Report on

# Ecological Assessment and Detailed Scoping Study in the Sundarbans and Hakaluki Haor Ecologically Critical Areas (ECA) for Nature-based Solutions (NbS) and Locally Led Adaptation (LLA)

## Adaptation in Ecologically Critical Areas in Bangladesh (AECAB)

**August 2024**

*NABAPALLAB, a consortium led by CARE in partnership with*

Report on

# Ecological Assessment and Detailed Scoping Study in the Sundarbans and Hakaluki Haor Ecologically Critical Areas (ECA) for Nature-based Solutions (NbS) and Locally Led Adaptation (LLA)

**Submitted by**
Center for Natural Resource Studies (CNRS)
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**Photo by**
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**Published on**
August 2024

# Acknowledgement

On behalf of the NABAPALLAB consortium and CARE, we are pleased to present the report **'Ecological Assessment and Detailed Scoping Study in the Sundarbans and Hakaluki Haor Ecologically Critical Areas (ECA) for Nature-based Solutions (NbS) and Locally Led Adaptation (LLA)'**. The study carried out by the Center for Natural Resource Studies (CNRS) and the Centre for Climate Change and Environmental Research (C3ER) of BRAC University, and coordinated by CARE, looked into the salient climatic, geophysical, socio-economic challenges and scopes with respect to the biodiversity dependent community of the two ECAs. The report shapes the scope of ecology-based adaptation (EbA) interventions in FCDO's flagship project **Adaptation in Ecologically Critical Areas in Bangladesh (AECAB)**, locally known *as* **NABAPALLAB - Nature Based Adaptation towards Prosperous and Adept Lives & Livelihoods in Bangladesh**, led by CARE.

Apart from CARE, CNRS and C3ER, the other six consortium members – CordAid, Dushtha Shasthya Kendra (DSK), Friendship, Humanity & Inclusion (HI), iDE, and Practical Action – supported on the ground data collection and interview process ensuring a participatory approach of climate vulnerable communities as well as local and national level public and private stakeholders.

We are grateful to the UK Foreign, Commonwealth and Development Office-FCDO of the UK government; without their financial support and technical guidance, the study wouldn't be possible.

We would like to sincerely thank the members of the ECA communities for their active participation in the consultations and for contributing invaluable insights that will shape our future endeavours. We extend our heartfelt gratitude to the Focus Group Discussion (FGD) and Key Informant Interview (KII) participants, and Government officials whose valuable insights and candid responses have been instrumental in shedding light on crucial aspects of our research. Their engagement and collaboration have been pivotal in shaping the context and understanding of our study.

My sincere acknowledgement to CARE UK and Bangladesh colleagues who held the study together both in terms of scope and methodology and finally working with CNRS and C3ER to finalise the report presented here.

**Selina Shelley Khan**

Chief of Party, NABAPALLAB, Humanitarian & Climate Action Program

CARE Bangladesh

# Acronyms

| | |
|---|---|
| ANR | Assisted Natural Regeneration |
| BBS | Bangladesh Bureau of Statistics |
| BCCSAP | Bangladesh Climate Change Strategy and Action Plan |
| BccGAP | Bangladesh Climate Change Gender Action Plan |
| BDPC | Bangladesh Disaster Preparedness Centre |
| BFD | Bangladesh Forest Department |
| BWDB | Bangladesh Water Development Board |
| BMD | Bangladesh Meteorological Department. |
| CBOs | Community-Based Organisations |
| CPP | Cyclone Preparedness Program |
| CPR | Common Pool Resources |
| CREL | Climate-Resilient Ecosystems and Livelihoods |
| CRA | Community Risk Assessment |
| CBD | Convention on Biological Diversity |
| CBAECA | Community-Based Adaptation in the Ecologically Critical Areas through Biodiversity Conservation and Social Protection |
| CBNRM | community-based natural resource |
| CI | Corrugated Iron |
| CSOs | Civil Society Organizations |
| CWBMP | The Coastal and Wetland Biodiversity Management Project |
| DAE | Department of Agricultural Extension |
| DDM | Department of Disaster Management |
| DWA | Department of Women Affairs |
| DoE | Department of Environment |
| DoF | Department of Fisheries |
| DLS | Department of Livestock Services |
| DPHE | Department of Public Health Engineering |
| DRR | Disaster Risk Reduction |
| EbA | Ecosystem-based Adaptation |
| ECAs | Ecologically Critical Areas |
| ESs | Ecosystem Services |
| EWS | Early Warning System |
| FCDO | Foreign, Commonwealth and Development Office |
| FGDs | Focus Group Discussions |
| IUCN | International Union for Conservation of Nature |
| IPAC | Integrated Protected Area Co-Management |
| ICS | Improved Cocked Stoves |
| KIIs | Key Informant Interviews |
| LPG | Liquefied Petroleum Gas |
| LLA | Locally Led Adaptation |
| LGI | Local Government Institute |
| M&E | Monitoring and Evaluation |
| MCA | Multi Criteria Analysis |
| MCPP | Mujib Climate Prosperity Plan |
| MoDRM | Ministry of Disaster Management and Relief |
| NAP | National Adaptation Plan |
| NbS | Nature-based Solutions |
| NBSAP | National Biodiversity Strategy and Action Plan |

| | |
|---|---|
| NDC | Nationally Determined Contributions |
| NGOs | Non-Governmental Organisations |
| PA | Protected Area |
| PEA | Political Economy Analysis |
| PES | Payment on Ecosystem Services |
| PIO | Project Implementation Officer |
| PSF | Pond Sand Filters |
| PwD | Person with Disabilities |
| RCC | Reinforced Cement Concrete |
| SLR | Sea Level Rise |
| RO | Reverse Osmoses |
| ToC | Theory of Change |
| ToR | Terms of Reference |
| UDMC | Upazila Disaster Management Committee |
| UNDP-GEF | United Nation Development Program Global Environment Facility |
| UNO | Upazila Nirbahi Officer |
| UTM | Universal Transvers Mercator |
| USGS | United State Geological Survey |
| USAID | United States Agency for International Development |
| VCF | Village Conservation Forums |
| VCG | Village Conservation Group |
| WASH | Water, Sanitation, and Hygiene |

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# Executive Summary

The Ecologically Critical Areas (ECAs) in Bangladesh, notably the Sundarbans and Hakaluki Haor are vital for biodiversity and livelihoods. The UK government's Adaptation in Ecologically Critical Areas known locally as NABAPALLAB- *(Nature Based Adaptation towards Prosperous and Adept Lives & Livelihoods in Bangladesh)* project aims to enhance resilience of the ecosystem and livelihoods through Nature-based Solutions (NbS) and Locally Led Adaptation (LLA). The project has conducted three separate assessments (Ecological Assessment and Detailed Scoping study; Stakeholder Mapping and Political Economy Analysis; and Baseline Study) simultaneously during its inception stage. This report synthesizes findings from the ecological assessment and detailed scoping study. Insights were gathered to understand ecological status, community needs, and intervention opportunities in the Sundarbans and Hakaluki Haor. The report further highlights current and emerging threats, drivers and complexities in both ECAs. The status of the natural resource base, degradation pattern and ecosystem health were also analysed and documented using physical data and recent satellite imagery.

In the Sundarbans, the study found different ecosystems, including wetlands, low-lying lands, riverside areas, homesteads, croplands, and coastal embankments. All of these ecosystems are affected by various climatic stressors such as salinity, tidal inundation, erratic rainfall, and cyclones. They are also impacted by anthropogenic drivers such as shrimp farming, water logging, overharvesting, illegal fishing, deforestation, poaching. For example, the study shows

that shrimp cultivation has a profound effect on agriculture with changes in land use and intrusion of saline water, which lead to decreased soil fertility, crop failure and lower productivity. Shrimp cultivation also contributes to surface water pollution, leading to scarcity of drinking water and negative impacts on WASH. The study also highlights significant threats to important endangered wildlife species in the Sundarbans ECA, including the Masked Finfoot and White-Rumped Vulture. In addition to the anthropogenic threats, the study has identified other problems such as fishing with poison, bird hunting, use of illegal fishing equipment, canal siltation, and intrusion of saline water into freshwater wetlands. These issues result in decreased fish population, depletion of wildlife and reduced agricultural productivity.

The Hakaluki Haor, encompassing 276 interconnected *beels* (wetland lakes) over an area of 18,000 hectares, faces significant threats from both anthropogenic and climate change stressors. Extensive sedimentation and agricultural expansion have led to the conversion of over 20 *beels* to agricultural production, impacting wetland productivity, aquatic vegetation, fish populations, and local livelihoods. Degradation of rivers, canals, and hill streams within the Haor has further exacerbated these problems and challenges, affecting crop production, fish yields, and biodiversity. Encroachment on protected swamp forest areas after phase-out of previous projects, wide-ranging deforestation, and conversion of raised land (*Kandas*) for agriculture have negatively impacted the habitats of fish and birds, and other wetland-dependent wildlife as well as waterfowl migratory routes. Furthermore, elite capture excludes poor fisher folk and landless individuals from fishing and accessing natural resources, while agricultural expansion in *Kanda* areas raises concerns about increased use of chemical pesticides and fertilizers that pollute wetlands.

Both ecosystems are affected by various climatic stresses: temperature rise, seasonal changes, drought, erratic rainfall, floods, cyclone, tidal surge, sea level rise and salinity. These are impacting the resource base, their compactness and productivity.

Government-managed wetland sanctuaries have experienced some governance challenges. For example, the land tenure of sanctuaries is owned by Ministry of Land (MoL); Department of Fisheries (DoF), under Ministry of Fisheries and Livestock (MoFL), is responsible for technical management of fisheries resources; and Department of Environment (DoE) is mandated to manage the ECA areas. However, there is currently no formal platform to coordinate these departments or ministries, which has led challenges in the governance of the wetlands. This is exacerbated by insufficient human and logistical resources in some of the respective departments, which combined with the geographical remoteness of the areas, has reduced ability to adequately monitor the sanctuaries.

Furthermore, the watershed of Hakaluki Haor suffers from soil erosion, encroachment (38% of the watershed), monoculture practices, improper management of bamboo *mohal* and illegal logging which have negative impacts on the wetlands downstream. These threats collectively intensify biodiversity concerns within the watershed, posing significant challenges to the ecological balance and the ecosystem's health and livelihoods of surrounding natural resource dependent communities.

Despite these challenges, communities have shared optimism about the potential for climate-resilient livelihoods and restoration of ecosystems through community-led management options, where ecosystem-based adaptation (EbA), Nature based Solutions (NbS) and Locally Led Adaptation (LLA) could be piloted. In this process, the marginalised and excluded communities are to be included. In small-scale agriculture, the study recognised the need for stress-tolerant species and varieties, and resilient poultry farming for poor and very poor dependent households. In addition, alternative and off-farm livelihood activities (e.g. handicrafts, tailoring, eco-tourism,

bee keeping, small business etc.) are essential for diversification of employment and income sources to reduce dependency on excessive harvesting from ECA.

The study has identified opportunities for adoption of clean and renewable energy options such as solar power and biogas. There is also potential for addressing energy accessibility issues to support resilient livelihoods and enhance income-generating activities, particularly for women and youth. Furthermore, the report highlights the urgent need for climate-resilient community infrastructures and WaSH facilities to mitigate the impacts of climate extremes on communities. Capacity-building initiatives targeting farmers, fisherfolk, women, and youth are crucial for enhancing skills and knowledge related to EbA, NbS, and resilient livelihoods.

The study has identified nature-based solutions (NbS), specifically EbA, as an effective approach to protect, restore and sustainably manage the ECA ecosystems, including canal restoration and afforestation. It provides human wellbeing and biodiversity benefits. The study recognized that collaborative efforts among government agencies, local communities, and environmental organisations are crucial for fostering long-term sustainability and resilience in the face of climate change. Besides, the study findings found that the resilience capacity of, and community members will benefit from increased technical knowledge related to climate change adaptation, EbA, and NbS. Despite this, community members, especially women, youth, and vulnerable groups (such as persons with disability, elderly people, and marginalised groups) are interested in engaging in activities to address the challenges posed by climate-related impacts on ecosystems and livelihoods. sectoral agencies at the local and regional levels

In the Sundarbans ECA, proposed NbS initiatives involve restoring 382 canals through community-based management, identifying 1,988 ha for potential mangrove restoration to safeguard against cyclones and tidal surges, and planting 228 km of embankment. In Hakaluki Haor ECA, the study identified opportunities to contribute to restoring seven sanctuaries covering 130.22 ha; afforesting *kanda* land to revive swamp forest across 550 ha; restoring six rivers covering 59 km; and introducing participatory land use planning involving all interest groups (farmers, fisher folk, *bathan* operators, lease holders and local administration). In the watershed area of the Hakaluki Haor, efforts focus on restoring 15,700 ha of forest, afforesting 200 km of strip/riparian land and establishing 2000 homestead plantations. Considering the resource availability, NABAPALLAB will demonstrate all of these interventions on a small scale to set an example to the community, while initiative will be taken to engage respective stakeholders through advocacy and capacity building activities for scale up the implementation. These interventions align with the identified and prioritised interventions in the Bangladesh National Adaptation Plan (NAP), which is analysed in more detail in the Political Economy and Stakeholder Analysis.

Many poor women are engaged in fuel and fodder collection as well as the collection of fish and vegetables both from the Sundarbans and Hakaluki Haor ECAs. A few poor women and their families also use water bodies in the Haor for duck farming. It has been reported that the women, girls, and people with disabilities are facing greater climate risks and vulnerability in agriculture, home gardening, water and firewood collection, WASH, increasing health risks, raising poultry and livestock, and small businesses. Inclusive policies, community engagement, changes in social norms and targeted interventions are needed to enhance resilience and mitigate the adverse effects of climate change on vulnerable groups. To promote resilience and sustainable development for local communities, it is essential to include women, youth, people with disabilities, and entrepreneurs in planning for climate adaptation, managing resources, and growing eco-friendly businesses like eco-tourism, handicraft making, vermicompost production, home gardening, etc. In both the ECAs, the study found that whilst women are part of ECA management committees, they do not have as much decision-making power as men in these forums. This illustrates a need to work on promoting women's voice and leadership to ensure more equal decision making within ecosystem and natural resource management.

The study also underscores various actors and stakeholders' pivotal role in planning and implementing EbA, NbS, and resilient livelihood interventions, including government agencies, NGOs, and local communities. Collaboration and coordination among these actors are critical for enhancing the effectiveness and sustainability of projects.

Lastly, the report emphasises the alignment of project interventions with existing government policies and strategies, such as the National Adaptation Plan (NAP), Bangladesh Climate Change Strategy and Action Plan (BCCSAP), and Mujib Climate Prosperity Plan. However, it also identifies gaps in relatively older policies that need urgent attention and advocacy. For example, policy engagement is required with the Bangladesh Forest Department (BFD) and Department of Environment (DoE) to advocate for the integration of EbA and LLA approaches into National Biodiversity and Strategy Action Plans (NBSAP) and ECA Rules.

In conclusion, the ecological assessment and detailed scoping study findings provide valuable insights and recommendations for revisiting the NABAPALLAB implementation strategy and guiding the choice and design of future interventions to enhance resilience to climate change and promote sustainable livelihoods while contributing to improving biodiversity and ecosystem services in both ECAs. By prioritizing community participation, gender inclusion, and stakeholder collaboration, NABAPALLAB can collectively work towards building a more climate-resilient and prosperous future for all.

***Keywords:*** *Anthropogenic activities, Biodiversity, Climate Change, Hakaluki Haor ECA, LLA, EbA, NbS, Governance, Livelihood, Climate Action, Sundarbans ECA, Wetland Sanctuary.*

# 1. Background and Introduction

The Sundarbans and Hakaluki Haor Ecologically Critical Areas (ECAs) in Bangladesh though threatened, are still rich in diverse natural resources and biodiversity. Thousands of people living in and around the ECAs depend on the natural capital of these ECAs for their employment, income, food, nutrition, health and livelihoods. Hence, there is urgent need for protection, conservation and restoration of ecosystems and the ecosystem services (ESs) that could be harnessed and utilised to enhance resilient livelihoods and adaptation to climate change by the most vulnerable last mile communities[1].

The Sundarbans ECA faces ongoing climatic challenges including intrusion of saline water due to sea level rising, tidal inundation, extreme weather events (cyclone, storm surges, erratic rainfall, and heat wave). In addition, the ECA faces anthropogenic threats including deforestation and habitat loss, monoculture farming practices, land leasing, conversion, and privatization of wetlands (including canals and rivers), pollution, poison fishing and poaching, and additional pressure from economic migrants. Additionally, encroachment on charland by shrimp farming and rapid urbanization further compound these issues. Industrialization and frequent breaching of coastal embankments are also significant threats to ecosystems within the Sundarbans ECA.

[1] CARE Inc., (2022): FCDO's Ecosystem-Based Adaptation in Ecologically Critical Areas of Bangladesh, VIP Road, Mohakhali, Dhaka

Similarly, in Hakaluki Haor, encroachment, conversions, and privatizations of wetland habitats, overharvesting of resources, clearing of swamp forests, poor management of sanctuaries, expansions of agriculture in wetland areas, wildlife poaching, and unsustainable watershed management are critical anthropogenic threats. Besides prolonged drought, frequent flash flooding, increased run-offs, and high sedimentation rates silting up wetlands are common climate-induced threats that, in combination with the impacts of human-induced threats, result in degrading loss of biodiversity and human livelihoods within the ecosystems.

Community-based natural resource management (CB-NRM) started in Bangladesh in the early 1990s under different donor-assisted projects (MACH, SEMP, WBRP, CBFM-II, CWBMP, IPAC, CREL, CBA-ECA) with demonstrated positive social-ecological outcomes. The significant outcomes from these projects encompass enhanced ecosystem health, habitat restoration, conservation of diverse flora and fauna species, as well as advancements in livelihoods and self-reliance. Moreover, there have been strides in water management aimed at alleviating both drought and flood risks, alongside the establishment of institutional and governance systems such as Community Based Organizations (CBOs), CMO, VCG and VCF (DoE, 2015[2]). Detailed learning from these projects is discussed in section three of this study.

CARE and consortium partners are implementing the Adaptation in Ecologically Critical Areas in Bangladesh project (locally known as NABAPALLAB) with funding from UK government. The project aims to support natural resource-dependent communities to strengthen the resilience of the Sundarbans and Hakaluki Haor ECAs, conserve biodiversity, and at the same time, diversify and improve people's livelihoods, reducing overdependence on critical ecosystems through innovative nature-based solutions (NbS) and locally led adaptation (LLA).

The project has conducted three separate assessments simultaneously during its inception stage:

i) An ecological assessment and detailed scoping study.

ii) Political economy analysis (PEA) study and stakeholder mapping.

iii) A baseline study.

The cumulative results of these studies will:

(i) inform NABAPALLAB of the ecological status of the two ECAs, including their interplay with climate change and people dependent on them; (ii) design the best-fit interventions to achieve the project objectives; (iii) develop a policy advocacy and stakeholder engagement plan; and (iv) develop the result framework and M&E tools[3]. This report synthesizes the findings and provides a comprehensive overview of the ecological status of the two ECAs, in conjunction with an analysis of the differentiated vulnerability, adaptation needs, and awareness levels about EbA, NbS, and climate-resilient livelihoods of the communities living in and near the ECAs.

## 1.1. The Objective of the Study

The purpose of the ecological assessment and detailed scoping study is to conduct an in-depth analysis of threats, ecological responses, nature-based solutions, and ecosystem-based adaptation approaches. It will enable the programme to verify its proposed locally-led nature-based adaptation interventions based on an initial scoping during the proposal development stage

[2] DoE (Department of Environment) 215. Community Based Ecosystem Conservation and Adaptation in Ecologically Critical Areas of Bangladesh: Responding to Nature and Changing Climate. Department of Environment (DoE), Ministry of Environment and Forests, Dhaka, Bangladesh, pp 122

[3] CARE Inc., et al (2023): ToR on Ecological Assessment and Detailed Scoping Study in the Sundarbans and Hakaluki Haor ECA for NbS and LLA

and finalise the technical interventions in line with the goals of the project. Likewise, this will also assist the CARE-led consortium to revisit the allocation of resources and work plan and ensure value for money.

The specific objectives are to:

a. Analyse the geophysical, hydro-meteorological, and ecological threats, drivers and complexities of the two ECAs due to climatic and anthropogenic phenomena based on previous projects' learning and present context.

b. Assess the interactions between people living in both the ECAs and their environment, as well as their socio-economic conditions and climatic vulnerabilities concerning their lives and livelihoods.

c. Identify potential nature-based solutions for the restoration and protection of the ECAs and diversifying and improving the livelihoods of the natural resource-dependent communities based on the ecological and climatic risk drivers as well as political economic dynamics of the Sundarbans and Hakaluki Haor ECAs

d. Understand community perceptions on ecosystem-based adaptation (EbA) considering regional biophysical and environmental characteristics; and

e. Assess and propose strategies for capacity building of communities and Local Government Institute (LGI) for effective ecosystem management and conservation.

## 1.2. Scope of the Study

This report presents the findings of an extensive ecological assessment and a detailed scoping study that have been recently completed with active participation and input from community people and local actors. The report explores the diversity of ecosystems in the two ECAs, the climatic and contextual drivers impacting them, and the scope for applying site-specific NbS interventions. It also identifies geographic boundaries (Union) and ECA buffer zones, relevant actors, different needs, roles, and challenges of various ethnic and gender groups living in or near to the ECAs, including dynamics of intersectionality. In addition, it highlights outcomes, challenges, and lessons from past projects and initiatives.

***Expected outputs/Deliverables:*** The assessment findings will produce a technical framework and intervention strategy for the implementation phase and will deliver a comprehensive report consisting of two complementary sub-sections leading to a set of NbS interventions for the restoration and protection of the Sundarbans and Hakaluki Haor ECAs and creation of climate resilient and ecosystem-based livelihoods for communities living within their 10 km buffer zone.

# 2. Methods

The study primarily applied a participatory and qualitative research approach to capture the views, experiential knowledge, insights and perspectives of the vulnerable communities, local actors and stakeholders, including those responsible for ecosystem management including Bangladesh Forest Department (BFD), Department of Environment (DoE) and Department of Fisheries (DoF) and development agencies such as Department of Agriculture Extension (DAE), Department of Public Health and Engineering (DPHE), Department of Women Affairs (DWA), Department of Disaster Management (DDM), Non-Government Organisations (NGOs) and Community-Based Organizations (CBOs).

The methods and tools of the study integrated qualitative information and analysis with limited quantitative data, which are grounded and reflected in secondary literature. The design and delivery of the study followed a series of structured steps, beginning with a literature review to assess existing knowledge and interventions. This was followed by finalising an appropriate research methodology, in collaboration with CARE, after which the survey tool was developed, designing instruments for data collection. The survey area selection identified the key locations for the study, and finally, training was conducted to ensure that enumerators and researchers were well-prepared for effective data gathering. The key steps in the process are reflected in figure 1 above.

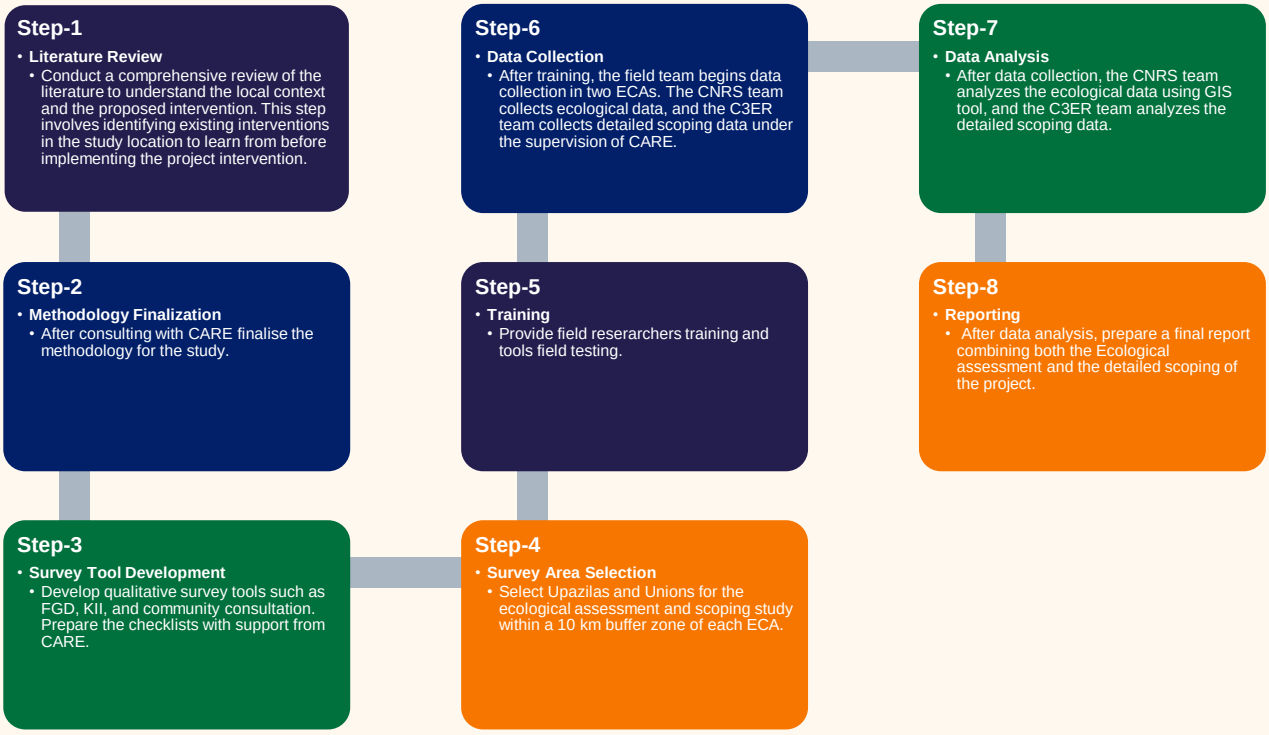



*Figure 1 Methodological framework of the study*

Using the participatory and reflective methods, the study team gained a comprehensive understanding of the local and increasingly complex contexts (i.e., climate change threats and social drivers of differentiated vulnerability, the status of natural resources and dependency of people, scope of EbA and NbS for resilient livelihoods); identified the needs and priorities in relation to LLA, capacity building and assessed the feasibility of the key interventions in the light of the broader framework and ToC of NABAPALLAB. The Focus Group Discussions (FDGs) and Key Informant Interviews (KIIs) provided valuable insights from a diverse range of community representatives and key stakeholders. During the study, 179 FGDs (involving 2327 community people) 211 KIIs, 16 upazila level consultations and 5 district level consultations were conducted.

During the study, FGDs were conducted with a diverse range of individuals from local communities such as men, women, elderly, youth, individuals with disabilities, and marginalized groups. The poor, extremely poor, and ethnic communities were also consulted in both ECAs, along with representatives from the private sector. The participants (around 10-13 in each FGD) encompassed various livelihood groups such as farmers, fishermen, livestock groups, as well as representatives from Village Conservation Forums (VCF) and Village Conservation Groups (VCG). In addition, KIIs included the Upazila Nirbahi Officer (UNO), Union/Upazila Parishad Chairman, representatives from the Department of Agricultural Extension (DAE), Department of Livestock Services (DLS), Department of Fisheries (DoF), Forest Range Officer, Project Implementation Officer (PIO), Department of Women Affairs (DWA), Department of Public Health Engineering (DPHE), local NGOs, Civil Society Organizations (CSOs), Youths, leaseholders, Bathan Operator (Cow and Buffalo Raiser), persons with disabilities (PwD), fishermen, and farmers. Please see Annex 1.a for the locations of FGDs and images from the field.

The district and upazila level consultations have further enriched the understanding of the climate, ecosystem and livelihood nexus that has helped to prioritise the project's thematic interventions. In addition, the study team used the pairwise ranking tool to prioritize threats in Hakaluki Haor

ECA with the youth group. Youth were considered for this exercise because they have ample access to information and are aware of the impact of climate change.

The study assessed the conditions of the ecosystems in two ECA sites - the Sundarbans and Hakaluki Haor. In the Sundarbans ECA, assessing the physical forest conditions of the Sundarbans Protected Area (PA) were beyond the scope of the study. However, in the catchment area of Hakaluki Haor, both a physical and literature review have been done. The Sundarbans ECA site under the study covers the surrounding area 10 km from the periphery of the Sundarbans reserved forests. This ECA covers nine (09) upazilas under three districts, viz. Satkhira (Shyamnagar, Ashasuni), Khulna (Dacope, Koyra, Paikgacha), Bagerhat (Mongla, Rampal, Morrelgonj, and Shoronkhola), vide gazette notification no. 22.00.0000.073.13.004.2014, dated May 24, 2017 (Figure 2). Hakaluki Haor ECA encompasses nine upazilas, including Fenchuganj, Golapganj, Balaganj, Dakhin Surma, and Beanibazar (Non-ECA) in the Sylhet district, as well as Barlekha, Juri, Kulaura, and Rajnagor (Non-ECA) in the Moulvibazar district. Hakaluki Haor is situated in the north-east of Bangladesh between 24°35' N to 24°44' N and 92°00' E to 92°08' E covering an area of over 18,000 ha (IUCN, 2005[4]) (Figure 3).The physical forest conditions of the catchment area of Hakaluki Haor were assessed by visiting the Lathi tilla, Sagornal forest beat (small section of forest) under the Juri Range, sadar forest beat under the Kulaura Range, and Madhobchara beat under the Barlekha Ranges. Secondary information was also gathered by visiting respective range offices.

### *Analysis of physical data and satellite images*

Satellite images were sourced from Google Earth, Base Map in ArcGIS environment and utilised to assess the physical data on the field regarding availability of unused land for afforestation and EbA measures. The extent of potential land availability was determined using the base map satellite imagery using different tools in GIS software, employing the UTM 45 N projected coordinate system. Different bands were composited using the “composite bands” tool[5] in ArcGIS. These composited images were further extracted from the area of interest using the “extract by mask” tool[6]. The “supervised classification” technique was employed to classify the extracted composited image where training samples were identified prior to this analysis. A ground-level checking was performed using “google earth pro”. These classified images from three different periods were converted into polygons based on land classification through the “Raster to Polygon” tool[7]. The polygon of wetlands in three different periods were calculated statistically using an attribute table via the calculate geometry tool in ArcGIS. The team analyzed geophysical and ecological drivers such as boundaries/ habitat extents, habitat features, seasonality, canopy cover, hydrology/seasonal water extents, land use and land cover, watersheds etc. as well as information from secondary sources: books, journal articles, brochures, research papers, and relevant offices and websites. After collecting the required data, we compiled and processed it in MS Word and MS Excel.

[4] IUCN (2005). A Plan for Sustainable Wetland Resource Management, IUCN Bangladesh Country Office, Dhaka, Bangladesh.
[5] This tool is useful to create a new raster data set with a specific band combination and order. Three image bands can be combined into one picture by display each band as either Red, Green or Blue. The Composite Bands function allows us to combine raster layers to form a multispectral image.
[6] Extract by Mask tool, the output raster will have cell values only for the area that lies within the intersection of the environment mask and the input mask data. This example extracts cells from a raster for all areas outside a mask defined by an input polygon shapefile feature class, keeping the output extent of the input raster. ‘Extract by mask’ will change the pixel values based on the two input raster data, while the Clip toolbox will clip the raster input without changing the digital numbers or the gray values.
[7] In ArcGIS Pro, a raster dataset can be vectorized when using the Raster to Polygon tool to generate a polygon feature output. However, the Raster to Polygon tool can only process integer input rasters. Therefore, a floating type raster must be converted to an integer type raster before using the tool.

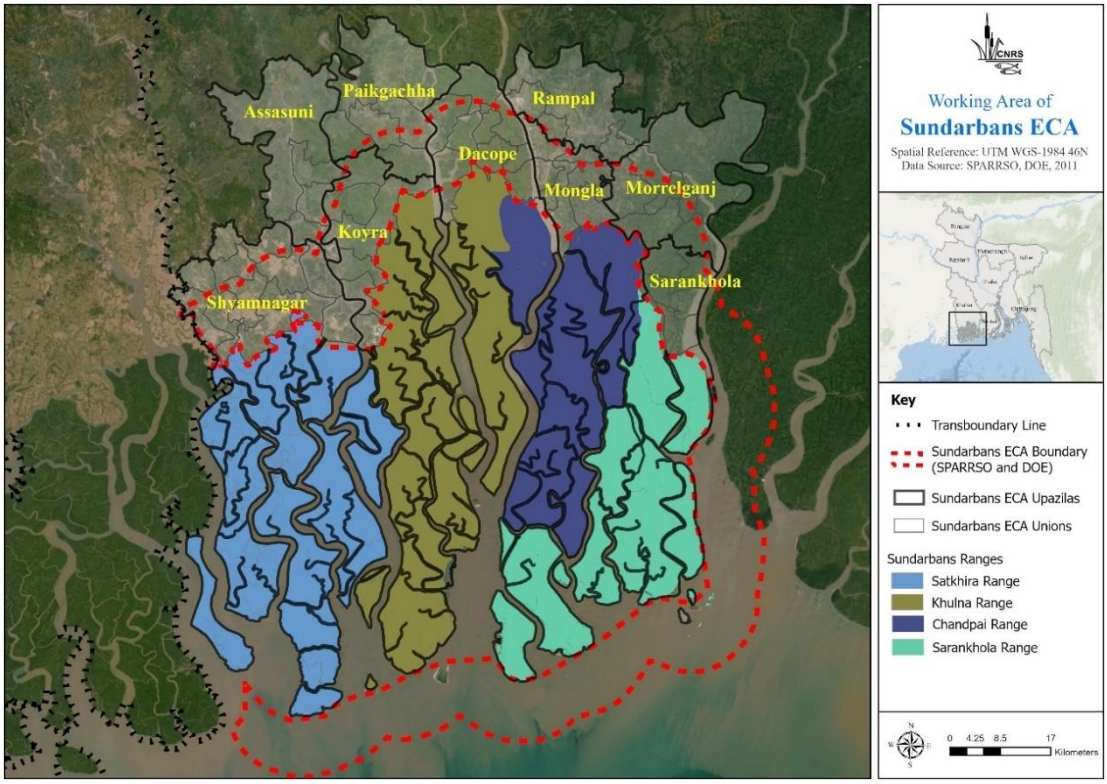



*Figure 2 Location of the study areas of the Sundarbans ECA*

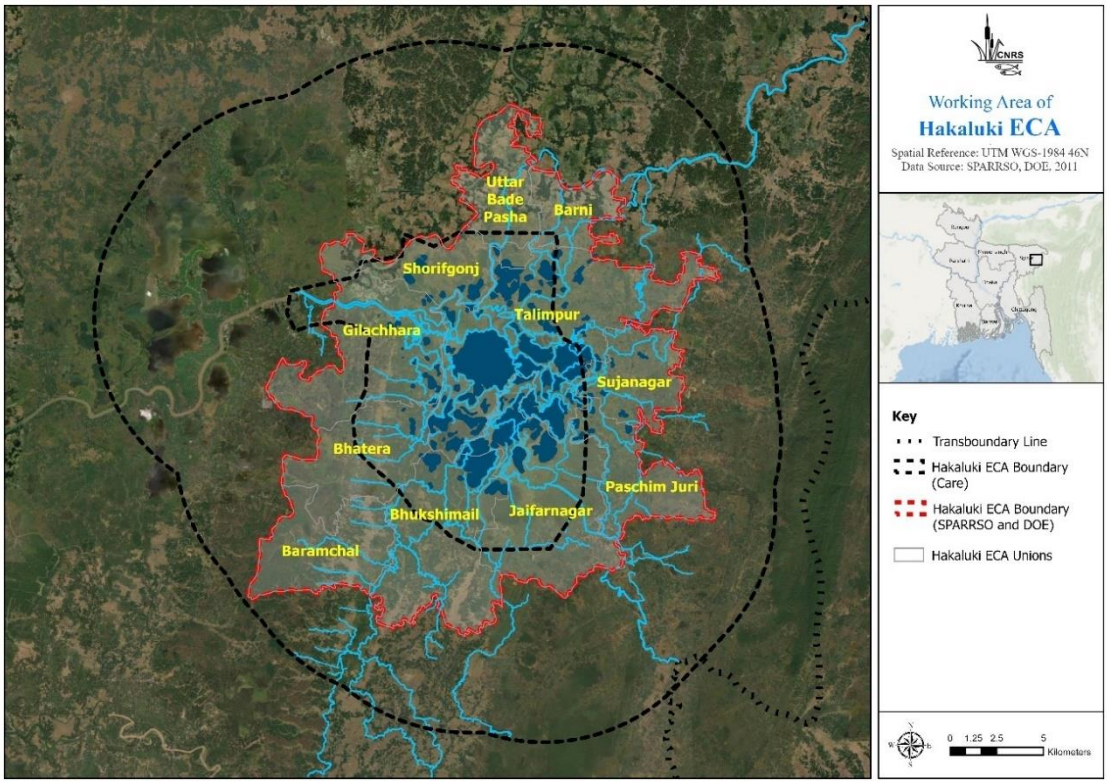



*Figure 3 Location of the study areas of the Hakaluki Haor ECA*

## 2.1 Limitations

Based on the initial scoping study, Upazilas were selected within a 10 km buffer zone, considering their dependency on the ECAs. However, a circular issued by the Department of Environment (DoE) highlighted that some of the Upazilas in Sylhet District (Dakshin Surma, Balaganj, and Beanibazar Upazilas) and in Moulavibazar District (Rajnagar Upazila) mentioned in the ToR were not dependent on the ECAs. As a result, only a limited number of FGDs and KIIs were conducted in those areas. Furthermore, time was a constraining factor which required us to complete the field operations faster than was optimal; but total number of FDGs and KIIs was the same, and the study's result was not impacted.

# 3. Key Findings

## 3.1. Ecosystems of ECAs: Threats, drivers and complexities

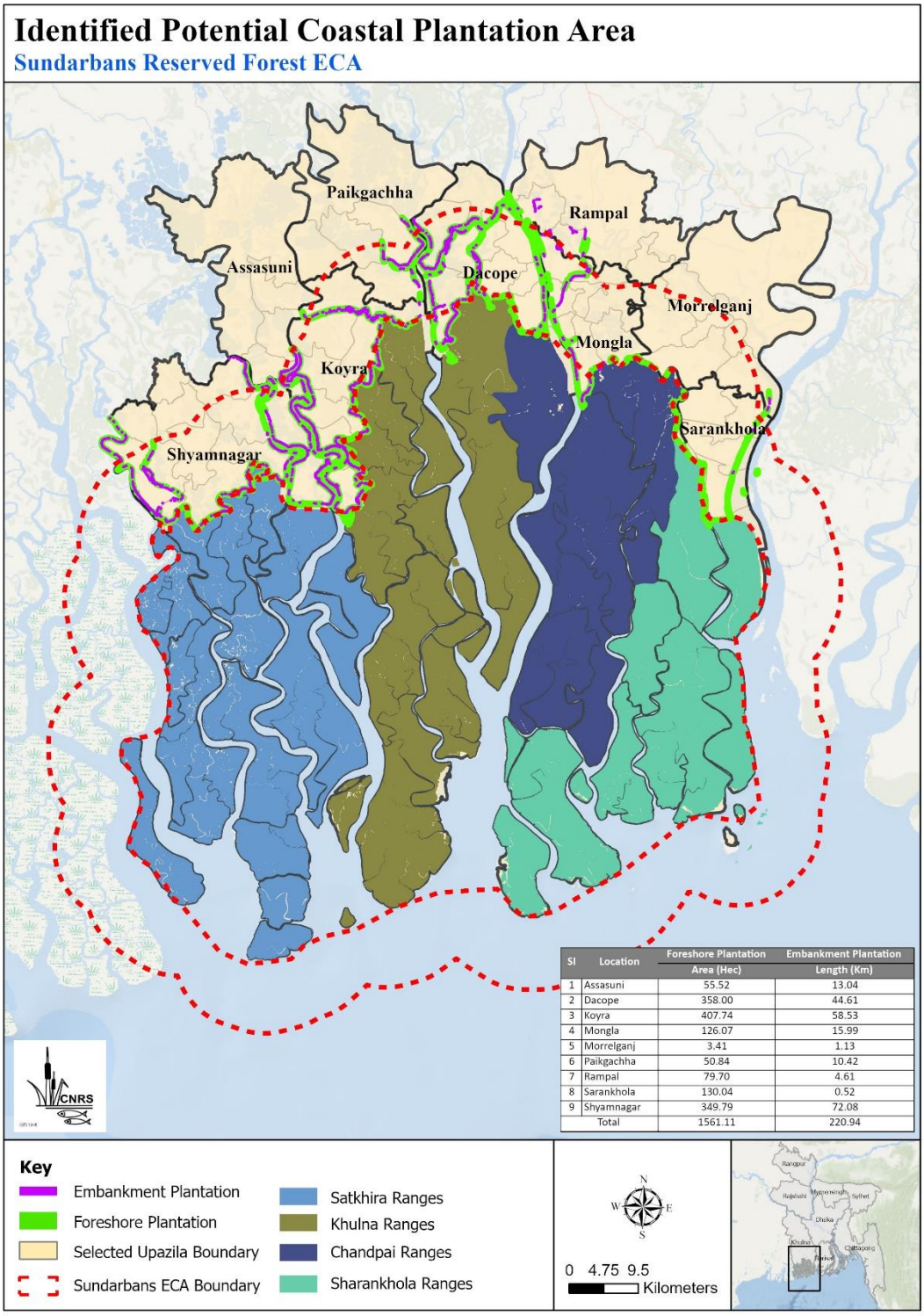
### 3.1.1. Ecosystem in the Sundarbans ECA

About 4.5 million people within and around the ECA directly depend on the natural resources of the Sundarbans Reserve Forest (SRF) for their livelihood (GIZ 2020)[8]. A variety of non-timber forest products such as honey, wax, medicinal plants, *golpata* and grass are extracted from the SRF by the dependent community for their daily livelihood. Around 12,000 km[9] of river in the SRF produces a large quantity of fish, shrimp and crabs. In addition, the Bay of Bengal is home to an important marine fishing industry whose stocks originate in the Sundarbans. The ecological and socio-economic importance of the SRF is associated with its rich biodiversity and the ecosystem's valuable ecological services and products. The ecosystems and communities within the ECA are impacted by various drivers, viz., land use changes, brackish-water shrimp farming, high salinity

GIZ (2020): Sundarbans Management Project (SMP) I & II, Internationale Zusammenarbeit (GIZ) GmbH, P.O. Box 6091, Gulshan 1, Dhaka 1212, Bangladesh. www.giz.de/bangladesh. P-2.

[9] Aziz, A.; Paul, A.R. Bangladesh Sundarbans: Present Status of the Environment and Biota. Diversity 2015, 7, 242-269. https://doi.org/10.3390/d7030242

in soil and water, frequent cyclones and storm surges, tidal inundation, erosion, and waterlogging. Recent industrialization has increased pollution that impacts aquatic and forest resources.




| Sl | Location | Foreshore Plantation Area (Hec) | Embankment Plantation Length (Km) |
|---|---|---|---|
| 1 | Assasuni | 55.52 | 13.04 |
| 2 | Dacope | 358.00 | 44.61 |
| 3 | Koyra | 407.74 | 58.53 |
| 4 | Mongla | 126.07 | 15.99 |
| 5 | Morrelganj | 3.41 | 1.13 |
| 6 | Paikgachha | 50.84 | 10.42 |
| 7 | Rampal | 79.70 | 4.61 |
| 8 | Sarankhola | 130.04 | 0.52 |
| 9 | Shyamnagar | 349.79 | 72.08 |
| | Total | 1561.11 | 220.94 |

*Figure 4 Potential site for coastal plantation*

## Ecosystem Types in the Sundarbans ECA

Types of ecosystems within the Sundarbans ECA include i) wetlands (canals and rivers), ii) low-lying seasonally flooded lands that are converted to shrimp/aquaculture ponds (modified ecosystems), iii) riverside land (Charland) either covered by mangroves or modified to shrimp ponds, iv) settlements as village forests (homestead), v) cropland ecosystems and vi) coastal embankments (Figure 4) with green cover that can also be treated as modified linear ecosystem. The Sundarbans ECA also includes a reserve forest, but this is out of the scope of the study so was not assessed.

The present study focused on three types of ecosystems restoration activities based on EbA and NbS approaches including:

i) canals restoration,
ii) mangrove afforestation in charlands
iii) afforestation of coastal embankment.

The first type will act as wetland ecosystems to support communities diversifying their crop farming and benefit from capture fisheries. The second type will be suitable for managing the existing natural growth and restoration of mangroves in non-vegetative foreshore areas, and the third one was a linear ecosystem through community-based planting and protection. All these restoration activities will serve as adaptation and mitigation measures for climate change impacts.

### *Canal Ecosystem*

During the field assessment, 375 canals were found in nine upazilas in three ECA districts (Annex 1b). All these canals are affected by siltation and need to be restored to rejuvenate the canal ecosystem towards the improvement of the livelihoods of local people. This situation is exacerbating every year, and canals are gradually dying. The canals that are currently elite captured, need to be opened to ensure the access of general people. On average, Satkhira district has the highest number of canals - 47, in Khulna - 45, and in Bagerhat - 36 (Box-1). While combining nine upazilas under three districts studied, there are 42 canals per upazila under varied management practices. Our GIS data revealed that the length of canals within ECA upazilas is 3,958 km, while within the ECA boundary, it is 1705 km. A district-wise length of canals is given in Figure 5. The canal management status and use patterns vary within and among the nine upazilas under the study. The management status of canals is categorised into three groups, viz.

**Box 1: Average number of canals/ UZ**

- Satkhira: 47 per upazila
- Khulna: 45 per upazila
- Bagerhat: 36 per upazila
- Overall: 42 per upazila

i) ***Canals are leased out to a person or group,*** and access by general people for fishing, shrimp cultivation and irrigation is strictly controlled by the leaseholders or their local agents.
ii) ***Canals that are elite captured*** and general people's access to the canal is restricted, and
iii) ***Canals that are under minimum control or open for public use as CPR (common pool resources),*** but a part of the canal is under localized control of local influentials.

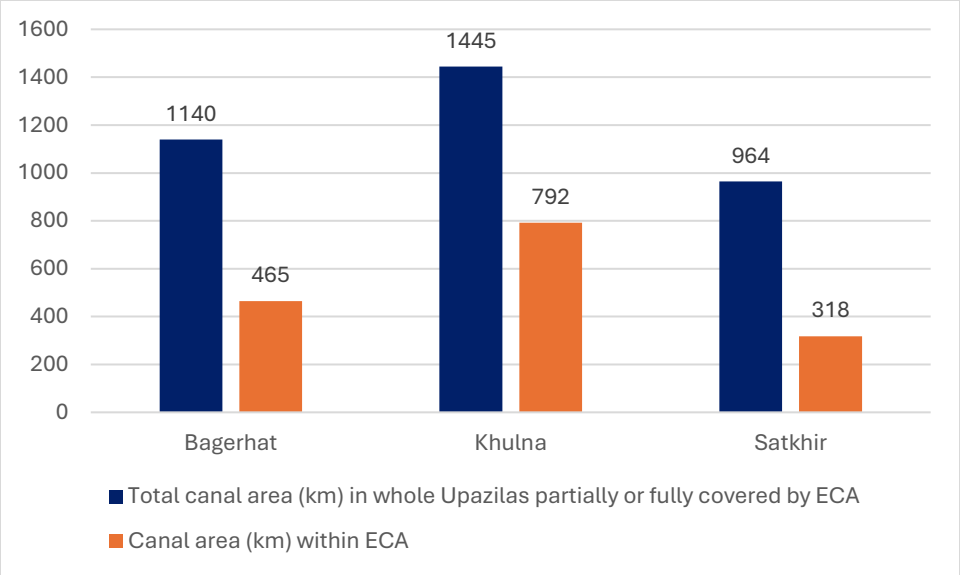



*Figure 5 District-wise length of canals (Km)*

The study found that 42%, 40%, and 1% of canals are under leasing systems in Satkhira, Khulna, and Bagerhat districts, respectively (**Annex 1b**). The lower canal leasing rate observed in Bagerhat district was attributed to less shrimp cultivation in this area. The elite capture of canals is also highest in Satkhira (25%), only 6% in Khulna, and 14% in Bagerhat district due to expansion of more shrimp cultivation. The general population needs access to canal water for purposes such as crop irrigation, household use, providing drinking water for cattle, and fishing. Data shows that more general people lost their access rights to canal resources in Satkhira due to leasing and elite capture, where people have access to 34% of canals.

At the same time, the highest number of canals, 85% in Bagerhat and 54% in Khulna are accessible to the general people (Annex 1b). This data indicates that all three districts still have high potential for locally-led, ecosystem-based canal management opportunities, more so if Shyamnagar of Satkhira and Koyra upazila of Khulna cancel the leasing of canals through the upazila and district authorities. Overall, the availability and accessibility of canal water are vital for sustaining agricultural productivity, contributing to food security and economic stability; ensuring the well-being of households without alternative water sources; supporting livestock for meat and dairy production; and enabling fishing activities that provide protein for local diets. However, canals are vulnerable to cyclones, saline water intrusion, and elite capture for shrimp farming discussed above. The normal flow of canals is being affected by environmental degradation which are exacerbated by climate change. This degradation is due to poor management that accelerates intrusion of saline water and improper shrimp farming, which ultimately impact soil and water ecosystem. Effective management and equitable distribution of canal water are essential to meet the needs of all users and to promote sustainable development in regions dependent on this resource.

### *Charland Ecosystems – Mangrove Restoration*

Riverside charlands along the edges of the Sundarbans mangrove forest are suitable places for the natural regeneration of mangrove species. If they remain undisturbed, these charlands become dense patches of mangroves in a few years. These riverside mangroves protect people and assets from cyclones and tidal surges and provide livelihood benefits from fish, shrimps, crabs, honey, fuel, nypa palm, keora fruits, and timber. Our assessment findings show that 1,988 hectares of charland are available across 9 upazilas in 3 districts within the Sundarbans ECA

(**Annex 2**). Of the total area, Khulna district has the largest area of 817 hectares (41%), followed by Satkhira (20.4%), 17% in Bagerhat (**Annex 2**).

### *Coastal Embankments Ecosystem*

GIS analysis and on-site observations revealed 228 km of embankment within the Sundarbans ECA (**Figure 4**). Most of the newly constructed embankments were without plantation, which remain very exposed to both climatic and anthropogenic threats leading to ecosystem degradation. The coastal embankments have faced degradation due to a range of factors such as deforestation, heavy rainfall, tidal action and rill erosion. Restoration is recommended to enhance their resilience and effectiveness in protecting coastal areas.

### Impact of Shrimp Cultivation

The study found that 203,796 ha of land in the Sundarbans ECA, suitable for crop production, has been brought under shrimp cultivation, driven by maximizing profit. In addition to reduced agricultural production, there is also evidence of the negative impact of increased pollution stemming from fertilizers, pesticides, agrochemicals, and antibiotics. Additionally, the destruction of mangrove habitats, loss of biodiversity, and disruption of natural ecosystems have occurred, leading to ecological shifts that impact agricultural endeavors through changes in water flow patterns, loss of land for grazing of livestock, changes in agricultural cropping patterns, nutrient cycling, and pest dynamics. There have also been socio-economic consequences on the livelihood patterns of people living in coastal areas. Sustainable management practices and integrated land use planning are essential to minimize negative impacts and ensure the coexistence of shrimp farming and agriculture in the region.

### Conservation of Endangered Birds

The study found that the Masked Finfoot or Asian Finfoot (*Heliopais personatus*), and White-rumped Vulture (*Gyps bengalensis*) face threats in the Sundarbans ECA region, necessitating conservation actions. For the Asian finfoot, the threats primarily stem from habitat loss and degradation due to human activities such as deforestation, unsustainable logging, and poison fishing. Pollution, particularly from industrial and agricultural sources, further compounds the problem by contaminating water bodies crucial for these species' survival. Additionally, the construction of infrastructure projects, such as dams and roads, disrupts their habitats and restricts their movements. Poaching and illegal wildlife trade pose direct threats, with these species often targeted for their feathers, meat, or perceived medicinal properties. Climate change exacerbates these challenges, leading to habitat alteration, increased salinity in water bodies, and unpredictable weather patterns that disrupt breeding and migration patterns.

The foremost anthropogenic threat faced by White-rumped Vultures is the administration of the veterinary drug 'diclofenac' to livestock. When vultures ingest carcasses of animals treated with diclofenac, it results in kidney failure and mortality among the birds. Additional threats encompass habitat loss, carcass poisoning, and food scarcity. To counteract these challenges, conservation initiatives include the banning of diclofenac usage, the creation of Vulture Safe Zones, public awareness campaigns, and habitat protection and restoration efforts. This involves safeguarding and rejuvenating natural habitats to secure suitable nesting and feeding environments for the vultures. Initiatives like artificial breeding programs, awareness campaigns, and stringent law enforcement could be implemented to further safeguard these endangered species.

## 3.1.2. Ecosystems in Hakaluki Haor ECA

The Hakaluki Haor is a large wetland ecosystem comprising 276 interconnecting *beels* [10] (238 state-owned and 38 private) covering an area of over 18,000 ha, of which 4,926 ha of *beels* (27%) and 621 ha of rivers and canals (3.3%) are suitable for fishing[11]. In addition to fishing, the Haor provides suitable habitats for many residents, and migratory birds, and other wildlife.

Hakaluki Haor ECA, along with its watershed, host a variety of ecosystems and ecological niches. Within the wetland basin, several types of ecosystems can be delineated, viz. wetlands (*beel*), canals and rivers, hill streams, swamp forests, *Kanda*[12] land, and crop land. In the Hakaluki watershed, hill slopes, streams, forests (planted and natural), and orchards are common. The climatic drivers such as monsoon rain, humidity, summer temperatures, flash floods, seasonal variation in water level, wind pattern, cyclones and storms influence both the haor ecosystem and surrounding communities. These factors play a crucial role in shaping the hydrology, ecology, and overall environment of the Hakaluki Haor region. Understanding these factors is essential for managing and conserving the area's natural resources and mitigating the impacts of climate change.

### Ecosystem Types in Hakaluki Haor ECA

#### *Wetland Ecosystem*

The assessment revealed that over 20 out of 55 wetlands/*beels* are fully converted due to sedimentation and filling in for crop farming. Over the last 20 years, almost every *beel* has been degraded/silted to varying extents due to sedimentation - Annex 3.

Figure 6,7 and 8 illustrate the changes in wetland reduction caused by siltation from 2003 to 2024. The study findings regarding siltation rates are summarized as follows:

- 12 Beels (22%) – silted up by up to 20%
- 19 Beels (35%) – silted up by 21%-50%
- 17 Beels (31%) – silted up by 51%-80%
- 03 Beels (05%) – silted up by 81%-90%
- 04 Beels (07%) – silted up by 91%-100%

Local communities reported a recent increase in sedimentation rate due to multiple factors, including climate-induced frequent flash flooding, clearing of forests and farming in the hills/watersheds, conversions of wetlands, and cutting off *Kanda* land within the Haor. Increased sedimentation has had various adverse effects due to decreased wetland productivity, encroachment and conversion of wetlands, and agricultural expansion which contributes to the destruction of aquatic vegetation, diminished fish yields and wetland-dependent birds/wildlife, all of which ultimately affect the livelihoods of local communities[13]. The extent of siltation also contributed to the severity of the recent flooding in 2022 and 2024 through significant reduction in the water carrying capacity coupled with excessive rainfall upstream.

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[10] *Beel* is a large surface waterbody that accumulates surface runoff water through internal drainage channels; these depressions are mostly topographic lows produced by erosions and are seen all over Bangladesh.

[11] Imran, F. M., Habib, A.H.M.S, and Hossain, M. N. 2023. Seasonal variation and fish assemblage at Hakaluki Haor, Moulvibazar, Bangladesh. International Journal of Fisheries and Aquatic Studies 2023; 11(3): 17-27. DOI: https://doi.org/10.22271/fish.2023.v11.i3a.2803.

[12] *Kanda* is a local term used to denote raised land at the edges of Beels in the greater Haor basin, usually covered with grasses, shrubs, and swamp trees, which provide microhabitats/niches for wetland biota.

[13] GoB 2020. Study on interaction between Haor and river ecosystem including development of wetland inventory and sustainable w etland management framework (Draft final report). Volume 1. IWM & MEGATECH, Department of Bangladesh Haor & Wetlands Dev elopment.

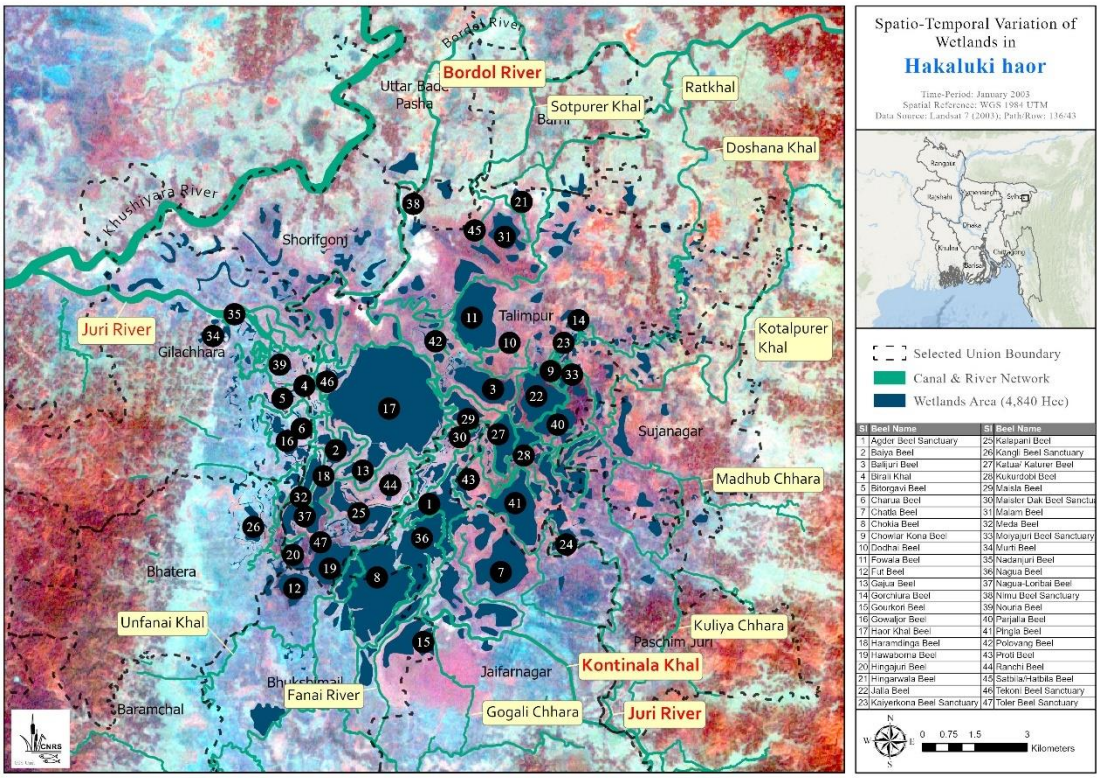



*Figure 6 Perennial waterbodies in Hakaluki Haor in 2003*

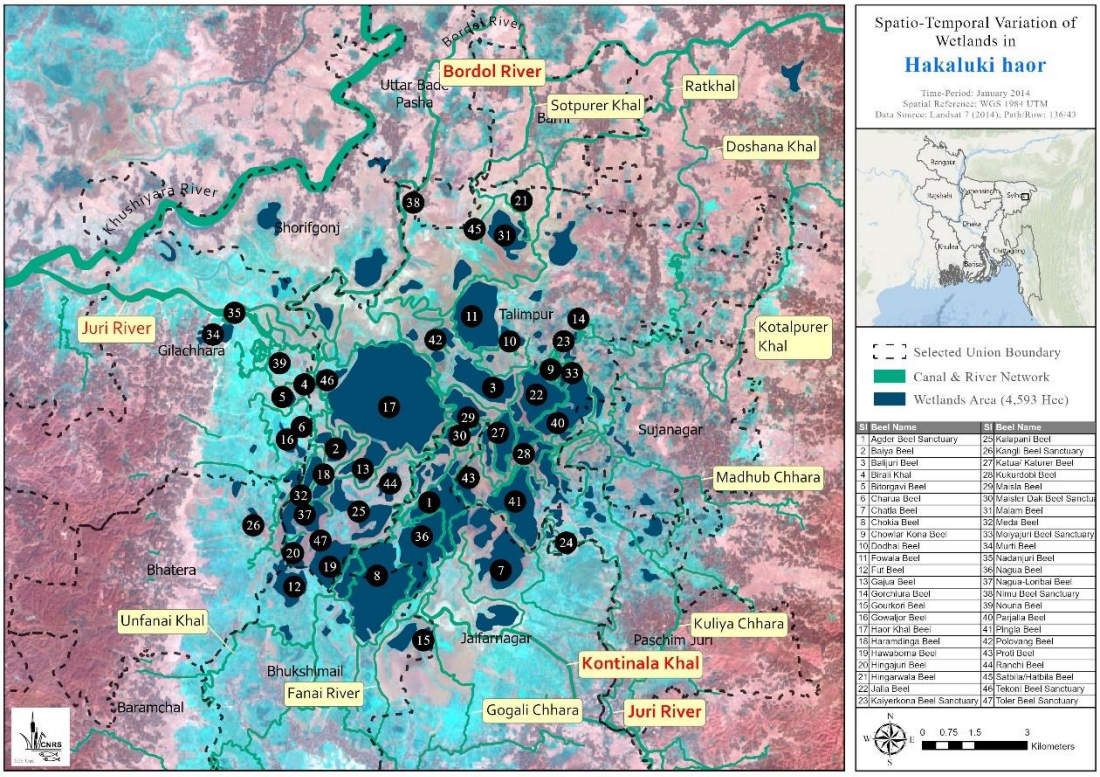
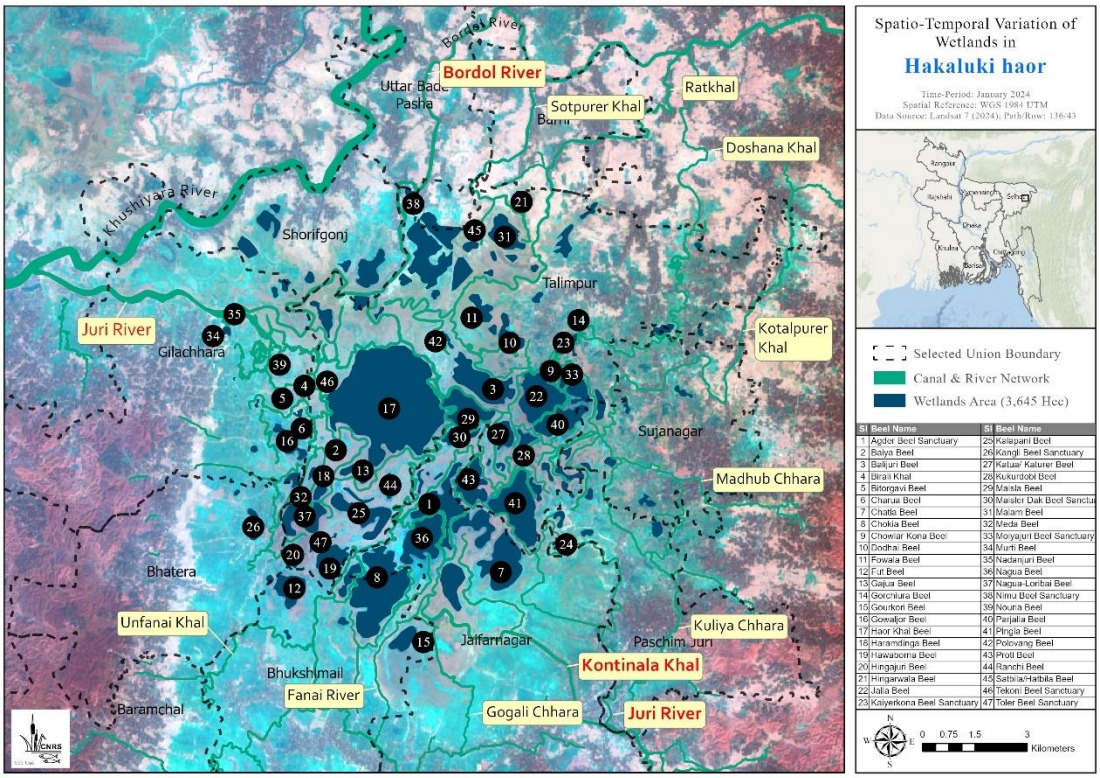
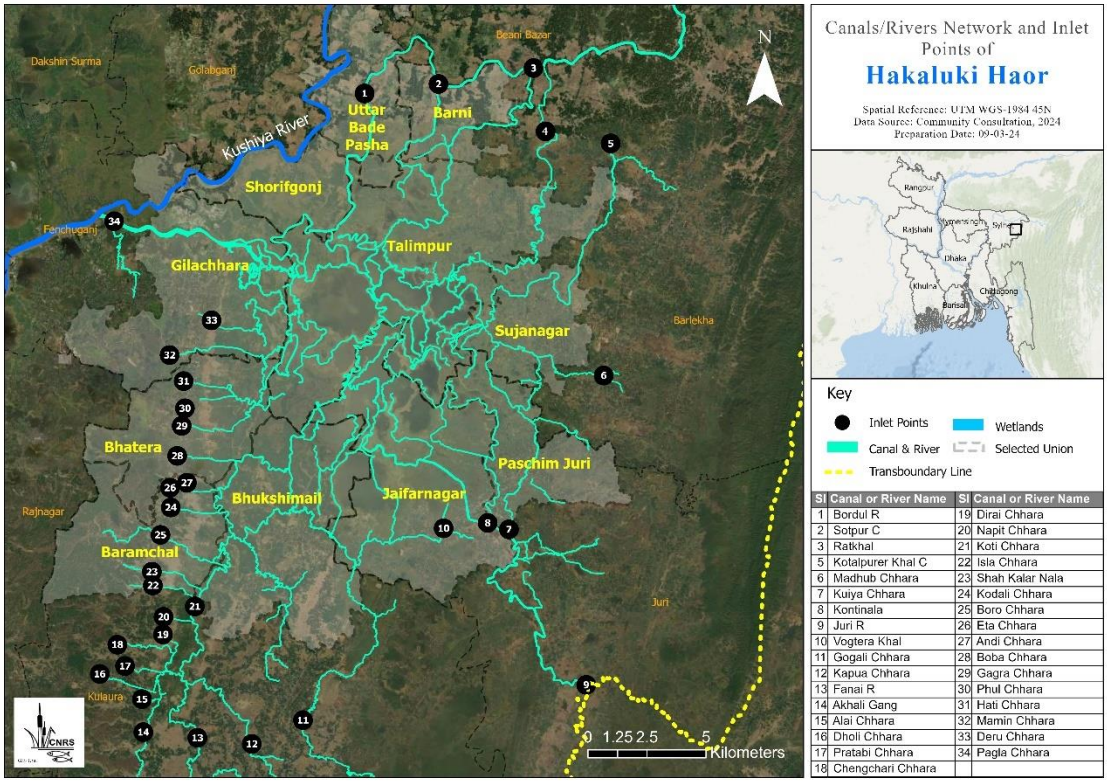



*Figure 7 Perennial waterbodies in Hakaluki Haor in 2014*




| Sl | Beel Name | Sl | Beel Name |
|---|---|---|---|
| 1 | Agder Beel Sanctuary | 25 | Kelapani Beel |
| 2 | Baiya Beel | 26 | Kangli Beel Sanctuary |
| 3 | Balijuri Beel | 27 | Kaltual/ Kalurer Beel |
| 4 | Birali Khal | 28 | Kukurdobi Beel |
| 5 | Bitongavi Beel | 29 | Maiala Beel |
| 6 | Charua Beel | 30 | Mailer Dak Beel Sanctu |
| 7 | Chatla Beel | 31 | Malam Beel |
| 8 | Chokla Beel | 32 | Meda Beel |
| 9 | Chowiar Kona Beel | 33 | Moiyajuri Beel Sanctuary |
| 10 | Dodha Beel | 34 | Murti Beel |
| 11 | Fowala Beel | 35 | Nadanjuri Beel |
| 12 | Fut Beel | 36 | Nagua Beel |
| 13 | Gajua Beel | 37 | Nagua-Loribai Beel |
| 14 | Gorchiura Beel | 38 | Nimu Beel Sanctuary |
| 15 | Gourkori Beel | 39 | Nouria Beel |
| 16 | Gowaljor Beel | 40 | Parjalia Beel |
| 17 | Haor Khal Beel | 41 | Pingla Beel |
| 18 | Haramdinga Beel | 42 | Polovang Beel |
| 19 | Hawaboma Beel | 43 | Proli Beel |
| 20 | Hingajuri Beel | 44 | Ranchi Beel |
| 21 | Hingarwala Beel | 45 | Satbila/Hatbila Beel |
| 22 | Jalia Beel | 46 | Tekoni Beel Sanctuary |
| 23 | Kaiyerkona Beel Sanctuary | 47 | Toler Beel Sanctuary |

*Figure 8 Perennial waterbodies in Hakaluki Haor in 2024*




| Sl | Canal or River Name | Sl | Canal or River Name |
|---|---|---|---|
| 1 | Bordul R | 19 | Dirai Chhara |
| 2 | Sotpur C | 20 | Napit Chhara |
| 3 | Ratkhal | 21 | Koti Chhara |
| 5 | Kotalpurer Khal C | 22 | Isla Chhara |
| 6 | Madhub Chhara | 23 | Shah Kalar Nala |
| 7 | Kuiya Chhara | 24 | Kodali Chhara |
| 8 | Kontinala | 25 | Boro Chhara |
| 9 | Juri R | 26 | Eta Chhara |
| 10 | Vogtera Khal | 27 | Andi Chhara |
| 11 | Gogali Chhara | 28 | Boba Chhara |
| 12 | Kapua Chhara | 29 | Gagra Chhara |
| 13 | Fanai R | 30 | Phul Chhara |
| 14 | Akhali Gang | 31 | Hati Chhara |
| 15 | Alai Chhara | 32 | Mamin Chhara |
| 16 | Dholi Chhara | 33 | Deru Chhara |
| 17 | Pratabi Chhara | 34 | Pagla Chhara |
| 18 | Chengchari Chhara | | |

*Figure 9 River eco-system in Hakaluki Haor*

### *Rivers and Stream Ecosystems*

Rivers, canals, and streams are linear wetlands that provide various ecosystem services. Based on our assessment, 10 rivers, 50 canals, and 28 hill streams pass through the Hakaluki Haor (Figure 9 and Annex 4). However, most rivers, canals, and streams have been severely degraded due to prolonged droughts, sedimentation, encroachment, conversions, agricultural expansions, construction of roads, bridges, culverts, etc. across the Haor region. Many rivers/canals originate in India and pass through the Hakaluki Haor. Elite capture has also excluded the local poor from these resources and caused them to suffer from livelihood insecurity.

### *Swamp Forest Ecosystems*[14]

During the British regime, all the *Kanda* land of the Hakaluki Haor was covered with swamp forests (mostly *Hijol* and *Koroch* trees) with an understory of grasses and reeds/shrubs. However, during the Pakistan period, some parts of the swamp forests were cleared, and after the liberation, most of the swamp forests were cleared and converted to cropland. After the declaration of Hakaluki Haor as an ECA in 1999, the Department of Environment (DoE) undertook efforts to restore swamp forests on *Kanda* lands across 35 Beels through planting and conservation/ protection of natural growth under the UNDP-GEF, CWBMP, and CBA-ECA projects from 2002 to 2015 and later BFD planted swamp trees on some *Kanda* land but they did not survive due to management weaknesses viz. guarding the plantation, lack in monitoring due to insufficient manpower of the department, poor enforcement of law etc. The assessment indicates that approximately 90% of the swamp forest land has been cleared (Annex 5). Several issues exacerbated this degradation, including unauthorized logging, branch removal for fish farming, fuelwood collection, and droughts and heat stress.

### *Kanda Land Ecosystems*

*Kanda* provides unique biodiversity and value as a micro ecosystems/niche. The study collected information on 89 different *Kanda*s and found that these are rapidly encroached, converted, and privatized (detailed status is given in Annex 6): Conversion percentage of *Kanda* land into crop farming in Hakaluki Haor is illustrated in Figure 10.

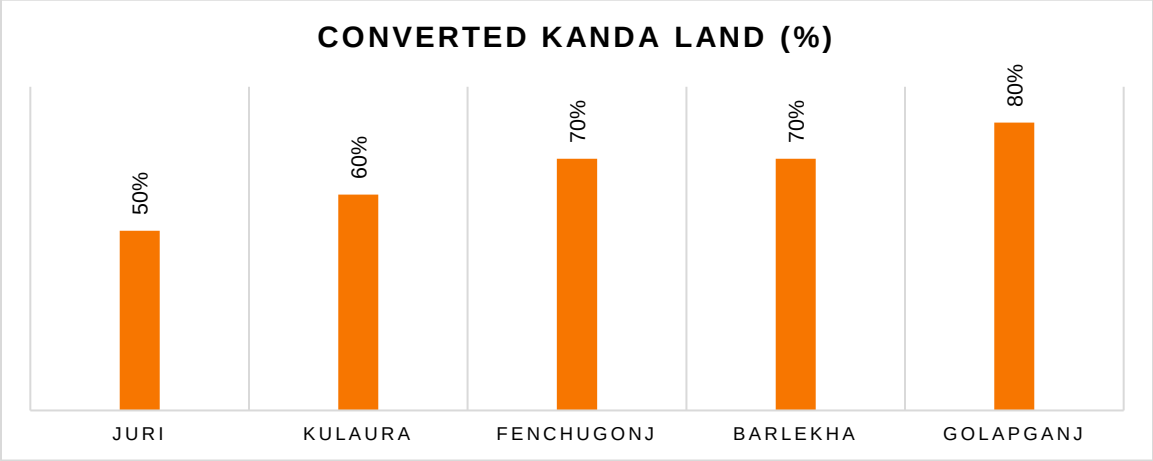



*Figure 10 Conversion percentage of Kanda land into crop farming in Hakaluki Haor*

[14] Swamp forests are unique ecosystems characterized by their waterlogged conditions, which can be either permanent or seasonal. These forests typically thrive along the lower stretches of rivers and around freshwater haor, where they play a crucial role in maintaining ecological balance. The constant presence of water creates a distinct habitat that supports a diverse range of plant and animal life adapted to these moist, often muddy environments. By acting as natural water filters and flood buffers, freshwater swamp forests not only contribute to the health of surrounding aquatic systems but also offer valuable resources and protection for various wildlife species

Loss of *Kanda* negatively impacts fish habitats, reduces substrate objects (surface or substance which organisms grow and live on), decreases recruitment potentials for fish species that release sticky eggs on substrates, and leads to a reduction of fish feeding, breeding, nursing, and refuge areas, and loss of micro-habitats affecting fish and non-fish aquatic species including wetland-dependent birds. Elite capture of *Kanda* also excludes poor fishermen and landless from fishing and collecting various resources. The expansion of agriculture in *Kanda* areas also heightens the risk of increased use of pesticides and fertilizers in croplands, which may adversely impact the Haor's biodiversity.

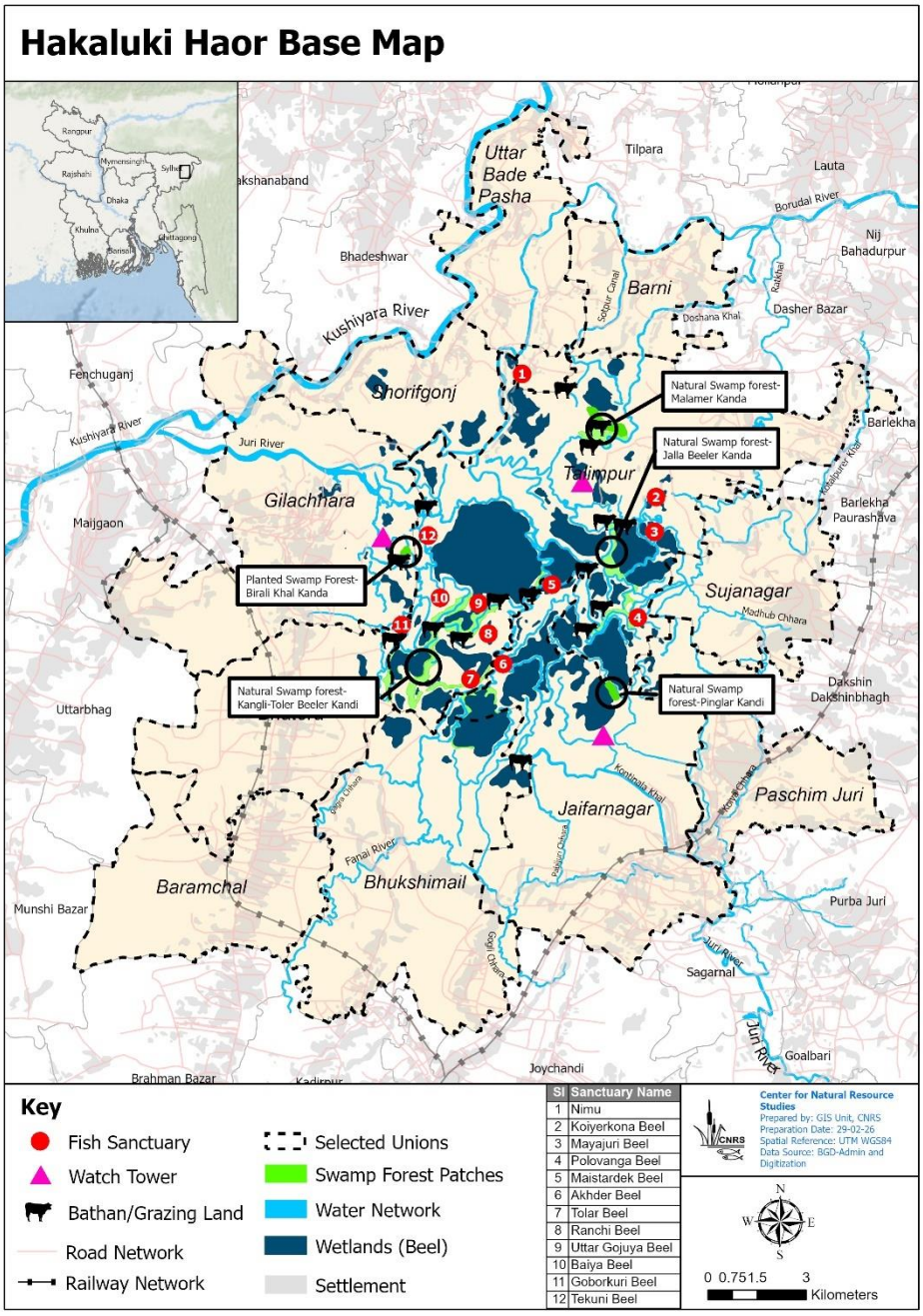



*Figure 11 Location of fish sanctuaries in Hakaluki Haor*

### Status of Wetland Sanctuaries

The Ministry of Land (MoL) declared 12 wetland sanctuaries from 2011-2012. It directed the Deputy Commissioners of Moulvibazar and Sylhet to establish sanctuaries with the support of different projects (Annex 7.a, Annex 7.b and Figure 11). As such, 12 wetland sanctuaries were established by the CBA-ECA project of DoE, DoF, and USAID's/IPAC and CREL projects from 2011 to 2013.

Without taking any corrective measures or improving the management of community-based sanctuaries, the MoL canceled the sanctuary status of four wetlands: two were designated for *khas* collection in 2023, two were leased under development projects in 2019, and the rest were handed over to the DoF in 2023 (Appendix 7.a). Consequently, only eight wetlands remain sanctuaries under the DoF's management. The study suggested that all sanctuaries would benefit from improved mangement, and there is scope for improvement under community-based management. Local government entities empower local communities to actively participate in sanctuary management through community-based approaches. They facilitate the establishment of community-based organizations, user groups, and cooperatives, allowing communities to have a voice in decision-making processes and take ownership of conservation initiatives.

### Pile Fishing Practices

Every Pile fishery[15] *beel* acts as a fish conservation site/sanctuary. The pile fisheries are especially helpful for fish species that mature to lay eggs at 2-3 years and can get refuge to avoid fishing mortality. However, the practice of pile fishery currently needs to be improved, as leaseholders opt to catch fish yearly through dewatering. Based on the assessment, pile fishing exists in only six *Beels* in Hakaluki Haor though they do not fully comply with the pile fishing norms (**Annex 8**). Consistent monitoring and enforcement, coupled with community/VCG involvement, could enhance the implementation. The Department of Fisheries (DoF) might spearhead these efforts.

### Group Fisheries and Wetland Leasing Under Development Schemes

There are 13 group-fisheries[16][17] in Hakaluki Haor (**Annex 9**). Two are managed as sanctuaries, 5 under development schemes, 4 under typical leasing, and 2 on *khas* collections[18]. The local leaseholders with good political connections get a lease of wetlands under the so-called "development schemes" from the MoL for nine years instead of a regular span of 3 years. However, in most cases, the leaseholder did not comply with the conditions (swamp forest restoration protection, maintaining a sanctuary, practicing pile fishing, protecting birds, biodiversity conservation, etc.) attached to development schemes; instead, they fish annually to maximize benefits (Oakkas et al., 2020[19]).

### Elite Capture and Illegal Leasing of Canals and Rivers

The Hakaluki Haor is traversed by 17 rivers/canals, facing severe threats from sedimentation, elite capture, and conversions (**Annex 10).** As per the wetland leasing policy, it is mandated that flowing rivers/canals remain exempt from leasing and accessible for community use. However, the present study reveals that local Union Parishads (UPs) illegally lease these water bodies to

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[15] *Plie fishing is a system introduced in the leasing contracts in the greater Haor area - a condition that the leaseholder, instead of fishing every year, fish once every three years so that the fish can take shelter and attain maturity in pile fishery beels*
[16] *Group fisheries —The MoL sometimes groups some adjacent wetlands under a single fishery, mainly for leasing purposes.*

[18] *Beels under disputes, local authorities collect revenue through selling yearly fishing rights - this system lack transparency.*
[19] Oakkas, M. A., Islam F. M., and Jalil, M.A. 2020: Fish, Fishing and Fishermen: A Case of Hakaluki Haor, Bangladesh. Social Science Journal, Faculty of Social Science, University of Rajshahi, ISSN: 1728-1474 Vol. 24 (Special Issue), March 2020, pp: 218-231.

fishermen or interested parties for their income in some areas. In addition, some rivers/canals are captured by local elites, controlling fishing and water use, accelerating wetland degradation, and excluding the poor from their traditional rights. Five rivers/ canals (Jaliar Khal, Shakna Khal, Halghata Khal, Mora Sonai, Gogali Chhara) are completely silted and used for agriculture. These linear wetlands need urgent restoration and rehabilitation to support biodiversity, fisheries, and agriculture within the basin.

### Fishermen' Status in Hakaluki Haor

Community-led management demands engagement and empowerment of genuine fishermen in planning and implementing management interventions. The DoF issues ID cards to genuine fishermen in the country. Without having a valid ID card, a fisher person lacks an official designation and thus lacks access to various benefits and entitlements (e.g. forming a cooperative society, providing proof of identity when applying for fishing leases, being eligible for loans from the DoF's development project, receiving government subsidies during fishing ban periods, and obtaining fishing rights). The study found that 38% of fishermen in the Hakaluki Haor area still lack fishermen ID cards due to delay in issuing ID cards from the DoF. Despite support from different development programmes to amplify their collective voice and build capacity for negotiation, there is a lack of formal structure for fishermen to hold DoF accountable, so they are deprived of getting fishers' benefits and services from the government (**Annex 11**).

### Fisheries Resources in the Haor

The Hakaluki Haor is historically known for having rich capture fisheries regarding production and species diversity. Over the years, the wetland ecosystems and their provisioning services have declined due to various contextual and climate-related drivers previously discussed. Many wetlands in the ECAs are permanently degraded and lost, seriously impacting fish production. About 20% of the fish species in Bangladesh are threatened in various categories, and urgent measures are needed to resolve the situation. A list of endangered fish species in projects ECAs is given in **(Annex 12)**. In the case of Hakaluki Haor, 83% (out of 63 fish species) of fish species were under the available category in 2008 which decreased to 51% in 2018 (Aziza et al., 2021[20]). This study suggests that fish species diversity has been declining in Hakaluki Haor owing to climate change (erratic rainfall, heavy rainfall, temperature fluctuation), anthropogenic activities (harmful fishing equipment, applying urea fertilizers for fishing, poison fishing, annual drying of beels, and overfishing) and socioeconomic condition of fishers.

### Status of Watershed in Hakaluki

The watersheds of Hakaluki Haor ECA cover three forest ranges, viz. Juri Range, Kulaura Range, and Borlekha Ranges and are under the jurisdiction of the Sylhet Forest Division. The primary cause of siltation in Hakaluki arises from extensive soil erosion in the watershed. The study has identified some issues that affect watersheds, forests, and biodiversity, of which encroachment of 38% of reserved forests is a key one**.** Encroachments include betel leaf cultivation by Khasia and Bengalis, establishing forest villages and illegal inhabitants, horticultural practices, and tea gardening. In addition, monoculture of Teak and *Akashmoni* plantations in social forestry within reserve forests, habitat loss for wildlife due to degradation and deforestation, wildlife poaching, cattle, and domestic elephant grazing are typical. The bamboo *mohal* encompassing 5339 ha bamboo forest, is vital in sustainable watershed management. Since 2013, all bamboo *mohals* have remained inoperative due to noncompliance with government rules, and legal litigations complicating the management of bamboo *mohals*. Sustainable harvesting and adherence to felling rules are crucial for the bamboo forests' lifespan, as failure to do so can degrade quality

[20] Hasanuzzaman, A.F.M., Sayeed, M.A.B., Rahaman, S.M.B. and Huq, K.A. 2010: Implications of climate change for fisheries and aquaculture in the Sundarbans regions of Bangladesh. Khulna University Studies · May 201. https://www.researchgate.net/publication/260872113

and make them vulnerable to fires and pests. Consequently, this situation could aggravate soil erosion and increase siltation in the Hakaluki Haor. Furthermore, the monocarpic nature of bamboo necessitates post-flowering management to prevent forest loss. Community-based collaborative management of bamboo forest for sustainable harvesting of bamboo resources could be the key to conserving the watershed of Hakaluki Haor.

### Key Threats to Ecosystems

The study conducted a threat ranking through an FGD in Hakaluki Haor ECA which revealed high sedimentation and clearing of swamp forests, political influence and poisoned bird hunting, poison fishing, and changes in land types/ conversions of wetlands are the most significant threats, (details in **Annex 13**). Especially poisoned bird hunting or poison fishing, where individuals deliberately deploy toxic substances to harm or kill birds, which constitutes a severe offense. Such poisoning can wreak havoc on bird species and their ecosystems, often tied to illegal hunting activities. Similarly, illegal poison fishing practices significantly threaten the fisheries resources and fish biodiversity in Hakaluki Haor.

### 3.1.3. Climate Change and Natural Disaster Patterns

The community people of the Sundarbans ECA consulted (farmers, fishermen, forest-dependent community and women) informed the study that their villages are grappling with escalating climate change impacts, which include rising temperatures, intensified cyclones, salinity intrusion, frequent flood, and changing precipitation patterns. In the Sundarbans ECA, rising sea levels and increased salinity are predicted to dominate the landscape, leading to loss of biodiversity and changes in mangrove species distribution. This area is expected to experience longer and more intense monsoon seasons, interspersed with pronounced drought conditions, posing further challenges for agriculture and local ecosystems. Climate induced displacement has become a harsh reality for many inhabitants, with the Sundarbans acting as a natural barrier against environmental hazards. The projections of Hakaluki Haor indicate an increase in the frequency and intensity of flash floods, which could alter the wetland's hydrological regime, affecting both biodiversity and the livelihoods of local communities. The wetland's role in flood mitigation, water quality maintenance, and as a carbon sink could be compromised, leading to a cascade of ecological and socio-economic challenges[21] (**Annex-14**).

Frequent cyclones and tidal surges affect the locality in April and May (Pre-Monsoon) and September to November (Post-Monsoon). Salinity becomes high in dry season during January to April while heat stress, drought and Nor'Wester (localised rain and thunderstorm) affect them in March to May. Therefore, community people face climate induced disasters that happen one after the other all year round. This affects their resources, health, income and livelihood which make them highly vulnerable to climate disasters.

The people in the Sundarbans ECA have witnessed profound transformations in their natural assets, particularly the rivers and canals with reduced freshwater flow and increased salinity. These changes, characterised by decreased river depth and riverbank erosion, are largely attributed to the impacts of climate change. Rising temperatures and increased salinity levels have altered water bodies, exacerbating the region's vulnerability to frequent cyclones and tidal surges. Notably, Cyclones Sidr (2007) and Aila (2009) significantly impacted the region, leading to extensive landscape changes affecting mangrove forests, roads, basic infrastructure, and residential structures. Key stakeholders such as DoF and DLS officials in the Sundarbans ECA highlighted that the Sundarbans region, characterized by its unique ecosystem, faces profound environmental challenges, which are being exacerbated by climate change, particularly rising sea level, increased frequency of cyclones and tidal surges. The increasing salinity in water and soil poses severe problems and barriers to development of agriculture, fisheries, and livelihoods of the common people.

In Hakaluki Haor, the region faces the dual threats of excessive flooding during the monsoon season and severe droughts in the dry season. These extreme weather events, exacerbated by rising temperatures and erratic rainfall patterns, have led to a decline in fish production, which is a crucial source of livelihood for the local community (**Annex-14**). Additionally, the reduced water availability for irrigation during the dry season threatens agriculture, further impacting food security and the economic stability of the region. Participatory research from the study suggests that the Haor ecosystem and people are severely affected during the summer and monsoon season. The livelihood of the community people particularly of the farmers, fishers and women are affected by flash floods, heavy rainfall, drought, and cold wave. Small scale agriculture, livestock, poultry, and duck rearing are highly impacted by floods, drought, heat stress and pest

[21] Islam, M.N., Rakib, M.R., Sufian, M.A., Raihan Sharif, A.H.M. (2018). Detection of Climate Change Impacts on the Hakaluki Haor Wetland in Bangladesh by Use of Remote Sensing and GIS. In: Islam, M., van Amstel, A. (eds) Bangladesh I: Climate Change Impacts, Mitigation and Adaptation in Developing Countries. Springer Climate. Springer, Cham. https://doi.org/10.1007/978-3-319-26357-1_8

attack. Flash floods cause huge loss and damage to crops such as dry season paddy (Boro rice) and vegetables on *Kanda*. Furthermore, in Baralekha Upazila of Moulavibazar District, drought and deforestation have significantly impacted biodiversity, causing a decline in bird and animal populations. The farmer groups in Fenchuganj Upazila of Sylhet District have reported that they are affected by flash floods, monsoon floods, drought, cold waves and fog every year. The women groups also reported being affected by heat stress, drought, colds and Kalbaishaki (land-based storms in summer) besides recurring floods. Please see the hazard and livelihood calendar of two ECAs for more details (**Annex-15**).

### 3.1.4. Lessons from Past Projects about EbA, NbS and Resilient Livelihoods

The FGDs and KIIs gathered information, views and perspectives of the communities and actors about the ECAs and the emerging approaches of EbA and NbS for ensuring resilient livelihoods. It is evident from the field research findings that government officials at the Forest Department (FD), Department of Fisheries (DoF), Department of Agricultural Extension (DAE) and Department of Livestock Services (DLS) are familiar with the terms and concepts.

Soon after the declaration of the ECA, the DoE-UNDP implemented a project (CWBMP) with the support of the UNDR-GEF for five years from 2003 to 2007. Later, the Embassy of the Kingdom of Netherlands (EKN) assisted the DoE in continuing NRM activities (CBA-ECA project) from 2007 to 2010, and USAID/IPAC worked on NRM activities from 2008 to 2012. After the end of the CBA-ECA project, the USAID-assisted CREL project worked in the Hakaluki Hoar for five years, from 2012 to 2018. These projects implemented various NRM activities, viz., established sanctuaries, restored swamp forests, watershed greening, supported the livelihood of the poor fishermen, and institutional capacity of village conservation groups (VCGs), provided an endowment fund to sustain institutional supervision and technical support to VCGs and strengthening union and upazila level ECA-Committees. The following are the key learnings of the previous projects:

- LLA can be more effective if all stakeholders and interest groups participation can be ensured in LLA process that leads reducing the human induced threats to ecosystem degradation, depletion of fish and wildlife biodiversity, wetland and *Kanda* land conversions, loss of swamp forests, and agricultural expansion by converting wetlands, swamp forests, and *Kanda* land within the Haor.
- Accountability and sense of ownership of mandated state agencies (DoE, BFD, DoF) and upazila and district administrations is essential to ensure regular ECA committee meetings, monitoring, supporting VCGs and transparency in NRM governance leading to sustaining ecosystem management efforts.
- Recognising and empowering VCGs as legal community institutions and giving them authority of ecosystem management can enhance ECA restoration initiatives sustainably.
- The DoE and previous CREL project engaged VCGs to manage the sanctuaries in Hakaluki. Initially, all these sanctuaries were reported to be well managed after the phasing out of projects. Later, MoL canceled four sanctuaries that were under the management of VCGs. This might have been avoided if they were declared as permanent sanctuaries and vested responsibilities of fisheries resource management were with the Department of Fisheries (DoF) as for *Baikka beel* in Moulvibazar District.

- Using a Market based approach for alternative income generation for dependent communities in and around the ECAs can reduce the dependency on natural resources lead in increasing fish population, wildlife, and overall biodiversity.
- Political commitment is vital to reduce the elite dominance over the wetland resources.

### 3.1.5. Socio-economic conditions and climatic vulnerabilities

Both the ECAs are highly populated with widespread poverty. According to the Bangladesh Bureau of Statistics (BBS) 2022, the total population of the Upazilas in Satkhira, Khulna and Bagerhat is 2,830,410, whereas the Upazilas in Sylhet and Maulavibazar that are part of the project have a population of 2,185,916[22]. Shyamnagar, and Morrelganj Upzilas have comparatively large populations in Khulna region while Kulaura and Golapganj Upzilas have comparatively large populations in Sylhet region.

In both regions, there are more females than males, with a male-to-female ratio of 49.7:50.2 in Khulna and 47.6:52.4 in Sylhet (BBS, 2022). The literacy rate is high in both sites, reaching 78.0% in Khulna and 78.2% in Sylhet in 2022. In both sites, males have a slightly higher literacy rate than females. The poverty rate is higher in both ECAs compared to the national average. The BBS 2022 report states that the Khulna region has 27.1% people living in poverty, and the Sylhet region has 22.5% people living in poverty in comparison to the national average of 18.7% moderate poor. A recent study shows that 15% of rural households and 24% of urban households could eat three meals per day[23]. The COVID-19 pandemic and climate change have reduced their food intake significantly in recent years. The food insecurity situation would be almost similar in the two ECAs. The study has tried to explore the differentiated risks and vulnerability of the women, girls, people with disabilities and ethnic communities in the two ecosystems, considering the climate stresses, socio-cultural conditions, and gender drivers. Women's dependency on ecosystems and natural resources for their livelihoods and family well-being as well as their interest and engagement in clean energy, WASH, EbA, NbS and resilient livelihoods, were sought. Many poor women are engaged in fuel and fodder collection as well as the collection of fish and vegetables both from the Sundarbans and Hakaluki Haor ECA. A few poor women (5% to 7% according to FGD participants) and their families also use water bodies in Haor for duck farming. It has been reported that the women, girls, and people with disabilities are facing greater climate risks and vulnerability in agriculture, home gardening, water and firewood collections, WASH, increasing health risks, raising poultry and livestock, and small businesses. FGDs with women reveled that climate change disproportionately affects vulnerable groups like women, adolescents, people with disabilities and marginalised populations. They face increased health risks, economic insecurity, and displacement due to their roles in caregiving, limited opportunities in society due to prevailing social norms, and many barriers to accessing resources during emergencies.

Inclusive policies, community engagement, changes in social norms and targeted interventions are needed to enhance resilience and mitigate the adverse effects of climate change on vulnerable groups. It is also considered essential to include women, youth, people with disabilities, and entrepreneurs in planning for climate adaptation, managing resources, and growing nature-based businesses to promote resilience and sustainable development for the local communities.

[22] Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS).
[23] Md Towhidur Rahman, Akter, S., Md Rahmatuzzaman Rana, Ashfak Ahmed Sabuz, & Md Fahad Jubayer. (2022). How COVID-19 pandemic is affecting achieved food security in Bangladesh: A perspective with required policy interventions. Journal of Agriculture and Food Research, 7, 100258–100258. https://doi.org/10.1016/j.jafr.2021.100258

Their involvement may result in more inclusive and holistic strategies because it brings different viewpoints, creativity, and economic empowerment. This can foster community ownership over natural resources and adaptation efforts, promote capacity building, creativity, and ultimately contribute to a more resilient and sustainable future by involving these groups.

In the Sundarbans, women's involvement in natural resource management is higher compared to Hakaluki Haor. In both the ECAs, women are part of ECA management committee, however their participation does not translate into involvement in decision making which is still dominated by men (see annex 16). This illustrates the need to focus on women's voice and leadership to promote gender equality in decision making related to ecosystem and natural resource management.

About 200 years ago, Jaminders brought the Munda ethnic people from Ranchi, Jharkhand, and Chattisgarh to the Sundarbans area, primarily in Shyamnagar, Koyra, and Tala Upazilas of Satkhira district. The Mundas cleared mangrove forests for cultivation but remained impoverished, living on khas land and subsisting on resources from the Sundarbans due to declining resources and restrictions. Today, many have migrated and found various livelihoods such as rickshaw pulling, earth cutting, and brick kiln work. Munda women are notably hardworking, contributing to farming and resource collection. Despite improvements, many still rely on Sundarbans resources and could benefit from organized support for sustainable harvesting and livelihood enhancement.

### 3.1.6. Impacts of Climate Change and Disasters on the Lives and Livelihoods

The community people (consulted through FGD and KII) have expressed their grave concerns about the growing impacts of climate variability (temperature rise and change in seasons and precipitation), slow onset events (like salinity, water logging, and sea level rise in the coastal villages) and extreme climatic events in the Sundarbans ECA. These are affecting their resource base, small infrastructure (houses, habitats and WASH facilities), health, employment, income, and livelihoods. Climate change and its effects on agriculture, fisheries, home gardens, and forest resources in the localities also undermines food security and nutritional status. In the Sundarbans ECA, the dependency of people on forests products for house construction and roofing materials has shifted due to government restriction on the Sundarbans, so coastal people look for alternative low-cost house construction materials and durable solutions.

The local fishermen in the Sundarbans' periphery heavily rely on water bodies and fisheries for their livelihoods, making them particularly vulnerable to changes in the landscape and waterways, especially exacerbated by climate-related problems. Twenty-six FGDs with fishermen and twenty-five FGDs with farmers informed that they have been compelled to change their occupation to cope with the increasingly unpredictable and challenging climate conditions. In Shoronkhola Upazila of Bagerhat District, a decade ago, many families (about 74% of the lower income people near Sundarbans)[24] relied on the Sundarbans for their livelihoods, but now, due to climate change, the resources are dwindling, and are therefore inadequate to support the increasing population of fishermen in the area. As a result, many fishermen (around 60%) have shifted their focus to sea fishing, while some have diversified into fish farming and rearing livestock as alternative livelihood. Cyclones, storms, and rising sea levels have exacerbated the depletion of fertile lands, rendering the delta infertile for farming due to excessive salinity. Salinity intrusion not only affects the quality of water but also contributes to water contamination, leading to health problems such as diarrhea, skin infections, and reproductive health problems with women and girls (Annex 17). The Sexual-Reproductive Health (SRH) of women and young girls are severely affected by salinity in water in the coastal villages. Women are forced to use saline water for bathing and basic cleanliness including menstrual management that enhance several health risks relating to SRH and skin diseases. Drinking saline water exacerbates hyper tensions, stomach upset and mental.

In Hakaluki, the smallholder farmer, fisher, forest dependent community, wage earner, small trade and business, etc. rely heavily on Haor ecosystems and natural resources for their subsistence, engaging in fish collection activities and cultivating crops, which are being affected by drought and flash flood. Additionally, the irregular rainfall patterns have led to crop failures, further impacting villager's income. Moreover, the shortage of rainfall has resulted in water scarcity, making agricultural activities more challenging. Further, the local communities in the Haor Basin have highlighted that heat stress and drought have significantly hampered crop yields and depleted fish populations, which is exacerbating food insecurity. Additionally, around 10% of the local population depends on Hakaluki Haor for collecting cane and reed forest materials (*murta* plants) for cottages industries and fodder for cattle. The wetland resources are being depleted due to both human pressures and climate change.

[24] Mohammad Abdullah, A. N., Stacey, N., Garnett, S. T., & Myers, B. (2016). Economic dependence on mangrove forest resources for livelihoods in the Sundarbans, Bangladesh. Forest Policy and Economics, 64, 15–24.

### 3.1.7. Community perceptions on ecosystem-based adaptation (EbA)

FGD findings from fishermen, farmers, youth, and women in both ECAs reveal that they are unaware of the approach of initiatives such as NbS, EbA, and LLA. However, they said they had received some training (from NGOs and projects like Suchana, CREL) on conserving and protecting wetlands resources to enhance their livelihoods with employment and income opportunities. Such activities could be related to EbA. Few of the VCG members said they received training (from NGOs and projects like CREL), awareness and financial support for minimising the risks of climate disasters on forests and wetlands, which may be linked to the emerging EbA, NbS and LLA initiatives in the ECAs. They also shared their expectations about achieving secure and climate-resilient livelihoods in both ECAs. All local communities expressed optimism regarding the potential for protection and restoration of ecosystems with greater ESS that will expand climate-resilient livelihoods. They are optimistic about the emerging opportunities in sustainable and climate-smart agriculture with saline and drought tolerant varieties, surface water irrigation and rainwater use in agriculture, homestead gardening, poultry and cattle rearing, integrated fish farming as well as crab farming, and potential for renewable energy supported livelihood options. The poor women of the Village Conservation Group (VCG) members preferred small businesses and non-farm activities, including handicraft as well as agro-business.

### 3.1.8. Natural Resource Base and Dependency of the People on the ESs

The community population and sectoral actors have informed that the ECAs were very rich in natural resources and biodiversity, including birds and wildlife, a decade ago in the Hakaluki Haor. The key natural resources in the Haor include bio-resources such as vast water bodies, fish, small hills with forests and biodiversity. The communities have informed that about 60%-70% households of the community directly or indirectly depended on the wetland resources for their livelihoods in Hakaluki Haor a decade ago. They have mentioned that significant changes occurred in the status of natural resources (fishes, flora, and fauna) over the recent few years, but management challenges hinder their ability to fully utilize the ESS for resilient livelihood. Institutional weakness, unregulated market force and climate change impacts have exacerbated the challenges faced in managing and maintaining bio-resource-dependent livelihoods. These complications likely include factors such as changes in weather patterns affecting farming activities, disruptions to ecosystems supporting biodiversity and fisheries, and potentially impacting wetlands through alterations in precipitation patterns. Earlier, the abundant natural resources, including *Khal, beel, various* bird species, fish, *Murta (wetland plant),* and aquatic plants, contribute significantly to the local ecosystem and livelihoods. The people residing in the Sundarbans ECA heavily rely on the mangrove forest resources and fisheries for their livelihoods. They collect other natural resources including honey, wood, *nypa* leaves, juvenile crab, shrimp fry, and fish fry within the Sundarbans and in the rivers of the buffer zone. However, the decline in fish populations due to obstacles like filled canals exacerbates the challenges faced by these communities. The inability of fish to pass through obstructed canals disrupts their natural migration patterns, further diminishing fish stocks and affecting the income of fishermen. In recent years, after the government enforced laws restricting access to the Sundarbans, local people have been forced to seek alternative means of livelihood.

## 3.2. Potential Nature-based Solutions (NbS)

The participatory research and local consultations have captured the views of the communities and actors about the feasibility of the possible interventions of the NABAPALLAB project. The details of preferred interventions in the six thematic areas of the project in **(Annex-18)**. The assessment assigned scores considering the Multi-Criteria Analysis (MCA), which included resilience to climate change and environmental conditions, social acceptance, availability of the materials and know-how (knowledge and skill) in the locality, economic cost-benefits, gender responsiveness, locally appropriate solutions, backward and forward linkages for services and technologies. This section highlights the potential options across the six thematic intervention areas of NABAPALLAB.

The thematic intervention of potential ecosystem restoration has been validated by the ecological assessment. Other interventions including renewable energy solutions, climate resilient livelihoods, climate resilient infrastructure and WASH, climate and weather information services, and early response support were directly verified by community people and stakeholders during the scoping study.

### Potential Ecosystem Restoration Interventions

Based on field assessment and community consultations, ecosystem-based interventions that build social-ecological resilience in the ECAs are prioritised. The priority interventions are presented below for both ECAs. A detailed discussion of the current operating context in the ECAs including who is doing what, where and how and alignment with the NAP priorities is discussed in the PEA and stakeholder study.

#### Sundarbans ECA

1. ***Rehabilitation of Canal networks*** to create freshwater provision for climate smart agriculture (agriculture, capture fisheries, and freshwater availability will support livestock and ducks)
2. ***Restoration and afforestation of riverside land*** (charland) adopting assisted natural regeneration (ANR) techniques – (mangroves can be restored by artificial planting as well

as protection from biotic interferences) there are 1,988 ha suitable char land for mangroves in the ECA of Sundarbans (hydrological assessment data)

3. ***Plantation of canal banks and dykes*** *adopting a* social forestry approach with BFD and UPs – 228 km of coastal dykes within ECA can be brought under strip plantation to greening dykes for the sustainability of dykes as well as create or recreate dyke-based ecosystems.
4. ***Introduction of crop agricultural activities in shrimp /aquaculture in Ghers***– integrated agriculture-aquaculture techniques that are resilient to climate shocks and stresses.
5. ***Plantation around shrimp Ghers*** to enhance plant diversity and improve the environmental health of the impacted areas around shrimp ghers and most importantly to protect soil erosion.
6. ***Protect riverbank erosion*** by adopting nature-based solution (NbS) approaches, such as planting on the slopes of coastal embankments and using grass hedging to stabilize the soil.
7. ***Improvement of water logging*** through drainage improvements by rehabilitating chocked-up canals jointly with communities, shrimp gher operators, BWDB, and local governments
8. ***Homestead plantations*** enhance plant diversity, create wildlife habitats, increase tree covers, and provide livelihood gains from homestead forestry.
9. ***Restoration of canals as natural barriers***—there are places where canals were used to form the boundary lines between the Sundarbans, and settlements are silted up, increasing the risk of tiger attacks and human-wildlife conflicts. This can be fixed by restoring such canals.

### Hakaluki Haor ECA

***A. Within the Hakaluki Haor Area:***

1. Implementation of sanctuary management interventions such as restoration of 7 sanctuaries covering an area of 130.22 ha (Annex-7.b).
2. Afforestation in *kanada* land to restore swamp forest over 550 hectares (see Annex 18).
3. Restoration of rivers and streams, targeting 6 rivers covering 59 km.
4. Conducting public awareness campaigns for ecosystem conservation.

***B. Watershed Area:***

1. Restoration of 15,700 hectares of forest
2. Afforestation of 200 kilometers of strip/riparian land and
3. The establishment of 2000 HH homestead plantations (Annex 18).

The scoping study validated and prioritised several potential EbA options (identified in the ecological assessment) like afforestation in *Kanda*, restoration of reed forest land in Haor as well as rehabilitation and restoration of canal networks and afforestation of river sides in Sundarbans ECA. These are to be promoted by the NABAPALLAB project. The communities surrounding ECA areas are familiar with various NRM and indigenous practices (e.g., ridge and farrow, bag gardening, *kanda* farming) aimed at coping with the challenges posed by climate-related impacts on both ecosystems and human systems. The KIIs and community consultation workshops have

made some recommendations on the feasibility of the EbA interventions in both ECAs. Table-2 below presents the most suitable EbA and NbS interventions in the ECAs based on the multi criteria assessment. The interventions preferred by the community include the conservation, protection and restoration of wetlands, fisheries, forests, wildlife and biodiversity that may also co-generate social and livelihood benefits for the resource dependent communities, poor women and most vulnerable groups. To ensure sustainable and climate resilient livelihoods, several trainings and orientation are needed for farmers, fishermen and women to enhance their skills and knowledge about EbA, NbS and resilient livelihoods.

The EbA and NbS interventions have been proposed considering the local climate factors. For examples wetland and *beel* sanctuaries, canal re-excavation and plantation are proposed in Hakaluki Haor in the face of growing drought. Community forestry, ANR and protection of Kanda with local species may work against flash flood, drought and other climatic stress. Similarly in Sundarbans ECA mangrove plantation, ANR, and community forestry may build resilience in the ecosystem and community to tackle the impact of cyclone and salinity. Re-excavation of canals and ponds will increase the reserve of fresh water that will create co benefits for both ecosystem health and resilient livelihoods.

*Table 1 Most suitable EbA &NbS interventions in the ECA (based on MCA)*

| SN | Hakaluki Haor | | Sundarbans | |
|---|---|---|---|---|
| | **Interventions** | **Total Score** | **Interventions** | **Total Score** |
| 1 | Establishment of wetland/Beel sanctuaries | 15 | Community forestry, plantation, and Assisted Natural Regeneration (ANR) | 15 |
| 2 | Canal re-excavation and restoration | 15 | Canal/pond re-excavation and restoration | 15 |
| 3 | Community forestry, plantation, and Assisted Natural Regeneration (ANR) | 15 | Establishment of canal/river sanctuaries | 15 |
| 4 | Protection of *Kanda* with local tree species | 15 | Strengthening co-management organisations | 15 |
| 5 | Strengthening co-management organisations | 15 | Increase Community Patrolling with PES (Payment on Ecosystem Services) | 15 |
| 6 | Increase Community Patrolling with PES (Payment on Ecosystem Services) | 15 | Create Awareness for Ecosystem Restoration | 15 |
| 7 | Create Awareness for Ecosystem Restoration | 15 | Stop destroying embankment/deforestation | 15 |
| 8 | Stop hill cutting and deforestation | 15 | Strengthening climate related information service providers (AIS, &UDMC) | 14 |
| 9 | Strengthening climate related information service providers (AIS, &UDMC) | 14 | | |

### 3.2.1. Climate Resilient Livelihood Options

The community members of both ECAs have expressed their concerns about the severe impacts of climate change on their livelihood assets and outcomes like food security, nutrition, health, wellbeing etc. They have also shared their expectations about secure and climate resilient livelihoods in both sites. All local communities expressed optimism regarding the potential for expanding climate-resilient livelihoods in the area, recognizing opportunities in activities in small agriculture with tolerant seeds, irrigation management, home gardening, poultry & cattle rearing and small businesses and non-farm activities including handicraft led by women. Additionally, they have urged for financial assistance and tailor-made training to enhance their knowledge for promoting climate resilient and nature positive livelihoods in the context of frequent floods, drought and changes in seasons.

The local communities in the Sundarbans ECA in Satkhira and Khulna districts have experienced excessive salinity (16.8 ppt in water and 21.12 ppt in soil) the reasons for which are discussed extensively in the sections above. Hence, saline-tolerant varieties of crops and adaptive cropping patterns should be introduced here with the active support of government departments like DAE, DoF and DLS as well as private sector. Further, agricultural diversification, crop intensification, mechanisation, and good agricultural practices are to be promoted in both ECAs. In this regard, the NAP has suggested various locally led and climate smart adaptation options for the climate stressed zones including the coastal village and Haor basin. These are stress tolerant varieties (flood, drought, short duration, salinity and water logging etc.); rice and non-rice crop varieties; raised bed crops; conservation agriculture with zero and minimum tillage crop such as, mustard, pulses and sesame etc. These are to be expanded through extension services of government, market linkages. But due to lack of knowledge *(such as overharvesting crab from natural sources)*, awareness as well as market linkage, community engagement in this livelihood is lagging behind. Moreover, poor women sometimes take on small loans for investing in honey production and storage and participate in the honey business.

The following table-1 presents the summary of the most suitable livelihood options in both ecosystems.

*Table 2 Most Feasible Options of Resilient Livelihoods in both Sites (based on MCA)*

| SN | Hakaluki Haor | | Sundarbans | |
|---|---|---|---|---|
| | **Interventions** | **Total Score** | **Interventions** | **Total Score** |
| 1 | Climate stressed (Flood, heat, drought, pest) tolerant, regenerative agricultural practice | 14 | Climate (Saline and drought) tolerant, Regenerative Agricultural Practice such as floating agriculture, *Sorjan* method and micro irrigation. | 14 |
| 2 | Community cattle shed or community raised plinth/cluster village | 15 | Community cattle shed or community raised plinth/cluster village | 15 |
| 3 | Livestock Vaccination Programmes | 15 | Establishment of Commercial Nursery (Crab) | 12 |
| 4 | Promote homestead gardening (vegetable cultivation in sack bag, tower, raised pit, use of mulching, shorjan etc.) for round the year | 15 | Strengthening household structure with saline tolerant materials/ environmentally friendly construction technology | 15 |

| | | | | |
|---|---|---|---|---|
| 6 | Off farm Activities (like agro-processing/handicrafts/eco-tourism) | 15 | Vaccination Programmes for livestock | 15 |
| 7 | Cattle, Duck/Chicken rearing | 15 | Support in re-introduction of locally extinct brood stock of fish | 14 |
| 8 | Establishment of growth center/Aggregation Center | 11 | Off farm Activities (Agro processing/handicrafts/eco-tourism) | 15 |

The livelihood interventions in Hakaluki Haor are limited but they may include flood tolerant and regenerative agriculture, community cattle sheds, livestock vaccination and off farm activities for poor women. The livelihood options in Hakaluki Haor may cover both farm-based and non-farm activities. According to the DAE and DLS officials in the Sylhet region, as well as field observation, the primary livelihoods surrounding the Hakaluki Haor revolve around crop farming and fish capture. For ensuring resilient livelihoods, they have suggested the establishment and management of sanctuaries in the Haor that may conserve fisheries and wetland resources with livelihood co-benefits for the fishermen and vulnerable communities.

It was also learned that, in a few cases, the local communities are aware of the concept of climate-resilient livelihoods and actions they can take to protect or adapt to climate impacts. The communities focused on household plinth raising to avoid inundation risk and enhancing home stead-based production. The Department of Agriculture Extension (DAE), private sectors and NGOs can provide training on site-specific crops and non-farm livelihood activities in the context of current and future climate change in the localities to address knowledge gaps. The community members also need the necessary information and guidance to improve production practices through climate-resilient crops to maximise their yield and enhance resilience to changing climate and environmental conditions. The key informants have further suggested conducting a comprehensive climate vulnerability and capacity assessment, focusing on diversification of livelihoods within the broader nature positive and NbS activities in the wetland and mangrove ecosystems. Community have also suggested strengthening housing structures and promoting environmentally friendly and durable construction materials. In reference to the ecosystem assessment, the key nature positive and climate resilient livelihood could include sustainable management of water bodies and fish sanctuaries, agro-forestry, mangrove restoration and sustainable use of ecosystem services for livelihoods.

### 3.2.2 Renewable Energy Solutions for alternative livelihoods

During the study, it was identified that communities mainly use grid energy or lighting, with electricity in the households and community places (such as schools, mosques, madrasas, marketplaces etc.). In the Sundarbans ECA, people mainly use fuel wood for cooking. They collect wood from the riverside or roadside forests for cooking, and some use gas cylinders. Electricity is available almost everywhere, but residents face challenges such as load shedding which limits their ability to use it for productive outcomes like income generation activities. Solar Home systems are common, but their uses are limited due to battery problems. Awareness about biogas is limited, with little understanding on bio-gas plant technologies, use and installation process. Furthermore, maintaining biogas plants becomes difficult during high tides with increased water levels.

In the Hakaluki Haor, the primary sources of cooking fuel consist of wood, leaves of trees and cow dung, with only a limited number of households utilising LPG cylinders. Electricity provided by the national and local power grid, known as "*Polli Biddut*", is available but not easily accessible to all due to financial constraints of the poor and women headed households. Some rich families have adopted solar energy solutions, but their use remains limited.

Small scale renewable energy technologies present an opportunity to support resilient livelihoods and alternative income generating activities. Community level consultation revealed a preference for solar energy, biogas plants and solar charging stations in both ECAs. The following table-3 presents the most suitable energy options in the two ECAs. Solar irrigation is proposed in the context of growing drought in both ECAs, while solar powered thresher, dryer, and husking machine for agro-processing are suggested for crop harvesting quickly before the flash floods experienced in Haor ECA and cyclones in Sundarbans ECA. Solar based clean energy systems like solar powered piped water, solar aeration for fishponds and shrimp *ghers* are the most suitable options because of the number of hours of sunlight and these may contribute to GHG emission reductions through clean energy. Biogas plants that can transfer waste into energy and produce biproducts like liquid fertiliser to support regenerative and climate smart agriculture could be utilised in both ECAs.

*Table 3 The preferred clean and renewable energy options (Based on the MCA)*

| SN | Hakaluki Haor | | Sundarbans | |
|---|---|---|---|---|
| | **Interventions** | **Total Score** | **Interventions** | **Total Score** |
| 1 | Establishment of Biogas Plant | 9 | Solar power thresher, Dryer, and Husking machine for agro-processing | 12 |
| 2 | Establishing Solar System for community | 9 | Establishing Solar System for community | 12 |
| 3 | Establishment of E-cook stove at HH level | 9 | Establishment of E-cook stove in HH level | 12 |
| 4 | Establishment of Solar Charging Stations | 11 | Establishment of Solar Charging Stations | 11 |
| 5 | Establishment of solar irrigation machine | 11 | Establishment of solar irrigation machine for surface water irrigation | 11 |
| 6 | Para-Solar Technician/Micro Entrepreneur Development | 8 | Installation of Solar powered village piped water supply systems for Sundarbans areas | 12 |
| 7 | Solar power thresher, Dryer and Husking machine for agro-processing | 12 | Solar Power Aerator for ponds | 11 |
| 8 | | | Establishment of Biogas Plant | 9 |

Training of women and youth in solar system maintenance is suggested for better utilisation of this technology. Schools, markets, madrasas, and mosques in this region rely on electricity generated from conventional energy for lighting, where solar energy could be used. The women, youth, farmer, and fisher groups are interested in involving themselves in clean and renewable energy initiatives, trade and business, which may create green jobs. Use of renewable energy solutions should be promoted to support income generation activities, small trade and business,

and resilient livelihoods of climate vulnerable communities. Awareness and training are needed to remove barriers towards the widespread adoption of clean energy and innovative technologies. Investing in education, particularly targeting women and youths, is crucial for empowering communities and unlocking the potential of renewable energy to support livelihood options.

### 3.2.3 Climate Resilient Community Infrastructures and WASH Facilities

The community infrastructures like houses, WASH facilities and rural communication networks are severely affected by climatic extremes in both ECAs every year. In the Hakaluki Haor, the absence of climate-resilient infrastructure and shelters poses significant challenges, leaving communities vulnerable during extreme weather events such as floods. Schools often serve as makeshift shelters in times of crisis. According to the local community, there is a dire need for the maintenance and availability of physical infrastructures like shelters and multi-use community facilities in this area. The construction of shelters is essential to provide refuge during emergencies such as natural disasters. The infrastructure is poor, exacerbating the community's vulnerability to various risks and challenges. In Baralikha, community people suggested raising house platforms and implementing raised twin-pit latrines to prevent waterborne diseases.

Cyclones, tidal inundation, and salinity in Sundarbans ECA affect houses and rural road networks including embankments. The housing structure has changed in recent years from mud walls and makeshift houses to Reinforced Cement Concrete (RCC) pillars and Corrugated Iron (CI) sheets for roofs of houses. The well-off families are constructing semi-*pacca* brick wall houses. The rural road infrastructure is improving gradually but poor rural road condition and connectivity are observed in remote locations and close to the Sundarbans. Additionally, inadequate water, sanitation, and hygiene facilities exacerbate health risks, particularly during floods. Community advocated for the installation of rainwater harvesting, Pond Sand Filter (PSF), and deep tube wells. According to the local community, tube wells with double platforms, deep tube wells with

submersible pumps, arsenic/iron removal plants, and solar-powered piped water supply systems are the most feasible options for ensuring reliable water for all. However deep tube wells are considered a driver for ground water depletion so other solutions are preferred. To mitigate the impacts of flooding on sanitation and health, the community have advocated for training programs in solid waste management and WASH practices.

Community awareness in WaSH and hygiene practices needs to be increased. For example, awareness sessions on WaSH conducted with women group, adolescent group, child group, mothers and caregiver group etc.

In Sarankhola Upazila, Sundarbans ECA, there are several functioning water-related infrastructures in place to combat the challenges posed by climate change stresses like salinity and cyclones. However, the situation in other locations is not good. For example, the utilisation of local ponds for rainwater storage, coupled with the upgrade of Pond Sand Filter (PSF) for broader accessibility for the poor would be a much more proactive approach to WASH and health risk management.

Climate resilient water supply and WASH facilities on the raised platforms are proposed in Hakaluki ECA in the face of flash floods and long-duration monsoon floods with high depth. The community also suggested maintenance and operation of the WASH facilities which are damaged frequently by floods. They also demanded water supply and WASH facilities maintenance and improvement of road communication to shelters due to cyclone and tidal surge.

### 3.2.4 Status of Climate and Weather Information Services

The primary source of weather updates in Hakaluki Haor is typically the announcement made via microphones from Union Parishad. Fishermen, women, elderly people, people with disabilities, and rural individuals often do not receive weather news and climate-related information in the right way. They face various challenges, such as limited access to devices like smartphones or televisions, which are commonly used to access weather updates. Individuals with disabilities encounter barriers in accessing information due to physical limitations or difficulties in using technology. There is a notable absence of signboards or digital boards, which the local population perceives as necessary for effective communication and awareness in Hakaluki Haor.

Significant efforts have been made to disseminate timely weather forecasts and ensure community preparedness for natural disasters since the devastating cyclone Sidr and Aila in Sundarbans ECA. The community suggested to strengthen the local Disaster Management Committees, comprising of local people, including farmers, fishermen, and small business owners. These committees are responsible for disseminating critical information about natural disasters and climate information to the entire community. Whilst, in Sundarbans ECA, women, fishermen, persons with disabilities, and marginalised groups sometimes receive required weather messages and early warnings of cyclones, they do not get adequate climate information for agriculture, fisheries, livestock, and other livelihood activities in the project villages (according to FGD participants).

Effective communication with climate information generation and dissemination is crucially important for disaster preparedness and resilient livelihoods. The NABAPALLAB project may take proactive measures with the communities and relevant government departments such as Bangladesh Meteorological Department (BMD), Department of Disaster Management (DDM), community radio, television and non-government actors like BRAC, BDPC and Cyclone Preparedness Program (CPP) in this regard. There is a specific need in both ECAs for improving the generation and dissemination of climate weather information services (CWIS), where the

project may take a lead role in collective efforts by involving community people, climate scientists, media personnel and development practitioners. This will serve the community as a local preparedness process with a contingency plan for timely and effective climate and disaster information for preparedness and shock responses towards social safety, reduction of loss and damage and resilient livelihood.

### 3.2.5 Access to Early Response Support

In both ECAs, vulnerable communities are affected by sudden shocks such as cyclones, flash floods, and tidal surge. The FGD findings highlighted that most of the time they didn't receive required emergency support to restore their livelihoods. They felt cash and non-cash (food, hygiene etc.) support are crucial for them. They also highlighted the importance for both preparedness and emergency response support to address the pre and post disaster situation.

### 3.2.6 Capacity building of communities and Local Government Institutions (LGI)

The study found the following capacity gaps in the knowledge and skills of the communities and local actors working in both ECAs:

- **Local Government Institutions and Local Authority in Ecological Critical Area (ECA)s**: Despite substantial efforts by the government in policy formulation and revision regarding climate change adaptation and mitigation, significant capacity gaps exist in effectively implementing these policies at the local level. These gaps include a lack of understanding of the intricacies of ecosystem-based adaptation (EbA), nature-based solutions (NbS), and locally led adaptation (LLA). Additionally, there is a pressing need for capacity building to integrate gender-responsive adaptation and empower marginalized communities within the government agencies responsible for implementing these policies.
- **Department of Environment (DoE), Bangladesh Forest Department (BFD), and Department of Fisheries (DoF)**: There is potential for increased integration of EbA and LLA into existing policies such as the National Biodiversity Strategy and Action Plan (NBSAP), Ecologically Critical Area (ECA) Rules, and Protected Area (PA) Management Rules. Training and awareness-raising efforts could enhance their appreciation of the value of these concepts and their importance in biodiversity conservation and resilient livelihoods.
- **Local Conservation Groups (VCG, VCF, CPG, VTRT, DCT, RMO and CMCs):** Despite the emphasis of the ECA Rules and PA Management Rules on strengthening local conservation groups, significant capacity gaps limit their effectiveness. Training, capacity-building, and mentorship programmes are essential to enhance their job performance and leadership in ecosystem management, biodiversity conservation, and sustainable livelihood generation.
- **Local Communities:** Capacity-building efforts are required at the community level to enhance their understanding of climate change adaptation, disaster preparedness, and sustainable livelihood practices. This could include training in alternative livelihood activities to reduce pressure on natural resources such as mangrove forests and Haor ecosystems, as well as capacity building in participatory research methodologies to explore local knowledge and traditional practices that can contribute to resilient livelihoods and biodiversity conservation.

# 4. Conclusions and Recommendations

The ecological assessment revealed that both sites have severe environmental concerns caused by multiple anthropogenic and climate drivers. The access of the poor and women to natural resources is decreasing daily, again affecting their livelihood strategies, activities, and livelihood outcomes (like employment, income, food, health, gender equity & social inclusion and well-being). The natural resource-dependent communities (like traditional fishermen and forest product collectors) and women are faced with differentiated impacts and vulnerability. In many cases, they are forced to migrate to other districts for survival. Involving the active participation of the resource user groups and other local actors in the protection, conservation and restoration of the Sundarbans and Haor ecosystems and the ecosystem services they provide, may support and improve the livelihoods of local communities dependent on the ECAs and help them to adapt better to current and future climate risks and vulnerability.

Both ECAs are under anthropogenic and climate-induced threats, losing their ecosystem functionality and reducing ecosystem services. The primary concern in the Hakaluki Haor is the poor management of the government-declared 12 wetland sanctuaries. Due to political influence, MoL has already transferred four sanctuaries to the traditional leasing systems. The other concern is poor watershed management, which is privatized in large parts, and negatively impacts the wetlands. Degradation of the watershed due to encroachment has resulted in increased soil

erosion and silted Hakaluki Haor's wetlands. Protecting the Hakaluki Haor from degradation will be challenging without improved watershed management and better governance. Rapid agricultural expansion within the Haor is a significant concern as this activity degrades the Haor ecosystems, which causes pollution and changes of wetlands into cropland. Agricultural expansion also encouraged the local elites to grab *khas* land within the Haor, thereby shrinking the wetland areas. Efforts are needed to promote community-based canal and beel management, particularly in certain upazilas.

The community members, resource users, and local actors, including the sectoral agencies, LGIs, and NGOs, have shown their preference and keen interest in NABAPALLAB's thematic interventions. They have different opinions and perspectives in the local, social, institutional, resource endowment and environmental/climate contexts. Further, effective, and purposeful engagement of the LGIs, NGOs and private sectors (particularly in WASH, agriculture, clean energy and small infrastructure) are crucially important for promoting LLA, resilient and secured livelihood of the poor as well as protection, restoration and conservation of the ecosystems and sustainability of the project.

Against this backdrop, the NABAPALLB project has the potential to address these problems and develop consensual ecosystem restoration and conservation plans with the participation of local communities and stakeholders in Hakaluki Haor and the Sundarbans ECAs. Both ECAs are impacted by the improper water management policies of neighboring countries, which demand transboundary water management. To protect these two vulnerable ecosystems from further degradation, the current management policy and strategies must be reviewed, towards co-developed sustainable management strategies for locally led NRM and climate actions.

Taking the assessment findings into account, the project will contribute to strengthening local climate action planning related to Ecosystem-based Adaptation (EbA) and Nature-based Solutions (NbS), including Assisted Natural Regeneration (ANR) of mangroves, embankment and wetland restoration through afforestation, and management support for sanctuaries. It will also bolster ECA management platforms such as Village Conservation Groups (VCG), Union Parishads, Upazila, and district ECA Management Committees. These efforts will enhance the capacity of communities and stakeholders for improved conservation, protection, restoration, and governance of natural resources in the project ECAs, while also generating co-benefits like resilient livelihoods and community wellbeing.

NABAPALLAB must collaborate with the BFD to address these challenges in the watershed. For example, rehabilitating degraded forests through Assisted Natural Regeneration (ANR), and adopting an agroforestry model within a collaborative forest management framework. Additionally, plant species favored by wildlife can be planted throughout the wildlife corridor to enhance wildlife habitat and reduce human-wildlife conflicts.

- The project may facilitate the formation of beneficiary groups and community patrol teams and provide training and monitoring support to combat forest offenses in partnership with the BFD. To formalize these collaborative efforts, an MOU outlining the roles and responsibilities of respective parties within the watersheds of the Sundarbans ECA and Hakaluki Haor.
- Plan to increase biodiversity and fisheries production in the Sundarbans ECA and Hakaluki Haor ECAs.
- Protect migratory birds and wildlife in Hakaluki Haor and Sundarbans ECAs.
- Develop a plan for wetland restoration for those already impacted due to increased sedimentations and climate change

- Restore swamp afforestation in areas suitable for planting swamp trees to enhance wetland habitats and create niches for fish and other aquatic biota.
- Protect *Kanda* land from encroachers.
- Plant and conserve reeds, and swamp forests to rejuvenate Haor ecosystems.
- The policy of leasing the *khal* for agriculture, catching fish or other purposes should be revised and enforced.
- Develop and implement consensual climate change adaptation and mitigation plans with active participation of communities and stakeholders on a priority basis on Hakaluki Haor and Sundarbans ECAs.
- Empower vulnerable groups and stakeholders through extensive capacity-building and training opportunities and resources on biodiversity conservation, climate change adaptation and mitigation, and NAP implementation processes.
- The restoration of mangrove ecosystems within the Charland area should be prioritized as a primary defense against cyclones and other coastal hazards.
- To maximize socioeconomic benefits for coastal fishermen and agricultural communities, efforts to restore the canal network in the Sundarbans ECA should be intensified.
- Embankment plantation initiatives should be expanded and optimized to sustain coastal protection measures while promoting biodiversity conservation. Planting suitable vegetation along embankments strengthens their structural integrity, reduces erosion risks, and provides diverse flora and fauna.
- There is a need to monitor the fish catches and species diversity in existing pile fisheries to generate evidence to influence leaseholders and MoL to increase the number of pile fisheries.
- A study on *beels* under development schemes should be urgently conducted to provide input for the MoL in deciding whether leasing of wetlands under development schemes should be continued.
- Promote climate resilient and environment-friendly livelihood practices to improve household incomes.
- Encourage investment in clean and renewable energy as well as engagement of youth, women and the private sector in clean energy and green jobs.
- Ensure access to climate resilient water supply, sanitation services, and facilities for vulnerable communities.
- Promote climate and weather information service for the vulnerable communities in both ECAs.
- Policy advocacy and policy engagement are needed for the transformation of good policy to local climate actions.
- Ensure the quality and impact of the project interventions by engaging LGIs, private sector and civil society organizations in implementation and monitoring processes.
- Prioritise household-level interventions over community-level interventions based on community preferences to enhance project effectiveness and relevance.

- Maintain close coordination among relevant government agencies, local government bodies, VCGs, and communities in planning, designing, and implementing consensual GESI inclusive ecosystem restoration and climate action interventions.
- Leverage local knowledge and human resources in planning and implementation of interventions, consulting and involving local experts and community members.
- Build awareness of communities, leaseholders, youths, and other stakeholders on environmental governance, sustainable NRM, resilient livelihood, biodiversity protection and better disaster preparedness.

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