ADB

Regional Flyway Initiative · Site Study

May 2026

RFI Priority Site · Eastern Sundarbans

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Asian Development Bank

General Site Information

Country	Bangladesh			
RFI Site Name	Sundarbans			ID001
City/ Municipality, Province, Region	Barisal, Khulna			
Geographical coordinates	22.00 N, 89.70 E		Area (has)	1,009,783 ha
Key species	Masked Finfoot, Spoon-billed Sandpiper, Spotted Greenshank. Four species of marine turtle. Bengal Tiger			
Key habitats (biomes)	low mangrove forest, high mangrove forest, open land/ grassland, riverine estuaries and muddy and sandy shorelines along the Bay of Bengal coast			
Key ecosystem services	Climate regulating services (especially from stored above- and below-ground carbon), cultural services, provisioning services (of NTFPs, e.g. fish and other harvested wild goods)			
Key drivers of change	Climate change, water pollution			
Conservation status (mark all that applies)	■	Protected Area		Flyway Network Site
		Ramsar Site		Others _____
IBA/ KBA name (and number) and other designations	Eastern Sundarbans			
Management Stakeholders	Forest Department of Bangladesh			
With management plan?	The management plan for the sanctuary is out-of-date, but it is still being followed, and an updated version is in preparation (UNEP-WCMC 2024).			
Project concept themes	Wetland restoration; site management; nature-based tourism; sustainable financing			
Length of project	5-10 years			
Sector/s	Biodiversity, tourism and rural industries			
No. of potential beneficiaries	300,000 people			
Indigenous Peoples		No	■	Yes Munda, Oraon jatis
Anticipated Implementation Risks	Reduced livelihoods for 100,000 to 300,000 local people due to further restrictions on fishing and collection of NTFPs, disturbance of wildlife from ecotourism development, conservation priorities of wetland management stakeholders, and capacity to implement carbon financing			
Estimated Project Budget (US$)	29,050,000 over five years			
Potential Source/s of Financing	■	Loan (to be identified)	■	Private Sector (to be identified)
		Grant		Public-Private Partnership

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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
NTFP	Non-timber forest products
RFI	Regional Flyway Initiative
SIZ	Sundarbans Impact Zone
SLR	Sea Level Rise
TESSA	Toolkit for Ecosystem Services Assessment
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USAID	United States Agency for International Development
USD	United States Dollars
VCG	Village Conservation Group

Executive Summary

The Sundarbans, the largest contiguous mangrove forest in south Asia, is located in the southern part of Khulna, Bagerhat and Satkhira districts of Khulna Division, southwest Bangladesh and adjacent parts of West Bengal, India, and are part of the vast wetlands that have formed in the deltas of the Ganges, Brahmaputra and Meghna rivers. The Sundarbans are of immense socio-economic importance, with about a third of the total area secured for biodiversity conservation as a series of protected areas and recognised as a UNESCO World Heritage Site, while the remaining two thirds form a production zone where timber and various non-timber forest products may be harvested by local communities, including indigenous minorities such as the *Munda* community. The mangrove ecosystems of the Sundarbans provide a seasonal source of livelihood for some 300,000 people in adjacent villages, while supporting a rich biodiversity, including the world's largest population of the Critically Endangered Masked Finfoot, and very large congregations of shorebirds, terns, gulls and ducks on the Sundarban's tidal flats. Four species of marine turtle use the coastal waters of the Sundarbans, which also support over 100 commercially valuable fish and shellfish species, including Hilsha *Tenualosa Ilisha* and tiger shrimp *Penaeus monodon*.

The climate regulating value of the Sundarbans is vast, compared to most wetlands in Bangladesh or even in region, and our modelled estimates based on remotely sensed data show that the eastern Sundarbans alone holds as much as 31,000,000 tonnes of stored carbon; this is on top of the diverse ecosystem services, ranging from recreational services (for tourists) to coastal and storm protection provided by the mangroves for local people, especially during major cyclones in the Bay of Bengal. These diverse provisioning services directly benefit 740,000 people who collect or trade in force resources. The Sundarbans have a long history of formal protection dating to 1875, and became recognised as a Ramsar Site in 1992, with the Forest Department as the management authority. The Bangladesh Sundarbans was inscribed as a World Heritage Site in 1997. As one of the largest intact areas of forest cover in the country, the wetlands of the Sundarbans are threatened by drivers of change ranging from hydropower development in the rivers upstream of the mangroves, as well as unsustainable harvesting of fish and other resources. Shipping activities using the channels of the Sundarbans causes disturbance to biodiversity and pollution.

As a result of its size, the Sundarbans hold some of the largest known storages of wetland carbon in Asia and therefore, directly offers strong opportunities for wetland (mangroves, forests) restoration, including restoration activities through novel financing approaches (including carbon financing). Harnessing carbon financing opportunities for the Sundarbans could generate funds that can support rural development for communities in and around the wetlands, while strengthening biodiversity conservation. Meanwhile, there is a need to strengthen access to livelihoods for human communities living on the fringes of the Sundarbans, especially for fishers, shellfish-collectors, and NTFP (thatching, honey) harvesters, while promoting the development of community-led tourism.

Currently, local people at the fringes of the Sundarbans (in in the Sundarbans Impact Zone, or SIZ, spanning 20 *upazilas*) face diverse challenges ranging from low incomes (many households are considered as below the poverty line), have limited or tenuous access to fishing as a result of increased regulations to protect fish stocks, and limited access to credit, and thus remain extremely vulnerable to climate change. Studies identified that credit-based capacity-building and training such as the development of microcredit access for local people alongside vocational training can strongly diversify income sources for Sundarbans communities.

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 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, 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 the Bangladesh include the Indian Skimmer *Rynchops albicollis* and the Baer's Pochard *Aythya baeri*.

2. Site profile of Eastern Sundarbans

Location: The Eastern Sundarbans are located in the southern part of Khulna, Bagerhat and Satkhira districts of Khulna Division, southwest Bangladesh, and are part of the vast wetlands that have formed in the deltas of the Ganges, Brahmaputra and Meghna rivers. They include one of the largest contiguous mangrove forests in the world, which extends from the shores of the Bay of Bengal to 80 km inland from the coast. The forest is bounded in the north by private settlements, in the south by the Bay of Bengal, in the east by the Baleshwar River and in the west by the Harinbhanga–Raimongal and Kalindi rivers, which form the international boundary between Bangladesh and India.

Area: The Sundarbans RFI site has an area of 1,009,783 ha, including the Sundarbans Impact Zone (see Figure 1), which border the protected areas of the Sundarbans.

Altitude: 0-3 m asl.

Geographical coordinates: 22.00 N, 89.70 E

Description of site: The Sundarbans forests grow on a level floodplain that is inundated twice a day by the high tide, and is dissected by innumerable tidal rivers, canals, creeks and small channels, all of which flow into the Bay of Bengal. The important rivers that pass through the Sundarbans are the Baleswar, Passur, Shipsa, Kobadak, Kholpetua and Kalindi, and these river systems have created four estuaries, known as the Bangra, Kunga, Malancha and Raimangal. The freshwater supplied by the rivers is very important for the productivity of the Sundarbans, including both plant growth and fisheries. The main habitats in the Sundarbans are a mosaic of low mangrove forest, high mangrove forest, open land/ grassland, riverine estuaries and muddy and sandy shorelines along the Bay of Bengal coast, which provide feeding areas for shorebirds. These habitats support extremely rich and economically important biodiversity. The AWC counting locations in the Eastern Sundarbans are Bangabandhu Char and Majher Char.

Site administration, management and land tenure: The Sundarbans have a long history of formal protection. The mangrove forests there were declared as the Sundarbans Reserved Forest in 1875, which was designated as a Ramsar Site in 1992, with the Forest Department as the management authority (UNEP-WCMC 2024). The Bangladesh Sundarbans was inscribed as a World Heritage Site in 1997 (https://whc.unesco.org/en/list/798/). The Sundarban East Wildlife Sanctuary was designated in 2017, also with the Forest Department as the management authority. The management plan for the sanctuary is out-of-date, but it is still being followed, and an updated version is in preparation (UNEP-WCMC 2024). The mangrove forests are the property of the Government of Bangladesh, which also has jurisdiction over the waters of the Bay of Bengal at the southern periphery, but the agricultural lands adjacent to the RFI site are privately owned. The Ministry of Environment and Forests have territorial jurisdiction over the Eastern Sundarbans, and the Department of Forests has functional jurisdiction. The management authorities are the Conservator of Forests and the local Divisional Forest Officers.

Social and economic values: The Sundarbans are of immense economic and social importance to the people of Bangladesh, with about one third of the total area protected for the conservation of biological diversity and two thirds of the area used as a production zone where timber, goalpata *Nypa fruticans*,

fuelwood (from *Ceriops decandra*), pulpwood (from *Excoecaria agallocha*), leaves, mollusc shells, crabs, honey, beeswax and fish are harvested by local communities. The mangrove forests comprise over half of the remaining natural forest in Bangladesh, and this ecosystem provides a livelihood for at least part of the year for some 300,000 people, including collectors and middlemen. A high proportion of the people who live in and around the Sundarbans are engaged in fishing (more than 100 fish species, including Hilsha) and the collection of shrimp fry (e.g. Tiger Shrimp *Penaeus monodon*) (Hussain 2014), both in the internal river systems and the offshore waters, and many more fishermen visit the area from elsewhere in Bangladesh. In the surrounding areas, there are private settlements used for traditional agricultural crop production and shrimp farming, and increased urbanisation as the population grows. Given the outstanding importance of the Sundarbans for biodiversity, this site provides excellent, and yet to be fully realised, opportunities for outdoor recreation, scientific research and conservation education, and ecotourism has been developed, albeit slowly. The mangrove forest also has a vital buffer function, protecting the densely settled agricultural areas to the north from the full force of cyclonic storms and tidal waves from the Bay of Bengal.

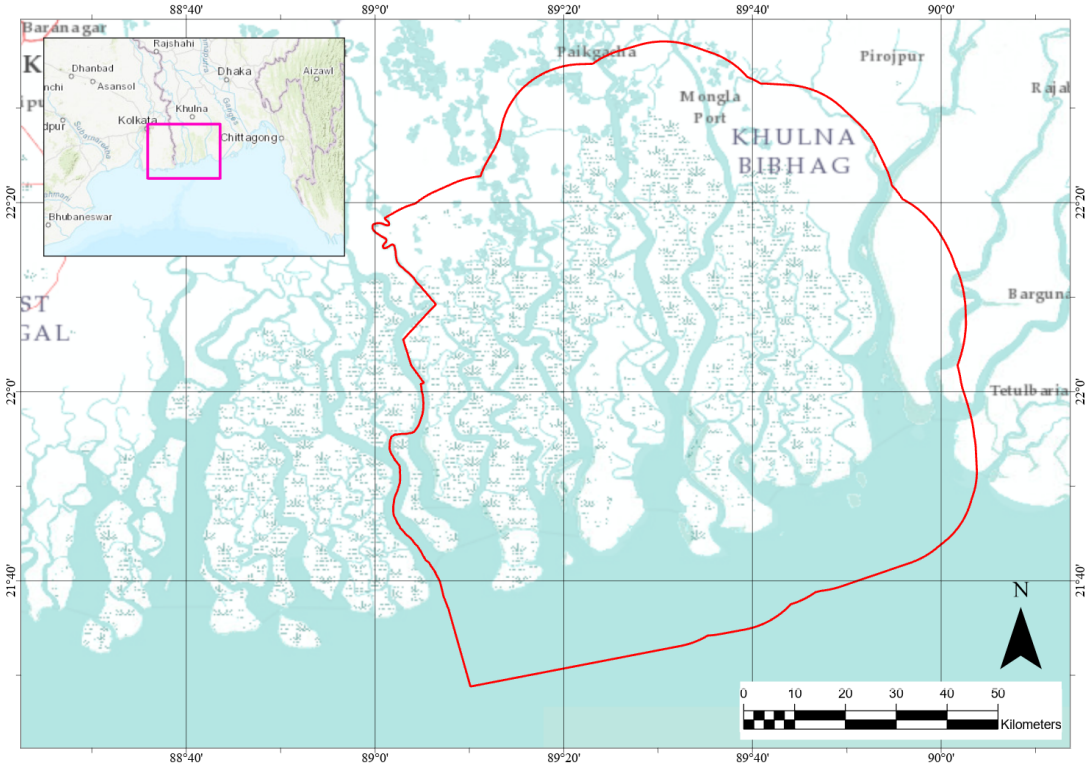

Figure 1 Map of the Bangladesh Sundarbans, showing its boundary (in red) and location within Bangladesh (in pink) (data from EAAFP Site Information Sheet).

3. Biodiversity value of Eastern Sundarbans

3.1. Key habitats

The main habitats in the Sundarbans are a mosaic of low mangrove forest, high mangrove forest, open land/ grassland, riverine estuaries and muddy and sandy shorelines along the Bay of Bengal coast, which provide feeding areas for shorebirds.

The mangrove forests were declared the Sundarbans Reserved Forest in 1875, which was designated as a Ramsar Site in 1992, with the Forest Department serving as the management authority (UNEP-WCMC, 2024). The Bangladesh Sundarbans was inscribed as a World Heritage Site in 1997 (https://whc.unesco.org/en/list/798/). The mangrove forests comprise over half of the remaining natural forest in Bangladesh, and this ecosystem provides a livelihood for at least part of the year for some 300,000 people, including collectors and middlemen.

3.2 Importance of the Eastern Sundarbans for migratory waterbirds

The vast mangrove forest and coastal mudflats in the Sundarbans support very large numbers of waterbirds, but only a few locations are covered there during the Asian Waterbird Census (AWC), which undoubtedly greatly underestimates the numbers of migratory (and resident) waterbirds that occur. Count data from the 2014, 2017 and 2020 Asian Waterbird Census (AWC) was used in the RFI priority sites analysis. Several counts were conducted in the Eastern Sundarbans during 2020, but only single counts in 2014 and 2017, and the results were averaged over these three years, and then compared to the Conservation Status Review (CSR1) 1% population estimates to calculate a score for each species. In addition, the RFI analysis used a population estimate for Masked Finfoot by Chowdhury et al. (2020). The three migratory waterbird species were found to regularly exceed the 1% population thresholds during these three years (Table 1), and the CSR1 scores for these species were summed to produce the overall site score.

The Eastern Sundarbans is recognised as the most important site for Masked Finfoot (CR) in the world, with the average count (which is based upon the analysis of the global status of this species by Chowdhury et al. (2020) indicating that this site regularly supports around 40% of the flyway (and global) population of the species. In addition to this highly threatened species, the AWC counts detected small numbers of two other threatened and near-threatened species in the Eastern Sundarbans between 2014 and 2020, namely Black-headed Ibis *Threskiornis melanocephalus* (NT) and Spoon-billed Sandpiper *Calidris pygmaea* (CR). Other threatened species that occur in the Sundarbans (or at least occurred there in the past) include Indian Skimmer *Rynchops albicollis* (EN) and Pallas's Fish-eagle *Haliaeetus leucoryphus* (EN).

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

Species name	IUCN	Average count	CSR1	CSR1 score
Masked Finfoot *Heliopais personatus*	EN	120	3	40.0
Ruddy Shelduck *Tadorna ferruginea*	LC	775	710	1.1
Lesser Sandplover *Charadrius mongolus*	LC	262	300	0.9

3.3 Other notable biodiversity

The Sundarbans are reported to have high floral diversity and a very rich and diverse fish fauna, with over 120 species of fish commonly caught by commercial fishermen. The mangrove forest and wetlands support a large population of the Bengal tiger *Panthera tigris tigris* (EN) and other threatened mammals that occur there include fishing cat *Prionailurus viverrinus* (VU) and Ganges River Dolphin *Platanista gangetica* (EN). Four species of marine turtle visit the coastal waters along the southern edge of the delta, Green Turtle *Chelonia mydas* (EN), Loggerhead Turtle *Caretta caretta* (VU), Olive Ridley Turtle *Lepidochelys olivacea* (VU) and Hawksbill Turtle *Eretmochelys imbricata* (CR), and two of these are known to nest, Green Turtle and Olive Ridley Turtle. Other threatened reptile species that occur are Northern River Terrapin *Batagur baska* (CR) and King Cobra *Ophiophagus hannah* (VU).

4. Ecosystem services

4.1. Ecosystem services provided by Eastern Sundarbans

The Eastern Sundarbans overlaps with diverse coastal wetland habitats, providing valuable provisioning, regulating and cultural ecosystem services (Figure 2). The results from the RFI workshop[1] highlights the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, particularly wild food provision, benefit communities within, adjacent to, and distant from the site. Regulating services, including local and global climate regulation, storm hazard regulation, and pollination, are crucial, also positively benefiting communities at all distances.

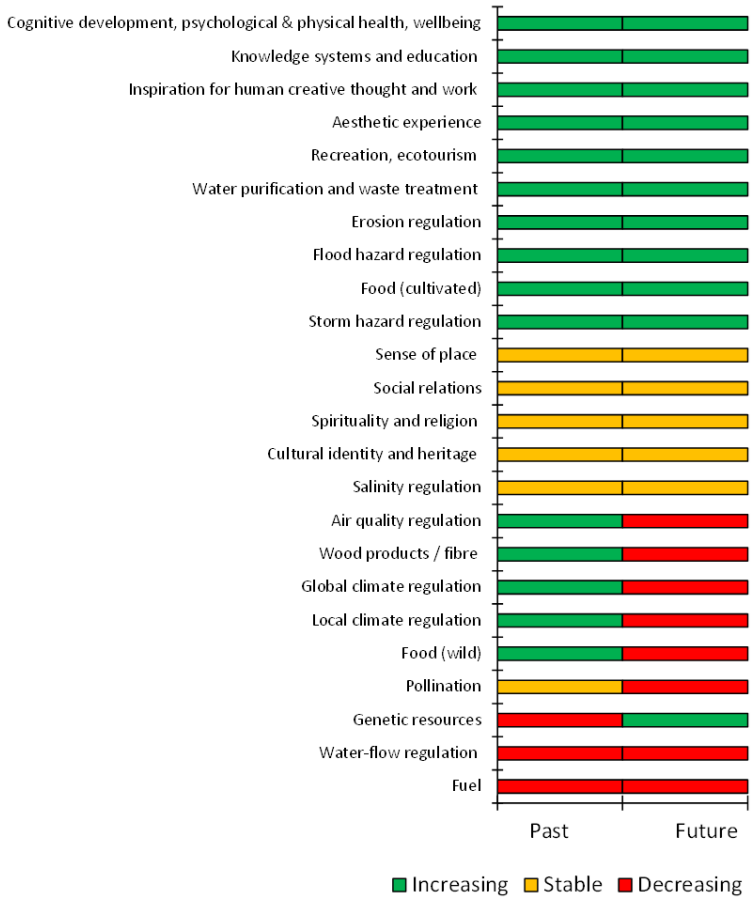

Figure 2 List of ecosystem services provided by Eastern Sundarbans, as identified through stakeholder consultation at the Regional Flyway Initiative workshop.

[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 Eastern Sundarbans.

Ecosystem services	Essential or non-substitutable	Benefits to communities			Change	
		Within the site	Adjacent to the site	Distant to the site	Past	Future
Provisioning services						
Food (wild)	Yes	✓	✓	✓	Increase	Decrease
Regulating services						
Local climate regulation	Yes	✓	✓	✓	Increase	Decrease
Global climate regulation	Yes	✓	✓	✓	Increase	Decrease
Storm hazard regulation	Yes	✓	✓	✓	Increase	Increase
Pollination	Yes	✓	✓	✓	No change	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 Sundarbans at 31,943,679 tonnes while the total sequestered carbon is estimated at 831,972 tonnes per year. The amount of carbon stored in Sundarbans based on published estimates (Chen and Lee, 2022; Stankovic et al., 2023) is comparable and is estimated to range from 10,200,000 to 154,000,000 tonnes, while the annual carbon sequestration rate is estimated to be between 742,000 and 1,010,000 tonnes per year.

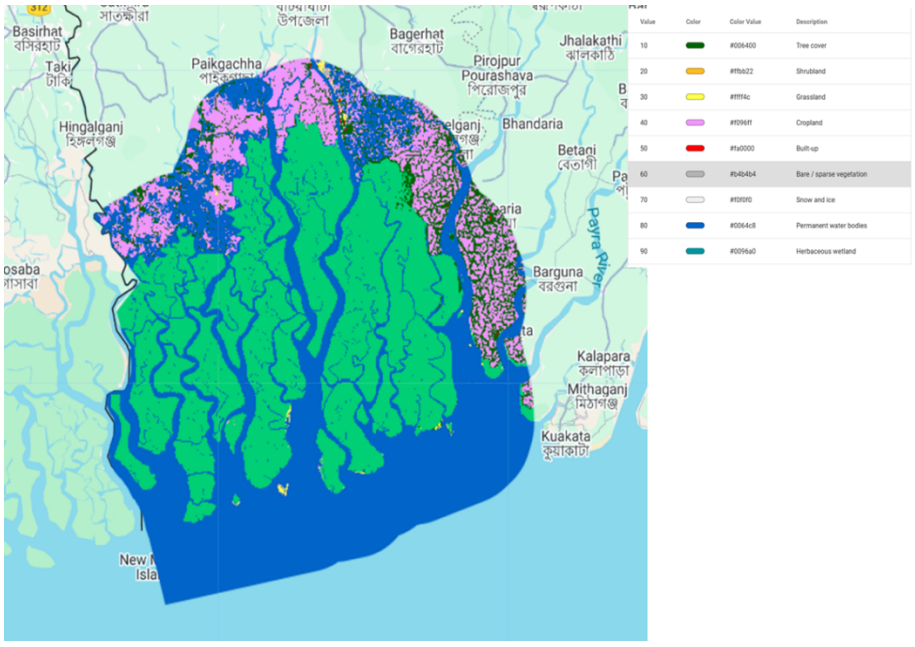

Figure 3 Map of the Sundarbans, showing approximate boundaries and dominant land cover types (map: Radhika Bhargava)

4.3. Coastal protection services

The coastal protection services provided by the Eastern Sundarbans 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 Eastern Sundarbans shows some mixed results in terms of risk level:

1. for the potential exposure to coastal hazards, the Eastern Sundarbans are consistently below average compared to RFI coastal sites (index: 2.91 vs. 3.13) and to all other coastal areas (index: 2.91 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 Eastern Sundarbans are above average (29 vs. 26 people/ha) for RFI coastal sites, but below average (29 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 Eastern Sundarbans are consistently above average (4.00% vs. 2.39% for RFI coastal sites and 4.00% vs. 1.69% for all other coastal areas).

In monetary terms (Table A4 in Annex 1), the Eastern Sundarbans ranks below both the national RFI and overall country averages in terms of total annual benefits per ha of mangroves (5,607 vs. 165,936 or 18,638 USD/ha). However, the Eastern Sundarbans is well above the average of all RFI coastal sites in Bangladesh regarding benefits against 100-year return period storms (1.1 vs. 0.5 billion USD).

5. Drivers of change and their potential impacts on Eastern Sundarbans

5.1. Current drivers of change and their level of impact

Stakeholders at the RFI workshop[2] identified at least 25 drivers of change impacting the Sundarbans, and their corresponding levels of impact on the wetland site (Table 3). High-impact drivers include dams within or upstream of the Sundarbans, which significantly alter the hydrological regime, affecting water flow and habitat conditions, with long term implications on sedimentation regimes. Fishing, killing, and harvesting of aquatic resources pose substantial threats to the biodiversity of the wetland. Ports with large-scale loading and unloading of goods, along with shipping lanes and canals, contribute to habitat disruption and pollution. Recreational activities and tourism further impact the site by disturbing habitats. Additionally, natural events such as storms and flooding, and erosion and siltation/deposition, have a high impact on the wetland's ecological balance.

Medium-impact drivers include agricultural and forestry effluents, which degrade water quality. The accumulation of garbage and solid waste also poses a moderate threat to the site's health. Loss of cultural links, traditional knowledge, and other 'edge effects' that degrade the wetland values further alter the natural state of the ecosystem. Pathogens add to the moderate impact on the wetland's ecological integrity.

Table 3 Drivers of change and their potential impact on the integrity of Eastern Sundarbans based on consultations with stakeholders.

Driver of change	Impact
Dams within or upstream of the wetland site, which alter the hydrological regime	High
Dams, hydrological modification and water management/use	
Fishing, killing and harvesting of aquatic resources	
Ports with large scale loading and unloading of goods	
Recreational activities and tourism	
Shipping lanes and canals	
Storm and flooding	
Erosion and siltation/deposition	Medium
Garbage and solid waste	
Loss of cultural links, traditional knowledge and/or management practices	
Other 'edge effects' that degrade the wetland site values	
Pathogens	
Agricultural and forestry effluents	Low
Commercial and industrial areas	
Excess energy	
Fire and fire suppression	
Household sewage and urban wastewater from outside the wetland site	
Hunting, killing and collecting of terrestrial animals	
Industrial, mining and military effluents	
Loss of keystone species	
Marine and freshwater aquaculture	
Research, education and other work-related activities	
Roads and railroads	
Temperature extremes	
Utility and service lines	

[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

5.2. Potential alternative state of Sundarbans under current drivers of change

Stakeholders at the RFI workshop[3] 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.

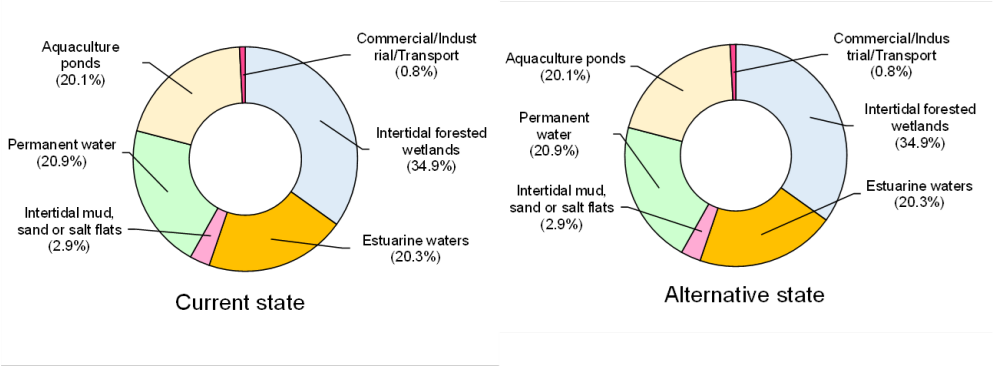

Figure 4 The proportional change in the extent of different habitat types between the current and alternative states of Eastern Sundarbans.

5.3. Expected changes in the ecosystem services of Eastern Sundarbans

Stakeholders at the RFI workshop[4] documented the future trends in the provision of ecosystem services in Eastern Sundarbans, 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 while there has been an increase in wild food provision in the past, a decrease in that provisioning service is anticipated by stakeholders in the future. For regulating services, both local and global climate regulation services have shown an increase in the past but are projected to decrease in the future. Storm hazard regulation is expected to continue increasing, reinforcing its importance in mitigating environmental hazards. Pollination, while stable in the past, is also expected to decrease in the future.

[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

In the alternative state, there is no loss of mangroves nor intertidal mudflats. Consequently, the amount of stored carbon and the rate of carbon sequestration (carbon accumulation) remain stable as long as these ecosystems remain undisturbed.

A loss of 0 ha of mangroves as presented in Table A5, is not expected to result in any reduction in coastal protection either. The findings in 4.3, though, support targeted investment in maintaining and enhancing existing natural protection, especially for long-term climate resilience. The Eastern Sundarbans present a mixed picture in terms of coastal protection services. Biophysically, the area shows relatively low exposure to coastal hazards and performs well in reducing risk. Economically, the annual benefits per hectare suggest limited per-hectare value under current use and condition. However, the site ranks significantly higher in terms of benefits under extreme events, indicating that mangroves in the Eastern Sundarbans play a particularly valuable role in mitigating damage from high-impact storms.

6. Capacity needs in Eastern Sundarbans

The stakeholder consultation and analyses with stakeholders representing government and civil society identified at least six major groups of stakeholders with clear roles in the long-term sustainable management of wetlands in the wider Sundarbans landscape and its buffer zones. Major gaps exist for government stakeholders in relation to strengthening the management and restoration of wetland landscapes, biodiversity and agricultural landscapes, and appears consistent with capacity gaps identified in the Sundarbans Vision 2050 (Zakir Hussain 2024). The Bangladesh Forest Department (BFD), a key stakeholder, for instance, currently (and is expected to play) key roles in ensuring that the Sundarbans landscape is well managed and protected (Table 4), but it faces major capacity and knowledge gaps, particularly in the development of policy frameworks and guidelines to enable carbon financing from global markets to drive wetland restoration activities within the Sundarbans and beyond.

Another major gap identified is the unclear administrative jurisdictions and policy overlaps across different government stakeholders, a challenge well documented in past consultations with Sundarbans stakeholders; addressing it will require concerted efforts to strengthen coordination and organisation structures across central and local government bodies. In parallel, there is a clear need to continue work to strengthen livelihood means of local communities, including through co-management structures already tried and tested elsewhere in Bangladesh.

Table 4 Stakeholder groups in the Sundarbans and their corresponding capacity gaps and needs.

Stakeholder group	**Current role in wetland management**	**Challenges faced and capacity gaps**	**Form of capacity development (e.g. training, organisational strengthening etc.)**
Bangladesh Forest Department	Development and implement management plans; biodiversity conservation and site management	Capacity gaps in monitoring. Limitation in resources and logistics for management and enforcement.	Training on how to access to global carbon markets to strengthen site management. Strengthening technical framework and basis of monitoring and enforcement.
Law enforcement agencies	Crime and poaching controls	Jurisdiction overlaps (intrusions); limited capacity for enforcement.	Organisation strengthening and improve coordination with other government stakeholders. Training to address illegal fishing, poaching and activities that impact biodiversity, especially threatened species.
Local governments	Administration of local land rights; litigation	Jurisdiction overlaps (intrusions)	Organisation strengthening, and improve coordination with other government stakeholders
Local communities	Harvest and trade in fish and NTFPs (e.g. honey, wood); livelihoods and local economy.	Illegal encroachment and harvest approaches, overharvests.	Strengthening participation and involvement in village conservation groups and resource management organisations (RMOs)
Tourism operators	Positive contribution to livelihoods and the local economy.	May contribute to novel environmental issues; currently limited role for wetland management.	Strengthen awareness in sustainable tourism activities
Research institutions	Strengthen education and awareness; develop policy recommendations.	No change	Provide continued capacity building for local stakeholders, in collaboration with research institutions.
Conservation organisations (NGOs)	Contribute to local development and biodiversity conservation. Drive capacity building for local stakeholders.	High	Provide continued capacity building for local stakeholders, in collaboration with research institutions.

7. Opportunities for RFI interventions

7.1 Recommended Interventions

As the largest mangrove forests in the Asian tropics, the Sundarbans hold some of the largest known storages of wetland carbon in the region and offers strong opportunities for wetland restoration, including conservation and restoration activities through novel financing approaches (including carbon financing), and which has been highlighted as a priority in previous stakeholder consultations (Zakir Hussain 2014), and through the RFI. Harnessing carbon financing opportunities for the Sundarbans could provide funding to support rural development for communities in and around the wetlands.

Strengthening access to livelihoods, especially for fishers, shellfish-collectors and NTFP (thatching, honey) harvesters, can also be expected to ensure a more sustainable approach to managing declining fisheries, and in accordance with management plans developed for the wider Sundarbans, although fishing moratoriums and bans imposed by the government has contributed in part to the vulnerabilities of communities in the Sundarbans (Siddique et al. 2023). Currently, communities on the fringes of the Sundarbans face various challenges, including low incomes, limited fishing rights, restricted access to credit, and inadequate fishing equipment (Sultana et al. 2024), and are extremely vulnerable to the effects of climate change. Addressing these livelihood challenges, which affect a significant proportion of local communities in the Sundarbans, will be crucial to strengthening frameworks that promote the sustainable use of fishing resources while ensuring the livelihoods of thousands of households. There is considerable scope for diversifying income-generating activities for local communities while taking into account gender-based issues and cultural considerations. Siddique et al. (2023) identified that credit-based capacity-building training such as the development of microcredit access for local people alongside some form of vocational training can strongly diversify income sources for Sundarban communities; this obviously needs to be coordinated with mechanisms to provide credit financing for local people during months of the year where access to fishing areas is curtailed.

Table 5: Summary of key RFI interventions proposed for the Eastern Sundarbans

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
Component 1: Establishing sustainable financing mechanisms through public and private funding sources					
Develop and upscale payments for ecosystem services (PES) via carbon financing for wetland protection and	National guidelines for carbon financing developed for the Sundarbans, and other	National guidelines for innovative financing mechanisms (e.g., payment for ecosystem services, carbon	200,000.00	5 years	Bangladesh Forest Department Law enforcement agencies Local government Local communities

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
management through the private sector, with a focus on the upper Sundarbans	Bangladesh wetlands	financing) developed. Number of piloted financing mechanisms with the private sector			Research institutions Conservation NGOs
Component 2: Restoration of degraded wetlands					
Habitat restoration focused on degraded mangroves (especially damaged areas from cyclones) and areas vulnerable to SLR-driven degradation.	Improved livelihoods for local communities (especially local people collecting NTFPs, fishing). Biodiversity improved.	Area of restored mangrove ecosystem	1,000,000.00	5 years	Bangladesh Forest Department Local government Local communities Research institutions Conservation NGOs
Component 3: Coastal wetland habitat protection and management					
Update existing management plan, while ensuring that the fishing restrictions for hilsha are retained and a biodiversity monitoring framework including studies in mudflat benthos is incorporated.	Improved livelihoods for local communities (especially local people collecting NTFPs, fishing). Biodiversity improved.	Number of updated local wetland management and financial plans, with gender-responsive and inclusive strategies Number of fishery management policies facilitated	50,000.00	2 years	Bangladesh Forest Department Law enforcement agencies Local government Local communities Research institutions Conservation NGOs
Creation of two (2) new fish sanctuaries at	Improved livelihoods for some local		500,000.00	5 years	Bangladesh Forest Department

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
prioritised spots in consultation with local co-management bodies.	communities, through alternative income streams. Best practices, guidelines and standards developed for nature-based tourism operators in the Sundarbans	Number of established fish sanctuaries			Law enforcement agencies Local government Local communities Research institutions Tourism operators Conservation NGOs
Strengthening local livelihoods through wildlife-focused ecotourism in the Sundarbans (buffer zone), with a focus on capacity building training (over 2-3 years)		Number of people benefitting from livelihood activities, with up to 30% beneficiaries from women, youth, elderly, indigenous people, and other vulnerable groups Number of people trained on livelihood activities Number of ecotourism infrastructure established	200,000.00	2 years	
Establishment of new infrastructure for ecotourism, including jetties and shelters.			9,950,000.00	2 years	
Scoping study on the needs of indigenous people.			50,000.00	up to 2 years	
Socioeconomic surveys and consultation with local communities			50,000.00	1 year	
Total investment for five years			**29,050,000.00**		

7.2 Potential Financing

The estimated project cost is USD 29,050,000 over five years. This budget supports the establishment of new eco-tourism infrastructure, the restoration of degraded mangroves, and the strengthening of local site management stakeholders' capacities. Table 5 summarizes the projected budget distribution across the proposed project components.

The proposed USD 1 million investment in the Eastern Sundarbans for mangrove restoration would enable the rehabilitation of roughly 50 hectares based on average restoration costs. With estimated coastal protection benefits of USD 5,607 per hectare annually (see Section 4.3), this nature-based component could yield approximately USD 280,350 in annual benefits, resulting in a benefit–cost ratio of approximately 2.8:1 over the long term. While this return is lower than in some other coastal regions, it may still justify investment when paired with hard infrastructure, offering a hybrid approach to climate resilience that balances short-term protection with long-term sustainability. In contrast, prioritizing land uses such as aquaculture may deliver near-term profits but risks eroding natural protective functions, incurring greater long-term costs.

There is an existing interest from private investment companies in implementing wetland restoration projects (with a carbon outcome) in the Sundarbans, as well as in trading carbon in the Sundarbans that can be further explored for co-financing. If successfully implemented, these carbon projects may generate between USD 1-10 million for local conservation efforts and new revenue for development in the Sundarbans.

7.3 Proposed Institutional Arrangements

The project implementation will be coordinated with the local government, local administration, and civil society organizations. The Bangladesh Forest Department will spearhead the capacity-building and awareness-raising activities for key stakeholders. Should the capacity-building activity involve the Bangladesh Forest Department and local communities, the project team can collaborate closely with civil society organizations for biodiversity conservation, which can play a significant role in delivering the training activities.

The private sector will be engaged as a key partner in establishing carbon financing guidelines and piloting carbon trading for mangrove and wetland restoration activities. This can be piloted in the densely inhabited buffer zone (SIZ) and suitable areas along the periphery of the Sundarbans. The Bangladesh Forest Department and civil society organizations will be engaged throughout the entire process.

7.4 Project Beneficiaries

Improving wetland management in the Sundarbans benefits approximately 300,000 people in adjacent villages, who depend on its mangrove ecosystems for their livelihood. Restoring degraded mangroves, exploring possible carbon financing options, and enforcing strict fishing restrictions would ensure the long-term provision of resources for both communities and migratory waterbirds. Establishing eco-tourism, on the other hand, would provide alternative livelihood opportunities for people residing in adjacent villages in a shorter time, especially during the fishing restrictions season.

There are significant Munda, and to a lesser extent, Oraon indigenous communities in the Sundarbans, but they are marginalised and have access to less livelihood opportunities compared to other groups. In addition, there are significant opportunities to enhance the representation of women and marginalized fishing communities, including fishing households that are currently unrepresented in broader frameworks, in shaping management structures that impact their livelihoods.

7.5 Anticipated Implementation Risks

Social Safeguards: The implementation of short-term fishing restrictions and quotas, as part of wider fisheries management plans and zonation plans on the Sundarbans coast, will have some implications on the livelihoods of local communities. This can generate future conflicts among law enforcers, indigenous people, women, and marginalized fishing communities. Stakeholder consultations are necessary to discuss alternative livelihood opportunities for affected villages. Scoping studies on the impact of fishing quotas on domestic incomes would help determine the most effective approach in enforcing fishing restrictions for the long-term provision of resources.

Environment: Establishing ecotourism can offer alternative livelihood opportunities for individuals who will be affected by the fishing restrictions in the Sundarbans. The proposed interventions include new infrastructure, such as shelters and boardwalks, that would help enhance the tourism experience for visitors. Building these infrastructures, however, would induce noise that may disturb the wildlife and may reduce essential habitats in the area. Planning with the stakeholders is critical before any infrastructure development.

Political and Governance: Jurisdictional overlaps among local government authorities and law enforcement agencies can complicate project implementation. The mangrove forests are the property of the Government of Bangladesh, which also has jurisdiction over the waters of the Bay of Bengal at the southern periphery. The agricultural lands adjacent to the RFI site, on the other hand, are privately owned. The Ministry of Environment and Forests have territorial jurisdiction over the Eastern Sundarbans, and the Department of Forests has functional jurisdiction. The management authorities are the Conservator of Forests and the local Divisional Forest Officers.

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.

Financial and Business Model: Carbon financing is a new approach for sustaining financing in the area. The potential for this through carbon markets would need to be assessed and possibly piloted, will consideration of the macroeconomic and political climate in Bangladesh.

Capacity for Implementation: Institutional capacity-building is recommended, particularly in enhancing cooperation among different government stakeholders, and the development of policy frameworks and guidelines to facilitate carbon financing from global markets, thereby driving wetland restoration activities in the Sundarbans. Engaging the civil society organizations will help implement project interventions in the local villages.

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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 Eastern Sunderbans 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)	238 – 267
Current maximum coastal risk to be mitigated, or potential exposure to coastal hazards (unitless index)	*2.88 – 2.93*
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)	3.24 – 3.29
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)	3.46 – 3.52
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #5 'Fossil-fuelled Development' (unitless index)	3.63 – 3.69
Current proportional risk reduction, nature's contribution to reducing coastal risk as a proportion of maximum coastal risk (unitless index)	0.11 – 0.12
Nature's contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast (# of people per hectare)	*27.34 - 31.37*
Nature's contribution to reducing coastal risk as a percentage of the maximum potential exposure (%)	*0.038 - 0.042*

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 Eastern Sunderbans 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$)**
Mangrove extent (hectares)[2]	50,827 – 1,875,486
Annual expected flood protection benefits to people (number of people)	79,493 – 156,021
Annual expected flood protection benefits to Industrial Stock (US$)	73,833,810 – 144,913,343
Annual expected flood protection benefits to Residential Stock (US$)	45,270,455 - 88,852,153
Annual expected flood protection benefits to Total Stock (US$)	*113,250,189 – 222,275,723*
Annual expected flood protection benefits to Industrial Stock per hectare of mangroves (US$ per hectare)	*3,785 – 7,428*
1-in-100-year return period damage in terms of area flooded (number of hectares)	19,946 – 151,773
Total expected flood protection benefits of mangroves per 100-year return period storms (US$)	*255,163,782 - 1,941,639,524*

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 Estuary	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 Sundarbans estimated 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 (%)
Intertidal forested wetlands	352,196.3	34.9	352,196.3	34.9
Estuarine waters	205,447.8	20.3	205,447.8	20.3
Intertidal mud, sand or salt flats	29,349.7	2.9	29,349.7	2.9
Permanent water	211,394.8	20.9	211,394.8	20.9
Aquaculture ponds	202,939.0	20.1	202,939.0	20.1
Commercial/Industrial/Transport	8,455.8	0.8	8,455.8	0.8
Total	1,009,783.4	100.0	1,009,783.4	100.0