

# Coastline Dynamics and Its Influence on Community Activities at Tanjong Lobang Beach, Miri, Sarawak

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## Abstract

Coastal areas are important especially for the tourism sector which involves recreational and business activities. However, the phenomenon of shoreline change has the potential to jeopardize the welfare of local communities, including the aspect of economic disruption. Tangible effects can be seen through the destruction of infrastructure, loss of land and destruction of vegetation. Pantai Tanjong Lobang located in Miri, Sarawak is an area that has experienced significant shoreline change. Therefore, this study aims to identify the extent of shoreline change in Tanjong Lobang, Miri, Sarawak while analyzing its impact on the socioeconomic activities of communities in the area. Shoreline changes were analyzed using Geographic Information System (GIS) software by comparing the shoreline position of remote sensing images (Google Earth Pro) in 2001, 2013 and 2023. To identify the impact of shoreline, change on community activities, a survey method was used. The results of the study found that in a period of 22 years (2001 to 2023) there was a change in the shoreline with 22 meters towards the coastal land. This change is indirectly found to have jeopardized the safety and comfort of visitors in carrying out their recreational activities in the beach area. Identification of coastal areas at risk of experiencing shoreline changes needs to be done so that the community and local authorities are willing to face these changes.

## 1. Introduction

The coastal region has been extensively utilized by humans until a close interconnection is established between the societies and the resources available in the region. This has resulted in an emphasis on boundaries and equilibrium as well as the durability of coastal border zones today (Baztan et al., 2015). This circumstance can be perceived in such a manner that around 44% of the global population resides within 150 km of the shore (Abd Mauludet al., 2015). Even eight of the world's ten largest urban centers are situated close to the shoreline. Urban centers comprise Mumbai, Tokyo, Shanghai, Lagos, Los Angeles, Calcutta, Buenos Aires, and Los Angeles. The escalating population expansion scenario in coastal regions combined with swift tourism activity will introduce further disturbance to the region (Muhammad & Nurul, 2016).

In Malaysia, the increase in population in coastal regions signifies an inclination towards stabilizing the vicinity against any peril of natural calamities. However, in accordance with Zarina (2016), there is a forecast indicating that 29% (1380 km) of the total shoreline in Malaysia is experiencing erosion. In contrast, within Sarawak exclusively, there exist two alterations in monsoon breezes, specifically the Northeast Monsoon, which

skipped the initial monsoon shift. This period extends from November to March. Conversely, the Southwest Monsoon persists from May or early June to September. The geographical orientation towards the South China Sea renders the Miri coastal zone susceptible to erosion. Waves, monsoon currents, tidal fluctuations, and sea level variations are inherent elements that could trigger the occurrence of coastal abrasion in Sarawak (Zarina, 2016).

One of the regions in Sarawak that has encountered a significant coastal phenomenon is Tanjung Lobang Beach. This particular beach is renowned as a popular destination for tourists and recreational activities in Miri, Sarawak. Regrettably, the observed phenomenon, attributed to the presence of substantial waves, has resulted in the destruction of numerous infrastructural facilities within the recreational vicinity. Specifically, two jetty structures utilized for admiring oceanic sceneries have suffered complete collapse. Furthermore, facilities such as the cottage located on the southern section of the beach have also been adversely affected by the aforementioned coastal process (Kandau, 2018). Therefore, the principal aim of this study is to examine the changes taking place along the Tanjung Lobang coastline in Miri, Sarawak, in reaction to the identified coastal phenomenon. Concurrently, the investigation aims to delineate the repercussions of coastline transformations on both visitors and traders frequenting the area.

## 2. Literature Review

The modification of coastlines denotes the interface between terrestrial and marine environments, subject to continual transformation owing to dynamic environmental circumstances (Fazly et al., 2018). Changes in coastlines primarily stem from various factors such as wave action, tidal movements, wind patterns, storms, fluctuations in sea levels, and anthropogenic interventions (Husain & Yaakob, 1995; Yoo et al., 2014).

Additionally, Abd Maulud et al. (2015) identified two principal sources contributing to shoreline adjustments: natural processes and human-induced impacts. Climate variability emerges as a significant factor influencing coastal geomorphology alterations. The repercussions of climate change encompass heightened intensity of natural phenomena, inundation, aridity, sea level elevation, and loss of biodiversity (Muhammad & Nurul, 2016). Furthermore, Faizal (2005) underscores the profound influence of rising sea levels resulting from global climate change on coastal areas.

### 2.1 Coastline Change Monitoring Using GIS and Remote Sensing

Geographic Information Systems (GIS) are software applications utilized for the storage, management, analysis, and visualization of various types of geospatially referenced data (Fatih & Savaş, 2016). Conversely, remote sensing is defined as the scientific and artistic practice of acquiring information regarding objects, regions, or phenomena by examining data collected from instruments that do not directly interact with the subject of interest (Chipman et al., 2008).

The integration of Remote Sensing and GIS proves particularly advantageous in the evaluation of environmental transformations on a global and local scale. Recently, remote sensing techniques have found widespread application in the examination of alterations along coastlines. The dynamics of coastal adjustments can be effectively illustrated through the outcomes of image interpretation conducted on a specific area at different points in time (Fatih & S. Savaş, 2016).

### 2.2 The Impact of Coastline Changes on the Community

Shoreline change can have a significant impact on the surrounding nature as well as the socio-economy of communities located in the coastal zone. For example, loss of property, threatening the safety of the surrounding community, disrupting agricultural activities and also losing recreational areas (Doong, 2009).

Malaysia is a maritime country where its people depend heavily on the sea for their source of income, transportation, trade and defense. It is estimated that the country has a coastline length of 4800km including the states of Sabah and Sarawak (Ismail, 2014). Its position on the shallow and geologically stable Sunda Shelf has led to fisheries as well as coastal zone settlements (Ong, 2001). Because of this, coastal communities are the most affected by any disasters arising from changes in coastal geomorphology.

## 3. Methodology

This study used two main types of data. To analyze the shoreline changes, Geographic Information System (GIS) software and remote sensing images (Google Earth Pro) have been used. To identify the impact of shoreline change on local community activities, a cross-sectional analysis method has been used.

### 3.1 Determination Method of Tanjung Lobang Shoreline Change

To obtain a clear picture of the coastal landscape, images from Google Earth Pro are very helpful. Based on the Historical Imagery feature of this application, users can select the desired time interval based on the availability of satellite images. To illustrate the patterns of shoreline change, three time series have been used in this study, namely in 2001, 2013 and 2023. These time series were chosen according to the interval of availability of images from Google Earth. Through this time interval, the changes that occur in the landscape of Tanjung Lobang Beach can be identified.

After obtaining the satellite image data from the Google Earth Pro application, the data was then assigned a 1948 RSO Borneo Meter leadogram using ArcMap 10.3 software for each image by year (Hughes et al., 2006). The coastline was then digitized by creating a polyline for each year. The layered colored lines of the different datasets allowed the different shoreline shapes to be detected easily. The patterns of coastal change (erosion and deposition) are revealed on each image following the time interval of 2001, 2013 and 2023. The extent of the area undergoing change due to the erosion phenomenon has been identified by creating polygons in the changed area using ArcGIS software. ArcGIS software has long been used for the purpose of natural disaster risk assessment (Jafar et al., 2020) including for monitoring the extent of coastal erosion.

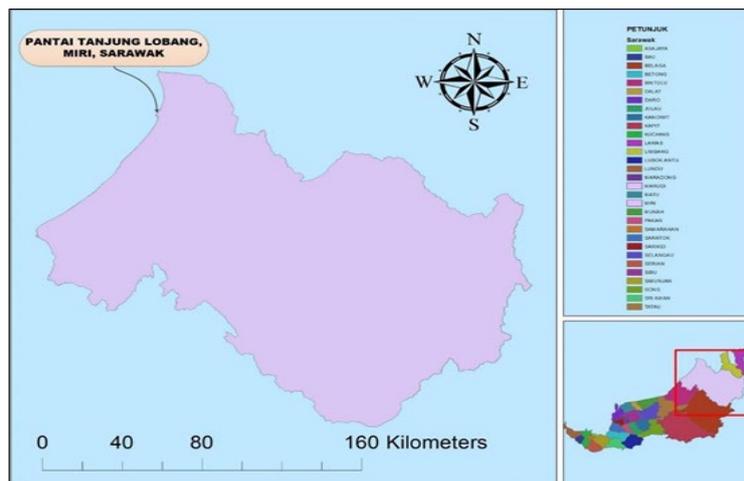
### 3.2 Cross-sectional Survey Method

The cross-sectional survey method has been used in this study to obtain information regarding the impact of shoreline change (hakisan & pемendapan actions) to the local community. By doing so, as many as 35 respondents consisting of visitors and merchants around Tanjung Lobang Beach were asked to answer the research question. The research question in this study is in the form of a Likert scale with five answer options ranging from 1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree and 5= Strongly agree (Jafar et al., 2023; Jafar et al., 2022; Jafar et al., 2021; Dollah et al., 2022).

The questionnaire data obtained were analyzed using descriptive statistical analysis (mean score). The mean score is then classified into five categories that range from strongly disagree (1.00-1.80), disagree (1.81-2.60), neutral (2.61-3.40), agree (3.41-4.20) and strongly agree (4.21-5.00) (Jafar et al., 2022).

### 3.4 Study Area

Tanjung Lobang Beach, also known as Brighton Beach, is located in Miri District, Sarawak (refer to Figure 1). The airport of Miri is located at latitude  $04^{\circ} 23' 0''$  N and longitude  $113^{\circ} 59' 0''$  E. The coastline extends approximately 32 kilometers. The southern part of Miri's coast is mostly coral reef sites. Among the important reef sites in the southern coastal area of Miri are Kenyalang Reef, Scuba Reef and Tayar Reef. There are also several hotels, resorts and condominiums in this area that span from Tanjung Lobang beach to Luak Esplanade beach. This shows that the coastline in the south of Miri is able to contribute to the growth of the tourism sector. In the northern part of Miri Beach, industrial activities including fisheries, oil and gas are very active (Zarina, 2016). Tanjung Lobang Beach is the choice of visitors due to its calm atmosphere with a refreshing breeze. Not only that, among the main attractions of visitors coming to Tanjung Lobang Beach is due to the beauty of its twilight view when the sun begins to set. On weekends, this beach is a popular destination for families to relax together. It is known as "Taman Selera" because of the many food vendors serving various types of delicious dishes. Aside from having fun with the family, the beach offers several other activities, including fishing and jogging, all of which are very popular among the Miri community.



**Fig. 1** Location of Tanjung Lobang Beach, Miri, Sarawak  
Source: Adapted from International Steering Committee for Global Mapping (2013)



**Fig. 2** Pantai Tanjung Lobang for three time series

## 4. Findings and Discussion

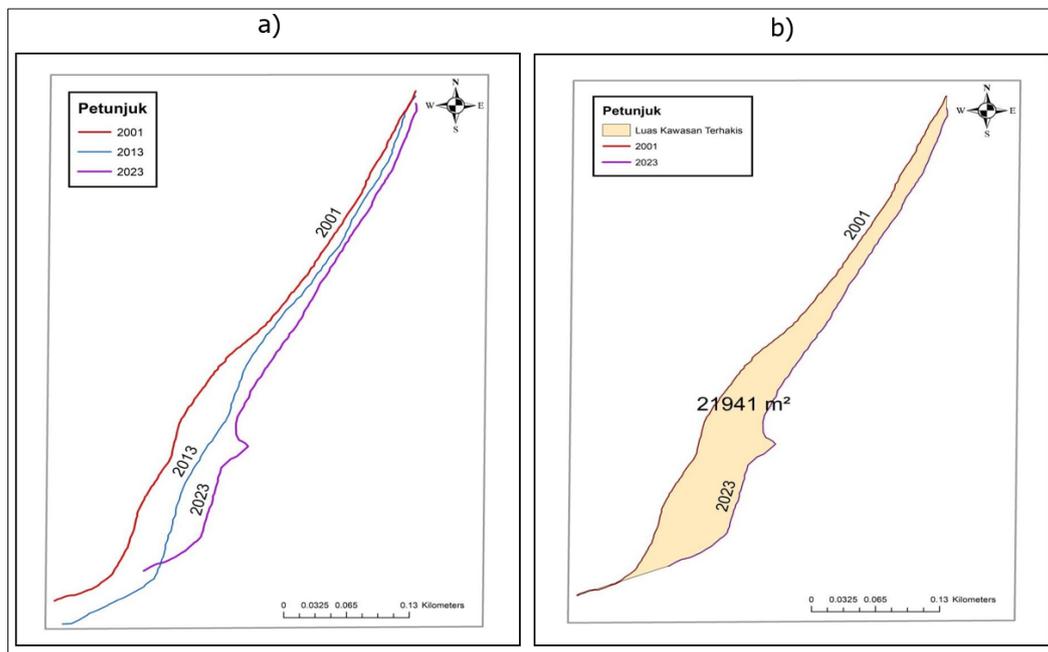
### 4.1 Changes of Tanjung Lobang Shoreline

The transformation of the Tanjung Lobang shoreline has undergone remarkable changes in its geographical layout, as illustrated in Figure 2. Back in 2001, the distance from the center of the jetty junction to the shoreline measured a mere 67 meters, indicating a relatively short span. Fast forward to the year 2013, an examination of the vegetation within the designated measuring area revealed a lack of significant alterations. This observation suggests that the trees within the research site have experienced growth and have been well-preserved, showing resilience against the erosion activities. In the year 2023, the observation of the vegetation's condition revealing a notable decrease in its spatial coverage serves as a clear indication of the ongoing erosion processes occurring along the perimeter of Tanjung Lobang Beach during the recent years. The alteration in distance recorded from 67 meters as of 2001 to 89 meters by 2023 has resulted in a shift of the coastline by a significant 22 meters at the specific measuring location. This phenomenon also elucidates the fact that the shoreline modifications are predominantly directed towards the mainland.



**Fig. 3** Pantai Tanjung Lobang for three time series

The changes in the shoreline can be observed more distinctly by referring to the visual representation provided in Figure 3a. Upon careful examination of the diagram, it becomes evident that the southern region of Tanjung Lobang Beach has undergone more pronounced alterations compared to its northern counterpart. To elaborate, the extent of change in the coastline of Tanjung Lobang in the southern section surpasses that of the northern segment over the span of 22 years, specifically from 2001 to 2023. This observation inherently suggests that the level of erosion along the southern stretch of Tanjung Lobang Beach exceeds that of its northern vicinity. In a comprehensive assessment, the collective area that has succumbed to erosion measures at 21941 square meters, which is approximately equivalent to 5.42 acres as delineated in Figure 3b. It is worth noting that the eroded area holds significant importance in facilitating recreational activities.



**Fig. 4** Shoreline changes due to erosion process

## 4.2 Effects of Shoreline Change from the Perspective of Visitors and Traders

Shoreline modifications are correlated with a rise in sea level as mentioned in the study by Jamaludin & Jaafar (2017). Elevated levels of seawater surpass the ordinary threshold, leading to the inundation of higher elevations by waves. The magnitude of the wave action plays a crucial role in determining whether erosion or deposition processes take place within a coastal region, as highlighted in the research conducted by Mohamad et al. (2014). Within the scope of the investigation, alterations in the shoreline predominantly stem from erosional processes. This scenario undeniably yields adverse repercussions on the local populace, particularly impacting visitors.

Table 1 shows the impact of shoreline changes caused by erosion phenomena on the visitors and vendors perspective at Tanjung Lobang Beach. The results of the study showed that the negative impact of erosion and shoreline change was felt by the visitors (mean min = 3.80) compared to the merchants (mean min = 2.50). Evidently, most visitors think that trees in the beach area are at risk of falling due to erosion phenomena (min=4.70). In addition, visitors also think that the erosion phenomenon causes the beach to become significantly steeper (min=4.67). This situation will increase the risk of visitor accident in the beach area. According to respondents, the area for worship purposes is also declining due to erosion (min=2.97). The negative views given by visitors to the changes in Tanjung Kapur Beach should be taken seriously. This is because, the beachside communities are the most affected group due to the morphological changes of the shoreline (Zarina et al., 2016). If this situation continues without efforts to curb erosion problems, it will definitely affect the quality of life of the local community. Humans living near the shoreline are highly exposed to various types of hazards including natural hazards (Jafar et al., 2022).

From the perspective of the traders, it was found, on average, that there was a disagreement in their perception regarding the potential impact of erosion on their business premise, as indicated by a minimum score of 2.40. Their perception encompassed the belief that the issue of erosion would have no bearing on the volume of visitors frequenting the area, supported by a minimum score of 2.40. Moreover, the traders held the view that the presence of coastal erosion did not present a significant menace to the long-term viability of their commercial activities, with a minimum score of 2.80 to back this assertion. Evidently, it can be extrapolated from these findings that the fluctuations in shoreline dynamics and the occurrence of coastal erosion are not deemed as pressing

concerns for the traders operating within the vicinity of Tanjung Kapor. The distance between the business premises and the shoreline is considerable, which is a significant factor in this situation. Nevertheless, this situation should not be permitted to persist without the implementation of effective mitigation measures to address the issue of coastal erosion. Consequently, a number of potential mitigation measures can be implemented to address the issue of coastal erosion. These include the construction of gabion fortifications (Liudmila, 2020), the planting of erosion-resistant trees (Siti et al., 2016), and the installation of stone protection layers (Nor Suzana, 2021).

**Table 1** Visitor and vendor perspective on impact of shoreline changes

Perspective	Statement	Mean Score	Average Mean	Level
Visitor	Trees are at risk of collapse due to erosion	4.70	3.80	agreed
	Route to the beach becomes steep due to erosion	4.67		
	There are facilities that cannot be used due to beach erosion	4.63		
	The aesthetic value of the beach degrades due to erosion	3.83		
	The beach becomes unsafe due to the presence of sharp objects (such as sharp wood)	3.33		
	The area for recreation is reduced due to coastal erosion	2.97		
	Lack of trees causes people to be exposed to the heat of the day	2.37		
Traders	The continuity of my business is threatened due to erosion risk	2.80	2.50	disagreed
	The number of visitors is decreasing due to erosion problems, thus jeopardizing my business.	2.40		
	The premise of my business has the potential to be damaged due to erosion problems	2.40		

## 5. Conclusion

This study was conducted with the aim of analysing shoreline changes at Tanjong Lobang, Miri, Sarawak, due to the phenomenon of beach nourishment while identifying the impact of these changes on the visitor and shopper groups. Tanjong Lobang was found to be experiencing significant landscape changes, especially in the southern part. This indicates a higher erosion rate in that section. Overall, the coastal area of Tanjong Lobang was eroded by 5.42 acres in a period of 22 years. The study showed that the negative impact of erosion and shoreline change was felt more by visitors than traders. Visitors expressed the risk of falling trees and changes in the route to the beach, causing a decrease in areas for recreational purposes.

Therefore, it is important to implement an effective coastal management strategy, including measures to reduce erosion, stabilize affected areas and maintain the natural landscape. In addition, safety measures for visitors also need to be implemented such as carrying out tree planting and improving routes to ensure safe access to the beach. Adequate signage and awareness campaigns can also contribute to visitor safety. Understanding that the impacts of coastal erosion involve more than natural changes, cooperative efforts between local communities, authorities and traders are important. This includes joint initiatives to address erosion, accompanying reforestation efforts and ensuring sustainable land use practices. Overall, the findings from this study emphasize the urgent need to address coastal erosion in Tanjong Lobang, not only to protect the natural surroundings, but also to ensure the safety and comfort of visitors. Collaborative and proactive efforts are needed to strike a balance between the maintenance of the beach ecosystem and the socio-economic activities that depend on it.

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### Conflict of Interest

There is no conflict of interests regarding the publication of this paper.

### Author Contribution

*Jonathan Lavung* has ontributed significantly to the **design and execution of data collection methods**, ensuring that the data acquired was relevant and reliable for the study objectives. His expertise likely involved selecting appropriate tools and techniques for effective data gathering. Meanwhile, *Adi Jafar* focused on the practical aspects of **data acquisition**, possibly overseeing the fieldwork and ensuring that data collection adhered to ethical guidelines and methodological standards. *Mohammad Tahir Mapa* played a role in **analyzing the collected data, which included processing and interpreting the raw data** to derive meaningful insights relevant to the research questions and *Listyo Yudha Irawan* assisted in **compiling and organizing the collected data**, ensuring that it was well-documented and accessible for analysis.

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