Climate Change Vulnerability Assessment Kaper Estuary - Laemson Marine National Park - Kraburi Estuary Wetlands, Thailand

Bampen Chaiyarak and Kittama Khunthong

Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region

Federal Ministry
for the Environment, Nature Conservation,
Building and Nuclear Safety

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Asia Regional Office
63 Sukhumvit Soi 39
Klongtan – Nua, Wattana
10110 Bangkok, Thailand
Tel +66 2 662 4029
Fax +66 2 662 4387
Email address: asia@iucn.org
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CONTENTS

ACRONYMS

BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
ha	Hectare
IBBRI	Indo-Burma Ramsar Regional Initiative
IKI	International Climate Initiative
IPCC	International Panel on Climate Change
IUCN	International Union for Conservation of Nature
km	Kilometre
m	Metre
NSBSAP	National Biodiversity Strategies and Action Plan
OISCA	Organization for Industrial, Spiritual and Cultural Advancement
ONEP	Office of Natural Resources and Environmental Policy and Planning
OTOP	One Tambon One Province
PRA	Participatory Rural Appraisal
THB	Thai Baht
UNESCO	United Nationals Educational, Scientific and Cultural Organization
UNFCC	United Nations Framework on Climate Change
VA	Vulnerability Assessment

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EXECUTIVE SUMMARY

"Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region" (2017-2020) aims to build climate resilience by harnessing the benefits of wetlands in Cambodia, Lao PDR, Thailand, and Viet Nam. The project is funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). Mekong WET will help the four countries address their commitments to the Ramsar Convention, an international treaty for the conservation and sustainable use of wetlands, and achieve the Aichi Biodiversity Targets.

Vulnerability Assessments (VAs) were conducted at ten sites in the four countries. VAs combined scientific assessments with participatory appraisals and dialogues with local communities and authorities including the Office of Natural Resources and Environmental Policy and Planning (ONEP). In Thailand, two sites were selected: Bang Pakong River Wetland, in Central Thailand and Kaper Estuary - Laemson Marine National Park - Kraburi Estuary Wetlands in southern Thailand, which is the focus of this summary.

The main objectives of the assessment were to determine the vulnerability of ecosystems and livelihoods to the impacts of climate change, and identify methods to address vulnerabilities and increase the resilience of wetlands and livelihoods to the impacts of climate change. The assessment incorporated community workshops and expert consultations with NGOs and academic specialists, to predict the potential implications that climate change may have on habitats, biodiversity and livelihoods. The VA covered villages that rely on wetland resources for their livelihoods, and assessed how these resources are affected by climate change and non-climate threats, including those from outside the wetland boundary. In this assessment, special attention was paid to the needs, perspectives and knowledge of women, because they may use wetlands and their resources differently than men.

The "Kaper Estuary - Laemson Marine National Park - Kraburi Estuary" wetlands were registered as a Ramsar Site on August 14, 2002. The site is situated in the Thailand peninsula, extending into the Andaman Sea to the west. It has the largest mangrove forest area in the Indo-Pacific region and is the only place in the region where primary undisturbed mangrove still exists. It covers 1,084 km^2, spread over 22 subdistricts (5 districts) of Ranong Province, with the Kraburi River as its natural border with Myanmar. The site comprises many wetland types, providing habitats for a diversity of plants and animal species.

The area is characterized by past intensive use of the mangrove forest, followed by more recent conservation efforts, strong economic development in agriculture, fisheries and industry, and the expansion of the tourism and service sector. These developments have attracted many people, including labour migrants, affecting the environment through overexploitation and loss of habitats, waste disposal and changes in water and air quality. The area is sensitive to natural disasters such as landslides and storms, and climate change is expected to exacerbate these problems.

Historic data and future projections give an indication of the future climatic changes in the wetlands of Ranong Province. These include:

- Rising temperatures with longer summers, shorter winters and intensifying drought conditions;
- Heavy and more frequent rainfall during the rainy season and fluctuating weather conditions;

- The site in a risk-prone area, vulnerable to wind, monsoons and tropical cyclones (and despite the limited amount of forecasting data, cyclones are expected to become more severe);
- Sea level rise will increase by 5-10 mm/year up to 2040 (and will continue to rise after this date), exacerbating coastal erosion rates which are likely to be higher in the beach areas compared to the floodplains connected to the mangrove forests;
- Ocean temperatures are likely to rise 1-3°C, affecting corals, aquatic nurseries, and fisheries and increase risks of floods and erosion.

Based on the habitat vulnerability assessment, coral reef ecosystems are the most vulnerable and least adaptive to the current ecosystem threats and future climate change. Increased sea temperature will cause coral bleaching and eventually death under sustained high temperatures. Reducing pressure from other impacts such as sedimentation and poor water quality can locally increase coral resilience to climate change, increasing survival. The second most vulnerable habitats are seagrass beds, canals and rivers, and coastal and marine areas; they are vulnerable to changing conditions of the ecosystem, especially human activities, but can adapt relatively well to climate change. Mangrove forests, beach forests and tidal flats are more adaptive, and therefore less vulnerable. Human activities, such as encroachment from shrimp farms and construction sites can threaten these ecosystems if not controlled.

Climate change will also affect the livelihoods of local communities that depend on wetland resources. The agriculture and fisheries sectors are highly vulnerable to climate change. Local knowledge of weather patterns has been challenged by unpredictable climatic conditions, and the lack of predictability in seasonal patterns has affected agriculture and fishery livelihoods. Changes in precipitation can affect agriculture yields while increased severity of storms impacts fishing conditions and economically important marine species. The study highlighted the wide variety of wetland resources used by women and men in the area. People along the coast and rivers collect various species of fish, crab, krill/shrimp, bivalves and snails. Other resources include jellyfish, mangroves, *Nypa fruticans*, fruit trees, and vegetables. While men prioritized resources based on economic value alone, women prioritized them based on economic value and easy access and use. While patterns of resource ranking among communities were very similar, there were also differences based on geographical location and local economy. Changes in environmental conditions may lead to changes in resource distribution in space and time, directly influencing the historical community ecological knowledge.

The species vulnerability assessment analysed various important species and their baseline threats and risks from climate change:

- **Water onions** (*Crinum thaianum*)*:* endangered. Highly vulnerable to the impacts of climate change. The wetland plants are sensitive to changing water levels and water quality and magnitudes of currents, especially from heavy rains. Rainfall in Ranong is predicted to increase by 10-20% in the next 30-90 years, which increases future risks for water onions.
- **Scleractinian corals** were found to have the highest climate change vulnerability of all species surveyed. Water temperatures above 30.1°C for more than three weeks can induce coral bleaching. This led to the death of more than 50% of the corals in the area in 2010. Runoff from construction and agriculture, and wastewater discharge increase turbidity, and limit the light penetrating to the symbiotic photosynthetic zooxanthellae.

Illegal fishing equipment such as trawler-nets can also cause physical damage to reefs, while the expansion of tourism can increase marine debris and damage from anchoring.

- **Mangrove pitta** (*Pitta megarhyncha)* a 'near threatened' passerine bird, faces habitat loss from coastal erosion and sea level rise. However, the conservation of mangroves in the area provides a refuge for the birds, making them relatively resilient to climate change.
- **Long-whiskered catfish** (*Sperata aor*), and **mangrove** *Bruguiera hainesii* XC.G.Rogers (white beans) have low climate change vulnerability. White beans can adapt relatively well to climate change but are fragile to other changes in the mangrove forest including shrimp farming and expansion of construction areas.
- **Crustaceans** the Meder's mangrove crab (*Scylla serrata*)**,** the serrated mud crab (*Sesarma mederi*) and the scorpion mud lobster (*Thalassina anomala*) have low baseline conservation risk, and low climate change vulnerability. They are able to adapt to changing climate conditions. However, the rehabilitation and preservation of their habitat ecosystems such as mangrove forests, canals and estuaries are essential to their survival.

The local community seems relatively well prepared for different types of climate impacts. Whereas current responses were more strongly associated with mitigation and prevention, future strategies focused on coping capacity and ecosystem rehabilitation. It is important to recognize the importance of actions at three different levels, and the need to implement them in parallel:

- *Household/individual level:* preparing for floods by raising houses, and digging household ponds deeper so that they can store more water in the dry season. Most of these responses are reactive and can be implemented immediately.
- *Community level*: constructing dams/walls to prevent erosions from waves and tides, mangrove reforestation, organizing regulations and public hearings with the community to announce specific plans.
- *Network-level*: increasing collaboration between government agencies, the private sector, communities, NGOs and external stakeholders, to develop a shared conservation and management plan.

Local stakeholders suggested setting up a "Wetland Management Committee" which will act as the collaborative mechanism and facilitate the implementation of the plan. The Committee is needed to assist in the nomination of the current Ramsar Site to Natural World Heritage Status. Conservation of cultural and natural values can highly benefit from dual designations under the Ramsar and World Heritage Conventions. This would further highlight the wetlands as a globally-important natural ecosystem, and could serve to increase eco-tourism and garner government support on local, provincial and national levels for policies related to wetland conservation.

1 INTRODUCTION

Wetlands, such as marshes, rivers, mangroves, coral reefs, and other coastal and inland habitats, have many important functions. They regulate water flows, provide clean water, store carbon and reduce disaster risk by acting as natural buffers against erosion and the impact of flood, tsunamis and landslides. In the Lower Mekong Region, millions of people rely on wetlands for their survival. In recent decades, however, infrastructure developments, deforestation, the expansion of irrigated agriculture and increasing urbanisation have led to a dramatic decline in the region's wetlands. Impacts on habitats, species and livelihoods are further intensified by climate change. Conserving, managing and restoring natural ecosystems in collaboration with local communities and stakeholders is increasingly recognised as critically important to maintain these unique environments.

Funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), the International Union for Conservation of Nature (IUCN) and various partners have started a new initiative. The project "Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region" (2017-2020) aims to build climate resilience by harnessing the benefits of wetlands in Cambodia, Lao PDR, Thailand, and Vietnam.[1] Mekong WET will help the four countries to address their commitments to the Ramsar Convention, an international treaty for the conservation and sustainable use of wetlands, and to achieve the Aichi Biodiversity Targets. Through its focus on wetland ecosystems, the project also supports governments in implementing National Biodiversity Strategies and Action Plans (NBSAPs) under the Convention of Biological Diversity and in pursuing their commitments on climate change adaptation and mitigation under the United Nations Framework on Climate Change (UNFCC).

As a first step of a participatory adaptation planning process, vulnerability assessments (VAs) were conducted in ten Ramsar sites/wetland sites in the four countries. These combine scientific assessments with participatory appraisals and dialogues with the people living at the site and the authorities responsible for management. For Thailand, two sites were selected: the "Bang Pakong River Wetland" (which is part of the larger Bang Pakong River Basin) and the "Kaper Estuary - Laemson Marine National Park - Kraburi Estuary" wetlands. This report presents the results of the VA for "Kaper Estuary - Laemson Marine National Park - Kraburi Estuary" wetlands, which is in Ranong Province.

The main objectives of the assessment were:

- To assess the vulnerability of ecosystems and livelihoods to the impacts of climate change.
- To identify options to address vulnerabilities and increase the resilience of wetlands and livelihoods to the impacts of climate change.

Since outcomes of the VAs should lead to actions and decisions at the local and potentially national levels, VA teams were formed, including representatives from government agencies, village heads, and community representatives, and supported by academia or a local or international organization with experience on climate change adaptation; the composition of these teams slightly differed depending on the location, but a core team of members was maintained throughout the assessments (see Annex 1 for the main members involved).

The assessment consisted of two parts: a description of the current situation of the wetland and a rapid assessment of its vulnerability.[2] The assessment of the wetland's vulnerability consisted of three tools in the form of excel spreadsheets: a Habitat VA tool, a Village VA tool (complemented with Participatory Rural Appraisal or PRA tools), and a Species VA tool. These

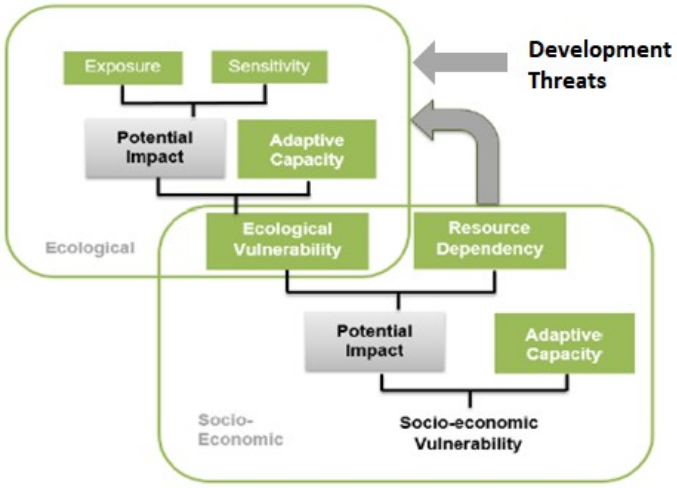
[1]See https://www.iucn.org/regions/asia/our-work/regional-projects/mekong-wet
[2]See guidelines provided by IUCN, 2017

tools were selected for their simplicity, clear instruction and guidance, and ecosystem focus; a socio-ecological framework was used to inform the design of the tools (see Box 1). While experts were consulted to complete and/or validate the Habitat and Species VA tools, the Village VA tool was completed in a consultative process with the communities.

The VA took place in 2017-2018 and covered the wetland and the communities that rely on its resources for their livelihood. It assessed how these are affected by climate change and non-climate threats including those from outside the wetland boundary. Special attention was paid to the needs and perspectives of women, because women may use wetland resources in different way than men do, and women may have different knowledge and perspectives of wetland resources than men. The report will be used as input for meetings with villagers and other relevant stakeholders to discuss the results and develop adaptation plans.

Box 1: *Conceptual framework Vulnerability Assessment (after Marshall, 2009; GIZ/ISPONRE/ICEM, 2016)*

According to the Intergovernmental Panel on Climate Change,[3] **vulnerability** is defined as the degree to which something (a species, an ecosystem or habitat, a group of people, etc.) is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is further explained as a function of the character, magnitude, and rate of climate variation to which a system/species is exposed, the system/species' sensitivity, and the system/species' adaptive capacity.



Exposure is defined as the extent to which a region, resource or community experiences changes in climate. It is characterised by the magnitude, frequency, duration and/or spatial extent of a weather event or pattern.

Sensitivity is defined as the degree to which a system is affected by climate changes.

Together, exposure and sensitivity describe the **potential impact** of a climate event or change.

This interaction of exposure and sensitivity is moderated by **adaptive capacity**, which refers to the ability of the system to change in a way that makes it better equipped to manage its exposure and/or sensitivity to a threat.

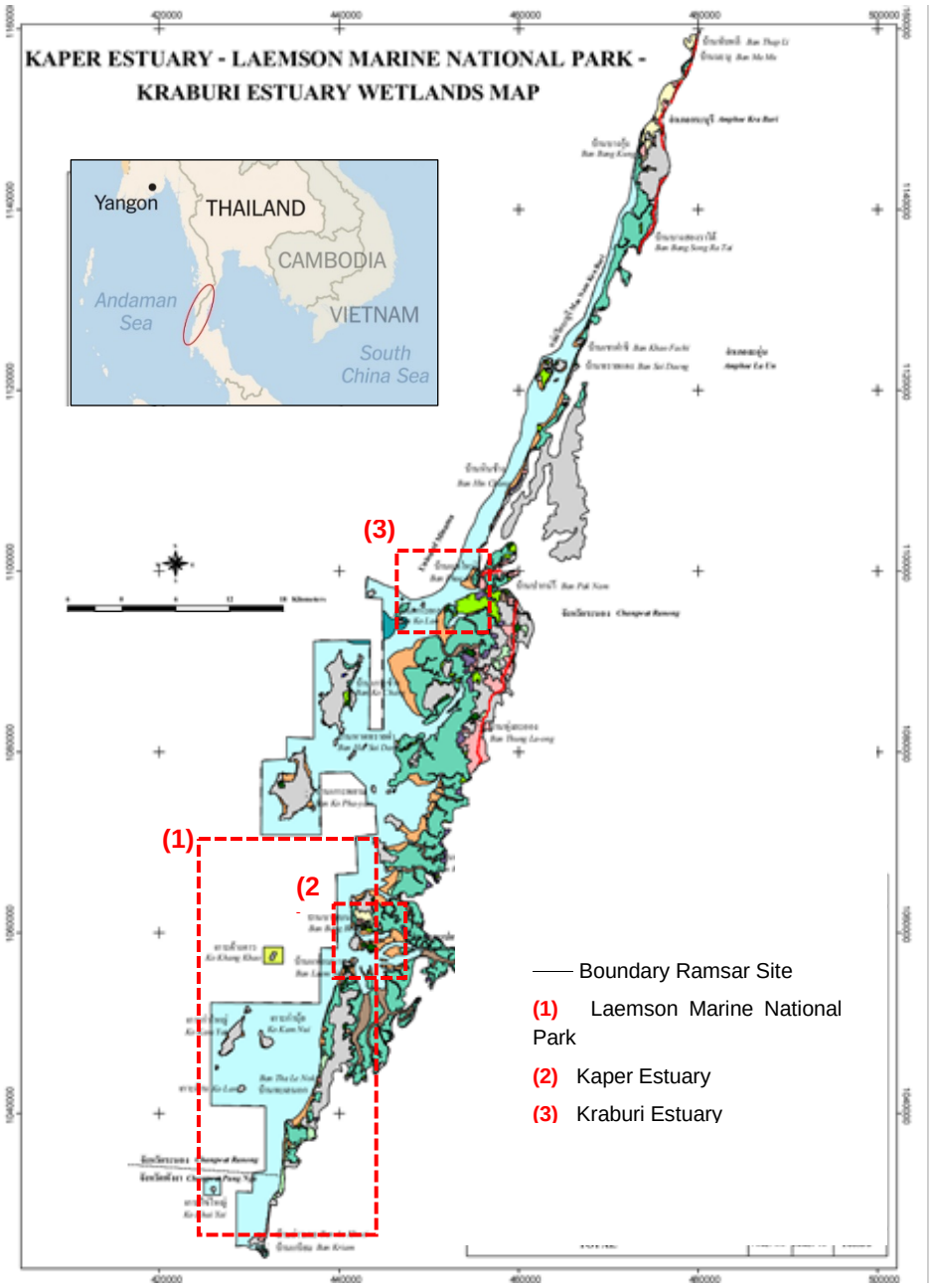
Within the context of Mekong WET (which focuses on wetlands), the **ecological system** consists of two elements: species and habitats. The **socio-economic system** refers to the socio-economic vulnerability (e.g., livelihoods etc.) of the villages or communities that are dependent on resources derived from the wetlands. Information collected during the assessment is used to evaluate how the ecological and socio-economic system interact in order to determine the overall vulnerability of the system, as well as the potential climate change impact.

[3]See IPCC, 2007

2 DESCRIPTION OF THE WETLAND

2.1 Location and site description

The “Kaper Estuary - Laemson Marine National Park - Kraburi Estuary” wetlands were registered as a Ramsar Site on August 14, 2002 (see Annex 2 for Thailand’s Ramsar Sites).[4] The site is situated in the Thailand peninsula, extending into the Andaman Sea to the west (see Figure 1). It has the largest mangrove forest area in the Indo-Pacific region and is the only place in the region where primary undisturbed mangrove still exists. The site covers 1,084 km^2 (677,625 rai or 108,420 ha), spread over 21 subdistricts (5 districts) of Ranong Province and 1 subdistrict of Phang Nga Province; it borders the Union of Myanmar, with Kraburi River as a natural boundary (Figure 1).



[4]The site includes three internationally significant wetland areas: Leamson Marine National Park, Kaper Estuary and Kraburi Estuary (according to revised Cabinet Resolution of 1 August 2000)

Figure 1. *Kaper Estuary - Laemson Marine National Park - Kraburi Estuary wetlands (source: adapted from Office of Natural Resources and Environment Planning, 2017).*

2.2 Current and historical climate

The site is characterized by a typical monsoon climate. The seasons can be categorized as follows:[5]

- **Winter** (October-February). This is when the northeast monsoon from the South China Sea and the Gulf of Thailand brings cool and dry air, causing the temperature to drop in January and February relative to the rest of the year. There is limited rain.
- **Summer** (February-May). From February onwards, the southwest monsoon from the Indian Ocean begins, making the temperatures increase, though wind and moisture from the sea reduces the heat.
- **Rainy season** (mid-May-mid-October). This season is strongly influenced by the southwest monsoon, causing heavy rainfall from May to September.

Key factors that determine and characterize the seasons are described in more detail below.

Temperature and rainfall. The 30-year statistical data (1981-2010) for temperature and rainfall are presented in Figure 2. Annual average temperature of this period has been 26.8ºC, with an average minimum of 23.6ºC and an average maximum of 32.2ºC. March has been the hottest month of the year with an average maximum temperature of 35.0ºC. The coldest month is January with an average minimum temperature of 21.9ºC. Average annual rainfall over the same period was 4,070 mm, with most rain (80-90%) between May-October, and with August being particularly wet. December to March are particularly dry with less than 100 mm per month. January and February are the driest months.

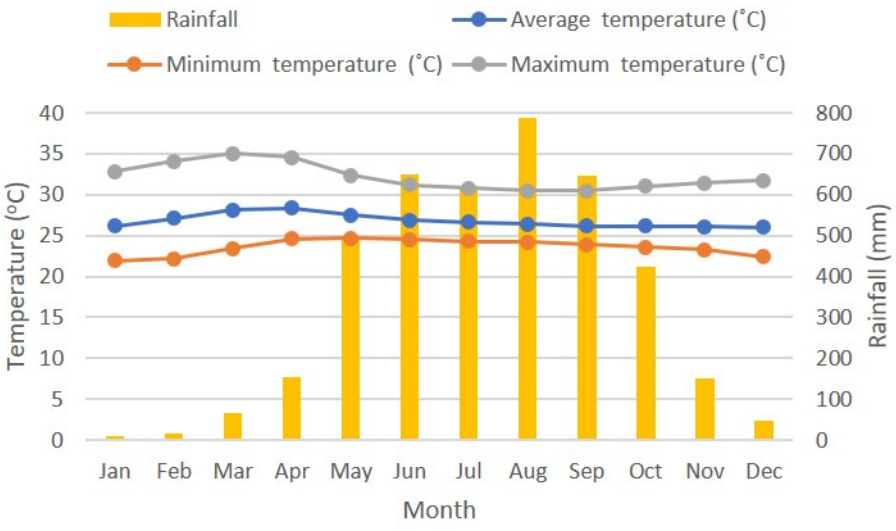


Figure 2. *Temperature and rainfall data based on 30-year statistical data (1981-2010) for Ranong Province (source: Meteorological Department, 2018; Poramet Amatayakul and Taywin Jomta, 2017)*

Heavy storms. The average number of heavy storms is in Thailand – including depressions, tropical storm, typhoons – over the past 60 years (1951-2012), was 3 per year (see Figure 3). The average number of storms has reduced each decade, from six to two; between 2008 and 2012, the average was only one per year. Most storms occur between September and November. This corresponds with provincial data on storms that pass through and affect Ranong. Most are

[5]Thai Meteorological Department. Historical Weather Statistics Report, Ranong Weather Statistics as accessed from https://www.tmd.go.th/province_weather_stat.php?StationNumber=48532 on 15 April 2018.

weak tropical depressions blowing from the South China Sea and the Pacific Ocean, but some can cause heavy rains and violent winds and flash floods.

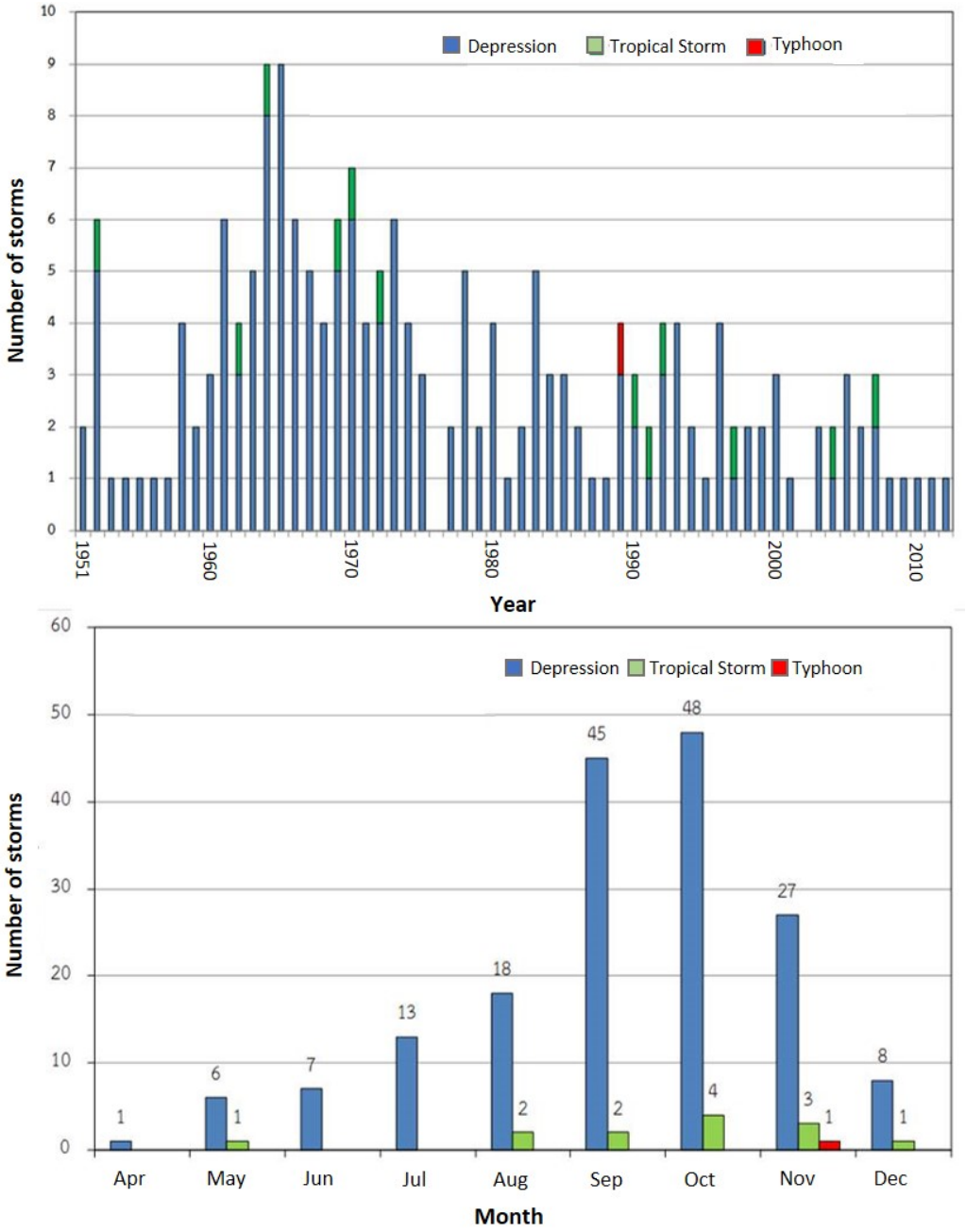


Figure 3: *Heavy storms in Thailand for 1951-2012 by year (top) and by month (bottom) (source: adapted from Thai Meteorological Department, 2018)*

El Niño and La Niña. The El Niño and La Niña phenomenon affect the start and end of the rainy season (Table 1). In La Niña years, the rainy season begins about eight days early (19 April vs 27 April) and ends 6 days later (26 November vs 20 November); in the year with the longest raining period, it lasted up to 12 days after the normal season (26 Decemeber vs 14 December). El Niño does not have as big an impact, although the end of the rainy season comes about 8 days earlier than normal (12 November vs 20 November).

Table 1: *Effect of El Nino and La Niña on start and end of rainy season for 1954-2009 (source: Poramet Amatayakul and Taywin Jomta, 2017)*

Year	Start rainy season			End rainy season		
	Average	**Earliest**	**Latest**	**Average**	**Earliest**	**Latest**
Normal	27 April	6 April	22 May	20 Nov.	19 Oct.	14 Dec.
El Nino	27 April	5 April	22 May	12 Nov.	7 Oct.	7 Dec.
La Niña	19 April	3 April	14 May	26 Nov.	26 Oct.	26 Dec.

2.3 Hydrological characteristics

The geohydrologic map of the wetlands of Laemson Marine National Park and the Kaper Estuary indicate that the hydrological characteristics are influenced by the short tributaries that line the coastline. The origin of the tributaries is in the eastern mountains and water flows down the slopes of the hills and narrow plains to the Andaman Sea in the west and southwest. In the Kraburi Estuary, hydrology is slightly different. In the dry (winter) season the mangrove wetland behaves in some respects like an evaporation pond. Salt and water are trapped upstream. In the wet (rainy) season the mangrove wetland is flooded both by runoff from the local stream and from the Kraburi River Plain. Short-lived local currents generate strong salinity stratification and episodically flush the estuary. Measurements of nutrient budgets also suggest significant outselling in the wet season. An outselling of mangrove litter and of local organic carbon throughout the year are probable, as is trapping of land-derived sediments in the wet season.[6]

2.4 Wetland habitats and biodiversity

The site comprises many wetland types, supporting a diversity of plants and animal species. At a meeting organized by the Mekong WET program in December 2017,[7] 10 distinctive habitat types were identified: estuaries, mangrove forest, seagrass, canals and rivers, islands, coral reef, beach, active tidal flats, beach forest, and coastal and marine area; their main characteristics are described below (since several types represent areas that embed other often similar habitats, key species are summarized in Box 2).

(1) Estuaries. There are two important estuary systems: Kaper Estuary and Kraburi Estuary.

Kaper Estuary.[8] The Kaper Estuary overlaps with the Laemson Marine National Park, a coastal area with islands in the southern part of the site. The estuary covers an area of 17,219 rai (2,755 ha) with both mangrove forests and coastal wetland. There are also small freshwater canals that meet before flowing into the Andaman Sea in the west. The area includes sandy beaches, coral reefs, coastal/beach forests, seagrass beds and islands; these islands function like a barrier, slowing down the flow of water out to the sea and creating a large salt-lake like area. It also protects the coastal area from monsoons and harsh winds. A mountain ridge separates the inland from the sea and protects the estuary from storms, harsh winds and currents, making it suitable for mangrove forest and seagrass. The mangrove forest in the Kaper Estuary was formerly affecting by logging and mining, therefore, most trees are newly planted; some areas with gentle

[6]This section is derived from the Office of Natural Resources and Environmental Policy and Planning" Ramsar Information Sheet "as accessed from http://wetland.onep.go.th/RIS_RAMSAR/Lameson.pdf on 1 January 2018
[7]Workshop on Assessing Vulnerability of Species and Habitats and Adaptation to Climate Change Situations in important wetland areas in Thailand by the Mekong WET project under the facilitation of IUCN Thailand, 6-8 December 2017, Muang, Ranong.
[8]Biology Department, Faculty of Science and and Technology, Rajbhat University Phuket. Project on Developing Guidelines and Mechanisms for Wetland Management in Laemson National Park, Kaper Estuary, Kraburi Estuary, Ranong as accessed from http://chm-thai.onep.go.th/chm/data_province/ranong/images/pdf/FINAL2.pdf on 25 March 2017

slopes have been encroached on and transformed into agricultural areas, such as coffee and rubber plantations. The estuary is most known for its seagrass beds. It has been reported that in 1992, fishermen found baby dugongs coming into the estuary to eat seagrass.

Kraburi Estuary. The Kraburi Estuary is part of Kraburi River National Park in the north of the site, covering an area of 120,675 rai (19,308 ha) with densely populated communities. The Kraburi River originates from the catchments of Klong Kadeang and Klong Kranei and is later joined with Klong Pak Chan in the north of Kraburi District. There are many rivers and water bodies, large and small, that flow from the highlands into the Kraburi River. These natural canals bring sediments, which are deposited along the estuary and the coasts, making the coastal area of the Kraburi Estuary a lush mangrove forest with silty beaches that run parallel to a mountain range. The area consists of mangrove forests, lagoons and sea areas; it includes a large part of the Ranong Biosphere Reserve (mangrove forests) and some islands, such as Koh Sinhai, Koh Chang and Koh Phayam, which are part of the Ranong Islands National Park.

Box 2: *Diversity of plants and animals in Kaper Estuary - Laemson Marine National Park - Kraburi Estuary wetlands*

Different type of wetland habitats can be found across Ranong Province. They are rich with mangroves, seagrass, and other plants and trees, various fishes and aquatic species, terrestrial and marine mammals, local and migratory birds, reptiles and amphibians.[9,10,11] Key species include:

- Mangrove: *Aegiceras corniculate, Kandelia candel*, *Rhizophora apiculata, R. mucronata, Avicennia* spp., *Ceriops* spp., *Xylocarpus* spp.*, Bruguiera spp., Excoecaria agallocha, Sonneratia ovata, Vigna mungo, Cerbera odollam Gaertn., Cynometra iripa, Heritiera littoralis Ait., Phoenix acaulis Ham., Nypa fruticans, and Acanthus ilicifolius Linn.*
- *Sea grass*: *Halophila ovalis, Halodule pinnifolia, Halodule uninervis, Cymodocea serrulata, Halophila beccarii*, *Enhalus acoroides, Halophila decipiens, and Halophila ovalis*
- *Other plants/trees*: *Casuarina equisetifolia* (Australian pine tree), *Terminalia catappa*, *Hibiscus tiliaceus*, *Atalantia monophylla*, and *Calophyllum inophyllum, Poemoea pescaprae*, *Spinifex littoreus*, and *Canallia rosea; Ipomoea pescaprae, Spinifex littoreus, Sesuvium portulacastrum, Clypeasteroida, Scaevola taccada, Suaeda maritima, Hibiscus tiliaceus, Terminalia catappa, Pandanus tectorius and Calophyllum inophyllum*.
- *Fish and other aquatic species*: fiddler crabs, meder's mangrove crabs, serrated mud crabs, saltwater crabs, hermit crabs, coconut crab, spider crab, swimming crab, ghost crab, mantis inshrimp, whiteleg shrimps, krill, dwarf prawns, snapping shrimp, scorpion mud lobster, oysters, Cerithidea sp., Nerite, *Sermyla riquetii* (horn shell), moon shell, mud skipper, bumblebee goby, mullets, needlefish, yellow-striped scad, puffer, barracuda, red snapper, white snapper, grouper fish, spotted mackerel, jellyfish, squid, black urchin, sea cucumber and corals.
- *Terrestrial and marine mammals*: long-tailed macaque, smooth-coated otters, flying lemur, squirrels, Indo-Chinese ground squirrels, bamboo rats, weasels/mongoose, musk, mouse deer, slow loris, banded surili, typical gibbons, felis viverrina, barking deer, Lyle's flying fox, rodents, dolphins, and dugongs.
- *Local and migratory birds*: hawks, crows, swallows, *Drungo*, wild fowl, white-breast waterhens, Collared kingfisher, white-bellied sea eagles, Asian koel, Oriental pied hornbill, hill myna, green pigeons, white-rumped shama, Oriental magpie robin, red turtle dove, large-tailed nightjar, red-wattled lapwing, and teals.
- *Reptiles and amphibians*: lizards, V*aranus salvator*, cobras, king cobra, boas and various types of turtles, frogs, toads, bullfrog, small green frog and tree frogs)

(2) Mangrove forest (Figure 4). In 2012, the Department of Marine and Coastal Resources identified a total of 198,467 rai (31,755 ha) of mangrove forest in Ranong, of which 136,305 rai (21,809 ha) is inside the National Reserved Forest and 20,889 rai (3,342 ha) is in National Parks.[12] The mangrove area has been used for activities such as agriculture, shrimp farming,

[9]Office of Natural Resources and Environmental Policy and Planning" Ramsar Information Sheet "as accessed from http://wetland.onep.go.th/RIS_RAMSAR/Lameson.pdf on 1 January 2018

[10]Biology Department, Faculty of Science and Technology, Rajbhat University, Phuket. Developing Guidelines and Mechanisms for Wetland Management in Laemson National Park, Kaper Estuary, Kraburi Estuary, Ranong. As accessed from http://chm-thai.onep.go.th/chm/data_province/ranong/images/pdf/FINAL2.pdf on 25 March 2017

[11]Smitinand, 1977a

[12]Department of Marine and Coastal Resources (2012) Biodiversity in Ranong Biosphere Reserve as accessed from http://www.dmcr.go.th/detailLib/129/ on 2 April 2018

mining, and fishing trading ports. Based on data from the Ranong Biosphere Reserve,[13] mangrove species found can be grouped into 26 families, 38 genera, and 52 species. Mangroves are also important nursery grounds for juvenile fish and shrimps of many commercial species. Despite heavy fishing pressure, the mangrove fish community of Ranong is both abundant and diverse. More than 98 species were recorded, the major ones being Gobidae, Clupeidae and Engraulidae. In addition, there are 124 species of phytoplankton, 28 species of crustaceans, 77 species of surface and sub-surface animals, and 30 species of insects. Other groups include mammals, birds, reptiles, amphibians, and marine animals.

Figure 4: *Mangroves in Ranong Biosphere Reserve* **Figure 5:** *Seagrass* (Photo credit: Nalinee Thongtham)

(3) Seagrass (Figure 5). The Ranong area currently contains 2,272 rai (364 ha) of seagrass beds, which accounts for 2.3% of all seagrasses on the Thai coasts of Andaman Sea and 1.4% of all the seagrass area in Thailand.[14] Although the area of seagrass is not large, seagrass beds are important in marine and coastal ecosystems; they provide area for spawning grounds, aquatic nurseries, refuges, food sources and sediment filters. Seagrass reduces the strength of the water current and is a source of economic aquatic animals and fisheries. Rare marine animals such as dugongs and turtles often feed directly on seagrass. In a survey by the Marine and Coastal Resources Research and Development Institute in 2006, 11 seagrass species were identified in Ranong and Phang Nga Provinces.[15] The seagrass beds in Kaper District and Suksamran District (Ranong Province) cover 940 rai (150 ha) and the northern part of the Kaper Bay is especially abundant with seagrass; it was found on sand dunes near the mangrove forest and the estuary at about 1.9-2.5m deep. Many animals are found in the seagrass bed, such as the single shells Cerihidea and Bivalia, there are also crabs (*Uca* spp.), living in the underground holes, and sea cucumbers.

[13]Biodiversity Information Dissemination Mechanism as accessed from http://chm-thai.onep.go.th/chm/data_province/ranong/Biosphere.html on 3 March 2018
[14]Dr. Nalinee Thongtam, expert at Marine and Coastal Resources Research Institute and the Andaman Coasts
[15]Sombat Puwatchiranon et al., .2006

(4) Canals and rivers (Figure 6) Ranong Province includes three water basins: Kraburi River Basin, Khlong La-oon River Basin, and the Upper West Bank Water Basin. The area also has many natural canals.[16] These canals are not only important waterways but also important habitats for many aquatic animals. Rivers and canals carry water from the foothills of the mountains to the sea, with various sub-habitats along the way. Riverbanks are home to various plant species, such as grasses, bamboo, herbaceous plants, perennial shrubs, as well as rocks, stumps, and roots, protecting the banks against erosion. There is water year-round, because of deep ponds, which act as natural reservoirs providing moisture in the dry season; these reservoirs also help slow down the flow of water in the rainy season. These characteristics provide a habitat for many animals and plants, including rare species of local flora, such as the water onion. The upper Phang Nga and Ranong area are the only places in the world where they can be found.

Figure 6: *River in the wetland*

(5) Islands. The area is rich in islands including Koh Kum, Koh Larn, Koh Phayam, Koh Khai Yai, Koh Khum Yai, Koh Khum Nuy, Koh Khum Klang, Koh Loog Khum Og, Koh Bang Jak, Koh Taa Khrut, and Koh Sinn Hai. The terrestrial ecosystem that is separated from the mainland is surrounded by water, which makes it possible to find many endemic plant and animal species. It is very abundant and rich in natural resources because of its geographic characteristics. Currents from many rivers carry sediment, organic and inorganic debris to the island. Seagrass beds and coral reefs are found near the islands, which are important habitats that can act as refuge and nursery area for marine animals. The type of forests found in this area are rich mangroves forests with high levels of biodiversity. Moist evergreen forests are still abundant, especially in the areas around the high mountains of Koh Bang Chak, Koh Yiw, Koh Chang, Koh Sai Dum and Koh Phayam. Beach forest can be found along the beaches of Koh Payam, Koh Chang and Koh Sai Dum. On Koh Yiw and Koh Sai Dum there are grassland areas mixed with sparse forest clusters. The islands are home to many fish species and other aquatic animals, as well as other animals, including mammals, birds, reptiles and amphibians.

(6) Coral reef (Figure 7)**.** Ranong's coral reefs cover an area of about 2,828 rai (452 ha), representing 3.9% of the coral reefs in the Andaman Sea of Thailand and about 1.9% of the reef area for the whole country.[17] Reefs can be found near Koh Son, Koh Si Hai, Koh Takhrut, Koh Chang, Koh Phayam, Kho Gum cluster, Koh Lan and Koh Khang Khaow. These islands are in shallow water, with the sea floor at 3-10 m depth within 3 km distance from the shore. The water around Koh Chang cluster is turbid, especially on the east side of the island, but it is clearer on the west side where it opens out to the sea and the sea floor is made up of fine sand; 5-20 species of corals can be found in this area. The water becomes even clearer towards Koh Phayam and the corals line up to form a reef.

[16]Such as the Klong Lum Liang, Klong Pak Chan, Klong Wan, Klong Kraburi, Klong La-oon, Klong Hat Som Pan, Klong Kaper (the longest canal at 32km), Klong Kum Puan, Klong Nakha, Klong Bang Rin, Klong La-ong, and Klong Rajkhud (shortest at 12 km)

[17]Dr. Nalinee Thongtam, pers. comm.

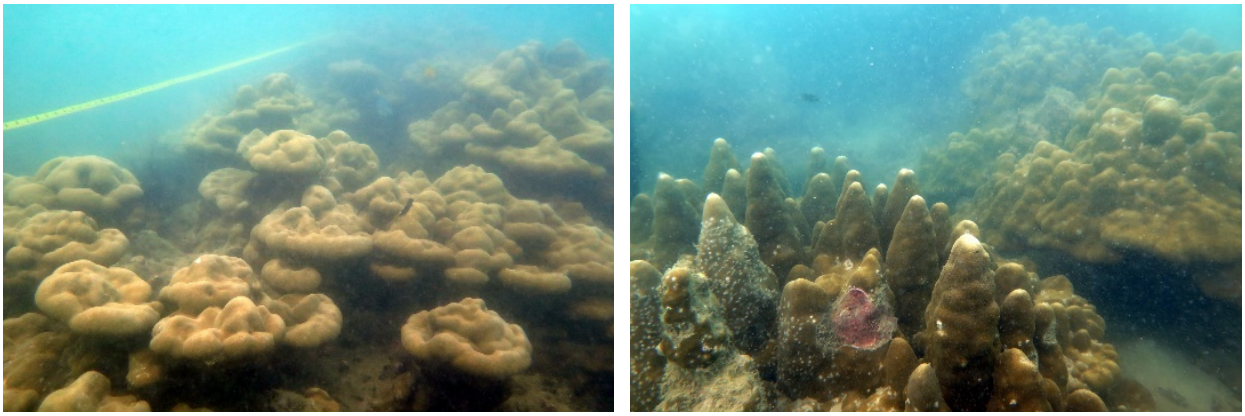


Figure 7: *Coral reef (Photo credit: Nalinee Thongtham)*

(7) Beach. Beaches form the connection between sea and land. There are three types: sandy beach, shingle beach and mud flats. Mud flats are usually found at the estuary of a large river, where the river brings in sediments from the land. However, before it reaches the sea, it forms a mud flat or silt flat (for example around Kaper Estuary and Kraburi Estuary). After the sloping area is flooded by high tides, a small well will remain in the middle of the field during low tides. Mangrove species will grow naturally on the muddy beach with abundant nutrients found in the sediments deposited in the area and the right level of seawater or brackish water. Seagrass can be found where mud beaches have a sandy mix and are shallow.

The beach is home to small organisms such as zooplankton and single celled algae, but also perennials, bushes, and trees. Animals include sea anemones, coral, jellyfish, clams, shellfish, bivalves, amphipods, isopods, and various types of shrimps and crabs. Some vertebrates that can move long distances can also be found here, such as stingrays (Batoidea) searching for food (bivalves). During low water levels, many types of birds come to feed in the area and it is a nesting ground for sea turtles.

Figure 8: *Mud-flat*

(8) Active tidal flats ("Paa Cheong Song"). These are flats in Kraburi District (1 m above sea level), which were previous connected to mangrove forest. However, they have become isolated and are only flood a few times a year from sea water because of buffers formed by deposited sediment; they may also be flooded in the rainy season with freshwater. In the future, these areas may transition into flood plains. Some 'true' mangrove species have adapted to this specific system, but many are associated mangrove species. Other species are *Oncosperma tigillarium*, a species of palm tree, and *Casuarina equisetifolia* (Australian pine tree), a she-oak species.

(9) Beach forest includes forest covering the coastal area that is not flooded by the sea or where the sandy beach has been raised by sand sludge from the sea or the rocky shore.[18] The soil is sandy and salty because of salt vapour sprayed from the sea. Most of the plants in this forest are halophytes, twisted from the strong winds. Beach forests can be found on the old beaches on the east coast and south coast of the Gulf of Thailand, and on the west coast from Ranong down to Satun Province. This also includes the small islands in the Andaman Sea. Since this type of forest is located near the beach, it is commonly destroyed and turned into tourist attractions, residential areas and communities. Only small patches remain in deteriorated conditions. The

[18]Thailand's ecosystems and forests (accessed from http://cyberlab.lh1.ku.ac.th/elearn/faculty/forest/fo22/chap8/c8-1.htm on 1 April 2018)

plants found are shrub-type with twisted trunks, lots of short branches, and thick leaves. *Casuarina equisetifolia* is found on newly formed beaches and they are the single dominant tree species in rocky coastal areas, but beach forests include several other species and some ground level plants.

(10) Coastal and marine area. The coastline of Ranong Province is 135 km long; the direction and velocity of the currents around its coastline are influenced by the monsoon and water from the rivers/canals, which flow into the sea in a turbulent form. The currents flow fastest at the surface in the middle and at about 1 meter above the sea floor. The deep-water currents of the Andaman Sea, flow from north to south. These waterflow dynamics make this habitat sensitive to erosion.

2.5 Land use

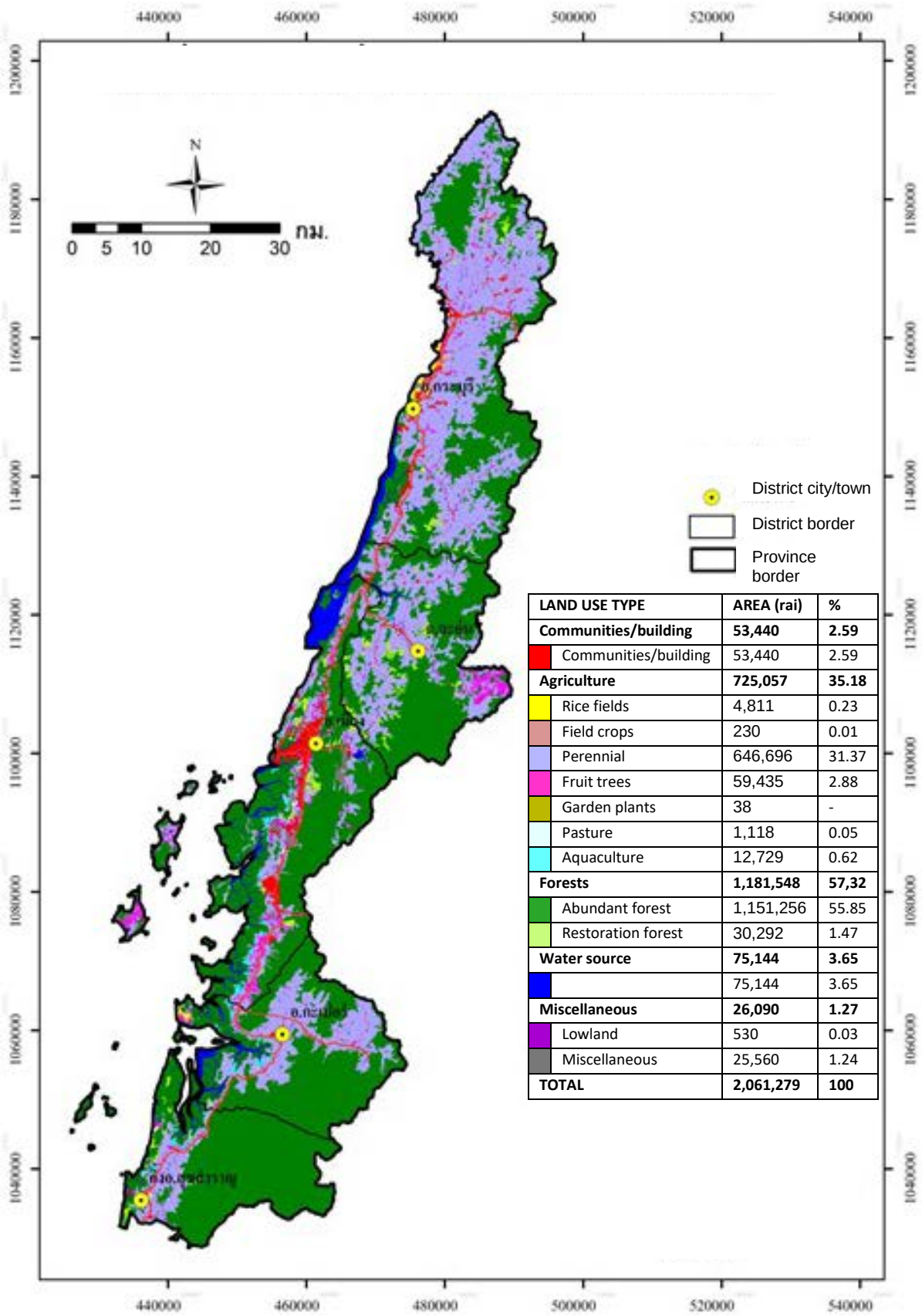
Most of Ranong's area consists of mountains and sea, with some coastal plains and lowland plains near the foothills. The total land area of the province measures about three times the size of the Ramsar site. Land use data for the past 10 years shows that most of the land has been used for forests and agriculture (see Table 2).[19] Between 2007 and 2013, about 57-60% of the area was forest land and 30-35% agricultural land; remaining areas (<10%), included land for residential areas, other infrastructure, water bodies, and miscellaneous. Land use patters have been relatively stable since 2007, although there has been some increase in agricultural areas at the cost of forest land.

Table 2: *Land use data for Ranong Province for the years 2007, 2013 and 2016 (source: Land Use Analysis Group, Division of Comparative Land Use Policy and Policy Plan, 2017)*

Type of use	2007			2013			2016		
	Rai	Ha	%	Rai	Ha	%	Rai	Ha	%
Forestry	1,245,349	199,256	60.4	1,224,993	195,999	59.4	1,181,548	189,048	57.3
Agriculture	643,375	102,940	31.2	671,186	107,390	32.6	725,057	116,009	35.2
Community/buildings	48,171	7,707	2.3	56,583	9,053	2.8	53,440	8,550	2.6
Water	45,920	7,347	2.2	74,097	11,856	3.6	75,144	12,023	3.7
Miscellaneous	78,466	12,555	3.8	34,419	5,507	1.7	26,,090	4,174	1.3
Total	2,061,281	329,805	100	2,061,278	329,804	100	2,061,279	329,805	100

Figure 9 provides a more detailed map of the land use profile for Ranong Province in 2016.

[19]Land Use Profile Analysis Group of the Land Development Department, 2017



LAND USE TYPE	AREA (rai)	%
Communities/building	**53,440**	**2.59**
Communities/building	53,440	2.59
Agriculture	**725,057**	**35.18**
Rice fields	4,811	0.23
Field crops	230	0.01
Perennial	646,696	31.37
Fruit trees	59,435	2.88
Garden plants	38	-
Pasture	1,118	0.05
Aquaculture	12,729	0.62
Forests	**1,181,548**	**57,32**
Abundant forest	1,151,256	55.85
Restoration forest	30,292	1.47
Water source	**75,144**	**3.65**
	75,144	3.65
Miscellaneous	**26,090**	**1.27**
Lowland	530	0.03
Miscellaneous	25,560	1.24
TOTAL	**2,061,279**	**100**

Figure 9: *Land use profile Ranong Province 2016 (source: adapted from Land Use Profile Analysis Group, Land Use Policy and Planning Unit, Land Development Department, 2017).*

As indicated, more than half of the province (1,181,548 rai or 189,048 ha) is covered by forest, with small areas being restored. Within the 725,057 rai (116,009 ha) used for agriculture,

perennial trees – especially para-rubber and oil palms – constitute the largest percentage with 646,696 rai (103,471 ha), while 59,435 rai (9,510 ha) were used for fruit trees. Aquaculture counts for 12,729 rai (2,037 ha), of which 10,877 rai (1,740 ha) was used for shrimp farming. There are 4,811 rai (770 ha) of rice fields, of which 1,574 rai (252 ha) was deserted. The rest of the area is used for animal husbandry and farms at an area of 1,118 rai (179 ha) and some small areas are for horticultural crop.

Area for communities/buildings is 53,440 rai (8,550 ha), and is primarily used for housing, government facilities and commercial purposes. As areas suitable for housing/buildings is limited, it is concentrated in the city and coastal plains. Recently, construction has expanded into conserved mangrove forest. Water area covers 75,144 rai (12,023 ha) of land, and includes rivers, canals, reservoirs, ponds, lakes and lagoons. The miscellaneous use of land area of 26,090 rai (4,174 ha) can be classified as grassland, alternating with bushes, natural pastures, mineral mines, old mines and soil ponds, etc.

2.6 Drivers of change

Some major developments that have affected land use, are: 1) the utilization/conservation of mangrove forests; 2) economic development; and 3) the expansion of tourism and service sector.

1) Utilization/conservation of mangrove forests. Changes in the wetland area have become evident through the utilization and conservation of mangrove forests, which can be divided into two phases.

- **Phase 1: Deteriorated mangrove forest and wetland areas (1977 – 1997)**. Mangrove forests are now protected by law, but initially laws were used to limit people's rights to mangrove resources while opening channels for state access to resources for economic growth. This is evident from concessions for charcoal and mineral mines in mangrove forest areas. In 1982, however, the Ranong Mangrove Forest Research Centre was established for research and restoration of remaining forests. In 1983, the Laemson Marine National Park was declared, although mangrove forests on the outside of the park were still being used. In 1987, there were various investors turning mangrove forest into industrial aquaculture areas, especially shrimp ponds. Most mining concessions in the mangrove forest areas ended in 1993.
- **Phase 2: Knowledge development and mangrove forest restoration (1997–present).** In 1997, the level of degradation in the mangrove forests was at its peak from the intensity of mining and shrimp ponds activities and the impact and aftermath of typhoon Gay in the area (1989). In 1997, UNESCO declared 30,300 ha of mangrove area near the research centre as the first Biosphere Reserve in Thailand. Soon afterwards, Lum Nam Kraburi National Park was established (1999), followed by the announcement of the "Registration of international and nationally significant wetlands in Thailand and conservation measures for the wetlands" (2000); the registration listed Laemson Marine National Park, Kaper Estuary and Kraburi Estuary as international significant wetlands. In 2002, they were registered as international wetlands under the Ramsar site scheme.

The community has become involved in mangrove reforestation and rehabilitation. The forest is now the most sustainable mangrove area in Indochina and the Pacific, although the government want to use land in mangrove areas for construction of infrastructure, i.e. waste disposal, government facilities, and ports.

2) Economic development. Ranong province has seen strong economic growth. Gross Provincial Product (GPP) in 2013 was 20,996 million THB (US $656 million). The main income source was from agricultural activities, hunting and logging with 4,575 million THB (US$ 143 million); the second source was fisheries, generating 3,625 million THB (US$ 113 million).

Ranong's annual per capita income in 2013 was 89,371 THB (US$ 2,793), ranked 11th amongst provinces of the southern region and 44th (from 76) in the country.[20]

- **Agriculture**. In 2012, there were a total of 25,809 households in Ranong active in the agricultural sector with 623,609 rai (99,777 ha) of agricultural land in their possession. The agricultural land formed less than a third of the provincial area, because the area is mostly mountainous with only 14% being flat lowland. The main crops that generate income for farmers in the province are para-rubber followed by oil palm, coffee and fruit trees such as durian, mangosteen, longkong, rambutan, and other local plants such as beagu (*Gnetum gnemon*) and cashew nuts (*Anacardium occidentale*). The value of animal husbandry, mainly pigs and chicken, was around 500 million THB (US$16 million) in 2011/2012.[21]
- **Fisheries**. Production in the fisheries sector includes commercial marine (deepwater) fishing and traditional fisheries (coastal). Second is aquaculture (salt water shrimp, white prawns, white snapper, sea bass, cockles and mussels). Although the fishery area in Ranong Province is limited to about 1,377 ha, it is the area most abundant in animal resources when compared to fishing piers in other provinces along the Andaman Sea. The average daily catch is about 30 tons, and only 10% is used or consumed in the province. The rest is shipped to Bangkok and Hat Yai for export overseas, mainly to Malaysia and Singapore. Small fish is sent to four fish processing factories to produce dried minced fish, with a production capacity of 24 tons per day.[22]

In 2011, Ranong had the highest production in three sectors in Thailand: food and beverages, manufacturing of non-metallic products (concrete products), and local sub-district products. Ranong has transboundary trade potential. The area border trade is a maritime trade location adjacent to Song Island of Myanmar. There are two border crossing points, the fish bridge at Pak Nam Subdistrict and at the Andaman Club port, both in Mueang District. At present, the boarder trade point in Ranong has the second highest value for border trade, after Mae Sot border in Tak Province. The trade area is also a starting point for the trade route from Ranong to Song Island to Meyeik – Tavoy, and all the way to Yangon in Myanmar. Transportation is both on land and by boat. Ranong has the potential to develop into an international maritime trade platform; there are deep water ports developed by the Port Authority of Thailand and the private sector that can link Southeast Asia to the western hemisphere through marine travel.

3) Expansion of tourism and services sector. Ranong represents an ancient history, biodiversity, and unique culture at both national and international level. The mangrove forest is abundant and was declared a biosphere reserve by UNESCO and the Laemson Marine National Park – Kaper Estuary – Kaburi Estuary wetlands were registered as a Ramsar Site. There are natural attractions such as islands and scenic beaches, as well as unique species such as "water onions" – endemic plants that not be found anywhere else in the world. In addition, there is a natural hot mineral water pool in Ranong. The report on the Integration of the Andaman Tourism Industry into a Global Tourism Hub 2010 by the Southern Andaman Strategic Management Office indicated that Ranong received 400,000 tourists per year. Most tourists travel by private car and some travel by local buses. About 92% of visitors are Thai, and the number of both Thai and foreign tourists is increasing. In addition, Ranong has the potential to develop into the gateway for tourism to the southern islands of Myanmar.

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[20]Labour status report for Ranong, Timester/2 2016) April-June 2016(as accessed from ranong.mol.go.th/sites/ranong.mol.go.th/files/sthaankaarnaitrmaas_2-2559 on 27 March 2018

[21]National Statistics Office, Local level statistical database for Ranong, as accessed from: http://osthailand.nic.go.th/masterplan_area/userfiles/file%20Download/Plan%20Development%20Statistical%20Province/แผนพัฒนาสถิติจังหวัดระนอง.pdf

[22]Department of Fisheries, Fisheries Act as accessed from http://www.fisheries.go.th/cs-ranong/law%20on%20fisheries.pdf on 1 April 2018

The development of the area is based on the provincial development strategy, which centres on high-quality tourism, constructive agriculture, attractive living, and a quality gateway for trade. The expansion of urban areas, industries and tourism have challenges and impacts on the environment.

2.7 Conservation and zoning

The area includes several conservation areas and activities. The announcement of new conservation areas over time has led to overlap, causing problems in terms of management. Some key conservation activities are described below.

(1) International Wetlands (announced under Cabinet resolution of 1 August 2000). These include: Laemson Marine National Park (196,875 rai or 31,500 ha), Kaper Estuary (17,219 rai or 2,755 ha), and Kraburi River National Park Wetlands 120,675 rai (19,308 ha).

(2) Forest conservation areas (based on the Forestry Act). There are 4 types forest conservation areas: National Parks with 519,813 rai (83,170 ha), including Laemson Marine National Park, Ranong Islands National Park, Kraburi River National Park; the National Reserved Forest with 1,392,300 rai (222,768 ha) (13 reserves); Khlong Naka Wildlife Sanctuary with 331,456 rai (53,033 ha); and Pa Muang Kluang non-hunting area with 81,900 rai (13,104 ha).

(3) Mangrove conservation area (approved and declared by the Cabinet on 15 December 1987, 22 August 2000 and 17 October 2000). The official protected mangrove forest area is 198,467 rai (31,755 ha) and is dispersed over five districts. Of this area, 136,305 rai (21,809 ha) is within the National Reserved Forest and 20,889 rai (3,342 ha) in the National Parks. The actual forest cover is about three-quarters of the officially protected area for mangrove forest (see Table 3).

Table 3: *Mangrove forest areas (protected area and actual cover) per district in Ranong Province*

District	Mangrove forest (protected area)		Mangrove forest (actual cover)	
	Rai	(ha)	Rai	(ha)
Kraburi	18,204	(2,913)	12,795	(2,047)
Laoon	9,924	(1,588)	3,224	(516)
Muang Ranong	106,092	(16,975)	85,452	(1,367)
Kaper	36,986	(5,918)	30,336	(4,854)
Suk Samran	27,261	(4,362)	22,642	(3,623)
Total	198,467	(31,755)	154,449	(24,712)

Note: Some mangrove areas may be protected, but may not represent actual forest cover.

In the past, mangrove forests in Ranong were affected by concessions for charcoal, tin mining, shrimp farming, and conversion of land into residential and buildings. Tsunamis and coastal erosion also caused the rapid decrease of mangrove forests. This induced a stricter enforcement of conservation laws and the reclamation of shrimp farm encroachment areas to be rehabilitated into mangrove forest together with the community; an example of an important and successful reforestation is at Peerasak Forest which is in Bang-rin Subdistrict, Muang District.

(4) Ranong Biosphere Reserve. UNESCO announced the Ranong Biosphere Reserve in 1997 and it became Thailand's fourth biosphere reserve with international recognition and the world's first mangrove forest biosphere reserve. The reserve is in Muang District, with a total area of 189,431 rai (30,309 ha) of which 62,424 rai (9,988 ha) is mangrove forest; the areas is under the supervision of Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment. The goals include: the conservation of the mangrove forests; promoting research, education and training on mangrove forest resource conservation; and enabling people access to the benefits of mangrove forests for eco-friendly economic and social development. The area is divided into the zones: a *core zone* with 28,588 rai (4,574 ha) mangrove forest, over 500 rai (80 ha) of original forest housing 200 year old trees, and surrounded by canals and the sea and kept as aquatic conservation and nursery area; a *buffer zone*, covering an area of 121,250 rai (19,400 ha), with mostly mangrove forest and some community areas, shrimp farms, agricultural

areas and terrestrial forests; and a *transition area* of 39,594 rai (6,335 ha) made up of residential areas, roads, rubber plantations, oil palm plantations, coconut groves and abandoned mines.[23]

(5) Reforestation area operated by the Royal Forestry Department. This area is 1,944 rai (311 ha). The restoration activities are completed by local agencies and communities and implemented in many areas, such as the Civil Volunteer Project in Kaper District including 140 rai (22 ha), the Natural Reserve Forest Restoration Project (450 rai (72 ha)) in Laoon and Rajkood forests, and the Economic and Catchment Area Forest Rehabilitation Project in Bangkaew Subdistrict, Laoon District including 200 rai (32 ha) which has been operating since 2008.

(6) Environmental conservation/rehabilitation areas led by communities and NGOs.

- *Mangrove restoration (Kaper District)*. People from three villages Baan Chee Me, Baan Dan, Baan Bang Lamphu cultured mangroves and replanted them in the forest. There are more than 50 households in the area around Kaper Bay and most are dependent on cutting, weaving and sewing of *Nypa fruticans* leaves for sale all year-round. Another 10 communities on the outskirts of the area regularly utilize non-timber forest products in the area.
- *Sustainable management of mangrove areas (Muang District).* Villagers from Baan Tha Chang took initiative to conserve, rehabilitate and campaign for sustainable management of mangrove areas. There is a variety of activities, such as the release of the black tiger shrimp (*Penaeus monodon*) and white bass, the release of *Laevistrombus canarium* and *Cerithidea sp.* (horn shell) as well as planting *Nypa fruticans* along the canals. Swimming crabs were released into nature and "young fishmonger" training was held on an annual basis to distribute knowledge about the ecological system of the community and to raise awareness. The community mangrove recovered and baby *Laevistrombus canarium* were found in the area, but the community also reported the problem of the use of illegal fishing gear and practices where juvenile animals were caught to sell, thought they were not yet adequate size.
- *Participatory mangrove planting.* Oiska Foundation Thailand, a Japanese volunteer organization, collaborated with the Department of Marine and Coastal Resources to promote participatory mangrove planting with the local community; this was supported by the Tokyo Marine Corps of Japan, which has helped to plant mangroves in the area since 1981. Today, the total area is over 6,375 rai (1,020 ha).

A collaboration between the Department of Marine and Coastal Resources with the governor of Ranong, the Mangrove Forest Board, People's Mangrove Forest Conservation Network, conservation NGOs, and relevant government agencies are advocating for the wetland to become a World Heritage Site. The proposed area consists of mangrove forest, the Ranong Biosphere Reserve and Ranong Wetlands, totalling an area of 782,342 rai (125,175 ha), not including Koh Phayam. The Marine and Coastal Resources Administration Office 8 is the main unit responsible for implementing the regulations. The Office of Natural Resources and Environmental Policy and Planning Office also proposed Ranong as a pilot province for a Thai National Heritage site for its richness in natural resources and biodiversity, as well as arts, culture, customs and historical sites.

3 COMMUNITY AND WETLAND LIVELIHOODS

[23]Department of Marine and Coastal Ministry of Natural Resources and Environment, 2015

3.1 Communities and population

Ranong has a long coastal area, which stretches 173 km along the Andaman Sea. Most of the terrain is mountainous, accounting for 86% of the land area, with forest cover in the eastern part of the province. About 14% of the land area is plateaus, which are also on the eastern side and suitable for settlers. These are lowland plateaus near the foothills and narrow strips of coastal plains. There are also 62 big and small islands in the area. The geographical characteristics of the area affect the way people choose their livelihoods. There are three type of settlements:

1. *Settlements found in the valley and on steep slopes.* Most of the houses are in the sub-district of Laoon also known as the Valley City and some are found on the mountain ridges. Most of them are engaged in agriculture, rubber and coffee plantations, and fruit orchards. In addition, there are some local fisheries in the canals and in the coastal area. This can be considered a rural area.
2. *Settlements found on lowland plateaus.* This is before the low slope that connects to the coastline, such as in some areas of Muang Ranong District and Kaper District. Because the plateau is small, the housing settlements are clustered densely and the area has become a business and commercial district and government centre. This area is densely populated and has a mixture of both urban and semi-urban communities.
3. *Settlements along the coasts and on islands*. For example, Koh Phayam and Baan Tha Chang. The houses are clustered along a narrow beach that connects the estuary and inland ponds. The density of the housing cluster is higher than in the first group.

The population is concentrated in the lowland plateaus, which has become an urban area. However, most people still rely on the forest, canal, mangrove, coastal and island ecosystems for their livelihoods.

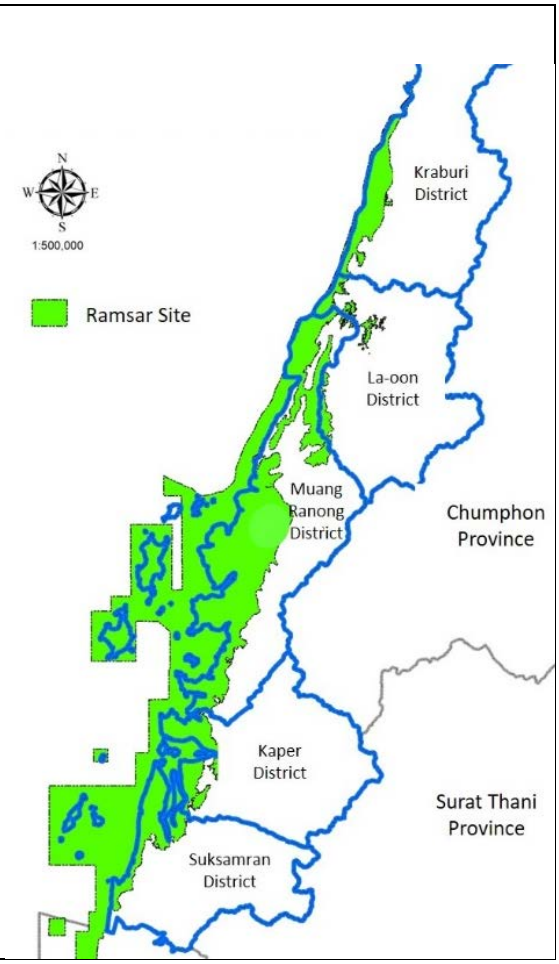
Within the site, there are 143,899 people (71% of Ranong's population), spread over 22 sub-districts of 5 districts (see Table 4).[24] The most populated area is in Muang Ranong District. The highly populated areas of Bang-rin (23,007 people) and Bang-non (13,581 people), form the transition areas between the commercial districts and the city centre; there is flat land for houses and farming – which is a main income activity of the people in the district – with products such as para-rubber, coconut, cashew nuts, bitter beans (*Parkia speciose*), and various fruits. In addition, the Klong Bang-rin, a natural canal, connects to the mangrove forest and the sea, supporting living conditions. Bang-rin Subdistrict also houses more than one hundred industrial plants, which is an important source of employment for local people and labour migrants (especially from Myanmar). Meanwhile, subdistricts in Laoon District have relatively low population numbers with Tai Subdistrict having the lowest with 1,315 people. Most of Laoon District is made up of forest and mountains with flat areas only at the foothills and valleys; thus, the terrain is not convenient for construction. Koh Phayam's population is also small with 1,544 people, if not counting the labor population of 2,200. Overall, the number of women is slightly smaller (46.6%) than the number of men (53.4%).

Most of the population is Buddhist (85%), followed by Muslims (13%), and Christians (1.7%).[25] Ethnically, there are Thai people who are Malay (Islamic) descendants, Chinese descendants (living mostly in urban areas), Mokens (an ethnic group on the islands), and local southern Thai. There are also migrant workers from Myanmar in the province.

[24]The Ramsar Site also includes 1 subdistrict of Phang Nga, but it was not included in this study
[25]Ranong Provincial Office as accessed from http://www.ranong.go.th/ on 25 March 2018.

Table 4: *Population data at sub-district level in the Ramsar site (source: adapted from The Bureau of Registration Administration, Ministry of Interior, 2018)*

District/ Sub-district	Population			Households
	Male	Female	Total	
Kraburi				
Lumliang	4,703	4,585	9,288	4,484
Nam-jued	2,149	2,015	4,164	2,141
Pak-jun	3,608	3,432	7,040	3,659
Mamu	2,409	2,481	4,890	2,475
Nam-jued Noy	1,541	1,569	3,110	1,237
Bangyai	1,655	1,574	3,229	1,347
Laoon				
Bangkaew	2,325	2,282	4,607	2,060
Laoon Nua	574	538	1,112	505
Bangpra Tai	503	478	981	425
Laoon Tai	854	851	1,705	733
Muang Ranong				
Bang-rin	11,294	11,648	22,942	15,665
Bang-non	6,734	6,874	13,608	7,984
Rajkood	5,419	4,346	9,765	3,270
Pak-nam	4,016	3,719	7,735	3,563
Ngao	3,323	3,266	6,589	2,216
Sai-deang	2,078	1,994	4,072	1,329
Koh Phayam	595	595	1,190	897
Kaper				
Ka-per	3,084	2,993	6,077	2,565
Bang-hin	2,278	2,125	4,403	1,625
Muangkluang	2,131	2,134	4,265	1,215
Suksamran				
Gumpuan	3,463	3,339	6,802	2,219
Nakha	3,587	3,704	7,291	2,108
Total	**68,323**	**66,542**	**134,865**	**63,722**



3.2 Key livelihood activities

The main livelihood is agriculture (para-rubber, oil palm and fruit orchards), followed by working as daily labourers in agriculture, industry and service sectors. Other occupations are in fisheries, aquaculture, and in the tourism and services sector.[26]

Agriculture. Despite limited lowland areas suitable for planting and poor soil conditions as result of mining, agriculture is the main occupation, adjusted for the steep slopes of the mountain sides. The main economic crops are para-rubber and oil palms, followed by fruit trees and coffee. Ranong Provincial Statistics Office indicated that the plantation area for both para-rubber and oil palms are likely to expand. Fruit orchards are diverse, there are plantations of mangosteen, longkong, rambutan, and durian; the number of fruit orchards has been declining because farmers are changing to oil palm and para-rubber.[27] Robusta coffee is grown in La-oon district. Agricultural practices in the area depend on rainwater, but if the amount of rain is too high it can cause the decay of products. On the other hand, if there is drought, the fruit trees will die. The people in this area are flexible in terms of livelihoods, for example, some may be both farmers and also work as seasonal employed labourers.

[26]Labour status report for Ranong, Timester/2 2016) April-June 2016(as accessed from ranong.mol.go.th/sites/ranong.mol.go.th/files/sthaankaarnaitrmaas_2-2559 on 27 March 2018
[27]Ranong Labor Situation Report, Tri-mester 2/2016 (April-June 2016) as accessed from ranong.mol.go.th/sites/ranong.mol.go.th/files/sthaankaarnaitrmaas_2559-2 on 27 March 2018

Fisheries and aquaculture. Traditional fishing is one of the most significant livelihood activities for local communities. Traditional fishery practices also have a spatial meaning; they include the ponds, mangrove forests, gulf areas, coastal areas or what is also known as the "inner sea," and extend to the open sea where there are islands, but not far from the coast due to the limitations of the type of boat and gears used. Most activities are at the household level and rely on family labour. Traditional fishing can be practiced throughout the year, during the monsoon season, fishermen will fish in the bay area, ponds, and mangrove forest. Fishing generates income and guarantees that there is food for consumption. Currently, marine animals are under pressure due to large-scale fisheries and the utilization of illegal fishing gear. As a result, there is a decline in species and quantity, which impacts traditional fisheries. In general, women fish in the coastal canals or mangrove forest areas, collecting shells, catching fish using fish nets, collecting shrimps, and looking for crabs, activities that they can do alone or as a women's group. Men participate in activities that require going out to sea and the bay, although some men may take their wives if there is not enough labour. Aquaculture is a relatively new practice in the area. Some residents culture mussels and soft-shell crabs in coastal areas, and others have shrimp ponds and fish farms, but there are not many people doing this because it requires high investment and it is highly sensitive to extreme weather. For example, heavy rainfall may reduce the salinity and affect the mussel farms which need salt or brackish water.

General/private sector employees. Many people work in the fishery industry and the processed agricultural products industry. There are as many as 107 industrial plants in Bang Rin Subdistrict that hire workers on a fulltime basis. In some communities (e.g., Baan Hua Tha, Baan Tha Chang, Baan Lang, Baan Sai Daeng, all Muang Ranong District), more than 70% of the population work as industrial labourers. Most workers in the agricultural sector also work as hired hands in rubber and oil palm plantations and as fruit collectors in orchards. Other hire hand jobs include catching shrimp, peeling shrimp and preparing krill. Almost all these jobs are temporary employment. Industries with labour intensive activities, such as catching shrimp and transporting oil palm, generally employ men whereas those which are less labour-intensive, such as peeling shrimp and preparing krill, employ females.

Tourism and related services. There is a movement to develop and improve the community to become a tourist attraction, especially in the area of La-oon District. Ecotourism initiatives emphasise culture and ecology, while promoting the simple ways of life, relying on homestay schemes. In Muang Ranong, Koh Phayam village tries to highlight tourism in natural locations such as beaches and islands, where it got its nickname "Maldives in Thailand." Although tourism in both areas "sells" the abundance and beauty of nature, the expansion of the tourism sector has had a negative impact on the environment. For instance, Koh Phayam produces an average of 5 tonnes of waste per day, exceeding the disposal capacity of the island; waste is dumped near the houses, on the roadsides, and some is left floating in the sea, stuck in mangroves and washed on to beaches.

3.3 Use of wetland resources

The wetlands provide space for people to settle and make a living. The site is not only accommodating local people, but also supporting people from outside who both directly and indirectly utilize the area. There are different types of resource utilization in the area:

- **A source of materials/construction and energy.** The wood from the mangrove forest is popular for firewood, making charcoal, and building various traditional fishing tools.[28] Prior to the strict enforcement of Royal Forestry Act, these activities were intensive in the area. Most villagers burned trees in the mangrove forest to make charcoal, cut them into firewood for household use and sale, and made fence posts and tree supports for agriculture. In addition, wood from *Avicennia alba* and *Xylocarpus* (both mangrove

[28]Sanit Aksornkaew, 2009:11.

species) was used for making fishing tools such as posts for culturing mussels and crab catching tools. *Nypa fruticans* is also considered an important plant species by the community. People use the leaves to weave and make roofs, and the fresh juvenile leaves are dried and rolled into traditional cigarettes. Mangrove forests were being used in a variety of ways and this enabled villagers to be self-reliant in terms of energy and other livelihood activities. However, the use of mangrove wood is currently restricted, and the mangrove forest has been classified as conservation forest.

- **A source of food.** Mangrove forests, ponds and canals, rivers, and the sea are important food sources for local vegetables and animals. The resources are heavily used in home consumption throughout the year. Women often combine collecting and catching food sources with other activities. As highlighted in the community assessment, women that live near the mangrove forest of Klong Lae Tae do not need to set aside much time to find food; they can use the time after they have completed other household chores or worked in the fields, plantations or orchards. They can go alone or in groups to catch fish and crabs, or to find shells. This activity may last anywhere from 2-4 hours in the canals and mangrove forest near their villages. If the catch is small, it will be cooked and consumed in the household. If they have a good catch, some will be sold at the community level. There are occasions, depending on the season, where they spend all day catching animals for sale and take cash home such as in the season for catching krill. While some of the plants and animals, such as serrated mud crab, snapper, melinjo leaves, and vegetable ferns (*Diplazium esculentum*) are available for consumption throughout the year, some are only available on a seasonal basis such as *Nypa fruticans* flowers, krill, and jellyfish. The availability of resources in each season give the villagers a diverse selection and ensures food security.
- **A source of income**. It is difficult to separate food security and economic stability of local people. Fisheries are an important source of income; this is mainly because traditional fisheries can be used throughout the year. During the monsoon season, when the boats cannot go out into the ocean, they will fish near the coast, in the estuary, ponds and canals, or in Kaper Bay. Households that make a living as fishermen will emphasize catching fish for sale and using the cash to buy other products needed for the household. On average, one household earns 10,000-20,000 THB (US $312-625) per month from fisheries.[29] The income and selling price depend on the timing and market demand.

Wetlands, especially mangrove forests, also function as protection against natural disasters. The impact of the 2004 tsunami was not as severe as in other areas in Southern Thailand, through it did affect 5,942 people (1,509 households) in Ranong Province and caused estimated damage of 321 million THB (US$ 10 million).[30,31] The communities believe that the mangrove forest played an important role by reducing the impact from the waves that inundated the villages. Currently the government and communities are working together to rehabilitate the mangrove forests through replanting and conservation activities so that they will be healthy and resilient. Healthy mangroves forests act as an aquatic animal nursery, and the rehabilitated mangrove area is also intended to be a defence system against future disasters.

3.4 Land tenure and land-use rights

Land use rights in the area are highly unstable; more than 80% of the land in Ranong Province was declared conservation forest, and there is area reserved for livestock, public ponds and state property, and government offices. This is impacting local livelihoods and residential areas.

[29]Information from community assessments of fishmongers in Baan Bang Hin village, Bang Hin sub-district, Kaper district on 9 December 2017.
[30]Database of people impacted by natural disasters, Disaster Victims Information Center, Department of Disaster Prevention and Relief, Ministry of Interior on 5 September 2005, as accessed from http://www.disaster.go.th/th/content-dispatch-1-0 on 5 April 2018.
[31]As accessed from http://www.komchadluek.net/news/local/77896 on 27 March 2018.

Conflicts between the government and communities occur throughout the area as the result of multiple ownership and land use certificates, which partly overlap with the reserved conservation area. For example, in one village in Muang Kluang Subdistrict, Kaper District, people held title deeds for 50 rai (8 ha) of the land for livelihood purposes and residential areas, but also claimed another 1,361 rai (218 ha) through other types of land-use certificates.[32] Most of the villagers of Phayam Island do not have certificates or title deeds due to conflicting land boundaries with the National Parks and the National Reserved Forest. In Nam-jued Subdistrict there are agricultural and residential lands in forest areas, and some people are trying to prove their right of use based on Cabinet Resolution 1998, regarding measures and resolutions on land use in forest areas.

3.5 Governance

Wetland management in Thailand falls under the jurisdiction of the National Environment Board, and is composed of a committee, a sub-committee and a working group. Their role is to specify the policy and plans for the management of wetlands in Thailand (see Annex 3 for wetland management policy since 1997). The management structure started to operate in 1993, as authorized through Section 18 of the National Environmental Quality Promotion and Conservation Act 1992.

The National Environmental Board appointed a sub-committee for wetland management, which is composed of representatives from relevant agencies, both governmental and non-governmental, and relevant experts. The wetlands subcommittee assists in developing rules and regulations, policies and national plans, and guidelines for the management and protection of wetland areas – in line with the policy for monitoring and evaluation as indicated in the Wetland Convention and relevant international agreements.[33] It also supports education and research, promotes participatory problem-solving, and establishes networks for cooperation between relevant agencies and domestic and international organizations. The Wetlands Working Group was appointed to support the work of the Wetlands Sub-Committee.

Most recently, the Office for Natural Resources and Environmental Policy and Planning developed the Master Plan on Integrated Biodiversity Management 2015-2021. The Master Plan was approved by the Cabinet in March 2015 and integrated into the Wetland Action Plan. Wetland conservation measures were set up according to the Cabinet Resolutions of November 2009 and May 2015 (see Annex 4). These measures are currently being implemented and involve many agencies. There are no specific governance structures for the Ramsar Site as a whole, nor for each of the Internationally Important Wetlands.

3.6 Stakeholder analysis

There are many different interest groups that can be distinguished. Main stakeholder groups are:

- **Farmers.** Agriculture is the main occupation for people living in the wetlands, with 24% of the total population engaged in farming. The trade value in 2017 totaled 4,864 million THB (US $152 million), with an employment of 61,989 people (45% of the workforce).[34] The main economic crops are para-rubber, oil palms and fruit. This stakeholder group faces challenges in terms of land use rights and seasonal variability – whether it is the early rainy season with heavier rains and longer lasting rainfall or severe droughts, weather directly affects productivity and production methods. There is currently no systematic management of water in the agricultural area.

[32]E.g., Nor Sor 3 Kor, Sor Por Kor, Sor Kor 1, Royal Land Certificate

[33]E.g., the International Convention on Wetlands or RAMSAR Convention, the Biodiversity Convention, the Convention on the Conservation of Migratory Species (Bonn Convention), the Man and Biosphere Reserve Project, and the United Nations Framework Convention on Climate Change (UNFCCC); in addition, there are at least 22 articles/acts of legislation dealing with the management of wetlands (ONEP, 2017)

[34]Ranong Labor Situation Report, Tri-mester 2/2016 (April-June 2016) as accessed from ranong.mol.go.th/sites/ranong.mol.go.th/files/sthaankaarnaitrmaas_2-2559 on 27 March 2018

- **Fishermen.** This group includes commercial and traditional fishermen. Fisheries are important to Ranong's economy. For 2016, sales of aquatic animals alone were 36,100 tons, valued at 2,265 million THB/year (US $71 million/year). When related activities are included, the value is around 4,000 million THB/year (US $125 million/year).[35] This group directly utilizes the resources from the wetland and faces decreasing populations of aquatic species found in the area due to natural disasters and human threats.
- **Business and industry.** In 2017, 315 factories in Ranong had licenses to operate. The total capital invested was more than 3,621 million THB (US$ 113 million), providing employment to 7,460 Thai nationals,[36] and tens of thousands of migrants. Most of the industries are related to fisheries; food production counts for 23% of the factories, which includes 31 ice factories, 12 minced fish factories, 10 frozen fishmeal factories, and 4 cold storage plants. Second is the transportation industry, which makes up 17%, followed by the timber and wood product industry at 15% of the factories. Most of these factories are in Muang District (Ranong Provincial Office, 2018).
- **Tourism and services.** In the past 10 years, natural tourist attractions in the area have become more popular with tourists visiting Koh Phayam, experiencing the local culture through a homestay at La-oon district, or visiting a coffee shop and houses surrounded by nature. Other attractions are cruises on the Kraburi River, so that visitors can observe the lifestyle of the people on the river. It is likely that this type of business will expand to accommodate the consumer market. Ranong is also connected to Myanmar, where people like to cross and go to Song Island and Emerald Island. Business owners include local operators, outside operators and foreigners.
- **Communities.** Communities depend on and utilize resources in the Ramsar Site for consumption, selling and for other livelihood purposes. Therefore, they are highly vulnerable to changes in the natural environment. They experience problems with the expansion of urban and industrial areas, development projects, and intensive use of resources to support the trade system; this has led to environmental risks, economic instability and food insecurity among communities. This stakeholder group includes the Community Organizations Development Institute (CODI), a public organization in the south, the Andaman Organization for Participatory Restoration of Natural Resources (ARR) and the OISCA Thai Foundation, which seeks to promote and campaign for sustainable wetland resource management and the strengthening of community-level organizations. These organizations are also promoting the Ramsar Site and surrounding area to become a world natural heritage site.
- **Government agencies and authorities.** Government authorities and other local agencies play a role in the implementation of wetlands conservation measures in the area. These include the Local Administrative Organization, educational institutions or schools and academic institutions in the wetland area, and the Provincial Natural Resources and Environment Office.

3.7 Gender and vulnerable groups

Small-scale farmers and fishermen are highly dependent on natural resources and the weather. Fishermen that depend solely on catching aquatic animals for sale and consumption are especially vulnerable. Women who rely on catching aquatic animals as their main source of income are also vulnerable due their limited access to resources in terms of equipment, area, and the added responsibility for taking care of their families. In case of farmers, land insecurity further compromises their situation.

Specialized farmers, e.g. in para-rubber plantations and fruit orchards and aquaculture, are also vulnerable. They often have high investment costs, while their business depends on the weather

[35]Ranong Provincial Office, 2018
[36]Ranong Provincial Industrial Office, 2017

conditions. For example, harvests and fruit-setting are highly sensitive to rainfall, while aquaculture in canals and beach areas is highly sensitive to changes in salinity.

Species community groups, such as communities along the shore, are sensitive to erosion and uncertain weather patterns, which threaten their houses (some are caught in between mountains and the sea). The Moken people, an ethnic minority group, which has been marginalized in terms of education, rights, and citizenship, are vulnerable. They are living on islands, but instead of benefiting of growing tourism, they have been further marginalized.

3.8 Perceived threats to wetland habitats and livelihoods

Threats to the way of life of people living in and dependent on the wetland can be classified into human threats and threats from natural causes, although the later are sometimes caused by humans as well.

(1) Human-induced threats. These come in various forms, both intentional and unintentional. Threats are most commonly from changes in the wetland ecosystem and the over-exploitation of natural resources.

- **Loss of habitats/over-exploitation**: Urban expansion and population growth are drastically changing the landscape. Roads, airports, draining/dredging, land filling or governmental and industrial facilities affect wetlands. In addition to the loss of habitats and biodiversity, resources are put under further pressure by illegal and unsustainable practices, such as the use of illegal fishing gear, catching fish in the spawning season, using chemicals to catch shrimp, and the use of large pull-nets that destroy mangrove soil.
- **Water and air quality**. Wastewater is being discharged from households, communities and establishments without pre-treatment process. The province is trying to develop a waste disposal centre and wastewater treatment facility in Pak-nam Subdistrict, Muang District. At present, the feasibility study of the project has been completed. There are also many complaints about air quality, such as odour problems from the smell of fish from the mincing factory and the accumulated remains of marine animals that cause discomfort to people.
- **Waste disposal.** There are three waste disposal areas in the province with about 239 tons/day of solid waste to manage; in addition, 23 tons/day of solid waste is produced from the latent (migrant) population. The total waste produced per day from households and industries in the province is about 262 tons. The large number of tourists that arrive each year, such as in Koh Phayam, generally additional waste. Currently there are insufficient waste disposal facilities to process inputs. Fishing boats have been reported to carry waste out through the canals and discharge it into the sea. This has a direct impact on the wetland and marine ecosystems.

(2) Threats from natural disasters and climate change:

- **Natural disasters**. Ranong has a high risk of landslides, especially when rainfall reaches 100 mm per day. The lack of a rooting system to hold the top soil together and steep slopes contribute to increased landslides. Droughts occur in the dry season and lead to a lack of water for consumption and agricultural activities. During the monsoon season there are floods and because the area includes lowlands in between mountainous areas, there is strong and fast flowing surface runoff during heavy rain, causing floods and mudslides in flat areas or near riverbanks. Ranong is also vulnerable to harsh wind and tsunamis. Natural disasters also impact resource habitats. In the past, aquatic animals have migrated due to such events, which affected the community's income and use of traditional ecological knowledge. In addition, strong waves also cause coastal erosion.
- **Climate change.** Climate change is becoming an increasingly important factor, exacerbating existing threats and impacting wetland resources and communities that depend on them.

4 CLIMATE PROJECTIONS FOR THE SITE

4.1 Overall climate projections for Thailand

A modelling study by the Office of Natural Resources and Environmental Policy and Planning on historic climate and climate change projections for Thailand has projected rainfall and temperature patterns and trends for the period 1961-2100.[37] Monsoons from the southeast will become more severe; the time duration between rainfall events will become longer, but amount of rain per event will increase with increased chance of floods. The Thai summer will extend, delaying the start of rainy season. Weather turbulence will increase, with Thailand facing more flood problems due to changes in the direction of monsoon winds – blowing more to the west when it used to blow north – including typhoons that move down to the south from October to December. The climate model indicates that in the next 60 years there will be 20% more rain compared to the past 100 years. Bangkok will be at risk of being a typhoon-prone area. The northeastern typhoons that blow to the south will not only bring rain but also create 3-4 m high ocean waves, causing erosion for up to 400 km of coastline.

4.2 Climate projections for Ranong Province

Ranong is on the Andaman coast of Thailand, in the narrowest part of the Malay peninsula between the Pacific Ocean and the Indian Ocean. Due to the vapour and moisture it receives from the southwest monsoon winds from the Indian Ocean, it gets more and heavier rain than other provinces. Using the PRECIS mathematical model developed in 2011, climate scenarios are presented for 30-year timeframes: 2010-2039, 2040-2069, and 2070-2099, using 1980-2009 as baseline.[38]

Temperature. Based on the model, average temperature shows an increasing trend for 2010-2039 and rises by 1-2°C during 2040-2069 and more than 2°C during 2070-2099 (Figure 10). The maximum temperature will be 1-2°C higher for 2040-2069 and more than 2°C higher for 2070-2099. The number of hot days will increase with 15-30 days for 2010-2039 and more than 60 days for 2040-2069 and after. The minimum temperature also rises by 1-2 °C for 2040-2069 and more than 2°C for 2070-2099. Most importantly, lows will never exceed 16°C. The findings are in line with the Master Plan for Climate Change Adaptation and Mitigation 2015-2040 and the National Master Plan for Climate Change 2010-2019. [39,40]

[37] http://www.onep.go.th/bangpakong-river/index.php?option=com_content&view=article&id=48&Itemid=62
[38] Chulalongkorn University, 2011.
[39] Office of Natural Resources and Environmental Policy and Planning, 2015
[40] Institute of Public Policy Studies, Chiang Mai University, 2009

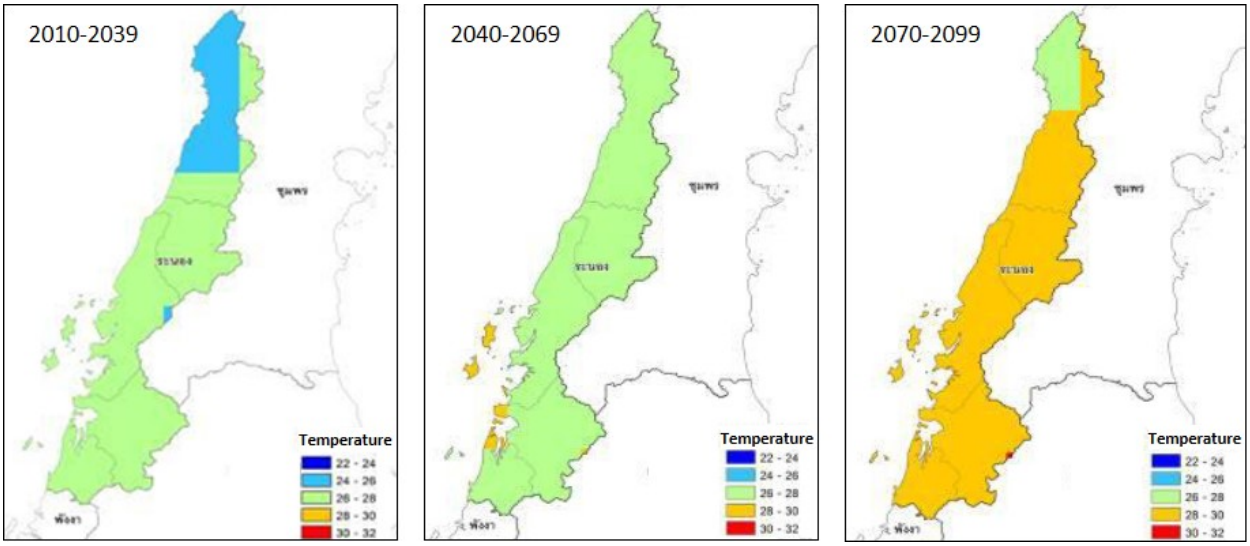


Figure 10: *Average temperature in 30-year periods for Ranong Province (source: Chulalongkorn University, 2011).*

Rainfall. Using the same model, rainfall trends were calculated up to 2100 (Figure 11). It is estimated that annual rainfall will be 3,700 mm/year for the first period (2010-2039), which is close to that of the baseline.[41] For some areas, it is likely to increase by 10-20% for 2040-2069 and there is a tendency that it will increase by another 20% for 2070-2099. This affects the number of rainy days, which was 120-150 for the baseline but is expected to increase with 5-10 days for 2010-2039, and by more than 10 for 2040-2069 and after.[42] Heavy rainfall events are forecasted to occur an average of 30-40 days per year. For 2010-2039, the amount of rain will likely be the same as for the base years, but by 2040-2069 and after, the number of days with heavy rainfall will increase by more than 4 days. Rainfall forecasts from the Office of Natural Resources and Environmental Policy and Planning,[43] Public Policy Studies Institute of Chiang Mai University,[44] and the Academic Services Centre of Chulalongkorn University, all indicate that Ranong Province will have a longer rainy season with heavier rainfalls. [45]

[41]Rainfall data presented in section 2.2. were based on observed rainfall data and referred to a different period, which may explain the difference.

[42] Raining days, days with more than 3 mm/ day of rain, and days with more than 35 mm/days of rain

[43]Office of Natural Resources and Environmental Policy and Planning, as accessed from http://www.onep.go.th/bangpakong-river/index.php?option=com_content&view=article&id=48&Itemid=62 on 3March 2018

[44]Public Policy Studies Institute, Chiang Mai University. National Master Plan for Adaptation to Climate Change 2010-2019 as accessed from www.eppo.go.th/index.php/th/component/k2/itemlist/.../404-2016-03-16-03-42-48 on 25 March 2018

[45]Academic Services Center, Chulalongkorn University, Southeast Asia's Global Climate Change Analytical, Research and Training Network Center, Chulalongkorn University and Climate Change and Future Climate Fluctuation and Adaptation in Major Sectors Project as accessed from www.undp.org/content/dam/thailand/.../SNC%20Vol%202_Impacts%20of%20CC.pdf on 8 April 2018.

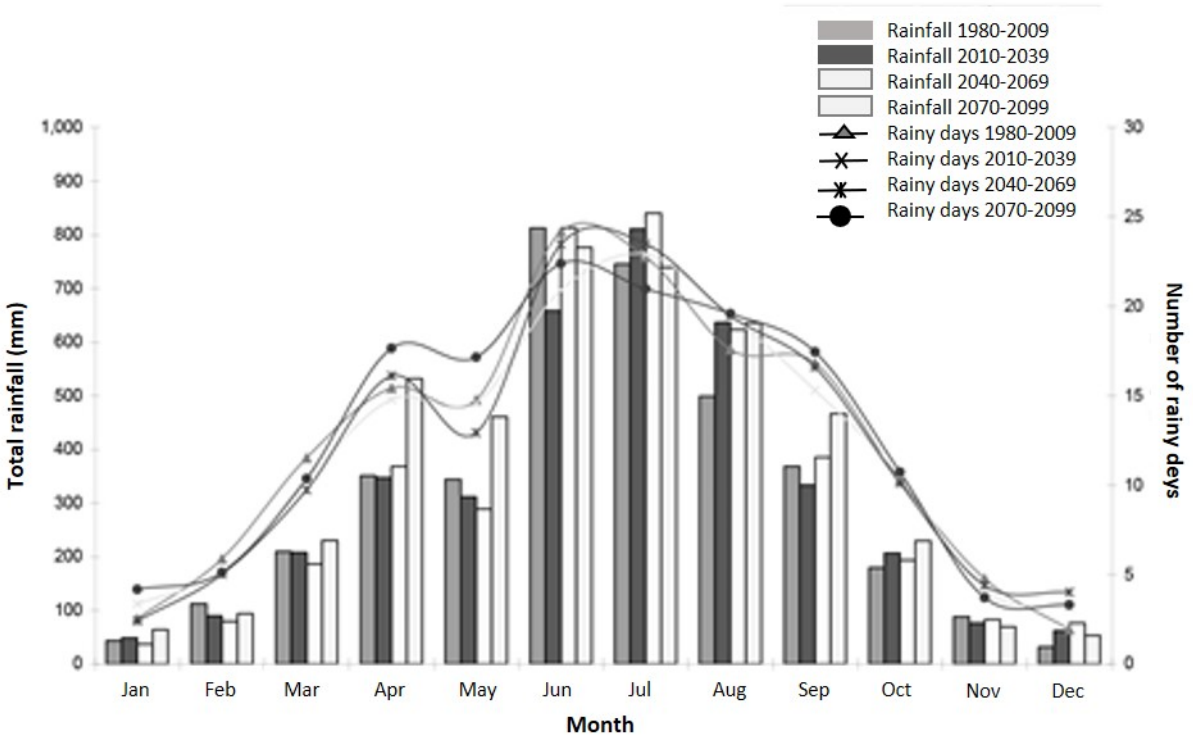


Figure 11: *Rainfall trends for 30-year time frames in Ranong Province (source: Chulalongkorn University, 2011)*

Heavy storms. There have been several heavy storms between 1951-2016 in Ranong.[46] Typhoon "Harriet" in 1962 was severe and caused widespread damage. People were injured and killed, and houses and property were damaged. In 1972, Typhoon "Sally" caused heavy rainfall measuring 94 mm in 24 hours. Because the number of typhoons in the Andaman Sea is limited, it is difficult to predict whether these types of events will increase. However, the southern provinces on the west coast, including Chumphon, Krabi, Ranong, Phang Nga, Phuket, Trang and Satun have been identified as vulnerable to disaster due to monsoons and tropical cyclones from the sea. The results of the impact will be heavy rain, risk of loss of life, and damage of assets and housing. Strong winds and currents affect fishing boats, their equipment and coastal aquaculture; strong winds also result in the loss of trees in terrestrial and mangrove forest and in erosion and loss of coastal areas.

Sea level and coastal erosion. Sea levels tend to rise globally because of the melting of polar ice and the expansion of ocean water from rising sea temperatures. An assessment of future sea level trends in the eastern and western coasts of the southern Andaman Provinces,[47] indicates that for 2010-2039 the mean sea level will rise in almost every province by 5-10 mm/year (or 15-30 cm by 2040 when compared to 2010). Based on the forecast of the sea level change in Krabi Province, which is on the same coast, the mean sea level between 2020 and 2050 will increase by 11-21 cm when compared to the base year (1995) due to the influence of the Southeast monsoon.[48] The 2007 Intergovernmental Panel on Climate Change (IPCC) showed that seawater temperatures will rise 1-3 °C for all regions. This will put corals at risk of bleaching and affect aquatic nurseries. The expansion of seawater will also put low coastal areas including houses, beaches and mangroves at risk of flooding and coastal erosion.

[46]Poramet Amattayakul and Taywin Jometa. Meteorological Facts for Agriculturalists in Ranong, 2017 as accessed from http://www.arcims.tmd.go.th/DailyDATA/Agroreport.html on 15 April 2018
[47]Using the average sea level rise model from the DIVA program (CINA-COAST (2003and SREA Emission, in conjunction with the study by Chulalongkorn Academic Services Center ((2011
[48]ONEP, 2015

4.3 Summary of predicted impacts of climate change

Overall, the predicted climate trends for Ranong can be summarized as follows:

- Rising temperatures with longer summers, shorter winters and intensifying drought conditions;
- Heavy and more frequent rainfall during the rainy season and turbulent fluctuating weather conditions;
- Storms expected to become more severe, increase in monsoons, strong winds and tropical storms. The wetlands are in a risk-prone area,
- Sea level will increase by 5-10 mm/year until 2040 (and will continue to rise), exacerbating coastal erosion rates which are likely to be higher in the beach areas compared to the floodplains connected to the mangrove forests;
- Sea temperatures are likely to rise 1-3^{o}C, affecting corals, aquatic nurseries, and fisheries, and increase risks of floods and erosion.

The change in climatic conditions will affect ecosystems and increase the risk of saltwater intrusion, seasonal variation, and food and economic insecurity. In addition, there is a risk of losing land along the coast, disease outbreak, and conflicts related to the management and utilization of resources in the future.

5 RESULTS OF VULNERABILITY ASSESSMENT

5.1 Habitat vulnerability

The assessment team conducted vulnerability assessments for 10 habitat types in the wetland to determine the threats of future climate change in Ranong Province. Data was based on consultations with communities, relevant institutes and resource experts.

5.1.1 Baseline threats

Baseline information and main threats are summarized for each habitat.

(1) Estuaries. The estuaries have high biodiversity and provide an important source of food and economic security for the community. The estuary is the meeting point of rivers and the sea; changes in water flows (intensive rainfall/droughts) affect the habitat and the animals and plants that depend on it. Non-climate threats include the expansion of districts such as Muang Ranong, Kraburi and Kaper, into economic centres, encroaching near the river and estuaries, forming a potential threat.

(2) Mangrove forest. There has been a permanent loss of the forest floor due to utilization in the past; the area has been used as a waste dumping facility, port, and been developed for offices or other facilities related to mining concessions of forest areas. Currently, shrimp farming and the expansion of urban areas and tourism are a concern, but mangrove forests are strongly protected and being restored.

(3) Seagrass. Storm surges, windstorms, and the destruction of forest areas increase the volume of sediments in the river which flows into the sea and affects the survival of seagrass. In addition, human activities such as coastal fishing using trawlers and push nets, water discharge from coastal aquaculture, and wastewater discharge from homes/factories accelerate the destruction of seagrass beds. This makes seagrass one of the most vulnerable habitats.

(4) Canals and rivers. Water quality in canals and rivers is a major concern; current threats include the development of sanitation systems and facilities (such as roads, bridges, and water drainage), dredging of canals, illegal rock mining, expansion of residential/industrial areas, and solid waste disposal and wastewater discharge. At the same time, the expansion of agricultural areas near natural canals and riverbanks has led to problems with soil erosion, while man-made changes in the river system may cause water to flow faster and stronger, further increasing the risk of landslides along riverbanks.

(5) Islands. Islands provide important habitats for fish, coral reefs, seagrass and mangrove forests. The expansion of the tourism industry is leading to issues that include solid waste accumulation, lack of fresh water, and over-exploitation of fishery resources. Meanwhile, indigenous people face challenges in adapting to a rapidly growing tourism-based economy.

(6) Coral reef. Coral reefs are affected by the expansion of terrestrial construction, which increases turbidity and affects symbiotic photosynthesizing zooxanthellae. The discharge of wastewater from households and industries into the sea increases nutrients and can lead to eutrophic conditions. Coral bleaching, or the expulsion of symbiotic zooxanthellae, also occurs when the corals are stressed by elevated water temperatures over an extended time period.

(7) Beach. The beach ecosystem is highly exposed to factors such as daily tides, currents, and changing salinity levels, but the habitat and its organisms are generally well adapted to these dynamics. Urban expansion, construction on the beachfront, and increasing tourism activities, are affecting the coastal area and species that live in the area such as turtles which use it as their breeding area.

(8) Active tidal flats ("Paa Cheong Song"). These areas are only flooded by seawater a few times per year. They house specific biota, including mangrove trees, terrestrial trees and brackish water trees. The lack of knowledge and gaps in appropriate management has allowed for encroachment and the exploitation of resources.

(9) Beach forest. The beach forest is constrained by the high soil salinity, and low nutrients and moisture retention. Most plants grow slowly and big trees fall easily in the loose substrate. Layers of deciduous tree leaves covering the soil interfere with regeneration of other species and can act as fuel for surface fires. In the past, there was not enough knowledge of coastal forest ecology to properly manage the area, but the main risk is urban expansion, which has caused permanent loss of forest areas.

(10) Coastal and marine area. The coastline of Ranong Province is 135 km long with seven areas facing coastal erosion, encompassing 23 km (17% of the total coastline). Ban Talay Nok, Amphoe Kapur, is facing severe coastal erosion around the beach area, which opens directly to the Andaman Sea; the 4 km eroded distance has occurred continuously since 1977 with an erosion rate of 6 meters per year. The erosion is caused by the southwest monsoon. The other areas suffer moderate erosion, including Bang Prapas Beach, Bang Bane Beach, Ban Hin Kong, Ban Tah Bhodi, Ban Khao Hin Chang and Sai Dum Beach. Coastal erosion also affects marine areas and the animals and plants that live in it.

5.1.2 Climate change vulnerability

The vulnerability of habitats to climate change depends on their exposure and sensitivity and ability to recover from impacts (Chapter 1, Box 1). Table 5 provides a summary of these aspects for key habitats.

Table 5: *Summary of climate vulnerability characteristics of wetland habitats in Ranong*

Habitat	Exposure	Sensitivity	Adaptive capacity
Estuary	- Typhoons/winds storms - Harsh winds/strong waves (may lead to temporary temperature increase sea water) - Seasonal fluctuations: heavier and longer rains/severe droughts - Higher temperatures	- Erosion - Ecosystem changes (water trenches turn into sand dunes)/tidal changes - Rapid changes salinity level - Decline in aquatic population (temporary) - Flooding from rising sea water level and/forest surface overflows.	- Moderate/high
Mangrove forest	- Typhoons/wind storms - Seasonal fluctuations (heavier and longer rains/severe droughts) - Higher temperatures	- Sensitive to changes in salinity - Damage of mangrove forest - Mangrove forests eroded - Affect diversity of species	- High (large area; strongly protected)
Seagrass	- Harsh winds/strong waves - Seasonal fluctuations (heavier and longer rains/severe droughts) - Higher temperatures	- Senstivy to changes in salinity - Damage seagrass beds	- Moderate
Canals and rivers	- Harsh winds/strong waves - Heavy continuous rainfall (flood) - Severe droughts / long rain gaps	- Erosion of river banks and land slides - Change in tidal system/river currents - Freshwater not suitable for brackish water animals and mussel culturing - Canal too saline for brackish species to lay eggs	- High
Islands	- Heavy continuous rain and floods - Severe droughts/ long rain gaps - Heavy storms/strong waves	- Risk of landslides in mountains - Natural (fresh) water sources drying	- Moderate
Coral reef	- Harsh winds/strong waves - Seawater temperature increase - Seasonal fluctuations	- Coral beds destroyed - Coral bleaching	- Low
Beach	- Typhoons/wind storms - Seasonal fluctuations (heavier and longer rains/severe droughts) - Higher temperatures	- Damage of beach/erosion - Changes in salinity and temperatures affecting aquatic species	- Moderate/high (resilient)
Active tidal flats	- Harsh winds/strong waves - Seasonal fluctuations (heavier and longer rains/severe droughts)	- May change ecosystem if flooded for longer period	- High (dynamic; used to change)
Beach forest	- Harsh winds/storms - Droughts/higher temperatures	- Beach forest destroyed/fallen trees - Forest fires	- High
Coastal and marine area	- Typhoons/wind storms - Harsh winds/strong waves	- Erosion of coastal area - Affecting marine life	- High (dynamic large area)

Heavier and more frequent rainfall affects waterflows in rivers and changes the balance of freshwater and saltwater in estuaries. Relatively rapid changes in salinity have a big impact on living conditions in certain areas, while long-term changes have a more lasting effect on general ecological conditions. If temperature increases, it may negatively affect animals that live in mud areas or j shrimp living in the estuary, undermining the nursery function of the habitat. High tides and heavy rains also cause erosion, and this is expected to get worse due to sea level rise; temperature increase will also affect species diversity in the mangrove forest and seagrass beds, although mangrove forests are protected and cover relatively large areas. Changes in river water flows do not only affect estuaries, but also erode riverbanks and may lead to loss of species such as water onions, which depend on the current ecosystem.

The island ecosystem is affected by currents, floods and storms; droughts may also intensify and result in freshwater shortages when combined with the expansion of tourism. Increased rainfall

may lead to mudslides in the high mountains of the island. Coral reefs near islands and shallow waters are also highly exposed; they are sensitive to rising sea temperatures, which have already led to bleaching events in the Andaman Sea. Corals tolerate a narrow range of temperatures (18-28 ºC) and salinity levels in the range of 30-36 ppm. If the temperature rises, even for a short period of time, corals may bleach and eventually die under sustained increased temperatures.

Beach areas are exposed to a range of elements. During the day, the sun and heat cause water in the sand to evaporate, making the soil saltier than normal. During the summer, increased temperatures may kill some animals during low tide because of dehydration; especially those that live in tidal areas and are exposed to direct sunlight. These conditions will become more extreme. Animals that cannot tolerate these conditions need to adapt their behaviour; for example, snails bury themselves in deep sand or attach themselves to gaps in the rocks and keep their shells tightly closed to reduce contact from sun, while other animals form mucus to prevent loss of water and direct contact from sunlight. High temperatures and lack of rain will stress coastal forests in severe droughts, while tidal flats may become inundated for longer periods due to flooding. Beach areas are generally well adapted to deal with natural changes.

Finally, Ranong's coastal and marine areas are strongly influenced by storm surges and sea level rise, which may have a negative impact on animals and plants living in the sea and along the coast. This may be further compromised by higher sea temperatures. Strong windstorms and sea level rise may also increase already high rates of coastal erosion, such as in Laemson Marine National Park.

5.1.3 Overall vulnerability

Baseline conversation risk and climate change vulnerability scores and status are summarized in Table 6.

Table 6: *Vulnerability of habitats in Bang Pakong River Wetland*

	Habitat	Baseline Conservation Risk		Climate Change Vulnerability	
		score	status	score	status
1	Estuary	1.9	M	2.0	M
2	Mangrove forest	1.9	M	1.8	L
	Seagrass	2.3	H	2.1	M
4	Canals and rivers	2.3	H	1.8	L
5	Islands	2.1	M	2.0	M
6	Coral reefs	2.3	H	2.4	H
7	Beach	2.1	M	2.2	M
8	Active tidal flats	2.1	M	1.8	L
9	Beach forest	2.1	M	1.8	L
10	Coastal and marine area	2.4	H	1.9	M

Note: Risk status categories are Very Low (1.0- 1.4), Low (1.5-1.8); Moderate (1.9-2.2); High (2.3-2.6); Very High (2.7-3.0)

All habitats are currently under threat to some extent but differ in their vulnerability to climate change. The habitats can roughly be divided into four categories:

- *High vulnerability*: Coral reefs (6) are currently under pressure of heavy pollution and are highly sensitive to changes in salinity and temperature.
- *Medium to high vulnerability*: This applies to sea grass (3), canals and rivers (4), and sea and coastal areas (10). These are currently under severe pressure of pollution, destruction and erosion; the impact of climate change is moderate, but less important than non-climate factors.
- *Medium vulnerability*: The estuary (1), islands (5), and beach (7) are currently at risk, but less so compared to habitats mentioned above. They are moderately affected by climate change.

- *Low to medium vulnerability*: Mangrove forest (2), active tidal flats (8) and beach forest (9) show moderate vulnerability to current impact (mainly non-climatic) and relatively low vulnerability to climate change; these habitats are relatively well adapted to natural dynamics or, as in the case of mangrove, large areas are well protected.

Differences in assessment scores between habitats were small and conditions may change over time, suggesting a need for regular monitoring.

5.2 Livelihood vulnerability

For the vulnerability assessment of communities, three aspects were considered important: (1) Involvement of experts from various sectors relevant to the management and utilization of wetland resources; (2) Residential areas selected for assessment based on representation of different habitats – these are marginal villages with specific characteristics; (3) Equal representation of women and men participating in activities and accessing platforms to allow the equal exchange of ideas. Participants differed in social status, occupation, and resource utilization characteristics.

The assessment team performed interviews and collected data. Expedited village surveys were conducted with representatives from the community. Besides individual interviews, gender-based and mixed focus groups were held to gather more information. The locations of the 10 selected communities are presented in Figure 12 with more details provided in Table 7.

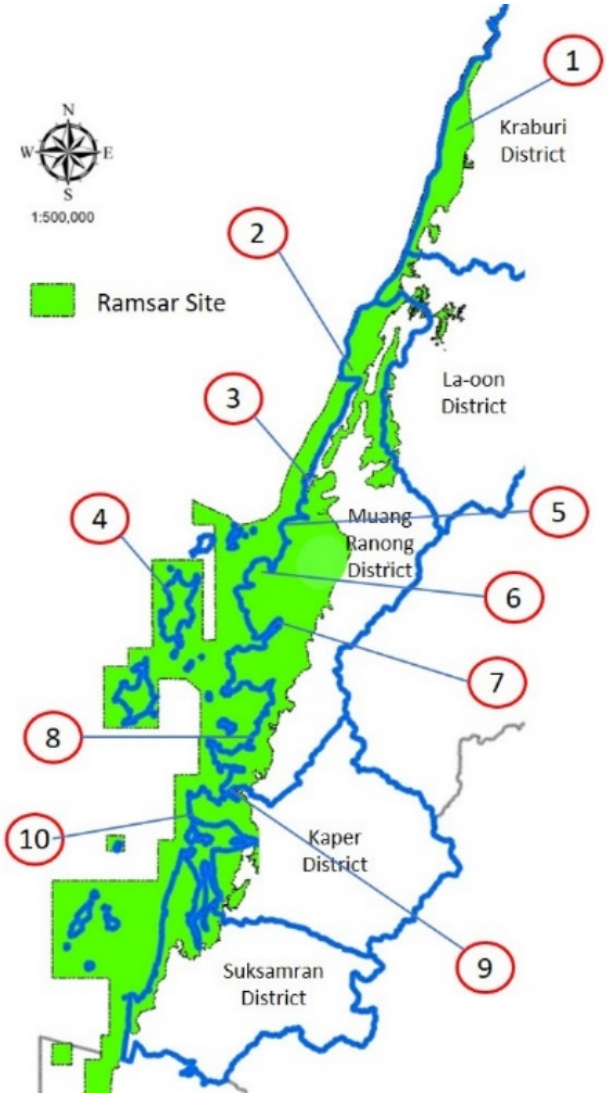


Figure 12: *Village locations (see Table 7 for more details)*

Table 7: *Selected communities and key characteristics*

	Village	Main occupation	Religion	Location, habitats and notable species
1	Baan Nam Jued, Nam Jued Subdistrict, Kraburi District	1.Agriculture (oil palm and para-rubber plantations, fruit orchards) 2.Traditional fishmongers	Buddhism 100%	- *Location*: Houses on seashore, banks of canal with steep slopes of mountains and flat plain areas (major source of rice in past) - *Habitats*: evergreen forest, mangrove forests, canals and sea - *Notable species*: eel tail catfish, shrimp, snapper, sand whiting, Kuhl's creek frog, field frog, and melinjo (evergreen tree)
2	Baan Sai Daeng, Sai Daeng Subdistrict, Muang Ranong District	1. Hired-hands 2. Local fishmonger	Buddhism 98% Islam 2%	- *Location*: By the sea with canal on the east, sitting on hillside slopes - *Habitats*: Terrestrial forest, mangrove forest, canals and sea - *Notable species*: baitfish, blue swimming crab, snapper, sand whiting, horseshoe crabs, clams, spotted babylon, and mussels
3	Baan Hin Chang, Pak Nam Subdistrict, Muang Ranong District	1.Traditional fishmongers 2. Agriculture (oil palm and rubber plantations); fruit orchards	Buddhism 70% Islam 30%	- *Location*: Small village along length of Kraburi River, peninsula stretching out into Andaman Sea, with slopes at foothills and flat areas on beach front - *Habitats*: Important canals flowing from mountain to sea (e.g. Klong Hing Chang), sea, beach, mangrove forest, island ecosystem; - *Notable species*: krill, crayfish, lobsters, and fish such as eel tail catfish, coral catfish and sea bass.
4	Koh Phayam, Koh Phayam Subdistrict, Muang Ranong District	1. Agriculture (coconut, para-rubber, cashew nut plantations) 2.Tourism service providers	Most Buddhist Some Islamic Others are Christians	- *Location*: Island community in Andaman Sea (important tourist attraction; cashews important product); - *Habitats*: evergreen and mangrove forest, beach forest, tidal flat. - *Notable species*: whiteleg shrimp, sea turtle, hawks, hornbills, dolphins, and otters.
5	Baam Hua Tha, Bang Rin Subdistrict, Muang Ranong District	1. Hired-hands 2. Business owners	Buddhism 96% Islam 3% Christianity/ others 1%	- *Location*: Close to town area with industries; - *Habitats*: Large area of rehabilitated mangrove forest, scattered *Nypa fruticans* forests; - *Notable species*: serrated mud crabs, sea bass, eels, venus clams, *Cerithidea sp., and Chylocheilichthys apogon*
6	Baan Tha Chang, Ngao Subdistrict, Muang Ranong District	1. Hired-hands 2.Para-rubber plantations 3.Aquaculture (clams, shrimp, fish)	Islam 97% Buddhism 3%	- *Location*: Small lowland near mountains and on one side parallel to sea and mangrove forest (like Baan Lang) - *Habitats*: abundant mangrove forest, canal, beach and sea, islands - *Notable species*: serrated mud crabs, fiddler crabs, mullet, giant sea perch, bigeye snapper, whiteleg shrimp, deep sea eels, spotted Babylon
7	Baan Lang, Ngao Subdistrict, Muang Ranong District	1.Traditional fishmongers 2. Hired-hands	Islam 97% Buddhism 3%	- *Location*: Small lowland near mountains and on one side parallel to the sea and mangrove forest (like Baan Tha Chang) - *Habitats*: Abundant mangrove forest, canal, beach forests, islands - *Notable species*: serrated mud crabs, fiddler crabs, mullets, giant sea perch, bigeye snapper, whiteleg shrimp, deep sea eels, spotted babylon
8	Baan Aow Kei, Muang Kluang Subdistrict, Kaper District	1. Traditional fishmongers 2. Agriculture (oil palm/para-rubber plantations)	Islam 97% Buddhism 3%	- *Location*: Along beach on Laem Son Beach (abundant fish in Kaper Bay during monsoon; has cooperative group making shrimp paste); - *Habitats*: mangrove ecosystem with canals going through, connecting the area to the coastal system - *Notable species*; sea crabs, croakers, groupers, serrated mud crabs, and sea turtles used to use beach as nesting area
9	Baam Chi Me, Kaper Subdistrict, Kaper District	1. Agriculture (oil palm and para-rubber plantations, fruit orchards) 2. Traditional fishmongers	Islam 70% Buddhism 28% Other 2%	- *Location*: Near foothills with The Chi Me canal flowing through before going out to sea (use resources from canals/Kaper Bay in rainy season) - *Habitats*: evergreen forest, mangrove forest, *Nypa fruticans* forests, canals and sea - *Notable species*: serrated mud crab, clams, mullets, jellyfish, and *Nypa* fruticans. Soft crabs are also farmed in this village
10	Baan Bang Hin, Bang Hin Subdistrict, Kaper District	1.Agriculture (oil palm and para-rubber plantations) 2.Traditional fishmongers	Islam 70% Buddhism 28% Others 2%	- *Location*: On foothills along banks of natural canal and sea; one side encircled by mountains; other having peninsular structure extending into sea (use resources from canal/Kaper Bay in rainy season) - *Habitats*: natural canal, mangrove forest, beach and coastal system; - *Notable species*: krill, croakers, scorpion mud lobster, and giant seaperch and mangrove red-snapper

5.2.1 Resource dependency

Communities were asked to prioritize their **key wetland resources** to provide an understanding of local people's dependency on wetland resources. Figure 13 presents the top 10 resources as mentioned by women and men for the 10 villages combined (see Annex 5 for priority rankings for each community).

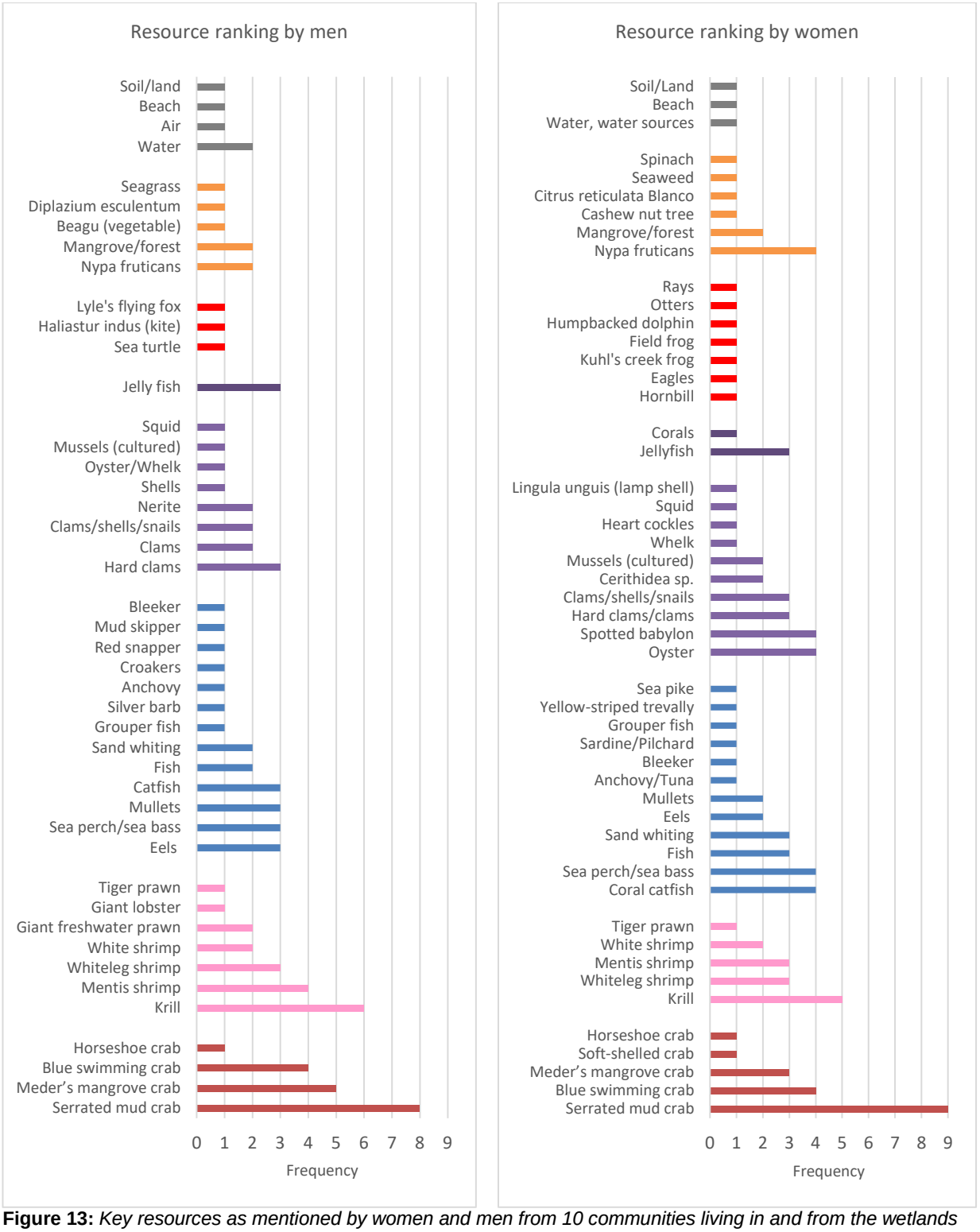


Figure 13: *Key resources as mentioned by women and men from 10 communities living in and from the wetlands*

The survey revealed a wide-range of wetland resources. Based on the initial list of resources in Thai language, as many as 60 species were identified (most of them aquatic); some of

these, however, refer to the same species in English (although there may be local differences within species). The prioritized resources are clustered into larger groups, i.e. crabs, krill/shrimp/lobster, fishes, clams/shells/snails, jellyfish and coral, trees/plants/ vegetables, animals, and other/general, with the frequencies per cluster presented in Table 8.

Table 8: *Frequency of reported species per cluster/group by women and men living in and from the wetland*

Resource cluster/group	Men	Women
Crabs	18	18
Krill/shrimps/lobster	19	14
Fishes	23	24
Clams/shells/snails	13	22
Jellyfish and coral	3	4
Animals	3	7
Trees/plants/vegetables	7	10
Other/general	5	3

Comparing overall frequencies for resources clusters shows that fish species were most often mentioned, closely followed by crabs and krill/shrimp/lobster. Clams/shells and snails were also popular, but especially among women. Of all species, serrated mud crab and krill were reported most often, followed by other crab species (Meder's mangrove crab, blue swimming crab), shrimp (mantis shrimp, whiteleg shrimp) and fish (sea perch/sea bass, catfish and eel). The frequency of reported resources closely reflects the overall priority ranking, with serrated mud crab and krill being the most important (see Annex 5). Most of these resources are used for both consumption and sale. Other animals and trees/plants/vegetables were also reported; *Nypa fruticans* is an important resource that was particularly mentioned by women.

Women selected priority resources based on two criteria: (1) resources that generate household income such as serrated mud crabs, sea perch/sea bass, and eel tail catfish, generally caught by men and sold outside the village, and (2) species that women can access for household consumption and sale within the community (particularly krill and Meder's mangrove crabs, clams, shells and snails that can be caught in the canals, coastal areas and mangrove forests). Men prioritize economically important aquatic species, especially serrated mud crabs, blue swimming crabs, and various fishes that can be caught all year round, which are in demand at the market, and earn the core income that supports the household.

The overall results of communities were similar, but there were some differences between groups. Resources that were not mentioned can still be important for specific communities, such as lobsters, sand fish, water sources, land/soil, cashew nuts, hornbills, and horseshoe crabs. Resource prioritization is related to the method of production and problems that communities are facing. For example, a community as Koh Payam, which faces problems of land security find "land" important, but, having many tourism operators, also values the abundance and beauty of nature, such as beaches, corals, otters, and dolphins. Women in communities located near foothills prioritized resources in the natural canals, whereas women in communities near the sea prioritized marine fish and animals.

Wetland resources are an important food and income source for communities, emphasizing the critical link between communities and the wetland system. Based on **village resource maps** (see Figure 14 and 15), resource habitats of importance to the community can be classified into five systems: the river-canal system; the mangrove forest system; the sea-island system; the beach forest system; and the agro-forestry system (para-rubber plantations and fruit plantations). Each of these systems is different in terms of accessibility and utility.

Figure 14: *Example of men's village resource map*

Men prioritized sea islands and the bay because it is an abundant source of aquatic animals. More than 20 islands were identified as habitats for aquatic animals such as Koh Pee, Koh Sui, Koh Yeepun, Koh Khum. All were considered equally important, but they differ in the types of species found. For example, lobsters are found most in the area between Koh Muang and Koh Lhek, dolphin sightings have been reported near the beach in front of Koh Son and Koh Lhek, jellyfish are in Koh Laow and croakers are found in large numbers around Koh Gum, Koh Kang Khaow, Koh Khai, and Pak Chong, while Kaper Bay is abundant with both brackish and marine animals. The men ranked mangrove forest next in importance, as they are perceived as a nursery for aquatic animals thus essential for food security, while also acting as a natural defence wall against high waves. Rivers and canals were given equal importance to mangrove forests.

Figure 15: *Example of women's village resource maps*

Women prioritized canals and rivers as their most important resource. Women use the area to catch aquatic animals for consumption and sale. It is an area where they can carry out activities by themselves or as a group (easy to access and safe). Activities include finding snails, shells, catching krill, fish and crabs, using small tools, such as hand-nets, rakes, and bamboo woven fishing gear. Sea and islands – although ranked important in terms of habitat abundant with aquatic animals and a major source of income– are limited to them in terms of access; most of the time they need to go with men on the fishing boat.

Table 9 shows the **seasonal calendar of resource utilization/collection** for villages in Ranong's wetlands. Activities related to resource utilization from the river, canal, bay, sea-island and mangrove, occur year round, whether catching crabs, shrimps, shells, or cutting *Nypa fruticans* leaves. Many of the year-round activities can be carried out by women, such as catching krill with hand nets (some used traditional fishery gear that is now prohibited), collecting cockles, raking lamp shells, and culturing mussels. Activities that require cooperation from men are generally activities in the sea and require the use of heavy labour, such as using trawler nets to catch mantis shrimp, serrated mud crabs, and hook fishing. In these activities, women take on a supporting role.

Table 9: *Seasonal calendar of utilization/collection of wetland resources by men and women in Ranong.*

NO.	Male		Female	
	Activity	**Month**	**Activity**	**Month**
1	Catching jellyfish	Oct.– Jan.	Krill fishing	Jun. – Oct.
2	Catching mantis shrimp	Year-round	Collecting clams	Year-round
3	Catching common silver barb	Year-round	Digging lamp shells	Year-round
4	Catching fish using fishing rods	Year-round	Catching serrated mud crab	Year-round
5	Collecting clams	Year-round	Catching fish using fishing rods	Year-round
6	Catching serrated mud crabs	Year-round	Catching mantis shrimp (using trawl)	Year-round
7	Culturing mussels	Apr.– Dec.	Catching jellyfish (swings)	Nov. – Jan.
8	Catching squid	Oct.– Dec.	Catching fish (using nets)	Oct. – May
9	Catching named/bagrid catfish	Year-round	Catching white-leg shrimps (nets)	Oct. – May
10	Raking shells	Year-round	Catching blue marlin (traditional boat)	Jan. – Apr.
11	Catching mullets	Year-round	Peeling *Nypa fruticans* leaves	Dec. – Jan.
12			Cutting *Nypa fruticans* fruits	Aug. –Oct.
13			Cutting *Nypa fruticans* tips	Year-round

Note: Results for 10 communities combined

Based on discussions, activities in each community are very similar, but there were some differences. For example, in communities in the upper part of the wetland, women focused more strongly on the collection of resources from the Nypa forest, whereas in the central and lower part most of the activities took place in mangrove forest and women supported the men with fishing activities.

5.2.2 Climate change impacts

The assessment team worked with wetland communities to develop a 30-year historical timeline of extreme weather events and their impact on resources and people's lives in Ranong Province (Figure 16).

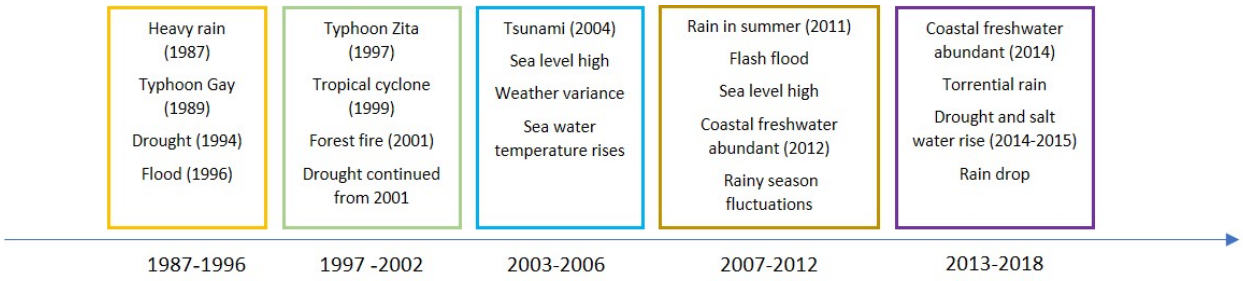


Figure 16: *Historical timeline of extreme weather events (1987-2018)*

The impacts differed based on the event; some have a severe immediate impact, while others cause long-term and continuous effects. Events can be classified into six types: typhoons/strong wind storms, drought/extensive rain gaps, heavy and continuous rain (floods), seasonal fluctuations, tsunami, and rising seawater temperatures. During the years 1997-2002 the community faced a series of heavy storms including typhoon Gay, which cause caused major damage in the coastal areas. No major storms occurred in the area after 1999. Approximately every 10 years, the area faces droughts and extensive rain gaps (1994, 2001-2002, and 2014-2015). Droughts have a substantial impact on the wetlands system and local livelihoods. Communities located at the foothills are vulnerable to surface water floods when there are heavy rainstorms. These events occur in short periods about every 15 years (1996 and 2011-2012). Flooding as result of sea level rise is also common and happens on a yearly basis. Rainfall may further contribute to the severity, directly affecting the houses at the

estuary and the seaside. Changes in seasons are evident, especially the early arrival of the rainy season (15-45 days earlier) and the more frequent rainfall. There is also heavy rain in the dry season around March. According to community members, some of these fluctuations came after the 2004 tsunami, which is one of the most significant natural disasters in the area. In addition, every year, strong winds come from the sea, causing coastal and beach erosion. The rising seawater temperatures cause coral bleaching (2005-2006) and affect marine species habitat; most villagers believe that this is a consequence of the tsunami. Table 10 gives an overview of impacts of extreme events as reported by the communities.

Table 10: *Impact of extreme weather events as reported by communities in Ranong Province.*

Weather event	**Impact**
Typhoons/ wind storms	- Fishmongers lose income from not being able to go fishing. - Fishing tools and boats are damaged from strong currents. - Farmers lose income from damaged products- small fruits and flowers fall off the branches - Trees fall and landslides occur, collapsing roadsides and blocking roads. - Coastal areas are eroded and severely damaged, especially on the beach.
Severe droughts/ extensive rain gaps	- Orchard plants/trees relying on rain (e.g. longkong, mangosteen, baegu, pararubber) will die - Saltwater seeping into the canals prevents brackish water fish (such as shads) from successfully laying eggs, but blue swimming crabs, serrated mud crabs, and squids come into the canals. - Farmed brackish water fish and oysters die from high salinity. - Well water dries up resulting in a lack of water for consumption/utilization - Breakout of aphids in plants, especially in cashew-nut trees
Heavy and continuous rain (floods)	- Fruit trees, such as cashews nuts, mangrosteen, longkong durian and coffee lose their flowers - More than 80-90% of cashews rot if there is heavy rain. - Rubber plantation owners must collect rubber sap on rainy days, makes them lose income - Aquaculture farms suffer because oysters and fish will die from freshwater shock. - Fish in aquaculture farms will be affected by currents. - Fishmongers lose income because fishermen are not able to catch fish. - Resources in canals are intensively utilized because villagers cannot go out to sea. - Houses damaged due to floods
Seasonal fluctuations	- Local fishmongers will not go fishing in severe rain, this will making them lose income. - Those who farm fish lose benefits because their fish die from changes in salinity. - Epidemic diseases emerge such as dengue fever. - Outbreak of aphids in plants and fruits during the dry season. - Local knowledge no longer adequate to analyse and predict weather based on experience - Brackish water fish will not lay eggs in the canals when level of freshwater is too high
Tsunami	- Houses damaged, and people died. - The ecosystem changes, e.g. the water trenches become sand dunes. - Fishmongers catch less fish in the next year as they migrated elsewhere. - Fish is harder to find. - Aquatic animals die from choking on mud. - Fish from Andaman coast not popular with consumers because they are viewed as corpse-eating fish (local beliefs). - Mangrove forests damaged by strong currents. - Changes in tidal system. - Seawater temperature higher, reducing aquatic animals (return to normal after 3-12 months). - Loss of over 20 rai (3-4 ha) of riverbanks and coastal erosion - Knowledge of former ecosystem of the community is lost because a new ecosystem was developed.
Rising seawater temperature	- Coral bleaching/white washing leads to fewer aquatic animals as there is no nursery area - Fewer aquatic animals impact fishmonger livelihoods

Excepting the tsunami of 2004, severe droughts, wind storms/typhoons and floods from rainfall or sea level rise are regular events that recur every 5-10 years, while changes in seasonal variation and rise in seawater temperature are ongoing. Communities regularly need to deal

with multiple events in short timeperiods, and sometimes extreme fluctuations, such as severe droughts/extensive rain gaps and heavy rains that causes floods within the same year.

5.2.3 Current and future coping

Community members were asked to reflect on existing and future coping strategies for extreme weather events. Communities' combined responses for women and men are presented in Annex 6.[49] Table 11 provides a summary. Key responses were related to disaster reduction and mitigation, prevention and vulnerability reduction, strengthening coping capacity and the rehabilitation of ecosystems. Whereas current responses were more strongly associated with disaster reduction, mitigation and prevention, future strategies emphasised enhanced coping capacity and ecosystem rehabilitation.

Table 11: *Community's adaptation option for climate change situations*

Type	Response
Disaster reduction and mitigation	- Keep track of weather forecasts. - Install alarms and warning systems and ensure they are working. - Replant mangrove forest to create protection against erosion from waves. - Create a bamboo walls for wave protection. - Move the fishing boats so they are protected from the winds and waves. - Move fishing docks to the areas with adequate amount of water. - Farm fish that can live in a wide range of salinities. - Stop farming during drought season and find alternative occupations.
Prevention/ vulnerability reduction	- Dig ponds/ make deep wells - Prepare water storage tanks for household use - Request local agencies to provide water storage tanks for household use. - Fix houses and make them stronger/raise the bottom of the house higher. - Relocate to higher grounds. - Move children and elderly people to safety areas. - Use sand bags to prevent water from coming into houses. - Engage in alternative livelihoods, such as hired labour or gardening instead of fishing. - Grow a variety of vegetables. - Add value to aquaculture products by processing products. - Sell dead fish to processed aquatic animal groups.
Strengthen coping capacity	- Link networks/information with external agencies to monitor disaster risks. - Improve disaster-warning centre to ensure that it is usable. - Practice evacuation plans. - Install a filter system to make freshwater from groundwater. - Adapt working conditions, e.g. change from rubber tapping at night to daytime - Set up regulations to control the use of resources. - Construct check-dams to retain water. - Campaign for planting backyard forests. - Observe nature using experiences. - Learn about the new ecosystems. - Develop community potential as an environmental and historical tourist attraction.
Rehabilitate ecosystem	- Replant mangroves for ecosystem restoration and to support aquatic animal nursery. - Make artificial reefs to support aquatic animal nursery. - Increase the variety and quantity of species by releasing aquatic animals. - Set up a traditional aquatic animal breeding bank. - Training for "young fishmongers", provincial plan to create community awareness - Build nurseries for local plants and mangrove restoration. - Set up zoning in mangrove forest for conservation and utilization.

[49]Attendance level and women's representation in some communities was low, therefore results should be treated with some caution.

	- Restore *Nypa fruticans* forest and set up management plan

Figure 17: *Group discussion with women on coping*

In general, the level of awareness about risks of climate change seemed moderate. High sea levels, droughts, rain and temperature fluctuations were often perceived as natural events, beyond human control. Therefore, current action plans were generally reactive and for some impacts, there were no preparedness plans, such as heavy rains, the decay of cashew nuts, and the falling of fruit flowers and small fruits. Most plans focused on adapting to conditions based on household capacity. Responses from men and women were generally consistent and similar, but there were also some differences, e.g.: in case of floods, men think about raising the house while women are prepared to put the things in the house up higher or move children and elderly out of harms' way; in case of droughts, women try to collect and find water from neighbouring wells while men focus efforts on coordinating with external agencies for support; and when resource habitats are affected, women are more inclined to regulate and set up rules to monitor resource utilization than men. In discussions on future strategies, communities proposed more proactive strategies to deal with the impact of extreme events as a result of climate change. Among the communities, Baan Bang Hin seemed exceptionally well prepared, while communities in the bay area seemed less well prepared.

5.3 Species vulnerability

Individual species were also assessed for climate change vulnerability. Species selection was based on their uniqueness or status (flagship species), their role in the ecosystem (keystone species) or their economic value. Twelve species were initially identified with support from experts and community representatives, but discussions with academics and community representatives, reduced the set to seven groups or species. These included:

- **Mangrove pitta** (*Pitta megarhyncha*), a 'near threatened' passerine bird in the Pittidae family native to the eastern Indian Subcontinent and western Southeast Asia and can be found in the Biosphere Reserve Forest;
- **Meder's mangrove crab** (*Scylla serrata*)***/*serrated mud crab** (*Sesarma mederi*), are ecologically important crab species found in the estuaries and mangroves of Africa, Australia and Asia and are economically relevant crab species commonly found in mangrove forests in Ranong;
- **Scleractinian corals** are marine invertebrates within the class Anthozoa of the phylum Cnidaria, which typically live in compact colonies of many identical individual polyps whose species include the important reef builders that inhabit tropical oceans and secrete calcium carbonate to form a hard skeleton;
- **Scorpion mud lobster** (*Thalassina anomala*) is found in the Indo-West Pacific Region and a keystone species in mangrove forest, found in Biosphere Reserve Forest;
- **Long-whiskered catfish** (*Sperata aor*), a species of bagrid catfish found in southern Asia in Pakistan, India, Nepal, Bangladesh and Myanmar. It is commercially fished and commonly found in Kraburi River;
- **Bruguiera hainesii C.G.Rogers** (white beans), belongs to a small genus of mangrove species on the Indian and west Pacific Ocean region, which is critically endangered tree with a few still found in the Biosphere Reserve Forest;

- **Water onion** (*Crinum thaianum*), is an endangered emergent water plant endemic to coastal plain of southern Thailand in Ranong and Phang Nga Province, more specifically it is found in natural canals in the southern part of Ranong (Kaper).

The VA team and experts assessed the species. Their current situation and threats are discussed below.

1) The mangrove pitta is found in the mangroves of the Biosphere Reserve Forest. They face habitat loss from coastal erosion and sea level rise. These factors also contribute to the disappearance of silt beaches and the plants and animals on which mangrove pittas feed, often exacerbated by the expansion of shrimp farming and the dredging of canals. Mangroves cover large areas and are protected, providing a refuge for mangrove pittas.

2) Serrated mud crabs/Meder's mangrove crabs live in mangrove forests, feeding at night, while they tend to escape people and the heat during daytime by digging holes in the ground. During the spawning seasons, April-July and September-November, they will travel to the river estuary to lay eggs. The eggs will take 14 days to hatch. The crabs play an important role recycling nutrients in the form of organic matter, thereby contributing to the abundance of the mangrove forest and its food sources. They are economically relevant species, which are caught in large quantities for sale at the market. Changes to mangrove forest in the future may also affect the crabs. In addition, higher temperatures and increased water salinity has a significant impact on the serrated mud crabs.

3) Scleractinan corals in the Andaman Sea have suffered from beaching from unusual increased water temperatures (<30 °C) from March 2010 onwards. If corals face water temperatures >30.1 ºC for more than three weeks, the bleaching process will start. This led to the death of more than 50% of the corals in the area in 2010. At present, the remaining corals are slowly recovering. Apart from rising sea temperatures, activities on land such as construction, agriculture, and discharge of wastewater from residential and industrial areas are threats; they create sludge in the coastal areas and turbidity in the water so that light cannot reach the photosynthesizing symbiotic zooxanthellae. In addition, illegal fishing equipment such as trawler-nets cause physical damage to coral reefs, while the expansion of tourism activities into the coral reef areas is another threat.

4) Long-whiskered catfish is a freshwater and brackish water fish species, normally greyish-gold or greyish-purple with a white belly. It feeds on shrimp, insect larvae, phytoplankton and other animals. As adults, the long-whiskered catfish will reach 12-15 cm in length and the largest found was 46 cm long. They often live in large schools in brackish water or at river estuaries. They are skin fish without scales and are resistant to the impacts of changing salinity level in the water within the range of 0-30 ppt.[50] The dissolved oxygen (DO) value in the water must be between 4.8-7.8 mg /L, and the water temperature must be between 25.1-28.5 ºC for their normal living conditions.

5) Scorpion mud lobster combines characteristics of shrimps and crabs. It can live on land for extended time and digs holes like scorpions. The scorpion mud lobster lives in the mangrove forest and piles soil into high dunes. It is considered an important species for the mangrove ecosystem as it helps to keep a 'healthy' balance between mud and soil. In Thailand, scorpion mud lobsters are only reported in the mangrove forests of the Andaman Sea. Sea level rise, which may affect mangrove forest floors, and the high salinity level of the soil in the dry season are potential risks, but mud lobsters seem to cope well with changing circumstances.

6) Bruguiera hainesii C.G.Rogers is a large perennial (mangrove) species 10-25 meters high, that has greyish-brown bark with large air pockets scattered throughout the trunk, a

[50]Boonchai, 1996.

slightly puffed base and a knee-shaped root. It is a critically endangered species that can be found at the Klong Ngao Estuary in the Biosphere Reserve. The soils in the mangrove forest are silty and regularly flooded with seawater. It has also been reported in Khlung District, Chantaburi Province and Khanom District of Nakhon Si Thammarat Province in Thailand. Sea level rise, strong winds and changes in salinity levels may form a risk, however, the encroachment into mangrove areas for shrimp farms, fish ponds, and urban and industrial development is a larger threat.

7) Water onions. Water onion is a delicate water plant, highly sensitive to changes in water flow. Extended periods of heavy rain impact water flow in the canal, which is the main habitat of water onions. It is estimated that increased intensity and duration of rainfall as result of climate change will increasedpressure on this unique species.

The assessment scores and risk status for baseline conservation and climate change vulnerability are summarized in Table 12.

Table 12: *Vulnerability assessment of selected species in the Ramsar Site*

Species	Baseline Conservation Risk		Climate Change Vulnerability	
	Score	Status	Score	Status
1. Mangrove pitta	2.1	M	1.7	VL
2. Serrated mud crab/meder's mangrove crab	1.7	L	1.8	L
3. Scleractinian coral	2.2	M	2.4	H
4. Long-whiskered catfish	2.2	M	1.4	VL
5. Scorpion mud lobster	1.8	L	1.3	VL
6. Bruguiera hainesii C.G. Rogers	2.3	H	1.4	VL
7. Water onion	2.6	H	2.2	M

Note: risk status categories are Very Low (1.0- 1.4), Low (1.5-1.8); Moderate (1.9-2.2); High (2.3-2.6); Very High (2.7-3.0)

There is a range in species baseline conservation risk and climate change vulnerability, although climate threats seem less important compared to non-climate ones. This is further visualized in Figure 18.

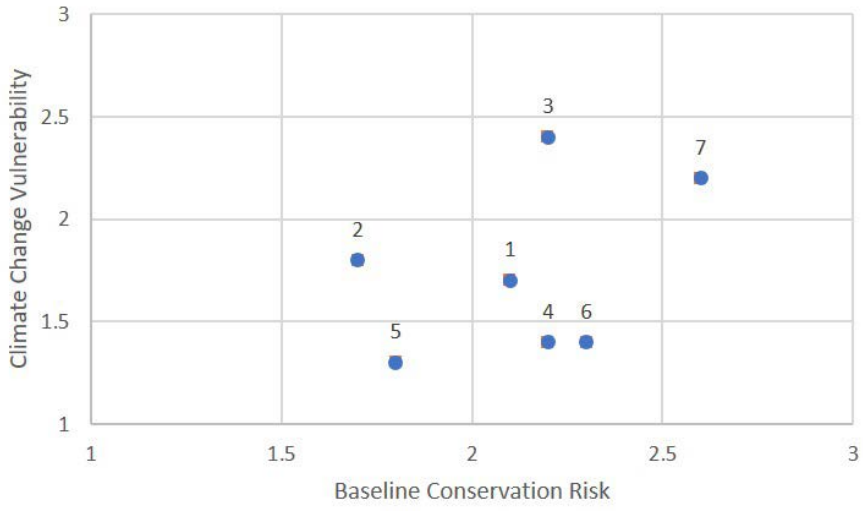


Figure 18: *Vulnerability diagram of selected species for the Ramsar Site*

The species can be divided into three categories:

- **Moderate to high vulnerability**. Coral (3) and water onions (7) fall into this category. These have a relatively high baseline conservation risk, which will be further compromised by relatively high climate change vulnerability. Coral can adapt relatively well to basic changes but are fragile and do not adapt well to changes in temperature.

Water onions are very rare and endangered. They are sensitive to changing water levels and magnitudes of currents, especially from heavy rains. With increased projected rainfall in the future, threats for water onions will even be more severe.

- **Moderate vulnerability**. Mangrove pitta (1), long-whiskered catfish (4), and Bruguiera hainesii C.G. Rogers (6) can be classified fall under moderate vulnerability. They have a moderate to high baseline conservation risk but show low vulnerability to climate change. Bruguiera hainesii C.G. Rogers is especially susceptible to changes in its key habitat (mangrove forest) due to shrimp farming, expansion of construction areas, or various public utility systems. However, all can adapt relatively well to climate change.
- **Low vulnerability**. Serrated mud crab/meder's mangrove crab (2) and scorpion mud lobster (5) show both a low baseline conservation risk and low vulnerability to climate change.

6 CONCLUSIONS

6.1 Summary of main vulnerabilities

Based on the habitat vulnerability assessment, coral reefs were most vulnerable and least adaptive to the current threats to the ecosystem and climate change. Raising sea temperature will cause coral bleaching and extended increased temperatures will lead to coral death. It is important to monitor water temperatures and reduce compounding threats such as physical damage from fishing gear, sedimentation and land based runoff. The second most vulnerable habitats are sea grass beds, canals and rivers, and coastal and marine areas; these are vulnerable to changing conditions of the ecosystem, especially human activities, but seem less affected by climate change. Other habitats seem more tolerant to both non-climatic and climatic factors. Mangrove forests, active tidal flats and beach forests seem more adaptive to threats and therefore less vulnerable. However, there are limits. If shrimp farms and construction sites continue to expand, these habitats will be directly affected.

Changes in climate will also affect communities in the area. Livelihoods that depend on agriculture or fisheries are highly vulnerable to climate change; it affects yields and activities, such as taking the boat out to sea, collecting rubber sap) while also impacting the resource base, i.e. the wetland habitat and species that live in it. The study showed a wide diversity of wetland resources that women and men rely on. Key plant and animal species are often connected through complex food webs, with declines in keystone species having an impact on others. Changes in environmental conditions may lead to changes in resource distribution over space and time, directly impacting the ecological knowledge base communities have been able to rely upon for generations. There is also a direct impact of extreme storms, landslides, and floods on local lives.

Water onions are highly vulnerable to the impacts of climate change. They are sensitive to changing water levels and magnitudes of currents, especially from heavy rains. Rainfall in Ranong is predicted to increase by 10-20% in the next 30-90 years, which means that the risks and threats for water onions will even be more severe in the future. Scleractinian corals are also highly vulnerable. The corals are highly sensitive to changes in temperature, caused by climate change. Mangrove pitta, long-whiskered catfish, and *Bruguiera hainesii XC.G.Rogers* (white beans) are moderately vulnerable. White beans are can adapt relatively well to climate change but are fragile to other changes in their key habitat (mangrove forest) due to shrimp farming, expansion of construction areas, or various public utility systems. Other species such as serrated mud crab/meder's mangrove crab and scorpion mud lobster have low vulnerability; these species can adapt well to changing climate conditions. However, the rehabilitation and preservation of their habitat ecosystems such as mangrove forests, canals and estuaries are important to maintain this.

6.2 Adaptation planning

Local community coping strategies can be divided into actions related to disaster reduction and mitigation, prevention and vulnerability reduction, strengthening coping capacity and the rehabilitation of ecosystems. It is important that all these aspects are addressed, starting with more immediate actions focused on mitigation and prevention and later supported through enhanced capacity and ecosystem rehabilitation. Furthermore, it is important to recognize the importance of action plans at three different levels:

- **Household/individual level.** Taking care of properties in case of floods by raising possessions off the ground or raising the floors of the houses. Digging deeper ponds households so they can store more water. Most of these responses are reactive and can be immediately implemented.

- **Community level.** This is a community level plan that requires collaboration with external agencies. For example, the construction of dams/walls to prevent erosion from waves and tides, mangrove forest reforestation, setting up regulations and public hearings to announce the use of the specific plans. This approach is more proactive to mitigate long-term problems. Because it requires cooperation and approval from communities and funding, implementation often takes longer and is more difficult to manage. Many communities have been trying to mobilize a community-based plan because it is perceived to be more effective.
- **Network-level.** Focuses on collaboration between government agencies, private sector, communities, NGOs and external stakeholders. An example is the cooperation between the Department of Marine and Coastal Resources and the National Park Wildlife and Plant Conservation Department in the area to prepare a shared conservation and management plan with the community. This level of collaboration is still in its infancy, whereas the cooperation with other communities in the wetland area have not yet begun.

Local stakeholders proposed several actions at the community, zonal and provincial level, as part of a management plan for wetland areas in Ranong (see Table 13).

A “Wetland Management Committee” should be established to act as a collaborative mechanism and facilitate the implementation of the plan. Most importantly, the Committee is needed to assist in the nomination of the Ranong Ramsar Site as a UNESCO Natural World Heritage site.

Table 13: *Actions proposed for management of the wetlands of Ranong Province*

	Community level	Zonal level	Provincial level
Economic	- Promote processing community products such as sugar from *Nypa fruticans,* and vinegar from its flowers - Scale up community products such as dried shrimp and krill - Form fishmongers group to directly negotiate with buyers - Explore information/potential of natural/cultural tourist attractions	- Form a group to produce products for sale distribution - Find a potential area and develop it into a tourist attraction - Organize activities to build relations between potential tourist attractions in the area	- Join the Pracharat market and the OTOP market - Link to the provincial tourism industry strategies
Social	- Raise awareness on mangroves and resource conservation at the community level in order to enable zoning of the area and setting up rules for utilization	- Create network and coordinate for management of wetlands and coastal resources to be able to respond to climate change	- Mobilize for activities to be included as part of provincial strategy
Disasters	- Follow up on information to be able to respond to disasters. - Disseminate knowledge about disaster response - Visit areas with effective disaster response schemes. - Establish community disaster database	- Create disaster recovery learning and network - Prepare disaster preparedness plan at zonal level - Create up to date disaster database and zone-level risk area - Visit to learn from areas with effective disaster response schemes	- Coordinate with relevant agencies to educate communities - Conduct participatory research on community disaster management throughout province - Establish disaster database at provincial level
Mangrove	- Create 2 zones: conserved forest and utilization forest - Public hearing for zonation of area and setting up rules of use - Campaign for waste management system (household/community) - Reforestation - Develop and implement conservation plan	- Create network for information exchange and awareness raising on mangrove management - Prepare joint management plan and submit to relevant agencies - Information dissemination, e.g. on waste management campaign, mangrove forest area declaration, and rules and regulations of use - Set up waste system in area	- Hold provincial level meetings and networking activities - Develop activity and budget plan and add it into provincial plan - Put waste management system as part of provincial strategy - Create channels for knowledge management on mangrove forest - Mobilize for declaration of “Mangrove forest utilization zone”
Aquatic animals	- Create protected area - Release aquatic species into water - Create community-based cooperation on conservation and regulations for catching animals. - Regulations to control fishing gear use and seasonal calendar for catching/collecting aquatic animals - Form fishmongers-group for direct marketing - Provide information/knowledge to community and universities. - Make barcodes for fishing boats and aquatic species	- Encourage setup of conservation zone and regulations on catching aquatic animals between communities in shared resource areas and with relevant agencies. - Release aquatic animals into water every year - Make database of aquatic species. - Hold zone-level network meetings on conservation and management aquatic resources - Coordinate for cooperation between government agencies, NGOs and with academic institutions as an ally	- Publicize the announcement of the conservation area - Organize a team to support the community process. - Create a provincial network to develop the plan, activities and budget for the implementation

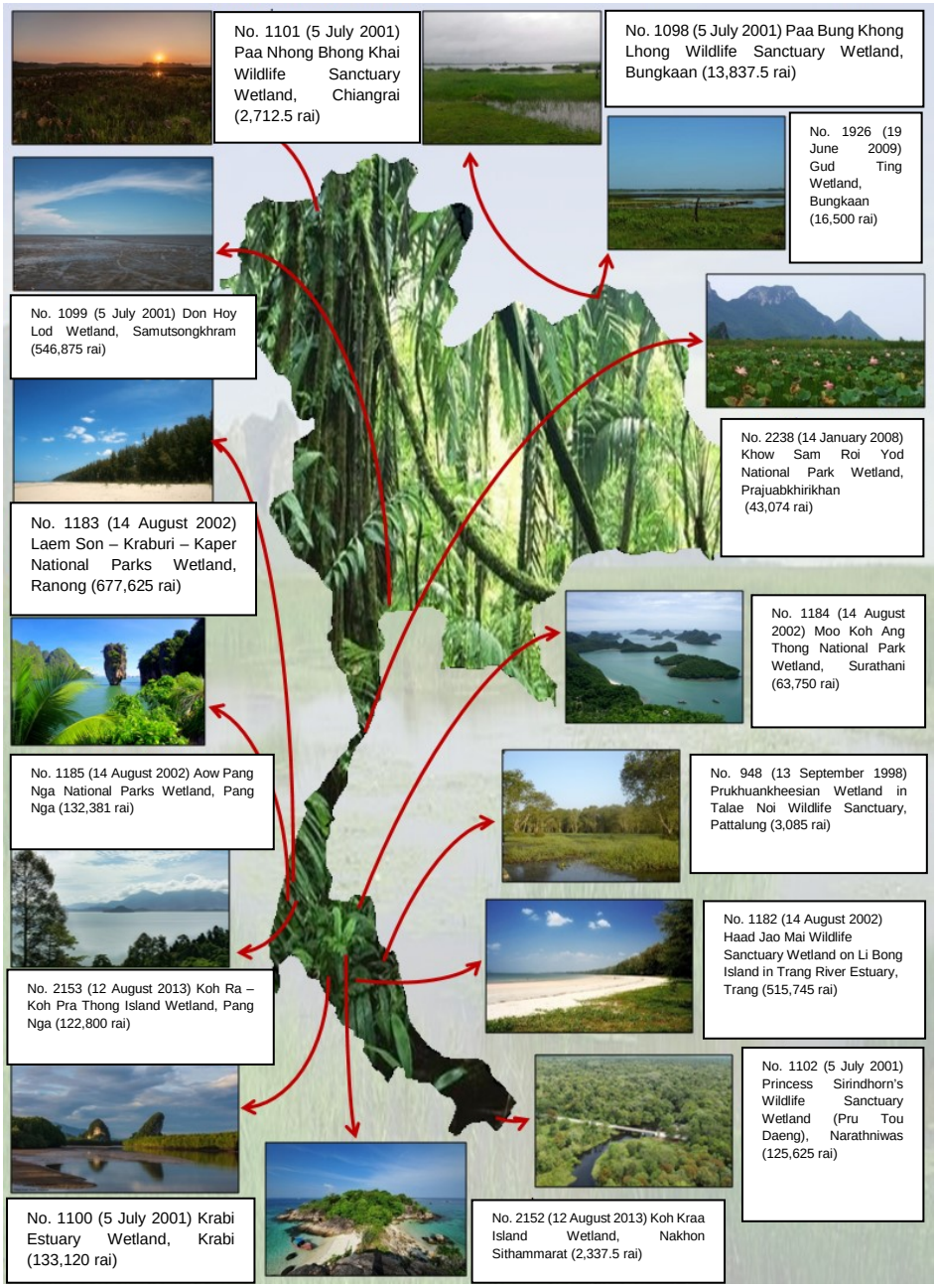
	Community level	Zonal level	Provincial level
Water onions	- Develop information flyers - Develop activity/conservation plan - Monitor/look after water onions	- Grow water onions - Organize awareness campaigns for better understanding on how to conserve water onions	- Publish media materials - Generate trend for conservation of water onions through provincial level activities

Annex I: VA Team Members

Name	Organization	Role
Bampen Chaiyarak	IUCN Thailand	
Petch Manoprawitr	IUCN Thailand	
Dr.Nalinee Thongtham	Phuket Marine Biological Center	Habitat and Species Expert
Dr. Wijarn Meephol	Ranong Biosphere Reserve	Habitat and Species Expert
Mr.Khayai Thongnunui	Coastal Conservation and Mangrove Restoration Coastal and Marine Resources Management Office 8 (Phang Nga)	Habitat and community
Mr. Montri Sumontha	Ranong Marine Fisheries Research and Development Station	Fisheries, Habitat and Species Expert
Mr. Tanu Naebnien	Andaman Organization for Participatory Restoration of Natural Resources (AR	community
Ms. Kitima Khunthong	Faculty of Humanities and Social Science, Sakon Nakhon Rajabhat University	community
Mr.Decha Duangnamol	Andaman Coastal Research Station for Development, Kasetsart University	Habitat and Species Expert
Team	Mangrove Forest Resource Development Station 9	Habitat, Species and community
Team	Mangrove Forest Resource Development Station 10	Habitat, Species and community
Team	Mangrove Forest Resource Development Station 11	Habitat, Species and community
Team	Mangrove Forest Resource Development Station 42	Habitat, Species and community

ANNEX II Ramsar Sites in Thailand

Thailand joined the Ramsar Convention in 1998. The country has a total of 14 wetlands of international importance registered as Ramsar Sites; of these, 9 sites are within conserved areas such as National Parks and Wildlife Sanctuaries and 5 are in community and/or public areas as shown in the following figure.



Source: Office of Natural Resources and Environmental Policy and Planning[51]

[51]Accessed from http://wetland.onep.go.th/images/Ramsarsite_edit.png on 2 December 2017

ANNEX III Wetland Management Policy In Thailand

At present, there are 22.9 million rai of wetland in Thailand, which is equivalent to 6.8% of the total area of the country. Thailand has 14 registered Ramsar Sites of international significance, 69 internationally important wetlands, 47 nationally important wetlands and 119,295 locally important wetlands. Of these, 28 areas should be considered as protected areas. Since 1997, several policies on wetland management and measures have been issued by the Office of Natural Resources and Environmental Policy and Planning. These policies are integrated in the National Biodiversity Strategies and Action Plan (NBSAP), which has a 5-year implementation and revision cycle as follows.

1) **Policy, Measures and Management Plan for Wetlands 1997-2002.** This included 28 implementation plans and 43 projects from 14 agencies. The total budget was 472.50 million THB and was approved by the Cabinet on 15 July 1997.
2) **Policy, Measures and Management Plan for Wetlands 2003-2007.** This plan was put together with the NBSAP which has 4 supporting action implementation plans, making up of 168 projects from 41 agencies. The total budget for this phase is 2,600.56 million THB and was approved by the Cabinet on 11 June 2002.
3) **Wetland Management Plan 2008-2012 .** This falls under the NBSAP 2008-2012 on measures for wetland management schemes. There are two main measures including 1) conservation of marine and coastal ecosystems and island ecosystems and, 2) protecting the wetland ecosystem and promoting sustainable utilization. These are based on the following principles for action plans:
    - Implement according to obligations, working programs, and consensus of alliances and initiatives of the Ramsar Convention and Biodiversity Convention;
    - Participatory approach is used in the development process of the management plan and for the presentation of wetlands with international significance, including setting up conservation zones, utilization zones, and Management Committee for each of the Ramsar sites;
    - A survey of the wetland area in all dimensions including physical, biological, social and economic aspects to be performed to support the revision of the status and to make amendments for the registration of the wetlands that are important for Thailand as well as to create back-up methods in case anything goes wrong, so that relevant legal changes can be mobilized to efficiently protect the wetland areas;
    - Cooperate between various agencies, working units, private sectors and relevant communities in the wetland areas for implementation of activities, which will assist in significantly reducing the loss of wetland ecosystems by 2010.

The Office of Natural Resources and Environmental Policy and Planning prepared an integrated Master Plan for Biodiversity 2015-2021. This plan was approved by the Cabinet on 13 March 2015 and integrated into the strategy on conservation and rehabilitation of biodiversity, specifically at the provincial, local and community levels, including the following measures:

- Provide support to relevant sectors that deal with implementation of the wetland management plan for wetlands with national and international significance. It should also push the relevant agencies to make use of the plans and streamline it into provincial, local and community plans and policies.
- Prepare and support implementation based on good practices for wetland management in urban and sub-urban areas. Try to integrate the practice into provincial and local plans and policies so they can be mobilized in line with the above-mentioned master plan.

The Office of Natural Resources and Environmental Policy and Planning proposed an Action Plan for Biodiversity Management 2017-2021 to the Cabinet and it was endorsed on 28 March 2017. Implementing measures and guidelines for practices are as follows:

- Integrating issues of wetland areas into the policy and plans, finding tools, mechanisms and networks to support and to increase the efficiency in management of the wetlands.
- Enhance capacity of government agencies, private sector development organizations, and local communities to increase efficiency in implementation of conservation and sustainable utilization of wetland areas.
- Prepare a registrar for important wetlands surveyed and prepare them for registration as wetlands at the various levels of significance accordingly.
- Monitor threats for wetland and promote sustainable utilization of the area along with controlling and protecting the wetland from activities that will create mal-impacts to the area, such as the expansion of community area, over fishing, alien species invasion, pollution and climate change impacts.

For wetland management at national level, there is a mechanism for wetland area conservation according to the Cabinet Resolution, which needs to be implemented along with the task of creating policies/plans.

Even though activity plans, project and responsible working unit have been identified, implementation has not fully taken place. From the report by the Office of Natural Resources and Environmental Policy and Planning in 2015 on increasing efficiency of wetland management practices in Thailand, it was found that there was a problem with the efficiency in implementing conservation measures according to Cabinet Resolution. Therefore, following changes were proposed:

- The government should scale up the wetland management policy to give it national significance. This will ensure that it will receive the recognition and is important for the implementation under the Ramsar Convention, other than that the management of the wetland is also the basic component of water resources management, the solution to climate change problems and the deterioration of natural resources and area-based environmental problems.
- Promote and support the local, provincial, wetland management committee organization in the province and local areas, and the responsible agencies according to the laws in terms of budget to develop the implementation plan for the wetlands. The policy, measures and management plan for the wetland in the country that are approved by the Cabinet under the implementation framework for should be funded accordingly to allow the management of the wetlands to move in the same direction and be implemented accordingly.

The legal mechanism and regulations in wetland management in the present is up to the lead agency which was legally appointed and holds the highest authority to implement in the area and/or by the unit that is set up which is backed by on agency or the other. However, there are some areas where these responsible agencies or lead agencies are still not clearly identified because of some overlapping administrative glitches. Another problem is that for some areas there are many agencies that has to do with the same roles and responsibility in the same area.

A report on how to increase the efficiency of wetland management practices for Thailand was prepared for the Office of Natural Resources and Environment Policy and Planning by the Thailand Science Development and Research Institute (TDRI) in August 2017, and can be summarized as follows:

- Survey on status and studies on biodiversity management in wetlands with high significance has been implemented in the 14 wetlands with international and national

significance (from 20 target sites). Conservation/sustainable utilization plans were developed for 7 of the prioritized wetlands.

- In terms of conservation and rehabilitation of wetlands, the target was set for 35% of total national wetland areas; current practices focus mostly on marine and coastal ecosystems.
- Target for strengthening community and local administrative organizations in conservation and utilization of wetland areas was set at 50% of communities/organizations in Thailand in 5 years.

ANNEX IV: WETLANDS CONSERVATION MEASURES: CABINET RESOLUTION NOV 2009 AND MAY 2015

	Conservation measures for wetland areas	Lead and supporting agencies
1	Announced that all wetlands in the country are public areas with special specifications that the fresh water wetlands are to be zoned off as green area and the government is to maintain and take care of it for use as a source of water supply and storage but nothing else.	**Lead**: Ministry of the Interior **Support**: Local Administration Organization; Department of Fisheries; Department of Lands; Royal Irrigation Department; Department of Water Resources; Department of Marine and Coastal; Natural Resources and Environmental Policy and Planning Office
2	Conduct surveying and monitoring activities to identify the boundaries of the wetland area according to the locally prioritized list of wetlands approved by the Council of Ministers on 1 August 2000. This area is to be kept as a sink to tap water from natural sources and slow down the flow of water to prevent floods and droughts.	**Lead**: Ministry of Natural Resources and Environment **Support**: Academic institution; Department of the Interior; Department of Local Administration Promotion; Local Administration Organization
3	Keep track, monitor and maintain the wetland sites registered as locally important areas. They should be reserved as a natural source of water, especially wetlands that have been registered as public water resources. At the same time, controls and prevention measures should be taken to ensure that there are no intrusions that will adversely affect wetlands that are public areas.	**Lead**: Ministry of the Interior **Support**: Marine Department; Department of Lands Department of Water Resources; Natural Resources and Environmental Policy and Planning Office Academic Institutions
4	Create awareness and instil knowledge so that people understand the value and importance of the area so that sustainable utilization of wetlands for all sectors and people at all levels can be ensured. The community is to be allowed to participate in the planning of international and national wetlands management schemes.	**Lead**: Ministry of Natural Resources and Environment **Support**: Academic Institutions; Department of Public Relations; Department of Local Administration Promotion; Ministry of Education; Local Administration Organization; Department of Water Resources
5	Propose the wetlands to be important international and national wetland sites under the Convention on Wetlands (Ramsar Sites)	**Lead**: Ministry of Natural Resources and environment **Support**: Department of National Park Wildlife and Plant Conservation; Department of Fisheries; Department of Local Administration Promotion; Department of the Interior; Local Administrative Organization; Department of Marine and Coastal Resources
6	Declare the wetland to be of international and national importance and as non-hunting zones or environmentally protected area or other types of conservation area as relevant.	**Lead**: Ministry of Natural Resources and Environment **Support**: Department of Fisheries; Department of Local Administration Promotion; Department of the Interior; Local Administration Organization
7	Accelerate the process of issuing the announcement/declaration/official statement to support the wetlands as important international and national public areas. Also, accelerate the implementation on clear identification of boundary lines to prevent invasion and without affecting the ecology of wetlands.	**Lead**: Ministry of the Interior **Support**: Local Administration Organization
8	Urgently restore internationally and nationally the important wetlands ecosystems that have been deteriorating so that they can function naturally in their roles for the ecosystem and hydrological system.	**Lead**: Ministry of Natural Resources and environment **Support**: Land Development Department; Academic institution; Navy Department of Water Resources
9	Develop a management plan for the wetland which is important both at international and national levels for both short and long-term implementations. This is to protect restore wetlands by zoning utilization areas into conservation zone and the development zone as	**Lead**: Ministry of Natural Resources and environment **Support**: Department of Fisheries; Marine Department; Academic institution; Land Development Department; Local Administrative Organization; Department of Water Resources

	well as the buffer zone area. Also, specific activities that can be done and prohibited in the area must be specified.	
10	Ensure that an Environmental Impact Assessment (EIA) is performed and reported for projects or businesses that affect the environment according to the Notification issued under Section 46 of the National Environmental Quality Promotion and Conservation Act 1992.	**Lead**: Project owner **Support**: Natural Resources and Environmental Policy and Planning Office; Department of National Park Wildlife and Plant Conservation; Department of Fisheries; Academic institution
11	Allow, promote and support researches and studies about the wetland ecosystems with international and national level significance and disseminate the information to the public.	**Lead**: Ministry of Natural Resources and environment **Support**: Department of Environmental Quality; Natural Resources and Environmental Policy and Planning Office
12	Continuously monitor and assess the changes in the wetlands with international and national significant ecosystems. The factors and indicators for the studies must be specified specifically.	**Lead**: Ministry of Natural Resources and environment **Support**: Academic institution
13	Continuously study and survey the wetland and its biodiversity to modify and improve the wetland registration with international and national significance according to the standard criteria.	**Lead**: Ministry of Natural Resources and environment **Support**: Academic institution
14	Provide pollution control and prevention measures and practices from the various sources such as communities', industrial, agricultural activities and other activities.	**Lead**: Local administration **Support**: Department of Public Works and Town Planning; Academic institution
15	Provide for the control of wildfires in internationally and nationally significant wetlands that may be caused by the community or other activities. The measures are as follows: (1) Forest fire prevention measures (maintain constant water level in the wetlands; Build a wet-line firebreak; Conduct all types of pro-active public relations activities to raise awareness and understanding of the danger of forest fire which will stop the community from setting fire to the forest. (2) Firefighting measures (Establish a forest fire control station to take care of the area, monitor and act to control forest fires in the key wetland areas; Provide training firefighting skills for wetland forest fires to forestry officers/ rangers; Use modern and appropriate tools and equipment for handling forest firefighting in wetlands).	**Lead**: Local administration; Ministry of Natural Resources and environment **Support**: Academic institution
16	Arrange for studies and prepare both short and long term a plan for physical landscape design of the surrounding international and nationally significant wetland area to conserve and restore the area as a whole.	**Lead**: Ministry of the Interior **Support**: Department of National Park Wildlife and Plant Conservation; Local Administrative Organization; Department of Fisheries; Department of Lands; Royal Irrigation Department; Department of Water Resources; Department of Marine and Coastal Resources
17	Prepare an evaluation report on the performance according to the Cabinet Resolutions No. 1-16 by monitoring the works of the lead agency and present to the Sub-committee for Wetland Management.	**Lead**: Ministry of Natural Resources and environment **Support**: Natural Resources and Environmental Policy and Planning Office

ANNEX V: RESOURCE PRIORITY RANKING BY WOMEN AND MEN IN RANONG PROVINCE

1	**Baan Nam Jued**	
Rank	Men	Women
1	Giant freshwater prawn	Nypa fruticans
2	Serrated mud crab	Coral catfish
3	Long-whiskered catfish	Tiger prawn
4	Beagu (vegetable)	Sea perch/sea bass
5	Krill/Diplazium esculentum	Spotted Babylon
6	Sand whiting	Spinach
7	Anchovy	Sand whiting
8	Tiger prawn	Citrus reticulata blanco leaves
9	Nerite	Kuhl's creek frog
10	Meder's mangrove crab	Field frog
11	Eel tail catfish	

2	**Baan Sai Daeng**	
Rank	Men	Women
1	Water	Anchovy/tuna
2	Serrated mud crab	White shrimp
3	Nypa fruticans	Rhizophora mucranata
4	Hard clams	Coral catfish
5	Giant sea perch	Serrated mud crab
6	Giant freshwater prawn	Cerithidea sp. (sea snail)
7	Sand whiting	Spotted babylon
8	Mud skipper	Grouper fish
9	Blue swimming crab	Meder's mangrove crab
10	Bleeker	Nypa fruticans flower
11	Nerite	Horseshoe crab
12	Clams	Rays
13		Small shells

3	**Baan Hin Chang**	
Rank	Men	Women
1	Mentis shrimp	Krill
2	Fish	Fish
3	Serrated mud crab	Mentis shrimp
4	Jelly fish	Mussels (cultured)
5	Giant lobster	Serrated mud crab
6	Krill	Clams
7	Common silver barb	Lingula unguis (lamp shell)
8	Horseshoe crab	Jellyfish
9	Squid	
10	Clams	

6	**Koh Phayam**	
Rank	Men	Women
1	Water	Water, water sources
2	Air	Mangrove (forests)
3	Whiteleg shrimp	Cashew nut tree
4	Beach	Beach
5	Soil – land	Hornbill
6	Mangrove (forests)	Blue swimming crab/ Serrated mud crab
7	Seagrass	Soil/Land
8	Sea turtle	Corals
9	Halistur indus (kite)	Sea pike/Eagles
10	Lyle's flying fox	Humpbacked dolphin
11		Otters
12		Various types of shells/clams

5	**Baam Hua Tha**	
Rank	Men	Women
1	Serrated mud crab	Serrated mud crab
2	Eel	Catfish/sea perch
3	Coral catfish/Giant sea perch	Heart cockles
4	Heart cockles/Cerithidea sp./ Chylocheilichthys apogon.	Nypa fruticans (leaves)
5	Krill	Cerithidea sp. (sea snails)
6	Meder's mangrove crab	Seaweed
7	Hard clams	

6	**Baan Tha Chang**	
Rank	Men	Women
1	Serrated mud crab	Serrated mud crab
2	Whiteleg shrimp	Whiteleg shrimp
3	Mullets	Mullets
4	Fish	Fish
5	D. sea eels /Blue swimming crab	D. sea eels/Blue swimming crab
6	Krill	Clams/shells/snails
7	Mentis shrimp	Mentis shrimp
8	Meder's mangrove crab	Meder's mangrove crab
9	Clams/shells/snails	Krill
10	Jelly fish	Jellyfish

7	**Baan Lang**	
Rank	Men	Women
1	Serrated mud crab	Serrated mud crab
2	Coral catfish	Coral catfish
3	Eel	Eels
4	Whiteleg shrimp	Whiteleg shrimp
5	Grouper fish /Giant sea perch	Grouper fish/Giant sea perch
6	Blue swimming crab	Blue swimming crab
7	Mentis shrimp	Mentis shrimp
8	Oyster/Whelk	Oyster/Whelk
9	Mussels (cultured)	Mussels (cultured)
10	Meder's mangrove crab	Meder's mangrove crab

8	**Baan Aow Kei**	
Rank	Men	Women
1	(not conduced)	Blue swimming crab
2	-	Serrated mud crab/squid
3	-	Fish
4	-	Krill
5	-	Whiteleg shrimp
6	-	Oyster
7	-	Clams/shells/snails
8	-	Sardine/Pilchard
9	-	Yellow-striped trevally
10	-	Jellyfish

9	**Baam Chi Me**	
Rank	Men	Women
1	Serrated mud crab	Nypa fruticans leaves
2	Shells	Hard clams
3	Mullets	Soft-shelled crab
4	Grouper fish	Krill
5	White shrimp	Mullets
6	Krill	Sand whiting
7	Blue swimming crab	Serrated mud crab
8	Meder's mangrove crab	Coral catfish
9	Jelly fish	Oyster
10		Spotted Babylon

10	**Baan Bang Hin**	
Rank	Men	Women
1	Mangrove trees	Whelk
2	Serrated mud crab	Spotted Babylon
3	Krill	Oyster
4	Hard clams	Hard clams
5	Nypa fruticans	Krill
6	Mullets	Sand whiting
7	Croakers	Bleeker
8	Red snapper	Giant sea perch/sea perch
9	White shrimp	White shrimp
10	Mentis shrimp	Serrated mud crab

ANNEX VI: COPING MECHANISMS WITH EXTREME WEATHER EVENTS IN RANONG PROVINCE

A: Current mechanisms to cope with extreme weather events by women and men in selected communities

Impacts	Men	Women
Typhoons/severe wind storms		
Loss of income from not being able go fishing	- Other activities such as gardening. - Temporary employment/hire hand.	- Daily hire or gardening
Fishing boats/tools damaged	- Follow-up on weather forecast and prepare for situation - Move the boat.	- Follow-up on weather forecast and be prepared to handle situation.
Farmers lose income from damaged products	- No back-up plan	- No back-up plan
Trees fall/landslides (blocking road)	- Alert responsible agency for response. - Villagers help to cut the trees and move them out of the way.	- Alert responsible agency for response. - Villagers help to cut the trees and move them out of the way.
Coastal areas eroded/damaged	- Build bamboo wall to protect area from currents. - Alert responsible agency for response. - No back-up plan in some communities	- Build bamboo wall to protect area from currents. Alert responsible agency for response. - No back-up plan in some communities
Severe droughts/extensive rain gaps		
Orchard plants/trees relying on rainwater die/shrive	- Lessen problem by pumping water from another source. - Some communities do not have a back-up plan.	- Lessen problem by pumping water from another source. - Some communities do not have a back-up plan.
Saltwater into canals affects current fish but allows others.	- Move trap nets to canals to catch blue swimming crabs, serrated mud crabs, and squids.	- Move trap nets to canals to catch blue swimming crabs, serrated mud crabs, and squids.
Fish/oysters in farms die from high salinity (dry season)	- Follow-up/monitor weather forecast and use it together with experience. - Move culture station to appropriate location. - Ask local agency to assist in annual water quality check-ups. - Find alternative livelihood activity. - Raise fish tolerant for salinity levels - Sell dead animals to the Aqua Animal Processing Group.	- Follow-up/monitor weather forecast and use it together with experience. - Move culture station to appropriate location. - Ask local agency to assist in annual water quality check-ups. - Find an alternative livelihood activity. - Raise fish tolerant for salinity levels - Sell dead animals to the Aqua Animal Processing Group.
Lack of water for consumption and utilization	- Request authorities for freshwater. - Dig deeper well in the house - Ask assistance from local authorities to dig wells that are deeper than 100meters around village.	- Ask water from neighbouring village whose well is not dry to lessen problematic situation.
Pest outbreaks	- Spray pesticides.	- (no response)
Heavy and continuous rain (floods)		
Fruit trees lose flowers	- No back-up plan	- No back-up plan
Cashew rots	- No back-up plan	- No back-up plan
Rubber plantations loose income	- Change time for collecting rubber saps from night to day time to make it easier to observe weather condition.	- Change time for collecting rubber saps from night to day time to make it easier to observe weather condition

Farmed fish/oysters die from freshwater shock.	- Use experience in observing and monitoring natural conditions. - Sell dead animals to Aqua Animal Processing Group.	- Use experience in observing and monitoring natural conditions. - Sell dead animals to Aqua Animal Processing Group.
Farmed fish affected by currents	- Follow up on weather forecasts.	- Follow up on weather forecasts.
Fishmongers can't fish/lose income	- Become hired-hand/day to day wage earner or find other activities - Gather aquatic animals in ponds or around gulf areas.	- Become hired-hands/day to day wage earner or find other activities - Gather aquatic animals in ponds or around gulf areas.
Intensive resource use in canals and gulf areas as people can't go to sea.	- Release local aquatic species into water bodies. - Build a synthetic coral reef line.	- Build a synthetic coral reef line.
Houses damaged due to floods	- Make houses higher. - Follow-up/monitor weather forecasts. - Prepare sand bags to block water in front of house. - Move appliances and valuables to higher grounds.	- Move elder people and children to higher ground for safety. - Follow-up/monitor weather forecasts. - Prepare sand bags to block water in front of house. - Move appliances/valuables higher.
Seasonal fluctuations		
Local fishmongers cannot fish when severe rains (loss income).	- Find other activities - Turn to take up temporary employment jobs.	- Build a wall or dam to protect the area from currents. - Plant mangrove forests.
Los of benefits when farmed fish dies from too much fresh/saltwater.	- Follow up on weather forecast and use previous experience and weather information in former year to make plans for aquaculture practice. - Sell the dead animals. - Some aquaculture operators still do not have back-up plan.	- Follow up on weather forecast and use previous experience and weather information from former year to make plans for aquaculture practice. - Sell the dead animals. - Some aquaculture operators still do not have back-up plan.
Epidemic diseases (e.g. dengue)	- Protect against mosquito bites.	- Protect against mosquito bites.
Pest outbreak during dry season.	- Spray pesticides.	- No back-up plan
Local knowledge no longer suitable to analyse/predict weather	- Learn about the new ecosystem.	- No back-up plan
Brackish water fish do not come to lay eggs in canals due to freshwater.	- None	- None
Tsunami		
Houses damaged/people died.	- Follow-up/monitor weather forecasts and Tsunami warning signals. - Practice evacuation drills annually. - Ensure the safety area is usable.	- Follow-up/monitor weather forecasts and Tsunami warning signals. - Practice evacuation drills annually. - Ensure the safety area is usable.
Ecosystem changed	- Learn characteristics new ecosystem.	- No back-up plan
Fishmongers catch less fish in first year after migrating.	- Change livelihood activity/occupation e.g., becoming a gardener/hired hand.	- No back-up plan
Fish harder to find.	- Change livelihood activity/occupation.	- Change livelihood activity/occupation.
Aquatic animals choke on mud.	- No back-up plan	- No back-up plan
Fish from Andaman coast not popular with consumers	- No back-up plan yet.	- No back-up plan yet.
Mangroves damaged by currents	- Plant more mangrove forest	- Plant more mangrove forest
Changes in the tidal system	- Learn characteristics of new system.	- No back-up plan

High seawater temperature reduces aquatic species (temporary)	- No back-up plan	- No back-up plan
River banks and coastal erosion	- Build bamboo walls. - Submit request to government for making tide break wall or use concrete to fix river bank erosion problem.	- Build bamboo walls. - Submit request to government for making tide break wall or use concrete to fix river bank erosion problem.
Knowledge former ecosystem lost due to new ecosystem.	- Learn characteristics new ecosystem.	- No back-up plan
Rising seawater temperature		
Coral bleaching/white washing (fewer aquatic animals).	- Plant mangrove forests to create a nursery for aquatic animals.	- No back-up plan
It is harder for fishmongers because of fewer aquatic animals.	- Plant mangrove forests. - Build a synthetic coral reef line.	

B: Future strategies to cope with extreme weather events by women and men in selected communities

Impacts	Men	Women
Typhoons/severe wind storms		
Loss of income from not being able to go fishing	- Other activities such as gardening - temporary employment/hire hand.	- Daily hire or gardening
Fishing boats/tools damaged	- Follow-up on the weather forecast and be prepared for the situation. - Move the boat.	- Follow-up on the weather forecast and be prepared for the situation.
Farmers lose income from damaged products	- No back-up plan	- No back-up plan
Trees fall/landslides (blocking road)	- Alert responsible agency for response. - Villagers help to cut the trees and move them out of the way.	- Alert responsible agency for response. - Villagers help to cut the trees and move them out of the way.
Coastal areas eroded/damaged	- Build wall/dam to protect area from currents. - Plant mangrove forests. - No back-up plan in some communities	- Build wall/dam to protect area from currents. - Plant mangrove forests. - No back-up plan in some communities
Severe droughts/ extensive rain gaps		
Orchard plants/trees relying on rainwater die/shrive	- Lessen problem by pumping water from another source - Plant more varieties. - Some communities do not have a back-up plan.	- Lessen problem by pumping water from another source - Plant more varieties. - Some communities do not have a back-up plan.
Saltwater into canals affects current fish but allows others.	- Move trap nets to canals to catch blue swimming crabs, serrated mud crabs, and squids.	- Move trap nets to canals to catch blue swimming crabs, serrated mud crabs, and squids.
Fish/oysters in farms die from high salinity (dry season)	- Follow-up/monitor weather forecast and use it together with experience - Move culture station to appropriate location. - Ask local agency to assist in annual water quality check-ups. - Find alternative livelihood activity. - Raise fish tolerant to salinity levels - Sell dead animals to Aqua Animal Processing Group.	- Follow-up/monitor weather forecast and use it together with experience - Move culture station to appropriate location. - Ask local agency to assist in annual water quality check-ups. - Find alternative livelihood activity. - Raise fish tolerant to salinity levels - Sell dead animals to Aqua Animal Processing Group.
Lack of water for consumption and utilization	- (not respone)	- Build reservoir or check dams to store water. - Prepare back-up water storage tanks by buying more and asking help from relevant agencies.

		- Ask local agencies for fresh water
Pest outbreaks	- Spray pesticides	- (not response)
Heavy and continuous rain (floods)		
Fruit trees lose flowers	- No back-up plan yet	- No back-up plan yet
Cashew rots	- No back-up plan yet	- No back-up plan yet
Rubber plantations loose income	Change collecting rubber saps from night to day time to make it easier to observe weather condition.	- Change collecting rubber saps from night to day time to make it easier to observe the weather condition.
Farmed fish/oysters die from freshwater shock.	- Use experience in observing and monitoring natural conditions. - Sell dead animals to Aqua Animal Processing Group.	- Use experience in observing and monitoring natural conditions. - Sell dead animals to Aqua Animal Processing Group.
Farmed fish affected by currents	- No back-up plan	- No back-up plan
Fishmongers can't fish/lose income	- Become hired-hands/day to day wage earner or find other activities - Gather aquatic animals in ponds or around gulf areas.	- Become hired-hands/day to day wage earner or find other activities - Gather aquatic animals in ponds or around gulf areas.
Intensive resource use in canals and gulf areas as people can't go to sea.	- Release aquatic species into water bodies with emphasis on local species. - Set up a bank system for aquatic animals, farming, nursery, breeding of rare local species or those that are endangered such as *Cerithidea sp.* - Rehabilitate mangrove forest so that it can become a nursery area - Organize training for "Young Fishmongers" in conjunction with Provincial annual workplan (to learn about the ecosystem and build awareness on nature conservation).	- Release aquatic species into the water bodies with emphasis on local species. - Set up a bank system for aquatic animals, farming, nursery, breeding of rare local species or those that are endangered such as *Cerithidea sp.* - Rehabilitate mangrove forest so that it can become a nursery area - Public consultation for regulating resource use and standards of practice, e.g. banning illegal fishing gears, irregular equipment, and outsiders collecting resources for commercial purpose. - Plant mangrove forests to increase the number of trees and aquatic animals. - Organize training for "Young Fishmongers" in conjunction with Provincial annual workplan (to learn about the ecosystem and build awareness on nature conservation).
Houses damaged due to floods	- Make houses higher. - Follow-up/monitor weather forecasts. - Prepare sand bags to block water in front of house. - Move appliances/valuables to higher grounds.	- Make houses higher. - Follow-up/monitor weather forecasts. - Prepare sand bags to block water in front of house. - Move appliances and valuables to higher grounds.
Seasonal fluctuations		
Local fishmongers cannot fish when severe rains (loss income).	- Follow up on accurate information on amount of rain. - Add livelihood activities in orchards by planting more plant varieties. - Rehabilitate/manage *Nypa fruticans* forest to benefit community - Tourism activity potential/capacity and challenges survey. - Develop plan for community eco- and historical tourism.	- Follow up on accurate information on amount of rain. - Add livelihood activities in orchards by planting more plant varieties. - Rehabilitate/manage Nypa fruticans forest to benefit community - Tourism activity potential/capacity and challenges survey. - Develop a plan for the community eco- and historical tourism.

	- Listen to and follow up on news and information. - Plan for community's waste management practice with focus on waste segregation.	- Listen to and follow up on news and information. - Plan for community's waste management practice with focus on waste segregation.
Los of benefits when farmed fish dies from too much fresh/saltwater.	- Follow up on weather forecast and use previous experience and weather information in former year to make plans for aquaculture practice. - Some aquaculture operators still do not have back-up plan	- Follow up on weather forecast and use previous experience and weather information in former year to make plans for aquaculture practice. - Some aquaculture operators still do not have back-up plan
Epidemic diseases (e.g. dengue)	- Protect from mosquito bites - Pour water from containers that may lock water in it.	- Protect from mosquito bites - Pour water from containers that may lock water in it.
Pest outbreak during dry season.	- No back-up plan yet.	- No back-up plan yet
Local knowledge no longer suitable to analyse/predict weather	- Learn about new ecosystem.	- No back-up plan yet
Brackish water fish do not come to lay eggs in canals due to freshwater.	- None	- None
Tsunami		
Houses damaged/people died.	- Follow-up/monitor weather forecasts and Tsunami warning signals. - Practice evacuation drills annually. - Ensure the safety area is usable.	- Follow-up/monitor weather forecasts and Tsunami warning signals. - Practice evacuation drills annually. - Ensure the safety area is usable.
Ecosystem changed	- No back-up plan yet.	- No back-up plan yet.
Fishmongers catch less fish in first year after migrating.	- No back-up plan yet.	- No back-up plan yet.
Fish harder to find.	- Change livelihood activity/occupation. - Plant mangrove forests - Build synthetic coral reef line to create a nursery.	- Change livelihood activity/occupation. - Plant mangrove forests. - Build synthetic coral reef line to create a nursery.
Aquatic animals choke on mud.	- No back-up plan yet.	- No back-up plan yet.
Fish from Andaman coast not popular with consumers	- No back-up plan yet.	- No back-up plan yet.
Mangroves damaged by currents	- Plant more mangrove forests and emphasize on using local species. - Build local plant nursery. - Build community awareness	Plant more mangrove forests and emphasize on using local species. - Build a local plant nursery. - Build community awareness
Changes in the tidal system	- No back-up plan yet.	- No back-up plan yet.
High seawater temperature reduces aquatic species (temporary)	- No back-up plan yet.	- No back-up plan yet.
River banks and coastal erosion	- Request government agencies for making tide break wall or use concrete to fix river bank erosion problem. - -Plant mangrove as tide break stretch.	- Request government agencies for making tide break wall or use concrete to fix river bank erosion problem. - Plant mangrove in same direction as tidal direction.
Knowledge former ecosystem lost due to new ecosystem.	- No back-up plan yet.	- No back-up plan yet.
Rising seawater temperature		
Coral bleaching/white washing (fewer aquatic animals).	- Plant mangrove forests to create nursery for aquatic animals	- Plant mangrove forests to create nursery for aquatic animals - Create zoning system for mangrove forests by separating conservation and utilization areas.
It is harder for fishmongers because of fewer aquatic animals.	- (no response)	- Plant mangrove forests. - Build a synthetic coral reef line.

		- Release aquatic species into waters. - Create regulations for taking care of resources.

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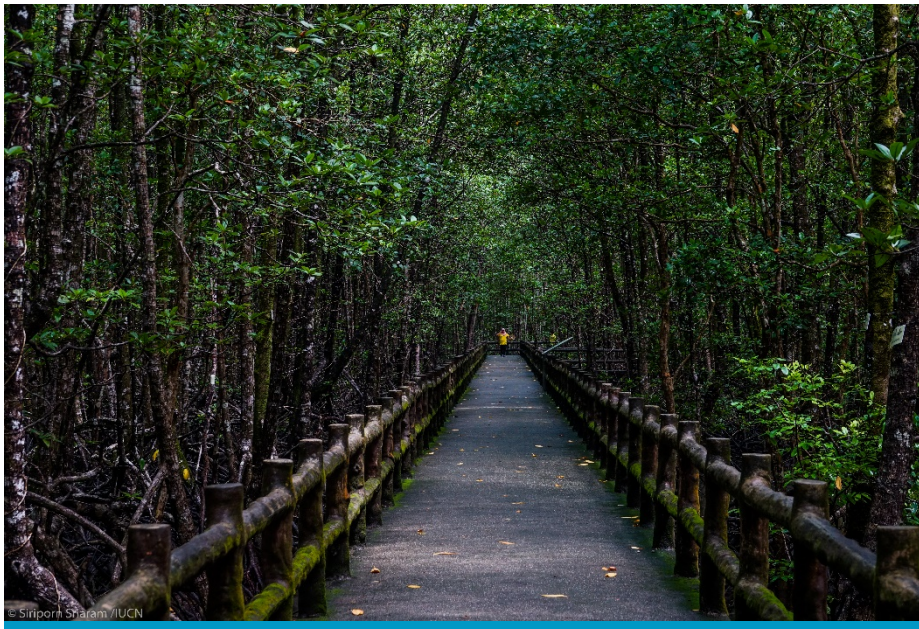

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

ASIA REGIONAL OFFICE
63 Sukhumvit Soi 39
Klongtan - Nua, Wattana
10110 Bangkok, Thailand
Tel +66 (2) 662 4029
Fax +66 (2) 662 4387
www.iucn.org/asia