

# *Monitoring of Mangroves in Trang Province, South of Thailand by Using Multi-temporal LANDSAT-5 TM, SPOT-5 and ALOS Data*

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## **Abstract**

In Thailand mangrove forests are found in 23 provinces of the coastline. Some 36% of the entire coast of Thailand is covered with up to 1,920 sq. km. of mangrove forests. Almost 50% of these are in the province of Phang-nga, Satun, Trang, Nakhon Si Thammarat and Ranong. It was found that 168,000 hectares of mangrove forests areas existed in 1996 and more than 55% of mangrove forests which cover an area of 200,100 hectares were lost during 1961-1996. The major activities that effected the reduction of mangrove forests are included shrimp farming, tin-mining activities, mangrove over-exploitation, industrial area and new settlements.

The main objectives of this study were firstly to detect, identify and delineate the area of mangrove forests in Trang province, South of Thailand. Secondly, to evaluate the mangrove forests during the last 17 years by using the multi-temporal LANDSAT-5 TM and ALOS data focus on 1990, 2000, and 2006 for analysis and change comparison of mangrove forests area in each year in order to identify the degree of change. The main tasks were to classify the existed mangrove forests area and land use in 1990, 2000 and 2007 based on automatic classification and visual interpretation of satellite imagery at the scale of 1:50,000 (LANDSAT-5 TM) and 1:12,500 (SPOT5 and ALOS). The results of the study found that during the period 1990 -2000, the area of mangrove forests decreased of 5.0 square kilometers or 3.55% of the total area of mangroves in 1990. 73% of the total lost of mangrove areas changed during period 1990-2000, they were transformed to shrimp aquaculture activity and 27% of total lost areas were transformed to rubber and oil palm plantation, paddy field, cities, villages and others. For the period 2000-2006, the areas of mangroves increased by 0.5 square kilometers or 0.4% of the total area of mangroves in 2000. The principal cause of the sector growing is the reforestation and mangrove plantation. The practices from this study provide a draft information on mangrove changes and also could be applied to other mangrove forests area in the country.

**Keywords:** Mangrove monitoring; Multi-temporal; bands combination

## **1. INTRODUCTION**

Mangrove forest is one of the most important coastal ecosystems. Since the last 40 years, a number of mangrove forest areas have been destroyed mainly by human activities. In Thailand, mangrove forest area was seriously reduced from a total of 3,681 sq. km. in 1961 to 1,680 sq. km in 1996. 30% total lost of mangrove forests area in this period changed to shrimp farm (NESDB, 2000). Therefore in 1972, Thailand has used a remotely sensed satellite data for assessment of natural resources in many fields, proving that remote sensing is a useful tool for assessing and monitoring the country's coastal resources, especially mangrove forests. Mangrove forest assessment and monitoring has been conducted continuously in Thailand since 1979.

In 1988, high resolution data of LANDSAT-5 TM and SPOT-PLA, which can provide more effective information than LANDSAT-MSS, was used for mangrove forest land use zoning monitoring. It was found that the LANDSAT-5 TM bands 4-5-3/R-G-B with linear stretching technique can be used to differentiate mangrove forest from other vegetation and SPOT-PLA shows a better pattern for shrimp farm and built-up areas. In addition, the combination of TM4-TM5-PLA/R-G-B via digital classification can easily depict the mangrove forest zonation which corresponds to the dominant species (Vibulsresth S. and Ratanasermpong S., 1990)

Therefore the integration of remote sensing and GIS for mangrove forest management is considered as an important tool for the development of effective plans by natural resource managers and planners. The main objective of this study is to demonstrate an effective approach for sustainable mangrove forest management. The main objectives of this study is to define and evaluate the evolution of mangroves forest during the last 17 years by using the multi-temporal LANDSAT-5 TM, SPOT-5 and ALOS data focus on 1990, 1996, 2000,

and 2006 for analysis and change comparison of mangrove forests area in each year in order to identify the degree of degradation by using remote sensing and GIS technology.

## 2. OBJECTIVE

The main objectives of this study were firstly to detect, identify and delineate the area of mangrove forests. Secondly, to define the evaluation of the mangrove forests during the last 17 years by using the multi-temporal LANDSAT-5 TM and SPOT-5 data focus on 1990, 1996, 2000, and 2006 for analysis and change comparison of mangrove forest areas in each year in order to identify the degree of degradation.

The practices from this study provide draft information on mangrove changes and also could be applied to other mangrove forest areas in the country.

## 3. STUDY AREA

The mangrove forest study area was selected along the Andaman sea is located between the latitudes 07°05'25''-07°18'19''N and the longitudes 99°34'27''-99°48'01''E, at Palian and Hat Samran district, Trang province, latitudes 07°34'21''-07°41'06''N and the longitudes 99°01'03''-99°09'52''E at Ko Lanta, Krabi province south of Thailand.

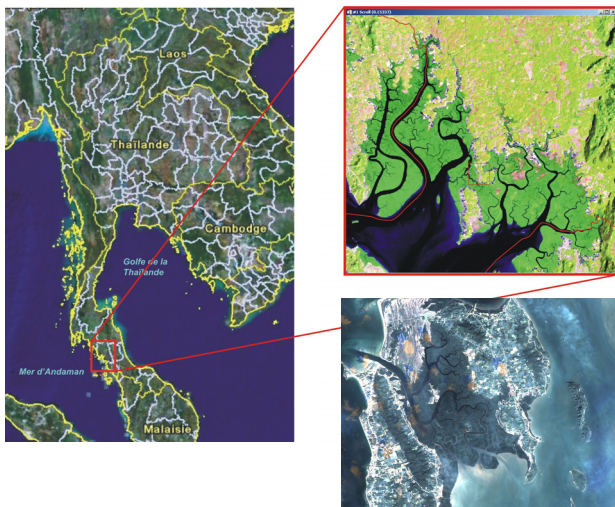


Figure 1. Study area is in Palian and Hat Samran district, Trang province and Ko Lanta, Krabi province South of Thailand.

## 4. DATA ACQUISITION

Multi-temporal data of LANDSAT-5 TM (Path 129, Row 55), 25 meters spatial resolution, acquired on 4 March 1990, 16 January 1996, 2 February 2000 and 28 February 2006.

SPOT-5 Panchromatic (K 263, J 335 and K262, J335), 5 and 2.5 meters spatial resolution, acquired on 12 March

2006 and 28 November 2005 from GISTDA, Thailand. ALOS AVNIR2, 10 meters spatial resolution acquired on 12 March 2006.

## 5. METHODOLOGIES

### 5.1. Analyze by Remote Sensing, in 1990, 1996, 2000 and 2006

On 1990, 1996 and 2000, Multi-temporal data of LANDSAT-5 TM were geometrically registered to UTM topographic maps (scale 1:50,000, WGS 1984) using a 1st degree polynomial interpolation and a cubic convolution transformation method and the false color composite was selected for this study. In the false color composite of TM bands 453/RGB with linear stretch enhancement differentiates mangrove forest from others feature such as terrestrial forest, agriculture area and shrimp ponds. Linear enhancement technique applied to the false color composition of TM 3 (blue), TM 5 (green) and TM 4 (red) to gain maximum contrast of the image. Training area up to 10 classes of land use in this study area such as; 1) mangroves 2) degraded mangroves 3) rubber and Oil palm 4) shrimp ponds 5) bare soil 6) paddy field 7) sea and river 8) reservoir 9) city and villages 10) sediment were selected for digital classification. The method of supervised classification used minimum distance classification.

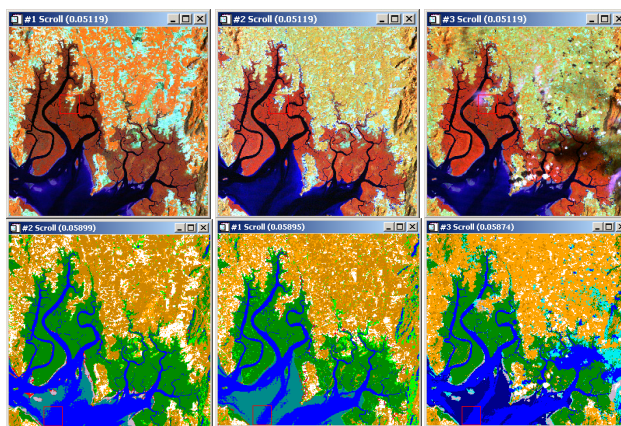


Figure 2. False color composite images of LANDSAT-5 TM bands 453/RGB were classified by method of supervised classification (Minimum distance).

On 2006, The SPOT-5 Panchromatic and ALOS AVNIR2 (421/RGB) images were first geometrically registered to UTM topographic maps (scale 1:50,000, WGS 1984) using a 1st degree polynomial interpolation and a cubic convolution transformation method. Then, the LANDSAT-5 TM image was registered to the corrected panchromatic image and resample from the pixel size of 25 meters to 2.5 meters using the same transformation method.

The combination of SPOT-5 Panchromatic and TM 4 and TM 5 images of LANDSAT-5 was selected for classify mangrove forests in the year 2006 base on their range of electromagnetic wave-bands which include visible, near infrared and short wave infrared. This should yield better results to both false color composite and automatic classification with the fact that the visible region (panchromatic 0.51-0.73 micron) is the chlorophyll absorption band while the near infrared region (TM 4 0.6-0.90 micron) and (TM 1.55 - 1.75 micron) responds to humidity condition of soil and vegetation.

The main tasks were to classify the existed mangrove forests area and land use in 1990, 1996, 2000 and 2006 based on automatically classification and visual interpretation of satellite imageries at the scale of 1:12,500. An image interpretation key indicating the tone, color, size, shape, texture, pattern, location and association can be prepared for each category of vegetation including mangroves using ground truth information, topographical maps, aerial photographs etc. The assessment and evaluation of evolution and change of mangrove forest areas were then conducted using GIS (ArcGIS).

### 5.2 Analyse by GIS on 1990, 1996, 2006 and 2006

All vectors of GIS data were processed with ArcGIS. The main data outputs were derived based on the compiled and extracted geographic databases as follows:

1. Land use in 1990, 1996, 2000 and 2006
2. Existed mangrove forests in 1990, 1996, 2000 and 2006
3. Change of mangrove forests during period 1990-1996, 1996-2000 and 2000-2006
4. Evolution of mangrove forests during period 1990-1996, 1996-2000 and 2000-2006

The layers (1990, 1996, 2000 and 2006) were overlaid and intersected according to the following schematic flowchart methodology diagram. A schematic flowchart methodology of the analysis of digital image in 1990, 1996, 2000 and 2006 are shown in figure 3 and 4.

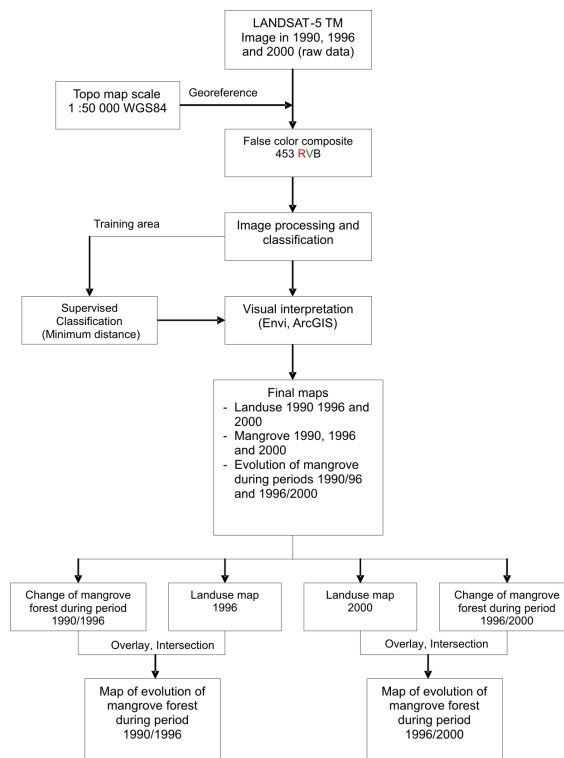


Figure 3. Diagrammatic of the methodology of the analysis of digital image in 1990, 1996 and 2000

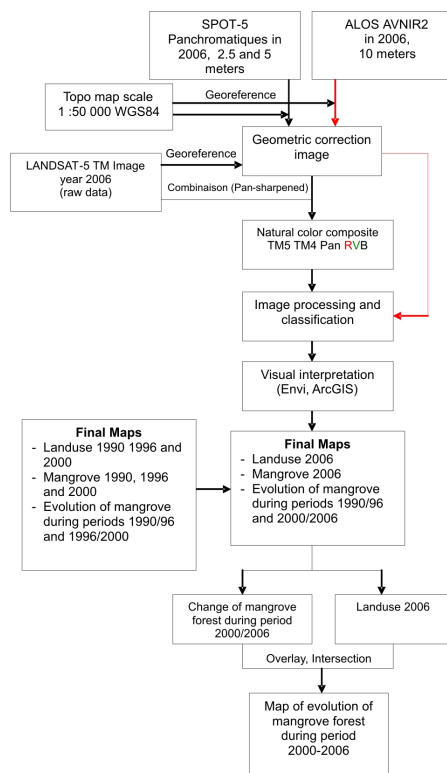


Figure 4. Diagrammatic of the methodology of the analysis of digital image in the year 2006.



## 6. RESULTS

The results of this study are the compilation of the data bases adapted sets of themes, evaluation and change of mangrove forests areas in 1990, 1996, 2000 and 2006. From the visual interpretation of the images satellite on the scale 1:12 500, the zones of mangroves were still classified in two classes according to their spectral signature on the image and their characteristics. Two classes of mangrove in particular “**Mangroves**” and “**Degraded mangroves**” were carried out.

This study concentrated on the existing and changes of mangrove forest area, then the plantation of rubber, oil palm and the paddy field were grouped in a class. Cities, villages and others also grouped in a class. The total surface of the existing areas of mangroves in 1990, 1996, 2000 and 2006 and changes of mangrove forests during periods 1990-1996, 1996-2000 and 2000 - 2006 are shown in tables 1, 2 and 3.

Table 1. Total existed mangrove forests area in Palain and Hat Samran district, Trang province, Thailand on 1990, 1996, 2000 and 2006.

Types	Area in sq.km. (km <sup>2</sup> )			
	1990	1996	2000	2006
Mangroves	136.5	130.0	130.6	131.8
Degraded of mangroves	4.8	5.3	5.1	4.1
<b>Total</b>	141.3	135.3	135.7	135.9

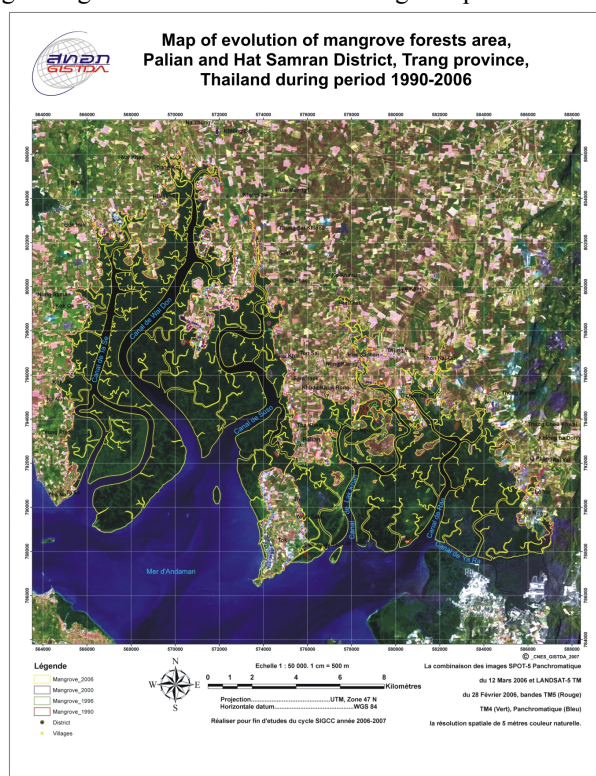
Table 2. Evaluation of mangrove forests area in Palain and Hat Samran district, Trang province, Thailand, during periods 1990-1996, 1996-2000 and 2000- 2006.

Types of evolution	Area in sq.km. (km <sup>2</sup> )		
	1990-1996	1996-2000	2000-2006
Degraded mangroves	0.828	0.230	0.511
Rubbers and Paddy fields	1.121	0.317	0.890
Shrimp farm	5.435	0.583	0.959
Villages and Others	0.064	0.040	0.275
<b>Total</b>	7.448	1.53	2.635

Table 3. Evaluation of degraded mangrove forests area in Palain and Hat Samran district, Trang province, Thailand, during periods 1990-1996, 1996-2000 and 2000- 2006.

Types of evolution	Area in sq.km. (km <sup>2</sup> )		
	1990-1996	1996-2000	2000-2006
Mangroves	0.575	0.762	1.363
Rubbers and Paddy fields	0.252	0.092	0.362
Shrimp farm	0.514	0.274	0.301
Villages and Others	-	-	0.055
<b>Totale</b>	1.341	1.128	2.081

The results of the studied found that during the period 1990 -1996, the area of mangrove forests decreased of 5.0 square kilometers or 3.55% of the total area of mangroves in 1990. 73% of the total lost of mangrove areas changed during period 1990-1996, they were transformed to shrimp aquaculture activity and 27% of total lost areas were transformed to rubber and oil palm plantation, paddy field, cities, villages and others. For the period 1996-2006, the areas of mangroves increased by 0.5 square kilometers or 0.4% of the total area of mangroves in 1996. The principal cause of the sector growing is the reforestation and mangrove plantation.



## 7. Conclusion

Mangrove forest changes can be monitored using multi-temporal LANDSAT-5 TM images. During period of 1990, 1996, 2000 and 2006 the major changes have been changes from mangrove forest to shrimp farming. The integration of remote sensing and GIS is considered as an important tool for assessment, management and monitoring of mangrove forest. For this study the combination of multi-sensor data, SPOT-5 Panchromatic and LANDSAT-5 TM or ALOS PRISM and LANDSAT-5 TM, yields, an excellent representation of ground features particularly on a natural and false color composite image. Panchromatic image (resolution of 2.5 or 5 meters of SPOT-5 and 2.5 meters of ALOS) gives better spatial characteristics whereas LANDSAT-5 TM offers spectral separabilities that are most useful for monitoring mangrove forest and vegetation study.

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