worker group for not being involved with such activity. • Workers should receive proper guidelines and training regarding GBV. • The OHS manager and Social Safeguard Specialist, or any such designated person should be in charge of monitoring during the construction work. • An onsite grievance box should be maintained.
Children's rights 【Common to all haors】	Construction activities may impact school-going children who travel on the roads twice a day.	• Traffic personnel should be appointed at every potential crossing of school for commuting children. • Safety signage should be placed properly installed to ensure that school-going children can easily access the route. • Proper consultation should be conducted with schoolteachers and the management committee. • EPC contractors should instruct workers and drivers to avoid school time for construction work in those particular areas.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
		• Child labour at construction site during the project implementation is strictly prohibited, in accordance with both Bangladeshi law and JICA guidelines.
Infectious disease, such as HIV/AIDS 【Common to all haors】	The influx of workers may increase the risk of infectious diseases.	• To minimise these impacts, preventive measures against such diseases should be considered and implemented by the construction contractors. • Health surveillance should be provided for workers. • Illness among workers should be prevented by undertaking health awareness and education initiatives, as well as conducting immunization programs. • Treatment should be provided through standard case management at on-site and community healthcare facilities, as necessary. • Project personnel and area residents should be educated about risks, prevention, and available treatment options. • Collaboration with local authorities should be promoted to enhance access of workers' families and the community to public health services and promoting immunization as necessary. • The use of repellents, clothing, netting, and other barriers to prevent insect bites should be promoted.
Working environment 【Common to all haors】	There is a possibility of accidents and incidents occurring during construction works for project implementation.	• Maintain general OHS guidelines at workplace. • Areas that are under construction should be protected from trespassing. • Emergency response measures, like first aid and rescuing facilities, for should be readily available in case of accidents.
Climate change 【Common to all haors】	GHGs emissions	• Regular maintenance of construction vehicles and machinery will be conducted. • Equipment operation will be optimized to avoid unnecessary idling and inefficient use. • Low-emission fuels and energy-efficient machinery will be used wherever feasible. • GHGs emissions from major construction activities will be regularly monitored.
Accidents 【Common to all haors】	Construction accidents and road accidents	• Prepare and enforce a comprehensive traffic and safety management plan at all construction sites. • Regulate the movement of heavy vehicles, particularly during peak traffic hours, to reduce risks to the local community. • Provide training and regular safety briefings to all drivers, equipment operators, and workers. • Enforce the mandatory use of personal protective equipment (PPE) at construction sites. • Install adequate warning signs, barriers, and lighting at hazardous locations. • Maintain first aid facilities and ensure availability of emergency response systems at all worksites.

Source: JICA Study Team

Table 8.1.16 Environmental Mitigation Plan for the BWDB Portion During the Operation Phase

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Biodiversity 【Common to all haors】	Terrestrial ecosystems and biota	• Implement community-managed afforestation using native species (Hijol, Koroch, Jarul, fruit trees) along embankments and haor edges. • Encourage integrated pest management (IPM) and organic practices to reduce pesticide and fertilizer runoff. • Promote wildlife-friendly practices, such as retaining selective vegetation along embankments rather than complete clearance.
	Fisheries and aquatic resources	• Implement fish-friendly gate operation schedules (partial opening, staggered drainage) in coordination with DoF and BWDB. • Promote IPM and the use of organic fertilizers. • Maintain and expand community-based wetland afforestation (Hijol, Palm) to stabilize banks and provide fish and bird habitats. • Regulate boat speeds and restrict night navigation in ecologically sensitive haor pockets.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Hydrology 【Common to all haors】	Impacts on drainage patterns and water resource	• The natural drainage pattern should be preserved. • Establish a regular maintenance program for regulators, culverts, and embankments to prevent drainage congestion. • Maintain flushing operations, where feasible, to reduce water stagnation and ensure water quality. • Strengthen embankments with protective works, such as revetments and vegetation cover, to minimize erosion. • Monitor hydrological performance and adjust the operation of structures (e.g., regulators, gates) based on seasonal flow conditions.

Source: JICA Study Team

Table 8.1.17 Environmental Mitigation Plan for the LGED Portion During the Construction Phase

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Air pollution 【Common to all haors】	Dust emissions	• Use water spraying during excavation, earth handling, and material storage areas. • Store soil and sand in designated areas; cover stockpiles with tarpaulin, keep them below 2 m in height, and maintain a safe distance from receptors. • Promptly re-vegetate exposed ground. • Maintain and clean access roads and nearby streets; enforce vehicle speed limits. • Educate communities on dust hazards and preventive measures. • Maintain an onsite grievance register. • Conduct periodic ambient air quality monitoring.
	Vehicular emissions	• Maintain machinery to prevent smoke emissions and ensure compliance. • Regularly inspect vehicle emissions. • Use electric or battery-powered equipment where possible, and maintain diesel-powered equipment properly. • Avoid idling of vehicles and equipment to reduce exhaust emissions. • Prohibit open burning of waste at or near the site. • Conduct periodic ambient air quality monitoring.
Water quality 【Common to all haors】	Surface water contamination	• Store fuels, oils, and chemicals safely with spill containment. • Treat construction camp wastewater before discharge. • Limit earthworks near watercourses; schedule dredging/excavation in low-flow periods. • Monitor surface water quality regularly during construction. • Train workers on safe material handling to prevent spills.
	Groundwater contamination	• Store fuels, oils, and chemicals with proper containment. • Treat construction camp wastewater; avoid direct soil infiltration. • Manage solid waste properly to prevent leaching. • Monitor groundwater quality regularly near construction sites.
Soil 【Common to all haors】	Soil contamination	• Maintain equipment regularly to prevent fuel leaks. • Manage soil contaminant spills and properly handle dredged or excavated waste. • Store fuels, chemicals, and lubricants with appropriate containment measures. • Treat and safely dispose of liquid and hazardous waste. • Minimize soil disturbance during construction. • Periodically monitor soil quality and train staff on safe material handling.
Waste 【Common to all haors】	Generation of construction waste and general waste due to the increase in workers	• Waste will be properly treated and disposed of in compliance with the Solid Waste Management Rules, 2021 and the National 3R Strategy for Waste Management, 2010. Hazardous waste is not expected; however, if it occurs, it will be managed and disposed of in accordance with the Hazardous Wastes and Ship Breaking Waste Management Rules, 2011. • Prioritize the 3R (Reduce, Reuse, Recycle) approach whenever possible, and ensure disposal is carried out through authorized waste management contractors. • Prepare and implement a construction waste management plan, including segregation, collection, and safe disposal.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
		• Provide training and guidance to workers to prevent littering and improper disposal of waste at construction sites. • Regularly monitor the implementation of waste management practices to ensure compliance with national regulations and the project EMP.
Noise 【Common to all haors】	Increased ambient noise	• Schedule the noisiest construction activities to minimize disturbance, and limit the operation times of noisy equipment. • Regularly maintain and service all equipment, including mufflers, and promptly replace damaged components. • Use quieter equipment models, acoustic covers, or erect acoustic barriers along site boundaries where practicable. • Train workers on noise-reducing practices and provide ear protection in high-noise areas; include reminders in daily toolbox briefings. • Reduce the number of simultaneously operating equipment and route mobile noise sources to minimize disturbance. • Prohibit vehicle movement at night on access roads. • Conduct daily inspections and noise monitoring to ensure compliance with the Noise Pollution (Control) Rules, 2025.
Vibration 【Common to all haors】	Vibration generation	• Operate machinery per manufacturer guidelines to reduce vibration. • Limit heavy equipment use near sensitive structures. • Schedule high-vibration activities to minimize exposure. • Periodically monitor vibration near sensitive structures.
Odour 【Common to all haors】	Occurrence of unpleasant odours from sanitation facilities for workers.	• Sanitation facilities within the construction camp shall be properly maintained, with regular cleaning and safe disposal of waste.
Bottom sediment 【Common to all haors】	Bottom sediment contamination	• Schedule dredging during dry or low-flow periods to minimize turbidity. • Limit the dredging and excavation area and duration to reduce sediment resuspension. • Dispose of dredged material at designated sites rather than directly into water bodies. • Monitor turbidity and suspended sediments during construction. • Train contractors and workers in responsible practices near aquatic habitats.
Biodiversity	Terrestrial ecosystems and biota 【Common to all haors】	• Restrict tree felling to the minimum and implement compensatory plantations. • Suppress dust through water spraying and by covering stockpiles. • Limit noisy activities to daylight hours. • Salvage and reuse topsoil for revegetation.
	Fisheries and aquatic resources 【Common to all haors】	• Dispose dredged materials at approved high-elevation areas. • Limit noisy activities to daylight hours. • Strictly prohibit construction workers from hunting, capturing, or disturbing wildlife. • Limit noisy activities to daylight hours.
	Impact on birds (important species) [Shanir Haor only]	• Conduct a baseline survey in Shanir Haor during the DD stage to assess potential impacts on migratory birds. If necessary, consider additional measures, including the option of excluding Shanir Haor from the project area.
Topography/Geology 【Common to all haors】	Modify the natural topography through earth filling and embankment works.	• Save topsoil removed at the start of the project and reuse it to reclaim disturbed areas upon completion of development and construction activities. • Restrict earth cutting and filling to the minimum required level consistent with submerged road design standards.
Loss of land 【Common to all haors】	Land acquisition may affect the livelihoods of people who own or use the affected land.	• Aim to minimize land acquisition, avoid physical displacement, and prevent the takeover of productive land. • When avoidance or minimization is not possible, prepare a comprehensive Resettlement Action Plan (RAP) with provisions for cash compensation for acquired land. • Properly monitor the implementation of the RAP.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Sharecroppers 【Common to all haors】	Loss of access to agricultural land	• If required, prepare an ILRP to minimize adverse impacts on livelihoods.
Poor people and socially vulnerable 【Common to all haors】	Poor people who worked on the acquired land may be affected by the loss of access to the land.	• Pay particular attention to the needs of poor and vulnerable and adapt the engagement process accordingly. • Prepare a context-specific ILRP and ensure that women have a role in decision-making. • Ensure effective implementation of the ILRP to minimize livelihood impacts.
Loss of livelihood 【Common to all haors】	Affected people may lose livelihoods due to land acquisition and restriction during construction	• Identify title and non-title vulnerable households during the RAP and prepare a context-specific ILRP. • Ensure implementation of the ILRP to minimize livelihood impacts. • Prioritize Project Affected Persons (PAPs) for any employment opportunities related to the project. • Follow measures to avoid disturbance in adjacent lands.
Land use and utilization of local source 【Common to all haors】	Reduction of agricultural land may result in a shift in agricultural practices for some people.	• Provide fair compensation to affected people. • Prepare a context-specific ILRP and ensure proper implementation. • Provide training and financial support to farmers to help them transition to alternative employment or adopt modern agricultural techniques.
Local communities and decision-making institutions 【Common to all haors】	Social and local decision-making institutions in the project area may be impacted.	• Conduct the land acquisition process through the enforcement of Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA), and ensure that landowners are duly compensated as per the provisions mentioned in the Entitlement Matrix of Resettlement Action Plan • Coordinate with relevant institutions like Union Parishad, DC office, etc. • Ensure participatory consultations with affected people.
Uneven distribution of damage and benefit 【Common to all haors】	Only landowners and affected labourers will be eligible for compensation and rehabilitation; others will be excluded from the criteria.	• Cover impacted people under the agriculture promotional activities, like training for the farmers. • Encourage contractors to prioritize hiring local workers, including unskilled labour, to ensure more equitable distribution of job opportunities. • Conduct consultations with affected communities to identify vulnerable groups and ensure their concerns are addressed in compensation and employment strategies. • Implement a context-oriented LRP. • Set up a transparent grievance redress system to allow affected individuals to voice concerns and seek fair resolution regarding compensation and employment.
Conflicts of interest within the region 【Common to all haors】	Due to an increase in employment opportunities during construction, construction workers may experience some conflicts between local communities.	• Ensure that contractors implement fair recruitment practices that prioritize local workers for unskilled or semi-skilled labour positions. • Conduct regular consultations with local communities to understand their concerns regarding employment opportunities and ensure transparency in the hiring process. • Establish a clear grievance redress system where local workers can raise concerns about employment opportunities and resolve issues amicably.
Gender 【Common to all haors】	There is a potential risk of gender-based violence.	• Inform resident women about the days during which the works will occur in the areas they use for movement or other activities. • Ensure EPC contractors should alert the labour and worker group for not being involved with such activity. • Provide workers with proper guidelines and training regarding GBV. • The OHS manager and Social Safeguard specialist or any such designated person should be in charge of monitoring during the construction work. • Maintain an onsite grievance box.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Children's rights 【Common to all haors】	Construction activities may impact school-going children who travel on the roads twice a day.	• Appoint traffic personnel at every school crossing used by commuting children. • Install clear safety signage to ensure school-going children can easily access the route. • Conduct proper consultation with schoolteachers and management committee. • Ensure EPC contractors advise workers and drivers to avoid school time for construction work in those particular areas. • Strictly prohibit child labour at the construction site during the project implementation, in accordance with both Bangladeshi laws and JICA guidelines.
Infectious disease, such as HIV/AIDS 【Common to all haors】	Influx of workers may increase the risk of infectious diseases.	• In order to minimize the impact, preventive measures against such diseases should be considered, and implemented by construction contractors. • Provide health surveillance for workers. • Prevent illness among workers by undertaking health awareness and education initiatives, including immunization programs. • Provide treatment through standard case management in on-site and community health care facilities as necessary. • Educating project personnel and area residents on risks, prevention, and available treatment. • Promote collaboration with local authorities to enhance access of workers' families and the community to public health services and promoting immunization as necessary. • Promote use of repellents, clothing, netting, and other barriers to prevent insect bites.
Working environment (work safety) 【Common to all haors】	Construction activities may pose a risk of accidents and incidents occurring during the implementation of the project.	• Maintain general OHS guidelines at workplace. • Restrict access to areas under construction to prevent trespassing. • Ensure emergency response measures, like first aid and rescuing facilities, are available for any accidents.
Climate change 【Common to all haors】	GHGs emissions	• Ensure regular maintenance of construction vehicles and machinery to reduce fuel consumption and GHG emissions. • Optimize machinery operation to avoid unnecessary idling or inefficient usage. • Use low-emission fuels or energy-efficient machinery where feasible. • Monitor GHG emissions from major construction activities periodically.
Accidents 【Common to all haors】	Construction accidents and road accidents	• Follow the Health and Safety Management Plan (HSMP) rules and regulations designated by contractors. • Provide traffic signs, road markings, speed bumps, zebra crossings, guard rails, poles, and curb stones as required. • Implement a proper traffic management plan to separate construction vehicles, machinery, and pedestrian movement. • Train workers in safety procedures and ensure the use of personal protective equipment (PPE). • Maintain emergency response measures and first-aid facilities on-site. • Conduct regular safety audits and hazard monitoring.

Source: JICA Study Team

Table 8.1.18 Environmental Mitigation Plan for the LGED Portion During the Operation Phase

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
Air pollution 【Common to all haors】	Dust emissions	• Maintain roads and, where possible, pave them to reduce dust. • Spray water or dust suppressants on unpaved sections. • Enforce speed limits to minimize dust. • Establish roadside vegetation to stabilize soil. • Clean paved surfaces regularly. • Cover and store construction materials properly. • Monitor dust levels at sensitive locations.

Affected Aspect	Potential Impacts	Proposed Mitigation/Enhancement Measures
	Vehicular emissions	• Promote smooth traffic flow through signage, speed control, and junction improvements. • Enforce vehicle emission standards and encourage the use of cleaner fuels and low-emission vehicles. • Develop green belts to filter vehicular pollutants. • Conduct driver awareness campaigns on maintenance and fuel efficiency. • Monitor ambient air quality at sensitive locations. • Encourage public transport, non-motorized transport, and ridesharing. • Maintain paved surfaces to reduce dust and congestion.
Biodiversity 【Common to all haors】	Terrestrial ecosystems and biota	• Maintain buffer strips along wetlands, Beels, and riparian vegetation to protect sensitive habitats from maintenance activities. • Retain native trees along embankments and avoid complete clearance during routine maintenance. • Limit human and vehicle movement to designated paths to reduce trampling and habitat disturbance. • Educate communities and maintenance teams about wildlife-sensitive practices.
	Fisheries and aquatic resources	• Implement fish-friendly gate operation schedules (partial opening, staggered drainage) in coordination with the DoF and BWDB. • Promote integrated pest management (IPM) and organic fertilizer use. • Maintain and expand community-based wetland afforestation (Hijol, Pulm) to stabilize banks and provide fish/bird habitats. • Regulate boat speeds and restrict night navigation in ecologically sensitive haor pockets.
Hydrology 【Common to all haors】	Submerged roads can modify micro-hydrology	• Preserve the natural drainage. • Align roads along natural ridges or higher ground to minimize interference with flood flow. • Provide adequate cross-drainage structures (culverts, bridges, regulators) at regular intervals to maintain natural water movement and connectivity.
Climate change 【Common to all haors】	Leading to a slight rise in vehicle-related emissions	• Promote regular maintenance of operational vehicles to reduce fuel consumption and emissions. • Encourage the use of low-emission vehicles and fuel-efficient driving practices. • Optimize traffic management to reduce congestion and associated emissions. • Maintain climate-resilient features of the road to prevent damage from extreme weather and preserve natural hydrological flows. • Periodically monitor vehicle-related GHG emissions in high-traffic sections to identify mitigation opportunities.

Source: JICA Study Team

(2) Environmental Monitoring Plan

In this project, monitoring will be conducted based on the following monitoring plan to identify the actual environmental impacts predicted in the EIA. The results obtained will be used to verify compliance with environmental standards, determine the need for additional mitigation measures, and assess the effectiveness of existing measures.

Table 8.1.19 Environmental Monitoring Plan for the BWDB Portion During the Construction Phase

Impact	Monitoring Means	Parameters	Location	Frequency
General 【Common to all haors】	Visual inspection of all active work areas	General compliance with mitigation measures presented in the EMP	Project activity areas and construction worker's camp	Daily
Air quality 【Common to all haors】	Measurement/ sampling	PM_{10}, $PM_{2.5}$, SPM, NOx, SO_2, CO, O_3	Construction sites	Quarterly
Noise 【Common to all haors】	Measurement	Leq (dBA)	Construction sites	Quarterly

Impact	Monitoring Means	Parameters	Location	Frequency
Surface water and groundwater 【Common to all haors】	Sampling	Temperature, turbidity, pH, dissolved oxygen (DO), BOD_5, COD, total dissolved solids (TDS), total suspended solids (TSS), electric conductivity (EC), ammonia (NH3), nitrate (NO_3), coliform (total), chloride (Cl-)	River/Khal at all construction sites	Quarterly
		Temperature, turbidity, total hardness, pH, TDS, EC, sulfate (SO_4), chloride (Cl-), arsenic (AS), iron, manganese (Mn), nitrate (NO_3), phosphate (PO_4), fluoride (F), total coliform (TC), faecal coliform (FC)	At all construction/work sites	Quarterly
Soil 【Common to all haors】	Sampling	pH, soil texture, TOC, total N, total P, and total K	Construction sites	Quarterly
Solid waste 【Common to all haors】	Audits, photographic documentation, and interviews	Generation, storage, recycling, transport, and disposal	Construction sites	Monthly
Terrestrial ecosystem 【Common to all haors】	Vegetation clearance	Number of trees fell, area of vegetation cleared	Project site	Once before starting the construction
	Disturbance to migratory birds/ waterbirds	Species composition and abundance, migration pattern	In and around the project site within 5 km	Monthly (November - March) for migratory birds/ waterbirds
Aquatic ecosystem 【Common to all haors】	Fish and crustaceans	Fish species, abundance, CPUE, fish mortality	In and around the project site within 5 km	Quarterly
Health and safety 【Common to all haors】	Health and safety surveys	Proper use of PPE, presence of safety signs, first aid kit, firefighting devices, and injury/illness records	Construction site	Continuously

Source: JICA Study Team

Table 8.1.20 Environmental Monitoring Plan for the BWDB Portion During the Operation Phase

Impact	Monitoring Means	Parameters	Location	Frequency
General 【Common to all haors】	Visual inspection of all project areas	General compliance with mitigation measures presented in the EMP	Project area	Weekly
Terrestrial ecosystem 【Common to all haors】	Disturbance to migratory birds and waterbirds	Species composition and abundance, including migration pattern	In and around the project site within 5 km	Monthly (November - March)
Aquatic ecosystem 【Common to all haors】	Fish and crustaceans	Fish species, abundance, CPUE, and fish mortality	In and around the project site within 5 km	Half-yearly or one year after construction
Hydrology 【Common to all haors】	Maintenance status of drainage facilities	Functionality of drainage facilities (drainage channels, sluice gates, regulators, box culverts) and verification that there is no waterlogging at these locations.	Drainage facilities (drainage channels, sluice gates, regulators, box culverts)	Once at the beginning of dry season (December)

Source: JICA Study Team

Table 8.1.21 Environmental Monitoring Plan for the LGED Portion During the Construction Phase

Impact	Monitoring Means	Parameters	Location	Frequency
General 【Common to all haors】	Visual inspection of all active work areas	General compliance with mitigation measures presented in the EMP	Project activity areas and construction worker's camp	Daily
Air quality 【Common to all haors】	Measurement/Sampling	PM_{10}, $PM_{2.5}$, SPM, NOx, SO_2, CO, O_3	Construction sites	Quarterly
Noise 【Common to all haors】	Measurement	Leq (dBA)	Construction sites	Quarterly
Surface water and groundwater 【Common to all haors】	Sampling	Temperature, turbidity, pH, dissolved oxygen (DO), BOD_5, COD, total dissolved solids (TDS), total suspended solids (TSS), electric conductivity (EC), ammonia (NH3), nitrate (NO_3), coliform (total), chloride (Cl-)	River/Khal at all construction sites	Quarterly
		Temperature, turbidity, total hardness, pH, TDS, EC, sulfate (SO_4), chloride (Cl-), arsenic (AS), iron, manganese (Mn), nitrate (NO_3), phosphate (PO_4), fluoride (F), total coliform (TC), fecal coliform (FC)	At all construction/work sites	Quarterly
Soil 【Common to all haors】	Sampling	pH, soil texture, TOC, total N, total P, and total K	Construction sites	Quarterly
Solid waste 【Common to all haors】	Audits, photographic documentation, and interviews	Generation, storage, recycling, transport, and disposal	Construction sites	Monthly
Terrestrial ecosystem 【Common to all haors】	Vegetation clearance	Number of trees fell, area of vegetation cleared	Project site	Once before starting the construction
	Disturbance to migratory birds/ waterbirds	Species composition and abundance, migration pattern	In and around the IBAs overlapped with Study Haor Road and Bridge/Culvert Crossings location	Monthly (November - March) for migratory birds/ waterbirds
Aquatic ecosystem 【Common to all haors】	Fish and crustaceans	Fish species, abundance, CPUE, fish mortality	In and around the project site within 5 km	Half yearly
Health and safety 【Common to all haors】	Health and safety surveys	Proper use of PPE, presence of safety signs, first aid kit, firefighting devices, and injury/illness records	Construction site	Continuously

Source: JICA Study Team

Table 8.1.22 Environmental Monitoring Plan for the LGED Portion During the Operation Phase

Impact	Monitoring Means	Parameters	Location	Frequency
General 【Common to all haors】	Visual inspection of all project areas	General compliance with mitigation measures presented in the EMP	Project area	Weekly
Air quality 【Common to all haors】	Dust emissions	PM_{10}, $PM_{2.5}$, SPM, O_3	Adjacent settlement area	Quarterly
	Vehicular emissions	NO_X, SO_2, CO,	Adjacent settlement area	Quarterly
Noise 【Common to all haors】	Measurement	Leq (dBA)	Adjacent settlement area	Quarterly
Terrestrial Ecosystem 【Common to all haors】	Disturbance to migratory birds and waterbirds	Species composition and abundance, migration pattern	In and around the IBAs overlapped with Study Haor	Monthly (November - March)
Aquatic Ecosystem 【Common to all haors】	Fish and crustaceans	Fish species, abundance, CPUE, fish mortality	In and around the Seasonal Beels targeted for excavation and fish sanctuary establishment Road and Bridge/Culvert Crossings location Fish Sanctuary and Community-Managed Sites Boat Landing Stations (Ghats) and Markets	Quarterly One year after construction

Source: JICA Study Team

(3) Reporting

The monitoring results of this project will be compiled and reported to the relevant authorities as outlined below. Each report will include, in addition to the above-mentioned monitoring items, information on social and environmental aspects—such as land acquisition status and progress in livelihood improvement—as well as details of grievance handling, including the number of cases, responsible agencies, and response status.

Table 8.1.23 Report of the Monitoring Results

Phase	Type of Report	Prepared by	Frequency	Submission to
Construction Phase	Quarterly Environmental Monitoring Report	Contractor	Quarterly	BWDB/LGED, JICA, DoE
Operation & Maintenance Phase	Quarterly Monitoring Progress Report	BWDB/LGED	Quarterly	JICA and DoE, as needed
Operation & Maintenance Phase	Annual Comprehensive Report	BWDB/LGED	Annually	JICA and DoE, as needed

Source: JICA Study Team

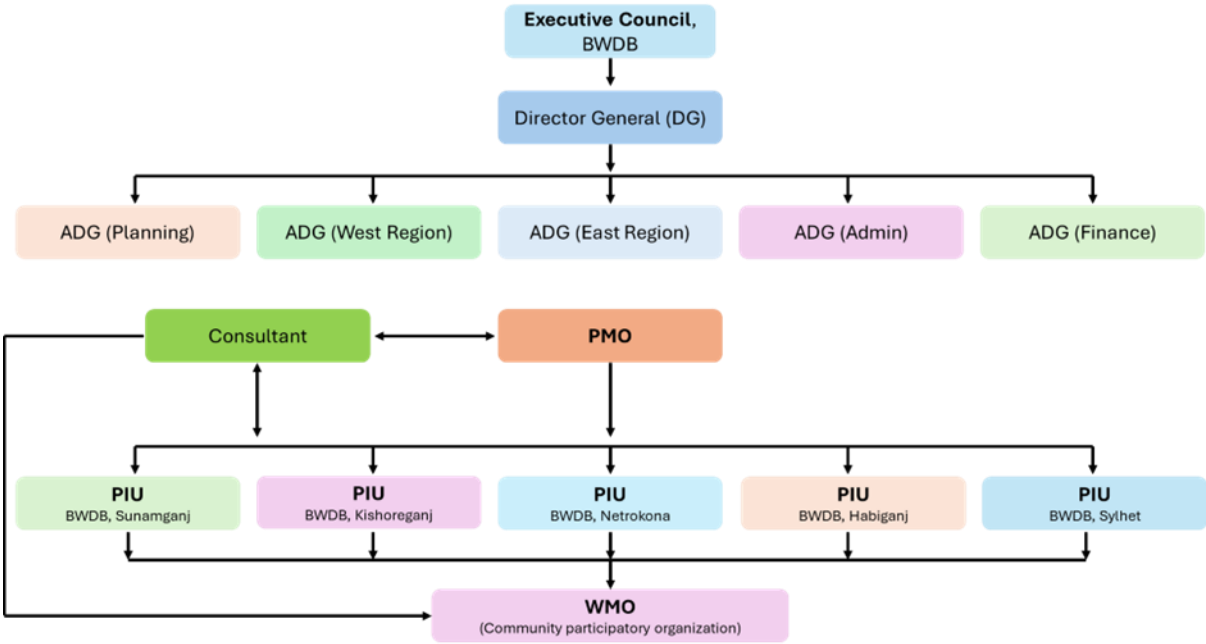
(4) Estimated Costs for Implementation of Mitigation Measures and Monitoring

The costs for mitigation measures and monitoring during the construction phase for both the BWDB portion and LGED portion were estimated.

8.1.6 Implementation Framework for Environmental and Social Considerations

(1) BWDB Portion

The implementation framework for environmental and social considerations in the BWDB portion is shown in Figure 8.1.1 below.



Source: JICA Study Team

Figure 8.1.1 Institutional Arrangement for Implementation for BWDB Portion

The BWDB will serve as the executing agency for the HARD Project, with overall responsibility for management and coordination. Oversight will be provided by the BWDB Executive Council and DG, supported by the ADGs for Planning, West Region, East Region, Administration, and Finance.

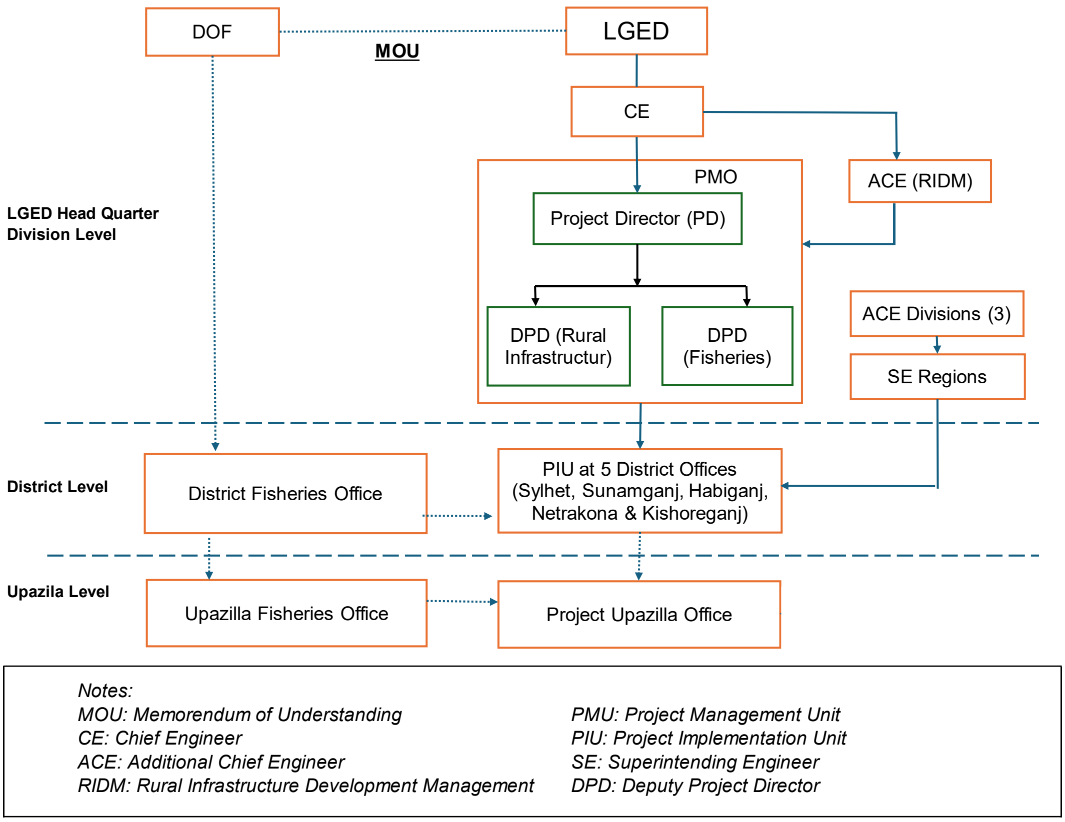
A Project Management Office (PMO) will be established at BWDB headquarters in Dhaka, headed by a Project Director at the level of Chief Engineer or Additional Chief Engineer. The PMO will act as the central body for coordination, management, and liaison. It will also oversee environmental management, including monitoring and liaison with the DoE. The PMO will guide and supervise the implementation of the EMP.

At the field level, Project Implementation Units (PIUs) will be established in Sunamganj, Habiganj, Sylhet, Netrokona, and Kishoreganj. Each PIU, headed by an Executive Engineer with support from Sub-Divisional Engineers (SDEs), will implement subproject activities under PMO guidance. Within each subproject area, a Subproject Management Office (SMO) will be formed from existing BWDB O&M offices to carry out daily implementation. Each SMO will be led by a senior Executive Engineer as Subproject Manager, supervised by the Superintending Engineer of the Eastern Circle, acting as Subproject Advisor.

During the operational phase, localized water management infrastructure—such as water retention structures, inlets/outlets, small regulators, and irrigation and drainage canals—with a command area below 5,000 ha will be managed by Water Management Organizations (WMOs). After construction and on-the-job O&M training, WMOs will take responsibility for EMP-related activities, with technical support from the SMO and PMO.

(2) LGED Portion

The implementation framework for environmental and social considerations in the LGED portion is shown in Figure 8.1.2 below.



Source: JICA Study Team

Figure 8.1.2 Institutional Arrangement for Implementation for LGED Portion

For the implementation of rural infrastructure and fisheries promotion activities, a PMO will be established at the LGED headquarters, headed by a PD. PIUs will be set up within the existing LGED district offices located in the targeted districts: Sunamganj, Habiganj, Sylhet, Netrokona, and Kishoreganj. LGED project upazila offices will be established within existing LGED upazila offices. District offices of the DoF are expected to coordinate with LGED PIUs to implement fisheries promotion activities. Roles of the PMO and PIUs are explained in the following Table 8.1.24.

Table 8.1.24 Roles of the PMO and PIUs (LGED Portion)

Implementation Structure	Roles
PMO	The LGED PMO will be responsible for the overall management of rural infrastructure development and fisheries promotion activities, with the objective of efficiently achieving project outputs. To implement the project, the PMO will carry out the following tasks and responsibilities: • Formulate the overall implementation plan. • Procure and manage consultants and project staff, and closely monitor their performance based on their TOR, utilizing appropriate monitoring and evaluation (M&E) tools and human capital development systems. • Prepare the Annual Work Plan and Budget (AWPB) and procurement plan for both the PMO and PIUs and obtain approval from the Chief Engineer of LGED. • Conduct detailed design. • Monitor progress of land acquisition. • Supervise activities and monitor implementation progress. • Coordinate rural infrastructure development with fisheries promotion activities. • Provide guidance to the PIUs. • Review and approve invoices from consultants and contractors. • Ensure compliance with environmental and social safeguard requirements. • Report to and coordinate with relevant agencies.

Implementation Structure	Roles
	• Organize stakeholder workshops at each stage of implementation. • Prepare knowledge management documents and share them with stakeholders. • Draft and ensure implementation of the following MOUs: - MOU between LGED and the DoF. - MOU between the LGD and the MoL. • Establish an internal control mechanism, including internal audit and audit by FAFD, and respond to audit recommendations.
PIUs	The LGED PIU will be responsible for implementing rural infrastructure development and fisheries promotion activities in the targeted haor areas and upazilas. The PIU will undertake the following tasks and responsibilities: • Prepare subproject and scheme implementation plans. • Conduct surveys and measurements. • Prepare bidding documents, issue bid invitations, and award and sign contracts. (Bid evaluation will be conducted by the Evaluation Committee, and the evaluation results will be approved by officials designated under government regulations). • Review and verify design specifications. • Carry out land acquisition. • Supervise the construction of rural infrastructure and the implementation of fisheries-related activities. • Review contractors' invoices. • Prepare progress reports.

Source: JICA Study Team

8.1.7 Public Consultation Meetings (PCM)

Prior to conducting the PCM, consultations were held with the DoE, the authority responsible for EIA, regarding the policy for organizing PCM. As a result, DoE suggested that PCM be conducted at three locations, one in each division: Mymensingh, Dhaka, and Sylhet—since the candidate haor project sites span these Divisions. However, considering the distribution of the 15 haors subject to the EIA and participants' accessibility, PCMs were implemented at four locations. In addition, considering that residents of all 15 target haors might not necessarily be able to participate in the PCMs due to scheduling and accessibility constraints, stakeholder consultations were conducted in all haors as part of the RAP survey, as described in Section 8.2.11, to complement the PCMs and to obtain participants' views on the project. Furthermore, the RAP survey included FGDs not only with SHMs but also with women's groups and other stakeholders, thereby ensuring due consideration for socially vulnerable groups.

Table 8.1.25 Overview of PCM Implementation

SN	Date	Location			Target Haor(s)
		Division	District	Upazila	
1	December 1st, 2025	Mymensingh	Netrokona	Kalmakanda	Updakhali Haor
2	December 2nd, 2025	Dhaka	Kishoreganj	Itna	Khaliajun Polder-1, Khaliajuri FCD (Polder-3), Mrigar Haor, Humayerpur Haor
3	December 2nd, 2025	Sylhet	Sunamganj	Jagannathpur	Khai Haor, Chaptir Haor, Boram Haor, Naluar Haor, Makalkandi Haor, Ballar Haor (Chagaiya Haor)
4	December 1st, 2025			Bishwamvapur	Shanir Haor, Hailr Haor, Karchar Haor, Pathor Chawli Haor

Source: JICA Study Team

Prior to holding the PCMs, in accordance with ECR 2023, the draft EIA (in English) and summary materials (in Bengali) were submitted to the DoE, and representatives for each PCM were nominated by the DoE. Furthermore, on 26 November 2025, the PCM schedule was published in national and local newspapers. Official invitations were also sent to relevant agencies, local residents, and other stakeholders to ensure awareness of the PCMs.

During each PCM, the following topics were explained, followed by an open discussion with local residents. Table 8.1.26 presents an overview of participants and discussion outcomes for each PCM. It was confirmed that the importance of the project was recognized, and there was no significant opposition from participants regarding project implementation.

- Purpose of PCM
- Background of project implementation
- Project outline and plan
- Explanation of basic design
- Description and results of environmental baseline survey
- Environmental and social impact assessment
- Explanation of Environmental Management Plan (EMP)
- Explanation of Environmental Monitoring Plan (EMoP)

Table 8.1.26 Summary of PCM Participants and Discussion Outcomes

SN	Participants	Discussion Outcomes
1	Government agencies and implementing organizations (DoE, BWDB, LGED, local administrative officers), consultants, local residents (farmers, fishers, community leaders, journalists, haor inhabitants, etc.) Approximately 45 participants (43 men and 2 women)	The importance of the project was confirmed, and it was verified that there was no significant opposition from participants regarding its implementation.
2	Government agencies and implementing organizations (DoE, BWDB, LGED, local administrative officers), NGOs, consultants (Nippon Koei), local residents (local university staff, farmers, community leaders, journalists, Haor inhabitants, etc.) Approximately 35 participants (31 men and 4 women)	• Local fishermen expressed concerns about the potential impacts of dredging on fish reproduction and emphasized the importance of considering the timing of dredging and maintaining natural water flows to ensure free fish movement. In response, the implementing agencies explained that water gates would be operated in consultation with local fishing communities in order to protect fish migration routes and safeguard fishermen's livelihoods. • The importance of the project was confirmed, and it was verified that there was no significant opposition from participants regarding its implementation.
3	Government agencies and implementing organizations (DoE, BWDB, LGED, local administrative officers), consultants, local residents (local university staff, farmers, community leaders, journalists, haor inhabitants, etc.) Approximately 40 participants (37 men and 3 women)	• Local farmers pointed out that continued soil extraction from public land within the haor areas for embankment and road maintenance has resulted in soil shortages. In response, the implementing agencies explained that soil extraction would be carried out in a planned manner while maintaining environmental balance, and that dredged material would be reused where feasible. • The Union Parishad Chairman of Chilaura-Holdipur requested that the project should not hinder fish reproduction or migration. In response, the implementing agencies explained that culverts and flood fuse systems would be introduced for flood management, ensuring fish movement and protecting water resources in the haor region, thereby preventing adverse impacts on the environment and the local economy. • Several local farmers emphasized the need for dredging and proper management of Beels and canals. • The importance of the project was confirmed, and it was verified that there was no significant opposition from participants regarding its implementation.
4	Government agencies and implementing organizations (DoE, BWDB, LGED, local administrative officers), consultants, NGOs, local residents (farmers, university staff, community leaders, journalists, haor inhabitants, etc.)	• Local NGOs expressed concern that fish resources in the haor areas are currently declining. In response, the implementing agencies explained that the project will include fisheries enhancement activities such as dredging and management of canals and Beels, as well as habitat restoration,

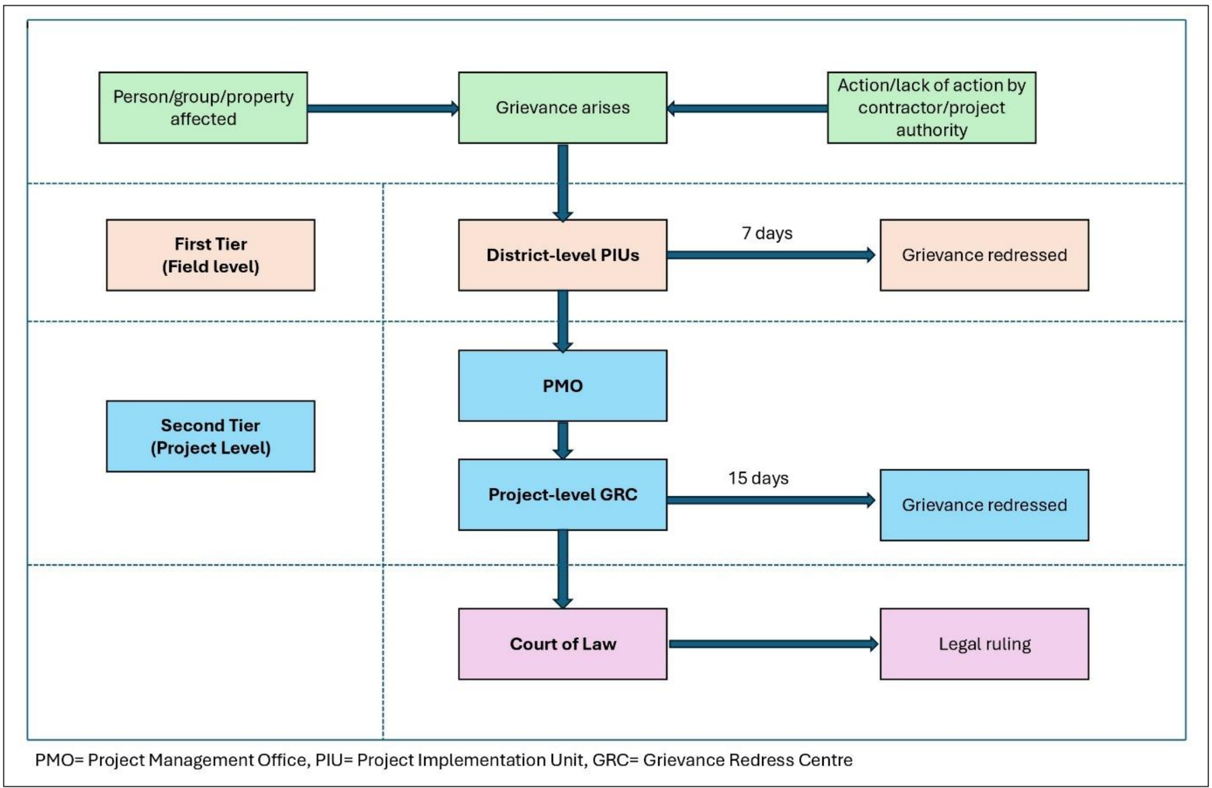
SN	Participants	Discussion Outcomes
	Approximately 60 participants (60 men)	which are expected to contribute to local food security and improved livelihoods. • The Chairperson (LGED Upazila Engineer) emphasized the importance of ensuring that the project does not hinder fish reproduction or migration, and of preventing agricultural land from being inundated due to poor drainage within the haor areas. • The importance of agricultural infrastructure such as farm roads and village protection works (VPWs), as well as the benefits of submerged embankments in preventing flash floods and supporting agriculture, were acknowledged. The importance of the project was confirmed, and it was verified that there was no significant opposition from participants regarding its implementation.

Source: JICA Study Team

8.1.8 Grievance Redress Mechanism

(1) BWDB Portion

The Grievance Redress Mechanism (GRM) for the BWDB portion consists of two tiers. The First Tier involves handling by the PIUs, established within BWDB's district-level offices, while the Second Tier involves handling by the PMO established at BWDB headquarters. Public awareness of the GRM for this project will be carried out by the PMO.



Source: JICA Study Team

Figure 8.1.3 Grievance Redress Mechanism for BWDB portion

First Tier:

The Executive Engineer of the PIUs will serve as the grievance handling officer. The officer will conduct site visits and consultations with stakeholders—including affected persons, contractors, district administration officials—to resolve grievances within seven working days. If a grievance is not resolved, it will proceed to the Second Tier.

Second Tier:

This tier is initiated based on reports submitted by the PIUs regarding unresolved grievances. The PMO will establish a Grievance Redress Committee (GRC), composed of the following members:

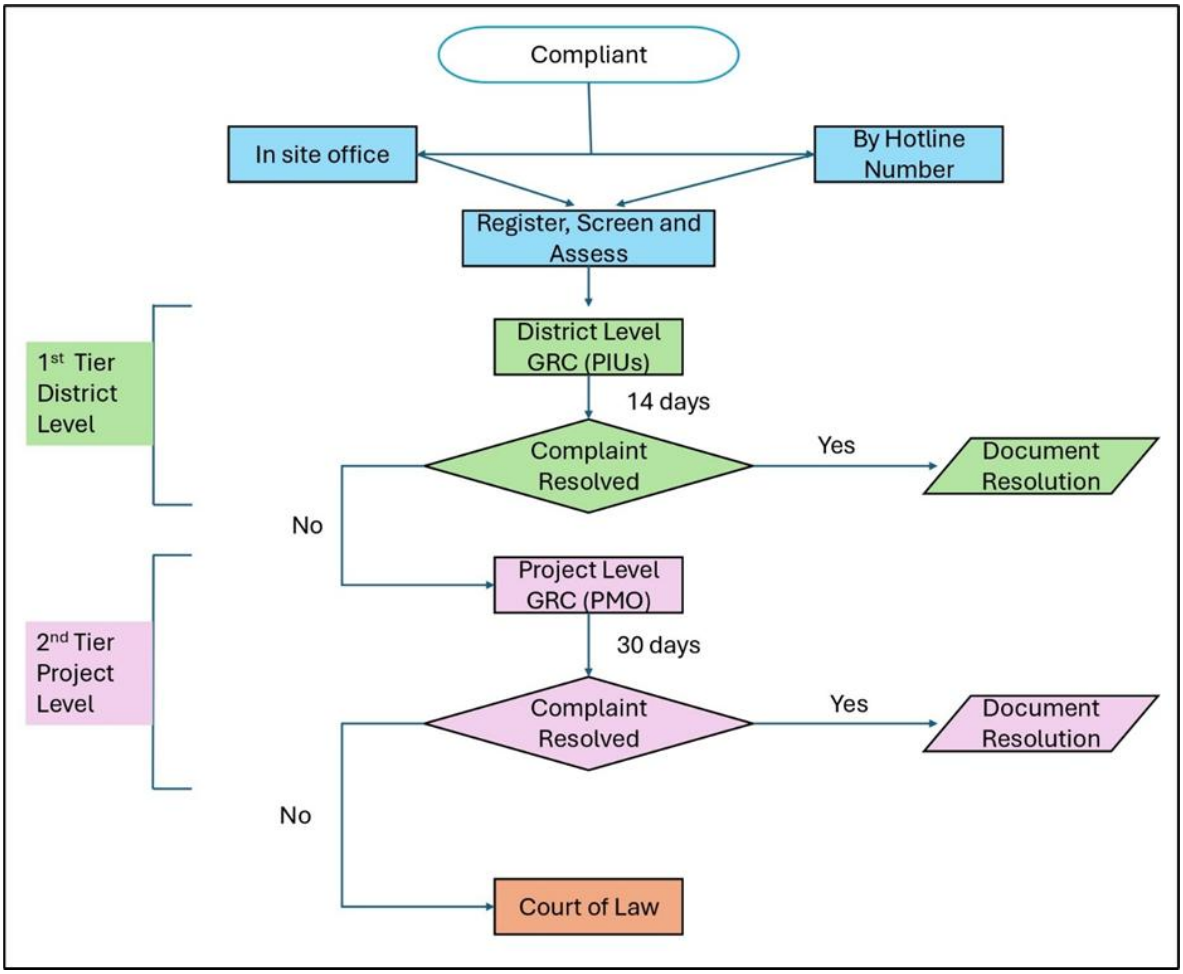
- Project Director (PD)
- Environmental Specialist
- PIU Representative (Executive Engineer)
- Representative of the concerned Union
- Representative of affected people
- Representative from the local DC Office
- DOE representative for environmental grievance redress

The GRC will hold hearings as necessary, and affected persons may present grievances or concerns directly to the GRC. The GRC will propose a resolution within 15 days and appoint a person responsible for implementation. The Executive Engineer of the PIU will be responsible for submitting documents to the GRC, managing the grievance database, recording decisions, preparing minutes, and monitoring the implementation of decisions.

If grievances remain unresolved at the Second Tier, affected persons may pursue appropriate legal action through the courts.

(2) LGED Portion

The GRM for the LGED portion consists of two tiers. The First Tier involves handling by the PIUs, established within LGED's district-level offices, while the Second Tier involves handling by the PMO, established at LGED headquarters. Public awareness of the GRM for this project will be carried out by the PIUs.



Source: JICA Study Team

Figure 8.1.4 Grievance Redress Mechanism for LGED Portion

First Tier:

Grievances are submitted directly by affected persons, either via phone to the help desk or in person at the PIUs office in each district. The PIUs will convene a committee chaired by the Executive Engineer of the LGED district-level office, with participation from the Senior Assistant Engineer, the Environmental and Social Safeguard Officer, and a representative of the district administration. The committee will conduct site visits and consultations with stakeholders—including affected persons, contractors, district officials—and propose a resolution within 14 days of grievance receipt. If the grievance is not resolved at this level, it will proceed to the Second Tier.

Second Tier:

At this stage, the PMO will handle the grievance, chaired by the LGED PD and including Environmental and Social Safeguard Specialists. The PMO must propose a resolution within 30 days of receiving the grievance. If the grievance remains unresolved at the Second Tier, affected persons may pursue appropriate legal action through the courts.

Table 8.1.27 PIU and PMO Members for LGED Portion

Tier 1: District Level GRC (PIUs)	Tier 2: Project Level GRC (PMO)
• Executive Engineer - LGED District Office (Chair) • Senior Assistant Engineer (Member Secretary) • Local Government Representative (e.g., Union Parishad Chairman) (Member)	• Project Director (Chair) • Deputy Project Director / PMO Officer (Member Secretary) • Social & Environmental Specialist (Member)

Source: JICA Study Team

8.2 Social Environment

8.2.1 Approach and Methodology Adopted for this Study

As the detailed design of the facilities is not included in the scope of this Preparatory Survey, exact land acquisition locations cannot be finalized at this stage. Additionally, the proposed embankment alignment is submerged during the monsoon season and only become accessible in November, making fieldwork physically impossible before that time.

As a result, it is proposed that a Simplified RAP be prepared for this Project under this Survey, including the outlines of Entitlement Matrix, implementation protocol, monitoring regime, and grievance redress mechanisms.

To estimate a ballpark land acquisition cost, the prevailing Mouza rate for each haor will be used. A sublet firm is engaged from early October 2025 to assist with this task.

8.2.2 Scope of Sublet Work

The selection of the sublet is expected to be completed by September 2025, after which fieldwork will commence immediately.

The scope of work covers, but is not limited to, the following:

1) Project description
2) Potential impact from the project
3) Objectives of the resettlement plan
4) Socioeconomic baseline study (using secondary data)
5) Regulatory and legal framework
6) Institutional framework for implementation
7) Eligibility criteria and definition of displaced persons
8) Valuation of losses and compensation mechanisms
9) Public participation and community consultation

10) Implementation schedule
11) Costs and budget
12) Grievance redress mechanism
13) Monitoring and evaluation
14) Arrangements for adaptive management
15) Income Restoration and Livelihood Plan (IRLP)
16) Gender mainstreaming

8.2.3 Necessity of Land Acquisition and Resettlement

For the BWDB portion, land acquisition will primarily be required for embankments proposed at new haors, with potential embankment base widening at rehabilitation haors. The JICA Study Team will follow the principle of Phase 1 Project, where no resettlement occurred, achieved through careful adjustment of embankment design. Similarly, in the Phase 2 Project, there will be no physical displacement of residential or commercial structures. However, linear land acquisition of agricultural lowlands near riverbank may be necessary, which could lead to economic displacement of PAHs due to the loss of partial agriculture land.

For the LGED portion, partial or linear land acquisition of farmland will be required only for village protection walls (VPWs). Road widening will occur within the existing road ROW, thus essentially, there will be no land acquisition for this activity.

On the other hand, the socioeconomic benefit from the Project is enormous.

In summary, it can be said that the overall impacts from social aspects will be positive in this project.

8.2.4 Scale of Land Acquisition and Resettlement

(1) BWDB Portion

The planned land acquisition for 13 submergible embankment rehabilitation sites and two new construction sites (Mrigar Haor and Ballar Haor) is approximately 1,737,600 m^2 or 429,187 acres. The three planned rehabilitation sites—Naluar Haor-1, Humaipur Haor, and Khaliajhuri FCD-3 Haor—will be rehabilitated within the existing land area, so no additional land acquisition will be required. According to the land registry, most of the land to be acquired is recorded as single-cropped agricultural land (Boro, Aman, Nama).

Table 8.2.1 Approximate Area of Land Acquisition under BWDB Portion

No.	Haor	District	New/ Rehabilitation	Planned Land Acquisition Area (m^2)	Planned Land Acquisition Area (acre)
1	Noluar Haor (Polder-1)	Sunamganj	Rehabilitation	0	0
2	Chaptir Haor	Sunamganj	Rehabilitation	82,345	20.339
3	Baram Haor	Sunamganj	Rehabilitation	99,000	24.453
4	Khai Haor	Sunamganj	Rehabilitation	114,836	28.364
5	Halir Haor	Sunamganj	Rehabilitation	227,685	56.238
6	Humaipur Haor	Kishoreganj	Rehabilitation	0	0
7	Khaliajuri FCD-1	Netrokona	Rehabilitation	66,581	16.445
8	Khaliajuri FCD-3 Haor	Netrokona	Rehabilitation	0	0
9	Mrigar Haor	Kishorganj	New	358,998	88.673
10	Shanir Haor	Sunamganj	Rehabilitation	113,435	28.018
11	Updakhali Haor	Netrokona	Rehabilitation	175,230	43.282
12	Korchar Haor	Sunamganj	Rehabilitation	90,792	22.426
13	Makalkandi Haor	Habiganj	Rehabilitation	71,080	17.557
14	Ballar Haor	Habiganj	New	271,563	67.076
15	Pathor Chawli Haor	Sylhet	Rehabilitation	66,057	16.316
			Total	1,737,600	429.187

Source: RAP (2025)

Because the site survey was impossible due to waterlogging and flooding during the monsoon season, the survey was conducted with the mouza maps (cadastral maps) by overlaying the project boundary on these maps using geographic information system (GIS) to identify the land plots to be acquired. The number of affected households was estimated based on the assumption that one household owns one land plot as a provisional condition. The approximate number of PAPs was estimated using the average family size per household from the BBS 2022 census data. As a result, 9,393 land plots across 15 haors are subject to land acquisition, impacting 9,393 households. A total of 46,133 PAPs (22,884 male and 23,249 female) are expected to be affected.

Since houses and other structures are built on the slightly higher land that is not normally flooded, submergible embankments will be constructed in a way that avoids these structures, thereby preventing the physical displacement of households.

Table 8.2.2 Estimated Number of PAHs and PAPs by Land Acquisition under BWDB Portion

Haor	Estimated No. of Landowner PAHs	Estimated No. of Landowner PAPs			Average Male/ Female Ratio	Average Family Size	Remarks
		Total	Male	Female			
Noluar Haor (Polder-1)	0	0	0	0	0	0	No additional land acquisition
Chaptir Haor	491	2,504	1,236	1,268	97.52	5.1	-
Baram Haor	594	3,148	1,583	1,565	101.17	5.3	-
Khai Haor	581	3,044	1,468	1,576	93.15	5.24	-
Halir Haor	515	2,657	1,321	1,336	98.93	5.16	-
Humaipur Haor	0	0	0	0	0	0	No additional land acquisition
Khaliajuri FCD-1	653	2,899	1,448	1,451	99.76	4.44	-
Khaliajuri FCD-3 Haor	0	0	0	0	0	0	No additional land acquisition
Mrigar Haor	1,247	5,587	2,815	2,772	101.52	4.48	-
Shanir Haor	1,640	8,462	4,209	4,254	98.93	5.16	-
Updakhali Haor	1,617	7,131	3,583	3,548	100.98	4.41	-
Korchar Haor	217	1,092	543	548	98.93	5.03	-
Makalkandi Haor	216	1,095	528	567	93.03	5.07	-
Ballar Haor	976	4,948	2,385	2,563	93.03	5.07	-
Pathor Chawli Haor	646	3,566	1,765	1,801	98.06	5.52	-
Total	**9,393**	**46,133**	**22,884**	**23,249**		-	-

Note: 1. The number of estimated PAHs was calculated based on the assumption that tentatively 1 land plot is owned by 1 household.

2. The number of estimated PAPs was calculated by multiplying the number of the estimated PAHs with the average number of family members per household based on the BSS data.

3. Total quantity of the planned land acquisition area does not match with the total quantity of each embankment area due to decimals.

Source: RAP (2025)

(2) LGED Portion

It is understood that the new and additional land acquisition of 213,333.30 m^2 (52.6933 acres) will be required for the construction of village protection wall (VPW) in 17 villages. As per the records collected from the government offices, all affected lands are categorized as arable, with most being single-cropped (Boro, Aman, Nama) and the remainder double-cropped.

Table 8.2.3 Approximate Area of Land Acquisition under LGED Portion (17 villages)

No	Haor	District	Upazila	Village	Mouza	Length (m)	Area (m^2)	Area (acre)
1	2	3	4	5	6	7	8	9
1	Noluar Haor (Polder-1)	Sunamganj	Derai	Das Naogaon	Kamar khal/ 2	1,014.00	5,070.00	1.2523
2	Chaptir Haor	Sunamganj	Derai	Kachua	Karimpur	1,318.74	6,593.70	1.6286
3	Shanir Haor	Sunamganj	Tahirpur	Sreepur	Sreepur/42	1,980.87	9,904.35	2.4464
4	Shanir Haor	Sunamganj	Bishwamvarpur	Boshontopur	Rajendropur/ 46	3,311.89	16,559.45	2.0451
					Bosontopur/44			2.0451

No	Haor	District	Upazila	Village	Mouza	Length (m)	Area (m^2)	Area (acre)
5	Korchar Haor	Sunamganj	Sunamganj	Jagannathupur	Monomoter Kora/43	3,038.00	15,190.00	3.7519
6	Halir Haor	Sunamganj	Jamalganj	Achanpur	Omedpur/31	1,301.54	6,507.70	1.6074
7	Khai Haor	Sunamganj	Shantiganj	Umednagar	Umednagar	2,107.00	10,535.00	2.6021
8	Updakhali Haor	Sunamganj	Dharampasha	Karuajan	Karuajan	7,257.67	36,288.35	8.9632
9	Mrigar Haor	Kishoreganj	Itna	Sohila	Joynshahi Sahila/69	2,816.25	14,081.25	3.4781
10	Humaipur Haor	Kishoreganj	Bajitpur	Nama Gushaipur	Poschim baid/81	2,488.47	12,442.35	3.0733
11	Humaipur Haor	Kishoreganj	Nikli	Chatirchar	Chatir char/43	2,968.33	14,841.65	3.6659
12	Updakhali Haor	Netrokona	Kalmakanda	Kesohobpur	Chowhatra/88	3,436.41	17,182.05	4.2440
13	Makalkandi Haor	Habiganj	Baniachang	Makalkandi	Makalkandi	2,066.00	10,330.00	2.5515
14	Makalkandi Haor	Habiganj	Nabiganj	Sordarpur	Sordarpur	3,512.00	17,560.00	4.3373
15	Pathor Chawli Haor	Sylhet	Companiganj	Putamara	Putamara	1,481.49	7,407.45	1.8296
16	Baram Haor	Sunamganj	Shulla	Kholapara	Kholapara	764.00	3,820.00	0.9435
17	Khaliajuri FCD-3 Haor	Netrokona	Khaliajuri	Adompur	Adompur/34	1,804.00	9,020.00	2.2279
	Total					42,666.66	213,333.30	52.6933

Source: RAP (2025)

As mentioned above, the number of land plots to be acquired was identified using mouza maps, and the number of PAPs was estimated using BBS census data. Consequently, 1,661 land plots in 17 villages will be subject to land acquisition, affecting 1,661 households and 8,063 PAPs (3,987 male and 4,075 female).

Since houses and other structures are typically built on slightly higher land, which is not flooded, VPWs will be constructed to avoid these structures, ensuring that no households will be physically relocated.

Table 8.2.4 Estimated Number of PAHs and PAPs by Land Acquisition under LGED Portion

Haor Name	Village	Affected Plots	No. of Estimated HH	No. of Estimated PAPs			Male/Female Ratio	Average HH Size
				Total	Male	Female		
Humaipur Haor	Nama Gushaipur	78	78	337	163	174	93.4	4.32
Humaipur Haor	Chatirchar	173	173	747	361	385	93.4	4.32
Mrigar Haor	Sohila	182	182	815	411	404	101.52	4.48
Shanir Haor	Sreepur	114	114	588	292	296	98.93	5.16
Shanir Haor	Boshontopur	165	165	851	423	428	98.93	5.16
Noluar Haor (Polder-1)	Das Naogaon	16	16	81	40	41	94.54	5.07
Chaptir Haor	Kachua	50	50	255	126	129	97.52	5.1
Halir Haor	Achanpur	39	39	201	100	101	98.93	5.16
Korchar Haor	Jagannathupur	55	55	277	138	139	98.93	5.03
Baram Haor	Kholapara	18	18	95	48	47	101.17	5.3
Khai Haor	Umednagar	61	61	320	155	165	93.15	5.24
Updakhali Haor	Karuajan	161	161	710	357	353	100.98	4.41
Updakhali Haor	Kesohobpur	107	107	472	238	234	100.98	4.41
Khaliajuri FCD-3 Haor	Adompur	45	45	202	102	100	101.52	4.48
Pathor Chawli Haor	Putamara	220	220	1,214	601	614	98.06	5.52
Makalkandi Haor	Makalkandi	96	96	487	234	252	93.03	5.07

Haor Name	Village	Affected Plots	No. of Estimated HH	No. of Estimated PAPs			Male/Female Ratio	Average HH Size
				Total	Male	Female		
Makalkandi Haor	Sordarpur	81	81	411	198	213	93.03	5.07
Total		1,661	1,661	8,063	3,987	4,075		

Note:

1. The number of estimated PAHs was calculated based on the assumption that tentatively 1 land plot is owned by 1 household.

2. The number of estimated PAPs was calculated by multiplying the number of the estimated PAHs with the average number of family members per household based on the BSS data.

3. Total quantity of the planned land acquisition area does not match with the total quantity of each VPW area due to decimals.

Source: RAP (2025)

8.2.5 Socio-economic Data (Common for BWDB & LGED)

The socio-economic data for the selected haors was compiled using existing BBS census data as follows:

(1) Household, Population, Sex Ratio, and Household Size

In most Upazilas, families consist of 5.0-5.2 persons. Some areas, such as Kalmakanda (4.29 people), Nikli (4.32 persons), and Bajitpur (4.33 persons), have slightly smaller family sizes, suggesting that many families are nuclear or have young members who have become independent. Comparing the gender ratio, there is a tendency for men to have fewer family members than women, particularly in Upazilas, where the ratio is significantly below 100 (e.g., Austagram 90.97, Baniachong 93.03), indicating that men are migrant workers. On the other hand, areas where the gender ratio is over 100 (e.g., Tahirpur 101.88, Itna 101.52) suggest that men are not migrant workers or that there is an influx of male seasonal workers.

Table 8.2.5 Household and Population Data

Haor	Upazila	Households				Population				Male/ Female Ration	Ave. Family Size
		Total	General[1]	Institutional[2]	Others[3]	Total	Male	Female	Hijra		
Ballar Haor	Baniachong	70,279	69,880	41	358	356,425	171,767	184,631	27	93.03	5.07
	Nabiganj	72,650	72,242	45	363	367,385	177,238	190,127	20	93.22	5.06
Baram Haor	Derai	49,740	49,519	4	217	253,705	125,255	128,437	13	97.52	5.10
	Shulla	23,010	22,831	5	174	117,630	59,156	58,470	4	101.17	5.11
Chaptir haor	Derai	49,740	49,519	4	217	253,705	125,255	128,437	13	97.52	5.10
Halir Haor	Bishwambharpur	37,815	37,718	12	85	190,350	94,654	95,678	18	98.93	5.03
	Jamalganj	36,015	35,836	7	172	185,866	92,318	93,533	15	98.7	5.16
	Tahirpur	43,543	43,383	16	144	224,853	113,470	111,371	12	101.88	5.16
Humaipur Haor	Austagram	33,898	33,720	5	173	151,238	72,043	79,195	0	90.97	4.46
	Bajitpur	62,234	61,851	64	319	269,756	130,265	139,472	19	93.4	4.33
	Nikli	33,773	33,647	25	101	145,887	71,721	74,162	4	96.71	4.32
Karchar Haor	Bishwambharpur	37,815	37,718	12	85	190,350	94,654	95,678	18	98.93	5.03

[1] A General Household consists of a person or group who lives together in a standard housing unit and shares resources for their daily living expenses.

[2] An Institutional Household is a group of non-family members whose basic shelter and subsistence are provided by a single formal authority or institution (e.g., a prison or hospital).

[3] Other Households are a residual category covering populations that are highly mobile or lack a fixed, conventional living arrangement, often termed the Floating Population.

Haor	Upazila	Households				Population				Male/ Female Ration	Ave. Family Size
		Total	General[1]	Institutional[2]	Others[3]	Total	Male	Female	Hijra		
	Sunamganj Sadar	63,303	62,752	43	508	318,099	156,923	161,141	35	97.38	5.03
Khai Haor	Shantiganj	39,142	38,952	9	181	204,998	98,859	106,124	15	93.15	5.24
Khaliajhuri Haor P1	Khaliajuri	21,736	21,562	6	168	96,345	48,112	48,227	6	99.76	4.43
	Itna	37,650	37,384	17	249	168,840	85,052	83,777	11	101.52	4.48
Khaliajhuri Haor P3	Khaliajuri	21,736	21,562	6	168	96,345	48,112	48,227	6	99.76	4.43
	Itna	37,650	37,384	17	249	168,840	85,052	83,777	11	101.52	4.48
Makarkandi Haor	Baniachong	70,279	69,880	41	358	356,425	171,767	184,631	27	93.03	5.07
Mrigar Haor	Itna	37,650	37,384	17	249	168,840	85,052	83,777	11	101.52	4.48
Naluar Haor	Jagannathpur	49,192	48,976	31	185	264,198	128,413	135,759	26	94.59	5.37
Pathar Chawli Haor	Companiganj	34,848	34,646	9	193	192,350	95,231	97,113	6	98.06	5.52
Shanir Haor	Bishwambharpur	37,815	37,718	12	85	190,350	94,654	95,678	18	98.93	5.03
	Jamalganj	36,015	35,836	7	172	185,866	92,318	93,533	15	98.70	5.16
	Tahirpur	43,543	43,383	16	144	224,853	113,470	111,371	12	101.88	5.16
Updakhali Haor	Madhyanagar	21,174	21,021	9	144	96,237	48,352	47,885	0	100.98	4.55
	Kalmakanda	63,302	62,945	48	309	271,348	133,814	137,514	20	97.31	4.29

Source：Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(2) Population by Religion

The project area is predominantly Muslim (85%). However, in some areas, such as Baram Haor, include Upazilas with a relatively large proportion of Hindu households (e.g., Shalla 44.19%, Khaliajuri 33.69%). Christian communities are also present, with the highest proportion found in Kalmakanda (2.87%).

Table 8.2.6 Population by Religion

Haor	Upazila	Muslim	Hindu	Christian	Buddhist	Others	Total
Ballar Haor	Baniachong	84.58	15.41	0.01	0.00	0.00	100
	Nabiganj	85.01	14.97	0.00	0.01	0.01	100
Baram Haor	Derai	74.54	25.44	0.00	0.01	0.01	100
	Shalla	55.78	44.19	0.01	0.00	0.02	100
Chaptir Haor	Derai	74.54	25.44	0.00	0.01	0.01	100
Halir Haor	Bishwambharpur	90.01	9.97	0.02	0.00	0.00	100
	Jamalganj	85.55	14.44	0.00	0.01	0.00	100
	Tahirpur	93.48	6.22	0.30	0.00	0.00	100
Humaipur Haor	Austagram	86.73	13.26	0.00	0.003	0.007	100
	Bajitpur	92.01	7.98	0.00	0.005	0.001	100
	Nikli	95.87	4.13	0.00	0.002	0.001	100
Karchar Haor	Bishwambharpur	90.01	9.97	0.02	0.00	0.00	100
	Sunamganj Sadar	90.67	9.13	0.17	0.03	0.00	100
Khai Haor	Shantiganj	91.24	8.75	0.01	0.00	0.00	100
Khaliajhuri Haor P1	Khaliajuri	66.30	33.69	0.01	0.00	0.00	100
	Itna	87.17	12.83	0.00	0.002	0.001	100
Khaliajhuri Haor P3	Khaliajuri	66.30	33.69	0.01	0.00	0.00	100
	Itna	87.17	12.83	0.00	0.002	0.001	100

Haor	Upazila	Muslim	Hindu	Christian	Buddhist	Others	Total
Makarkandi Haor	Baniachong	84.58	15.41	0.01	0.00	0.00	100
Mrigar Haor	Itna	87.17	12.83	0.00	0.002	0.001	100
Naluar Haor	Jagannathpur	90.39	9.59	0.00	0.01	0.01	100
Pathar Chawli Haor	Companiganj	93.72	6.25	0.02	0.01	0.00	100
Shanir Haor	Bishwambharpur	90.01	9.97	0.02	0.00	0.00	100
	Jamalganj	85.55	14.44	0.00	0.01	0.00	100
	Tahirpur	93.48	6.22	0.30	0.00	0.00	100
Updakhali Haor	Madhyanagar	76.81	22.07	1.02	0.01	0.09	100
	Kalmakanda	87.07	9.82	2.87	0.00	0.23	100

Source：Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(3) Marital Status of Population

The majority of the population is married (60%), while the rates of divorce and separation are low, generally below 0.5%. Jagannathpur is an exception, with a slightly high rate of unmarried individuals (42.88%) and a low proportion of married individuals (49.48%). The data suggests that young people in Jagannathpur may be delaying marriage due to longer education and exposure to modern social norms.

Table 8.2.7 Marital Status of Population Aged 10 Years and Above by Sex and Upazila (%)

Haor	Upazila	Never Married	Currently Married	Widow/ Widower	Divorced	Separated
Ballar Haor	Baniachong	36.74	56.55	5.86	0.40	0.46
	Nabiganj	38.23	54.42	6.28	0.55	0.51
Baram Haor	Derai	37.29	56.05	6.06	0.26	0.34
	Shalla	33.77	60.25	5.58	0.14	0.27
Chaptir Haor	Derai	37.29	56.05	6.06	0.26	0.34
Halir Haor	Bishwambharpur	34.75	59.39	5.21	0.29	0.36
	Jamalganj	35.59	58.61	5.30	0.25	0.26
	Tahirpur	35.72	58.74	4.90	0.23	0.40
Humaipur Haor	Austagram	31.11	62.51	5.81	0.23	0.33
	Bajitpur	32.33	61.06	6.00	0.29	0.31
	Nikli	30.95	62.01	6.30	0.40	0.34
Karchar Haor	Bishwambharpur	34.75	59.39	5.21	0.29	0.36
	Sunamganj Sadar	37.07	56.70	5.56	0.32	0.36
Khai Haor	Shantiganj	39.74	53.71	5.86	0.38	0.31
Khaliajhuri Haor P1	Khaliajuri	31.05	61.64	6.77	0.19	0.34
	Itna	30.93	63.12	5.47	0.18	0.30
Khaliajhuri Haor P3	Khaliajuri	31.05	61.64	6.77	0.19	0.34
	Itna	30.93	63.12	5.47	0.18	0.30
Makarkandi Haor	Baniachong	36.74	56.55	5.86	0.40	0.46
Mrigar Haor	Itna	30.93	63.12	5.47	0.18	0.30
Naluar Haor	Jagannathpur	42.88	49.48	6.50	0.57	0.56
Pathar Chawli Haor	Companiganj	38.66	56.29	4.37	0.31	0.37
Shanir Haor	Bishwambharpur	34.75	59.39	5.21	0.29	0.36
	Jamalganj	35.59	58.61	5.30	0.25	0.26
	Tahirpur	35.72	58.74	4.90	0.23	0.40
Updakhali Haor	Madhyanagar	31.30	62.15	6.07	0.20	0.28
	Kalmakanda	29.61	63.69	6.19	0.21	0.30

Source：Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(4) Literacy Rate by Sex

Overall literacy among the population aged 7 and above is relatively high, generally above 60%. Nabiganj (70.55%) and Bajitpur (68.46%) stand out as the most educationally advanced areas, having successfully expanded access to schooling. On the other hand, Khaliajhuri Haor P1, Khaliajhuri Haor P3, Itna (56.45%) in Mrigar Haor, and Khaliajuri (59.32%) had relatively low literacy rates. In terms of gender, it was confirmed that the school enrolment rate of women remains low among the population aged 15 and above.

Table 8.2.8 Literacy Rate by Sex (%)

Haor	Upazila	5 Years & Above			7 Years & Above			15 Years & Above		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
Ballar Haor	Baniachong	64.57	64.13	64.98	65.78	65.51	66.02	59.46	59.50	59.43
	Nabiganj	69.51	70.04	69.02	70.55	71.28	69.89	65.64	66.54	64.86
Baram Haor	Derai	66.44	67.49	65.42	67.69	68.93	66.50	62.30	64.13	60.60
	Shalla	62.39	63.90	60.88	63.82	65.48	62.15	58.73	61.33	56.17
Chaptir Haor	Derai	66.44	67.49	65.42	67.69	68.93	66.50	62.30	64.13	60.60
Halir Haor	Bishwambharpur	62.75	62.95	62.56	64.17	64.50	63.84	57.36	58.29	56.47
	Jamalganj	57.35	58.35	56.37	58.56	59.72	57.43	51.90	53.85	50.04
	Tahirpur	59.08	60.21	57.94	60.71	61.96	59.44	53.01	55.33	50.70
Humaipur Haor	Austagram	59.52	60.15	58.97	60.86	61.71	60.09	53.51	55.10	52.16
	Bajitpur	67.23	67.69	66.81	68.46	69.13	67.83	63.42	64.63	62.36
	Nikli	58.39	59.15	57.66	59.28	60.19	58.42	52.03	53.50	50.68
Karchar Haor	Bishwambharpur	62.75	62.95	62.56	64.17	64.50	63.84	57.36	58.29	56.47
	Sunamganj Sadar	66.80	68.29	65.36	67.99	69.65	66.39	62.74	65.05	60.57
Khai Haor	Shantiganj	63.87	64.39	63.39	65.17	65.89	64.52	58.82	59.71	58.03
Khaliajhuri Haor P1	Khaliajuri	58.23	59.25	57.22	59.32	60.44	58.22	52.63	54.36	50.98
	Itna	55.36	56.13	54.59	56.45	57.35	55.53	49.14	50.65	47.66
Khaliajhuri Haor P3	Khaliajuri	58.23	59.25	57.22	59.32	60.44	58.22	52.63	54.36	50.98
	Itna	55.36	56.13	54.59	56.45	57.35	55.53	49.14	50.65	47.66
Makarkandi Haor	Baniachong	64.57	64.13	64.98	65.78	65.51	66.02	59.46	59.50	59.43
Mrigar Haor	Itna	55.36	56.13	54.59	56.45	57.35	55.53	49.14	50.65	47.66
Naluar Haor	Jagannathpur	67.39	68.56	66.28	68.66	69.99	67.41	64.42	66.14	62.84
Pathar Chawli Haor	Companiganj	59.64	60.28	59.01	61.33	62.17	60.52	54.14	55.77	52.62
Shanir Haor	Bishwambharpur	62.75	62.95	62.56	64.17	64.50	63.84	57.36	58.29	56.47
	Jamalganj	57.35	58.35	56.37	58.56	59.72	57.43	51.90	53.85	50.04
	Tahirpur	59.08	60.21	57.94	60.71	61.96	59.44	53.01	55.33	50.70
Updakhali Haor	Madhyanagar	56.62	57.87	55.36	57.70	59.10	56.30	49.48	51.51	47.50
	Kalmakanda	62.87	63.65	62.12	63.80	64.69	62.94	57.10	58.41	55.88

Source：Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(5) Employed Population by Sector and Sex

Most of the population in the project area is engaged in agriculture, with high participation rate of women in the sector. Despite this, 36.4% of the rural population in the project area lives below the poverty line[4].

Table 8.2.9 Employed Population by Sector and Sex (%)

Haor	Upazila	Grand Total			Agriculture		Industry		Service	
		Total	Male	Female	Male	Female	Male	Female	Male	Female
Ballar Haor	Baniachong	100	85.13	14.87	80.90	19.10	91.79	8.21	91.77	8.23
	Nabiganj	100	84.81	15.19	79.41	20.59	93.06	6.94	91.71	8.29
Baram Haor	Derai	100	85.82	14.18	84.73	15.27	91.60	8.40	88.14	11.86
	Shalla	100	86.03	13.97	86.58	13.42	89.11	10.89	78.97	21.03
Chaptir Haor	Derai	100	85.82	14.18	84.73	15.27	91.60	8.40	88.14	11.86
Halir Haor	Bishwambharpur	100	87.47	12.53	85.14	14.86	95.03	4.97	91.14	8.86
	Jamalganj	100	86.81	13.19	84.57	15.43	93.03	6.97	91.93	8.07
	Tahirpur	100	85.82	14.18	82.67	17.33	93.87	6.13	91.29	8.71
Humaipur Haor	Austagram	100	84.07	15.93	81.75	18.25	93.52	6.48	88.47	11.53
	Bajitpur	100	85.50	14.50	79.75	20.25	95.02	4.98	89.19	10.81
	Nikli	100	87.09	12.91	85.32	14.68	92.93	7.07	89.91	10.09

[4] https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/57def76a_aa3c_46e3_9f80_53732eb94a83/2023-04-13-09-35-ee41d2a35dcc47a94a595c88328458f4.pdf

Haor	Upazila	Grand Total			Agriculture		Industry		Service	
		Total	Male	Female	Male	Female	Male	Female	Male	Female
Karchar Haor	Bishwambharpur	100	87.47	12.53	85.14	14.86	95.03	4.97	91.14	8.86
	Sunamganj Sadar	100	85.94	14.06	82.05	17.95	95.72	4.28	88.4	11.60
Khai Haor	Shantiganj	100	84.10	15.90	79.78	20.22	95.26	4.74	91.78	8.22
Khaliajhuri Haor P1	Khaliajuri	100	86.88	13.12	87.62	12.38	82.59	17.41	84.99	15.01
	Itna	100	86.68	13.32	85.50	14.50	91.00	9.00	91.04	8.96
Khaliajhuri Haor P3	Khaliajuri	100	86.88	13.12	87.62	12.38	82.59	17.41	84.99	15.01
	Itna	100	86.68	13.32	85.50	14.50	91.00	9.00	91.04	8.96
Makarkandi Haor	Baniachong	100	85.13	14.87	80.90	19.10	91.79	8.21	91.77	8.23
Mrigar Haor	Itna	100	86.68	13.32	85.50	14.50	91.00	9.00	91.04	8.96
Naluar Haor	Jagannathpur	100	84.77	15.23	78.60	21.40	95.58	4.42	91.67	8.33
Pathar Chawli Haor	Companiganj	100	84.62	15.38	75.04	24.96	95.28	4.72	93.74	6.26
Shanir Haor	Bishwambharpur	100	87.47	12.53	85.14	14.86	95.03	4.97	91.14	8.86
	Jamalganj	100	86.81	13.19	84.57	15.43	93.03	6.97	91.93	8.07
	Tahirpur	100	85.82	14.18	82.67	17.33	93.87	6.13	91.29	8.71
Updakhali Haor	Madhyanagar	100	86.59	13.41	86.53	13.47	87.68	12.32	86.47	13.53
	Kalmakanda	100	86.92	13.08	84.93	15.07	93.13	6.87	90.41	9.59

Source: Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(6) Households by Main Source of Drinking Water

The region has largely succeeded in providing safe drinking water, with the vast majority of households (over 97% in many areas) relying on tube-wells, a major public health achievement. However, Kalmakanda is the most alarming outlier, with only 33.83% of households using tube-well, indicating that many households may rely on alternative, often unsafe, water sources. In Companiganj, a relatively high percentage of households (7.88%) use unsafe water from ponds, rivers, canals, or lakes for drinking purposes.

Table 8.2.10 Household by Main Source of Drinking Water (%)

Haor	Upazila	Total	Tap/ Pipe (Supply)	Tube-well (Deep/ Shallow)	Bottled/ Jar Water	Well	Pond/ River/ Canal /Lake	Spring	Rain Water	Others
Ballar Haor	Baniachong	100	0.00	98.02	0.01	0.00	1.90	0.00	0.00	0.06
	Nabiganj	100	0.00	99.10	0.05	0.02	0.83	0.00	0.00	0.00
Baram Haor	Derai	100	0.06	99.09	0.01	0.01	0.82	0.00	0.00	0.00
	Shalla	100	0.00	99.73	0.06	0.00	0.21	0.00	0.00	0.00
Chaptir Haor	Derai	100	0.06	99.09	0.01	0.01	0.82	0.00	0.00	0.00
Halir Haor	Bishwambharpur	100	0.00	97.06	0.3	1.42	1.14	0.00	0.00	0.08
	Jamalganj	100	0.00	99.78	0.03	0.00	0.19	0.00	0.00	0.00
	Tahirpur	100	0.00	99.08	0.03	0.41	0.46	0.00	0.00	0.03
Humaipur Haor	Austagram	100	0.00	99.80	0.09	0.00	0.04	0.00	0.00	0.06
	Bajitpur	100	1.6	98.34	0.03	0.00	0.01	0.00	0.00	0.03
	Nikli	100	0.00	99.98	0.00	0.00	0.01	0.00	0.00	0.01
Karchar Haor	Bishwambharpur	100	0.00	97.06	0.30	1.42	1.14	0.00	0.00	0.08
	Sunamganj Sadar	100	3.70	93.38	0.48	1.4	1.03	0.00	0.00	0.01
Khai Haor	Shantiganj	100	0.00	99.41	0.01	0.04	0.47	0.00	0.00	0.07
Khaliajhuri Haor P1	Khaliajuri	100	0.00	99.65	0.24	0.00	0.06	0.00	0.00	0.05
	Itna	100	0.00	99.79	0.05	0.00	0.09	0.00	0.00	0.07
	Khaliajuri	100	0.00	99.65	0.24	0.00	0.06	0.00	0.00	0.05

Haor	Upazila	Total	Tap/ Pipe (Supply)	Tube-well (Deep/ Shallow)	Bottled/ Jar Water	Well	Pond/ River/ Canal /Lake	Spring	Rain Water	Others
Khaliajhuri Haor P3	Itna	100	0.00	99.79	0.05	0.00	0.09	0.00	0.00	0.07
Makarkandi Haor	Baniachong	100	0.00	98.02	0.01	0.00	1.90	0.00	0.00	0.06
Mrigar Haor	Itna	100	0.00	99.79	0.05	0.00	0.09	0.00	0.00	0.07
Naluar Haor	Jagannathpur	100	0.13	97.13	0.35	0.01	2.34	0.00	0.00	0.03
Pathar Chawli Haor	Companiganj	100	0.09	90.75	0.53	0.42	7.88	0.16	0.00	0.17
Shanir Haor	Bishwambharpur	100	0.00	97.06	0.30	1.42	1.14	0.00	0.00	0.08
	Jamalganj	100	0.00	99.78	0.03	0.00	0.19	0.00	0.00	0.00
	Tahirpur	100	0.00	99.08	0.03	0.41	0.46	0.00	0.00	0.03
Updakhali Haor	Madhyanagar	100	0.00	98.16	0.01	0.75	1.04	0.00	0.00	0.03
	Kalmakanda	100	0.00	33.83	0.01	0.00	0.40	0.00	0.00	0.02

Source: Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(7) Households by Sanitation Facilities

Only a minority of households use high-standard facilities (safe disposal with flushing/pouring water), with the highest proportion observed in more developed centres like Bajitpur (51.52%). The widespread use of kancha/open/hanging latrines (highest in Madhyanagar at 31.83% and Shalla at 22.1%) is particularly worrying. These structures are common in flood-prone areas but are highly ineffective at preventing the spread of waste and disease, especially during the monsoon season. The persistence of open defecation in areas like Tahirpur (17.23%) is a fundamental public health failure that requires immediate, targeted behavioural change campaigns and infrastructure provision. The use of unhygienic outdoor and hanging toilets in flooded areas is a concern from the perspective of disease control. The relatively high rate of open defecation in Tahirpur (17.23%) is also an issue.

Table 8.2.11 Household by Toilet Facilities (%)

Haor	Upazila	Total	Safe Disposal with Flushing /Pouring Water	Unsafe Disposal with Flushing/Pouring Water	Pit Latrine with Slab / Ventilated Improved Latrine / Composting Latrine	Pit Latrine Without Slab / Open Pit	Kancha / Open / Hanging Latrine (Permanent/ Temporary)	Open Defecation / No Latrine Available
Ballar Haor	Baniachong	100	31.40	24.89	18.86	15.05	8.52	1.28
	Nabiganj	100	38.92	17.72	22.08	12.69	6.87	1.73
Baram Haor	Derai	100	24.52	15.61	31.54	14.92	11.18	2.23
	Shalla	100	5.96	15.88	40.70	13.39	22.10	3.28
Chaptir Haor	Derai	100	24.52	15.61	31.54	14.92	11.18	2.23
Halir Haor	Bishwambharpur	100	27.29	19.57	18.72	14.63	15.67	4.11
	Jamalganj	100	14.29	12.76	32.63	12.04	22.67	5.61
	Tahirpur	100	10.22	26.30	17.70	14.30	2.35	17.23
Humaipur Haor	Austagram	100	20.04	31.53	24.26	12.38	10.58	1.22
	Bajitpur	100	51.52	21.41	17.02	5.62	3.72	0.71
	Nikli	100	40.76	37.06	8.46	4.84	6.96	1.91
Karchar Haor	Bishwambharpur	100	27.29	19.57	18.72	14.63	15.67	4.11
	Sunamganj Sadar	100	13.06	42.60	17.49	13.04	17.58	6.45
Khai Haor	Shantiganj	100	15.17	28.15	20.39	14.36	17.94	4.34
Khaliajhuri Haor P1	Khaliajuri	100	17.27	31.72	28.05	10.62	10.07	2.27
	Itna	100	19.51	32.14	11.91	16.53	17.83	2.08
Khaliajhuri Haor P3	Khaliajuri	100	17.27	31.72	28.05	10.62	10.07	2.27
	Itna	100	19.51	32.14	11.91	16.53	17.83	2.08
Makarkandi Haor	Baniachong	100	31.40	24.89	18.86	15.05	8.52	1.28

Haor	Upazila	Total	Safe Disposal with Flushing /Pouring Water	Unsafe Disposal with Flushing/Pouring Water	Pit Latrine with Slab / Ventilated Improved Latrine / Composting Latrine	Pit Latrine Without Slab / Open Pit	Kancha / Open / Hanging Latrine (Permanent/ Temporary)	Open Defecation / No Latrine Available
Mrigar Haor	Itna	100	19.51	32.14	11.91	16.53	17.83	2.08
Naluar Haor	Jagannathpur	100	45.43	20.44	17.54	7.32	6.61	2.66
Pathar Chawli Haor	Companiganj	100	26.53	23.14	13.23	13.55	17.51	6.05
Shanir Haor	Bishwambharpur	100	27.29	19.57	18.72	14.63	15.67	4.11
	Jamalganj	100	14.29	12.76	32.63	12.04	22.67	5.61
	Tahirpur	100	10.22	26.30	17.70	14.30	2.35	17.23
Updakhali Haor	Madhyanagar	100	10.70	29.52	9.43	15.38	31.83	3.13
	Kalmakanda	100	13.94	20.22	27.61	17.27	16.24	4.71

Source: Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(8) Main Source of Energy

The National Grid is the dominant power source of electricity, reflecting successful electrification efforts across the region. The rate of households with no electricity connection is remarkably low, typically under 2% in most upazilas, indicating high coverage even in remote areas. Solar power provides an important energy alternative (e.g., Shalla at 3.24%), serving as an essential source for the few areas where grid access remains difficult or as a backup during outages.

Table 8.2.12 Main Source of Energy (%)

Haor	Upazila	Total	National Grid	Solar Power	Others	No Electricity Connection
Ballar Haor	Baniachong	99.17	98.37	0.67	0.13	0.83
	Nabiganj	98.87	98.06	0.57	0.24	1.13
Baram Haor	Derai	98.28	96.32	1.57	0.40	1.72
	Shalla	98.95	95.53	3.24	0.18	1.05
Chaptir Haor	Derai	98.28	96.32	1.57	0.40	1.72
Halir Haor	Bishwambharpur	98.92	97.79	0.89	0.24	1.08
	Jamalganj	99.02	98.04	0.66	0.32	0.98
	Tahirpur	99.18	96.23	1.37	1.57	0.82
Humaipur Haor	Austagram	98.92	97.91	0.82	0.19	1.08
	Bajitpur	99.29	99.05	0.06	0.17	0.71
	Nikli	99.06	98.74	0.23	0.09	0.94
Karchar Haor	Bishwambharpur	98.92	97.79	0.89	0.24	1.08
	Sunamganj Sadar	99.21	98.40	0.43	0.37	0.79
Khai Haor	Shantiganj	98.72	97.95	0.60	0.17	1.28
Khaliajhuri Haor P1 (Polder 1)	Khaliajuri	97.8	96.67	0.62	0.51	2.20
	Itna	98.9	97.51	1.04	0.34	1.10
Khaliajhuri Haor P3 (Polder 3)	Khaliajuri	97.8	96.67	0.62	0.51	2.20
	Itna	98.9	97.51	1.04	0.34	1.10
Makarkandi Haor	Baniachong	99.17	98.37	0.67	0.13	0.83
Mrigar Haor	Itna	98.9	97.51	1.04	0.34	1.10
Naluar Haor	Jagannathpur	98.38	96.54	0.83	1.01	1.62
Pathar Chawli Haor	Companiganj	97.95	96.59	0.44	0.92	2.05
Shanir Haor	Bishwambharpur	98.92	97.79	0.89	0.24	1.08
	Jamalganj	99.02	98.04	0.66	0.32	0.98
	Tahirpur	99.18	96.23	1.37	1.57	0.82
Updakhali Haor	Madhyanagar	99.15	95.99	2.35	0.80	0.85
	Kalmakanda	99.23	97.84	0.82	0.57	0.77

Source: Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

(9) Households by Main Source of Cooking Fuel

The region has a profound reliance on traditional fuels, with wood, chalk, and chopped wood being the main energy source for over half of all households. Usage peaks dramatically in Kalmakanda (80.02%) and Tahirpur (78.95%). This high reliance on biomass is a primary cause of indoor air pollution, which severely affects the health of women and children. The adoption of Liquefied Petroleum Gas (LPG) is a clear sign of economic progress, with the highest usage rates in Bajitpur (15.75%) and Sunamganj Sadar (10.06%). Sunamganj Sadar shows the highest use of gas (13.57%), confirming its status as a commercial hub where access to modern utilities and higher household incomes support a more diversified and cleaner energy mix.

Table 8.2.13 Household by Main Source of Cooking Fuel (%)

Haor	Upazila	Total	Straw/Leaf/Bran/Husk	Wood/Chalk/Chopped Wood	Wood-coal/Charcoal/Dried Dung	Kerosene/Paraffin	Petrol/Diesel	Electricity Supply	Gas	LP Gas	Bio gas	Others
Ballar Haor	Baniachong	100	6.23	51.58	30.47	0.02	0.01	0.12	0.00	11.50	0.05	0.03
	Nabiganj	100	2.91	71.20	17.96	0.02	0.00	0.01	2.50	5.34	0.01	0.06
Baram Haor	Derai	100	4.85	49.54	35.10	0.01	0.00	0.00	0.00	10.39	0.02	0.07
	Shalla	100	4.83	23.19	66.14	0.02	0.00	0.03	0.00	5.73	0.00	0.07
Chaptir Haor	Derai	100	4.85	49.54	35.10	0.01	0.00	0.00	0.00	10.39	0.02	0.07
Halir Haor	Bishwambharpur	100	7.26	74.04	13.88	0.01	0.03	0.03	0.00	4.66	0.01	0.08
	Jamalganj	100	7.01	53.57	28.50	0.01	0.02	0.04	0.00	10.67	0.07	0.12
	Tahirpur	100	4.10	78.95	9.76	0.03	0.02	0.02	0.00	7.02	0.07	0.03
Humaipur Haor	Austagram	100	4.18	44.34	41.25	0.04	0.02	0.05	0.00	10.06	0.05	0.02
	Bajitpur	100	7.79	62.21	15.75	0.01	0.01	0.06	0.00	14.06	0.07	0.04
	Nikli	100	2.97	60.47	26.77	0.01	0.02	0.03	0.00	9.61	0.10	0.01
Karchar Haor	Bishwambharpur	100	7.26	74.04	13.88	0.01	0.03	0.03	0.00	4.66	0.01	0.08
	Sunamganj Sadar	100	6.78	59.30	10.00	0.02	0.02	0.08	13.57	10.06	0.11	0.07
Khai Haor	Shantiganj	100	5.56	64.48	22.55	0.01	0.01	0.00	0.00	7.21	0.09	0.07
Khaliajhuri Haor P1	Khaliajuri	100	2.87	30.79	60.75	0.02	0.03	0.10	0.00	5.32	0.01	0.11
	Itna		4.58	51.17	38.07	0.03	0.10	0.07	0.00	5.88	0.02	0.09
Khaliajhuri Haor P3	Khaliajuri	100	2.87	30.79	60.75	0.02	0.03	0.10	0.00	5.32	0.01	0.11
	Itna		4.58	51.17	38.07	0.03	0.10	0.07	0.00	5.88	0.02	0.09
Makarkandi Haor	Baniachong	100	6.23	51.58	30.47	0.02	0.01	0.12	0.00	11.50	0.05	0.03
Mrigar Haor	Itna	100	4.58	51.17	38.07	0.03	0.10	0.07	0.00	5.88	0.02	0.09
Naluar Haor	Jagannathpur	100	2.72	73.00	15.55	0.02	0.01	0.01	0.00	8.59	0.04	0.05
Pathar Chawli Haor	Companiganj	100	4.34	63.18	23.37	0.03	0.10	0.05	0.00	8.75	0.10	0.08
Shanir Haor	Bishwambharpur	100	7.26	74.04	13.88	0.01	0.03	0.03	0.00	4.66	0.01	0.08

Haor	Upazila	Total	Straw/Leaf/Bran/Husk	Wood/Chalk/Chopped Wood	Wood-coal/Charcoal/Dried Dung	Kerosene/Paraffin	Petrol/Diesel	Electricity Supply	Gas	LP Gas	Bio gas	Others
	Jamalganj	100	7.01	53.57	28.50	0.01	0.02	0.04	0.00	10.67	0.07	0.12
	Tahirpur	100	4.10	78.95	9.76	0.03	0.02	0.02	0.00	7.02	0.07	0.03
Updakhali Haor	Madhyanagar	100	8.06	71.49	14.53	0.03	0.03	0.08	0.00	5.67	0.08	0.03
	Kalmakanda	100	5.51	80.02	9.20	0.03	0.04	0.31	0.00	4.79	0.02	0.09

Source: Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS)

8.2.6 Eligibility

(1) Eligibility

Entitlements are established in accordance with ARIPA (2017) and the JICA Guidelines for Environmental and Social Considerations (2020). The legal cut-off date for land and structure owners is the date on which the Section 4 Notice is issued during the land acquisition process under ARIPA, 2017. Because the project site is located in a rural area prone to flooding during the monsoon season, it is not expected that land is occupied by illegal occupants or users. However, the BWDB and LGED have set the cut-off date for non-title PAHs (social cut-off date) is 2 November 2025 (see the attached cut-off date letter in the RAP).

(2) Entitlement Matrix

The proposed entitlement matrix was prepared based on types of losses, categories of entitled persons and the corresponding compensation and assistance. The matrix also follows the common practices in RAP implementation for projects funded by JICA, the World Bank, and similar institutions.

In addition, because other types of losses may be identified if the design changes, the entitlement matrix includes losses that are not currently expected.

Table 8.2.14 Proposed Entitlement Matrix

Sl#	Type of Loss	Entitled Persons (Beneficiaries)	Entitlements (Compensation Package)	Implementation Issues/Guidelines
1	Farmland: Loss of agricultural land, pond, ditches and orchards, etc.	Legal owner(s) of the land	• Cash Compensation under Law (CCL) plus a 200% premium • Additional grant to cover the replacement value of land, to be determined by the Property Valuation Advisory Team (PVAT). • Stamp duty and registration cost at 12% of the replacement value of the land	a. Assessment of CCL b. Payment of CCL plus 200% premium c. PAPs shall be fully informed of the entitlements and procedures regarding payments d. Assessment of the quantity and quality of land through a Joint Verification Survey (JVS) e. Assessment of market value by Land Market Survey (LMS) f. Updating of land titles of the affected persons g. Payment of an additional cash grant to cover the current market price of land. h. Stamp duty and registration fees will be added, amounting to 12% of the replacement value to facilitate purchase alternative plots, provided that land is purchased within one year from the receipt of compensation money.
2	Farm Products (if affected before harvesting): Crop or fish damage for owners, cultivators, tenants, sharecroppers, mortgagees of the land	Tenants, sharecroppers, legal owners, growers, socially recognized owners, lessees, or unauthorized occupants of the land	• Crop compensation shall be calculated as follows: • Per-acre average crop yield of 1.51 metric tons x crop intensity of 1.1 x BDT 30,000 per metric ton[5] = BDT 49,830. • Compensation for fish stock shall be determined by the Fisheries Department.	a. All individuals identified by the Joint Verification Team (JVT) as tenants of sharecroppers, owner, or users of landowner. b. Price of crops will be determined by the PVAT and yield by the DAE. c. Price of fish stock shall be determined by the fisheries department.
3	Non-farmland: Loss of homestead, residential, commercial, or Common Properties Resource (CPR) plots by owners or authorities	Legal owner(s) of the land	• CCL plus 200% premium • Replacement value of land (CCL plus 200% premium as per law and additional grant to cover the market value of land as MARV) at the market price to be determined by PVAT. • Stamp duty and registration cost at12% of the replacement value of the land	a. Assessment of CCL b. Payment of CCL plus 200% premium c. PAPs will be fully informed of the entitlements and procedures regarding payments d. Assessment of quantity and quality of land by JVS e. Assessment of market value through an LMS f. Updating of land titles of the affected persons. g. Additional cash grant to be paid to the owner or authorized member of the management committee for CPR to cover the current market price of land. h. Stamp duty and registration fees will be added, amounting to 12% of the replacement value to facilitate purchase alternative plots, provided that land is purchased within one year from the receipt of compensation money.

[5] As per official website of GOB, the GOB is procuring paddy @ BDT 30/kg equals to BDT 30,000/Metric Ton.

Sl#	Type of Loss	Entitled Persons (Beneficiaries)	Entitlements (Compensation Package)	Implementation Issues/Guidelines
4	Non-farm Product: Loss of trees or fish stocks	Persons with legal ownership of the land Socially recognized owners or unauthorized occupant of the trees or fishes	• CCL for trees and fish stocks for legal owner of the land • Additional cash grant to cover replacement value assessed by PVAT for legal owner of the land. • Cash compensation for trees at replacement value, determined by PVAT for socially recognized owners or unauthorized occupants of the trees or fishes. • Compensation for fruits, to be determined by the DAE, for legal owners, socially recognized owners, or unauthorized occupants of the trees. • Compensation for fish stock at 600 = per decimal. • Distribution of five saplings to each affected household. • Owners shall be allowed to cut and remove their trees.	a. Payment of CCL for trees. b. Assessment of loss and market value of affected trees. c. Payment of additional cash grants and compensation for fruits. d. Payment of compensation for fish stock. e. Distribution of saplings to affected HHs.
5	Structure on Title Land: Loss of non-residential, non-commercial, or secondary structure by the owner(s)	Owner(s) of structures with legal title	• CCL • Replacement value of structures at market price determined by PVAT. • *Transfer grant at 7.50% of the replacement value of structures, as assessed by PVAT. • *Reconstruction grant at 7.50% of the replacement value of structures, as assessed by PVAT. • Owners shall be allowed to remove all salvage materials free of cost	a. Payment of CCL for structure loss b. Verification of structures and their owners by the JVT and the PVAT c. PAPs shall be fully informed about their entitlements and assisted in obtaining them. d. Payment of transfer grant, reconstruction grants, and additional assistance for female headed household and other vulnerable households
6	Structure on Non-title Land: Loss of structure by squatters and unauthorized occupants	Owner(s) of structures without legal title	• Replacement value of structures at market price determined by PVAT. • *Transfer grant at 7.50% of the replacement value of structures, assessed by PVAT. • *Reconstruction grant at 7.50% of the replacement value of structures. • Owners shall be allowed to remove all salvage materials free of cost.	a. Verification of structure and their owners by the JVT and the PVAT. b. PAPs shall be fully informed about their entitlements and assisted in obtaining them. c. Payment for the replacement of structures d. Payment of transfer grants, reconstruction grants, and additional assistance for female-headed and other vulnerable households.
7	Wage Loss: Loss of income and workdays due to land acquisition	Household heads or employees identified by the JVT	• Cash grant to affected employees or wage earners equivalent to 90 days' wage: BDT 400 for unskilled labourers and BDT 500 for skilled labourers. • Preferential employment in project construction work, if available. • Additional cash grant of BDT 10,000 for female headed households and other vulnerable households.	a. All entitled persons recorded by the JVS b. Cash grants to be paid to household heads or employees c. Involvement of incumbents in project civil works d. Involvement in jobs related to fishing, livestock, and poultry, horticulture, welding, mechanics, plant cultivation, and social forestry on roadside land
8	Vulnerable Households:	Poor and vulnerable households, including informal occupants,	• Additional cash grant of BDT 20,000 for affected women headed households and other vulnerable households	a. Identification of vulnerable households as per the criteria in Chapter 6.3 Categories of Affected Persons.

Sl#	Type of Loss	Entitled Persons (Beneficiaries)	Entitlements (Compensation Package)	Implementation Issues/Guidelines
	Poor and vulnerable households	squatters, women headed, disabled headed, and elderly headed households below poverty line identified by the JVT	• Training and cash grant for PAPs or their nominees for Income Generation Activities (IGA), as determined by PVAT.	b. Income restoration schemes as outlined separately for vulnerable households. c. Arrangement of training for income-generating activities
9	Community Properties: Displacement of Community Properties Resources (CPR)	Duly constituted management committee (MC) of CPR, identified by the JVT or the MC, authenticated by the UP Chairman	• CCL • Replacement value of structures, as determined by PVAT. • *Transfer grant at 7.5% of the replacement value of structures, as assessed by PVAT. • *Reconstruction grant at 7.5% of the replacement value of structures, as assessed by PVAT. • Cash grant of Tk. 100,000 per CPR for facilitating establishment of a better one. • Owners shall be allowed to remove all salvage materials free of cost.	a. Payment of CCL b. Payment of additional cash grants for reconstruction or improvement to match the replacement value of CPR and for transfer/ shifting
10	Temporary Impact: Temporary impacts during construction	Community/ individual	• The contractor shall bear the cost of any impact on structure or land due to the movement of machinery or in connection with collection and transportation of borrow materials. • All temporary use of land outside the proposed ROW shall be undertaken by the contractor only with a written agreement between the landowner and the contractor. • Land shall be returned to the owner after being rehabilitated to the original condition, preferably in a better condition, by the contractor.	a. Community people shall be consulted before the start of construction regarding air pollution, noise pollution, and other environmental impacts. b. Laborers in the camp shall be trained about safety measures during construction and made aware of health safety. The contractor shall ensure the availability of a first aid box and other safety measures at the construction site. c. Child labour will not be employed. d. Compensation for adverse impact during construction shall be determined by the authorized representative of the LGED and the UP Chairman.
11	Unforeseen Loss: Unforeseen impacts	Households or persons affected by any unforeseen impacts identified during the RAP implementation	• Entitlements shall be determined as per the past practices of the Haor Flood Management & Livelihood Improvement Project, the ARIPA 2017, JICA Guidelines for Environmental and Social Considerations (2020), and the World Bank ESSS 5.	The unforeseen impacts will be identified through the special survey by the JVT as per request from impacted population. The entitlements will be approved by the Ministry.

Note: * PVAT will review the prevailing conditionalities during implementation of RAP and finally decide the percentage of replacement value of affected structure as transfer grant/reconstruction grant accordingly.

Source: RAP (2025)

8.2.7 Implementation Arrangement

(1) Executing Agency (BWDB and LGED)

A PIU is planned to be established in each of the target districts—Netrokona, Kishoreganj, Habiganj, Brahmanbaria, Sunamganj—to oversee field-level implementation of the Project. The PIU will coordinate and manage land acquisition and rehabilitation of PAPs, disburse resettlement benefits through the RAC, and ensure PAPs' access to development programs. With assistance from the IA, the PIU will carry out the following specific tasks:

a) Laison with district administration to support RAP implementation activities, including appointments of the JVT, GRC, RAC, and PVAT members and conveners;

b) Discharge overall responsibility for planning, management, monitoring, and implementation of the land acquisition and rehabilitation program;

c) Ensure availability of budget for all land acquisition and RAP implementation activities;

d) Synchronize land acquisition activities and hand over encumbrance-free land to the contractor within the construction schedule;

e) Develop RAP implementation tools and form necessary committees with assistance from IA; and

f) Monitor the effectiveness of entitlement packages and payment modalities.

(2) Other Agencies Involved in the Process

(a) Deputy Commissioners

The DC has the power to acquire land and assess compensation for property thus acquired. Under the , 2017, the DC conducts the acquisition process through the Land Acquisition Officer (LAO) of the concerned districts. The LAO (or his officers) along with the PIU, LGED, and IA staff, will conduct joint physical verification of properties in accordance with the Land Acquisition Proposal (LAP) submitted by the PMO once detailed design and alignments for project interventions are available.

The DC's office is responsible for the entire acquisition process, from notification to affected households to award of compensation to owners of property and payments of compensation. Upon fulfilment of the criteria of the LA office (i.e., submission of necessary documents for payment), the LA officials will prepare cheque and disburse payments to the EPs. The PIU and IA shall liaise with the concerned DC offices to ensure timely completion of the land acquisition process. The LAO will also prepare estimates for LA and request fund allocation from the PMO. The PIU will maintain all liaison with the DC office on behalf of the PMO regarding land acquisition procedures for RAP implementation. Furthermore, the LAO will share the award and payment data with the PIU through the IA to facilitate data processing for resettlement benefit provision by the executing agency.

(b) RAP Implementing Agency (IA)

The Implementing Agency (IA), which may be an NGO or Social Consulting Firm, will be engaged for field-level level implementation of the RAP. A TOR will be prepared and approved for RAP implementation, covering activities such as consultation and public information campaign for rapport-building, issuance of ID cards, payment of eligible resettlement benefits (including top-ups) to affected households or individuals, institutional development, skill and management training, community awareness, and empowerment initiatives. The IA will initially create ID numbers for each EP as identified during the JVS conducted by the JVT and prepare an ID card for each EP with a photograph. The photographs of the EPs will be attested by the concerned UP Chairman and affixed to the ID card. The ID card will include information such as the EP's name, father's/husband's name, mother's name, age, education, identifiable marks, detailed address, and details of quantity of losses. The ID card will be issued by the executing agency with the joint signature of the executing agency and IA representatives, and distributed among the EPs by the IA.

The IA will assist EPs in preparing documents and opening bank accounts in their names to receive cheques from the executing agency. The IA will form focus groups with affected people based on homogeneity and/or proximity and hold regular meetings to inform them of their rights and entitlements as prescribed in the RAP. The executing agency will form a ward- or union-based Resettlement Advisory Committee (RAC) to involve local communities and PAPs in the implementation process. The executing agency will provide necessary support and honoraria for the RAC, fostering a cordial relation with project authority and affected communities.

The IA will establish a management information system (MIS) section in its central office for record-keeping of PAPs, including individual ID numbers, preparation of EP files based on quantity of losses, and entitlement cards (ECs) linked to loss type and budget. The IA will submit monthly progress reports to the PMO, detailing the progress of activities to be carried out by the IA.

(c) Ministry of Water Resources and Ministry of Local Government, Rural Development and Cooperatives

The ministries will form the JVT, PVAT, and GRC through gazette notifications to oversee field-level implementation of the RAP. The IA will work as the Member Secretary for all committees and teams, which will involve representatives from the DC, the executing agency, LGI, and PAPs. These committees/teams will ensure stakeholders' participation and uphold the interest of the vulnerable PAPs. The powers and jurisdictions of the committees and teams will be clearly defined in the gazette notification.

(d) Joint Verification Team

The Ministries will form a Joint Verification Team (JVT) for the project through a gazette notification to compare and review the physical verification data collected by the IA with the DC’s assessment of loss of physical assets and their owners. The scope and responsibilities of the JVT will be clearly defined in the gazette. The IA will process the entitlements of PAPs using the JVT data as one of the key determinants. The JVT will be a three-member body, and comprised as follows:

- Sub-divisional Engineer, Sub-division Office, the executing agency – Convener
- Representative of the Deputy Commissioner – Member
- Area Manager, IA – Member Secretary

(e) Property Valuation Advisory Team (PVAT)

A PVAT will be formed by the respective ministries through a gazette notification for the project. The PVAT will review the IA’s assessment of the market price of properties affected by the project at their replacement cost. The scope and responsibilities of the PVAT will be clearly defined in the gazette. The IA will process the entitlements of PAPs using PVAT data as one of the determinants. The PVAT will be comprised of the following members.

- Sub-divisional Engineer, Sub-division Office, the executing agency – Convener
- UP Chairman or designated Member– Member
- Area Manager, IA – Member Secretary
- Representative of affected persons or the community – Member

(f) Grievance Redress Committee

A GRC will be formed at the Ward or Union level to address any grievances involving resettlement benefits, relocation, and other forms of assistance. A gazette notification on the formation and scope of the GRC will be required from the Ministry of Water Resources or the Ministry of Local Government, Rural Development and Cooperatives. Each Ward/Union GRC will be comprised of the following:

- Executive Engineer, PIU, the executing agency – Convener
- Area Manager, IA – Member Secretary
- UP Chairman or designated Member – Member
- One representative of PAPs – Member

(g) Resettlement Advisory Committee (RAC)

The IA will assist the executing agency in forming a union-based RAC at the project level to involve local communities and PAPs in the implementation process. The RAC will be comprised of an executing agency's representative (Executive Engineer or equivalent) as the Chair, the IA as the Member Secretary, two local key informants (one male and one female) selected by the executing agency, and representatives of various stakeholders and PAPs, including at least one female PAP from the respective area, selected by the executing agency in consultation with the LGI representative. The committees will seek local inputs from the affected people and communities, assist the executing agency in all matters related to resettlement, and ensure local participation in RAP implementation. If the PAPs in an area demonstrate positive motivation toward the project, the executing agency may decide that formation of a RAC is not required. If a RAC is formed, members will receive an honorarium, and an operational budget will be allocated for RAC activities.

(h) Women Groups in Resettlement Process

The RAP implementation will adopt a gender-sensitive approach in planning, management, and operations of resettlement activities. Separate groups of female PAPs will be formed and facilitated by the IA. Feedback from female PAPs and female headed PAHs will be obtained through these women-focused groups for planning relocation and resettlement. Female staff engaged by IA will identify the specific needs of female PAPs for income restoration approaches and implementation of the income restoration component of the RAP. Women will be consulted during social appraisal and will be further consulted during the process of RAP implementation.

8.2.8 RAP Implementation Schedule (Common for BWDB and LGED)

The tentative RAP implementation schedule without physical displacement is shown below. The land acquisition and RAP implementation process will be started by the executing agencies after the loan agreement. The schedule below shows the average schedule for land acquisition and RAP implementation, and the actual duration will be shortened or take longer depending on the scale of land acquisition.

8.2.9 Land Acquisition Cost and Budget

(1) Methodology

The design drawings were overlaid on the collected Mouza maps to identify the affected plots. Mouza rates were obtained to determine the average transaction price for each land type. Based on this information and the ARIPA, 2017, land acquisition costs were calculated by multiplying each Mouza rate by three. A provisional land compensation amount was estimated using the Mouza rates, and a 20% contingency fee was added to the estimate.

(2) Estimated Cost

(a) BWDB Portion

For the BWDB portion, land acquisition will be required for widening the footprint of existing embankments, in addition to constructing new embankments. No land acquisition is expected for other related facilities.

(b) LGED Portion

For the LGED section, land acquisition is required only for village protection walls (VPWs). In principle, no land acquisition is required for road improvement, Ghats, or Huts.

8.2.10 Internal Monitoring and Monitoring Form by the Executing Agency

The executing agency will work with the PIU and others to establish RAP implementation monitoring system using an MIS, including a database. Monitoring will include items such as DC office's payment of cash compensation under law (CCL) and the executing agency's payment of resettlement benefits, which are additional compensation and support, as shown in the table below. The results of internal monitoring will be compiled on a quarterly basis and submitted to JICA by the implementing agency along with a Quarterly Project Progress Report (PPR).

Table 8.2.15 Proposed Monitored Indicators for Internal Monitoring

Monitoring Issues	Monitoring Indicators
1. Budget and Timeframe	• Have all resettlement staff been appointed and mobilized for field and office work on schedule? • Have capacity building and training activities been completed on schedule? • Land acquisition progress (LAP approval, issuance of Section 4 notice, Joint Verification Survey, issuance of Section 7 notice, issuance of Section 8 notice, CCL payment) • Are land acquisition and RAP implementation activities being done as per agreed implementation plan? • Are funds for land acquisition and RAP implementation being allocated on time? • Have funds been disbursed according to the Entitlement Matrix of RAP. • Has all the land made encumbrance free and handed over to relevant parties in time for project implementation?
2. Delivery of Entitlements	• How many affected households have land titles? • Have all PAPs received entitlements according to the quantity and categories of loss set out in the Entitlement Matrix? • Are income and livelihood restoration program activities being implemented as planned? • Have community structures been compensated and rebuilt at new site?
3. Consultation, Grievances and Special Issues	• Has the RAP information brochure/leaflet been prepared and distributed? • Have consultations taken place as scheduled, including meetings, groups, and community activities? • Have any PAPs used the grievance redress procedure? What grievances were raised? What were the outcomes? • Have grievances and resolutions been documented? • Have any cases been taken to court? • Have conflicts been resolved?
4. Benefit Monitoring	• What changes have occurred in patterns of occupation compared to the pre-project situation? • What changes have occurred in income and expenditure patterns compared to pre-project situation? • Have PAPs' income kept pace with these changes? • What changes have occurred for vulnerable groups?

Source: RAP (2025)

A sample form for internal monitoring is shown below. In addition, internal monitoring will track changes in livelihoods, income compared to the pre-project, impacts on vulnerable people, and other social indicators. These assessments will be conducted separately based on the monitoring indicators mentioned above and compiled into a report.

Table 8.2.16 Sample Monitoring Form for Internal Monitoring

Component	Unit Total	Completed in %	Cumulative Achievement Total	Completed %	Progress During Reporting Period			Status & Remarks
					Target	Achievement	%	
RAP Implementation Preparation								
Appointment of officers in charge of RAP implementation at the executing agency								
Distribution of brochures								
Identification of PAHs								
Issuance of ID cards								
Consultation meetings								
Formation of PVAT/JVT/GRC/RAC								
Payment of Compensation								
Compensation for land								
Compensation for crop/ fish stock/ trees								
Compensation for structure, if any								

Component	Unit Total	Completed in %	Cumulative Achievement Total	Completed %	Progress During Reporting Period			Status & Remarks
					Target	Achievement	%	
Resettlement Benefits Provision								
Grant for land (stamp duty and registration cost)								
Grant for structures (transfer grant, reconstruction grant), if any.								
Grant for loss of wages for wage earners								
Grant for women headed households								
Grant for training and cash for vulnerable households								
Payment for indirect/unexpected impact								
Employment opportunities during construction								
Others								
Grievances								

Source: RAP (2025)

The executing agency will conduct external monitoring biannually and the final evaluation accordingly.

8.2.11 Outcome of Stakeholder Meetings

(1) Outcome of Stakeholder Meetings for BWDB & LGED at Haor Level

In November 2025, a joint BWDB/LGED stakeholder meetings were held at 13 locations, covering 15 haors. The locations were selected in consultation with the executing agency, taking into account their ease of access after the monsoon season and administrative boundaries. Participants included representatives from the executing agency, local governments at the Upazila level, the Forest Department, the Agriculture Department, and local residents.

Table 8.2.17 Stakeholder Meeting Schedule

No.	Date	Time	Venue	Haors	Upazila	District
1	11 February 2025 (Sunday)	11:00 AM	Tarol Union Parishad Bhaban, Derai	Baram Haor and Chaptir Haor	Derai, Shulla, Derai	Sunamganj
2	11 March 2025 (Monday)	11:00 AM	Ashammura Primary School, Shantiganj	Khai Haor	Shantiganj	Sunamganj
3	11 April 2025 (Tuesday)	11:00 AM	Chilaura Union Parishad Bhaban, Jagannathpur	Naluar Haor (Polder 1)	Jagannathpur	Sunamganj
3	11 May 2025 (Wednesday)	11:00 AM	Beheli Union Parishad Bhaban, Jamalganj	Halir Haor	Jamalganj Tahirpur Bishwamvarpur	Sunamganj
5	11 June 2025 (Thursday)	10:00 AM	Bishwambharpur Upazila Parishad Bhaban	Karchar Haor	Sunamganj Sadar Bishwamvar pur	Sunamganj
6	11 June 2025 (Thursday)	2:30 AM	Sulemanpur Madrasa, Tahirpur Upazila	Shanir Haor	Jamalganj Tahirpur Bishwamvar pur	Sunamganj
7	11 February 2025 (Sunday)	11:00 AM	Ambaria Government Primary School, Kolmakand.	Updakhali Haor	Kolmakanda Sadar Moddhyanagar Sadar	Netrokona
8	11 March 2025 (Monday)	11:00 AM	Khaliajhuri Upazila Hall Room	Khaliajhuri FCD Polder-3 Haor	Khaliajuri Sadar, Itna	Netrokona, Kishoreganj

No.	Date	Time	Venue	Haors	Upazila	District
				Khalijhuri Polder-1	Khaliajuri Sadar,	
9	11 April 2025 (Tuesday)	10:00 AM	Chatirchor, Nikli	Humaipur Haor	Bajitpur Nikli Austogram	Kishoreganj
10	11 May 2025 (Wednesday)	10:00 AM	Itna Upazila Hall Room	Mrigar Haor	Itna	Kishoreganj
11	11 February 2025 (Sunday)	11:00 AM	Poilarkandi Bazar	Ballar Haor	Baniachang Nabiganj Baniachang	Habiganj
12	11 March 2025 (Monday)	3:30 PM	Vati Sherpur Bazar	Makalkandi Haor		
13	11 April 2025 (Tuesday)	11:00 AM	4 No. Isa Kolosh Union Parishad	Pathar Chawli Haor	Companiganj	Sylhet

Source: Meeting Records

Consultation meeting outcomes are summarised in the following tables.

Table 8.2.18 Stakeholder Meeting Outcomes

No	Date, Time and Venue	Name of Haors	Upazila and District	No. of Participants (M and F)	Major Findings
1	11 February 2025 11:00 AM Tarol Union Parishad Bhaban, Derai	Baram Haor and Chaptir Haor	Derai, Shulla, Sunamganj	Male -78 Female -2	• Recurrent flooding and prolonged waterlogging. • Inadequate road access and fragile embankments. • Urgent need for river dredging, elevated roads, strengthened embankments, and safety measures to protect livelihoods and property.
2	11 March 2025 11:00 AM Ashammura Primary School, Shantiganj	Khai Haor	Shantiganj, Sunamganj	Male - 93 Female -8	• Flood-induced infrastructure damage and weak road networks. • Insufficient drainage systems and limited access to education and healthcare. • Community suggested interventions, including river dredging, elevated roads, reinforced embankments, guide walls, and alternative livelihood opportunities.
3	11 April 2025 11:00 AM Chilaura Union Parishad Bhaban, Jagannathpur	Naluar Haor (Polder 1)	Jagannathpur, Sunamganj	Male -104 Female -1	• Persistent haor-related challenges, including embankment deterioration, river siltation, and weak infrastructure. • Existing budgets are insufficient to address issues. • Recommended interventions: dredging, durable roads, embankment reinforcement, flood-resilient infrastructure, and livelihood support programs.
4	11 May 2025 11:00 AM Beheli Union Parishad Bhaban, Jamalganj	Halir Haor	Jamalganj Tahirpur Bishwamvarpur, Sunamganj	Male -71 Female -1	• Widespread poverty, waterlogging, embankment failures, and riverbank erosion affecting agriculture and fishing. • Recommendations included permanent embankments, dredging, elevated roads, flood gates, drinking water facilities, and sanitation improvements.
5	11 June 2025 10:00 AM Bishwambharpur Upazila Parishad Bhaban	Karchar Haor	Sunamganj Sadar Bishwamvar pur, Sunamganj	Male - 40 Female - 0	• Chronic flooding, submersible roads, and weak embankments causing crop and fish losses. • Emphasis on permanent embankments, river dredging, low-cost durable roads, livelihood support, and quality-controlled infrastructure.
6	11 June 2025 2:30 PM Tahirpur Sadar Union parishad,	Shanir Haor	Jamalganj Tahirpur Bishwamvar pur,	Male - 65 Female - 0	• Embankment weaknesses, river erosion, waterlogging, and limited access to education and healthcare. • Suggested interventions included sluice gates, permanent embankments, dredging, improved

No	Date, Time and Venue	Name of Haors	Upazila and District	No. of Participants (M and F)	Major Findings
	Tahirpur Upazila		Sunamganj		road and bridge connectivity, and community facilities to enhance resilience.
7	11 February2025 11:00 AM Ambaria Govt. Primary School, Kolmakanda.	Updakhali Haor	Kolmakanda Moddhyanagar Netrokona	Male - 42 Female - 2	• Seasonal flooding, embankment breaches, canal blockages, and limited medical access. • Recommendations included haor-access roads, school playground improvements, canal excavation, and enhanced water management strategies.
8	11 March 2025 11:00 AM Khaliajhuri Upazila Hall Room	Khaliajhuri FCD Polder-3 Haor	Khaliajuri, Netrokona,	Male - 33 Female - 3	• Importance of embankment protection, river dredging, canal excavation, and flood control measures. • Community advocacy for village protection, afforestation, and collaboration with BWDB and LGED for sustainable haor management.
9	11 April 2025 10:00 AM Chatirchor, Nikli,	Humaipur Haor	Bajitpur Nikli Austogram, Kishoreganj	Male - 112 Female - 0	• In addition to improving the drainage system for densely populated villages, it was suggested to have high and wide roads, village protection walls, deeper canals, and construction of dam to reserve water, and development of tourist spotting areas and ferry piers. • Public toilets are needed in the market.
10	11 May 2025 10:00 AM Itna Upazila Hall Room	Mrigar Haor	Itna, Kishoreganj	Male - 44 Female - 0	• Need for embankment, paving of kacha road, all-weather roads, elevation of village connecting roads, village protection walls to prevent flash floods. • A connecting road is needed from Sahila to Migra • Provision of paddy threshing areas and lightning protection measures
11	11 February 2025 11:00 AM Poilarkandi Bazar	Ballar Haor	Baniachang Nabiganj, Habiganj	Male - 38 Female - 08	• Need for new switch gates, village and bazar protection walls, and road construction. • Emphasis on irrigation improvements, fish landing facilities, women's livelihood programs, and social infrastructure development.
12	11 March 2025 3:30 PM Vati Sherpur Bazar	Makalkandi Haor	Baniachang, Habiganj	Male - 42 Female - 00	• Inadequate road connectivity, silted rivers, and insufficient bridges. • Recommended interventions included excavation of new khals for irrigation, construction of village protection walls, and provision of drinking water facilities.
13	11 April 2025 11:00 AM 4 No. Isa Kolosh Union Parishad	Pathar Chawli Haor	Companiganj, Sylhet	Male - 42 Female - 05	• Flood-prone conditions, poor road and embankment conditions, and drainage challenges. • Recommendations interventions included road and embankment improvements, school infrastructure enhancements, women's training programs, and general haor development interventions.

Source: Meeting Records

(2) FGDs at Village Level under BWDB Portion

In addition to the stakeholder meetings, FGDs were conducted in 15 villages targeting the 15 haor areas. Separate FGDs for women were held in four locations (common for BWDB and LEGD). A total of 314 participants attended, consisting of 242 men and 72 women.

Table 8.2.19 FGD Schedule at Village Level under BWDB Portion

No.	Time and Date	Venue	Target	No. of Participants		
				Male	Female	Total
1.	24 October 2025	**Karchar Haor (Women Group)**	Women Group	0	21	21

No.	Time and Date	Venue	Target	No. of Participants		
				Male	Female	Total
	Friday, 4:00 PM	Jogonnathpur, 9 No Ward, Gourarong Union, Sunamganj Sadar Upazila, Sunamganj District				
2.	25 October 2025 Saturday, 10:00 AM	**Makalkandi Haor** Makalkandi Purba Para, Baniachang, Habiganj	PAPs (Landowners)	13	0	13
3.	25 October 2025 Saturday, 3:30 PM	**Humaipur Haor** Humaipur, Bajitpur, Kishoreganj.	PAPs (Landowners)	16	0	16
4.	26 October 2025 Sunday, 12:00 PM	**Ballar Haor** Poilerkandi, Baniachang, Habiganj	PAPs (Landowners)	18	0	18
5.	26 October 2025 Sunday, 4:00 PM	**Halir Haor** Pandup Bazar, South Sreepur, Tahirpur, Sunamganj District	PAPs (Landowners)	13	0	13
6.	27 October 2025 Monday, 12:00 PM	**Mrigar Haor** Mriga Union Parishad, Anando Bazar, Itna, Kishoreganj	Community Leaders	19	0	19
7.	29 October 2025 Wednesday, 11:00 AM	Khaliajuri FCD- 1 and 3 Muslimhati, Khaliajuri, Netrokona	PAPs (Landowners)	15	0	15
8.	29 October 2025 Wednesday, 12:15 PM	**Pathar Chaoli Haor** Parkul Bazar, Companiganj, Sylhet	PAPs (Landowners)	16	1	17
9.	29 October 2025 Wednesday, 1:10 PM	**Pathar Chaoli Haor (Women Group),** Parkul,Companiganj, Sylhet	Women Group	0	18	18
10.	29 October 2025 Wednesday, 11:30 AM	**Noluar Haor** Das Noagao, Chilaura Holdipur, Jagannathpur, Sunamganj District	PAPs (Landowners)	12	0	12
11.	30 October 2025 Thursday, 3.30 PM	**Updakhali Haor** Kesobpur Bazar, Kolmakanda, Netrokona.	PAPs (Landowners)	22	0	22
12.	30 October 2025 Thursday, 4:00 PM	**Chaptir haor** Kaliar kapon Bazar, Jagodal, Derai, Sunamganj District	PAPs (Landowners)	13	0	13
13.	31 October 2025 Friday, 2:30 PM	**Baram Haor** (Women Group) Kholapara, 7 No Ward, Habibpur Union, Shalla Upazila, Sunamganj District	Women Group	0	14	14
14.	31 October 2025 Friday, 3:00 PM	**Khaliajuri FCD-1** Patra Primary School, Khaliajuri, Netrokona	PAPs (Landowners)	22	0	22
15.	31 October 2025 Friday, 4:00 PM	**Baram Haor** Kadirpur, Tarul, Derai, Sunamganj District	Vulnerable and Marginalized Groups	15	0	15
16.	1 November 2025 Saturday, 4:00 PM	**Khai Haor** Babongao, East Birgao, Shantiganj Upazila, Sunamganj District	Community Leaders	14	0	14
17.	4 November 2025 Tuesday, 1:00 PM	**Humaipur Haor** (Women Group) Chatirchor, Nikli, Kishoreganj.	Women Group	4	18	22
18.	7 November 2025 Friday, 3:00 PM	**Karchar Haor** Ahmodabad, Iccherchor Point, Gourang Union, Sunamganj Moulvibazar District	PAPs (Landowners)	15	0	15
19.	7 November 2025 Friday, 4:30 PM	**Shanir Haor** Lokha Chourasta, Fatehpur Union, Bishwamvapur Upazila, Sunamganjss District	Community Leaders	15	0	15
Total				242	72	314

Source: FGD Record

The FGDs also covered flood control measures, VPW, embankment rehabilitation, canal maintenance, drainage improvement, crop and livestock losses, waterborne diseases, and lack of access to clinics and communication during the monsoon season. The main findings of the discussions are as follows:

Table 8.2.20 FGD Outcomes under BWDB Portion

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
1.	**24 October 2025, 4:00 PM** **Karchar Haor (Women Group)** Jogonnathpur, 9 No Ward, Gourarong Union, Sunamganj Sadar Upazila, Sunamganj District	Women Group	• Women have no specific profession and are dependent entirely on their husbands' income. • Farming and cattle rearing by men are seasonal and not available year-round. • Moderate education level: approximately 60% of boys and girls study up to college. • Limited employment opportunities directly accessible to women. • Fear during monsoon as homesteads risk submergence; houses are 7–8 ft above the road. • Severe shortage of safe drinking water; collected from distant sources. • Communal pond exists but is insufficient for daily use. • Requests for sewing machines and mobile phones for livelihood improvement.	The team thanked the group for these specific and actionable inputs. These livelihood and empowerment requests are direct inputs for the Livelihood Restoration Plan (LRP) and Gender Action Plan (GAP) within the RAP. Water and health-service gaps will be communicated to relevant agencies. Monsoon-related mobility and risk concerns, as well as education and livelihood insights, were noted. The session was a highly productive for designing targeted support.
2.	**25 October 2025, 10:00 AM** **Makalkandi Haor** Makalkandi Purba Para, Baniachang, Habiganj	PAPs (Landowners)	• Existing embankments need repair; new ones are needed. • Two new switch gates are needed, and one old needs repair. • Re-excavation of canals and rivers for water drainage. • High grounds for threshing and slope protection are required. • No compensation has been provided for flood losses. • Schools are inaccessible during flood season. • Hospital 12 km away; difficult to reach. • Women's decisions are less valued. • The 12 km road from Baniachang to Makalkandi needs paving. • Village protection wall and eight boat Ghats needed. • Road from village to haor required for crop transport.	The team clarified the scope of RAP compensation. The critical issue of the 12 km road was highlighted as a major connectivity constraint; this will be strongly recommended to LGED for separate funding. Gender and education access issues will be featured in the GAP and social impact analysis.
3.	**25 October 2025, 3:30 PM** **Humaipur Haor** Humaipur, Bajitpur, Kishoreganj.	PAPs (Landowners)	• Re-excavation of rivers and canals. • Permanent embankment construction. • Ferry piers on both sides of the river. • Construction of a dam to reserve water.	The team assured that project-related impacts on access will be recorded.
4.	**26 October 2025, 12:00 PM** **Ballar Haor** Poilerkandi, Baniachang, Habiganj	PAPs (Landowners)	• Haor embankment required to protect villages. • Culverts along embankment needed. • Re-excavation of small canals. • River dredging for irrigation and drainage. • Switch gates required for water balance. • High land for threshing.	Culverts are part of BWDB's engineering design. This FGD helped identify areas demanding protection, which will be noted in the project's overall social and technical analysis.

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
			• Slope protection required.	
5.	**26 October 2025, 4:00 PM** **Halir Haor** Pandup Bazar, South Sreepur, Tahirpur, Sunamganj District	PAPs (Landowners)	• Existing embankments need repair, and new ones are required in weak areas. • No compensation is received for annual flood losses. • Need for switch gates, canal re-excavation, and river dredging. • High lands required for crop threshing. • Slope protection is required to prevent erosion. • Livestock fodder shortage and waterborne diseases are common during floods. • Need more boat landing Ghats and better village-to-haor road connectivity. • Women's opinions receive less value in decision-making.	The team clarified that the RAP study focuses on compensation for project-induced land acquisition, not annual natural disaster losses. However, the need for threshing grounds lost to the project will be included in the RAP's Livelihood Restoration Plan. The issue of women's participation has been noted for the Gender Action Plan (GAP).
6.	**27 October 2025, 12:00 PM** **Mrigar Haor** Mriga Union Parishad, Anando Bazar, Itna, Kishoreganj	Community Leaders	• Request for construction of a permanent embankment • Lightning protection measures to protect Mriga Haor. • Prevention of flash floods through re-excavation of rivers and canals	The project includes river dredging and long-term embankment construction; canals will be re-excavated; authorities will be informed.
7.	**29 October 2025, 11:00 AM** **Khaliajuri FCD-3** Muslimhati, Khaliajuri, Netrokona	PAPs (Landowners)	• Re-excavation of rivers and canals • Construction of permanent embankment • Suitable for use as an and road at the same time • Embankment afforestation	The team confirmed that river and canals re-excavation, embankment afforestation, and embankment-cum-road construction are high priorities for the study, as it affects many people.
8.	**29 October 2025, 12:15 PM** **Pathar Chaoli Haor** Parkul Bazar, Companiganj, Sylhet	PAPs (Landowners)	• Existing embankment serves as the only road and needs urgent repair. • New embankments required at critical points. • Electricity supply is irregular and unresponsive. • Old switch gate needs repair; new gates needed. • Canal is filled and re-excavation is required. • Slope protection is needed.	The team confirmed that embankment-cum-road conditions are a high priority for the study, as it affects many people. The issue of power supply, while outside BWDB's mandate, will be formally communicated to the local power utility office.
9.	**29 October 2025, 1:10 PM** **Pathar Chaoli Haor (Women Group),** Parkul, Companiganj, Sylhet	Women Groups	• Household decisions are jointly made, but male opinions dominate. • Women involved in livestock rearing and family finances. • Women require permission for social activities or travel. • Need for sewing machines, training, and livestock distribution. • Village road repairs are needed. • Women's opinions are valued in health and savings decisions. • Request for cottage industry training and better housing.	The team thanked the group for these specific and actionable inputs. These livelihood and empowerment requests are direct inputs for the Livelihood Restoration Plan (LRP) and Gender Action Plan (GAP) within the RAP. This was a highly productive session for designing targeted support.
10.	**29 October 2025, 11:30 AM** **Noluar Haor**	PAPs (Landowners)	• Entire haor area requires embankment protection. • Culverts and drainage facilities are needed.	The study will identify land needs for specific BWDB infrastructure. These broader requests for new

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
	Das Noagao, Chilaura Holdipur, Jagannathpur, Sunamganj District		• River and canal re-excavation required. • Switch gates are necessary for water management. • Slope protection and high grounds for crop threshing needed.	protections across the entire haor will be documented and shared with BWDB for consideration in its long-term master planning.
11.	**30 October 2025, 11:00 AM** **Updakhali Haor** Karuajan, Madhanagor, Sunamganj	PAPs (Landowners)	• Need for Village Protection Wall along with roads • Two internal roads are needed inside Ghoraduba Haor. • Road construction and canal excavation needed in front of the village. • Arrangements must be made for paddy threshing. • New road of about 500 m will have to be constructed from Karuajan Government Primary School to the riverbank. • Re-excavation the canals inside the haor.	The team thanked the group for these specific and actionable inputs. authorities informed
12.	**30 October 2025, 3:30 PM** **Updakhali Haor** Kesobpur Bazar, Kolmakanda, Netrokona.	PAPs (Landowners)	• Ensure water flow to rice fields and flood management • Use local soil sources if possible • Canal re-excavation for 2 km needed • Ensure proper drainage • Gates need enlargement for proper water flow • Ramp needed for safe movement to and from the village • Dredging of rivers needed to prevent flood damage	The team differentiated between project impacts and recurring seasonal issues. The RAP will focus on mitigating project-specific impacts
13.	**30 October 2025, 4:00 PM** **Chaptir Haor** Kaliar kapon Bazar, Jagodal, Derai, Sunamganj District	PAPs (Landowners)	• Repair and new construction of embankments needed. • River dredging and canal excavation are required. • Need for threshing grounds and slope protection. • Fodder shortage and poor connectivity from village to haor. • Women’s participation in decision-making limited. • Need for skill development training in agriculture, including operation of agricultural machineries	Connectivity issues related to project infrastructure will be assessed for impacts. The gender concerns will be integrated into the stakeholder engagement strategy and GAP to ensure women's voices are included in future project consultations. Project will take necessary steps to arrange training based on need assessment.
14.	**31 October 2025, 2:30 PM** **Baram Haor** (Women Group) Kholapara, 7 No Ward, Habibpur Union, Shalla Upazila, Sunamganj District	Women Group	• Women have no specific livelihood and are dependent on husbands’ income. • Men rely on seasonal farming and cattle rearing. • Low education levels; most study only up to high school only. • College education requires BDT 8,000–10,000 per month—unaffordable for most. • Haor remains waterlogged approximately six months per year with no alternative employment. • Nearby computer training centre is irregularly staffed and poorly attended.	The team thanked the group for these specific and actionable inputs. These livelihood and empowerment requests are direct inputs for the Livelihood Restoration Plan (LRP) and Gender Action Plan (GAP) within the RAP. Healthcare access and water scarcity concerns will be communicated to relevant authorities for coordination. Education and livelihood challenges were noted to inform gender and social analysis. This was a highly

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
			• Limited access to doctors or health workers; community clinics rarely functional in monsoon. • Severe shortage of safe drinking water. • No old-age allowance received in the union. • Communal pond exists but insufficient. • Requested sewing machines and mobile phones for income and communication.	productive session for designing targeted support.
15.	**31 October 2025, 4:00 PM** **Baram Haor** Kadirpur, Tarul, Derai, Sunamganj District	Vulnerable and Marginalized Groups	• Embankments require urgent repair. • Switch gates need repair, and canal dredging is necessary. • Floods damage crops yearly. • Livestock feed shortages and communication barriers in monsoon. • Lack of access to healthcare services. • There is a need for skill development training in agriculture	The team acknowledged the acute vulnerability of the group. While the RAP cannot solve general healthcare access, the specific challenges in relocating or accessing services due to the project will be considered in the resettlement planning and GAP. The project will take necessary steps to arrange training based on need assessment.
16.	**1 November 2025, 4:00 PM** **Khai Haor** Babongao, East Birgao, Shantiganj Upazila, Sunamganj District	Community Leaders	• Two new switch gates required; repair of old ones needed. • Canals and rivers need re-excavation. • Slope protection, high threshing yards, and communication roads are required. • Lack of compensation for crop damage. • Shortage of boats and Ghats for communication. • Poor access to health services.	As community leaders, participants were informed that the request for new gates is an engineering decision for BWDB. The RAP will address the loss of existing boat Ghats due to the project. General development needs, including healthcare and general crop losses, will be passed to relevant departments.
17.	**4 November 2025, 1:00 PM** **Humaipur Haor (Women Group)** Chatirchor, Nikli, Kishoreganj.	Women Groups	• Household decisions jointly made. • Health centres with necessary facilities are needed. • Women involved in livestock rearing and family finances. • Women require permission for social activities or travel. • Need for sewing machines, training, and livestock distribution. • Village road repairs and connecting new roads needed. Re-excavation of rivers and canals, permanent embankment construction, and improved drainage system. • Most women shoulder household chores, care work, community activities alone. • Women’s opinions are valued in decisions related to health and savings. • Gender composition of fisheries management groups: women have no role. • Although there are no existence of women's groups or support organizations in the agriculture	The study team engaged with women in rural areas to identify their situation and needs. The systemic issue of women's participation was identified as a key finding and will be addressed in the project's GAP and consultation framework, as well as Restoration and Livelihood Plan (IRLP) and Gender Action Plan (GAP) within the RAP. This was a highly productive session for designing targeted support.

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
			and fisheries sectors, women play in agricultural products and fisheries processing is very important. • The Haor region is not very well educated in terms of education, but the girls here are ahead. • Need for sewing machines, training, and livestock distribution.	
18.	**7 November 2025, 3:00 PM** **Karchar Haor** Ahmodabad, Iccherchor Point, Gourang Union, Sunamganj Moulvibazar District	PAPs (Landowners)	• Crop suffer repeated flood damage. • Embankments need strengthening, and canal require re-excavation. • Switch gates are required for better water management. • Slope protection needed. • Health risks and livestock losses during floods. • Skill development training in agriculture is needed.	The team differentiated between project-related impacts and recurring seasonal issues. The RAP will focus on mitigating project-specific impacts, while broader health and disaster resilience concerns will be compiled for BWDB and the local health department. The project will take necessary steps to arrange training based on a needs assessment.
19.	**7 November 2025, 4:30 PM** **Shanir Haor** Lokha Chourasta, Fatehpur Union, Bishwamvapur Upazila, Sunamganj District	Community Leaders	• Embankments need repair, and canals require re-excavation. • Slope protection and improved drainage systems are required. • Food shortages and limited healthcare access during floods. • Additional boat Ghats are needed. • Women's participation in development activities is limited.	The team assured that project-related impacts on access will be recorded. The systemic issue of women's participation was noted as a key finding and will be addressed in the project's GAP and consultation framework.

Source: FGD Records

(3) FGDs at Village Level Under LGED Portion

In addition to stakeholder meetings, FGDs were conducted in 17 villages targeting 15 haor areas. Separate FGDs for women were held in four locations (common for BWDB and LEGD). A total of 317 people participated, consisting of 240 men and 77 women.

Table 8.2.21 FGD Schedule at Village Level under LGED Portion

No.	Time and Date	Venue	Target Group	No. of Participants		
				Male	Female	Total
1.	24 October 2025 (Friday), 10:30 AM	**Korchar Haor** Noluar Par, 7 No Ward, Gourarong Union, Sunamganj Sadar	PAPs (Landowners)	16	0	16
2.	24 October 2025 (Friday), 3:00 PM	**Humaipur Haor** Chatirchor, Nikli, Kishoreganj	PAPs (Landowners)	18	0	18
3.	25 October 2025 (Saturday), 11.30 AM	**Humaipur Haor** Gushaipur,Humaipur, Bajitpur, Kishoreganj	PAPs Groups	19	0	19
4.	25 October 2025 (Saturday), 12:00 PM	**Shonir Haor** Sreepur, Tahirpur Upazila, Sunamganj	PAPs (Landowners)	16	0	16

No.	Time and Date	Venue	Target Group	No. of Participants		
				Male	Female	Total
5.	26 October 2025 (Sunday), 12:00 PM	**Halir Haor** Achhanpur, Jamalganj Upazila, Sunamganj	PAPs (Landowners)	15	0	15
6.	27 October 2025 (Monday) 4.00 PM	**Mrigar Haor** Shohila,Mriga, Itna, Kishoreganj	PAPs (Landowners)	12	0	12
7.	27 October 2025 (Monday), 4:00 PM	**Shonir Haor** Basantapur, Biswambarpur Upazila, Sunamganj	PAPs (Landowners)	16	0	16
8.	29 October 2025 (Wednesday) 3:00 PM	**Khaliajuri FCD-3** Adampur (Nagor UP), Khaliajuri, Netrokona	PAPs (Landowners)	14	0	14
9.	29 October 2025 (Wednesday) 4:00 PM	**Noluar Haor** Noagaon, Jagannathpur Upazila, Sunamganj	PAPs (Landowners)	12	0	12
10.	30 October 2025 (Thursday) 11:00 AM	**Chaptir Haor** Kachua, Ward 19, Karimpur Union, Dirai Upazila, Sunamganj	PAPs (Landowners)	11	0	11
11.	30 October 2025 (Thursday), 11:00 AM	**Updakhali Haor** Karuajan, adhyanagor,Sunamganj.	PAPs (Landowners)	16	0	16
12.	30 October 2025 (Thursday), 4:30 PM	**Updakhali Haor** Kesobpur Hori Mondir para, Kolmakanda, Netrokona.	PAPs (Landowners)	11	5	16
13.	31 October 2025 (Friday), 11:30 AM	**Baram Haor** Kholapara, 7 No Ward, Habibpur Union, Shalla Upazila, Sunamganj	PAPs (Landowners)	16	0	16
14.	1 November 2025 (Saturday), 11:00 AM	**Khai Haor,** Umed Nagar,West Birgaon Union, Shantiganj Upazila, Sunamganj	Community Leader	11	0	11
15.	4 November 2025 (Tuesday), 1:00 PM	**Humaipur Haor (Women Group)** Chatirchor, Nikli, Kishoreganj.	Women Group	4	18	22
16.	31 October 2025 (Friday), 2:30 PM	**Baram Haor (Women Group)** Kholapara, 7 No Ward, Habibpur Union, Shalla Upazila, Sunamganj District	Women Group	0	14	14
17.	29 October 2025 (Wednesday) 1:10 PM	**Pathar Chaoli Haor (Women Group),** Parkul,Companiganj, Sylhet	Women Group	0	18	18
18.	24 October 2025 (Friday), 4:00 PM	**Karchar Haor (Women Group)** Jogonnathpur, 9 No Ward, Gourarong Union, Sunamganj Sadar Upazila, Sunamganj District	Women Group	0	21	21
19.	25 October 2025 (Saturday), 11:00 AM	**Makalkandi Haor** Makalkandi poschim para,Baniachang, Hobigonj	PAPs (Landowners)	11	1	12
20.	25 October 2025, (Saturday) 02:00 PM	**Makalkandi Haor** Naohati. Baniachang, Hobigonj	PAPs (Landowners)	10	0	10
21.	29 October 2025,	**Patherchaoli** Bagjur Bazar. Companigonj, Sylhet	PAPs (Landowners)	12	0	12

No.	Time and Date	Venue	Target Group	No. of Participants		
				Male	Female	Total
	(Wednesday) 02:00 PM					
Total				240	77	317

Source: FGD Records

The FGDs covered topics such as flood control measures, VPW, Village road rehabilitation, and production centres. Also discussed were embankment rehabilitation, canal maintenance, drainage improvement, crop and livestock losses, waterborne diseases, and lack of access to clinics and communication during the monsoon season. The main findings of the discussions are as follows:

Table 8.2.22 FGD Outcomes at Village Level under LGED Portion

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
1.	24 October 2025, 10:30 AM **Korchar Haor** Noluar Par, Sunamganj Sadar	PAPs (Landowners)	A Village Protection Wall is needed to prevent homes from washing away. Canals inside the haor need excavation due to lack of irrigation water. The Jirag River needs excavation. Durable protective embankments are needed. Roads are needed to transport rice from the haor. Yards are needed for threshing and drying rice. Needs skill development training on Agriculture including operation of agricultural machineries	If the project is implemented, expected benefits include easier movement and commuting, improved travel to the Upazila; trade expansion; increased agricultural product prices; easy buying/selling; improved education and healthcare. Project will take necessary steps to arrange training based on need assessment.
2.	24 October 2025, 3:00 PM **Humaipur Haor,** Chatirchar, Nikli, Kishoreganj	PAPs (Landowners)	Village protection wall needs expansion to the north side. Needs connection to Village Protection system. Ensure proper drainage. Chatirchar village needs a bridge to connect to the road. Village connecting roads needed.	The team acknowledged these infrastructure needs; they will be considered in overall planning for village connectivity and Haor protection.
3.	25 October 2025, 11:30 AM **Humaipur Haor,** Gushaipur, Humaipur, Bajitpur, Kishoreganj	PAPs (Landowners)	Ensure proper drainage. Village connecting roads needed. Connecting road to central graveyard of Gushaipur. Roads alongside village protection walls. Local market development.	The project team noted need for improved connectivity and drainage. These issues will inform the design considerations of local roads and markets.
4.	October 25, 2025, 12:00 PM **Shonir Haor,** Sreepur, Tahirpur Upazila, Sunamganj	PAPs (Landowners)	Unemployment occurs for half the year. Students must lodge or rent in Upazila. Healthcare services are very poor. A Village Protection Wall from Sreepur up to Tahirpur. Canals need excavation. Durable protective embankment. Roads to bring rice. Yard for threshing/drying rice. Needs skill development training on Agriculture including operation of agricultural machineries	If implemented, the project's benefits include easier commute; trade expansion; increased agri-product prices; improved education and healthcare. Project will take necessary steps to arrange training based on need assessment.
5.	26 October 2025, 12:00 PM **Halir Haor,** Achhanpur, Jamalganj	PAPs (Landowners)	Education services are poor; lodging is needed for college. Poor healthcare services. A Village Protection Wall needed. A paved jetty is required at Pandup Bazar. Roads to bring rice.	Expected benefits include improved mobility, trade, education, and healthcare; water well drilling and protective infrastructure recommended.

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
	Upazila, Sunamganj		Raised graveyard needed. Yard for threshing/drying rice. Severe scarcity of pure drinking water (drill 700–750 ft).	
6.	27 October 2025, 4:00 PM **Mrigar Haor,** Shohila, Mriga, Itna, Kishoreganj	PAPs (Landowners)	Lightning protection measures are needed. Local market development is required. A road connecting the village to the central graveyard of Shohila is needed. The Shohila–Mriga Bazar Road. Neighbourhood connecting roads are needed. Paddy threshing/yard arrangements. Needs skill development training on Agriculture including operation of agricultural machineries	The project includes river dredging and long-term embankment; canals will be re-excavated; authorities informed. Project will take necessary steps to arrange training based on need assessment.
7.	27 October 2025, 4:00 PM Shonir Haor, Basantapur, Biswambarpur Upazila, Sunamganj	PAPs (Landowners)	Irregular work availability. Students must lodge or rent. Healthcare services are moderate but irregular. A Village Protection Wall from Basantapur to the bazar. Canals need excavation. Durable protective embankment. Submersible road to transport rice. Yard for threshing/drying rice.	Expected benefits include improved mobility, trade, education, and healthcare access.
8.	29 October, 2025, 3:00 PM **Khaliajuri FCD-3,** Adampur, Khaliajuri, Netrokona	PAPs (Landowners)	Roads alongside Village Protection Walls are needed. Village connecting roads are needed. A threshing yard needed. An all-weather road from Adampur to Khaliajuri is required.	The team confirmed the importance of connecting roads and protective embankments for supporting livelihood and mobility.
9.	29 October 2025, 4:00 PM **Noluar Haor,** Noagaon, Jagannathpur Upazila, Sunamganj	PAPs (Landowners)	Education services are poor; children cannot attend school in monsoon. Poor healthcare services. Village Protection Wall needed. Scarcity of pure drinking water (drill 700–750 ft). Switch gate needed in Burai Canal. Roads to bring rice. Yards are needed for threshing and drying rice. Road to Noagaon Jame Mosque and graveyard. Needs skill development training on Agriculture including operation of agricultural machineries	Project benefits include improved mobility, trade, education improvements; long-term water management needs considered in master planning. The project will take necessary steps to arrange training based on need assessment.
10.	30 October 2025, 11:00 AM **Chaptir Haor,** Kachua, Dirai Upazila, Sunamganj	PAPs (Landowners)	Education services are poor; children cannot attend school in monsoon. Poor healthcare services. Canals need excavation. Village Protection Wall needed. Village roads need paving. Roads to bring rice. Cremation ground needed. Temple expansion required. Yards are needed for threshing and drying rice. There is a scarcity of pure drinking water (drill 700–750 ft).	Project benefits include improved mobility, trade, education, and healthcare.
11.	30 October 2025, 4:30 PM **Updakhali Haor,** Kesobpur	PAPs (Landowners)	A road to the UP Parishad is needed. A Village Protection Wall along roads is needed. Kesobpur–Baro Kapan (2 km) needs paving.	The team differentiated between project-specific impacts and seasonal issues. The RAP will focus

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
	Hori Mondir Para, Kolmakanda, Netrokona		Internal kacha roads need paving. Warehouses needed to protect rice.	on mitigating project-related impacts.
12.	31 October 2025, 3:00 PM **Khaliajuri FCD-1,** Patra Primary School, Khaliajuri, Netrokona	PAPs (Landowners)	Roads alongside village protection walls. Village connecting roads needed. All-weather road required. Primary school connecting road. Paddy threshing yard/playground needed. Needs skill development training on Agriculture including operation of agricultural machineries	The team thanked participants and noted that their inputs will inform the project road and protection designs. The project will take necessary steps to arrange training based on a needs assessment.
13.	31 October 2025, 11:30 AM **Baram Haor,** Khalapara, Shalla Upazila, Sunamganj	Landowners Group	Unemployment. Poor education. Poor healthcare. Village Protection Wall needed. Scarcity of pure drinking water. Canals need excavation. Destroyed overflow sluices causing waterlogging. Roads to bring rice. Yard for threshing/drying rice.	Expected benefits include improved mobility, trade, and healthcare access. Water management improvements are also recommended.
14.	1 November 2025, 11:00 AM **Khai Haor,** Umed Nagar, Shantiganj Upazila, Sunamganj	Community Leader	Unemployment occurs for half the year. Poor education. Poor healthcare. A Village Protection Wall is needed. Paved jetty for school children. Roads to bring rice. Yard for threshing/drying rice. Scarcity of pure drinking water (drill 700–800 ft). Needs skill development training on Agriculture including operation of agricultural machineries	Expected benefits include improved mobility, trade, education, and healthcare; water scarcity issues documented for intervention planning. The project will take necessary steps to arrange training based on need assessment.
15.	4 November 2025, 1:00 PM **Humaipur Haor (Women Group),** Chatirchar, Nikli, Kishoreganj	Women Group	Household decisions jointly made. Health centres needed. Women involved in livestock/family finances. Need permission for social activities. Sewing machines, training, livestock distribution needed. • Village road repairs and new roads required. Re-excavation of rivers and canals; permanent embankment; drainage system. Household chores mostly done by women. Women's role in fisheries/agriculture important. Literacy low; girls ahead.	Study team identified systemic gender participation issues; inputs feed into GAP and IRLP within RAP. Highly productive session for targeted support.
16.	31 October 2025, 2 :30 PM **Baram Haor (Women Group)** Kholapara, 7 No Ward, Habibpur Union, Shalla Upazila, Sunamganj District	Women Group	No specific women's livelihood; dependent on husbands' income. Men rely on farming cattle rearing, and seasonal work. Low education levels: most complete only up to high school. College requires BDT 8,000–10,000 per month—unaffordable for most. The haor remains waterlogged for approximately six months per year, leaving no alternative employment. A nearby computer training centre exists, but trainers do not attend regularly.	The team thanked the group for these specific and actionable inputs. These livelihood and empowerment requests are direct inputs for the Livelihood Restoration Plan (LRP) and Gender Action Plan (GAP) within the RAP. Healthcare access issues and water scarcity concerns will be communicated to relevant authorities for coordination. Education

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
			No access to doctors or health workers; community clinics are rarely functional in monsoon. Severe shortage of safe drinking water. No old-age allowance received in the union. Communal pond exists but insufficient. Requested sewing machines and mobile phones for income and communication.	and livelihood challenges were noted to inform gender and social analysis. This was a highly productive session for designing targeted support.
17.	29 October 2025, 1:10 PM **Pathar Chaoli Haor (Women Group),** Parkul,Companiganj, Sylhet	Women Group	Household decisions are made jointly, but male opinions tend to dominate. Women participate in livestock rearing and family finances. Women generally require permission for social activities or travel. There is a need for sewing machines, training, and livestock distribution. Village road repairs are needed. Women's opinions are valued in health and savings decisions. The community requests for cottage industry training and better housing.	The team thanked the group for these specific and actionable inputs. These livelihood and empowerment requests are direct inputs for the Livelihood Restoration Plan (LRP) and Gender Action Plan (GAP) within the RAP. This was a highly productive session for designing targeted support.
18.	24 October 2025, 4 :00 PM **Karchar Haor (Women Group)** Jogonnathpur, 9 No Ward, Gourarong Union, Sunamganj Sadar Upazila, Sunamganj District	Women Group	Women have no specific profession and are entirely dependent on husbands' income. Farming and cattle rearing by men are not available year-round. Moderate education levels: approximately 60% of boys and girls study up to college. Limited employment opportunities directly accessible to women. Fear during monsoon as homesteads risk submergence; houses 7–8 ft above road. Severe shortage of safe drinking water; collected from distant sources. Communal pond exists but is insufficient for daily use. Community members requested sewing machines and mobile phones for livelihood improvement.	The team thanked the group for these specific and actionable inputs. These livelihood and empowerment requests are direct inputs for the Livelihood Restoration Plan (LRP) and Gender Action Plan (GAP) within the RAP. Water and health-service gaps will be communicated to relevant agencies. Monsoon-related mobility and risk concerns, as well as education and livelihood insights, were noted. This was a highly productive session for designing targeted support.
19.	25 October 2025, 11:00 AM **Makalkandi Haor** Makalkandi Poshchim Para, Baniachang, Hobigonj	PAPs (Landowners)	There are no health service in the village; a community clinic is needed (nearest facility 12 km away). A road is required for access to the village temple. A protection wall around the village is needed. Agriculture is the main occupation; training on improved agriculture practices required. Small number of villagers depend on boatman/fishing; livelihood support needed. Raised platforms in the haor for threshing and drying crops are needed. Require 04 boat-landing Ghats at different points of the village. Renovation required for the Kali Temple. Only one seasonal crop produced annually from agricultural land. Liberation War memorial requires renovation and maintenance.	If the project is implemented, communities will benefit through improved mobility, safer access to markets and services, increased agricultural productivity, and enhanced livelihood opportunities. Project will consider community infrastructure needs and may coordinate with relevant authorities. Skill development and livelihood training will be arranged based on assessed needs.

No.	Time, Date, Venue	FGD Target	Questions	Responses by Organizer
20.	25 October 2025, 02:00 PM **Makalkandi Haor** Naohati, Baniachang, Hobigonj	PAPs (Landowners)	River dredging is needed to improve water drainage and ensure flood control. A new road required from Naohati to Makalkandi. A Village Protection Wall is needed to prevent erosion and flooding. Raised mounds are needed for threshing paddy. Boat-landing Ghats are needed around the village. A local marketplace is needed for trade and economic activities. Due to early floods, farmers cannot bring harvested paddy home on time.	The project will enhance connectivity and support flood management through improved infrastructure. Livelihood and agricultural support interventions will be designed based on vulnerability assessment. Community requests will be shared with relevant agencies for possible integration.
21.	29 October 2025, 02:00 PM **Patherchaoli Haor** Bagjur Bazar, Companiganj, Sylhet	PAPs (Landowners)	Repair and rehabilitation of Bagjur Bazar road are needed. Ghatla (landing steps) and a guide wall are required for the village mosque. A road from the village to the haor is needed for crop transportation. A community clinic is urgently needed for basic healthcare. Public toilet is needed at Bagjur Bazar. The only road to the Union Parishad is unpaved; needs to be upgraded to a paved road.	The project will improve transportation networks, enhancing access to markets, education, and healthcare. Public facilities and community structures identified during the FGD will be communicated to relevant authorities for consideration. Improved mobility will directly support agriculture, trade, and socio-economic development.

Source: FGD Records

(4) Information Disclosure of RAP by the Executing Agency

The RAP will be disclosed at the offices of the executing agencies for public viewing after finalization.

8.3 Gender Survey

8.3.1 Relevant Legislation and Policy

Relevant legislation and policies on gender are summarized in the following Table 8.3.1 below.

Table 8.3.1 Legislation and Policy on Gender in Bangladesh

No.	Legislation	Description
1.	Constitution of the People's Republic of Bangladesh, 1972	Article 19 (1): The State shall endeavour to ensure equality of opportunity to all citizens. Article 19 (2): The State shall adopt effective measures to remove social and economic inequality among individuals and to ensure equitable distribution of wealth among citizens, and of opportunities in order to attain a uniform level of economic development throughout the Republic. Article 19 (3): The State shall endeavour to ensure equality of opportunity and participation of women in all spheres of national life. Article 27: All citizens are equal before law and are entitled to equal protection of law Article 28 (1): The State shall not discriminate against any citizen on the grounds of religion, race, caste, sex, or place of birth. Article 28 (2): Women shall have equal rights with men in all spheres of the State and of public life.
2.	National Women Development Policy, 2011	Section 16: The 22 goals of National Women Development Policy, 2011, include the prevention of violence against women; elimination of discriminations; increased opportunity for education, health, safety, and employment; protection of person with disabilities; protection from disasters; and political and administrative empowerment of women.

No.	Legislation	Description
3.	National Action Plan on Women Development, 2013	In order to achieve the objectives of the National Women Development Policy, 2011, the National Action Plan for the implementation of this policy was formulated in 2013. The main coordinator for the implementation of the basic activities under the National Action Plan is the Ministry of Women and Children Affairs.
4.	Eighth Five-Year Plan (July 2020 - June 2025) Gender Equality Strategy	In line with the Prime Minister's declaration of gender equality as one of the developmental priorities, the Eighth Five-Year Plan incorporates a framework for women's empowerment and gender equality. It has been prepared in line with the framework of the Seventh Five-Year Plan. It comprises five areas of strategic objectives: (1) improve women's human capabilities; (2) increase women's economic benefits; (3) enhance women's voice and agency; (4) create an enabling environment for women's advancement; and (5) enhancing Mother and child benefit programme.
5.	Social Security Strategy, 2015	In light with the provisions set out in the country's constitution, the Bangladesh government approved the Social Security Strategy in 2015. This strategy is designed to support social development, including the eradication of extreme poverty among the poor and the most vulnerable people in society.

Source: Relevant Legislation and Policy

8.3.2 Survey Outcomes

The stakeholder meeting results show that women's participation in public consultation meetings was limited. It is therefore necessary to organize smaller meetings or FGDs specifically targeted at women to capture their views and feedback. The following tables summarize FGD results, including those targeting general PAHs, community leaders, and women. Even in FGDs targeting PAHs and community leaders, some male participants mentioned that women's participation in decision-making is limited. In the FGDs targeting women, female participants described that while decisions within the family are made by both men and women, women's opinions are often not incorporated in decision-making outside the household.

Table 8.3.2 FGD Outcomes (Common for BWDB and LGED)

No.	Date and Venue	FGD Target	Discussions
1.	25 October 2025, 10:00 AM, Makalkandi Haor	PAPs (Landowners)	Women's decisions are less valued.
2.	26 October 2025, 4:00 PM, Halir Haor	PAPs (Landowners)	Women's opinions receive less value in decision-making.
3.	30 October 2025, 4:00 PM, Chaptir Haor	PAPs (Landowners)	Women's participation in decision-making limited.
4.	7 November 2025, 4:30 PM Shanir Haor	Community Leaders	Women's participation in development limited.

Source: SCM Records

Table 8.3.3 Outcomes of FGDs for Women (Common for BWDB and LGED)

No.	Date / Place	Issues Raised
1.	**24 October 2025, 4:00 PM** **Karchar Haor (Women Group)** Jogonnathpur, 9 No Ward, Gourarong Union, Sunamganj Sadar Upazila, Sunamganj District	Women have no specific profession and entirely dependent on their husbands' income. Farming and cattle rearing by men are not available year-round. Moderate education level: approximately 60% boys and girls study up to college. Limited employment opportunities directly accessible to women. Fear during monsoon as homesteads risk submergence; houses 7–8 ft above road. Severe shortage of safe drinking water; collected from distant sources. Communal pond exists but is insufficient for daily use. Requested sewing machines and mobile phones for livelihood improvement.
2.	**29 October 2025, 1:10 PM** **Pathar Chaoli Haor (Women Group),**	Household decisions are made jointly, but male opinions tend to dominate. Women participate in livestock rearing and family finances. Women generally require permission for social activities or travel. There is a need for sewing machines, training, and livestock distribution. Village road repairs needed. Women's opinions are valued in health and savings decisions.

No.	Date / Place	Issues Raised
	Parkul, Companiganj, Sylhet	The community request for cottage industry training and better housing.
3.	**31 October 2025, 2:30 PM** **Baram Haor (Women Group)** Kholapara, 7 No Ward, Habibpur Union, Shalla Upazila, Sunamganj District	No specific women's livelihood; most women are dependent on their husbands' income. Men rely on farming, cattle rearing, and seasonal work. Low education levels: most individuals study up to high school only. College requires BDT 8,000–10,000 per month—unaffordable for most. The haor remains waterlogged for approximately six months per year, leaving no alternative employment. Computer training centre nearby but trainers do not attend regularly. No access to doctors or health workers; community clinics rarely functional in monsoon. Severe shortage of safe drinking water. No old-age allowance received in the union. Communal pond exists but insufficient. Requested sewing machines and mobile phones for income and communication.
4.	**4 November 2025, 1:00 PM** **Humaipur Haor (Women Group),** Chatirchar, Nikli, Kishoreganj	Household decisions are made jointly. Health centres are needed. Women participate in livestock rearing and family financial management. Women generally need permission for social activities. Sewing machines, training, livestock distribution are needed. • Village road repairs and new roads required. Re-excavation of rivers and canals; permanent embankment; drainage system. Household chores are mostly done by women. Women's role in fisheries and agriculture are important. Literacy levels are low, with girls performing better ahead.

Source: FGD Records

Gender-related FGD outcomes and existing BBS socio-economic data were summarized in the following tables.

【Flood Prevention Infrastructure Development】

Table 8.3.4 Outcomes of FGDs on Flood Prevention Infrastructure Development

No.	Item	Outcome
1.	Member composition (by gender) of community-led flood infrastructure maintenance groups	A respondent stated that women's participation in development is limited.
2.	Access restrictions and disparities within the group due to gender	A respondent stated that women's participation in development is limited. Women generally need to obtain permission for social activities, travel, or go out.
3.	Gender differences in voice within the group	While women's opinions are given importance in household decisions regarding health and savings, there is a perception that men's opinions dominate, even though general household decisions are jointly made by men and women. Respondents commonly stated that women's participation in discussions outside the household and in decision-making is limited.

Source: FGD Records

【Agriculture Infrastructure Development】

Table 8.3.5 Outcomes of FGDs on Agriculture Infrastructure Development

No.	Item	Outcomes
1.	Gender-based differences in the use of rural infrastructure and related issues regarding access and utilization	A respondent stated that women's participation in development is limited. Women generally need to obtain permission for social activities and to travel.

Source: FGD Records

【Agriculture and Fishery Promotion Activities】

Table 8.3.6 Outcomes of FGDs on Agriculture and Fishery Promotion Activities

No.	Item	Outcome
1.	Status of rigid/traditional gender-based division of labour	Most women are responsible for household chores, care work, and community activities on their own (Humaipur Haor).
2.	Differences in labour burden by gender (agriculture, fisheries, household chores, care work, community activities), including whether household and care work is disproportionately borne by women, and whether livelihood improvement support for women imposes additional burdens	Most women are responsible for household chores, care work, community activities on their own (Humaipur Haor).
3.	Gender composition of fishery management groups	Women have no role in fisheries management groups (Humaipur Haor).
4.	Status of gender-based access restrictions or disparities within these groups	A respondent stated that women's participation in development is limited. Women generally require permission for social activities or travel.
5.	Differences in influence or decision-making power by gender within these groups	While women's opinions are given importance in household decisions regarding health and savings, there is a perception that men's opinions dominate, even though general household decisions are jointly made by men and women. Respondents commonly stated that participation in discussions outside the household and in decision-making are limited.
6.	Existence of women’s groups or support organizations in agriculture and fisheries	Although there are no formal women's groups or support organizations in the agriculture and fisheries sectors, women play a vital role in agricultural production and fisheries processing (Humaipur Haor).
7.	Literacy and school enrolment rates by gender	• Literacy rates in the target haor areas are generally in the 60-70% range, which is lower than the national average of 76.8%. • FGD results shows a mixture of opinions that school enrolment rates were high and low. According to BBS literacy data compiled by haor, literacy rates for men and women vary slightly. The lowest literacy rates for individuals aged 15 and over among the three haor areas ranged from 50.68% (female in Nikli Upazila for Humaipur Haor) to 65.05% (male in Sunamganji Sadar Upazala for Karchar Haor) and indicate no general trend toward higher or lower educational levels by upazila or haor. For details of the relevant statistical data, see Section 4.2.9 Socio-economic Data. • Moderate education levels: approximately 60% of boys and girls study up to college (Karchar Haor). • The Haor region is generally not highly educated; however, girls are slightly ahead (Humaipur Haor). • Low education levels: most students study up to high school only (Baram Haor).
8.	Differences in access to markets by gender	Regarding market access, it was mentioned in general terms that access is worse during the monsoon season only (e.g., VPWs are needed to reach the market at Shonir Haor). There were no specific view on market access in terms of gender mainstreaming. Furthermore, it was stated that women's participation in development is limited.
9.	Distribution of female-headed households and government support status by government agencies	Although there is no data specifically for widowed households, BBS upazila-level marriage data for the target haors shows that the proportion of widowed/widowered households is low, ranging from 4.37% to 6.77%. The proportions of divorced and separated households are very low, ranging from 0.14% to 0.57% and 0.26% to 0.56%, respectively.
10.	Existence of gender-related policies within the executing agencies	**BWDB**: No formal gender policy has been identified; however, the Guidelines for Participatory Water Management (Ministry of Water Resources, 1999) engage women's participation. Membership in the Water Management Group and Water Management Association is open to women, and 30% of the Labour Contracting Society (LCS) positions are reserved for women. **LGED**: Based on the National Women Development Policy (2011), LGED formulated its Gender Equality Strategy (GES) to mainstream gender equality in all areas of LGED's activities. The Gender Equality Development Training Manual (LGED, Gender and Development Forum, 2022) was also prepared under ADB’s

No.	Item	Outcome
		TA-9575 BAN: Institutionalizing Gender Equality Practices in LGED.
11.	Appointment of gender focal points within the implementing agencies	**BWDB**: While there is no identified department responsible for gender, each project addresses gender issues. The National Water Policy stipulates that BWDB's responsibilities include environmental and social safeguards, stakeholder participation (with an emphasis on women's participation), community participation, inclusion of vulnerable groups, and strengthening women's role in water management. **LGED:** The Environmental and Gender Section was established to oversee environmental and social safeguards, LCS, gender mainstreaming, and monitoring the inclusion of vulnerable groups. Furthermore, LGED has strengthened gender mainstreaming through ADB-funded TA-9575 BAN: Institutionalizing Gender Equality Practices in LGED. The Gender Equality Development Training Manual (LGED Gender and Development Forum, 2022), compiled under this TA, states that the Gender and Development Forum (GAD Forum) within LGED is responsible for gender issues.

Source: Relevant Policy and Manual, FGD Records, BBS Census Data (2022)

8.3.3 Outcomes of Social and Gender Analysis

From the perspective of promoting gender equality and women's empowerment, national legislation, executing agencies' policies, and FGD outcomes regarding the roles, challenges, and needs of men and women organizations have been analysed. The key challenges identified are summarized in the table below. While gender-related laws and policies are relatively well established; traditional division of roles between men and women remains strong.

CHAPTER 9 PROJECT EFFECTS

The effects expected to be obtained by the project were evaluated separately in terms of quantitative and qualitative effects.

9.1 Quantitative Effects

9.1.1 Economic Analysis

An economic analysis was conducted to ascertain the impact of the project on society as a whole and to evaluate the economic relevance of the project by calculating the difference in economic benefits between the "with project" case and the "without project" case, as well as assessing the project's financial plan. Based on the base-case scenario and several assumed cases in the sensitivity analysis, the economic internal rate of return (hereinafter referred to as "EIRR"), the benefit-cost ratio (hereinafter referred to as "B/C"), and economic net present value (hereinafter referred to as "ENPV") were calculated. In this report, the "with project" case and the "without project case" are defined as follows:

- ✓ **"With project case":** In the Haor region, the implementation of flood control facilities, the repairing and constructing rural infrastructure, and the promotion of agriculture and fisheries are expected to reduce flood damage in the area, improve access to basic infrastructure, and enhance agricultural and fisheries productivity.
- ✓ **"Without project case":** In the Haor region, the lack of implementation of flood control facilities, the restoration and construction of rural infrastructure, and agricultural and fisheries promotion activities means that flood damage in the region will not be mitigated, and improvements in access to basic infrastructure and agricultural and fisheries productivity will not be achieved.

(1) Applied Guidelines

The following guidelines were referred to in the analysis.

- "IRR (Internal Rate of Return) Calculation Guideline", 2019, JICA Review Task Force
- "IRR (Internal Rate of Return) Calculation Manual", 2017, JICA Operations Strategy Department
- "Handbook on Cost-Benefit Analysis (CBA) of Public Investment Projects: Applications with Excel Examples", 2024, Bangladesh Planning Commission
- "Guideline for Development Project Preparation, Processing, Approval & Revision", 2022, Bangladesh Planning Commission
- "Development Project Proforma/Proposal (DPP) Manual (Instructions for Preparing Development Project Proposal) Part-1: Main Guideline", 2014, Bangladesh Planning Commission
- "Guidelines for Effect Monitoring and Evaluation (EME) of Road and Market Improvement", 1999, LGED
- "Guidelines for Project Assessment", 1992, Flood Plan Coordination Organization (Ministry of Irrigation, Water Development and Flood Control of the People's Republic of Bangladesh)

(2) General Assumptions

The following assumptions were made in the economic analysis presented in this chapter.

- Social discount rate: 12%[1]
- Exchange rates:
  - USD 1 = JPY 151[2]
  - USD 1 = BDT 122[3]

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1 "Handbook on Cost-Benefit Analysis (CBA) of Public Investment Projects: Applications with Excel Examples", 2024, Bangladesh Planning Commission
2 "Bangladesh: FY2025 Yen Loan Common Matters for Evaluation", October 2025, JICA
3 "Bangladesh: FY2025 Yen Loan Common Matters for Evaluation", October 2025, JICA

- Standard Conversion Factor (hereinafter referred to as the "SCF") [4]: 0.90

(3) Economic Benefit

There are economic benefits associated with both the BWDB part and the LGED part in this project. These benefits are explained in this section.

(a) Economic Benefit of the BWDB Part

The economic benefit of the BWDB part of the project which is the flood damage reduction benefits in harvest of Boro Rice, namely, flood damage reduction benefits related to the harvest of Boro rice that would be reduced by the construction of flood control facilities, flood forecasting and early warning systems, and agricultural promotion activities, is calculated.

(b) Economic Benefit of the LGED Part

The economic benefits of the LGED part of the project were calculated as follows:

1) Reduction in vehicle operating costs (hereinafter referred to as "VOC") due to road improvement,

2) Reduction in travel time costs (hereinafter referred to as "TTC") due to road improvement,

3) Quality degradation savings (hereinafter referred to as "QDS") due to market improvement,

4) Reduction in erosion damage due to Village Protection Wall (VPW) works, and

5) Benefits from fishery promotion activities.

(4) Results of the Economic Analysis

(a) Base Case

The cost-benefit flow analysis based on the above assumptions resulted in an overall EIRR of 21.4%, and ENPV of BDT 8,419.8 million, at a social discount rate of 12%. The EIRR exceeds the social discount rate of 12%, indicating that the project is economically justified.

Table 9.1.1 Results of the Economic Analysis

	EIRR	ENPV
BWDB Part	19.1%	BDT 3,264.1 mil. (JPY 4,040.0 mil.)
LGED Part	23.5%	BDT 5,181.4 mil. (JPY 6,413.0 mil.)
From road improvement and rehabilitation	22.1%	BDT 3,597.8 mil. (JPY 4,453.0 mil.)
From market improvement	45.2%	BDT 262.3 mil. (JPY 324.6 mil.)
From village protection wall works	31.8%	BDT 458.8 mil. (JPY 557.8 mil.)
From fishery promotion	22.0%	BDT 741.0 mil. (JPY 917.2 mil.)
Whole Project	21.4%	BDT 8,445.5 mil. (JPY 10,453.0 mil.)

Source: JICA Survey Team

9.1.2 Financial Analysis

No financial analysis is carried out for this project because it does not involve future government fee revenues, in accordance with the Japan International Cooperation Agency (JICA) IRR manual[5].

9.1.3 Operational and Effectiveness Indicators

[4] In developing countries, market prices often diverge from their true social opportunity costs due to tariffs, subsidies, price controls, monopolies, and other factors. Therefore, it is necessary to calculate the economic price of goods and services by multiplying the market price by a "standard conversion factor". The Standard Conversion Factor used in this report was derived from "Development Project Proforma/Proposal (DPP) Manual (Instructions for Preparing Development Project Proposal) Part-1: Main Guideline".

[5] Source: "IRR (Internal Rate of Return) Calculation Manual", 2017, JICA Operations Strategy Department

Regarding the operation and effectiveness indicators of the project, the following effectiveness indicators are proposed for use. An ex-post evaluation will be conducted two years after the project completion (2035).

(1) Operational and Effectiveness Indicators for the BWDB Part

The operational and effectiveness indicators for the BWDB part are shown in Table 9.1.2 below.

Table 9.1.2 Operational and Effectiveness Indicators for the BWDB Part

Indicator	Baseline Value	Target Value	Reasoning and/or Remarks
Operational Indicator			
Lead time ensured by the constructed flood forecasting system	Up to 72 hours	Improvement in actual values (more than 72 hours)	The lead time for flood forecasting in the project area is currently three days. There is a need to extend the lead time to support early harvesting of Boro rice. While it is possible to extend the lead time by utilising ensemble forecast rainfall data, the feasibility of extending the lead time without compromising the accuracy of forecasts will be examined, and a numerical target will be set.
Forecast accuracy ensured by the constructed flood forecasting system	-	Improvement from baseline values	Specific indicators and numerical targets will be determined after confirming the current operational status. The basic numerical target is to improve the current accuracy of the flood forecasting system.
Effectiveness Indicator			
Frequency of flooding in the project haor due to external water (flash floods) during the pre-monsoon season	Three (3) times in the last 15 years (2010, 2017, and 2022)	One (1) time or less	The flood control facility is to prevent flooding damage in the project haor caused by flash floods in the pre-monsoon season. Since the design water level of the submerged embankment corresponds to the 10-year probability flood level under future climate conditions. The possibility of flooding in the project haor due to external water in the pre-monsoon season in the first two years after the facility begins operation is less than one.
Area affected by pre-monsoon floods (%)	15%	0% (in case of flush floods with the size of less than a 10-year flood)	Average annual pre-monsoon flood damaged areas (% of total cultivable area), including flash floods. This indicator is currently used by the implementing agencies to evaluate the effectiveness of Phase 1.
Percentage or number of beneficiaries covered by the flood forecast who were able to obtain and use flood forecast information	-	Improvement from baseline values	Specific indicators and numerical targets will be set after confirming the current operational status. The basic numerical target is to improve the penetration rate of the current flood forecasting system penetration rate.
Area of growing early-harvesting, cold-resistant rice varieties in introduced areas	0 ha	More than half the total area	The reduction in Boro rice harvest due to flash flood increases with delayed harvest. Planting early-harvested and cold-resistant rice varieties with shorter harvest periods in the target haor can reduce these losses.
Average income of farmers involved in the introduction and	Approx. BDT 150,000	BDT 200,000	In the Haor region, irrigation water scarcity due to drought necessitates the adoption of water-

Indicator	Baseline Value	Target Value	Reasoning and/or Remarks
promotion of water-saving intermittent cultivation, rice straw compost, and silicate materials			saving intermittent cultivation practices, which reduce both water use and labor hours. In addition, the application of rice straw compost and silicate materials can prevent rice blast disease, thereby reducing the loss of income. The target value of 200,000 BDT is based on an estimated 30% increase in yield resulting from introducing AWD and the application of compost, raising the average income from approximately BDT 150,000 in the base year to BDT 200,000, an increase of about BDT 5,000. As this value is set based on the current price level, the degree of improvement in household income will be assessed at the time of the pre-completion evaluation, taking into account the socio-economic conditions faced by agricultural households, such as rice prices.
Cultivated area where field crops are cultivated in the haor and where field cash crops are introduced	0 ha	More than half the total area	From the current situation of Boro rice monoculture, the introduction of a field cash crop and an expansion in cropland area is expected to increase household income.
In haors where the introduction and promotion of home gardening and animal husbandry for women is practiced, including: 1. Number of women practicing home gardening 2. Number of women with increased income	1. 0 2. 0	1. More than half 2. More than half	Introduction of vegetable gardens, livestock rearing (e.g. ducks and others), worm composting, and similar activities will increase women's income and contribute to the stabilisation of household finances.

Source: JICA Survey Team

(2) Operational and Effectiveness Indicators for the LGED Part

The operational and effectiveness indicators for the LGED part are shown in Table 9.1.3 below.

Table 9.1.3 Operational and Effectiveness Indicators for the LGED Part

Indicator	Baseline Value	Target Value	Reasoning and/or Remarks
Operational Indicator			
Average Annual Daily Traffic (AADT)	980 vehicles/day	1,300 vehicles/day	Traffic volume was identified as an indicator of the operational status of the developed rural infrastructure.
Effectiveness Indicator			
Average Annual Daily Traffic (AADT)	980 vehicles/day	1,300 vehicles/day	The objectives of the rural road infrastructure development are to reduce and expedite the removal of agricultural products damaged by flooding in the target haor areas, and to improve access to public service facilities. An increase in traffic volume was designated as an indicator of improved removal efficiency and accessibility.

Indicator	Baseline Value	Target Value	Reasoning and/or Remarks
Increased market sales due to market improvements	BDT 1,670,000/market	BDT 2,500,000/market	The goal is to increase economic activity by improving the targeted growth centers and rural markets. The increase in sales per market is used as an indicator. Since this value is set based on the current price levels, the degree of improvement in household income will be assessed during the pre-completion evaluation, taking into account socio-economic conditions faced by fishing households, such as fish prices.
Number of houses and utilities with reduced erosion risk due to Village Protection Walls (VPWs)	0	1,400	The number of houses and public facilities protected from wave erosion is reduced by constructing village protection walls is used as an indicator. In principle, the number of houses and facilities located on the periphery of the village that are effectively safeguarded by these walls.
Increase in fish catch	230 kg/ha/year	660 kg/ha/year	Short-term increases in catch are often difficult to observe, becoming more apparent only through cumulative effects over successive years. Typically, organised fishing activities by BUGs occur from late November, when the water levels recede, until about March of the following year. Therefore, it is desirable to aggregate and compare catches for the past year in March or April of each year. However, since fishing activities by individual fishermen are conducted year-round, it is necessary to select and sample multiple fishermen to monitor monthly catches, thereby enabling accurate comparison annual catches.
Household income and assets from fishing activities	BDT 70,000/household/year	BDT 150,000/household/year	Fishery income and income from processing catch fluctuates significantly depending on seasonal factors (e.g. rainy and dry seasons, flood magnitude, length of fishing season length); therefore, by summarising them on yearly basis, seasonal fluctuations between seasons can be normalised, allowing comparison as a more stable indicator. The target value is established based on the current price level. When assessing the effects at the end of the project, the degree of improvement in income levels will be confirmed based on the socio-economic conditions faced by fishing households at that time, including fish prices and main living expenses.
Fish Diversity	90 ～ 100 species	120 ～ 130 species	Similar to the two indicators above, fish species diversity is difficult to observe in the short

Indicator	Baseline Value	Target Value	Reasoning and/or Remarks
			term. Furthermore, since catch volume and diversity fluctuate significantly due to seasonal factors (spawning season, flooding/drought, and migration/recruitment), it is necessary to monitor monthly catch volumes and compare them annually through year-round accumulation. Therefore, data collectors are assigned to each water area to conduct regular surveys on multiple days each month, recording catch volumes by fish species.
Percentage of women participating in alternative livelihood and income-generating activities (e.g., home pond aquaculture, small-scale fish processing and dry fish production, household-based petty trading, and poultry rearing)	15 ～ 20%	35%	While the female participation rate improved to 28-32% at the end of the project in the Phase 1 target sites, participation is considered limited in the new target sites. In particular, it is assumed that women's participation in BUG management and processing activities is partial.
Percentage of women in positions and reflected in minutes BUGs	Positions: less than 5% Minutes reflection: almost 0%	Positions: 30% Minutes reflection: 25%	The percentage of women in Executive (Managing) Committee positions (Chair, Vice Chair, Secretary, Treasurer, etc.) and the percentage of agenda items proposed or raised by women that were adopted in the minutes and acted upon—these metrics measure not just the "number of participants", but "how much women are able to participate in BUG operations".

Source: JICA Survey Team

9.2 Quantitative Effects

There are several important benefits that are difficult to quantify in economic value but have significant impacts to society. The potential intangible benefits are briefly reviewed and summarised below.

(1) Qualitative Effects for the BWDB Part

(a) Establishment of the Methodology for Planning the Layout of Flood Control Facilities in the Haor Area

The soft component of the project utilises inundation analysis to plan the layout of flood control facilities, predict overflow points in haors and optimise the slope protection works of submerged embankments. This approach reduces flood damage not only to the levee area but also to the flood control facilities themselves. It is expected that this method will be adopted as a standard for planning the layout of flood control facilities in the Haor area in the future.

(b) Establishment of Topography Estimation Method Using Satellite Images in the Haor Area

In the soft component of the project, satellite imagery is employed to determine the topography of the Haor area with high accuracy and simplicity. The resulting topographic map can be utilised for flood inundation analysis, and topographic changes over time can also be determined. This method eliminates the need for certain field surveying in the vicinity of the project haor, thereby reducing survey costs. It is expected that this method will serve as a standard for future topographic estimation in the Haor area.

(c) Reduction of Large-Scale Flood Damage through the Introduction of Flood Forecast and Early Warning Systems

The introduction of a flood forecasting and early warning system as a soft component of the project will ensure residents receive advance notification even when floods exceed the design standards of the embankments. This enables the early harvesting of vulnerable and damaged rice crops before flooding occurs, facilitates the evacuation of assets and residents themselves, and minimises overall damage. Furthermore, the implementation of this system is expected to provide qualitative mitigation benefits against risks associated with the uncertainties of climate change impact assessments.

(d) Damage reduction on Fisheries Output

Implementation of flood control projects reduces flood damage, thereby providing benefits such as preventing declines in resource quantities for fishery products—not only agricultural crops—due to overflow and loss of aquaculture ponds and storage facilities, fish dispersal, loss of spawning grounds in natural waters, and fish mortality from high turbidity. Furthermore, implementing flood control projects can reduce damage to fishing gear, boats, and infrastructure facilities that occurred during flash floods, thus providing additional benefits through reduced flood-related damage.

(e) Reduction in Human Dislocation

The economic cost of dislocation of dwellers can be reduced because flooding will be reduced by the Project. The beneficiaries can allocate their saved expenses and time to other economic activities, such as agriculture, or own business.

(2) Intangible Effects for the LGED Part

(a) Increase in Job Opportunities in the Area

According to the past project impact assessment in Sunamganj District, approximately 94% of respondents reported an improvement in job opportunities after the project. The construction of facilities, as well as operation and maintenance activities under the Project implementation creates a direct impact to the local community. Furthermore, some residents living around the road development project have better access to the city centre, where more jobs are available. They also have the opportunity to work as rickshaw drivers along the developed road.

(b) Increase in Trade Activities

Trade and businesses along the project area are expected to accelerate due to improved road networks. Farm and fishery beneficiaries can save time and reduce cost in transporting fertilisers, crops, and labour outside the area. Furthermore, businesses are likely flourish, and increase in land prices within the project site are expected due to the influence of improved economic environment.

(c) Better Access to Social Services such as NGOs, Farmers Organisations, Schools, and Hospitals

The project beneficiaries will have easier access to various social services. Several NGOs and farmers' organizations provide training, educational opportunities, and micro-credit schemes in the area. The improvement of access to these services is expected to contribute significantly to rural society development. Referring to other published project reports, improved access to social services tends to have a positive impact to women and children who are facing severe conditions in the society. Consequently, this may lead to more effective poverty reduction.

(d) Increase in Electricity Accessibility

Reliable access to electricity is essential for socioeconomic development, yielding benefits for public health, social welfare, and economic production. Since power lines are typically installed along roads, areas with inadequate road infrastructure have historically experienced lower electrification rates. Improving rural roads is therefore expected to help address this challenge.