



Regional Flyway Initiative · Site Study

May 2026

RFI Priority Site · Central Meghna Delta

Prepared by Ding Li Yong & Mike Crosby, with additional input from Billy Fairburn, Kelvin Peh, Evelyn Pina-Covarrubias, Stefano Barchiesi and Radhika Bhargava

BirdLife International, University of Southampton, University of Singapore

This consultant's report does not necessarily reflect the views of ADB, or the Government concerned, and ADB and the Government cannot be held liable for its contents.

Asian Development Bank

Disclaimer: The views expressed in this document are the views of the author/s and do not necessarily reflect the views or policies of the Asian Development Bank, or its Board of Governors, or the governments they represent. ADB does not guarantee the accuracy of the data included in this document and accepts no responsibility for any consequence of their use. By making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

General Site Information

Country	Bangladesh			
RFI Site Name	Central Meghna Delta	ID007		
City/ Municipality, Province, Region	Barisal			
Geographical coordinates	21.93 N, 90.62 E	Area (ha)	591,436 ha	
Key species	Spoon-billed Sandpiper, Spotted Greenshank, Fishing Cat			
Key habitats (biomes)	intertidal mud, sand, or salt flats, intertidal marshes, intertidal forested wetlands, permanent shallow marine waters, marine subtidal aquatic beds, sand, shingle, or pebble shores, and estuarine waters			
Key ecosystem services	Storm and flood hazard regulation; climate regulation. Also provisioning services (fisheries)			
Key drivers of change	Unsustainable agriculture, land clearance, siltation and climate change			
Conservation status (mark all that applies)	<input checked="" type="checkbox"/>	Protected Area	<input checked="" type="checkbox"/>	Flyway Network Site
	<input type="checkbox"/>	Ramsar Site	<input type="checkbox"/>	Others _____
IBA/ KBA name (and number) and other designations	Ganges-Brahmaputra-Meghna delta			
Management Stakeholders	Forest Department, local district administration, fisher cooperatives			
With management plan?	Protected areas such as Char Kukri-Mukri have management plans but needs to be updated.			
Project concept themes	Livelihood development, sustainable fisheries, wetland restoration			
Length of project	5-10 years			
Sector/s	Fisheries, agriculture			
No. of potential beneficiaries				
Indigenous Peoples	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	Yes _____
Anticipated Implementation Risks	Climate vulnerability and high population in areas of high conservation priority for migratory waterbirds, short-term impact on the income of local communities with regulations and restrictions on fisheries, wildlife disturbance during ecotourism development, and conservation priorities and capacity of wetland management stakeholders.			
Estimated Project Budget (US\$)	5,750,000 (over three years)			
Potential Source/s of Financing	<input checked="" type="checkbox"/>	Loan (to be identified)	<input type="checkbox"/>	Private Sector
	<input type="checkbox"/>	Grant (to be identified)	<input type="checkbox"/>	Public-Private Partnership

Table of Contents

General Site Information	3
Abbreviations	5
Executive Summary	6
1. Background of the Regional Flyway Initiative	7
2. Site profile of Central Meghna Delta	8
3. Biodiversity value of Central Meghna Delta	9
3.1. Key habitats.....	9
3.2 Importance of Central Meghna Delta to migratory waterbirds	10
3.3 Other notable biodiversity	10
4. Ecosystem services	11
4.1. Ecosystem services provided by Central Meghna Delta.....	11
4.2. Global climate regulating services.....	12
4.3. Coastal protection services	13
5. Drivers of change and their potential impacts on Central Meghna Delta	14
5.1. Current drivers of change and their level of impact.....	14
5.2. Potential alternative state of Central Meghna Delta under current drivers of change	16
5.3. Expected changes in the ecosystem services of Central Meghna Delta.....	16
6. Capacity needs in Central Meghna Delta	17
7. Opportunities for RFI interventions	19
7.1 Recommended Interventions.....	19
7.2 Potential Financing.....	21
7.3 Proposed Institutional Arrangements	21
7.4 Project Beneficiaries.....	22
7.5 Anticipated Implementation Risks	22
References	23
Annex 1. Supplementary information on coastal protection services	24

Abbreviations

ADB	Asian Development Bank
AWC	Asian Waterbird Census
BEZA	Bangladesh Economic Zones Authority
BDT	Bangladesh Taka
CREL	Climate Resilient Ecosystems and Livelihoods
CSR	Conservation Status Review
DMC	Developing Member Country
EAAFP	East Asian-Australasian Flyway Partnership
ECA	Ecologically Critical Area
IBA	Important Bird and Biodiversity Area
IUCN	International Union for the Conservation of Nature
NGO	Non-governmental Organisation
RFI	Regional Flyway Initiative
TESSA	Toolkit for Ecosystem Services Assessment
USAID	United States Agency for International Development
USD	United States Dollars
VCG	Village Conservation Group

Executive Summary

The Central Meghna Delta is a vast estuarine region (area of 590,000 ha) that spans several small, low-lying islands (locally known as *chars*) and the associated intertidal wetlands on the outer delta of the Meghna River. Much of this site is located administratively in Bhola District, Barisal Division. On these low-lying islands, there are extensive intertidal mudflats and mangrove forests broken by tidal creeks, among the largest in Bangladesh outside the Sundarbans. Further inland, the landscape is covered mostly by agricultural land and plantations. The coastal wetlands in the Meghna Delta are generally important feeding and roosting habitats for large congregations of waterbirds. Count data from the 2018-2022 Asian Waterbird Census (AWC) found that at least three migratory waterbirds regularly exceed the 1% population estimates, including some of the largest congregations of shorebirds, terns, and gulls in Bangladesh, and regular wintering Spoon-billed Sandpiper. In addition, the wetlands of the Central Meghna have provided substantial ecosystem services that benefit people living within the site, and communities further away; these involve regulation services such as climate regulation, flood and storm hazard regulation, as well as the control of erosion. The wetlands of the central Meghna Delta are estimated to store as much as 34.5 GT of carbon. To protect biodiversity in this region, two major protected areas have been designated: the Char Kukri-Mukri Wildlife Sanctuary in 1981 and the Sonarchar Wildlife Sanctuary in 2011, with management jurisdiction from the Forest Department.

Presently, wetlands across the Megha Delta are under considerable anthropogenic pressure resulting from unsustainable use. High-impact drivers of change include agricultural intensification and expansion, which significantly alter land use and contribute to habitat degradation. Other pressures include the expansion of commercial and industrial areas and the expansion of existing settlements. Strengthening livelihoods, especially for fishing communities, can also be expected to ensure a more sustainable use of declining fisheries, and in accordance with management plans developed for the Meghna Delta region, given the imposition of fishing restrictions on Hilsha Shad by the Government. Fishing communities across the Meghna Delta face various challenges, including low incomes, fishing rights, limited access to credit, and fishing equipment, and declining fisheries, including the commercially valuable Hilsha shad.

Addressing these livelihood challenges, which affect a large proportion of local communities across the Meghna Delta, is a major step to strengthen frameworks promoting sustainable use of fishing resources, while ensuring the livelihoods of thousands of households. Meanwhile, there is scope for soft interventions to strengthen awareness of wildlife such as migratory waterbirds, while managing disturbance to wildlife and habitat loss as a result of agricultural and fishing activities.

1. Background of the Regional Flyway Initiative

In July 2021, the Asian Development Bank made a commitment to develop a long-term Regional Flyway Initiative (RFI) in the East-Asian Australasian Flyway (EAAF) (Sovereign Project 55056-001) to protect and restore priority wetland ecosystems and the associated ecosystem services they provide in the EAAF, the most threatened migratory bird flyway globally. The Initiative is slated for implementation in nine ADB developing member countries (DMCs) in East, South and Southeast Asia: Mongolia, People's Republic of China (PRC), Bangladesh, Viet Nam, Cambodia, Philippines, Thailand, Malaysia and Indonesia. In 2023, the geographic scope of the RFI was further extended to two DMCs in Southeast Asia and the Pacific respectively, Lao PDR and Papua New Guinea.

The primary aim of the RFI is to enhance and expand the existing efforts in conserving and managing wetlands of the highest priority for migratory birds within the EAAF through innovative loan and grant financing, and at scale. Consultations and analyses over the development period help identify key interventions to strengthen the management of wetlands, enabling the implementation of nature-based solutions while strengthening biodiversity protection. Over time, the RFI seeks to leverage collaborative opportunities by developing partnerships among important stakeholders including national governments, civil society organizations, communities, regional organizations like the East Asian-Australasian Flyway Partnership (EAAFP), development agencies, the private sector, and other relevant entities.

Through the RFI Technical Assistance (TA) implemented over the RFI's development phase from 2021 to 2024, BirdLife International takes the lead in providing and coordinating technical support for development of the RFI. This is carried out in collaboration with the EAAFP and a consortium of international non-governmental organizations including Wetlands International and the Paulson Institute, as well as two universities, namely the University of Southampton, UK and the National University of Singapore. Over the development phase, the TA team undertook a site selection analysis to identify priority wetland sites in all 10 countries based on recent bird data benchmarked against internationally accepted criteria under the Convention on Wetlands of International Importance (or Ramsar Convention), EAAFP Flyway Network Sites and Important Bird and Biodiversity Areas (IBAs). The team further developed ecosystem services profiles for prioritised wetlands using a multi-pronged approach used the TESSA ecosystem services assessment tool, and data-driven modelling of water-based ecosystem services and stored carbon.

In Bangladesh, a total of 20 wetland sites, including many Asian Waterbird Census (AWC) count sites, were initially assessed through data analysis and expert consultation, of which eight (8) were defined and identified to be RFI priority sites on the basis that they support more than 1% the flyway population of at least one EAAF migratory waterbird species. Five of the RFI sites identified in Bangladesh are coastal wetlands, a consequence of the country's long coastline and its estuarine geography, with the largest cluster of priority sites being the Sundarbans and the Meghna Delta, which consist of a cluster of three sites. 17 EAAF species exceeded the 1% threshold at the site level in Bangladesh, with species such as Masked Finfoot reaching in excess of 50% of its flyway (and global) population (eastern Sundarbans) and the Spoon-billed Sandpiper. Other species with important non-breeding populations in Bangladesh include the Indian Skimmer *Rynchops albicollis* and the Baer's Pochard *Aythya baeri*.

2. Site profile of Central Meghna Delta

Location: The Central Meghna Delta comprises several small, low-lying islands (locally known as *chars*) and the associated intertidal wetlands in the south of the outer delta of the Meghna River, including Kukri-Mukri Char, Sonor Char and Char Shahjalal. It is located in southern Char Fassion *upazila*, Bhola District, Barisal Division, Bangladesh.

Area: The Central Meghna Delta RFI site has an area of 591,436 ha.

Altitude: 0-1 m asl.

Geographical coordinates: 21.93 N, 90.62 E

Description of site: The Central Meghna Delta comprises several small, low-lying islands with extensive intertidal mudflats and mangrove forests. The islands are dissected by small creeks or *khals*, and at high tide much of the islands are under water, other than the central parts where there is agricultural land and plantations of coconut *Cocos nucifera*, banana *Musa spp.* and mango *Mangifera indica*. The AWC counting locations at the Central Meghna Delta are Ander Char, Char Pial, Char Sakuchia South, Dhal Char, Dhal Char East, Kalkinir Char, Kukri-Mukri Char Sanctuary, Montaj Char, Shahjalal Char and Sonar Char.

Site administration, management, and land tenure: Char Kukri-Mukri Wildlife Sanctuary (5,086 ha) was designated in 1981, and Sonarchar Wildlife Sanctuary (2,026.48 ha) was designated in 2011, with the Forest Department as the management authority of both protected areas (UNEP-WCMC 2024). On Char Kukri-Mukri, the mangrove forests are state-owned, but the cultivated areas in the interior of the island are privately owned.

Social and economic values: On Char Kukri-Mukri, no forestry activity is carried out in the mangroves except for the purpose of protecting and managing wildlife populations. The interior of the island is under cultivation, and nearby newly accreted islands are also being colonised and cultivated by the local communities.

Currently, fishing communities across the Meghna Delta face various challenges, which include low incomes, limited fishing rights, limited access to credit, and fishing equipment (Sultana et al. 2024) and declining fisheries, while current fishery cooperatives are too small to ensure that the needs of fishermen are adequately met. Season bans on the take of the commercially important Hilsha, and of young fish or *jatka* has also impacted the livelihoods of many fishers, and compensation schemes have been established to compensate for lost incomes of many fishing communities (Haldar & Ali 2014)

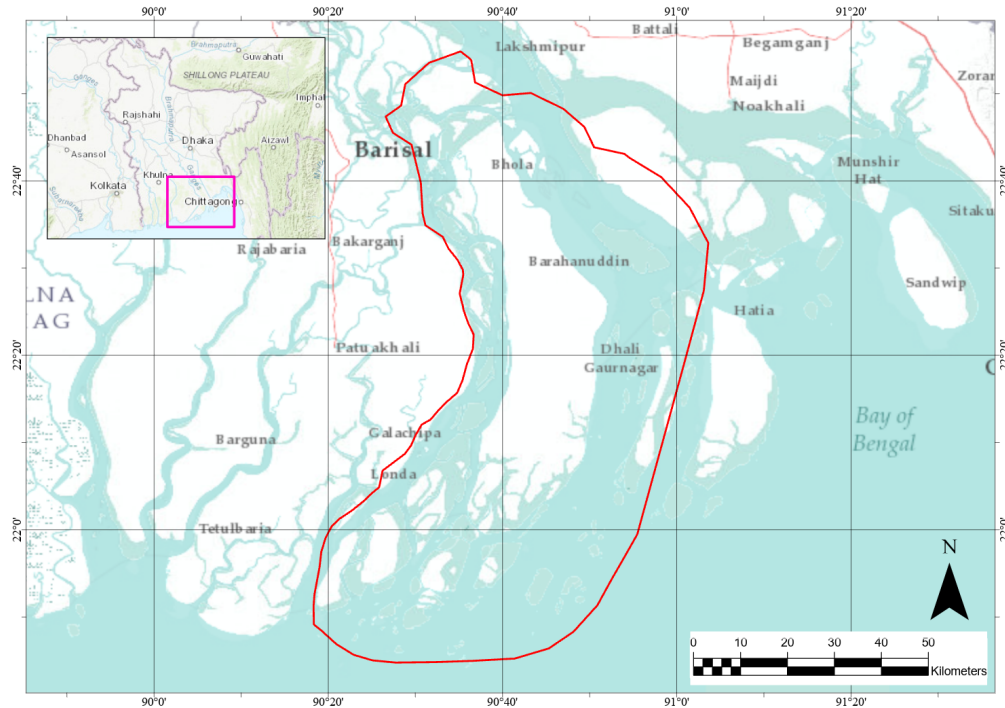


Figure 1 Map of the central Meghna Delta, showing its boundary (in red) and location within Bangladesh (in pink) (data from EAAFP Site Information Sheet).

3. Biodiversity value of Central Meghna Delta

3.1. Key habitats

The Central Meghna Delta is a vast estuarine region (area of 590,000 ha) that spans several small, low-lying islands (locally known as *chars*) and the associated intertidal wetlands on the outer delta of the Meghna River. On these low-lying islands, extensive intertidal mudflats and mangrove forests are found, broken by tidal creeks, among the largest in Bangladesh outside the Sundarbans. Further inland, the landscape is covered mainly by agricultural land and plantations.

Key habitat types in Central Meghna Delta, based on the stakeholder-based assessment at the Regional Flyway Initiative workshop in May 2024, included intertidal mud, sand, or salt flats, intertidal marshes, intertidal forested wetlands, permanent shallow marine waters, marine subtidal aquatic beds, sand, shingle, or pebble shores, and estuarine waters.

3.2 Importance of Central Meghna Delta to migratory waterbirds

The coastal wetlands in the Central Meghna Delta are important feeding and roosting habitats for large congregations of waterbirds, including Char Kukri-Mukri Wildlife Sanctuary, which supports a diversity of shorebirds, gulls, and terns, and contains a large breeding colony of herons and egrets.

Count data from the 2018-2022 Asian Waterbird Census (AWC) was used in the RFI analysis for the Central Meghna Delta. Three counts were conducted there annually, and the results of these counts were averaged over this five-year period, and then compared to the Conservation Status Review (CSR1) 1% population estimates to calculate a score for each species. The three migratory waterbird species were found to regularly exceed the 1% population estimates during these five years (see Table 1), and the CSR1 scores for these species were summed to produce the overall site score.

In addition to Black-headed Ibis (NT), the AWC recorded small numbers of three globally threatened and near-threatened species at the Central Meghna Delta during 2018-2022, namely Spoon-billed Sandpiper *Calidris pygmaea* (CR), Spotted Greenshank *Tringa guttifer* (EN) and Black-tailed Godwit *Limosa limosa* (NT).

Table 1 List of migratory species (based on the EAAFP list of species) with globally significant congregations in the Central Meghna Delta.

Species name	IUCN	Average count	CSR1	CSR1 score
Black-headed Ibis <i>Threskiornis melanocephalus</i>	NT	139	100	1.4
Lesser Sandplover <i>Charadrius mongolus</i>	LC	328	300	1.1
Common Shelduck <i>Tadorna tadorna</i>	LC	1,220	1,200	1.0

3.3 Other notable biodiversity

Several globally threatened mammals and reptiles occur in the Central Meghna Delta, including Asian Small-clawed Otter *Aonyx cinerea* (VU), Fishing Cat *Prionailurus viverrinus* (VU) and Yellow Monitor *Varanus flavescens* (EN).

4. Ecosystem services

4.1. Ecosystem services provided by Central Meghna Delta

The Central Meghna Delta is a crucial region that provides provisioning, regulating and cultural ecosystem services, which benefit communities within, adjacent to, and distant from the site (Fig. 2). The results from the RFI workshop¹ highlights the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Regulating services, including local climate regulation, flood hazard regulation, storm hazard regulation, erosion regulation, and salinity regulation, are fundamental to the region. They positively impact communities at all distances from the site.

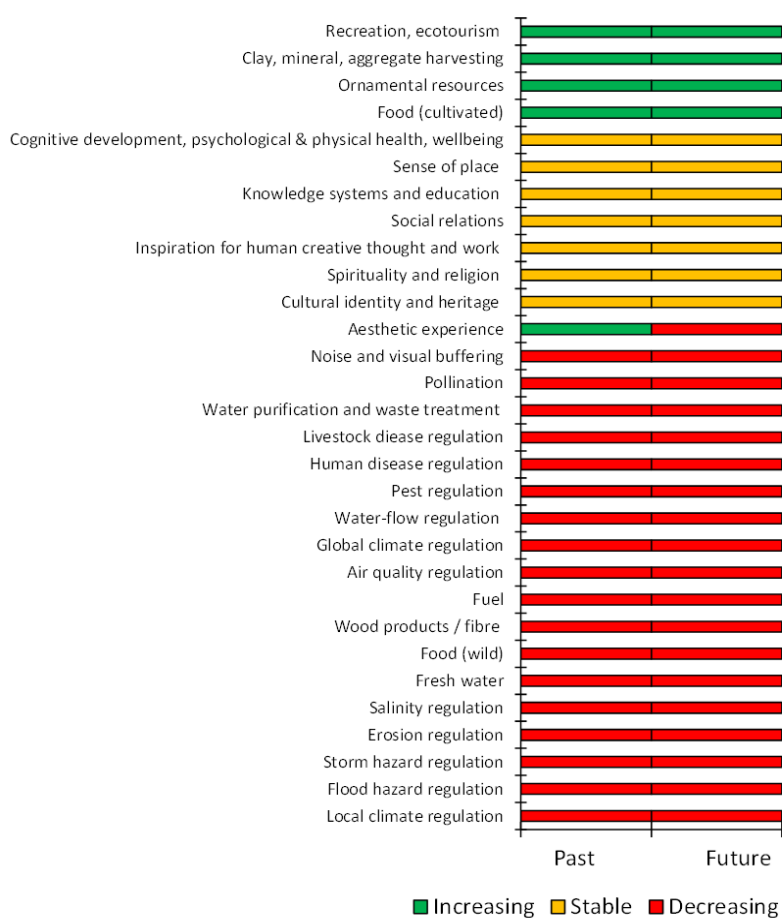


Figure 2 List of ecosystem services provided by Central Meghna Delta, as identified through stakeholder consultation at the Regional Flyway Initiative workshop.

¹ Asian Development Bank. (2024, May 27–29). *Bangladesh: Wetland Ecosystem Services Workshop* [Workshop]. Srimangal, Moulvibazar, Bangladesh. <https://events.development.asia/learning-events/bangladesh-wetland-ecosystem-services-workshop>

Table 2 List of top ecosystem services provided by Central Meghna Delta.

Ecosystem services	Essential or non-substitutable	Benefits to communities			Change	
		Within the site	Adjacent to the site	Distant to the site	Past	Future
<i>Regulating services</i>						
Local climate regulation	Yes	✓	✓	✓	Decrease	Decrease
Flood hazard regulation	Yes	✓	✓	✓	Decrease	Decrease
Storm hazard regulation	Yes	✓	✓	✓	Decrease	Decrease
Erosion regulation	Yes	✓	✓	✓	Decrease	Decrease
Salinity regulation	Yes	✓	✓	✓	Decrease	Decrease

4.2. Global climate regulating services

Using remote sensing data based on ESA maps that are open access, we estimated the stored carbon for the central Meghna Delta at 34,509,000 tonnes, while the total sequestered carbon is estimated at 831,972 tonnes per year. The amount of carbon stored in Central Meghna Delta based on published estimates for the main land cover types is comparable, and ranges from 21,400,000 to 42,600,000 tonnes (Chen and Lee, 2022; Stankovic et al., 2023), while the annual carbon sequestration rate is estimated to be between 339,000 and 348,000 tonnes per year. As a result of this site, the central Meghna holds the second largest stores of carbon outside of the Sundarbans.

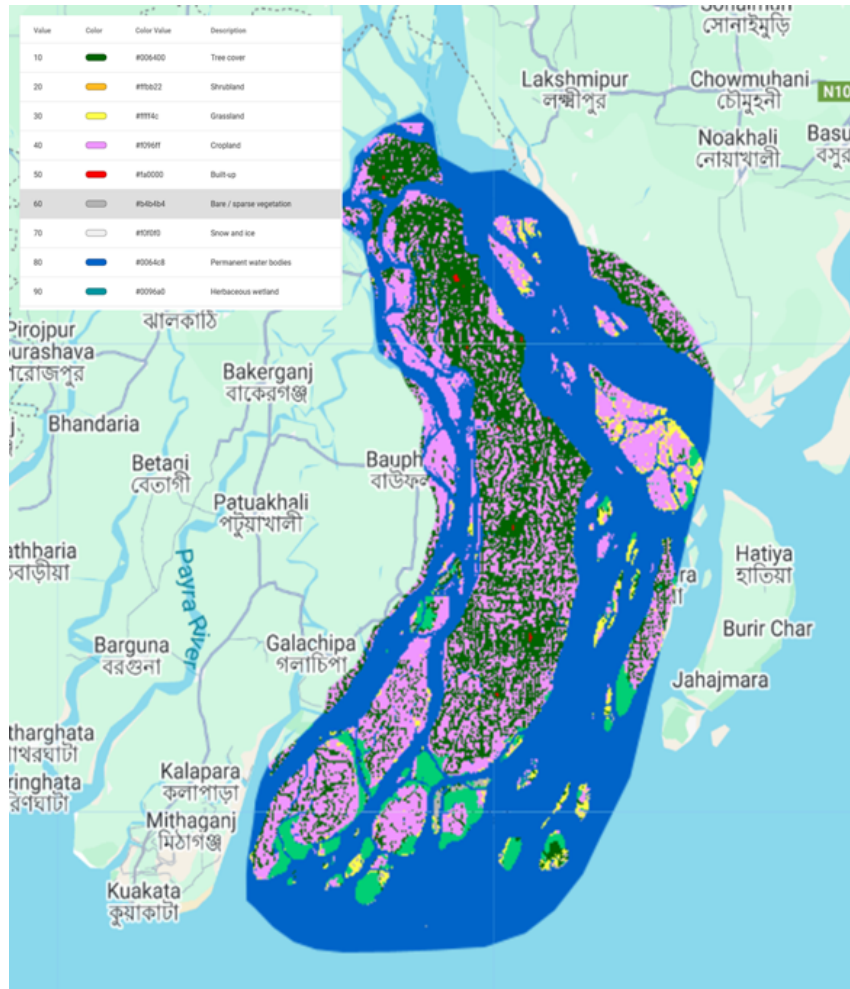


Figure 3 Map of the Central Meghna Delta, showing approximate boundaries and dominant land cover types such as cultivated areas (map by Radhika Bhargava).

4.3. Coastal protection services

The coastal protection services provided by the Central Meghna Delta were assessed using both biophysical indices and monetary values (see Tables A1 and A2, and Annex 1 for details). When compared to both the average of the five RFI coastal sites and the average of all other coastal areas in Bangladesh (Table A3 in Annex 1), the Central Meghna Delta shows some only partly mixed results in terms of risk level:

1. for the potential exposure to coastal hazards, the Central Meghna Delta is slightly below average compared to RFI coastal sites (index: 3.11 vs. 3.13), but above average compared to all other coastal areas (index: 3.11 vs. 2.99);

2. for the contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast, the Central Meghna Delta is consistently below average (12 vs. 26 people/ha for RFI coastal sites 12 vs. 38 people/ha for all other coastal areas); and
3. for the contribution to reducing coastal risk as a percentage of the maximum potential exposure, the Central Meghna Delta is also consistently below average (0.61% vs. 2.39% for RFI coastal sites and 0.61% vs. 1.69% for all other coastal areas).

In monetary terms (Table A4 in Annex 1), the Central Meghna Delta ranks well above both the national RFI and overall country averages in terms of total annual benefits per ha of mangroves (794,504 vs. 165,936 or 18,638 USD/ha). Moreover, the Central Meghna Delta is also above the average of all RFI coastal sites in Bangladesh regarding benefits against 100-year return period storms (1.5 vs. 0.5 billion USD).

While biophysical indicators show the Central Meghna Delta provides slightly below-average per-hectare protection to populations, its high monetary value reflects the significant economic assets and broader services safeguarded by its extensive mangrove systems—especially during extreme events.

5. Drivers of change and their potential impacts on Central Meghna Delta

5.1. Current drivers of change and their level of impact

Stakeholders at the RFI workshop² identified 59 drivers of change impacting the wetlands of the Central Meghna Delta, and their corresponding levels of impact on the wetland site (see Table 3). High-impact drivers include annual and perennial non-timber crop production, which significantly alters land use and contributes to habitat degradation. Commercial and industrial areas further exacerbate habitat loss and pollution. Other high-impact activities include erosion and siltation/deposition, habitat clearing, habitat shifting and alteration, housing and settlement development, increased fragmentation within the wetland, and isolation from other natural habitats. Industrial mining, livestock farming, loss of keystone species, and large-scale operations such as ports, shipping lanes, and canals also pose substantial threats to the ecosystem. Natural events like storms and flooding are additional high-impact factors affecting the site's resilience.

² Asian Development Bank. (2024, May 27–29). *Bangladesh: Wetland Ecosystem Services Workshop* [Workshop]. Srimangal, Moulvibazar, Bangladesh. <https://events.development.asia/learning-events/bangladesh-wetland-ecosystem-services-workshop>

Medium-impact drivers include agricultural and forestry effluents, which degrade water quality. Dams, hydrological modifications, and water management practices alter the natural water flow and connectivity. Fishing, hunting, logging, and harvesting activities contribute to ecosystem stress, while recreational activities, tourism infrastructure, roads, railroads, utility lines, and energy generation projects (e.g., hydropower dams) moderately modify the site (medium impacts).

Table 3 Drivers of change and their potential impact on the integrity of Central Meghna Delta based on consultations with stakeholders.

Driver of change	Impact
Annual and perennial non-timber crop production	High
Commercial and industrial areas	
Erosion and siltation/deposition	
Habitat clearing	
Habitat shifting and alteration	
Housing and settlement	
Increased fragmentation within the wetland site	
Industrial, mining and military effluents	
Isolation from other natural habitats	
Livestock farming and grazing	
Loss of keystone species	
Ports with large scale loading and unloading of goods	
Shipping lanes and canals	
Storm and flooding	
Activities of site managers	Medium
Agricultural and forestry effluents	
Dams within or upstream of the wetland site, which alter the hydrological regime	
Dams, hydrological modification and water management/use	
Earthquakes/tsunamis	
Energy generation, including from hydropower dams, wind farms and solar panels	
Fishing, killing and harvesting of aquatic resources	
Garbage and solid waste	
Household sewage and urban wastewater from outside the wetland site	
Hunting, killing and collecting of terrestrial animals	
Logging and timber harvesting	
Loss of hydrological connectivity	
Marine and freshwater aquaculture	
Oil and gas drilling, extraction of sand	
Other 'edge effects' that degrade the wetland site values	
Recreational activities and tourism	
Roads and railroads	
Temperature extremes	
Tourism and recreation infrastructure	
Utility and service lines	
Water extraction/diversion within the wetland site or catchment	
Wood pulp and plantations	Low
Air-borne pollutants	
Avalanches/landslides	
Collecting terrestrial plants or plant products (non-timber)	
Desertification	
Destruction of cultural heritage buildings, gardens, sites, etc.	
Drought conditions	
Droughts	
Drug cultivation	
Excess energy	
Excess ponding of water onsite	
Fire and fire suppression	
Flight paths	
Introduced genetic material	
Invasive animal species	
Invasive plant species	
Loss of cultural links, traditional knowledge and/or management practices	
Mining and quarrying	
Natural deterioration of important cultural wetland site values	
Pathogens	
Research, education and other work-related activities	
Restoration for conservation	
Sewage and wastewater from wetland site facilities	
War, civil unrest and military exercises	

5.2. Potential alternative state of Central Meghna Delta under current drivers of change

Stakeholders at the RFI workshop³ defined the most plausible future alternative state (to 2035), and how this will translate to a net change in the cover of different types of wetland habitat types within this site (current habitat cover vs future alternative cover; Figure 4). The alternative state of the site assumes there will be no changes in the current drivers of change impacting the site, and the current management regime.

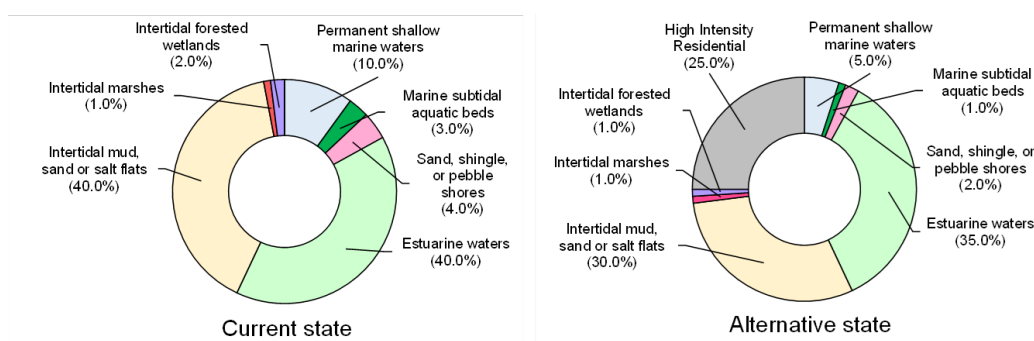


Figure 4 The proportional change in the extent of different habitat types between the current and alternative states of Central Meghna Delta.

5.3. Expected changes in the ecosystem services of Central Meghna Delta

Stakeholders at the RFI workshop⁴ documented the future trends in the provision of ecosystem services in Central Meghna Delta, indicating if the ecosystem services provided by this site (to 2035) will increase, decrease, or will remain stable if the current drivers of change impacting this site will continue in their present condition, with the intervention remains unchanged.

Figure 2 and Table 2 highlight that regulating services, including local climate regulation, flood hazard regulation, storm hazard regulation, erosion regulation, and salinity regulation, have experienced a decrease in the past and are projected to continue decreasing in the future.

In the alternative state which is highly likely, the loss of 50% of mangrove, 67% seagrass, and 24% of intertidal mudflat will result in a loss of stored carbon, estimated to range from 5,340,000 to 12,900,000

³ Asian Development Bank. (2024, May 27–29). *Bangladesh: Wetland Ecosystem Services Workshop* [Workshop]. Srimangal, Moulvibazar, Bangladesh. <https://events.development.asia/learning-events/bangladesh-wetland-ecosystem-services-workshop>

⁴ Asian Development Bank. (2024, May 27–29). *Bangladesh: Wetland Ecosystem Services Workshop* [Workshop]. Srimangal, Moulvibazar, Bangladesh. <https://events.development.asia/learning-events/bangladesh-wetland-ecosystem-services-workshop>

tonnes, and a decrease in carbon sequestration rate (carbon accumulation) by approximately 88,900 to 93,400 tonnes per year.

A loss of 5,914.3 ha of mangroves as presented in Table A5, however equivalent to less than 1% of the total land use for the site, is expected to result in roughly a 50% reduction in coastal protection. This may amount to approximately 193 million USD in lost total benefits per year (based on 32,588 USD per hectare of mangroves as assessed by stakeholders which is more conservative than 794,504 USD per ha as per modelling) and 738 million USD in lost total benefits per 100-year return period storm.

6. Capacity needs in Central Meghna Delta

The stakeholder consultation and analyses with stakeholders representing government and civil society identified at least nine major groups of stakeholders with clear roles in the long-term sustainable management of wetlands in the wider Meghna Delta landscape. Major gaps exist for government stakeholders in relation to strengthening the management and restoration of wetland landscapes, biodiversity, and agricultural landscapes. The Bangladesh Forest Department (BFD), a major stakeholder, for instance, currently (and is expected to play) a role in ensuring that sites within the wider Meghna landscape, such as Nijhum Dwip, are well managed for biodiversity. However, it faces capacity gaps as a result of resource and organisational constraints.

Table 4 Stakeholder groups and their corresponding capacity gaps and needs.

Stakeholder group	Current role and impact in wetland management	Possible future role in wetland management	Current capacity for sustainable wetland management	Form of capacity development (e.g. training, organisational strengthening etc.)
Bangladesh Forest Department	Sustainable management of agriculture, including plantations	Reforestation, Wildlife protection and Conservation	Inadequate resourcing for site management.	Strengthening organisational structures; improve resourcing.
Local District Administration	Land litigation; manage land disputes from local people and entities	Address land ownership issues; community support, drive law enforcement	Inadequate, with major gaps for improvement.	Further capacity strengthening to address land lease and ownership issues.

Stakeholder group	Current role and impact in wetland management	Possible future role in wetland management	Current capacity for sustainable wetland management	Form of capacity development (e.g. training, organisational strengthening etc.)
Boat (and ship) owners	Income generation Social safety Driver of water pollution	Ecotourism support; support livelihoods of other industries Larger role to managing water pollution.	Adequate but lack of coordination as most operate independently.	Training for roles in ecotourism and livelihoods needed.
Local Government	Provide social safety	Community involves fail to create awareness	Inadequate resourcing	Organisation strengthening needed.
Fishermen (and associated cooperatives)	Income generation Pollute wetland	Income generation Larger role to manage pollution	Inadequate resourcing	Training needed for sustainable fishing practices.
NASS	Community management; site management	Livelihood support to community awareness	Inadequate; need community involvement	Training to build awareness of conservation issues
Tourism operators	Income generation, but responsible for pollution and habitat disturbance	Improve management of ecotourism activities, contain pollution.	NA	NA
Local community	Livelihood support	Stronger role in supporting biodiversity conservation	Inadequate	Training to build awareness of conservation issues

7. Opportunities for RFI interventions

7.1 Recommended Interventions

The densely populated and highly climate-vulnerable coast of the Meghna Delta overlaps with several wetland landscapes of high conservation priority in Bangladesh such as Nijum Dwip and Sandwip, and where there is scope for stronger management and conservation interventions, alongside interventions to promote livelihoods of local communities. Improving the management of the wider Meghna Delta will require a combination of terrestrial and marine interventions to address unsustainable grazing which increases erosion and lead to vegetation degradation on riverbanks and sand islands ('chars'), key wildlife habitat, and targeted interventions to address unsustainable marine fishing activities, which threaten fish stocks across the coastal zones of the Meghna Delta.

Strengthening access to livelihoods, especially for fishing communities, can also be expected to ensure a more sustainable use of declining fisheries, and in accordance with management plans developed for the coastal and estuarine waters of the delta.

Addressing these livelihood challenges, which affect a large proportion of local communities in the Meghna Delta, will be critical to strengthen frameworks promoting sustainable use of fishing resources while ensuring the livelihoods of thousands of households. Compensation schemes or payments for ecosystem services help to finance livelihood development work to some extent. Meanwhile, there is scope for soft interventions such as joint capacity-building interventions led by the BFD and civil society to strengthen awareness of wildlife, such as migratory species, while managing disturbance to wildlife and habitat loss as a result of agricultural and fishing activities.

Table 5 Summary of key RFI interventions proposed for Central Meghna Delta

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
<i>Component 1: Strengthening sustainable wetland-based ecotourism</i>					
Develop alternative livelihood and income-generating activities for local communities, especially	Local communities developed and have improved access to livelihood opportunities.	Number of people benefitting from livelihood activities, with up to 30% beneficiaries from women,	300,000.00	2 years	Bangladesh Forest Department Local District Administration Local Government
			200,000.00	2 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
communities near to ecologically sensitive areas.	Ecosystem services are better conserved.	youth, elderly, indigenous people, and other vulnerable groups Number of people trained on livelihood activities			Fishermen (and associated cooperatives) Local community
<i>Component 2: Coastal wetland habitat protection and management</i>					
Strengthen the management (and enforcement) of fisheries through targeted fishing bans and take quotas (for sensitive species), in accordance with current management plans.	Fish stocks of commercially important species (e.g. Hilsha) are sustainably harvested. Productivity of fisheries are maintained over time.	Number of fishery management policies facilitated Number of trained national and local wetland stakeholders based on local capacity needs, with at least 30% participants from women, youth, and indigenous people's groups	100,000.00	2 years	Bangladesh Forest Department Local District Administration Local Government Fishermen (and associated cooperatives) Local community
<i>Component 3: Restoration of degraded wetlands</i>					
Scale up mangrove restoration at	Degraded mangrove areas in the	Area of restored	1,500,000.00	3 years	Bangladesh Forest Department

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
degraded areas of mangroves, especially around protected areas.	foreshore parts of the Meghna Delta and associated distributary channels restored.	mangrove ecosystem			Local District Administration Local Government Local community
Socioeconomic surveys and consultation with local communities			50,000.00	1 year	
Total investment for 3 years			5,750,000.00		

7.2 Potential Financing

The estimated project cost is USD 5,750,000 over three years. This project budget supports the scaling up of the mangrove restoration and reforestation program, the installation of coastal protection infrastructure, the updating of the site management plan for protected areas such as Char Kukri-Mukri, the construction of ecotourism infrastructure, and the implementation of capacity-building activities for sustainable fisheries and ecotourism.

If around half of the proposed USD 1.5 million investment in the Central Meghna Delta is assumed for mangrove restoration, that would enable the rehabilitation of roughly 75 hectares based on average costs. With estimated coastal protection benefits of USD 32,588 per hectare annually (see 5.3), this nature-based component could yield USD 2.44 million per year—offering a benefit–cost ratio above 3:1. Paired with hard infrastructure, the intervention provides a cost-effective, hybrid approach to climate resilience. In contrast, prioritizing uses such as aquaculture may deliver short-term gains but risks long-term losses in natural protection far exceeding their value.

7.3 Proposed Institutional Arrangements

Capacity building and awareness activities will be led by the Bangladesh Forest Department, and implemented over a period of 5 years. Civil society organisations with a focus on biodiversity conservation can play a major role with leading and delivering training activities on the ground at selected villages. The Fisheries Department will lead the implementation of fishery-related components of the project, focusing on activities to scope and develop management plans (2 years), and follow up activities to implement the

management plans. Implementation will be coordinated with the local government, local administration and civil society organisations. Mangrove and wetland restoration activities can be financed by the private sector, and driven on the ground through consortiums between the BFD and civil society organisations.

7.4 Project Beneficiaries

There are a few indigenous communities in the proposed project site, but there are major opportunities to strengthen the representation of women and marginalised fishing communities (including fishing households unrepresented in any broader frameworks) in influencing management structures affecting their livelihoods.

7.5 Anticipated Implementation Risks

Social Safeguards: The implementation of short-term fishing bans and quotas, as part of wider fisheries management plans and zoning plans for the Meghna coastline, will have significant implications for the livelihoods of local communities. Scoping studies will be needed to assess the impact of fishing quotas on domestic incomes and the challenges of implementing quotas and fishing restrictions in a complex environment.

Environment: Eco-tourism has been identified as a key project concept theme. The proposed interventions include new infrastructure, possibly shelters and boardwalks, that would enhance access in the Central Meghna Delta. Building these infrastructures, however, would induce noise that may disturb the wildlife in the area. Planning with the stakeholders is critical before any infrastructure development.

Political and Governance: The Forest Department is the management authority of both protected areas, namely Char Kukri-Mukri Wildlife Sanctuary and Sonarchar Wildlife Sanctuary. On Char Kukri-Mukri, the mangrove forests are state-owned, but the cultivated areas in the interior of the island are privately owned. Understanding the relevant management stakeholders, conservation priorities, and capacity is essential for implementing project interventions effectively. Stakeholder mapping would facilitate better coordination with management stakeholders.

References

- Haldar, G.C., & Ali, L. (2014). *The cost of compensation. Transaction and administrative costs of hilsa fish management in Bangladesh*. IIED Working Paper. IIED, London.
- Hoque, M. Z., Cui, S., Islam, I., Xu, L., & Tang, J. (2020). Future impact of land use/land cover changes on ecosystem services in the lower Meghna River estuary, Bangladesh. *Sustainability*, 12(5), 2112.
- Islam, S. N. (2016). Deltaic floodplains development and wetland ecosystems management in the Ganges–Brahmaputra–Meghna Rivers Delta in Bangladesh. *Sustainable Water Resources Management*, 2, 237-256.
- Mondal, K. P., Samad, S., Sarkar, M., Rahman, S. H., Islam, S. T., & Talukder, B. (2025). Wetlands of Bangladesh: Biodiversity, Livelihoods, and Conservation. *Wetlands of Tropical and Subtropical Asia and Africa: Biodiversity, Livelihoods and Conservation*, 19-39.
- Rahman, M. M., Haque, A., Nicholls, R. J., Darby, S. E., Urmi, M. T., Dustegir, M. M., ... & Haque, M. A. (2022). Sustainability of the coastal zone of the Ganges-Brahmaputra-Meghna delta under climatic and anthropogenic stresses. *Science of the Total Environment*, 829, 154547.
- Sultana, M. A., Sunny, A. R., Hussain, M. A., Islam, M. R., Raposo, A., Al Shiam, S. A., ... & Prodhan, S. H. (2024). Beyond Economics: The Multitude of Benefits from Ecosystem Services in the Meghna River Basin. *Regional Studies in Marine Science*, 103985.

Annex 1. Supplementary information on coastal protection services

To further validate the identification of the top ecosystem services by means of stakeholder consultation, an expectedly essential or non-substitutable regulating service across all RFI sites, namely coastal protection and flood mitigation (i.e., storm and flood hazard regulation), was assessed based on a combination of globally available datasets supplemented by web-based tool Co\$tingNature (Mulligan, 2022). Estimates for coastal protection by mangroves (after the effects of coral reefs) were spatially inferred in QGIS from a selection of metrics expressing different biophysical and monetary values modelled by Chaplin-Kramer et al. (2023) and Menéndez et al. (2020), respectively.

The key metrics selected for biophysical values (Table A1) were current maximum potential exposure to coastal hazards, which is a vulnerability risk index calculated in InVEST^[1] for several hazard variables (i.e., wind, waves, sea level rise, geomorphology, and bathymetry) in the hypothetical absence of current mangrove extent, and nature’s (i.e., the mangroves’) contribution to reducing this coastal risk, both as an absolute value multiplied by the local population affected and a percentage of the maximum potential exposure.

Table A1. Contribution of mangroves to coastal protection as a critical natural asset in the Central Meghna Delta based on site-level (biophysical) values inferred from Chaplin-Kramer et al. (2023) and expressed as ranges to represent the resulting uncertainty. Key metrics are in italics.

Critical contribution of mangroves to coastal protection (metrics)	Risk levels
Current population density within 2.5 km of the coast (number of people per hectare)	580 – 637
<i>Current maximum coastal risk to be mitigated, or potential exposure to coastal hazards (unitless index)</i>	<i>3.09 – 3.13</i>
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC’s Shared Socioeconomic Pathway #1 ‘Sustainability’ (unitless index)	3.47 – 3.51
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC’s Shared Socioeconomic Pathway #3 ‘Regional Rivalry’ (unitless index)	3.71 – 3.76
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC’s Shared Socioeconomic Pathway #5 ‘Fossil-fueled Development’ (unitless index)	3.89 – 3.94
Current proportional risk reduction, nature’s contribution to reducing coastal risk as a proportion of maximum coastal risk (unitless index)	0.016 – 0.022

Critical contribution of mangroves to coastal protection (metrics)	Risk levels
<i>Nature's contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast (# of people per hectare)</i>	9.40 – 13.76
<i>Nature's contribution to reducing coastal risk as a percentage of the maximum potential exposure (%)</i>	0.005 – 0.007

The key metrics selected for economic values (Table A2) were the annual expected flood protection benefits to total stock, which is the monetary value of the averted damages to the industrial and residential stocks (i.e., property) in 2015 US\$, the same total annual benefits expressed per hectare of mangroves, and the total benefits in the event of a 100-year return period storm, which are the rarest of cyclonic conditions but cause the most flood damages to property (i.e., maximum level of coastal protection by mangroves).

Table A2. Coastal protection benefits offered by mangroves in the Central Meghna Delta based on site-level (monetary) values inferred from Menéndez et al. (2020) and expressed as ranges to represent the resulting uncertainty. Key metrics are in italics

Benefits of mangroves in terms of coastal protection (metrics)	Avoided costs (US\$)
Mangrove extent (hectares) ^[2]	320 – 57,473
Annual expected flood protection benefits to people (number of people)	192,973 – 249,144
Annual expected flood protection benefits to Industrial Stock (US\$)	222,688,174 – 287,509,248
Annual expected flood protection benefits to Residential Stock (US\$)	131,748,154 - 170,097,998
<i>Annual expected flood protection benefits to Total Stock (US\$)</i>	<i>336,497,453 – 434,446,643</i>
<i>Annual expected flood protection benefits to Industrial Stock per hectare of mangroves (US\$ per hectare)</i>	<i>693,561 – 895,446</i>
1-in-100-year return period damage in terms of area flooded (number of hectares)	46,052 – 173,878
<i>Total expected flood protection benefits of mangroves per 100-year return period storms (US\$)</i>	<i>618,239,442 – 2,334,278,711</i>

Table A3. Biophysical benefits from RFI coastal wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

Site name	Max pot exp (index)	Risk reduction (index * pop)	Risk reduction (% max pot exp)
Central Meghna Delta	3.11 (±0.02)	17 (±2)	0.61 (±0.11)
Eastern Meghna Delta	3.09 (±0.05)	No Data	No Data
Eastern Sundarbans	2.91 (±0.02)	29 (±2)	4.00 (±0.16)
Nijhum Dwip NP & FNS	3.10 (±0.06)	0 (±0)	5.06 (±0.69)
Sonadia Island FNS	3.45 (±0.08)	89 (±32)	2.27 (±0.80)
Bangladesh RFI average	3.13	26	2.39
Bangladesh national average	2.99	38	1.69

Table A4. Monetary benefits from RFI coastal wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

Site name	Total annual benefits (US\$)	Per mangrove area (US\$/ha)	For 100-yr return period storms (US\$)
Central Meghna Delta	385,472,048 (±48,974,595)	794,504 (±100,942)	1,476,259,077 (±858,019,635)
Eastern Meghna Delta	8,289,751 (±48,734)	1,050 (±6.17)	53,592,048 (±786,645)
Sundarbans	167,762,956 (±54,512,767)	5,607 (±1,822)	1,098,664,838 (±3,285,219,032)
Nijhum Dwip NP & FNS	19,582,720 (±994,316)	21,346 (±1,084)	19,090,534 (±19,325,668)
Sonadia Island FNS	22,061,094 (±20,477,324)	7,176 (±425)	72,607,057 (±992,19)
Bangladesh RFI average	120,633,714	165,936	544,042,711
Bangladesh RFI total	603,168,569	Not Applicable	2,720,213,554
Bangladesh national average	15,050,804	165,936	87,177,719
Bangladesh national total	872,946,651	Not Applicable	4,533,241,399

Table A5. Key habitat types in the Central Meghna Delta based on stakeholder-based assessment at the Regional Flyway Initiative workshop in May 2024.

Habitat type	Current state		Alternative state (2035)	
	Area (ha)	Cover (%)	Area (ha)	Cover (%)
Permanent shallow marine waters	59,143.6	10.0	29,571.8	5.0
Marine subtidal aquatic beds	17,743.1	3.0	5,914.4	1.0
Sand, shingle, or pebble shores	23,657.4	4.0	11,828.7	2.0
Estuarine waters	236,574.2	40.0	207,002.5	35.0

Habitat type	Current state		Alternative state (2035)	
	Area (ha)	Cover (%)	Area (ha)	Cover (%)
Intertidal mud, sand or salt flats	236,574.2	40.0	177,430.7	30.0
Intertidal marshes	5,914.4	1.0	5,914.4	1.0
Intertidal forested wetlands	11,828.7	2.0	5,914.4	1.0
High Intensity Residential	0.0	0.0	147,858.9	25.0
Total	591,435.6	100.0	591,435.6	100.0