

## **AN APPLICATION OF GEOINFORMATICS AND MARKOV CHAIN MODEL TO STUDY LAND USE CHANGES : A CASE STUDY OF NONG YAI DISTRICT, CHON BURI PROVINCE**

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### **ABSTRACT**

This study aims to identify and compare the usefulness of land around Nong Yai District, Chon Buri Province in 2003, 2006 and 2009. This research data are classified by the Visual Interpretation classification and Applied of Markov Chain and CA Markov model to study the pattern of land use changes in the period of 2003-2009 and to predict the trends of land use in 2012. The total area of Nong Yai District is around 456.01 square kilometers, equivalent to 285,006 rai. In this study, the land use area can be classified into 10 classes including water source, forest, cassavas, pineapples, palm trees, rubber trees, sugar canes, fruit trees, habitats and others. The data analysis during the year of 2003-2006 showed that the total area of 86.90 square kilometers representing 19.06 percent, compared with the whole proportion of the area has changed. Among the changes, it was found that the sugar canes have the biggest change, as evident from the increased area of around 19.91 square kilometers representing 22.91 percent. Other areas have the most reduction indicated by the area of around 38.81 square kilometers representing 44.66 percent. During the year of 2006-2009, the total changed area was found to be around 39 square kilometers representing 8.55 percent. From the total changed areas, the palm trees area was changed the most. the increasing area was equal to 10.45 square kilometers representing 26.79 percent. Additionally, the most decrease was cassava trees area being around 8.78 square kilometers representing 22.51 percent of the total area. The data of land use in the year 2003 and 2006 were analyzed by the CA Markov model to predict and analyze the land use in 2009. After that the data were used to compare the land use with Visual Interpretation to analyze the model. The result indicates the difference of area approximately 66.82 square kilometers representing 14.65 percent. The accuracy of the result of the model analysis is a square matrix of errors showing that the model of 76.84 percent are accurate. Therefore, the Markov Chain model is appropriate for predicting the trend of land use change in Nong Yai District, Chon Buri Province in the year 2012.

**Keywords:** Geoinformatics, Markov chain, land use change

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## Introduction

From the past up to present, Thailand has been continuously changed and developed rapidly as it shows in economic growth, tourism, industry, agriculture and population growth. Such changes and development increase the need of resources utilization (Somporn Chobtham, 2008) resulting in severe changes in land use and land cover (Skole, 1994 and Foody, 2001). It is believed that land use and land cover change is the main factor causing more impact to the world than that of climate change. Therefore, continuous change of land use and land cover will cause impact to environmental change including climate change, precipitation, and temperature. Those environment changes also influence human living conditions. Land use change model is a tool often used for forecasting a land use change trend.

This research, therefore, focused on land use and land cover change occurring in 2 periods by using LANDSAT-5 TM data acquired on December 30<sup>th</sup> 2003, December 22<sup>nd</sup> 2006, and December 1<sup>st</sup> 2009. The forecast on future trend of land use change was conducted by using Markov Chain Model which can specify location and rate of land use change. Geographic information system was applied for data comparison and the increase of accuracy of spatial data analysis. It can also be used for monitoring and assessing of changes effectively which bring to rapid and appropriate formulation of policy and guideline for problem prevention and solving.

## Objectives of study

1. To classify and compare the land use in 2003, 2006 and 2009 in Nong Yai District, Chonburi Province.
2. To forecast the future trend of land use in Nong Yai District, Chonburi Province

## Methodology

### Land use Classification

1. The data reparation LANDSAT-5 TM data acquired on December 30<sup>th</sup> 2003 from Geo-Informatics and Space Technology Development Agency-GISTDA, and acquired on December 22<sup>nd</sup> 2006 and December 1<sup>st</sup>

2009 from The United States Geological Survey – USGS were used.

2. Geometric correction of LANDSAT-5 TM images was done by using ground control points (GCPs), which are outstanding and difficult to change, distributed through the whole images. The image to map registration was first applied by using topographic map at a scale of 1:50,000 as a reference. Then the registered (corrected) image was used as a reference for geometric correction of the rest of images (Image to image).
3. Land use classification was carried out by visual interpretation of those geo-corrected images.

### Study on Land Use Change

The study on land use change between 2003-2006 and 2006-2009 was done by applying Markov Chain Model. The area of each land use category was calculated. The proportion of land use change between 2006-2006 was applied for land use modeling of 2012 by using CA Markov to calculate area of each category.

## Results

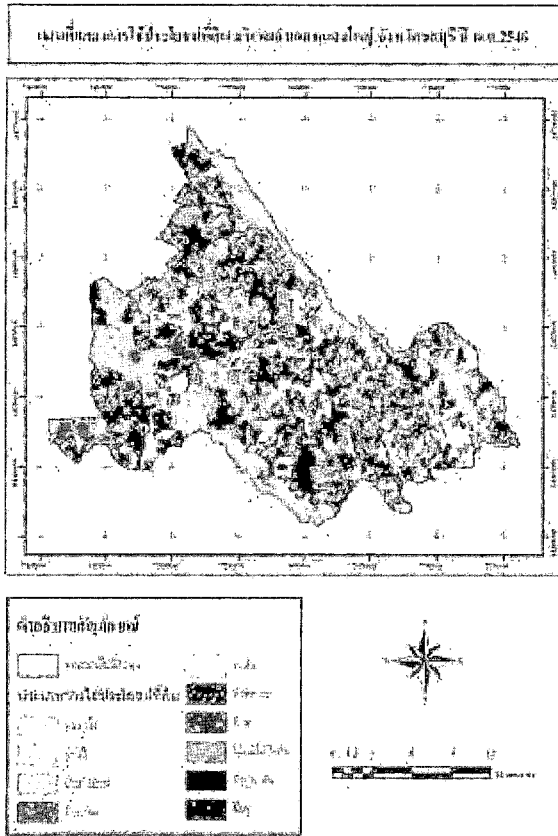
The study on application of geo-information system and Markov Chain Model focused on land use change in Nong Yai District of Chonburi Province covering an area of 456.01 km<sup>2</sup> or approximately 285,000 rai. Three temporal LANDSAT-5 TM images acquired on December 30<sup>th</sup> 2003, December 22<sup>nd</sup> 2006 and December 1<sup>st</sup> 2009 were applied for land use change comparison. The accurate assessment was done by using Markov Chain Model. CA Markov was also used for geo-information analysis. The study results can be described as follows:

### 1. Land Use Classification

The land use categories were derived from visual interpretation of the three satellite images acquired in 2003, 2006 and 2009 as illustrated in Figure 1,2,4 and Table 1.

### 2. Land Use Change

The study on land use change was undertaken by overlaying of land use map of 2003 onto 2006, and land use map of 2006 onto 2009. Geo-informatics software was used for the analysis and calculation of land use and land use change.



The map shows the classification results of land use in 2003, Nong Yai District, Chon Buri Province.

1.1 Land use change between 2003-2006 as appeared in Figure 4 and Table 2 can be described as follows : From Table 2, it can be concluded that during 2003-2006 total land use change is 86.90 km<sup>2</sup>. The most decreased area occurred in other land use category as of 38.81 km<sup>2</sup> or 44.66% of the total changed area whereas sugar cane area is 19.91 km<sup>2</sup> increased and cassava field is 14.12 km<sup>2</sup> increased, being equivalent to 22.91% and 16.25% of the total changed area respectively.

1.2 Land use change between 2006-2009 as appeared in Figure 5 and Table 3 can be described as follows : From Table 3, it can be concluded that during the year of 2006-2009, the total land use changed area is 39 km<sup>2</sup>. The most increased area occurred in oil palm as of 10.45 km<sup>2</sup> or 26.79% of the total changed area whereas cassava and sugar cane decreased as of 8.78 km<sup>2</sup> or 22.51% and 8.6

km<sup>2</sup> or 22.05% of the total changed area respectively. Study and Forecast of Land Use Change in Nong Yai District, Chonburi Province in 2012 by Using Model

The forecast of future trend of land use change by Markov Chain Model was undertaken by applying land use data of 2003 and 2009 as the baseline data. The results obtained are values of change opportunity and proportion. The change proportion of the land use was then applied for CA Markov Modeling resulting in the forecast model of the land use of 2012 as appeared in Figure 7.

**Conclusion**

The study area covers 456.01 km<sup>2</sup> or 285,006 rai in Nong Yai District of Chonburi Province. The study was carried out using 3 temporal images of LANDSAT-5 TM acquired on December 30<sup>th</sup> 2003, December 22<sup>nd</sup> 2006 and December 1<sup>st</sup> 2009. Ten land use categories were obtained from visual interpretation of those three images. The area of each category ranging from the biggest to smallest number of rai are as follows : rubber, cassava, oil palm, forest, pineapple, sugar cane, other land use, standing tree and orchard, residential area, and water body. The study was divided into two periods : between 2003-2006 and 2006-2009.

The total area of land use change in Nong Yai District Chonburi Province occurred between 2003-2006 is 86.90 km<sup>2</sup> or 19.06% of the total study area. According to the proportion of changed area, it was found that sugar cane is the most changed with 19.91 km<sup>2</sup> increased or 22.91%. The most decreased category was found in other land use as of 38.81 km<sup>2</sup> or 44.66%.

As for the period of 2006-2009, it was found that the total changed area is 39 km<sup>2</sup> or 8.55% of the total study area. According to the proportion of changed area, it was found that oil palm is the most changed as of 10.45 km<sup>2</sup> increased or 26.79%. The most decreased category was found in cassava or of 8.78 km<sup>2</sup> or 22.51% of the total area.

From the study on land use trend by using land use data of 2006 and 2009 analyzed by CA Markov Model, The land use of 2012 in Nong Yai District

was obtained. It revealed that in 2012 oil palm tends to be most increased with an area of 29.88 km<sup>2</sup> or 18.16%, followed by sugar cane as of 24.58 km<sup>2</sup> or 15.31%. As for the category most likely to be decreased is other land use as of 58.35 km<sup>2</sup> or 36.34% whereas water body tends to be least change.

The accuracy of the study can be improved by including other factors influencing the land use change such as economic and social situation, topography, etc. for analyzing together with change opportunity and proportion of land use change.

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