COASTAL CHANGES DETECTION USING REMOTE SENSING TECHNIQUE IN KARAKIT, BANGGI ISLAND

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DISERTASI INI DIKEMUKAKAN UNTUK MEMENUHI SEBAHAGIAN DARIPADA SYARAT MEMPEROLEHI IJAZAH SARJANA MUDA SAINS DENGAN KEPUJIAN

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ABSTRACT

Karakit is located at the southern part of Banggi Island, in Kudat, Sabah. This area is important in providing marine resources and habitat for human, flora and fauna and also identified for being one of the richest area for coral reefs. The main objectives of this study are to compare coastal changes between 1970 and 2003, to classify coastal features of Karakit from aerial photo with satellite image and to identify unstable area of coastline in Karakit. SPOT 5 image with date acquisition 6th June 2003 with 10 m resolution and aerial photo with date acquisition on 7th July 1970, obtained from Malaysia Centre for Remote Sensing (MACRES) and Department of Land and Survey respectively. Topographic map dated 1999 was also used as a reference for image classification. The coastline changes can be detected by using overlaying technique. Results indicate that erosion occurred in the western and southern part of Karakit over a period of 33 years, from 1970 to 2003. The rate of deposition was found in the western and southern part of Karakit, but the occurrence are less than the rate of erosion. Size of mangrove forest decreased in Karakit, where in 1970 the size of the mangrove area was 246.97 hectares but in 2003 it was 225.7 hectares. Total land cover of Karakit decreased, where in 1970 it was 737.24 hectares but in 2003 it decreased to 721.71 hectares. However, further investigation and ground truthing is needed to determine the accuracy of coastline changes in Karakit area. The outcome of this study provides useful information in coastal area management and hydrodynamics study for future researches in Banggi Island.

ABSTRAK

Kawasan Karakit terletak di bahagian selatan Pulau Banggi di Kudat, Sabah, membekalkan sumber-sumber marin dan sebagai habitat kepada manusia serta flora dan fauna. Objektif utama kajian ini adalah membandingkan perubahan pesisir pantai antara tahun 1970 dan 2003, membuat klasifikasi ciri-ciri pesisir pantai berdasarkan foto udara dan imej satelit dan mengenalpasti kawasan yang sensitif di garisan pantai Karakit. Imej SPOT 5 yang diambil pada 6 Jun 2003 dengan resolusi 10 m dan foto udara yang diambil pada 7 Julai 1970 masing-masing diperolehi dari Pusat Remote Sensing Negara (MACRES) dan Jabatan Tanah dan Ukur. Peta topografi pada tahun 1999 telah digunakan sebagai rujukan untuk klasifikasi imej. Perubahan pesisir pantai dikesan dengan mengunakan teknik pertindihan imej. Keputusan menunjukkan dalam jangka masa 33 tahun hakisan berlaku di bahagian barat dan timur Karakit. Sedikit pemendapan juga berlaku di kawasan barat dan timur Karakit. Luas paya bakau di Karakit pada tahun 1970 ialah 246.97 hektar dan berkurang kepada 225.7 hektar pada tahun 2003. Luas kawasan kajian pada tahun 1970 ialah 737.24 hektar, tetapi pada tahun 2003 luas berkurang kepada 721.71 hektar. Kajian lanjut dan tinjauan kawasan kajian perlu dilakukan untuk menentukan ketepatan hasil kajian ini. Bagaimanapun, diharapkan informasi dari kajian ini dapat digunakan dalam pengurusan pesisir pantai dan kajian hidrodinamik di Pulau Banggi pada masa hadapan.

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km	kilometre
m	metre
mm	millimetre
ha	hectares
SPOT	Le Systeme Pour l'Observation de la Terre SPOT
NOAA	National Oceanic and Atmospheric Administration
HR VIR	High resolution visible infrared
RBV	Return Beam Vidicon
SPOT	Le Systeme Pour l' Observation de la Terre
XS	Multispectral
RMSE	root mean square error
AOI	area of interest

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

1.1.1 Coasts

Coasts are active areas where marine, terrestrial, atmospheric, and human factors converge (Garrison, 2002). About 60% of human population in the world are living within this area. The importance of these areas are to provide food sources and shelter to humans, a medium of transportation and also a habitat for many types of marine species. Coastal areas are very sensitive to the environmental impact of land use in watersheds, along the coast and further inland. There are several types of processes occuring in the coastal region: the distribution of tidal currents, sedimentation patterns, beach erosion processes, the distribution of suspended solids, mixing and dispersion processes (Robinson, 1995). Coastal changes can be detected in several ways. One of them, the collection of data with traditional coastal installations remains an important component of such research. However, the large space scales and short time scales of coastal area require the use of remote sensors (Barale and Folving, 1996).

1.1.2 Remote Sensing

Remote sensing is defined as a technique of obtaining information about objects through the analysis of data collected by special instruments that are not in physical contact with the objects of investigation (Figure 1.1).

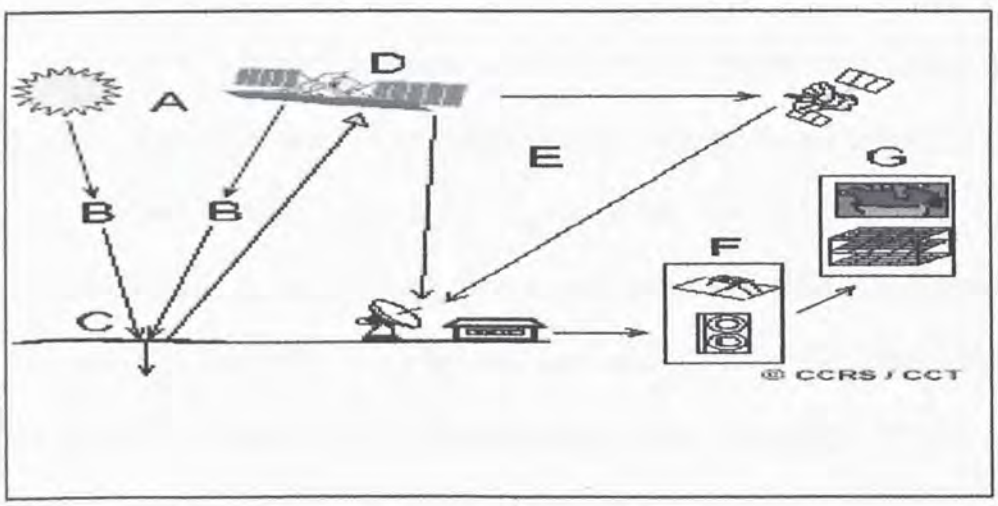

Figure 1.1 Principles in remote (Source : http://www.ccrs.nrcan.gc.ca)

Figure 1.1 explains the principles in remote sensing. A, is showing the sun emits energy and both sun and sensor are recording certain target in B. Then, energy from target is reflected or absorbed in C. D showed the sensor and E, shows the sensor is transferring information of target to ground receiving station. F, is where the process of data storage is happening and lastly, G, the image have been produced after processing.

As such, remote sensing can be regarded as 'reconnaissance from a distance', 'teledetection' or a form of the common adage 'look but don't touch'. Remote sensing thus differs from in situ sensing, where the instruments are immersed in, or physically touch, the objects of measurement. A common example of an in situ instrument is the salinometer (http://www.ccrs.nrcan.gc.ca).

Traditionally, the energy collected and measured by remote sensing has been electromagnetic radiation, including visible light and invisible thermal infrared (heat) energy, which is reflected or emitted in varying degrees by all natural and synthetic objects. The scope of remote sensing has been recently broadened to include acoustical or sound energy, which is propagated under water. With the inclusion of these two different forms of energy, the human eye and ear are examples of remote sensing data collection devices (Institute of Advanced Technology, 2001).

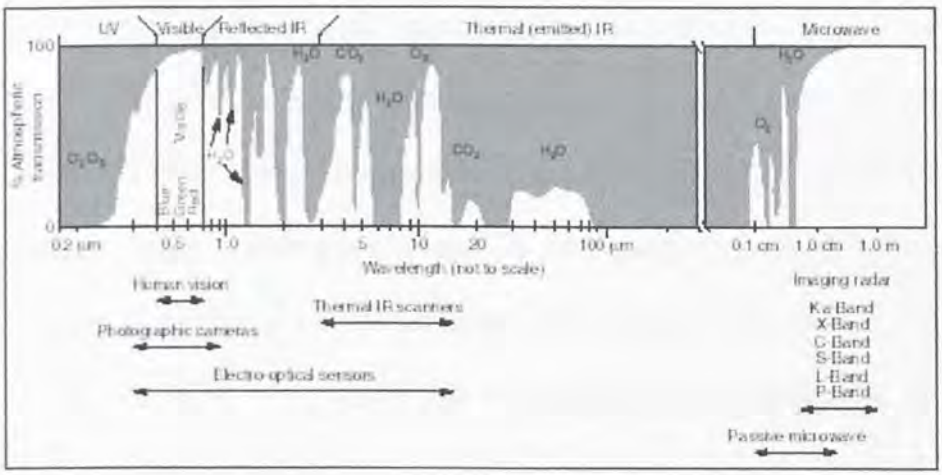

Figure 1.2 Electromagnetic spectrum (Source : Institute of Advanced Technology - ITMA , 2001)

The instruments used for this special technology are known as remote sensors and include photographic cameras, mechanical scanners, and imaging radar systems. Regardless of type, they are designed to both collect and record specific types of energy that impinges upon them. Remote sensing devices can be differentiated in terms of whether they are active or passive. Active systems, such as radar and sonar, beam artificially produced energy to a target and record the reflected component. Passive systems, including the photographic camera, detect only energy emanating naturally from an object, such as reflected sunlight or thermal infrared emissions. Today, remote sensors, excluding sonar devices, typically carried on aircraft and earth-orbiting spacecraft, which has led to the familiar phrase 'eye in the sky'. Sonar systems propagate acoustical energy through water for the reconnaissance of subaqueous features.

To complete the remote sensing process, the data captured and recorded by remote sensing systems must be analyzed by interpretive and measurement techniques in order to provide useful information about the subjects of investigation. These techniques are diverse, ranging from traditional methods of visual interpretation to methods using sophisticated computer processing. It cannot be emphasized too strongly that data is not information. Accordingly, the two major components of remote sensing are data capture and data analysis (http://rst.gsfc.nasa.gov)

1.1 Study Area

Banggi Island is located at the northern part of Sabah, and is known as the largest island in Malaysia (Figure 1.3). It covers a total area about 440.7 km^2. It is accessible

by boat approximately two hours from Kudat to the island. Being isolated from the mainland of Sabah, most of the coastal areas are less disturbed and exploited compared to other islands in west coast of Sabah. However, effects of natural forces are continuously disturbing the coastline. This area is greatly affected by the forces from different seasonal monsoon throughout the year.

The coastline of Banggi Island is important to be studied because there has been little study conducted on this island. The island is a large area. There are certain coastal areas on the island that are difficult to be reached even by boat, therefore remote sensing is the best solution. Coastline study is conducted at the southern part of Banggi Island. The area selected is Karakit, the largest town on Banggi Island. Karakit is selected because it is closest to the mainland of Sabah. It is a sheltered area compared to other part of Banggi Island, thus the population is high. Remote sensing is useful as a tool to identify the status of the coastal area while saving cost and time.

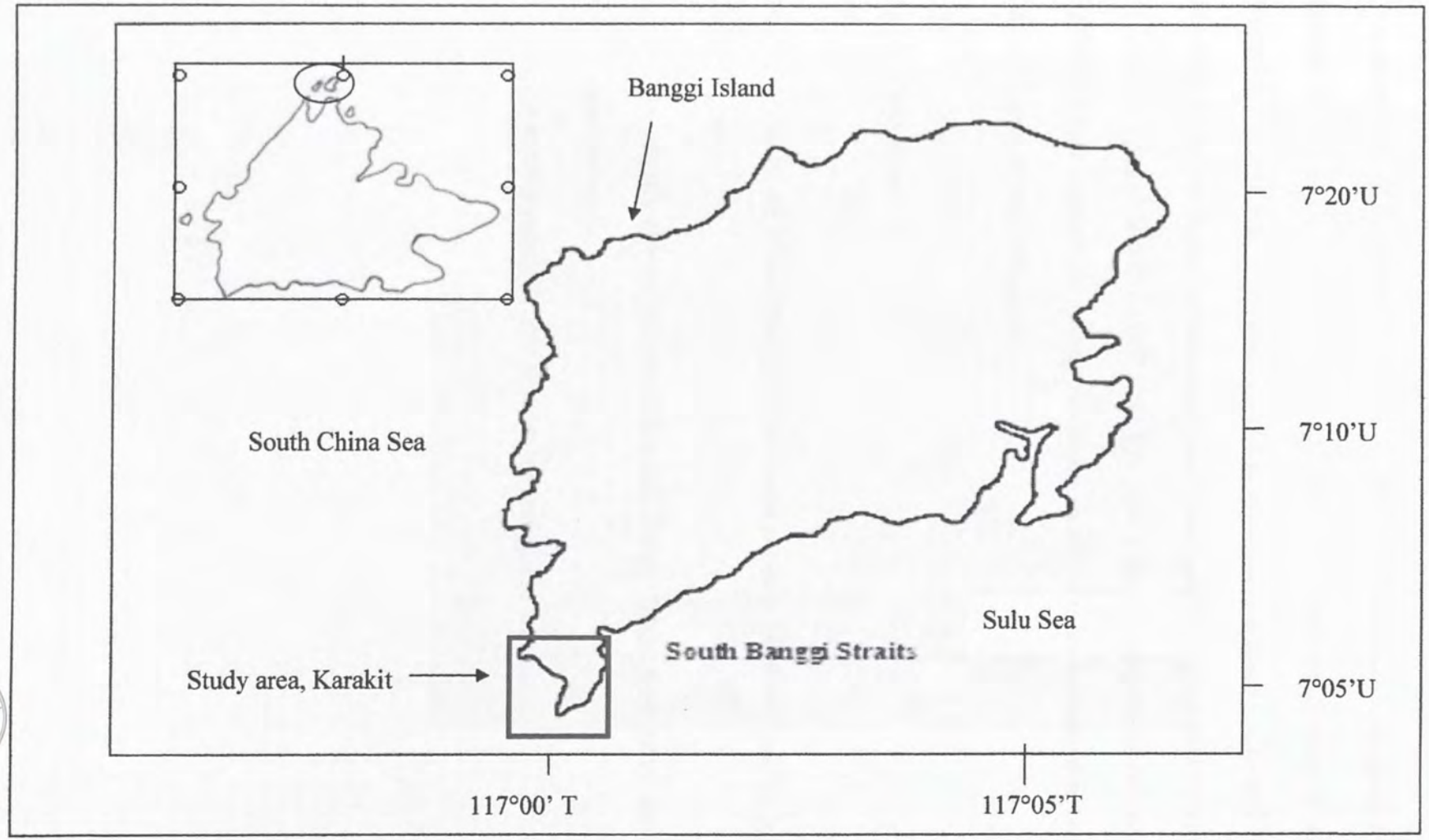

Figure 1.3 Map of Banggi-Balambangan Island (Source : Director of National Mapping, Malaysia, 1999)

1.3 Importance of study

This study is focusing on remote sensing as a tool to detect coastal changes in Karakit, Banggi Island. This latest technology can identify and detect changes in Karakit, Banggi Island at a variety of spatial and temporal scales using ground-level sensors and high spatial resolution of imaging systems (Stow, 2004). The coastal development in Karakit, Banggi Island is still very low and a lot of research is needed to be conducted to understand the marine environment and to discover natural resources in order to increase its development.

1.4 Objectives

1. To compare coastal changes from aerial photo in 1970 and satellite image in 2003.
2. To classify coastal features of Karakit, Banggi Island from aerial photo with satellite image.
3. To identify sensitive area of coastline changes in Karakit.

CHAPTER 2

LITERATURE REVIEW

2.1 Coasts

Coastal areas join land and sea, which are categorized as dynamic and changeable places. The place where ocean meets land is usually called the shore, while coast refers to the larger zone affected by the processes occurring at the boundary (Garrison, 2002). A coast is an active place, where deposition and erosion always occur. There are many factors that contribute to these processes, such as sea waves and currents, sedimentation, wind and anthropogenic activities. The waves are commonly caused by winds blowing over water surface. Most physical coastal changes are affected by distribution of the sediments, where sediments move in and out of the coastal area. The increasing coastal development has led to a conflict between man and nature, with man's desire for development conflicting with natural processes that modify the land being developed. As a result, most coastal nations have had to address coastal zone management problems (Camfield and Morang, 1996).

Understanding and being able to manage the coastal environment is important. About two-thirds of the world's population lives on or near the coast, and many others visit the coast periodically. This creates strong pressure for shore development for housing and recreation and for shore protection from storm-induced damage. Shore protection and stabilization problems often require regional solutions rather than a response by a single or small number of property owners. Therefore, a coastal management and monitoring is needed for protection and maintenance of this area (Sorensen, 1997).

2.1 SPOT

There are many satellite systems, such as Landsat, Le Systeme Pour l' Observation de la Terre (SPOT) and National Oceanic and Atmospheric Administration (NOAA) (Verbyla, 1995). However, in this study, SPOT satellite will be used to detect Karakit, Banggi Island coastal changes.

2.1.1 History of SPOT Satellite

The SPOT4 satellite was launched in 1998. SPOT 4 carries High Resolution Visible Infrared (HR VIR) instruments that obtain information in the visible and near-infrared spectral bands. The SPOT 4 satellite orbits the Earth at 822 km at the Equator. The SPOT 4 satellite has two sensors on board: a multispectral sensor, and a panchromatic sensor. The multispectral scanner has a pixel size of 20 ´ 20 m, and a swath width of 60 km. The panchromatic scanner has a pixel size of 10 ´ 10 m, and a swath width of 60 km (ERDAS Field Guide, 2002)

Table 2.1 SPOT 4 bands and frequencies

Band	Frequencies
1	0.50 to 0.59 μm
2	0.61 to 0.68 μm
3	0.79 to 0.89 μm
4	1.58 to 1.75 μm
panchromatic	0.61 to 0.68 μm

SPOT is a pushbroom system that can obtain data in two modes (Table 2.1). In multispectral mode (XS) SPOT 1,2,3 obtain data at a radiometric resolution of 8 bits for three bands using 3000 separate detectors. The resolution for this configuration is 20 m. SPOT 1,2,3 may also obtain a single band panchromatic image using 6000 detectors in the 0.51 – 0.73 mm waveband with a 10 m resolution. SPOT collects its data in the morning, crossing the equator at approximately 10.30 am local time. The multispectral capabilities of SPOT 4 are similar to those of the earlier satellites but it also obtains data in a fourth waveband at 20 m spatial resolution and also carries onboard instruments with a wide swath (2200 km) with a 1.1 km spatial resolution in the same three wavebands as the earlier SPOT satellites. Also the panchromatic band on SPOT 4 has a narrower spectral resolution than the earlier satellites (Sanchez and Canton, 1999).

2.3 Aerial Photographs

The types of photographs and images that can be processed within IMAGINE OrthoBASE include aerial, terrestrial, close range, and oblique. Aerial or vertical (near vertical) photographs and images are taken from a high vantage point above the Earth's surface. The camera axis of aerial or vertical photography is commonly directed vertically (or near vertically) down. Aerial photographs and images are commonly used for topographic and planimetric mapping projects. Aerial photographs and images are commonly captured from an aircraft or satellite (ERDAS Field Guide, 2002).

CHAPTER 3

METHODOLOGY

3.1 Data sources

The study of coastal changes in Karakit, Banggi Island was done by using SPOT 5 image provided by Malaysian Centre for Remote Sensing (MACRES) and aerial photo from Department of Land and Survey. The image was taken in 2003 and the aerial photo was taken in 1970. The two different period images were used to compare and detect the coastal changes that occur in Karakit, at the southern part of Banggi Island. In addition, Banggi Island topographic map was collected from the Department of Land and Survey, for the year 1999 as comparison with the satellite images overlaid with topographic map. Also , the output map is useful as a reference for the satellite image analysis.

3.2 Image analysis for SPOT Image

There are a series of image analysis procedures that should be conducted before the satellite image can be interpreted. These procedures are shown in the flow chart in Figure 3.1.

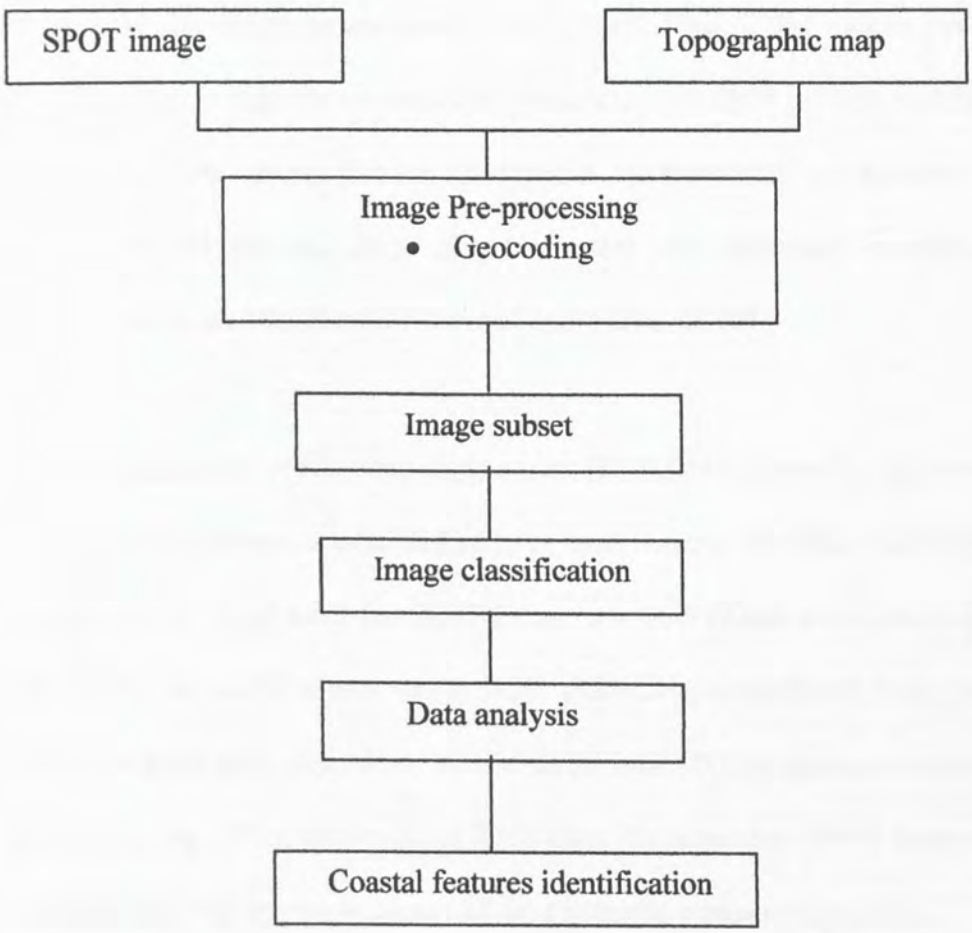

Figure 3.1 Procedures for image analysis (Source : Lillesand and Keifer, 2000)

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