ADB

Regional Flyway Initiative · Site Study

May 2026

RFI Priority Site · North Manila Bay (Bulacan)

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Asian Development Bank

General Site Information

Country	Philippines			
RFI Site Name	North Manila Bay (Bulacan)			ID115
City/ Municipality, Province, Region	Municipalities and barangays of Paombong, Malolos, Masukol, Santa Cruz, Pamarawan, Caliligawan, Bagumbayan, Bulacan, Bagumbayan, Bambang, Taliptip, Bulacan Province			
Geographical coordinates	14.77Nº, 120.79ºE		Area (has)	100,636 has
Key species	At least eight species of migratory waterbirds (exceeding 1% of EAAF thresholds), including Curlew Sandpiper (VU) and Caspian Tern.			
Key habitats (biomes)	Mangrove forests and largest areas of intertidal mudflats in North Manila Bay			
Key ecosystem services	Coastal protection, climate regulation			
Key drivers of change	Pollution (water, solid waste), siltation and erosion			
Conservation status (mark all that applies)	☐ Protected Area		☐	Flyway Network Site
	☐ Ramsar Site		☐	Others _____
IBA/ KBA name (and number) and other designations	North Manila Bay			
Management Stakeholders	DENR, PENRO Bulacan, San Miguel Corporation (SMAI), LGUs			
With management plan?	Yes, under the Manila Bay Sustainable Development Master Plan			
Project concept themes	Wetland restoration, sustainable fisheries and aquaculture			
Length of project	5-10 years			
Sector/s	Sustainable fisheries and aquaculture			
No. of potential beneficiaries				
Indigenous Peoples	☒ No		☐	Yes, _____
Anticipated Implementation Risks	Wildlife disturbance during infrastructure development and wetland-based tourism operations; project will mitigate impacts arising from airport development.			
Estimated Project Budget (US$)	9,550,000			
Potential Source/s of Financing	☒ Loan (to be identified)		☐	Private Sector
	☒ Grant (to be identified)		☒	Public-Private Partnership

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Abbreviations

ADB	Asian Development Bank
AWC	Asian Waterbird Census
CSR	Conservation Status Review
DENR	Department of Environment and Natural Resources
DOT	Department of Tourism
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
LGU	Local Government Unit
NMIA	New Manila International Airport
NGO	Non-governmental Organisation
PENRO	Provincial Environment and Natural Resources Office
RFI	Regional Flyway Initiative
SMAI	San Miguel Aerocity Inc
SLR	Sea Level Rise
TESSA	Toolkit for Ecosystem Services Assessment
USAID	United States Agency for International Development
USD	United States Dollars

Executive Summary

Manila Bay covers more than 1,900 km^2 and encloses a low-lying coastline of around 196 km spanning Cavite in the south to Bataan, Pampanga and Bulacan in the north. As a whole, Manila Bay extremely is rich in intertidal wetlands and contains significant areas of mudflats, seagrass beds, mangroves, and *nipa* swamps, and is easily the most important RFI landscape for migratory species in the Philippines, supporting key congregations of shorebirds and migratory terns and gulls. Bulacan is located in the northeastern part of Manila Bay and includes the intertidal foreshore and riverine wetlands in Bulacan Province together with extensive areas of fishpond and aquaculture. Several sites within the Bulacan section of Manila Bay are known to be internationally important for waterbirds and are located in the municipalities of Paombong, Malolos, and Bulacan. At least eight (8) species were identified to have exceeded 1% of the EAAF population thresholds. Bulacan's wetlands also provide critical ecosystem services, and its provisioning and regulating services are especially important to local communities along the fringes of Manila Bay. Bulacan performs well above the average of all RFI coastal sites for its total benefits against extreme storm events - 100-year return period storms (6.6 vs. 2.4 million USD per annum).

As with elsewhere in Manila Bay, wetland ecosystems in Bulacan are highly fragmented, degraded and remain under significant anthropogenic pressure from reclamation, aquaculture expansion, solid waste pollution and coastal development resulting from the expansion of Manila's urban sprawl. The construction of the New Manila International Airport (NMIA) on the coastal zone of Bulacan immediately impacts some of the most important areas of coastal wetlands for migratory species, although there are ongoing activities to offset the impact of this development through mudflat restoration.

Mangrove restoration has been carried out on the Bulacan coast by LGUs, in complement to other coastal wetland restoration and rehabilitation works resulting from offset interventions because of the airport development. Ongoing efforts to restore degraded areas of intertidal flats under the NMIA project in Pamarawan (40 ha) have shown early signs of success. However, there is scope and opportunity for further mangrove restoration at disused fishponds along Bulacan coast whilst strengthening the monitoring and management of existing areas of mudflats; this needs to be underpinned by further scoping studies to identify the best areas for successful restoration. Furthermore, there is opportunity to strengthen the resilience of coastal communities and improve livelihoods through the creation of local financing initiatives and capacity building and awareness programmes targeting fisher cooperatives and fishpond owners. This is expected to involve small-scale financing and credit (through small loans and grants), in complement with capacity building on good fishing and fishpond management practices to benefit biodiversity. Finally, there are opportunities to established new, locally protected areas for migratory species, as has been achieved in other parts of Manila Bay (e.g. Pampanga, Bataan).

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 the Philippines, a total of 20 wetland sites, including many Asian Waterbird Census count sites, were initially assessed through data analysis and expert consultation, of which twelve (12) 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. The majority of the RFI wetlands prioritised for the Philippines are coastal wetlands, a consequence of the country's long coastline, with the largest cluster of priority sites being North Manila Bay, which constitutes three sites across the provincial jurisdictions of Bataan, Pampanga and Bulacan. 28 EAAF species exceeded the 1% threshold at the site level, with species such as Chinese Crested Tern, Chinese Egret and the Tufted Duck.

2. Site profile of North Manila Bay (Bulacan)

Location: This site lies in the northeastern part of Manila Bay and includes the intertidal foreshore and riverine wetlands in Bulacan Province, including estuarine wetlands on the Pampanga River mouth (abutting Pampanga province). The locations in this part of Manila Bay that are known to be internationally important for waterbirds (exceeding 1% of flyway population thresholds) are in the following municipalities: (1) Paombong – Barangays Masukol, Santa Cruz, (2) Malolos – Barangays Pamarawan, Caliligawan, and (3) Bulacan – Barangays Bagumbayan, Bambang, Taliptip. Some of these coastal areas have been modified or lost due to reclamation and coastal infrastructure work associated with the development of a new airport project.

Area: The North Manila Bay (Bulacan) RFI site has an area of 100,636 ha

Altitude: 0-3 m asl.

Geographical coordinates: 14.77Nº, 120.79ºE

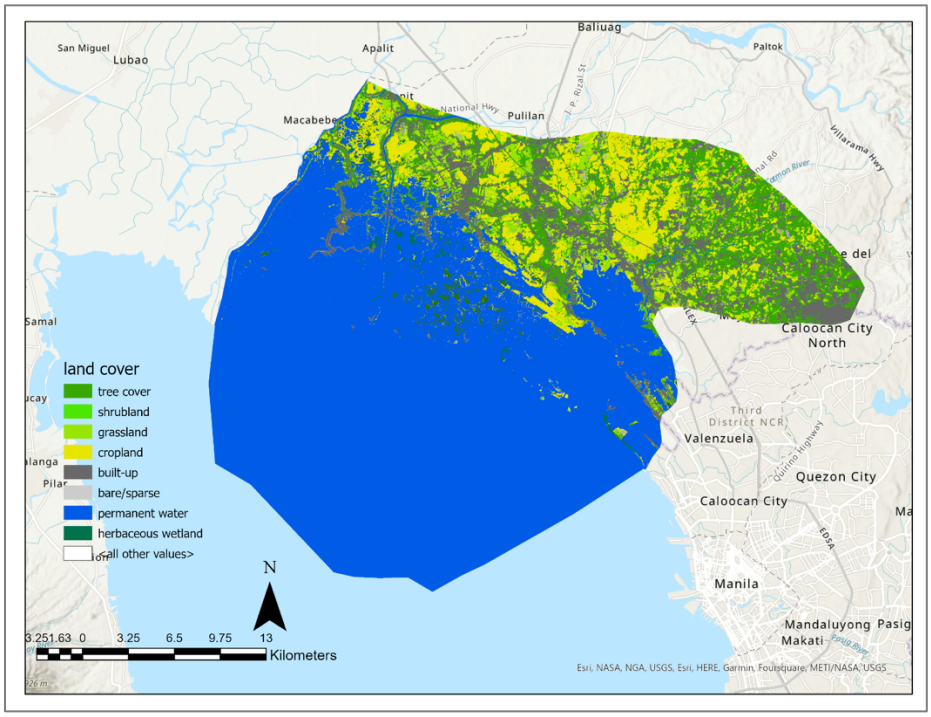

Figure 1 Map of the Bulacan sector of North Manila Bay, showing the distribution of vegetation cover across the coastal zone. Bulacan holds the largest areas of coastal wetlands in North Manila Bay. The inshore waters of Manila Bay still form more than half of the area of this site. (Map: Radhika Bhargava)

Description of site: Manila Bay covers more than 1,900 km^2 and has a coastline of around 196 km from Cavite City to Bataan Province, including the coastline of Bulacan. It is a large semi-enclosed bay fringed

by shallow intertidal areas with relicts of mudflats, mangroves, and nipa swamps. The status and distribution of remaining habitats in Manila Bay was assessed and mapped during a series of rapid surveys in 2016-2018 (Jensen 2018). These surveys identified the largest foreshore areas to be in Bulacan Province (6,425 ha), followed by Bataan (4,962 ha) and Pampanga (3,562 ha), although large areas of this coastline have been converted to fishponds. Intertidal flats (both sand flats and mud flats) are the single most important habitat for a diversity and congregation of migratory waterbirds, notably shorebirds, but it has been greatly reduced in area in Manila Bay, although important areas of semi-permanent mudflat are found scattered in drained fishponds and saltpans. The largest remaining mudflats and sandbars in Manila Bay in good ecological condition are found in Barangay Bulacan in Bulacan Province (>313 ha), and the main remaining area of coastal saltmarsh in Manila Bay is also in Bulacan Province, in a narrow band along the shoreline of the Tanza Peninsula, although even this has been degraded recently due to coastal works. Mangroves have also been greatly reduced in extent all across Manila Bay, with remaining areas in Bataan (37.4% of the original extent), Pampanga (15.3%) and Bulacan (11.1%). Fragmented areas of seagrass survive, mostly offshore in Bataan and Bulacan provinces, a habitat that is the main breeding areas for a large number of fish species vital for the local economy. The internationally important waterbird sites in Bulacan Province include the Paombong-Malolos wetlands (Masukol, Santa Cruz, Pamarawan, Caliligawan and tidal mudflats) and Bagumbayan-Bulacan wetlands (Bagumbayan, Bambang and Taliptip).

Site administration, management and land tenure: Manila Bay as a whole is recognised as an Important Bird and Biodiversity Area (Mallari et al. (2001) and a Key Biodiversity Area (Conservation International 2006, IUCN 2014) because it supports internationally important populations of migratory waterbirds, including several globally threatened species. There are a few areas in North Manila Bay that are legally protected, typically as 'Critical Habitat and Ecotourism Areas', but these are usually very small areas of mangroves and limited intertidal flats.

Social and economic values: Manila Bay is very important for its fisheries production which supports the large urban population around the periphery of the Bay, with important species such as Milkfish *Chanos chanos*, tilapia (various species), shrimp and crabs. There are high concentrations of various fish trapping devices, and extensive areas with fishpens in the open sea area, as well as aquaculture along the shorelines (Mialhe et al. 2015, BirdLife International 2017a). Aquaculture may account for nearly two thirds of the total economic value of Manila Bay (PEAMSEA, 2006).

The wetland ecosystems in Manila Bay are under significant anthropogenic pressure. Tidal foreshore areas, riverine habitats (especially in the Pampanga River Estuary) and the remaining patches of mangroves continue to be converted to aquaculture (UNEP-TEEB 2017) and polyculture (Mialhe et al. 2015) which is evident from the extensive areas of fishponds, fish pens, and shellfish pens throughout the bay. Other important issues affecting the wetlands include large-scale development projects and sea-level rise.

The Manila Bay Sustainable Development Master Plan (MBSDMP) was formulated through a bilateral project between the Governments of the Philippines and the Netherlands in 2019 to provide an overarching framework for development across all of Manila Bay. There are however major gaps in the development of the MBSDMP, including in the protection of critical habitats and the provisions for the management of biodiversity and ecosystems (Lopez 2019).

A private-public partnership covering an area of about 18,000 ha in Manila Bay is being assessed for implementation by the Department of Public Works and Highways (DPWH 2016, PPP Center 2016). It is named the Manila Bay Integrated Flood Control and Coastal Defence and Expressway Project, and it aims to reclaim coastal areas from Navotas City in Metro Manila to Bataan Province. The design includes the creation of five artificial islands in the habitats of commercially important fish species and areas where migratory waterbirds congregate (Daily Economic 2014, Mooyart et al. 2015, DA-BFAR 2015b, and this study).

A private sector proposal to develop a new international airport in Manila Bay has been approved by the National Economic Development Authority (NEDA) and is currently in under construction in the largest intact coastal wetland in Bulacan Province (PPP Center 2018). This is resulting in extensive earthworks and changes to the coastline through reclamation, alongside associated infrastructure and development projects, although interventions are being implemented to mitigate overall impacts on Manila Bay's intertidal wetland ecosystem, including biodiversity offsets from habitat restoration.

3. Biodiversity value of North Manila Bay (Bulacan)

3.1 Key habitats

Manila Bay is a large semi-enclosed bay fringed by shallow intertidal areas with relicts of mudflats, mangroves, and nipa swamps. Intertidal flats (both sand flats and mud flats) are the single most important habitat for a diversity and congregation of migratory waterbirds, notably shorebirds, but it has been greatly reduced in area in Manila Bay, although important areas of semi-permanent mudflat are found scattered in drained fishponds and saltpans. The largest remaining mudflats and sandbars in Manila Bay in good ecological condition are found in Barangay Bulacan in Bulacan Province (>313 ha), and the main remaining area of coastal saltmarsh in Manila Bay is also in Bulacan Province, in a narrow band along the shoreline of the Tanza Peninsula, although even this has been degraded recently due to coastal works.

Mangroves have also been greatly reduced in extent all across Manila Bay, with remaining areas in Bataan (37.4% of the original extent), Pampanga (15.3%) and Bulacan (11.1%). Fragmented areas of seagrass survive, mostly offshore in Bataan and Bulacan provinces, a habitat that is the main breeding areas for a large number of fish species vital for the local economy. The internationally important waterbird sites in Bulacan Province include the Paombong-Malolos wetlands (Masukol, Santa Cruz, Pamarawan, Caliligawan and tidal mudflats) and Bagumbayan-Bulacan wetlands (Bagumbayan, Bambang and Taliptip).

3.2 Importance of North Manila Bay (Bulacan) to migratory waterbird species

Waterbird count data from the 2019, 2020 and 2021 Asian Waterbird Census (including datasets from seven different areas in the site, which were summed to create four datasets) was used in the RFI priority sites analysis for North Manila Bay (Bulacan). The four datasets from these three years were averaged and then compared to the CSR1 1% population estimates to calculate a score for each species. Eight species were found to exceed the 1% population estimates (Table 1), and the scores for these species were summed to produce the overall site score for North Manila Bay (Bulacan).

Tan et al. (2023) found that several additional migratory waterbirds exceeded their 1% of flyway population thresholds on a least one occasion in North Manila Bay (Bulacan) between 2021-2023, namely Little Ringed Plover *Charadrius dubius* (LC), Broad-billed Sandpiper *Calidris falcinellus* (LC), Long-toed Stint *Calidris subminuta* (LC), Black-headed Gull *Larus ridibundus* (LC) and Little Tern *Sternula albifrons* (LC).

Several globally threatened and near-threatened species have been recorded in substantial numbers in North Manila Bay (Bulacan), including Black-faced Spoonbill *Platalea minor* (EN), Chinese Egret *Egretta eulophotes* (VU), Eurasian Curlew *Numenius arquata* (NT), Far Eastern Curlew *Numenius madagascariensis* (EN), Bar-tailed Godwit *Limosa lapponica* (NT), Black-tailed Godwit *Limosa limosa* (NT), Great Knot *Calidris tenuirostris* (EN), Red Knot *Calidris canutus* (NT), Sharp-tailed Sandpiper *Calidris acuminata* (VU), Curlew Sandpiper *Calidris ferruginea* (NT), Red-necked Stint *Calidris ruficollis* (NT), Asian Dowitcher *Limnodromus semipalmatus* (NT), Grey-tailed Tattler *Tringa brevipes* (NT) and Nordmann's Greenshank *Tringa guttifer* (EN).

Table 1 List of migratory species (based on the EAAFP list of species) with globally significant congregations in the coastal wetlands in Bulacan Province.

Scientific name	IUCN	Average count	CSR1	CSR1 score
Kentish Plover *Charadrius alexandrinus*	LC	5,632	700	8.0
Pacific Golden Plover *Pluvialis fulva*	LC	7,897	1,200	6.6
Lesser Sandplover *Charadrius mongolus*	LC	1,119	300	3.7
Marsh Sandpiper *Tringa stagnatilis*	LC	2,363	1,300	1.8
Whiskered Tern *Chlidonias hybrida*	LC	13,611	10,000	1.4
Common Redshank *Tringa totanus*	LC	1,090	1,000	1.1
Curlew Sandpiper *Calidris ferruginea*	VU	924	900	1.0
Caspian Tern *Hydroprogne caspia*	LC	239	250	1.0

3.3 Other notable biodiversity

Manila Bay is essential for its fisheries production which supports the large urban population around the periphery of the Bay, with important species such as Milkfish *Chanos chanos*, tilapia (various species), shrimp and crabs.

4. Ecosystem services

4.1. Ecosystem services provided by North Manila Bay (Bulacan)

The North Manila Bay (Bulacan) site encompasses diverse habitats that provide valuable provisioning, regulating, and cultural ecosystem services (Figure 2). The results from the RFI workshop[1] highlight the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, particularly fresh water and food provision are critical for communities both within, adjacent to, and distant from the site. Regulating services, such as flood hazard regulation, are also essential, benefiting communities within and adjacent to the site. Cultural services, including cultural identity and heritage and a sense of place, bene benefit communities within and adjacent to the site.

[1] Asian Development Bank. (2023, June 27–30). *Philippines: Wetland Ecosystem Services Workshop* [Workshop]. Asian Development Bank Headquarters, Manila, Philippines. https://events.development.asia/learning-events/philippines-wetland-ecosystem-services-workshop

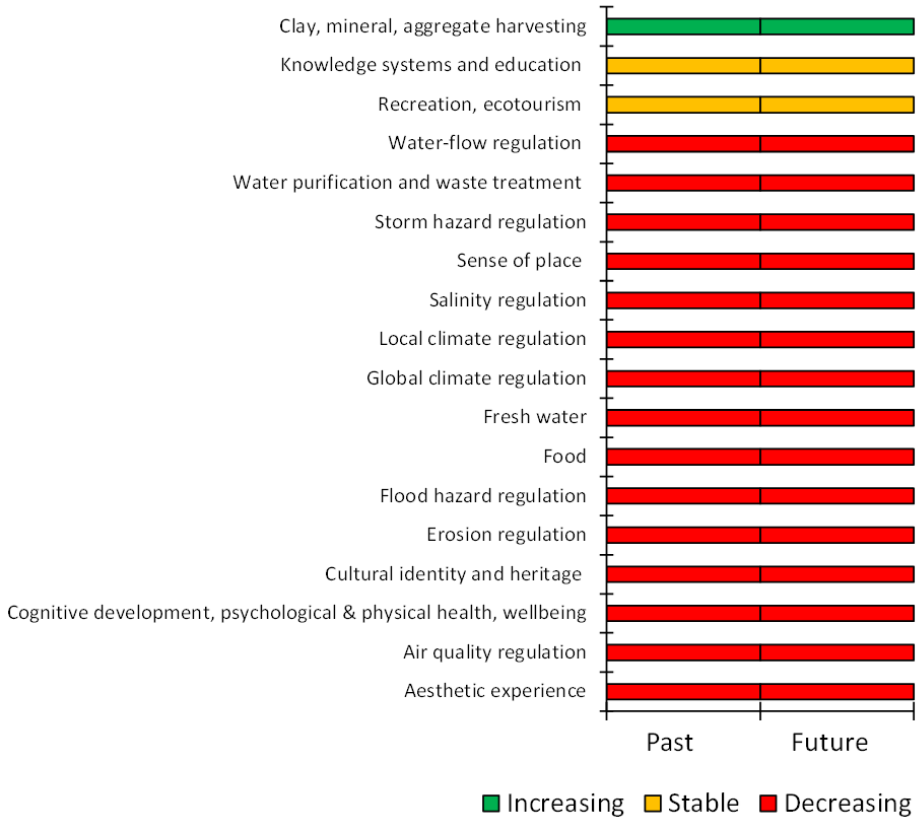

Figure 2 List of ecosystem services provided by North Manila Bay (Bulacan), as identified through stakeholder consultation at the Regional Flyway Initiative workshop.

Table 2 List of top ecosystem services provided by North Manila Bay (Bulacan).

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						
Fresh water	Yes	✓	✓	✓	Decrease	Decrease
Food	Yes	✓	✓	✓	Decrease	Decrease
Regulating services						
Flood hazard regulation	Yes	✓	✓		Decrease	Decrease
Cultural services						
Cultural identity and heritage	Yes	✓	✓		Decrease	Decrease
Sense of place	Yes	✓	✓		Decrease	Decrease

4.2. Global climate regulating services

Based on systematic reviews (Chen and Lee, 2022; Stankovic et al., 2023), the amount of carbon stored in North Manila Bay (Bulacan) is estimated to range from 218,000 to 1,700,000 tonnes, while the annual carbon sequestration rate is estimated to be between 3,500 and 11,200 tonnes per year.

4.3. Coastal protection services

The coastal protection services provided by North Manila Bay (Bulacan) were assessed using both biophysical indices and monetary values (see Tables A1 and A2, in Annex 1 for details). When compared to both the average of the nine RFI coastal sites and the average of all other coastal areas in the Philippines (Table A3 in Annex 1), Bulacan shows mixed results in terms of risk level:

(1) for the potential exposure to coastal hazards, Bulacan is consistently above average (index: 3.16 vs. 2.70 for RFI coastal sites and 2.36 for all other coastal areas);

(2) for the contribution to reducing coastal risk as a proportion of population density with 2.5 km of the coast, Bulacan is slightly below the average of RFI coastal sites (296 vs. 306 people/ha) but above average compared to all other coastal sites (296 vs. 122 people/ha); and

(3) for the contribution to reducing coastal risk as a percentage of the maximum potential exposure, Bulacan is well below average (3.34% vs. 5.28% for RFI coastal sites and 6.60% for all other coastal areas).

In monetary terms (Table A4 in Annex 1), Bulacan ranks well below both the national RFI and overall country averages in terms of total annual benefits per ha of mangroves (4,200 vs. 14,895 or 11,160 USD/ha). However, Bulacan is well above the average of all RFI coastal sites in the Philippines regarding total benefits against 100-year return period storms (6.6 vs. 2.4 million USD).

5. Drivers of change and their potential impacts on North Manila Bay (Bulacan)

5.1. Current drivers of change and their level of impact

Stakeholders in the RFI workshop[2] identified 31 drivers of change impacting North Manila Bay (Bulacan) and their corresponding levels of impact on the wetland site (see Table 3). High-impact drivers include agricultural and forestry effluents, which contribute to water pollution and nutrient loading, significantly degrading the wetland's health. Erosion and siltation/deposition further threaten the site by altering habitat conditions and reducing water quality. Habitat clearing and fishing, killing, and harvesting of aquatic resources pose substantial threats to the biodiversity and ecosystem stability. Household sewage and urban wastewater from outside the wetland, as well as garbage and solid waste, add to the high impact through pollution. Other significant threats include increased habitat fragmentation within across the site, isolation from natural habitats, loss of cultural links and hydrological connectivity, storms and flooding, and water extraction/diversion within the wetland or catchment area. Medium-impact drivers include habitat shifting and alteration, which disrupts the ecological balance within the site. Commercial and industrial areas contribute to moderate levels of habitat degradation. Other medium-impact activities include industrial mining, military effluents, invasive animal species, and marine and freshwater aquaculture, which collectively affect water quality and habitat health.

[2] Asian Development Bank. (2023, June 27–30). *Philippines: Wetland Ecosystem Services Workshop* [Workshop]. Asian Development Bank Headquarters, Manila, Philippines. https://events.development.asia/learning-events/philippines-wetland-ecosystem-services-workshop

Table 3 Drivers of change and their potential impact on the integrity of North Manila Bay (Bulacan) based on consultations with stakeholders.

Driver of change	Impact
Agricultural and forestry effluents	High
Dams, hydrological modification and water management/use	
Earthquakes/tsunamis	
Erosion and siltation/deposition	
Fishing, killing and harvesting of aquatic resources	
Garbage and solid waste	
Habitat clearing	
Household sewage and urban waste water from outside the wetland site	
Hunting, killing and collecting of terrestrial animals	
Increased fragmentation within the wetland site	
Isolation from other natural habitats	
Loss of cultural links, traditional knowledge and/or management practices	
Loss of hydrological connectivity	
Restoration for conservation	
Storm and flooding	
Water extraction/diversion within the wetland site or catchment	
Commercial and industrial areas	Medium
Habitat shifting and alteration	
Industrial, mining and military effluents	
Invasive animal species	
Marine and freshwater aquaculture	
Air-borne pollutants	Low
Destruction of cultural heritage buildings, gardens, sites, etc.	
Droughts	
Flight paths	
Invasive plant species	
Loss of keystone species	
Research, education and other work-related activities	
Roads and railroads	
Temperature extremes	
Utility and service lines	

5.2. Potential alternative state of North Manila Bay (Bulacan) under current drivers of change

Stakeholders in 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 3). 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.

[3] Asian Development Bank. (2023, June 27–30). *Philippines: Wetland Ecosystem Services Workshop* [Workshop]. Asian Development Bank Headquarters, Manila, Philippines. https://events.development.asia/learning-events/philippines-wetland-ecosystem-services-workshop

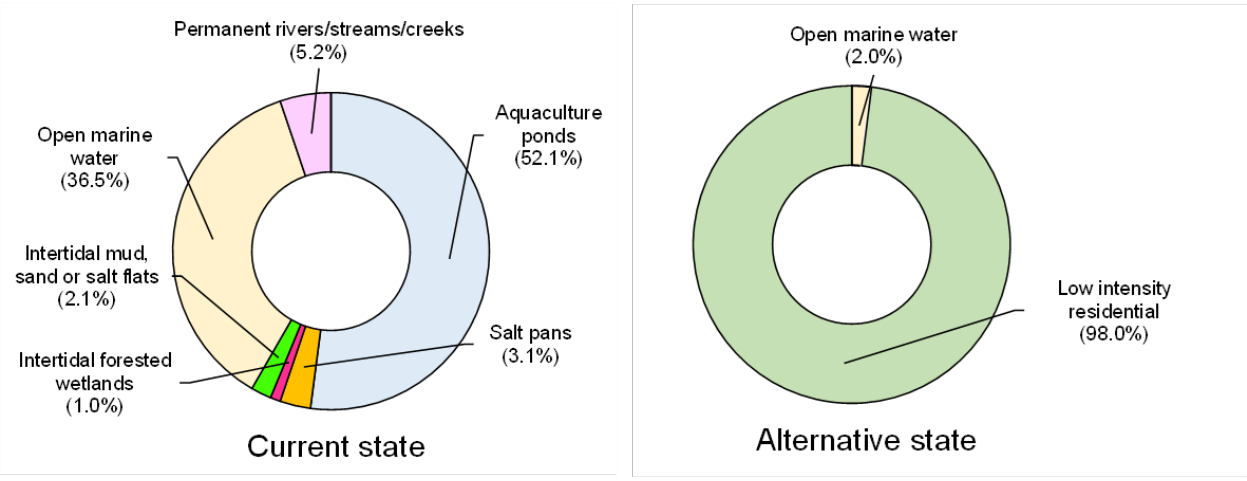

Figure 3 The proportional change in the extent of different habitat types between the current and alternative states of North Manila Bay (Bulacan).

5.3. Expected changes in the ecosystem services of North Manila Bay (Bulacan)

Stakeholders in the RFI workshop[4] documented the future trends in the provision of ecosystem services in North Manila Bay (Bulacan), indicating if the ecosystem services provided by this site (to 2035) will increase, decrease, or will remain stable, assuming that 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 provisioning services, particularly fresh water and food provision have experienced a decline in the past, with further decreases anticipated in the future. Regulating services, such as flood hazard regulation, have also seen a decrease in the past and are projected to continue decreasing. Cultural services, including cultural identity and heritage and a sense of place, have also faced a decline and are expected to continue decreasing.

In the alternative state, the loss of all (100%) mangrove and intertidal mudflat is expected to result in a loss of stored carbon, estimated to be between 218,000 and 1,700,000 tonnes and a loss of carbon sequestration (carbon accumulation) by approximately from 3,500 and 11200 tonnes per year.

A loss of 1,048.3 ha of mangroves (Table A5), equivalent however to only 1% of the total land use for the site, is expected to result in roughly a 122% reduction in coastal protection (as estimated based on a mangrove area of 129 ha from remote sensing). This reduction may amount to over 4.4 million USD in lost total benefits per year (based on 1,687 USD per hectare of mangroves) and 8.0 million USD in lost total benefits per 100-year return period storm (based on the same 122% reduction in coastal protection).

[4] Asian Development Bank. (2023, June 27–30). *Philippines: Wetland Ecosystem Services Workshop* [Workshop]. Asian Development Bank Headquarters, Manila, Philippines. https://events.development.asia/learning-events/philippines-wetland-ecosystem-services-workshop

6. Capacity needs in North Manila Bay (Bulacan)

The stakeholder consultation and analyses with stakeholders representing government and civil society identified at least 10 major stakeholder groups with clear roles in the long-term sustainable management of wetlands in North Manila Bay (Bulacan). Current role and opportunities for building local capacity on wetland management are summarized in Table 4.

Table 4. Capacity needs for improved management of North Manila Bay wetlands, identified at the stakeholder level.

Table 4 Capacity needs for improved management of North Manila Bay wetlands, identified at the stakeholder level.

Stakeholder	Current Role in wetland management	Future role (alt state)	Future capacity (alt state)	Form of capacity development
Fishpond owners	End-user/direct beneficiary	Potential supporters of wetland conservation and advocacy.	Expand infrastructure for tourism (e.g. boardwalks) Mobilise financing for wetland restoration etc (as part of San Miguel compliance), and from private sector Strengthen capacity for legal protection - local, national designation (e.g. Ramsar) or other OECMs Critical habitat designation for specific species - proposed from DENR (Asian Dowitcher, Great Knot, Far Eastern Curlew) in collaboration with LGUs Produce site-level assessment reports and management plans for stakeholders. Define clearly species, habitat and stakeholders; strengthen relationship with LGUs Strengthen LGU Relationships	
Salt pan owners	End-user/direct beneficiary			
Fishers				
Local residents				
SMAI (environmental offset and project expansion)	Offset buyer/project implementer	Provide financing for further wetland protection and restoration.		
Private monitoring consultancies	Biodiversity and threat monitoring, and surveys.	Generate data on threatened species and key habitats from further surveys.		
DENR	Biodiversity monitoring (annually)	Facilitator to enhance wetland conservation and management.		
LGUs (village - barangay)	Minimal role in addressing pollution management, fishing practices.	Critical habitat designation, find local champion (mayor, village leader) and build support.		

Stakeholder	Current Role in wetland management	Future role (alt state)	Future capacity (alt state)	Form of capacity development
Local government (city/municipality)			Work with fishpond owners to ensure some ponds are managed and conserve for biodiversity Communication/education of local communities Assess the value of ecosystem services gleaned from Manila Bay wetlands (vs income from development) Continuation of livelihoods (cultural ES) Build capacity to raise the profile of Manila Bay for wetland conservation **Further steps (potentially the role of RFI interventions)** Report for critical habitat designation Work with local politicians/champions (like Balanga's LGUs) Strengthen local capacities for environmental awareness and education Collaborate with SMAI to implement wetland restoration and offset works effectively (and ideally complement it), to ensure no net loss Seek legal conservation for most important areas of coastal wetlands before further development	
Local government (planners)				
Tourism operators	End-user/direct beneficiary	bird tour near airport (e.g. board walk)		
Local conservation NGOs	Biodiversity monitoring and advocacy	Biodiversity monitoring and advocacy		
International conservation NGOs				

7. Opportunities for RFI interventions

7.1 Recommended Interventions

Bulacan's coastal zone forms the largest part of North Manila Bay, and its few remaining areas of intertidal flats (e.g. in Pamarawan, Malolos, Taliptip) in the province are among the most important sites for shorebird conservation in the Philippines. Bulacan's coastal zone is also heavily impacted by the construction of the New Manila International Airport (NMIA) and its associated infrastructure, which is expected to lead to further degradation of existing areas of coastal wetlands, while impacting local fishing communities in several municipalities. Proposed interventions are expected to strengthen the resilience of coastal communities through building capacity and setting up new initiatives to improve local livelihoods, alongside local-led initiatives for biodiversity monitoring and environmental education.

There are also opportunities to restore degraded wetlands in fishponds (with mangroves) in existing areas of fishponds and salt pans that are presently not impacted by airport construction, alongside interventions to ensure that offset sites from the airport project are effectively managed for migratory species, in complement with the NMIA's biodiversity offset project, 'Saribuhay sa Dampalit', which has thus far restored 40 ha of coastal wetlands.

Tourism is not identified as a priority for Bulacan, but there is scope for limited tourist activities.

Table 5 List of proposed interventions for the Bulacan sector of North Manila Bay, and the expected output and timeframes for project implementation.

Intervention	**Outcome**	**Indicators**	**Cost**	**Timeframe**	**Potential Stakeholders**
Component 1. Improvement in biodiversity and pollution monitoring					
Establish a local-led biodiversity and wetland (mangrove) monitoring scheme across key municipalities	Biodiversity and wetlands monitoring framework and mechanism for the site established. Improved local biodiversity and wetland information for better site management. Formation of a locally led conservation	Biodiversity and wetland (mangrove) monitoring framework identified and used for site monitoring Number of monitoring reports on the biodiversity and wetland (mangrove) status generated,	100,000	5 years	Department of Environment and Natural Resources PENRO Bulacan LGUs for Masukol, Santa Cruz, Pamarawan, Caliligawan, Bulacan.

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
	monitoring groups led by concerned LGUs	especially during the migration season Locally led conservation monitoring group, with target of 3 across concerned LGUs, organized			Research institutions Conservation organizations
Build institutional capacity on biodiversity and pollution monitoring	Training and capacity needs for biodiversity and pollution monitoring assessed Relevant training modules developed and implemented with key stakeholders (e.g., DENR, LGUs, provincial government) Improved capacity of key stakeholders about biodiversity and pollution monitoring	Training Needs Assessment on biodiversity and pollution monitoring completed and disseminated to concerned stakeholders Number of training modules developed based on the results of training needs assessment Number of capacity-building activities administered with concerned stakeholders Number of target stakeholders trained in the capacity-building activities			

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
Component 2. Improvement of local livelihoods through microfinance mechanisms					
Establish financing instruments, including through microfinance for fishers, aquaculture operators, and tourism operators	Improved capacity for financial management of local communities Financial mechanism and management board established to manage disbursement of small loans and grants relevant to site management Better fishing practices documented in the areas covered by the capacity-building activities	Financial mechanism and management board established to manage disbursement of small loans and grants. Microfinancing mechanism for small grants/loans to fishers strengthened or established to at least 5 barangays. Number of small loans for fisherfolk disbursed.	500,000	5 years	BFAR Provincial Government of Bulacan LGUs for Masukol, Santa Cruz, Pamarawan, Caliligawan, Bulacan. Existing fishing and aquaculture cooperatives Conservation organizations
Build institutional capacity for small-scale fisheries through strengthening existing cooperatives.	Improved capacity for sustainable fishing practices of local communities Training and capacity needs for fisherfolk assessed Relevant training modules developed and implemented with key stakeholders (e.g., DENR, concerned LGUs, provincial government, DA) Improved capacity of key stakeholders	Training Needs Assessment on sustainable fishing practices completed and disseminated to concerned stakeholders Number of training modules developed based on the results of training needs assessment Number of capacity-building activities administered with concerned	500,000	5 years	

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
	about sustainable fishing practices	stakeholders Number of people benefitting from the capacity-building activities, especially those from the vulnerable groups			
Build institutional capacity for aquaculture operators (and fishpond owners) for 'wildlife-friendly' fish and shrimp farming.	Improved capacity for aquaculture management, and 'biodiversity-friendly' aquaculture among aquaculture operators Training and capacity needs for aquaculture operators assessed Relevant training modules developed and implemented with key stakeholders (e.g., DENR, concerned LGUs, provincial government, DA) Improved capacity of key stakeholders about aquaculture management and 'biodiversity-friendly' aquaculture	Training Needs Assessment on aquaculture management and 'biodiversity-friendly' aquaculture completed and disseminated to concerned stakeholders Number of training modules developed based on the results of training needs assessment Number of capacity-building activities administered with concerned stakeholders Number of people, with target of at	100,000	5 years	

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
		least 50 aquaculture operators, benefitting from the capacity-building activities			
Establish incentives for the development of wildlife-friendly aquaculture products; creation of markets for products	Aquaculture operators and fishpond owners actively trained on biodiversity-friendly fishpond and shrimp pond management approaches. Training programmes for certification, and business development for aquaculture operators are created for possible scale up Increased practice of wildlife-friendly aquaculture reduces pressure on Manila Bay Demand for wildlife-friendly aquaculture products is created, driving shift from operators	Number of 'biodiversity-friendly' aquaculture products, with target of up to 10, developed. Number of business plans and trade networks mapped and established for aquaculture operators, with target of up to 20 operators Number of adopters of 'biodiversity-friendly' aquaculture	200,000	5 years	BFAR Provincial Government of Bulacan LGUs for Masukol, Santa Cruz, Pamarawan, Caliligawan, Bulacan. Aquaculture operators Private sector (seafood production companies)
Component 3. Improvement of wetland management					
Expand mangrove restoration plots at degraded areas of mangroves adjacent	Wetland under sustainable management scaled up; degraded	Area of restored mangrove areas, with a restoration target of up to 100	200,000	5 years	DENR Provincial Government

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
to the Aerocity site, including disused aquaculture ponds, in synergy with restoration and offset plots.	mangrove areas restored and more resilient to coastal action.	ha at identified plots Area of newly accreted and created mudflats monitored and managed, with a target of up to 100 ha			LGUs for Masukol, Santa Cruz, Pamarawan, Caliligawan, Bulacan local communities Conservation organizations
Scale up the sustainable management initiatives for mudflats	Important areas of mudflats are identified, mapped, and constantly monitored, which can be used to influence use of wetland use. Appropriate nature-based solutions are identified and possibly implemented to manage erosion and loss of mudflat areas.	Baseline information and map of existing mudflats generated and presented to key stakeholders Area of mudflats, especially those known to be important for shorebirds, identified, restored, and sustainably managed. Area of mudflats, especially those known to be important for waterbirds, monitored.	100,000	5 years	

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
Component 4: Payments for ecosystem services (PES) schemes					
Explore the feasibility of payments for ecosystem services, with focus on coastal protection	Feasibility of payment for ecosystem services for coastal protection, and other potential financing mechanisms assessed. Public and private financing mechanisms identified to sustain interventions for Manila Bay PES implementation plan is developed for Manila Bay, if seen applicable.	Feasibility of PES scheme has been assessed and presented to key stakeholders, particularly those involved in policy-making Number of stakeholders engaged for the assessment of the PES scheme applicability PES implementation plan developed, if seen applicable by key stakeholders	50,000.00	2 years	DENR PENRO Bulacan Concerned LGUs Research institutions Conservation organizations
Component 5: Strengthening infrastructure for wetland-based ecotourism in Bulacan					
Assess existing ecotourism plan and program to identify supporting activities	Wetland-based tourism strategy developed with inputs from key stakeholders Supporting activities for strengthening ecotourism identified and aligned with current ecotourism plan in Bulacan	Scoping of existing ecotourism initiatives and recommendations completed and presented to key stakeholders. Number of stakeholders engaged for the identification of supporting wetland-based tourism activities	500,000	2 years	DENR DOT LGUs for Masukol, Santa Cruz, Pamarawan, Caliligawan, Bulacan etc. Ecotourism operators Conservation organizations (including bird and community-
Expand and improve ecotourism infrastructure including access	Stronger (and functional) infrastructure to host tourists,	Number of infrastructure established/ improved (i.e., at			

Intervention	Outcome	Indicators	Cost	Timeframe	Potential Stakeholders
roads, boardwalks, signages and viewing structures at prioritised areas for migratory species.	including platforms, boardwalks, and signages Ecotourism as a source of livelihood and revenue. Strengthened.	least 0.5 km boardwalks and hides) constructed			focused NGOs)
Total investment for five years			**9,550,000**		

7.2 Potential Financing

The estimated project cost is USD 9,550,000 for five years. This project budget the improvement of biodiversity and pollution monitoring, building the capacity of small-scale fisherfolk and aquaculture operators on sustainable practices and microfinancing, expanding mangrove restoration plots, the assessment and possible establishment of a PES scheme, and strengthening the local wetland-based tourism.

If the proposed USD 200,000 investment over five years is allocated to expanding mangrove restoration in North Manila Bay (Bulacan), it could support the rehabilitation of up to 100 hectares of degraded mangroves, including disused aquaculture ponds and offset areas adjacent to the Aerocity site. With estimated coastal protection benefits of USD 1,687 per hectare annually (see Section 5.3), this intervention could generate approximately USD 168,700 in annual benefits—equivalent to over USD 843,500 over five years. This results in a benefit–cost ratio of over 4:1, indicating a strong return on investment in nature-based coastal defense. In addition to enhancing resilience to storm surges and shoreline erosion, the intervention supports sustainable wetland management and leverages synergies with ongoing restoration and offset initiatives. Allowing these degraded areas to remain unmanaged would mean forgoing valuable protection benefits and missing a timely opportunity to align ecological restoration with broader climate adaptation and infrastructure resilience efforts in the bay area.

Existing biodiversity monitoring activities as a result of the SMAI-led Airport project can complement interventions under this project. New (hard) infrastructure is expected to be created as a consequence of the airport development, including access roads, alongside wetland interventions for restoration under the airport's offset project.

7.3 Proposed Institutional Arrangements

The Bulacan Provincial Government, LGUs and key barangays around the Bulacan coast are expected to be key implementing partners. Bulacan Provincial Environment and Resources Office (PENRO) are expected to be a key partner for the development and implementation of this project, together with the

Department of Tourism (DOT) and Department of Environment and Natural Resources (DENR), while can provide technical input for project development and implementation.

7.4 Project Beneficiaries

Proposed interventions are expected to involve the participation of LGUs from Masukol, Santa Cruz, Pamarawan, Caliligawan, Bulacan, and other stakeholder groups representing the local communities (e.g. cooperative leaders), with strong representative of women and disadvantaged groups. This includes fisherfolk, small aquaculture businesses (for seafood-based food products). There are no indigenous or minority peoples in this landscape.

7.5 Anticipated Implementation Risks

Environment: Wetland-based tourism has been identified as a key project concept theme. The proposed interventions include new infrastructure, possibly access roads and boardwalks, that would enhance the tourism experience in Manila Bay. 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.

Poorly planned establishment of mangrove plantings may lead to loss of foraging habitat for some waterbirds and is a known issue in many parts of the Philippines where coastal restoration is being implemented. Evidence-based scoping needs to be carried out to identify key restoration plots.

Feasibility studies on the impact of expanding tourism are also necessary (rather than specialized ecotourism), and it is important that development that can drive mangrove loss must be averted – further safeguarding is needed to ensure the integrity of the mangroves is not impacted by proposed development.

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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 Bulacan 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)	(1,437) – 7,502
Current maximum coastal risk to be mitigated, or potential exposure to coastal hazards (unitless index)	*3.13 – 3.19*
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)	3.51 – 3.58
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)	3,94 – 4.02
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)	4.09 – 4.17
Current proportional risk reduction, nature's contribution to reducing coastal risk as a proportion of maximum coastal risk (unitless index)	0.09 – 0.13
Nature's contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast (# of people per hectare)	*(155) – 748*
Nature's contribution to reducing coastal risk as a percentage of the maximum potential exposure (%)	*0.03 – 0.04*

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 Bulacan 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$)**
Mangrove extent (hectares)[2]	(95) – 354
Annual expected flood protection benefits to people (number of people)	(20,214) – 25,085
Annual expected flood protection benefits to Industrial Stock (US$)	(14,720,100) – 18,267,395
Annual expected flood protection benefits to Residential Stock (US$)	(15,997,928) – 19,853,158
Annual expected flood protection benefits to Total Stock (US$)	(30,056,892) – *37,300,094*
Annual expected flood protection benefits to Industrial Stock per hectare of mangroves (US$ per hectare)	*(34,860) – 43,260*
1-in-100-year return period damage in terms of area flooded (number of hectares)	(487) – 551
Total expected flood protection benefits of mangroves per 100-year return period storms (US$)	*(99,848,999) - 113,067,968*

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)**
Bangrin Marine Protected Area	No Data	No Data	No Data
Kabasalan-Siay Wetland Area	2.24 (±0.03)	50 (±13)	8.2 (±0.2)
Negros Occidental Coastal Wetlands Conservation Area (NOCWCA)	2.55 (±0.04)	187 (±37)	4.8 (±0.3)
North Manila Bay (Balanga Wetlands Park)	No Data	No Data	No Data
North Manila Bay (Pampanga River East Bank)	3.16 (±0.03)	296 (±451)	3.3 (±0.6)
North Manila Bay (Sasmuan Pampanga Coastal Wetland)	2.99 (±0.06)	18 (±28)	5.3 (±1.3)
Olango Island Wildlife Sanctuary	2.77 (±0.09)	496 (±87)	7.7 (±0.2)
Panabo Coast	2.40 (±0.05)	1,537 (±617)	8.1 (±0.5)

Site name	Max pot exp (index)	Risk reduction (index * pop)	Risk reduction (% max pot exp)
Tubbataha Reef Natural Park	2.82 (±0.04)	Not Applicable	0.8 (±2.1)
Philippines RFI average	2.70	306	5.28
Philippines national average	2.36	122	6.60

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$)
Bangrin Marine Protected Area	1,045,290 (±98,880)	15,294 (±1,447)	331,327 (±31,342)
Kabasalan-Siay Wetland Area	86,324,218 (±160,880,759)	12,182 (±22,704)	1,571,774 (±3,587,626)
Negros Occidental Coastal Wetlands Conservation Area (NOCWCA)	2,511,290 (±2,318,575)	1,687 (±1,557)	5,477,498 (±5,654,072)
North Manila Bay (Balanga Wetlands Park)	1,207,200 (±572,108)	28,002 (±13,270)	202,433 (±6,784)
North Manila Bay (Pampanga River East Bank)	3,621,601 (±33,678,493)	4,200 (±39,060)	6,609,485 (±106,458,484)
North Manila Bay (Sasmuan Pampanga Coastal Wetland)	3,621,601 (±102,747)	28,002 (±794)	607,298 (±17,229)
Olango Island Wildlife Sanctuary	No Data	No Data	No Data
Panabo Coast	No Data	No Data	No Data
Tubbataha Reef Natural Park	No Data	No Data	No Data
Philippines RFI average	16,388,533	14,895	2,466,636
Philippines RFI total	98,331,201	Not Applicable	14,799,814
Philippines national average	1,849,798	11,160	4,933,082
Philippines national total	789,863,793	Not Applicable	2,136,024,319

Table A5. Key habitat types in North Manila Bay (Bulacan) based on stakeholder-based assessment at the Regional Flyway Initiative workshop in June 2023.

Habitat type	Current state		Alternative state (2035)	
	Area (ha)	Cover (%)	Area (ha)	Cover (%)
Aquaculture ponds	52414.6	52.1	0.0	0.0
Salt pans	3144.9	3.1	0.0	0.0
Intertidal forested wetlands	1048.3	1.0	0.0	0.0
Intertidal mud, sand or salt flats	2096.6	2.1	0.0	0.0
Open marine water	36690.2	36.5	2012.7	2.0
Permanent rivers/streams/creeks	5241.5	5.2	0.0	0.0
Canals and drainage channels, ditches	0.0	0.0	98623.3	98.0
Total	100636.0	100.0	100636.0	100.0

[1] https://naturalcapitalproject.stanford.edu/invest/coastal-vulnerability

[2] The reference value used by Menéndez et al. (2020) for their modelling is c. 565 ha, remote sensing data from ESA World Cover 2020 map at 10m resolution.