# APPLICATION OF GEOINFORMATICS TECHNOLOGY FOR LAND USE CHANGE DETECTION IN COASTAL AREA OF PHANG NGA PROVINCE, THAILAND

**T Kumlom, A Pansuwan**

Phuket Rajabhat University, Phuket, Thailand

**Corresponding Author. Email:** tidarat.k@pkru.ac.th

**Abstract**

*Application of geoinformatics technology for land use change detection in the coastal area of Phang Nga Province using satellite imagery data between 2000 to 2018. Using the object base classification method and field data collection. Accuracy equals to 81% and kappa coefficient of 0.76, indicating higher accuracy. The results showed that, in the year 2000, there were agricultural areas (45.37 %), forest areas (35.77 %), urban areas (4.40 %), water areas (8.42 %) and miscellaneous areas (6.04 %). In the year 2004. There were agricultural areas (52.07 %), forest areas (35.51 %), urban areas (3.85 %), water areas (3.99 %) and miscellaneous areas (4.58 %) and in 2018, there were agricultural areas (45.09 %), forest areas (35.31 %), urban areas (5.86 %), water areas (6.37 %) and miscellaneous areas (5.37 %).*

*Land use change using the method of partial overlapping regions similar to union method. Agricultural land increased in 2000 and 2004 and decreased in 2018 whereas forest area, urban areas, water areas and miscellaneous areas decreased in 2004 and increased in 2018. Land use change can be used as information to keep detection of the changing trend that can affect coastal erosion causing damage to property values and environmental conditions in the coastal area of Phang Nga Province and also guidance on how to prevent future acts of violence.*

**Keywords:** Geo informatics technology; Land use changes; Object based classification.

## 1. Introduction

The Andaman coastlines constantly change due to the influence of waves and monsoon winds and natural hazards. Causing the natural balance of the coastal systems to be constantly disturbed especially in coastline areas of Phang Nga Province which is an important tourist attraction in the country and residential sources in communities. Changes that took place were the effects of erosion and deposition. In addition, human activities within coastal zones such as the construction of hotels and resorts, tourist facilities, coastal aquaculture, agriculture, industry, construction of the building docks and coastal defense structures are catalysts for changing more to coastlines, coastline changes, especially when erosion occurred naturally, caused damage to houses, infrastructure, coastal aquaculture area, agricultural area, and coastal ecosystems, including way of life and the quality of life of people and coastal communities, including the overall national economy. The government must allocate large sums of money each year to prevent them and solve problems from occurring. In the future, the coastal erosion problems tends to intensify.

Tsunami Disaster: On Sunday morning, December 26, 2004, can refer to a magnitude 9 earthquake occurring off the west coast of northern Sumatra, Indonesia. Causing huge waves to crash into the shore, it's a tragedy that has caused major loss of life and property in 6 provinces, including Ranong, Phang Nga, Phuket, Krabi, Trang and Satun Province. Phang Nga Province was the most affected province of these 6 provinces affected by the tsunami disaster. Causing a disaster for people who were living, resting and having a seaside business. The overall death toll reached 4,224 in this province, 5,597 people were injured and 1,762 lives were lost, 2,541 houses and 98 hotels/resorts were damaged, including agricultural areas and natural resources on the coastlines with a length of about 50 km [1], especially the loss of coastal land due to severe beach erosion within areas along coastlines. There were significant changes in the sea and coastal conditions such as changes in the slope of the beach and a disaster area where is flooded by seawater in the tsunami, new sediments are often found accumulating and accessing to land, hundreds of meters from the beachfront. In some places the sand dunes were swept away by seawater in the tsunami, causing them uneven elevation, As a result, shapes of dunes look different from the original [2].

Coastal regions are extremely important for the national economy. Therefore, people require huge amounts of coastal land uses without the process of proper land use planning causing a large impact on land resources and other natural resources because coastal land has a fragile and complex ecosystem. When there are damage and deterioration to an ecosystem or one of the resource types, it inevitably affects other ecosystems and resource types. Therefore, this research has the objective to study the coastline changes in Phang Nga Province between 2000 - 2018 by applying geoinformatics technology for detection and monitoring changes in land use is important in order to be guideline to control the environmental impacts and suitable guidelines for land use so as to not affect people and natural resources In order to achieve resource use sustainability in the future.

## 2. Methodology

### *2.1. The data used in this study*

The basic data used in this study included land use data for 2001, 2007 from the Land Development Department in order to initially understand an area of study before conducting field survey and Landsat - 5 satellite imagery data for 2000 and 2004 and Landsat - 8 satellite imagery for 2018. Black and white pixels with detail, 15 - meter pixels with detail in multi-spectral imaging, 30 - meter pixels with detail includes the range of visible light spectrum, the range of green, red, and blue wave and the range of near-infrared wave which is the wave range used for modeling vegetation index, soil index and water index and Pan sharpening.

### *2.2. Classification of land use pattern using satellite information and images*

- Preliminary image analysis (Pre-processing) based Geometric Correction of satellite image data by referring to the WGS 1984 coordinate system with a 1: 50,000 numerical map data that indicated geometric accuracy and setting ground control points (GCPs) to spread throughout the study area using the second - order linear polynomial equation model and arranging image resampling by estimating the value at Nearest Neighbor Interpolation and Image Enhancement by focus on an image in order to make a difference between the grey values in the image (Contrast Manipulation) using Histogram Equalization Stretch Method and performing Pan Sharpening by mixing different wavelengths to get a detailed picture of 15 meter.

- Data type identification (Nomenclature Identification): A key factor in determining the types of data is to take land use data from Land Development Department to analyze in conjunction with a preliminary field survey in order to determine the area type, namely agricultural land, community area and construction, forest area, Mangrove forest area, water source areas and miscellaneous areas adapted from Land Development Department (2007).

- Area classification with object based classification techniques relies on the value of reflection and considering the size, shape, color, flatness and the clustering of satellite imagery data that is divided into two steps: the process of segmentation and data classification where large data sets in the process of segmentation, will be divided first in order to extract small objects to minimize data mixing and classify objects from conditional division. Light reflectance value in statistics: vegetation index (NDVI), soil index (BI) and water index (WI).

+ Image segmentation for the purpose of object-based classification: in order to distinguish the mangrove area from other land utilization types by considering the size, shape, color, flatness and the clustering of satellite imagery data.

+ Ratio analysis of reflectance spectra: Level 1 - watery and non-watery terrain characteristics were separated using mean value of light reflectance value. Level 2 - separating characteristics of the area covered by living plants and non-plants using mean value of light reflectance value and final level - the classification of small objects: non water area and plants. Final classification, NDVI, BI, WI will be used to help classify. The details are as follows:

**Normalized Difference Vegetation Index: NDVI**

$$NDVI = \frac{NIR-RED}{NIR+RED}$$

By RED = RED band (0.62 - 0.69 µm)

NIR = Near Infrared (0.77 - 0.90 µm)

**Bare Soil Index: BI**

$$BI = \sqrt{\frac{BLUE^2+GREEN^2+RED^2}{3}}$$

By BLUE = BLUE band (0.45 - 0.52 µm)

GREEN = GREEN band (0.53 - 0.60 µm)

RED = RED band (0.62 - 0.69 µm)

**Water Index: WI**

$$WI = \frac{GREEN-NIR}{GREEN+NIR}$$

By NIR = Near Infrared (0.77 - 0.90 µm)

GREEN = RED band (0.62 - 0.69 µm)

*Source: Geo-Informatics and Space Technology Development Agency, 2009*

- Accuracy assessment: To determine the correct classification of land use from satellite imagery and real-time field survey. Number of samples of at least approximately 30-50 dots per sample must be calculated to increase statistical reliability and collect geographic coordinates using GPS. Taking photographs of the actual area and taking note of the details of general area such as types of land use, morphology. After that, the survey results obtained in the real-time area will be checked for accuracy with the results of land use classification.

**3. Results**

1) The result of the study of land use in the coastal area of Phang Nga Province

The interpretation of satellite imagery using object based image analysis to calculate percent accuracy, found that The overall accuracy is 81% and Kappa coefficient of 0.7604, showing that when the value of more than 0.75, indicating higher accuracy between data obtained from satellite image classification and references. It shows that land use classification from the Landsat 5 TM satellite image and Landsat 8 satellite image data using object based image analysis method, it shows moderate accuracy in classification, which is in line with Thopthong Chancharoen and Suwit Ongsomwang's research [4] who did research on extraction of land use and land cover from the Theos satellite using object based classification. Providing the overall accuracy and higher values of kappa where kappa coefficient obtained shows high consistency between classification and reference data. The details are shown in Table 1.

***Table 1. Results of land use types in each year 2000, 2004 and 2018***

| Types of land use | 2000 | | 2004 | | 2018 | |
|---|---|---|---|---|---|---|
| | Area ($Km^2$) | Percentage | Area ($Km^2$) | Percentage | Area ($Km^2$) | Percentage |
| Agricultural (A) | 1,126.95 | 45.41 | 1,406.40 | 5.67 | 1,167.65 | 47.05 |
| Forest (F) | 862.67 | 34.76 | 579.18 | 23.34 | 764 | 30.79 |
| Miscellaneous (M) | 117.09 | 4.72 | 81.61 | 3.29 | 155.92 | 6.28 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Urban (U) | 222.80 | 8.98 | 276.35 | 11.14 | 233.55 | 9.41 |
| Water (W) | 152.09 | 6.13 | 138.06 | 5.56 | 160.10 | 6.45 |
| Total | 2,481.60 | 100 | 2,481.60 | 100 | 2,481.60 | 100 |

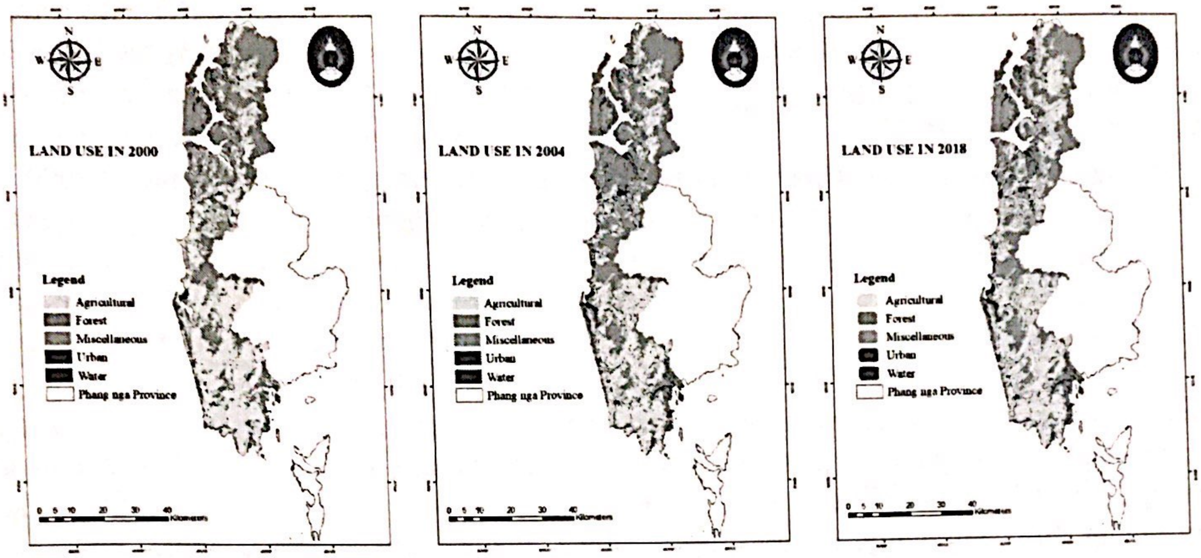


***Figure 1: Land use Change in 2000, 2004 and 2018 at the coastal area of Phang Nga Province***

2) Land use changes in coastal areas of Phang Nga Province

Tsunami disaster that occurred on December 26, 2004 in Phang Nga province, has caused both loss of life and property damage, also including the sudden change of natural resources and studies of land use change in coastal areas of Phang Nga Province during an 18-year period. This can be divided into 3 distinct periods: before (2000), during (2004) and after (2018) Tsunami disaster that was caused. Results from classifying land use into 5 different categories, can be summarized as follows:

- Changes in agricultural areas: Agricultural areas are the largest proportion of total land area. Expansion of land in agricultural use takes place all the time. It can be seen that it was 1,126.95 square kilometers in 2000 and 1,406.40 square kilometers in 2004, which has increased by 279.45 square kilometers or 11.26 percent. After the disaster they were rescued by relevant agencies such as Ministry of Agriculture and Cooperatives came to oversee budget management to support the rehabilitation of agricultural crops and establish restoration and development projects related to agriculture, fisheries, forestry and natural resources in the areas affected by the 2004 tsunamis and they received a financial assistance program from the project supported by the Japanese Government as well. In 2018, the area of it was 1,167 square kilometers which has been decreasing from the original amount by 100 square kilometers, accounting for 9.59 % of the original amount.

- Changes in forest areas: Forest areas has decreased. In 2000, it had an area of 826.67 square kilometers and 579.18 square kilometers in 2004 which has been decreasing by 283.49 square kilometers, accounting for 11.42 %, and in 2018, it was 764 square kilometers which has been increasing by 184.82 square kilometers, accounting for 7.44 %. Changes in forest land use which is the area that the most noticeable changes is to be seen because the involvement of the mangrove forest areas where are located next to the sea and study results in 2000 - 2004, forest area decreased by 283.49 square kilometers, accounting for 11.42 % due to the tsunami washed out various items from land located on the coastline. Later, the government has allocated some forest areas which are degraded land to establish permanent residence for tsunami victims and partly due to population growth resulting in many activities that are important, including fisheries and aquaculture, especially shrimp farming, expansion of community resources, construction of dock, road construction and transmission lines, etc. According to 2018 study, found that forest area has been increasing by 184.82 square kilometers, accounting for 7.44 % which Is the result of forest restoration activities in different projects such as: Conservation of mangrove forests youth project, mangrove forest planting activity project, a seed of thought, mangrove forest planting project in honor of His Majesty the King on the occasion of the auspicious ceremonies celebrating the 87th Birthday Anniversary, the MEA project, to combine the power of people, cultivating mangrove forest, and the mangrove forest planting to preserve land project, etc [6].

- Changes in urban areas: Changes in types of land use, category: urban areas in 2000, Phang Nga Province is a province that is very popular for tourists. There are constructions, the residence hotel, apartment and resort, etc in coastal region. But when the tsunami disaster occurred, buildings were swept into the sea and from the study of community areas and buildings. In 2000, the area of it was 222.80 square kilometers and in 2004 it was 276.35 square kilometers, which has been increasing by 53.55 square kilometers, accounting for 2.16 %. Later in 2018, the area of it was 233.55 square kilometers, which has been decreasing by 42.80 square kilometers, accounting for 1.72 %. As a result of assistance provided by the various departments and foundations such as World Vision Foundation of Thailand, The Chaipattana Foundation, Siam Gamma Foundation, etc. in the field of housing such as Ban Thung Rak community, Rotary project, house village (to be allocated), lions clubs, etc. But they will start resettlement to live in an area that should not be reached by water from a tsunami.

- Changes in water areas: Changes in land use of water areas is accounted for 0.57% as a result of the tsunami. Usually there is accumulation of sediments deposited and found in a new location. Later, in 2018, area of it was 160 square kilometers which has been increasing by 22.04 square kilometers, accounting for 0.89 % as a result of harsh wind waves that cause coastal erosion resulting in the increase in water area.

- Changes in miscellaneous areas: Changes in miscellaneous areas, including beach area and open space. From the study of miscellaneous areas in 2000, area of it was 117.09 square kilometers and in 2004, it was 81.61 square kilometers, which has been decreasing by 35.48 square kilometers, counting for 1.43 percent as a result of severe beach erosion and some fractions of the dunes were washed out to sea. Later in 2018, area of it was 155.92 square kilometers, which has been increasing over the previous year by 74.31 square kilometers, accounting for 2.99 as a result of attempts to prevent a wave in the beach and sand filling, etc.

As mentioned above, it can be seen that various factors affecting the land use change in areas affected by the tsunami, in the coastal area of Phang Nga Province is consistent with the factors resulting in rapid changes from tsunami disaster. As can be seen from Chanchai Thanawut and Chao Yongchalermchai's studies (2013) [3] on the changes of the Andaman coastline in areas of Ranong, Phang Nga and Phuket Province using remote sensing data and geographic information systems data, found that. The highest erosion rate in coastal areas is estimated to be 29.277 meters per year, occuring during 2000 - 2004 in Bang Muang District. Takua Pa District, Phang Nga Province and the highest deposition rate in coastal areas is estimated to be 18.413 meters per year, occuring during 2004 – 2551. In erosion areas, found that the coastal area that is severely eroded counting the largest area is 368 rai, located in Ko Phra Thong Subdistrict, Khura Buri District, Phang Nga Province during 2000 - 2547, when the tsunami occurred in 2004 and The largest areas where sediments are deposited along the coasts is 206 Rai, located in Ko Phra Thong Subdistrict, Khura Buri District, Phang Nga Province during 2004 - 2008.

**4. Conclusion**

Most land use in coastal areas of Phang Nga province areas that have increased in 2004 and decreased in 2018 are agricultural areas. The cause of the change is Tsunami disaster and changed into urban area. The areas that decreased in 2004 and increased in 2018 are forest areas, urban areas, water areas and miscellaneous areas due to forest restoration activities from various projects. Including providing assistance from various departments In addition, it is the result of harsh wind waves that cause severe erosion on the coast and is the result of efforts to make waves at the beach and in the sand filling after the tsunami disaster.

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