Regional Flyway Initiative · Site Study

January 2026

RFI Priority Site · Ao Phang Nga

Asian Development Bank

General Site Information

Country	Thailand			
RFI Site Name	Phang Nga Bay (Ao Phang Nga)			ID137
City/ Municipality, Province, Region	Mueang Phang Nga and Takua Thung districts, Phang Nga Province			
Geographical coordinates	8.32ºN, 98.52ºE		Area (has)	42,253 ha
Key species	Tibetan Sandplover, Chinese Egret; various cetaceans and Dugong			
Key habitats (biomes)	Mangrove forests and intertidal mudflats.			
Key ecosystem services	Provisioning and regulating services (Coastal fisheries and shellfisheries, ecotourism, wetland carbon)			
Key drivers of change	Unsustainable ecotourism, overfishing, pollution from industries			
Conservation status (mark all that applies)	■	Protected Area		Flyway Network Site
	■	Ramsar Site		Others _____
IBA/ KBA name (and number) and other designations	Phang Nga Bay			
Management Stakeholders	Department of National Parks, Wildlife and Plant Conservation (DNP), Department of Marine and Coastal Resources (DMCR)			
With management plan?	Yes			
Project concept themes	Wetland restoration, small-scale fisheries and shellfisheries (e.g. oyster farms) and sustainable ecotourism			
Length of project	6 years (at least), but potentially 10 years, including for fishery and tourism components			
Sector/s	Ecotourism, fisheries			
No. of potential beneficiaries				
Indigenous Peoples		No	■	Yes, Moken and Moklen people
Anticipated Implementation Risks	Infrastructure construction expected to cause short-term disturbance on site.			
Estimated Project Budget (US$)	14,400,000			
Potential Source/s of Financing	■	Loan (to be identified)		Private Sector
	■	Grant (to be identified)		Public-Private Partnership

Table of Contents

Acronyms

ADB	Asian Development Bank
APNNP	Ao Phang Nga National Park
AWC	Asian Waterbird Census
BCST	Bird Conservation Society of Thailand
CSR	Conservation Status Review
DMC	Developing Member Country
DMCR	Department of Marine and Coastal Resources
DNP	Department of National Park, Wildlife and Plant Conservation
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
OECM	Other Effective area-based Conservation Measure
ONEP	Office of Natural Resources and Environmental Policy
RFI	Regional Flyway Initiative
TAO	*Tambon* Administrative Organisation
TESSA	Toolkit for Ecosystem Services Assessment
USAID	United States Agency for International Development
USD	United States Dollars

Executive summary

Ao Phang Nga (42,253 ha) Marine National Park is located on the west coast of peninsular Thailand, just the north-east of the island of Phuket and is one of the best known marine protected areas in Thailand. (Ao) Phang Nga Bay extends northwards from Phuket Island and eastwards along the mainland coast past the mouths of six rivers (including the Phang Nga River) to the mouth of the Marui. The easternmost boundary of the site is delimited by the large promontory of Khao Ao Muang. Phang Nga Marine National Park is managed by the Department of National Park, Wildlife and Plant Conservation, and protect some of the most pristine areas of mangroves (21,000 ha) in Peninsular Thailand; the site is studded with spectacular steep sided limestone islands and contains a diversity of wetland ecosystems such as enclosed bays, estuaries, intertidal mudflats, rocky shores and seagrass beds. Mangroves outside the park boundary are state-owned, with jurisdiction from the Royal Forest Department, and are protected and carefully managed for harvest. Despite limited surveys to date, Phang Nga Bay's coastal wetlands is known to support regular and large congregations of migratory shorebirds and is identified as a significant site for Tibetan Sandplover *Anarynchus atrifrons* (>1% of the regional population), together with six globally Near Threatened or Threatened species such as Pale-capped Pigeon *Columba punicea* and Chinese Egret *Egretta eulophotes*. Several globally threatened mammal species, including Dugong *Dugong dugon* (VU), Indo-Pacific Finless Porpoise *Neophocaena phocaenoides* (VU) occur in the shallow waters of the Bay.

Phang Nga Bay's wetland ecosystems provide critical provisioning, regulating, and cultural services for communities living along the Bay's two districts. It is estimated that the site's wetlands effectively store 1,450,000- 9,830,000 tonnes of above-ground carbon alone and offers more than 5.7m USD of coastal protection under extreme weather scenarios. Presently, the predominant economic activity for local communities in at Phang Nga Bay is tourism through its many resorts and tourism operators, and generates significant revenue for Phang Nga, and adjacent Phuket provinces. Phang Nga Bay also supports key fisheries and shellfish farms, many of which supply the site's demand from tourism. Unsurprisingly, the site is negatively impacted by unsustainable exploitation of these resources (fisheries are in decline) and though mass tourism, which has increased disturbance, pollution, and driven unsustainable fishing.

RFI interventions at this site should aim to reduce the principal negative impacts at the site through a multi-stakeholder and iterative approach to improve the sustainability of tourism, through interventions to build the capacity of tourist operators and regulations and guidance on environmentally friendly, best practices from the tourism industry. There is also a clear need for interventions to manage solid and water pollution in Phang Nga Bay, and this is expected to involve the improvement of wastewater management practices and guidelines for tourism operators such as resorts and boat operators. Local fishing communities should be supported to adopt better fishing practices, whilst the National Park's management is strengthened to address illegal fishing and encroachment. As with most coastal sites in Peninsular Thailand, Phang Nga is vulnerable to sea-level rise and climate change, targeted interventions can be made through targeted land use planning and mangrove restoration to strengthen the sites and the local community resilience.

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 Thailand, a total of 36 wetland sites, including several Asian Waterbird Census (AWC) count sites, were initially assessed through data analysis and expert consultation, of which 18 were short-listed for assessment. Of this pool of sites, 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. Nine (9) of the RFI sites identified are coastal wetlands, a consequence of the country's long coastline along the Gulf of Thailand and Peninsular Thailand, with the largest cluster of priority sites concentrated in the Inner Gulf of Thailand (four: Pak Thale-Laem Pak Bia, Khok Kham, Bang Pu, Khlong Tamru). 15 EAAF species exceeded the 1% threshold at the site level in Thailand, with species such as Spotted Greenshank exceeding 10% of the estimated population in just one site (Laem Pak Bia) on a

regular basis. Other species with important non-breeding populations in Thailand includes Spoon-billed Sandpiper, Great Knot, and Sarus Crane.

2. Site profile of Phang Nga Bay

Location: Phang Nga Bay is in Phang Nga Province on the Andaman Sea coast of Peninsular Thailand and located approximately 800 km south of Bangkok (see Figure 1).

Area: Phang Nga Bay covers an area of 42,253 ha, including significant areas of coastal waters.

Altitude: Mostly sea level, but the limestone hills on the mainland and several islands can reach up to 439 m.

Geographical coordinates: 8.32ºN, 98.52ºE

Description of site: Phang Nga Bay is a shallow bay, varying in depth between 1-4 meters, with approximately 42 islands (including many steep limestone karst hills) and diverse wetland ecosystems such as bays, estuaries, mangrove forests, mudflats, cliffs, rocky shores and seagrass beds. The bay extends northwards from Phuket and eastwards along the coast of mainland Thailand past the mouths of six river systems to the mouth of the Marui River. The easternmost boundary of the site is delimited by the large promontory of Khao Ao Muang. The mangrove forests in Phang Nga Bay are among the largest and best-preserved in Thailand, covering approximately 21,000 ha, while intertidal mudflats cover about 4,000 ha. The principal vegetation in adjacent areas is semi-evergreen rainforest, with drier forest types on exposed limestone outcrops. Rubber plantations dominate in lowland areas outside the National Park.

Site administration, management, and land tenure: Phang Nga Bay (or Ao Phang Nga) Marine National Park was established in 1981 and is state-owned, being managed by the Department of National Park, Wildlife and Plant Conservation (DNP). The mangrove forests, which are mostly outside the boundaries of the national park, are also state-owned and are designated as a protected forest. The areas surrounding the national park are both privately owned and state-owned.

Social and economic values: The mangrove forest around Phang Nga Bay is an extensive area of some of the most fertile forest in Thailand which is an important source of timber and a nursery for marine animals. The fronds of *Nypa* palms are cut for the production of thatch and rubber is widely cultivated in the surrounding area. The bay is an important fishery, supporting many small-scale fishing operators, and also plays a significant role in maintenance of seawater quality and the trapping of sediment. Edible-nest Swiftlets breed in caves, and their nests are harvested and sold as a luxury foodstuff. Phang Nga Bay is a major tourist attraction, and many boatmen supplement their income by transporting parties of sightseers. Shellfish farming is a major industry (to support tourism) with a concentration along the Marui canal at Phang Nga Bay (Jeamsripong et al. 2018).

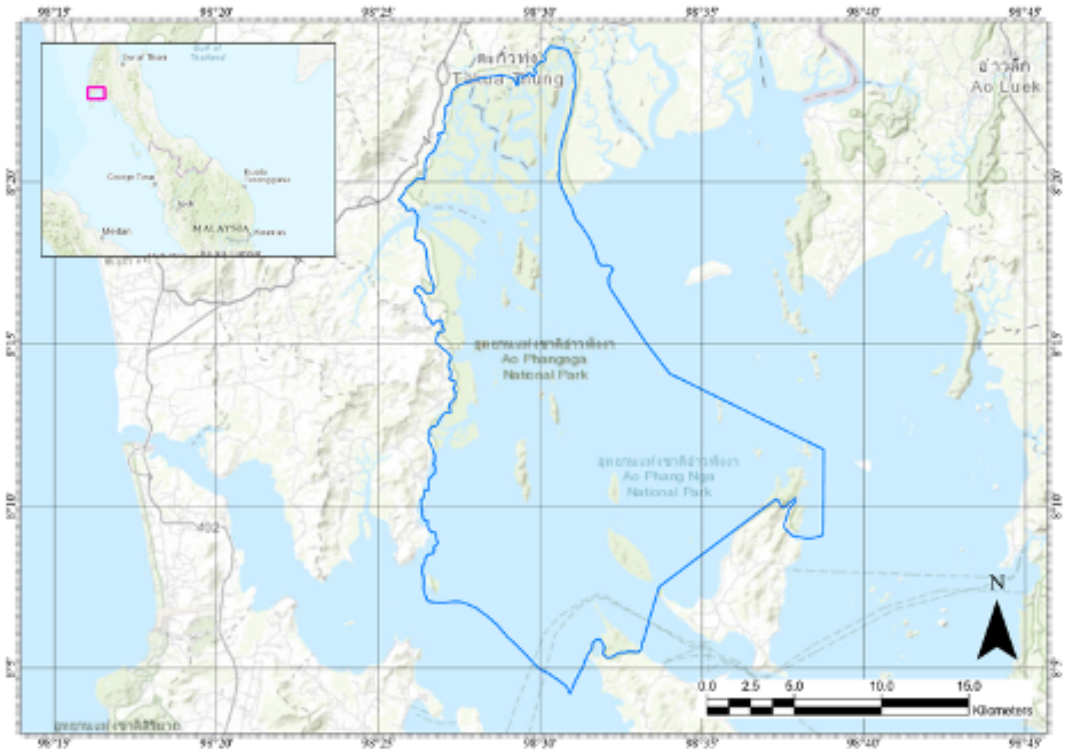

Figure 1. Map of Phang Nga Bay, showing its boundary (in blue) and location within Thailand (in pink) (data from EAAFP Site Information Sheet).

3. Biodiversity value of Phang Nga Bay

3.1. Key habitats

Phang Nga Bay is a shallow bay, varying in depth between 1-4 meters, with approximately 42 islands (including many steep limestone karst hills) and diverse wetland ecosystems such as bays, estuaries, mangrove forests, mudflats, cliffs, rocky shores, and seagrass beds.

The mangrove forests in Phang Nga Bay are among the largest and best-preserved in Thailand, covering approximately 21,000 ha, while intertidal mudflats cover about 4,000 ha. The principal vegetation in adjacent areas is semi-evergreen rainforest, with drier forest types on exposed limestone outcrops. Rubber plantations dominate in lowland areas outside the National Park.

3.2. Importance of Phang Nga Bay for migratory waterbird species

Phang Nga Bay's coastline is very extensive and has not to date been comprehensively surveyed; bird counts are typically conducted at limited accessible sites. It is likely to support larger congregations of migratory waterbirds than what is currently documented. Count data from the Thailand Shorebird Survey (2021-2022) was used in the RFI analysis for this site and then compared against the Conservation Status Review (CSR1) 1% population estimates to calculate a score for each species. The Lesser Sandplover was found to regularly exceed the 1% population estimate during this survey (Table 1), and the CSR1 score for this species provided the overall site metric.

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

Scientific name	IUCN	Average count	CSR1	CSR1 score
Tibetan Sandplover *Anarynchus atrifrons*	LC	450	300	1.5

Phang Nga Bay was also found to support significant numbers of two near-threatened waterbird species (but not exceeding the 1% thresholds), Eurasian Curlew *Numenius arquata* (NT) and Bar-tailed Godwit *Limosa lapponica* (NT). A further four Threatened or Near Threatened migratory bird species have been found in smaller numbers Chinese Egret *Egretta eulophotes* (VU), Broad-billed Sandpiper *Calidris falcinellus* (VU), Curlew Sandpiper *Calidris ferruginea* (VU) and Red-necked Stint *Calidris ruficollis* (NT). Masked Finfoot *Heliopais personatus* (CR) was historically found at the site but has not been documented for over 20 years.

3.3. Other notable biodiversity

The forests in and around Phang Nga Bay support several globally threatened bird species, including Wreathed Hornbill *Rhyticeros undulatus* (VU) and Pale-capped Pigeon *Columba punicea* (VU) (Yong, D.L. pers. obs), the later documented recently by BCST surveys. Several globally threatened mammal species also occur at this site, including Dugong *Dugong dugon* (VU), Indo-Pacific Finless Porpoise *Neophocaena phocaenoides* (VU), Lar Gibbon *Hylobates lar* (EN), Mainland Serow Capricornis sumatraensis (VU), Dusky Langur *Trachypithecus obscurus* (EN), Smooth-coated Otter *Lutrogale perspicillata* (VU) and Long-tailed Macaque *Macaca fascicularis* (EN).

4. Ecosystem services

4.1. Ecosystem services provided by Phang Nga Bay

Phang Nga Bay (both the national park and the surrounding areas of coastal wetlands) encompasses diverse coastal habitats, providing essential 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, such as food and natural medicines, primarily benefit adjacent and distant communities. Both services have seen an increase in the past, but a decrease is expected in the future, indicating potential concerns for resource availability. Regulating services, particularly erosion regulation, benefit adjacent communities. This service experienced a decrease in the past but is projected to increase in the future, highlighting its role in mitigating environmental changes. Cultural services, including recreation ecotourism and sense of place, are significant for adjacent communities. These services have remained stable in the past but are expected to increase moving forward, reinforcing Phang Nga Bay's value for both local tourism and cultural significance.

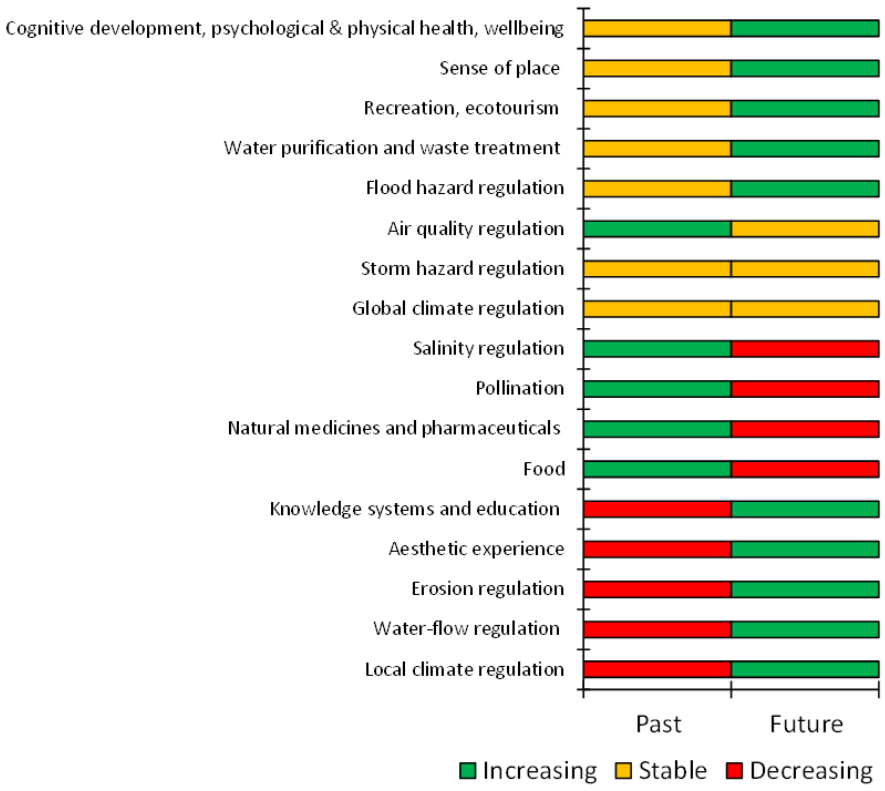

Figure 2.List of ecosystem services provided by Phang Nga Bay, as identified through stakeholder consultation at the Regional Flyway Initiative workshop.

[1] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

Table 2. List of top ecosystem services provided by Phang Nga Bay.

Ecosystem services	Essential or non-substitutable	Benefits to communities			Change	
		Within the site	Adjacent to the site	Distant to the site	Past	Future
Provision services						
Food		✓	✓		Increase	Decrease
Natural medicines and pharmaceuticals		✓	✓		Increase	Decrease
Regulating services						
Erosion regulation		✓			Decrease	Increase
Cultural services						
Recreation, ecotourism		✓			No change	Increase
Sense of place		✓			No change	Increase

4.2. Global climate regulating services

Based on data published in systematic reviews (Chen & Lee, 2022; Stankovic et al., 2023), the amount of carbon stored in Phang Nga Bay is estimated to range from 1,450,000 to 9,830,000 tonnes, while the annual carbon sequestration rate is estimated to be between 16,200 and 105,000 tonnes per year.

4.3. Coastal protection services

The coastal protection services provided by Phang Nga Bay 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 nine RFI coastal sites and the average of all other coastal areas in Thailand (Table A3 in Annex 1), Phang Nga Bay shows some mixed results in terms of risk level:

(1) for the potential exposure to coastal hazards, Phang Nga Bay is consistently below average (index: 2.45 vs. 2.75 for RFI coastal sites and 2.70 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, Phang Nga Bay is also below average (12 vs. 63 people/ha for RFI coastal sites and 30 people/ha for all other coastal areas); and

(3) for the contribution to reducing coastal risk as a percentage of the maximum potential exposure, Phang Nga Bay is consistently above below average (6.02% vs. 5.44% for RFI coastal sites and 3.92% all other coastal areas).

In monetary terms (Table A4 in Annex 1), Phang Nga Bay ranks well below the national RFI average (86 vs. 1,987 USD/ha) in terms of total annual benefits per ha of mangroves. Consequently, these benefits for the total area of Phang Nga Bay are also below average (82 thousand vs. 1.8 million USD for RFI coastal sites and 0.8 million USD for all other coastal areas in Thailand). However, when flooding extends well inland such as in the event of 100-year return period storms, the benefits of mangrove protection from the total area of Phang Nga Bay are above the average of all RFI sites in Thailand (5.7 vs. 4.0 million USD).

5. Drivers of change and their potential impacts on Phang Nga Bay

5.1. Current drivers of change and their level of impact

Stakeholders at the RFI workshop[2] identified several drivers of change impacting Phang Nga Bay and its surrounding landscapes. High-impact drivers include restoration for conservation activities, which significantly modify the natural state of the wetland (see Table 3). Tourism and recreation infrastructure further disrupts habitat integrity, adding to the high-level impact.

Medium-impact drivers involve fishing, killing, and harvesting of aquatic resources, which threaten biodiversity. Other medium-impact factors include garbage and solid waste, housing and settlement developments, marine and freshwater aquaculture, and recreational activities and tourism. Additionally, shipping lanes and canals, along with activities of site managers, moderately alter the wetland's ecological balance.

[2] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

Table 3. Drivers of change and their potential impact on the integrity of Phang Nga Bay based on consultations with stakeholders.

Driver of change	Impact
Restoration for conservation	High
Tourism and recreation infrastructure	
Fishing, killing and harvesting of aquatic resources	Medium
Garbage and solid waste	
Housing and settlement	
Marine and freshwater aquaculture	
Recreational activities and tourism	
Shipping lanes and canals	
Activities of site managers	Low
Agricultural and forestry effluents	
Commercial and industrial areas	
Energy generation, including from hydropower dams, wind farms and solar panels	
Erosion and siltation/deposition	
Excess ponding of water onsite	
Household sewage and urban wastewater from outside the wetland site	
Logging and timber harvesting	
Loss of keystone species	
Other 'edge effects' that degrade the wetland site values	
Research, education and other work-related activities	
Roads and railroads	
Sewage and wastewater from wetland site facilities	
Storm and flooding	
Temperature extremes	
Utility and service lines	
Wood pulp and plantations	

Low lying coastal sites are at risk from the effects of climate change effects, implications for Phang Nga Bay indicate that sea-level at the site is expected to increase by 0.3m up to 2050 and 0.7m by the late century under a high emissions pathway (Norris et al. 2024). Under this scenario there is expectedly an increased risk of flooding and erosion, saline intrusion, changes to the extent of mangroves and changes to the available area for sea-bird food foraging. Temperatures are also expected to increase, exacerbating heat stress. Rainfall is likely to be more variable, with larger dry periods and increased rainfall in shorter timeframes. These effects will have impacts on both the biodiversity and on the resident population.

5.2. Potential alternative state of Phang Nga Bay 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 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, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

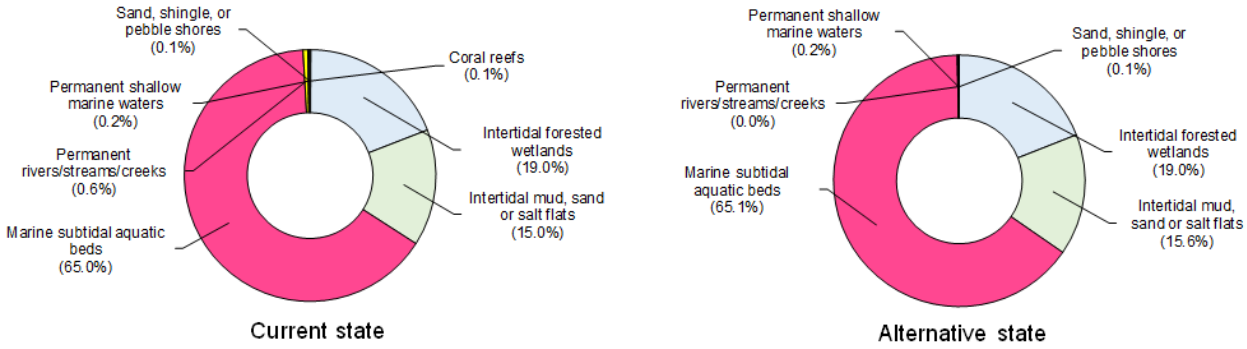

Figure 3. The proportional change in the extent of different habitat types between the current and alternative states of Phang Nga Bay.

5.3. Expected changes in the ecosystem services of Phang Nga Bay

Stakeholders at the RFI workshop[4] documented the future trends in the provision of ecosystem services in Phang Nga Bay, 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 provisioning services, particularly food provision, are expected to increase in the long term. However, there is concern that regulating services, such as air quality and global climate regulation, as well as flood and storm hazard regulations may decrease in the long term, while cultural services, particularly recreation and tourism, remain stable.

Phang Nga Bay encompasses diverse coastal habitats, providing essential provisioning, regulating, and cultural ecosystem services (Figure 2). The results from the RFI consultation workshop[5] highlights the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, such as food and natural medicines, primarily benefit adjacent and distant communities. Both services have seen an increase in the past, but a decrease is expected in the future, indicating potential concerns for resource availability. Regulating services, particularly erosion regulation, benefit adjacent communities. This service experienced a decrease in the past but is projected to increase in the future, highlighting its role in mitigating environmental changes. Cultural services, including recreation ecotourism and sense of place, are significant for adjacent communities. These services have remained stable in the past but are expected to increase moving forward, reinforcing Phang Nga Bay's value for both local tourism and cultural significance.

[4] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

[5] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

In the alternative state, the increase of 0.2% of mangrove and 0.1% of intertidal mudflat will result in a gain of stored carbon, estimated to be between 1,920 and 10,800 tonnes, and an increase in carbon sequestration rate (carbon accumulation) by approximately 27 to 213 tonnes per year.

A gain of 16.9 ha of mangroves as presented in Table A5, which is equivalent to 0.04% of the total land use for the site, is expected to result in roughly a 1.8% increase in coastal protection. This may amount to 1,456 USD in lost total benefits per year (based on 86 USD per hectare of mangroves) and approximately 26 thousand USD in lost total benefits per 100-year return period storm.

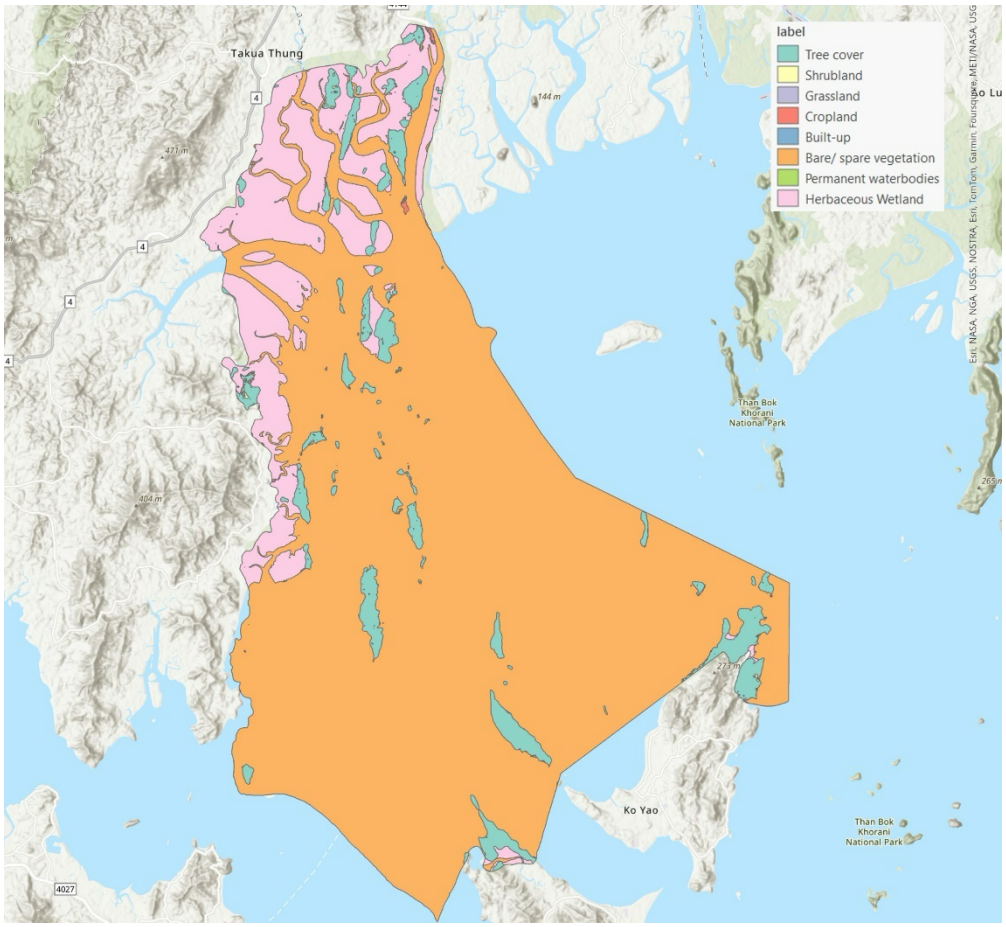

Figure 4. Main land cover types in Phang Nga Bay based on remotely sensed data (Map: Radhika Bhargava). Mangrove forests form the dominant vegetation type on the mainland coastline.

6. Capacity needs in Phang Nga Bay

Stakeholder consultations with representatives of Phang Nga local governments identified major capacity gaps for local tourism development and the development of businesses for smallholders involved in community-based products. Local stakeholders highlighted knowledge gaps in ecotourism practices and the development of itineraries for visitors. There is also an opportunity for stakeholder groups focused on sustainable ecotourism to be established to promote capacity building for local communities.

Table 4. Capacity gaps for improved management of Phang Nga Bay wetlands, as identified by stakeholders at the RFI workshop in Bangkok in December 2023.

Stakeholder group	Current role in wetland management	Possible future role in wetland management	Current capacity for sustainable wetland management	Capacity development needed to improve wetland management	Form of capacity development (e.g. training, organisational strengthening etc.)
Local communities	Basic land care; support sustainable management of the land.	Knowledge exchange between local communities; joint awareness and capacity building activities.	Operate tours. Strengthening publicity to improve awareness and enhance site management	Support development of tourism programmes. Learning field trips in and around Phang Nga Bay. Involve youth/young ambassador program. Training for local communities.	Field training/visits, within the community and other sites. Knowledge exchange visits in the bay, and at other sites.
Ecotourism operators	Human resources and provide support to site management. Contribute funding for rehabilitation and improvement of infrastructure and land care.	Support capacity building. Promote collaboration and joint initiatives across community groups for ecotourism and	-	-	Sustainable ecotourism training activities, with targeted awareness of the wetlands and biodiversity in Phang Nga Bay. Youth-based or 'ambassador' programs targeted at young

Stakeholder group	Current role in wetland management	Possible future role in wetland management	Current capacity for sustainable wetland management	Capacity development needed to improve wetland management	Form of capacity development (e.g. training, organisational strengthening etc.)
	Provide ecotourism services for local and international tourists.	environmental protection.			representatives from the local communities.

7. Opportunities for RFI interventions

7.1. Recommended Interventions

Ao Phang Nga National Park is one of the most important protected areas for tourism revenue generation in Peninsular Thailand and supports considerable tourism infrastructure (e.g. hotels, resorts, access roads) in and around the national park in the districts of Takua Thung and Mueang Phang Nga. Phang Nga's coastal wetlands also provide habitat for migratory shorebirds and support major ecosystem services (including carbon). Tourism contributes significantly to the local economy and there are definite opportunities to develop tourism products and initiatives around biodiversity, and to improve capacity and knowledge to benefit conservation. Notwithstanding, stakeholders identified weakly regulated tourism as one of the major threats to the landscape. Wastewater and solid waste management on canals draining into Phang Nga Bay from villages, tourism establishments and fisheries result in coastal pollution (existing studies show high level of coliform bacteria contamination). In addition, there are several residential areas, commercial centres and fishing communities in and around the national park. These developments also contribute to increase wastewater pollution and habitat change, while some mangroves areas have been deforested. Unsustainable fishing practices have resulted in declining catches and reduced resilience (Jannekarn & Chullasorn 1996; Department of Fisheries 2020).

To strengthen management and conservation of the wider Phang Nga Bay landscape, there is a need to:

(1) Sustain and improve the existing management of coastal wetlands through
   a. Understanding future risks to the landscape and planning interventions accordingly to ensure the long-term success of interventions.
   b. Work towards better management of the Phang Nga Bay, reducing wastewater and pollution, and ensuring upstream flow into the system to sustain the habitat.

c. Expansion of wetland restoration work with a focus on 'mangrove zones' to strengthen shoreline stability at suitable areas, notwithstanding the coastal erosion challenges the site faces.
d. Strengthen and formalise co-management structures involving the local community and government agencies

(2) Improve the sustainability of tourism activities in the area
   a. Improve revenue generation from tourism to support environmental management
   b. Improve access and infrastructure at key biodiversity sites for ecotourism and education.
   c. Manage and restrict access to sensitive sites.
   d. Develop and build capacity for more sustainable tourism operators.

(3) Enable, and up-scale (economic) infrastructure for compatible forms of economic activity for local communities
   a. Promoting sustainable approaches to fisheries that are biodiversityfriendly.
   b. Capacity building and improved access to finance for local fishing communities.

Table 5. Summary of key RFI interventions proposed for Phang Nga Bay

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
Component 1. Strengthening site-level and landscape management of Phang Nga Bay, with a focus on Ao Phang Nga National Park					
Conduct an assessment and a scoping study of past and existing interventions and mapping of projects being implemented in the Phang Nga area. Identify, successes and failures, and potential lessons for RFI interventions.	Best practices, guidelines, and standards for proposed RFI interventions	Assessment report with key threats identified and recommendations for improved management published and disseminated to key stakeholders. Number of consultations conducted with local stakeholders for a participatory process in the assessment and scoping study Number of stakeholder groups engaged in the assessment and scoping study	100,000	1 year	DNP DMCR Consultancy companies

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
Undertake an environmental and social impact assessment.	Best practices, guidelines, and standards for proposed RFI interventions	Environmental and social impact assessment report finalised and disseminated with key local stakeholders. Guidelines for evaluating proposed project components on their positive and negative impacts developed. Guidelines and standards for an iterative process on redesigning project components developed and implemented. Number of consultations conducted with local stakeholders for a participatory process in developing standard and guidelines for project interventions Number of stakeholder groups engaged in the assessment and development of project interventions' guidelines	100,000	Up to 1.5 years.	DNP DMCR Mueang Phang Nga and Takua Thung district (*amphoe*) government Consultancy companies .
Conduct a hydrological and climate change impact assessment.	Priority sites for mangrove restoration, as well as impacts of sea-level rise and shifts in hydrology identified.	Hydrological and climate change impact assessment report finalised, presented to local stakeholders and endorsed by designated management authority. Area for mangrove restoration identified.	100,000	Up to 1.5 years.	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		Number of consultations conducted with local stakeholders for a participatory process in the local assessment. Number of stakeholder groups engaged in the assessment.			
Review and strengthen the national park management plan, considering impacts of climate change and priority sites for migratory shorebirds (including high tide roosts).	Improved site management through updated management plan and zonation revised to consider climate change and sea level rise, and review of management goals over new timeframes.	Site management plan with updated zonation, revision to consider climate change and sea level rise, and reviewed management goals over new timeframes, endorsed by DNP and park management. Number of consultations conducted with key stakeholders for a participatory process. Number of stakeholder groups engaged in the site management planning Number of activities in the site management implemented	200,000	2 years	DNP, including management office of APNNP Conservation organisations Research institutions (e.g. Mahidol University)
Identify key areas of the coastal in Ao Phang Nga National Park and surrounding (mangrove) landscapes for restoration.	Improved site management through site identification and prioritization suitable for mangrove restoration.	Number of areas identified for mangrove restoration. Number of consultations conducted with local stakeholders for a participatory process in the local assessment.	100,000	2 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		Number of stakeholder groups engaged in the assessment.			
Restore targeted mangroves and other habitats, including at plots that are degraded from the 2004 Tsunami and wood harvesting.	Integrity of mangrove forest cover maintained. Ecological connectivity strengthened.	Up to 300 ha of mangrove and mangrove corridors replanted and restored using latest planting techniques.	500,000	5 years	DNP, including management office of APNNP Mueang Phang Nga and Takua Thung district (*amphoe*) government
Establish a long-term biodiversity and threat monitoring framework developed for Phang Nga Bay (including APNNP), focusing on waterbirds and aquatic biodiversity.	Improved biodiversity conservation through monitoring and increased participation of local communities in protecting migratory waterbird species and aquatic biodiversity.	Biodiversity monitoring and adaptive management framework focusing on key species indicators established and implemented. Indicator species identified and actively monitored. A capacity program on the developed biodiversity monitoring framework created for key stakeholders Number of people trained on biodiversity monitoring. A multi-sector biodiversity monitoring group organized.	100,000	5 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		Number of biodiversity monitoring activities implemented.			
Component 2. Exploring the feasibility of carbon financing for mangrove conservation in Phang Nga Bay					
Assess feasibility of carbon financing for the site, and other wetlands with high mangrove cover in the Thai Peninsula.	Feasibility and suitability of carbon financing better understood for key wetland sites in Thailand.	Feasibility study report for carbon financing for Phang Nga Bay completed and presented to management authority. Investment guidelines for carbon financing from mangrove conservation drafted and endorsed by government agencies. Number of consultations conducted with local stakeholders for a participatory process in the local assessment. Number of stakeholder groups engaged in the assessment.	100,000	2 years	ONEP DWNP Phang Nga provincial government, Mueang Phang Nga and Takua Thung district (*amphoe*) government Consulting companies
Component 3. Addressing water (and plastic) pollution and strengthening wastewater management from villages and ecotourism areas in Phang Nga Bay					
Assess the extent of water and associated pollution in Phang Nga Bay (e.g. point source discharges from commercial sites, solid waste in ditches and pollution from residential areas	Improved wetland management through better water and wastewater management in Phang Nga Bay.	Strategy for wastewater management developed and disseminated with key stakeholders. Study on causes and impact of water pollution, and methods to address water pollution undertaken.	100,000	1 year	DMCR DWR Phang Nga provincial government, Mueang Phang Nga and Takua Thung district (*amphoe*) government

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
draining into the Phang Bay Bay)		Guidelines and recommendations for businesses, especially aquaculture and tourism operators developed and promoted. Number of consultations conducted with local stakeholders for a participatory process in the local assessment and strategy development Number of stakeholder groups engaged in the assessment, strategy building, and guidelines development.			Consultancy companies
Strengthening wastewater management in Phang Nga Bay	Improved wetland management through increased awareness of wastewater management approaches among communities and ecotourism operators, including decentralised wastewater treatment.	Number of wastewater management infrastructure improved. Regulations and guidelines on wastewater and pollution management improved and disseminated with key stakeholders. Baseline and targets metrics on key chemical and biological contamination in water developed. Set target reduction on key chemical and biological contamination in water achieved.	200,000	5 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		Number of consultations conducted with key stakeholders, ensuring a participatory process. Number of people engaged in wastewater and pollution management Number people engaged in the awareness-raising activities on wastewater management.			
Component 4. *Upscaling of tourism infrastructure with a focus on sustainable tourism in the Phang Nga Bay Area*					
Strengthen local capacity for nature-based tourism in at least two communities	Improved protection and management of Phang Nga Bay through nature-based tourism benefits and increased capacity of local stakeholders on alternative livelihood. Economic conditions for small-scale operators and businesses improved	Training programme established for nature guides (including women) developed Number of training activities implemented. Number of (50 individuals in two communities) trained on nature-based tourism and financial management.	100,000	3 years	Department of Tourism Phang Nga provincial government, Mueang Phang Nga and Takua Thung district (*amphoe*) government Conservation organisations
Build local capacity (for local operators) to support tourism		Training programme established for supporting tourism businesses (cafes, shops) Local granting mechanism and incentives created to support local-based tourism operators. Number (target of at least 20 local tourism operators) of tourism	100,000	3 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		operators trained with sustainable practices and financial management. Number of local operators engaged in sustainable practices. Number of local-based tourism operators benefitting from the established local granting mechanism.			
Develop and promote a sustainable tourism code of conduct for hotels and operators in the area.	Better wetland management through sustainable tourism adopted by local business operators.	Sustainable tourism code reviewed and presented to hotels and operators in the area. Number of consultations conducted for a participatory process. Number of people trained on sustainable and biodiversity-friendly tourism. Number of business clients nudged to encourage operators to adopt sustainable standards.	100,000	2 years	
Strengthen infrastructure for tourism, including signages, trails on boardwalks and wetland interpretation facilities, shelters and bird hides	Improved protection and management of Phang Nga Bay, through nature-based tourism benefits, increased appreciation of waterbirds, and the wetlands, and expanded field	Number of tourism infrastructure (including at least 0.5 km of boardwalk created in mangrove forest inside park) established and improved. Number of people benefitting from nature-based tourism.	500,000	2 years	DNP and management board of Ao Phang Nga National Park Department of Tourism

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
	infrastructure for tourist visitors.	Number of nature-based trips organized in Phang Nga Bay			
Component 5. Livelihoods and resilience of fishing communities in Phang Nga Bay strengthened					
Improve and renovate water management infrastructure such as canals and sluice gates based on findings of hydrological report.	Better site management through improved water pollution management. Sea-level rise impacts mitigated through green infrastructures.	Number of water management infrastructure (including canals and sluice gates) repaired. Regulations and guidelines on water pollution management improved and disseminated with key stakeholders. Number of consultations conducted with key stakeholders, ensuring a participatory process. Number of people engaged in water pollution management	1,000,000	5 years	DMCR Phang Nga provincial government, Mueang Phang Nga and Takua Thung district (*amphoe*) government
Develop or improvise a co-management system for small-scale artisanal fisheries in two subdistricts or *tambon* (to strengthen value chains, as a contribution to Thailand's Marine Fishery Management Plan.	Improved management of Phang Nga Bay through improved local livelihood, shifting to sustainable fishing practices and support for local community cooperatives. Management system strengthened, fishery resources are better managed and conserved.	A co-management framework and plan for small-scale fishers finalized and approved by Department of Fisheries and other government agencies. Number of identified activities in the co-management plan implemented. Number of fishing households (At least 100 small-scale fishing operators engaged across two districts) benefitting from activities to promote sustainable fishing	100,000	10 years	Department of Fisheries/MAC Mueang Phang Nga and Takua Thung district (*amphoe*) government *Tambon* administration offices Fisheries and shellfishery cooperatives Conservation NGOs

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
	Local fishing cooperatives and communities developed and have stronger access to livelihood opportunities.	practices and co-management. Number of community-led agreements and training on sustainable fishing practices, supported with improved storage and processing capability to increase market access and reduce wastage implemented. Number of local fishing cooperatives and communities supported.			Local conservation groups Fishing operators
Strengthen the capacity for local fishing communities (with a representative % of women) in cooperative structured and sustainable fisheries management.	Better management for Phang Nga Bay through increased capacity of local fishing communities on sustainable fisheries and financial management, and microfinance mechanisms. Improved inclusivity with the engagement of women in the workforce.	Training programmes for sustainable fishing practices developed, in line with Thailand Marine Fishery Management Strategy. Number of training activities implemented for local fishing communities. Number of people, with a representative % of women) trained on sustainable fisheries and financial management trained. Microfinance mechanism established. Number of local fisherfolk benefitting from the established microfinance mechanism.	200,00	5 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		Number of fishing cooperatives (target of at least 3 in two districts) supported.			
Strengthen the enforcement on fishing practices in and around the National Park	Improved site management through patrol and enforcement on fishing practices. Reduced illegal fishing practices and encroachment incidents in the National Park waters	Patrol and enforcement plan developed, integrated in the site management plan, and disseminated with local stakeholders. Number of incident reports on encroachment and illegal fishing activities Number of patrol and enforcement activities implemented. A patrol group established for the National Park.	100,000	3 years	DNP and management board of Phang Nga National Park Conservation organisations
Total investment for 10 years			**USD 14,400,000**		

7.2. Potential Financing

The estimated project cost is USD 14,400,000 over 6-10 years. This budget supports the development of site management and zoning plans; carbon financing assessments; wastewater and water pollution management; mangrove restoration; nature-based tourism development; and capacity-building for local stakeholders in biodiversity monitoring, tourism, pollution management, sustainable fisheries, and nature-based tourism. Table 5 summarizes the projected budget distribution across the proposed project components.

If the proposed USD 500,000 investment over five years is allocated to the restoration of mangroves and associated habitats in Phang Nga Bay—particularly in areas degraded by the 2004 tsunami and unsustainable wood harvesting—it could support the rehabilitation of up to 300 hectares using improved restoration techniques. With estimated coastal protection benefits of USD 86 per hectare annually (see Section 5.3), this intervention could yield approximately USD 25,800 in annual benefits, or around USD 129,000 over five years. This results in a benefit–cost ratio of approximately 0.26:1 when coastal protection alone is considered. However, this figure does not fully reflect the broader value of the intervention. Restoring these mangrove corridors would help maintain forest integrity, strengthen ecological connectivity, and enhance the resilience of coastal ecosystems—delivering important

biodiversity, carbon sequestration, and cultural co-benefits. In this context, the intervention should be seen as a strategic investment in ecosystem recovery and long-term sustainability rather than purely in financial returns from coastal protection. Forgoing restoration would risk continued habitat fragmentation, loss of ecosystem function, and reduced capacity to respond to future climate and coastal pressures.

7.3. Proposed Institutional Arrangements

The proposed project is expected to be implemented over a period of 6-10 years, with specific project components focusing on improved site management for Ao Phang Nga National Park (provisioning led by DNP, potentially in collaboration with DMCR), tourism operators across Phang Nga Bay (with district governments and villages), and improved fishery management (with Department of Fisheries and local cooperatives)

7.4. Project Beneficiaries

Initiatives to promote gender inclusion and the vulnerable (immigrant workers in the fishery and shellfishery industry) and participation in livelihood activities. Limited women involvement at present. Develop and organise training programmes for community members focused on women in artisanal fisheries (or cottage industries).

There are small communities of 'sea people', known locally as the Moken and Moklen living in villages on the Phang Nga coast. Some members of these communities are involved in the fishing industry as small-scale fishers and should be engaged under the fishery component of the proposed project.

7.5. Anticipated Implementation Risks

Environment: Most proposed interventions are relatively low impact, but it may be necessary to consider the effects of expanding tourism in Phang Nga Bay, which could increase anthropogenic pressures and lead to greater disturbance of wildlife. Planning with stakeholders to reduce noise pollution during the construction of ecotourism facilities and ongoing ecotourism activities, as well as managing waste pollution from increased tourist traffic, is essential.

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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 Phang Nga Bay 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)	77 – 86
Current maximum coastal risk to be mitigated, or potential exposure to coastal hazards (unitless index)	*2.36 - 2.55*
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)	2.64 - 2.86
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)	2.83- 3.06
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #5 'Fossil-fueled Development' (unitless index)	3.08- 3.33
Current proportional risk reduction, nature's contribution to reducing coastal risk as a proportion of maximum coastal risk (unitless index)	0.14- 0.15
Nature's contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast (# of people per hectare)	*11 – 13*
Nature's contribution to reducing coastal risk as a percentage of the maximum potential exposure (%)	*5.67 - 6.37*

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 Phang Nga Bay 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$)**
Mangrove extent (hectares)[2]	7,270 – 39,697
Annual expected flood protection benefits to people (number of people)	0
Annual expected flood protection benefits to Industrial Stock (US$)	(4,766) - 56,314
Annual expected flood protection benefits to Residential Stock (US$)	(8,006) - 94,599
Annual expected flood protection benefits to Total Stock (US$)	*(15,116) - 178,605*
Annual expected flood protection benefits to Industrial Stock per hectare of mangroves (US$ per hectare)	*(16) – 188*
1-in-100-year return period damage in terms of area flooded (number of hectares)	(1,826) – 4,979
Total expected flood protection benefits of mangroves per 100-year return period storms (US$)	*(6,627,615) - 18,074,414*

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)**
Bang Pu	No Data	No Data	No Data
Khlong Tamru (Bang Pakong)	3.22 (±0.17)	147 (±39)	4.87 (±0.25)
Khlong Yai	2.15 (±0.07)	59 (±16)	7.27 (±1.91)
Khok Kham	3.02 (±0.09)	0 (±0)	5.18 (±0.16)
Ko Libong	2.63 (±0.07)	21 (±1)	6.21 (±0.34)
Krabi Estuary	2.69 (±0.07)	17 (±1)	5.68 (±0.28)
Pak Nam Prasae	2.63 (±0.20)	53 (±1)	5.94 (±0.44)
Pak Thale	3.23 (±0.08)	28 (±8)	3.36 (±0.85)
Ao Phang Nga	2.45 (±0.10)	12 (±1)	6.02 (±0.35)
Thailand RFI average	2.75	63	5.44
Thailand national average	2,70	30	3.92

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$)
Bang Pu	723,608 (±1,023,384)	985 (±1,393)	1,252,086 (±1,252,144)
Khlong Tamru (Bang Pakong)	4,064,792 (±101.810)	1,698 (±43)	1,028,638 (±46,938)
Khlong Yai	299,013 (±35,045)	37 (±4)	0 (±0)
Koh Kham	9,699,944 (±5,444,336)	12,815 (±7,193)	17,562,472 (±14,369473)
Ta Libong	0 (±0)	0 (±0)	3,564,916 (±55,274)
Krabi Estuary	0 (±0)	0 (±0)	4,150,201 (±45,319)
Pak Nam Prasae	557,410 (±3,584,456)	300 (±1,929)	1,464,757 (±2,408,230)
Pak Thale	806,609 (±1,685,154)	1,967 (±4,109)	962,707 (±1,130,299)
Ao Phang Nga	81,744 (±96,861)	86 (±102)	5,723,399 (±12,351,015)
Thailand RFI average	1,803,680	1,987	3,967,686
Thailand RFI total	16,233,119	Not Applicable	18,146,703
Thailand national average	789,242	2,702	9,197,142
Thailand national total	85,257,773	Not Applicable	377,082,842

Table A5. Key habitat types in Phang Nga Bay based on stakeholder-based assessment at the Regional Flyway Initiative workshop in November 2023.

Habitat type	Current state		Alternative state (2035)	
	Area (ha)	Cover (%)	Area (ha)	Cover (%)
Coral reefs	42.3	0.1	0.0	0.0
Intertidal forested wetlands	8033.9	19.0	8050.8	19.0
Intertidal mud, sand or salt flats	6342.6	15.0	6596.3	15.6
Marine subtidal aquatic beds	27484.4	65.0	27535.2	65.1
Permanent rivers/streams/creeks	253.7	0.6	0.0	0.0
Permanent shallow marine waters	84.6	0.2	67.7	0.2
Sand, shingle, or pebble shores	42.3	0.1	33.8	0.1
Total	42283.8	100.0	42283.8	100.00