

MONITORING SHORELINE CHANGE USING IKONOS IMAGE AND AERIAL PHOTOGRAPHS: A CASE STUDY OF KUALA TERENGGANU AREA, MALAYSIA

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ABSTRACT:

The pattern of shoreline changes of Kuala Terengganu was identified using IKONOS data acquired in 2004 and aerial photographs during 1966, 1975, 1983 and 1994. In this study we proposed segmentation method to extract the shoreline. This method becomes more important in remote sensing field particularly with the increasing of spatial resolution of imagery. The shoreline vectors were compared to each other to determine shoreline change along Kuala Terengganu shoreline. The results revealed that there is a greatest value of accretion over 38 years of studying. The aim of this paper is to map and analyze the historical changes of shoreline of Kuala Terengganu.

1. INTRODUCTION

Malaysia is situated in the Southeast Asia, between Latitudes 1° and 7° North, and Longitudes 100° and 119° East. It comprises two regions, Peninsular Malaysia and the states of Sarawak and Sabah on the northern part of the Borneo Island. The surface area is about 330,400 km². These regions are separated by 640 km of South China Sea. Malaysia's coastline is over 4,809 km where more than 1,300 km of Malaysia's beaches are experiencing erosion (Stanly, 1985). This has since increased to 2,327km that is means from 47 sites to 74 sites in 2000 (Muslim, 2004). Kuala Terengganu is one area which was subjected to critical erosion. Erosion's problem in Malaysia is due to the dynamic process, change in sea level and human activities.

Therefore it is necessary to monitor shoreline of Kuala Terengganu. Remote sensing data with GIS and software package can be useful tools to analyze, visualize and map a shoreline from fine spatial resolution imagery using segmentation technique. The aim of this study is to map the dynamic shoreline of Kuala Terengganu using aerial photographs and IKONOS image.

2. OBJECTIVES

1. To detect shoreline erosion and deposition using time series data from 1966 to 2004
2. To map shoreline of Kuala Terengganu

3. STUDY AREA

The study area is located on the East Coast of Peninsular Malaysia facing the South China Sea. It is located between latitude 103° 7' 44" and 103° 19' 56" East, and longitude 5° 21' 49" and 5° 16' 39" North (Figure 1). The shoreline is about 17 km long from Tok Jembal in the North to Kuala Ibai in the South. The beach of this area is interrupted by the river of Kuala Terengganu and Chendering. The climate of Kuala Terengganu is characterized by the Northeast monsoon which prevails between November and March. The annual temperature is between 25.6 °C to 27.8 °C [Lokman et al, 1995]. According to [Rosnan et al, 1995], the study area is characterized by diurnal

tides which varies between 1m and 2m, the wave height is less than 1.8m.



Figure 1. Study Area

4. MATERIALS AND METHODS

4.1 Dataset

Data used in this study was acquired from different sources as shown in Table 1:

- Aerial photographs scale of 1:25,000 and 1:5,000 of 1966, 1975 and 1983. These aerial photographs were acquired from Jabatan Ukur Dan Pemetaan Negara (JUPEM).
- Remote Sensing data covering the Kuala Terengganu coastline from Tok Jembal to Kuala Ibai was acquired on November 25, 2004.

Type of data	Date	Resolution (m)	Scale
Aerial Photographs	1966	2 after scanning	1:25,000
	1975	2 after scanning	1:25,000
	1983	2 after scanning	1:25,000
IKONOS (Pan-Sharpener Multispectral)	2004	1	

Table 1. Acquisition Date and Resolution of data

4.2 Geometric Correction of IKONOS image and aerial photographs

Geometric correction of IKONOS data and aerial photographs was carried out using PCI v9. In this study, we used Malaysia Rectified Skewed Orthomorphic (MRSO) as projection system.

5. METHODOLOGY

Many semi-automatic or automatic segmentation techniques were applied to extract the shoreline from variety of remote sensing data [White et al., 1999 and Dellepiane et al., 2004] but there is no single method which can be considered good for all images (Pal and Pal, 1993). In this study, the methodology proposed for the extraction of the shoreline is based on segmentation technique (Pixel-based-segmentation or grey-level thresholding). This method is known as a process that segments an image into two categories on observed image into its homogeneous regions, based on DN threshold (Schowengerdt, 1997).

Pixel based segmentation technique was applied on IKONOS image and aerial photographs. The attributes were classified depending on the DN threshold where the value varies from one subset to another. The partition of the land

and sea boundary was done using pseudo color which exhibits a strong contrast between land and water features due to the high absorption by water and strong reflectance by vegetation [Mohd-Suffian et al., 2004].

Classification method was then conducted, which was used to classify similar pixel values in a group and give them a name using unsupervised classification. Recode was set up by choosing two attributes, 1 for the classes with a value of 1 and all other classes to 0. The conversion from raster to vector was successful after recode. The shoreline was exported to a GIS environment and vectorized using ArcInfo software. After editing, the shoreline was referenced to a tidal level and cleaned (Figure 2). From ArcView3.2, linear vector themes of different years were overlaid as polygons to calculate area of erosion and accretion automatically.

Differential Global Positioning System (DGPS). Root Mean Square Error (RMS) in X and Y are 0.37 and 0.29, respectively. The error in location was less than half pixel (1 m).

In order to geometrically corrected the IKONOS, 36 ground control points (GCPs) were collected on the ground between Kuala Terengganu and Kuala Ibai using Aerial photographs during the 1966, 1975 and 1983 were also corrected and for this proposes IKONOS image was used as a reference. The correction from PCI was not accurate because of the low quality of slides, therefore it was necessary to fit the aerial photographs with IKONOS image from ArcView 3.2 using image analysis model. The data was brought to PCI for another correction. Using this approach, we found that the accuracy was acceptable (less than half pixel).

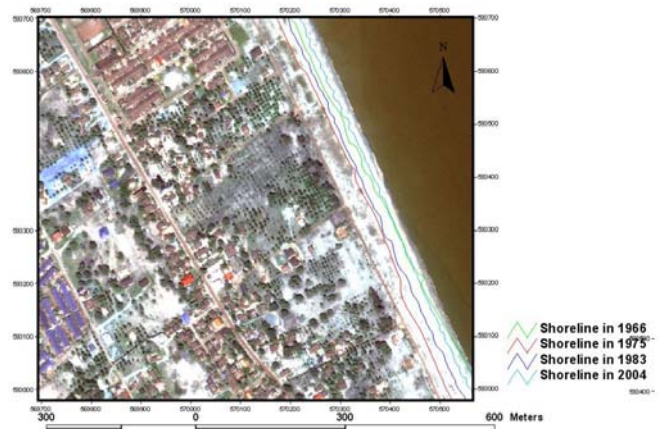


Figure 2. Shoreline vectors of different years

6. RESULTS AND DISCUSSION

The results show that there is spatially significant change of all shorelines either erosion or accretion trends. The results were divided into 2 sections (figure 3) before analyzing the four shoreline polygons;

Section 1: from TokJembal to Seberang takir.

Section2: from Seberang takir to Kuala Terengganu river

From figure 4, it is clear that spit of Kuala Terengganu was extracted easily using pixel based segmentation. Therefore pixel based segmentation method can be useful for extracting the complex area such as spit (Aicha chalabi et al., 2005).

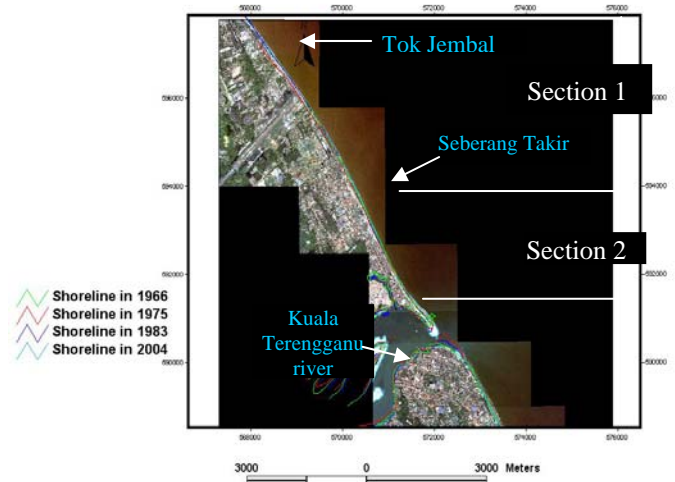


Figure 3. Sections of study area

6.1 Section1: TokJembal – Seberantak

During 1966-1975 about 1.207 ha of land was eroded from the area (figure 4), but between 1975 and 1983, accretion is about 2.344 ha. From 1983 to 2004, the accretion increased to 0.366 ha and decreasing of erosion to 0.056 ha. If we compare between 1966 and 2004, the accretion is more dominant 0.404 ha than erosion 0.121 ha. The area between 1975 and 2004 was affected by accretion 2.932 ha as shown table 2.

Year	Accretion (ha)	Erosion (ha)	Total growth (ha)	Growth rate (ha/yr)
1966-1975	-	1.207	-1.207	-0.134
1975-1983	2.344	-	+2.344	+0.293
1983-2004	0.366	0.056	+0.310	+0.014
1966-2004	0.404	0.121	+0.283	+0.007
1975-2004	2.932	-	+2.932	+0.154

Table 2. Erosion and accretion between TokJembal – Seberantak

6.2 Section2: Seberantak – Kuala Terengganu river

In this area, the shoreline change is related more to the accretion as show figure 5. Between 1966 and 1975, there is less erosion 0.12 ha. However, there was more accretion 0.41 ha. This value was decrease to 0.245 ha during 1975-1983 but erosion increase to 0.762 ha. During 1983-2004, the value of erosion and accretion were close (0.322 and 0.325 ha). There was more accretion of about 0.859 ha and 0.237 ha as erosion between 1966 and 2004. Also, the difference between accretion and erosion is located during 1975-2004 are respectively (0.497 ha and 0.503 ha) see table 3.

Year	Accretion (ha)	Erosion (ha)	Total growth (ha)	Growth rate (ha/yr)
1966-1975	0.41	0.12	+0.29	+0.032
1975-1983	0.245	0.762	-0.517	-0.064
1983-2004	0.325	0.322	+0.003	+0
1966-2004	0.859	0.237	+0.622	+0.016
1975-2004	0.497	0.503	+0.106	+0.005

Table 3. Erosion and accretion between Seberantak – Kuala Terengganu river

In other hand, spit of Kuala Terengganu was identified and analyse (figure 6). It appears more narrow and complex at the bottom during 1966. Between 1966-1975, the spit shifted down about 426.2 m toward the Northeast. By 1975 the length of the spit had increased by 75 m. from 1975 to 2004, it become wider with fewer complexes an the side facing the South China. The spit extended an additional 255.5 m in length, over this period. Every year, the length of the spit increased 8m

Phenomenon of shoreline changes can be quantified by analysis the remote sensing image with GIS. In this study, results of time series data were combined and compared to each other showing spatial changes of shoreline. Erosion and accretion in this part of the area reveal the geomorphological changes that have been taken place over 38 years period (between 1966-2004) which are identified with different vectors. From these results, the value of erosion and sedimentation are not stable, that is means there are some factors influence it, one of this factors is tide.

This area is characterized by diurnal tide that ranged between 1 m to 2 m. the second factors is wave. As we know, Kuala Terengganu is exposed to the South China Sea, which the wave is highest about 2 m (Rosnan et al, 1995). The third factor is human's activities.



Figure 6. Spit of Kuala Terengganu

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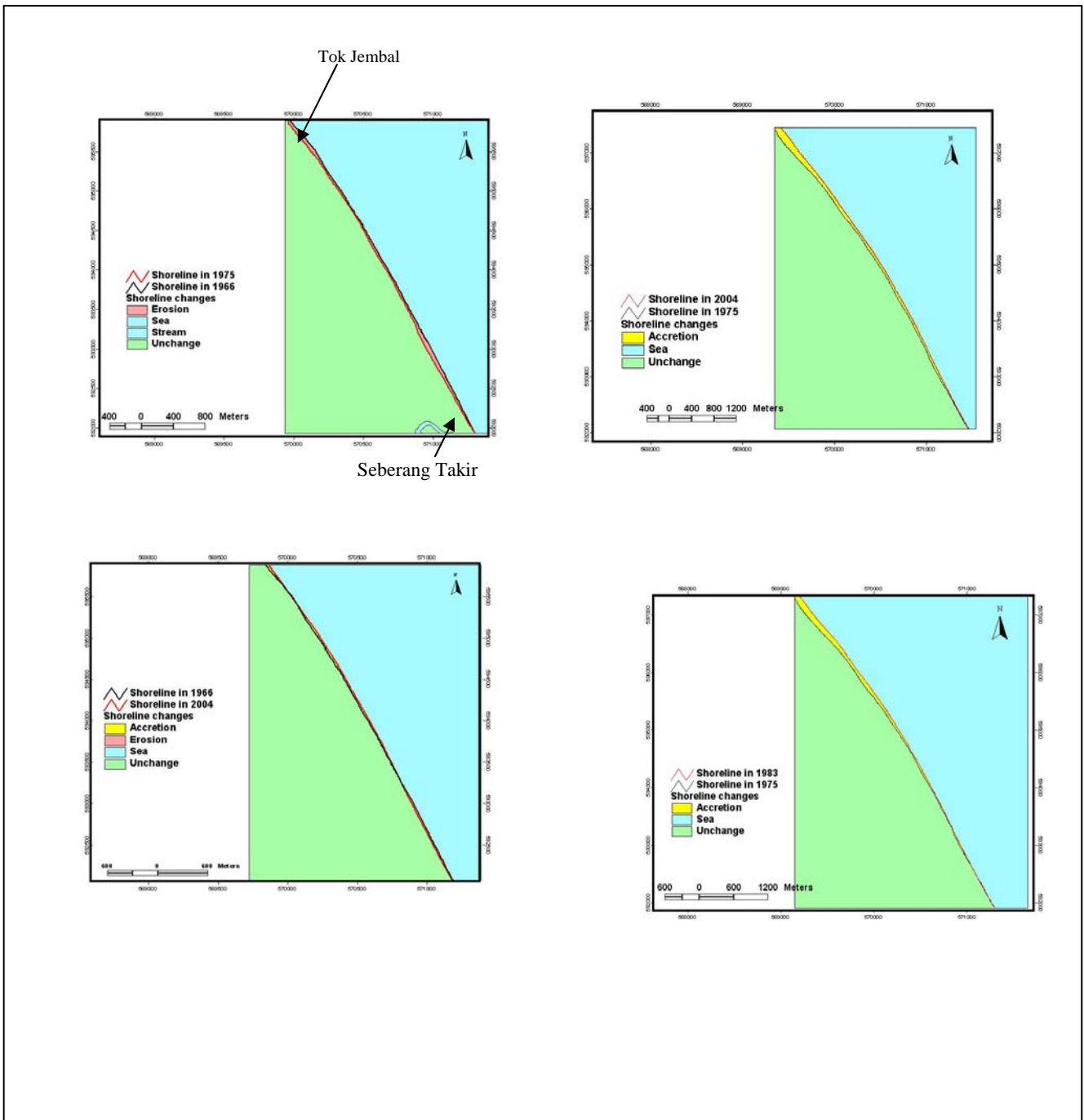


Figure 4. Shoreline change from 1966 to 2004 between Tok Jembal and Seberang Takir

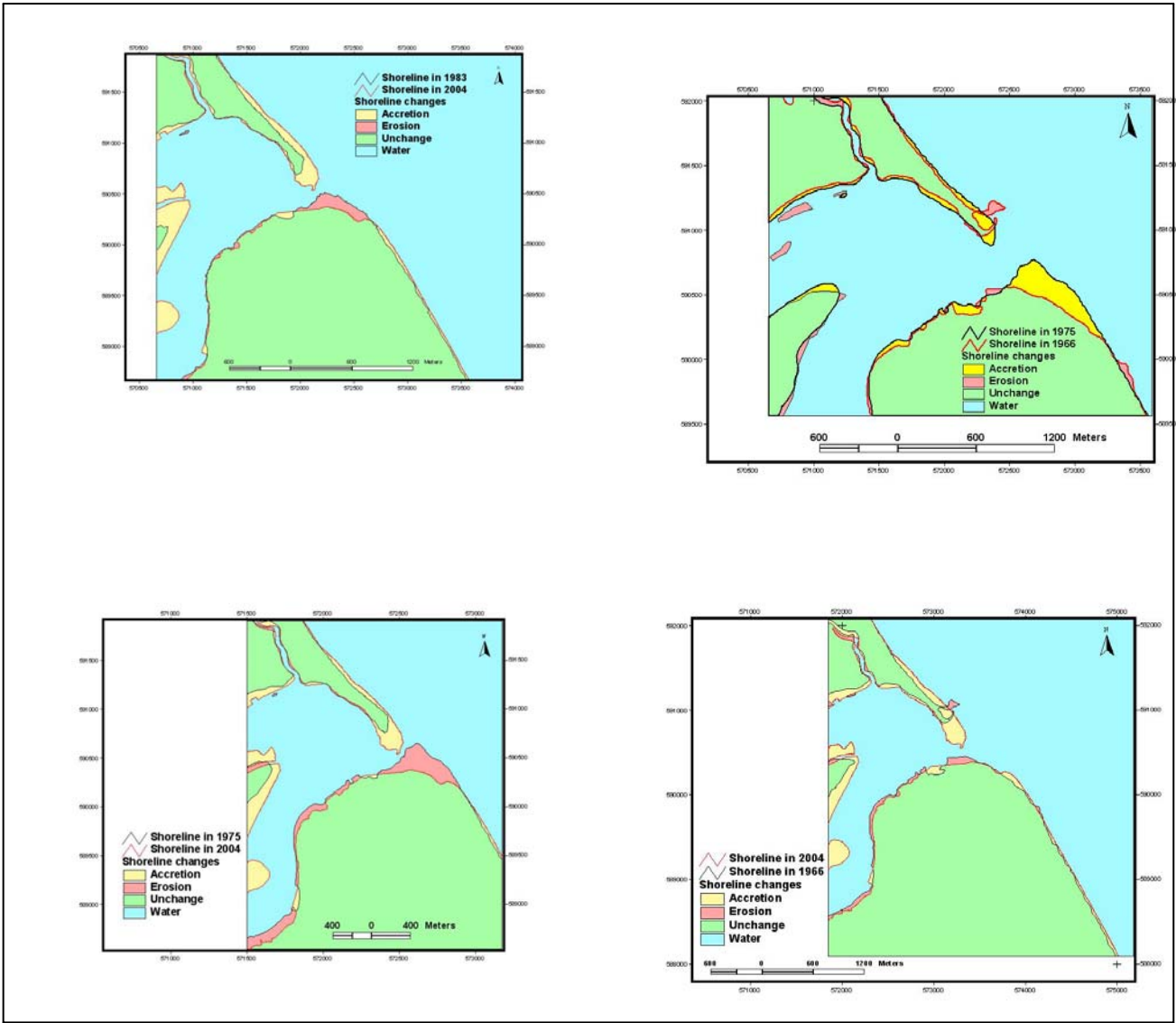


Figure 5. Shoreline change from 1966 to 2004 between Seberang Takir and Kuala Terengganu river

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