

# Coastal Change Assessment in Sirinath National Park, Thalang District, Phuket Province

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## Abstract

Coastal change in Sirinath National Park, Thalang District, Phuket Province was found at several points. The purposes of coastal change assessment in Sirinath National Park were to examine coastal change, assess the situation of shoreline, and analyze guidelines for coastal erosion prevention and impact reduction in Sirinath National Park. The results showed that between the years 2005 and 2019 the areas of Sirinath National Park were eroded along the coastline in the form of erosion, covering total areas of 96,601.62 square meters, and the change of coastline in the form of accretion areas of 69,688.06 square meters. Comparing the coastline change, it could be seen that the areas where the change occurred in the form of erosion were more than the accretion. The situation of coastal area change was found that the coastal areas of Nai Thon Beach were changing at a steady-state level (0.22 meters per year), while Sai Kaew Beach, Mai Khao Beach and Nai Yang Beach were changing at moderate erosion levels (1.02-1.89 meters per year). In the future, coastal erosion rates tend to increase in areas of Mai Khao Beach, Nai Yang Beach and Nai Thon Beach. Coastal change in the form of erosion had a direct impact on the physical environment of shoreline area as some partial beach areas of Sai Kaew, Nai Yang and Mai Khao were absent and Sea Pines on the beach were eroded by the sea. Therefore, the beach nourishment, sand bypassing, dune nourishment or beach forest afforestation should be appended in the areas of Sirinath National Park to maintain the shoreline from being eroded and preserve the beaches for tourist attraction.

**Keyword:** Coastline change, Coastal Erosion, Sirinath National Park

## **Introduction**

Phuket is located on the Andaman coast. Most of the coastal areas are beautiful beaches with natural resources such as coral resources, mangrove resources and beach forest resources that are still abundant. These attract tourists to travel increasingly each year but cause the rapid expansion of the city in the coastal areas. On the contrary, the beauty and abundance of natural resources in the coastal areas of Phuket are undermined by coastal erosion. The coastal erosion causes the damage to the land, basic utilities, beauty of the scenery, ecological environment, quality of life and communities which is likely to be more violence in the future (Department of Marine and Coastal Resources, 2018).

Sirinath National Park is in Thalang District, Phuket Province. It is a marine national park on the northwest coast of Phuket Island, which has a total area of 90 square kilometers. It is divided into 76 percent of the water and 24 percent of the land. The area consists of natural sea pine forests, beautiful coral reefs and white sandy beaches where many turtles and sea crabs come to lay their eggs (Department of National Parks, Wildlife and Plant Conservation, 2018).

Coastal erosion problem in Sirinat National Park was found at several points, especially in the coastal areas near Nai Yang Beach. This is caused by the large degradation and death of coral reefs. As coral reefs influence on wave diffraction and sand build-up on Nai Yang beach. When there are no coral reefs, the strength of water that hits the beach becomes more intense, causing erosion and many large pine trees to die. A change in the direction of freshwater flowing into the sea due to the construction and filling of various swamps which used to be an area to support rainwater or water from other parts, causes those freshwater to flow directly into the coral reef area. When large quantities of freshwater flow into the sea, the coral reefs located on the beach get worse and eventually die (Plathong, 2000).

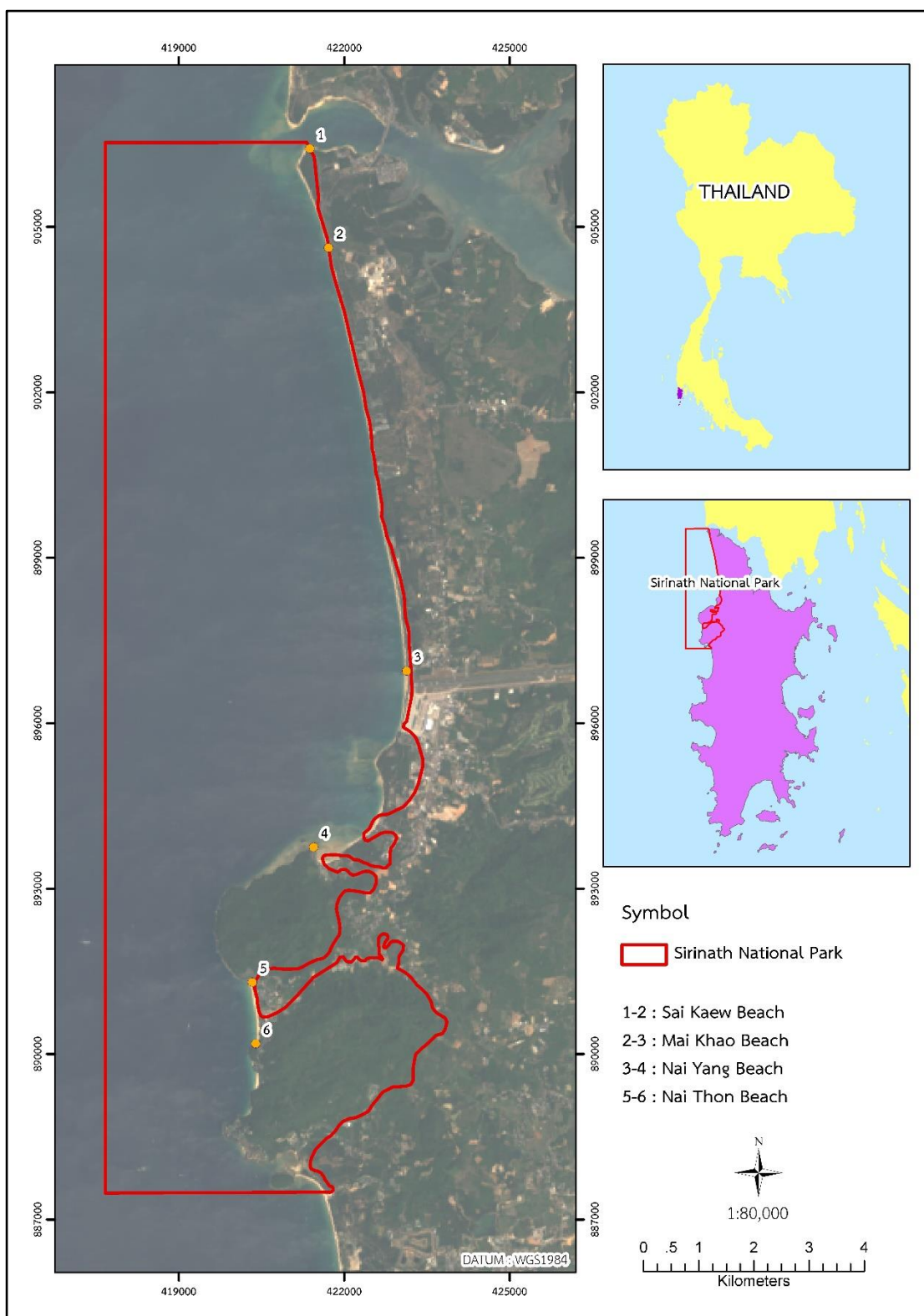
This study is to assess the situation of coastal change and enable of shoreline data analysis over a long time or multiple periods of an area in Sirinat National Park, Thalang District, Phuket Province. The results of the study can be used as a basis for tracking trends in coastal change and it can also be used as a way to prevent future coastal erosion violence.

## **Objectives**

To assess coastal change and situation and to analyze guidelines for coastal prevention in Sirinath National Park

## **Study Area**

Sirinath National Park, Thalang District, Phuket Province is a marine national park on the northwestern coast of Phuket Island (Figure 1) with a total area of 90 square kilometers. This area consists of Sai Kaew Beach, which is approximately 2 kilometers, Mai Khao Beach is approximately 8 kilometers, Nai Yang Beach is approximately 5 kilometers, and Naithon Beach is approximately 1 kilometer (Department of National Parks, Wildlife and Plant species, 2018).



**Figure 1** Map of Sirinat National Park

**Source:** 2<sup>nd</sup> Marine National Park Operation Center, Phuket Province (2019)

## Methods

Assessing the situation of coastal change in Sirinat National Park, Thalang District, Phuket Province consists of the analysis of coastal change, situation of coastline and way to prevent and mitigate the impact of coastal erosion. The methods are as follows:

### 1) Assessment of coastal change and situation in Sirinath National Park

The data of the sea coastline in polyline format was performed using a visual interpretation method from satellite images. The line between the beach and the line of trees or vegetation from the satellite images in the year 2005, 2011, 2017 and 2019 were observed. The coastlines at different times were combined to form polygon data and analyze the nature of shoreline shifts that occurred. The distance of shoreline change was then calculated. (Ali, 2010; Addo *et al.*, 2011; Bouchahma and Yan, 2012; Jayaprakash, 2013). The changed coastal area from 2005 - 2019 was examined in both erosion and deposition forms.

Assessing the coastal situation included the causes of coastal erosion and factors affecting coastal erosion. Shoreline change was compared and a map showing coastal change was provided.

For the determination of the rate of coastline change, the average width of the shifted coastlines was divided by time. This gives an idea of the rate and level of shoreline change. The level of coastline change can be shown in Table 1.

**Table 1** Level of coastal change

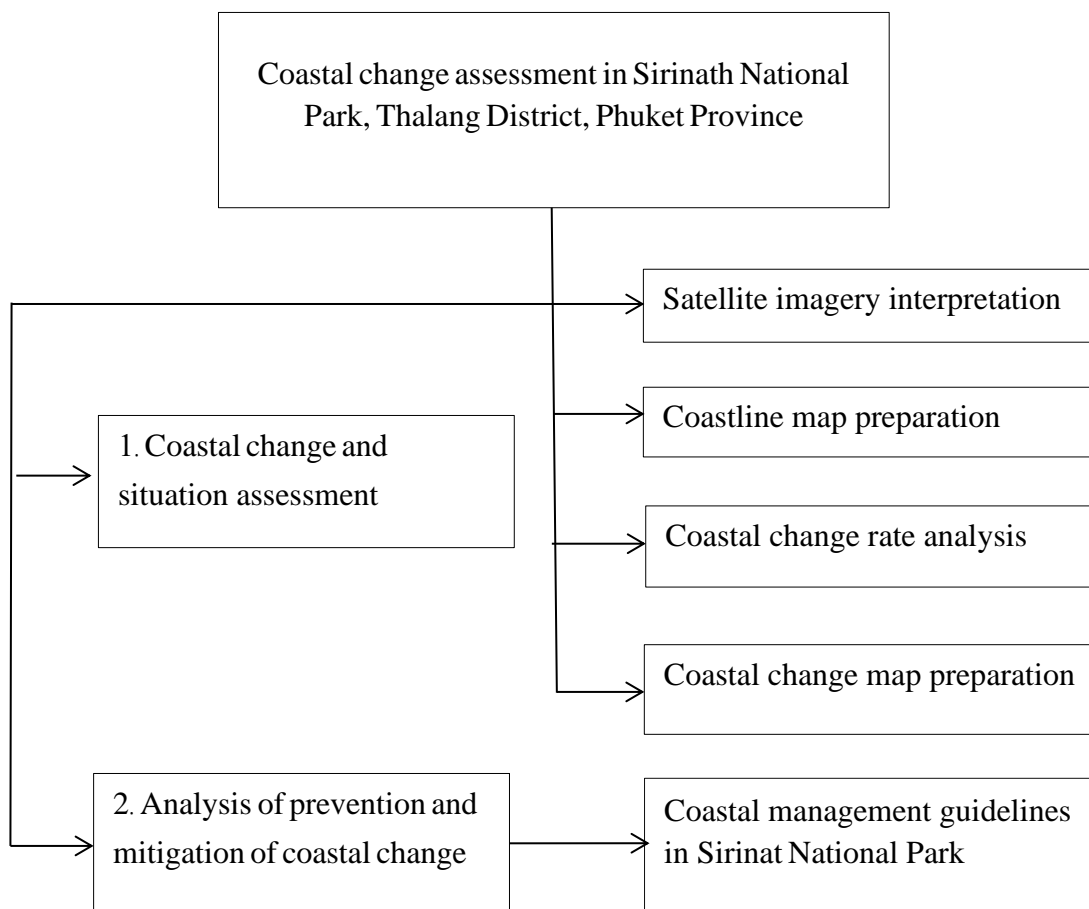
Level of coastal change	
Severe erosion	Erosion rate is more than 5 m/year
Moderate erosion	Erosion rate 1 - 5 m/year
High depositional coast	Deposition rate is more than 5 m/year
Moderate depositional coast	Deposition rate 1 - 5 m/year
Stable coast	Erosion and deposition rate is less than 1 m/year

**Source:** Sinsakul *et al.* (2001); Wattanaprida (2014) and Department of Marine and Coastal Resources (2015)

### 2) Analysis of prevention and mitigation of coastal change in Sirinat National Park

From the analysis of shoreline change and assessment of the coastal situation, together with spatial and community survey in Sirinat National Park, the various erosion prevention methods and management guidelines were analysed to find suitable ways to prevent and mitigate the impacts caused by the coastal change in Sirinat National Park.

Research conceptual framework is shown in Figure 2



**Figure 2** Conceptual framework for assessing the situation of coastal change in Sirinat National Park, Thalang District, Phuket Province

## Results

The results of the coastal change assessment in Sirinat National Park, Thalang District, Phuket Province are as follows:

### 1) Coastal change and situation in Sirinat National Park

For the study of coastal change in Sirinat National Park, coastlines were prepared through satellite imagery interpretation from the boundary of trees or beach vegetation. Then shoreline change was analyzed both in forms of erosion and accumulation. The results are shown in Table 2.

**Table 2** Coastal change in Sirinat National Park, Thalang District, Phuket Province

		Coastal change							
Beach	Change Form	2005-2011		2011-2017		2017-2019		2005-2019	
		Distance (m)	Area (sq.m)	Distance (m)	Area (sq.m)	Distance (m)	Area (sq.m)	Distance (m)	Area (sq.m)
Sai Kaew	Erosion	644.06	7,477.66	1,401.89	19,030.45	1,286.91	3,373.64	1,563.74	19,992.92
	Deposition	1,296.83	11,928.32	588.16	10,920.35	725.54	2,981.91	485.00	15,934.77
Mai Khao	Erosion	3,876.64	19,844.47	4,937.06	37,462.79	4,627.14	5,388.71	4,073.43	42,453.73
	Deposition	3,936.71	18,162.95	2,855.93	15,844.17	3,740.81	7,883.43	3,757.55	21,376.00
Nai Yang	Erosion	1,999.53	21,419.47	2,579.71	25,535.92	2,418.11	11,803.00	2,074.76	33,831.68
	Deposition	2,172.66	32,405.28	1,903.98	11,968.70	2,174.88	6,751.90	2,538.28	26,199.21
Naithon	Erosion	491.64	1,217.61	500.02	1,916.22	384.56	971.28	141.54	323.29
	Deposition	654.66	3,095.04	645.93	3,101.70	852.84	3,763.19	1,035.00	6,178.08
Total	Erosion	7,011.87	49,959.21	9,418.68	83,945.38	8,716.72	21,536.63	7,853.47	96,601.62
	Deposition	8,060.86	65,591.59	5,994.00	41,834.92	7,494.07	21,380.44	7,815.84	69,688.06

During the years 2005–2019, for Sai Kaew beach, the coastal changed in the form of erosion with a distance of 1,563.74 meters or an area of 19,992.92 square meters. While, the coastal changed in the form of deposition with a distance of 485.00 meters, or an area of 15,934.77 sq.m.

For Mai Khao beach, the coastal changed in the form of erosion with a distance of 4,073.43 meters or an area of 42,453.73 square meters. While, the coastal changed in the form of deposition with a distance of 3,757.55 meters, or an area of 21,376.00 sq.m.

For Nai Yang beach, the coastal changed in the form of erosion with a distance of 2,074.76 meters or an area of 33,831.68 square meters. While, the coastal changed in the form of deposition with a distance of 2,538.28 meters, or an area of 26,199.21 sq.m.

For Naithon beach, the coastal changed in the form of erosion with a distance of 141.54 meters or an area of 323.29 square meters. While, the coastal changed in the form of deposition with a distance of 1,035.00 meters, or an area of 6,178.08 sq.m.

The assessment of the coastal situation was classified according to the rate of change over time. The results of the study can be shown in Table 3 and Figure 3-4.

**Table 3** Coastal situation in Sirinath National Park, Thalang, Phuket

Coastal situation assessment									
Beach	Change form	2005-2011		2011-2017		2017-2019		2005-2019	
		Rate (m/year)	Change Level	Rate (m/year)	Change Level	Rate (m/year)	Change Level	Rate (m/year)	Change Level
Sai Kaew	Erosion	1.92	Moderate	1.81	Moderate	1.40	Moderate	1.89	Moderate
	Deposition	3.92	Moderate	2.21	Moderate	1.51	Moderate	2.79	Moderate
Mai Khao	Erosion	1.01	Moderate	1.01	Moderate	1.17	Moderate	1.02	Moderate
	Deposition	1.17	Moderate	1.04	Moderate	1.10	Moderate	0.43	Stable
Nai Yang	Erosion	1.51	Moderate	1.77	Moderate	2.06	Moderate	1.35	Moderate
	Deposition	2.47	Moderate	1.16	Moderate	1.29	Moderate	0.79	Stable
Naithon	Erosion	0.53	Stable	0.65	Stable	0.85	คงสภาพ	0.22	Stable
	Deposition	0.89	Stable	0.86	Stable	1.34	Moderate	0.37	Stable

For coastal situation during the years 2005–2019, it was found that Sai Kaew Beach had the erosion rate of 1.89 meters per year as a moderate erosion level and the accumulation rate of 2.79 meters per year as a moderate deposition coast.

Mai Khao Beach had the erosion rate of 1.02 meters per year as a moderate erosion level and the accumulation rate of 0.43 meters per year as a stable coast.

Nai Yang Beach had the erosion rate of 1.35 meters per year, as a moderate erosion level and the accumulation rate of 0.79 meters per year as a stable coast.

Naithon Beach had the erosion rate of 0.22 meters per year and the accumulation rate of 0.37 meters per year as a stable coast.

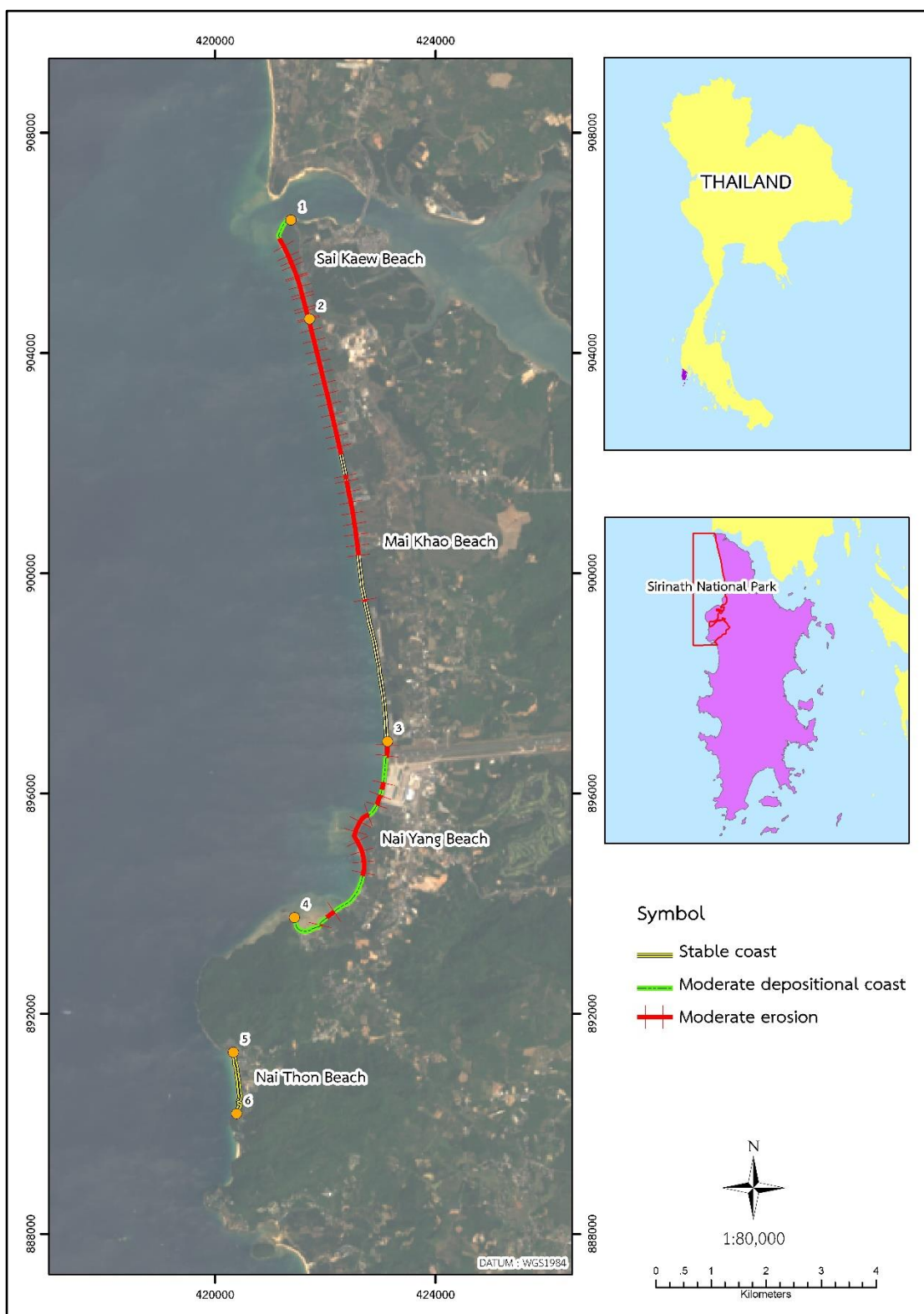
## 2) Prevention and mitigation approaches for coastal change in Sirinat National Park

Prevention and reduction of coastal erosion in Sirinat National Park can be summarized as shown in Table 4.

**Table 4** Coastal management in Sirinat National Park, Thalang District, Phuket Province

Beach	Plan	Responsibility
Sai Kaew	Afforestation	-Sirinat National Park
Mai Khao	Beach nourishment	- Department of Marine and Coastal Resources
	Sand bypassing	- Local government organization
Nai Yang	Dune nourishment	- Stakeholders and local community
	Afforestation	
	Beach nourishment	
Naithon	Sand bypassing	
	Dune nourishment	
	Afforestation	
Naithon	No Action	-

As Sirinat National Park had moderate coastal erosion (1.02-1.89 meters per year), soft structures such as beach nourishment, sand bypassing, dune nourishment, afforestation like mangrove and beach forest should be operated in the area to keep the coastline from being eroded.



**Figure 3** Map of coastal situation in Sirinath National Park, Thalang, Phuket during the years 2005-2019





**Figure 4** Coastal erosion in Sirinath National Park, Thalang, Phuket during the years 2005-2019

## Conclusion and Discussion

Assessing the situation of coastal change in Sirinat National Park, Thalang District, Phuket Province can be summarized and discussed as follows:

The coastal area in Sirinat National Park during the years 2005-2019 had changed in the form of erosion with the total area of 96,601.62 square meters and the form of deposition with the total area of 69,688.06 square meters. Comparison of the coastline had shown that the area that changed in the erosion pattern was greater than the area that changed in the accumulation pattern.

For the coastal situation in Sirinat National Park, it was found that in Nai Thon Beach, the coastal area had changed in the stable level (0.22 meters per year), which was consistent with the change in the stable level of the coastal erosion monitoring project in the critical area of Ratsada Beach, in Phuket City (Department of Marine and Coastal Resources, 2015)

For Sai Kaew Beach, Mai Khao Beach and Nai Yang Beach, the coastal situation had changed at a moderate erosion level (1.02 -1.89 meters per year), which was consistent with a moderate erosion of the beach monitoring in Hat Chao Mai National Park in Trang Province (Marine National Park Operation Center 3, Trang Province, 2015). This erosion was due to various environmental aspects, including natural causes such as the intensity of the waves, monsoons, currents and human actions such as the construction of the resort, breakwater, sandbags, beach front line and the formation of wave barriers. These were factors that caused erosion of the coastline that had degraded the Andaman coastal ecosystem (Thanawut and Yongchalermchai, 2013).

The coastal change was due to the influence of monsoon waves and tides, as well as human activities such as the development of the coastal area to support the tourism industry and invasion of beach forests that have resulted in the coastline change. For Sirinat National Park, there was a coastal problem in the form of erosion in many places, especially in Nai Yang beach which has no island as a wave barrier, therefore causing beach erosion (Innovation Institute of National Parks and Protected Areas, 2015). It could also be caused by human action, as the area around Nai Yang Beach had been developed. Additionally, various peats which are the area to retain rainwater or water from other parts had been invaded, causing freshwater to flow directly into the sea. Consequently, the coral reefs at Nai Yang Beach had been degraded and eventually died. When the coral reefs that used to slow waves died, the limestone structure collapsed. This led to the diffraction of the waves and sedimentation of the beach. As a result, the strength of the wave that hit the beach was more intense and caused erosion on Nai Yang beach (Plathong, 2000).

However, from the study of coastal change and situation in Sirinat National Park during the years 2005-2019, the severe coastal erosion area had not been found. Although there was seasonal variation in the coastal area, there was no serious damage impact on the shoreline. However, coastal management should be undertaken, especially for public

and tourist access to the coastal area for recreation. The coastal environment and coastal management plan should be taken into account.

For the coastal accumulation, it was found in Sai Kaew Beach and Nai Yang Beach, which was an area where the current was not very intense. This caused sediments to accumulate in a parallel arc along the coastline. Sedimentation and sand accumulation were due to the influence of waves, currents and monsoons (Department of Mineral Resources, 2012). The sand sediment that had been blown up on the beachfront may also be carried from an area where shoreline change had occurred in the form of erosion.

Coastal change directly affected the physical environment of the coastal area. Erosion had resulted in some area of the beaches at Sai Kaew, Nai Yang, and Mai Khao Beach. Many pine trees on the beach were eroded and died. (Institute of National Park and Protected Areas, 2015) The degradation of coastal ecosystems precisely affected coastal life and biodiversity (Suwanich, 2009). Change in the coastline on Sai Kaew and Nai Yang beach could be observed in the wide area of shoreline degradation. Besides, the changing scenery of the beach made some area no longer visited by tourists, resulting in the area to become a deserted zone. As a result, the function of the ecosystem was impaired and inefficient. The quality of life of people and communities living in the coastal area had also deteriorated. Therefore, there should be guidelines for coastal area management to prevent coastal erosion problems, including restoring the coastal ecosystem to its normal state as soon as possible (Department of Marine and Coastal Resources, 2011).

The study of the Department of Marine and Coastal Resources (2018) found that the past coastal situation in Phuket experienced the erosion problem for a distance of approximately 100 kilometers (of which 75 km of moderate erosion and 25 km of severe erosion). For the current coastal situation, it was found that Phuket had been operating with different structures. Currently, Phuket coastline was about 202.83 kilometers, consisting of 101 kilometers of sandy beaches, 6.36 kilometers of muddy beaches, 8.52 kilometers of muddy sand beaches, 83.07 kilometers of rocky beaches and 3.87 kilometers of river outlets. It was also possible to classify the coastal situation into severe erosion ( $> 5$  m/year) as 0.42 km, moderate erosion (1-5 m/year) as 0.24 km, stable coast ( $< 1$  m/year) as 0.63 km, recovery area as 23.48 km, the equilibrium area as 88.72 km, the high depositional coast as 0.03 km, the estuary as 3.87 km, the rocky beach area as 82.51 km and the poaching area 2.93 km.

When comparing the erosion situation of Phuket Province with one on the Andaman coast (Hinthong *et al.*, 2000) such as Satun Province, which consisted of a sandy lagoon beach. Satun beach was severely eroded for a long time, especially in the outer sandy beach open to the sea. Its erosion rate was approximately 6-7 meters per year, classified as the severe erosion ( $> 5$  meters per year). There was a great loss of land, soil and sediment, causing critical property damage of state and citizens (Suwanich, 2009). In addition, residents who lived in this area had to migrate into the inner area. This erosion was caused by the change in tectonic conditions in the Andaman Sea and the phenomenon

of sea-level rise. Coastal erosion was therefore caused by a change to normalize the natural equilibrium rather than human action. The same erosion could also be seen from another coastal area such as Krabi Province. The study of Somsak Watanaprida (2014) found that the coastal erosion of the Andaman coast as a whole was less severe than that of the Gulf of Thailand, both in terms of the number of eroded areas and the severity of the effect of coastal erosion. Because there were different geological features along the coast. The Andaman coast was mostly cliffs and islands initiating short and narrow sandy beaches between Pocket Beach. Furthermore, Land use characteristics of most Andaman coast are evergreen forest and mangrove forest.

According to the forecast of global temperature rise models, temperatures would rise by 1.2-2 degrees Celsius over the next 40-50 years, and sea levels would rise 0.3-0.66 meters over the next 100 years. Therefore, the trend of coastal change in the future was likely as a result of more waves and strong winds. For example, the problem of coastal erosion in the Pak Phanang River Basin, Nakhon Si Thammarat Province was found that the coastal currents in the past were moving from north to south, that was opposite from nowadays, which moved from the south to the north direction. From the analysis of sedimentation and direction of sediment movement in the coastal area of the Pak Phanang River Basin, there was a tendency in direction change of sedimentation, especially in the estuary during the monsoon season. In the future, due to coastal morphological condition, the rise of sea level and coastal erosion, the cape in the basin would be severely eroded and disappear (Suwanich, 2009). So, the effect of global warming was likely to bring the seriousness of the coastal erosion sooner or later, if the problem was not properly assessed and prevented.

For prevention and mitigation of impact from the coastal change in Sirinat National Park, soft structures such as beach nourishment, sand bypassing, dune nourishment, afforestation like mangrove and beach forest should be applied for the area to serve as natural defense barriers that protect the coastline from being eroded. These soft structures save the beach for a tourist destination because they do not obscure the beautiful scenery of the coast and do not have the visual aesthetic effects. Moreover, these preventions do not obstruct the rise of the turtles and sea crabs to lay their eggs on the beach. Also, there should be additional implement, including the set back without any development that may cause an erosion in the coastal area.

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