

# Changes of Coastline: A Study Case of Carey Island-Morib Coast, Selangor, Malaysia

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## 1 Introduction

Generally, the coast is the area that separates the coastal land and sea areas. History has proven the coast into focus as diverse as the development of settlements, fisheries, agriculture, port activities, and recreation area. Nowadays, development activities have increased geomorphological processes along coastal land and destroyed a huge area of natural coastal ecosystem. These situations have resulted in degraded coastal resources and expose the coastal landscapes to vulnerability. According Basir et al. [9], the increase in the intensity of coastal development utilizing the available resources in the coastal areas as well as the lack of awareness and involvement on conservation measures raises a lot of negative impacts on the coastal environment. This, coupled with the nature of the coastal ecosystems of the most dynamic landscape, affects land and sea and wind actions. The combination of these three agents, and accompanied by human activities, can promote changes in the coastal zone. According to Ahmad [4], changes in coastal or more accurately the changes in the coastline are also strongly influenced by the effects of sea level rise from global climate change. Global climate change is said to be able to change the process of sediment transport and the transfer of land and sea next to a beach and has implications for the increase or reduction of precipitated material in coastal zones. The direct impact of this natural process is the change in shoreline position.

Malaysia which has a length of 4,809 km coastline was not spared from natural processes in coastal zones. This could be associated with two main coastal geomorphological processes of erosion and deposition that transferred the coastal materials along the coastal zone. These physical processes have been able to change the coastline of the country [8]. Data from the Department of Irrigation and

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Drainage (DID) show nearly 1,400 km of coastline in Malaysia experiencing critical erosion process. Many beaches in the east coast of Peninsular Malaysia are among the 65 locations experienced critical erosion. The Department of Irrigation and Drainage defined critical coastal erosion as any part along the coastal zone that suffered a serious erosion process and therefore difficult to be conserved. As a result, it's leaving a serious impact to the coastal zone and affected the stability of the natural beach profile. In the socioeconomic context, it referred to a situation that is capable of threatening the lives of coastal residents, especially the aspects of safety and economy.

Although the beaches in Malaysia have long suffered serious erosion processes, the aspects of coastal management are not included in the priority list of the government until the 1980s. Before that, the responsibility for monitoring and implementing control works and mitigation coast was placed under the jurisdiction of the joint committee by the DID, district office, and local government. As early as the 1980s, efforts were initiated to strengthen aspects of coastal management. The government has established a Coastal Engineering Technical Centre in January 1987, and this center serves as technical advisor for any development projects involving coastal component. In addition, the agency is also responsible for performing the monitoring, control, and conservation of coastal zone with the primary focus on coastal areas experiencing critical erosion problems.

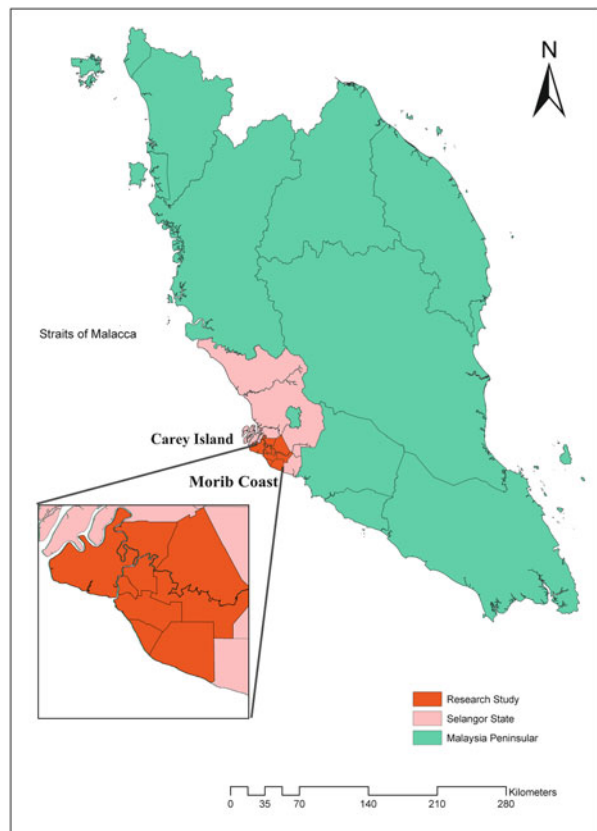
As stated above, most beaches on the east coast of Peninsular Malaysia experience critical erosion process. However, the opposite is detected in most of the west coast of Peninsular Malaysia. Most of the beaches in the east coast of Peninsular Malaysia are directly exposed to the northeastern monsoon. This monsoon capable to produce aggressive waves that could erode the coastal zone rapidly. However, the opposite is happening in the western part of Peninsular Malaysia where wind action and wave action are moderate and less aggressive and act as corrosion agents rather than agents of deposition.

In this case, the beaches in Selangor are not immune from both the natural process of coastal erosion and deposition processes. As one of the most developed states in Malaysia, Selangor experienced a very rapid development process. Land use changes occur rapidly and also removed the sediments eroded into the river system that flows directly into the Straits of Malacca. Removed sediment eroded into the river system is transported to the mouth of the river, and most of the muddy sediments were deposited directly into the mouth of the river. A serious deposition process occurs as the waves are not aggressive [5]. This situation is also assumed to occur at Carey Island-Morib coast. Preliminary observations in the field show that there are certain parts along the coast which suffered serious deposition process, while some others are experiencing erosion process. Therefore, this article seeks to clarify the changes of coastline along the Carey Island to Morib beach. The changes are based on the assumption of the presence of muddy material during low tide, and the velocity of waves during high tide is considered at high momentum. Both situations were observed during the first visit in the fields and these led to the study of coastline change along the Carey Island to Morib beach. Data on physical characteristics of the study area could be used as a baseline data to regulate and conserve resources in the coastal zone especially in the study area.

## 2 Methodology and Research Background

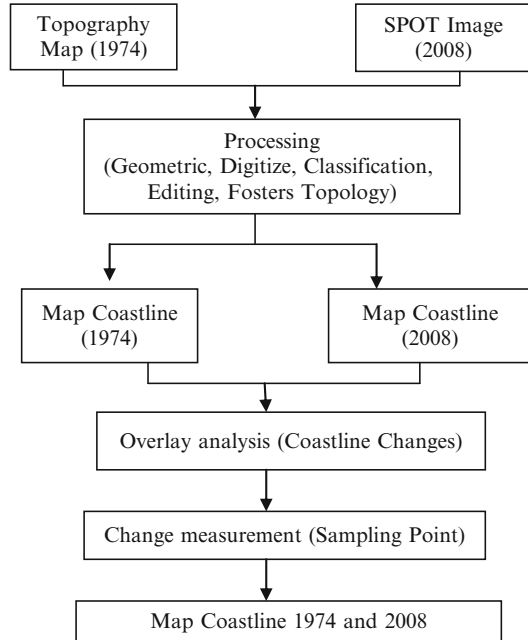
As stated above, the study of shoreline change is done in Carey Island Morib coast. The beach is located in the western part of Peninsular Malaysia  $2^{\circ} 36'32.64''$  N  $101^{\circ} 41'05.68''$  E and  $2^{\circ} 36'32.64''$  N  $101^{\circ} 41'05.68''$  E as shown in Fig. 1. The coastline is about 30 km long and characterized as muddy and sandy sediments. The Carey Island covered with Langat River in the north and south, and both are skirting out into the Straits of Malacca. The Straits of Malacca are one of the busiest sea routes in terms of ship movements and carrier trade. The beach is known for rest and recreation. Some beaches along the Carey Island to Morib are covered with mangrove and this mangrove is seen as a wave's buffer zone. Preliminary observations in the field show that certain parts of the mangrove clusters have collapsed and died, and this is an early indication of coastal erosion processes. Another part of the coast indicates the presence of a lot of precipitates, and these precipitates are an early indication of deposition process.

To track the changes to the coastline of Carey Island-Morib coast, edge geospatial technology is fully applied. A summary of the study methodology is shown in Fig. 2. In general, this article will only involve the measurement of



**Fig. 1** Carey Island-Morib coast. *Source:* Modified from Malaysia Peninsular Boundary map

**Fig. 2** Flow chart of research methodology



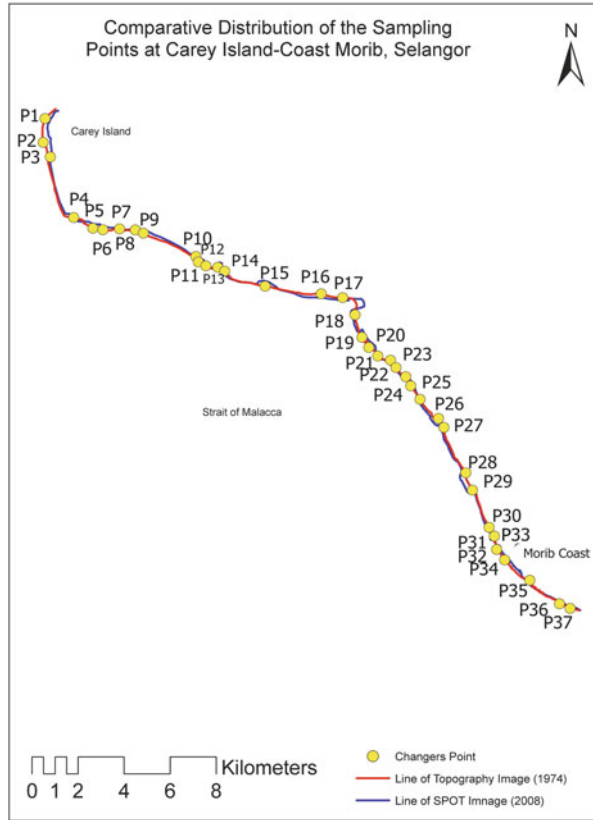
shoreline change at the first stage of identifying the source of this change through map and source images. The second stage involves the measurement of the coastline in the field using the Global Positioning System (GPS), but this level will not be covered in this article.

The first process is digitizing the coastline of Morib coast and Carey Island (source topographic maps that represent the position of the shoreline in 1974). This process is done using geographical information system (GIS) in which a digital map layer is built into ArcGIS package. Meanwhile, the ERDAS package had been used to build the coastline of the study area. Both data have been through some geographic processes such as geometric, topological classification and thematic layer construction. In order to detect the changes of the Carey Island-Morib coastlines, all thematic maps were analyzed using simple overlay procedures. In addition, the measurement of distance change was based on 37 locations of field sampling points (Fig. 3).

### 3 Research Result and Discussion

Figure 4 shows the results of mapping Carey Island-Morib coast for 1974 and 2008. In general, both erosion and deposition processes can be traced along the coast. The north coast of Carey Island was experiencing serious erosion process while middle

**Fig. 3** Distribution of sampling points relative

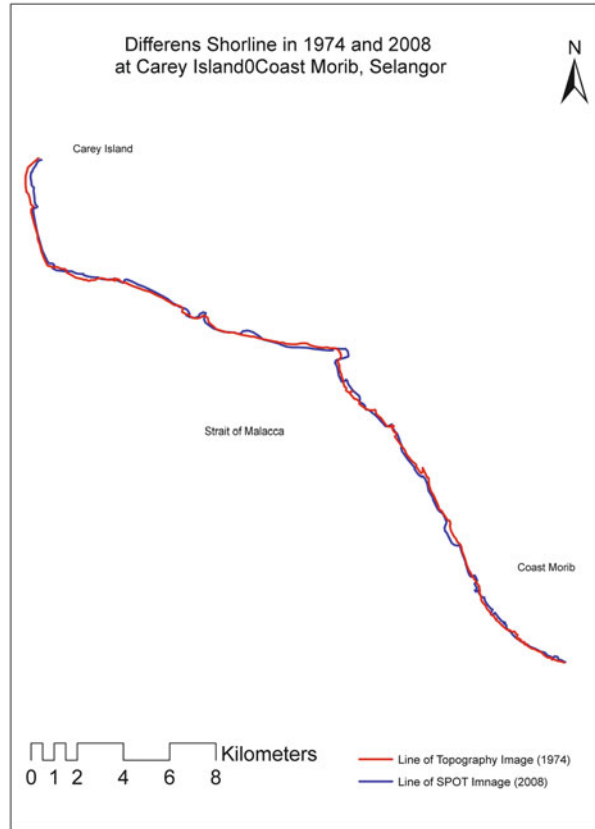


parts of Morib beach were suffered deposition process. Sg. Langat, south coast of Carey Island, is also found to undergo a process of erosion.

To clarify the picture of the erosion-deposition process that occurred on both beaches, shoreline change measurement data are shown in Table 1. P1–P3 sampling locations that represent the area on the north coast of Carey Island recorded the average distance of highly eroded beach, about 261 m. Even the highest eroded beach distances are also recorded in this part of the sampling locations of P2 380.8 m. Meanwhile, the deposition process was detected seriously in the southern part of the Morib beach from P26 to P30 sampling points. The average value of deposited beach distance recorded for P26–P30 sampling locations is 214 m. The highest deposition distance was recorded at P27 and P29 sampling points of 294 and 299 m respectively. In addition, 20 sampling points experienced erosion process while another 17 sampling points experienced deposition process. The average value of eroded coastline was 170 m, and 157 m was the case of deposit coastline.

Based on these initial findings, it is clear that Carey Island-Morib coast experienced more erosion process than deposition process. As a comparison, Carey Island

**Fig. 4** Comparison of shoreline in 1974 and 2008



experienced more erosion process while Morib beach experienced more deposition process. Generally both processes are strongly influenced by the action of the dynamic agents of fluctuation which include coastal waves, currents, tides, and wind. All these agents act by affecting the energy intensity. The energy contained in the waves and currents is able to move the activity to alter the shape of the beach. Waves are the main cause of the changes taking place on the beach. Waves provide an important energy source for coastal construction, the production of materials on the basis of surface coastal sediments, and transporting the raw materials to the shore, offshore, and parallel to the beach. Strong waves with strong energy are capable to move beach materials, especially moderate and fine sands [6]. If the wave energy decreases, the precipitated material is deposited in the bottom and on the shore. The energy of wave is also can be reduced if the movement of the wave to the beach shore was hindered by any object such as shelf sand and huge beach rock. In addition, the energy of the wave could be increased when the wave reflected back to the sea [3]. Therefore, both of movement and reflected wave to and from the beach would affect the coastline profile along the Carey Island and Morib beach.

**Table 1** Coastline change based on erosion-deposition processes

Sampling location	Coastline change (m)	
	Erosion	Deposition
P1	236	
P2	381	
P3	166	
P4		127
P5	179	
P6	127	
P7		65
P8		72
P9	140	
P10		53
P11	245	
P12		143
P13	140	
P14		157
P15	214	
P16		173
P17	130	
P18		200
P19	100	
P20	171	
P21	94	
P22		158
P23		94
P24	102	
P25	130	
P26		113
P27		294
P28		123
P29		299
P30		245
P31	150	
P32		218
P33	216	
P34	179	
P35		149
P36	137	
P37	171	

Currents in coastal area are created by the interference waves. This highly influential currents erode, transport and deposit sediment material. Currents also cause a rapid flow of water on the coast [2]. Wind action on the coastline occurs directly and indirectly. Currents and winds in both of these situations act as an agent of erosion or deposition. Wind indirectly creates waves and waves act as an agent of erosion and sedimentation in coastal areas. Direct action of the wave could be associated with its function in transferring fine materials to the berms while indirectly wind could create strong wave and current and eroding the coastal zone.

In addition, wind velocity along the study area could be decreased as the study area is barred by the Sumatera Island, Indonesia [7].

The period between high tide and low tide is called ebb tide. Tides in the ocean are more influenced by the moon than the sun. Time of high tide and low tide is closely related to place the month. Therefore, tides are also important in determining the length of the beach profile. Relatively, when the tides reached its highest level, the beach profile will be shorter, and the beach profile seems longer during the low level of tides. During low tide, the beach profile is longer and at high tide, it is shorter.

In addition, human factors such as the movement of large ships in the Straits of Malacca are believed to play an important role in influencing the process of erosion on the north coast of Carey Island. The north coast of the Carey Island is closed to the port activity known as Port Klang where many large ships moving daily within the port zone. Large vessels are capable of producing energy waves, and when the waves get to the beach, these act as an agent of erosion. Meanwhile, the process of muddy deposition in Morib could be related to changes in land use activity on the mainland. Nearby land to the sea along the Morib beach has been planted with oil palm. This plantation could lead to soil erosion as its soil surface does not cover with vegetation cover. Eroded soil, then has been transported into nearby streams and flowing down to the estuaries. During low tide, most of eroded sediment that reached the river mouth will be stranded and remains as muddy sediment.

## 4 Conclusion

This article has discussed the shoreline change in Carey Island-Morib coast. The findings clearly show that the study area experienced both erosion and deposition processes therefore affect the changes in Carey Island to Morib coastline. Geospatial technology involves the use of GIS and satellite imagery applied in this study. Based on the overlay analysis of thematic maps, the processes of erosion and deposition shown in the format of the line that representing changes in the coastline. However, coastal erosion processes were more dominant in Carey Island and more dominant deposition process in Morib coast. Apart from the action of natural agents, geomorphology, currents, tides, and wind, it is believed that the movement of large ships in the Straits of Malacca and Port Klang has resulted in beach erosion processes in Carey Island. Meanwhile, human activities, especially land use change are believed to affect the presence of serious muddy material deposition along the Morib beach. To confirm these initial findings, further studies need to be moved to include observations in the field to measure the physical characteristics of the beach. The combination of data obtained from the analysis of thematic maps and field data is convincing more interpretation of shoreline change at Carey Island-Morib coast that can be associated with erosion and sedimentation processes.



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