Study of Land Use Changes in Sa Kaeo Province Using Object-Based Image Analysis

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Abstract

The classification and analysis of land use changes in Sa Kaeo province between 2006 and 2014 based on LANDSAT 5 TM and LANDSAT 8 OLI satellite image data by using object-based image analysis found that land use was divided into 7 categories, including Urban and Built-up Land, Paddy Field, Field crop, Perennial and Orchard, Forest Land , Water Body and Miscellaneous Land. It was also found from the study that most of the land uses in 2009 was paddy fields of 1,984,722.72 rai accounted for 44.13 percent, followed by forest lands of 894,240.13 rai or 19.88 percent, and the urban and built-up of 473,795.42 rai or 10.53 percent,. By contrast in 2014, most of the land uses was the field crops of 1,599,777.97 rai, accounted for 35.56 percent, followed by paddy fields of 1,225,790.40 rai or 27.25 percent and forest lands of 901,881.10 rai or 20.06 percent. The land use changes occurred between those two period showed that the field crops had the largest increase in area while the paddy fields had the most reduced area accounted for 26.95 and16.87 percent respectively.

Keywords: Object -based classification, Land Use, Change, Image Analysis

I. Introduction

Located in the eastern part of Thailand, Sa Kaeo province has a border with Cambodia with the largest border trade market in the ASEAN region [1]. In 2017, the trading value reached 72,829.19 million baht, while tourism income was 6,306.25 million baht increased by 9.31 percent comparing with the previous year [2]. In addition, policies from the government have designated the area as Sa Kaeo Special Economic Zone with a purpose to promote trade, investment and improve the quality of life of people which can be considered economic factors resulting in changes in land use patterns [3] affecting social and environmental conditions afterward. It was found that the change of agricultural area to a residential community and industrial plants, resulting in very low water quality [4] loss of agricultural land, but the increase in community areas causes congestion [3].

The analysis and monitoring of land use with satellite imagery data can provide information which is considered important for land use and natural resource planning [5] by data classification via object-based image analysis techniques: OBIA) There are also other techniques that can be used to classify land use [6] [7], such as image segmentation. (Segmentation) instead of pixel-base classification, which is used for processing since the Landsat 1 satellite, on the other hand, [8] identifies Landsat 5 TM satellite image data via object-based image analysis methods. The researchers then examined the overall accuracy and Kappa statistics [9] [10]. The results of validation by data classification in this way were found to be more accurate than the point-oriented image classification method [5] [11] [12] [13]

This study is a classification of land use in Sa Kaeo province by using object-based image analysis methods from LANDSAT 5 TM satellite image data recorded on November 4, 2006 and LANDSAT 8 OLI recorded on December 12 2014 by dividing the types of land use into 7 categories, namely Urban and Built-up Land (U);Paddy Field (A1),Field crop(A2),Perennial and Orchard (A3); Forest Land (F); Water Body (W) and Miscellaneous Land (M). The land use data for both periods were then analyzed to analyze land use changes. The results of the study were data on land use changes during this period which can be used to plan and monitor land use changes that may affect the well-being and occupation of the people in Sa Kaeo province.

II. Objective

To classify type of land use and analysis of land use changes in Sa Kaeo province between 2006 and 2014 with object-base image analysis method.

III. Methodology

The analysis of land use changes in Sa Kaeo province defined study area ,Information sources, and study method as follows:

1) Area of Study

This study defined the study area as Sa Kaeo province, with an area of 7,195.43 square kilometers or approximately 4,496,962 rai, divided into 9 districts, 58 sub-districts, 731 villages [1].

2) Image and Source

Land use classification in Sa Kaeo province used data from two satellite images, including LANDSAT 5 TM satellite image data, recorded on November 4, 2006 and LANDSAT 8 OLI satellite image data recorded on

December 12 2014, downloaded from the website http://earthexplorer.usgs.gov. Detail of satellite images as shown in Table I.

TABLE I. Detail of satellite image data

Satellite		Year	Path	Row	Date
LANDSAT 5 TM		2006	128	50	4/11/2006
			128	51	4/11/2006
LANDSAT 8 OLI		2014	128	50	12/12/2014
			128	51	12/12/2014

3) Process of Study

Land use classification and land use changes in Sa Kaeo province had processes to prepare and analyze data as follows:

(3.1) The researchers chose and downloaded satellite imagery from LANDSAT 5 TM 2006 and LANDSAT 8 OLI 2014 covering study area then adjusted the Geometric Correction of the data taken by the satellite with the ground control point (GCP), determined the UTM (Universal Transverse Mercator) position system, WGS Zone 47N, and perform Radiometric Correction and Image Enhancement for satellite images with accurate positioning that reduced errors caused by the signal agitation in order to obtain the clearer images. After that, the researchers set the Training area from the field survey in the study area for the object to be processed. Land use was divided into 7 categories as shown in Table II.

TABLE II. Description of each type of land use

Type of Data	Land Description
1. Urban and Build-up Land (U)	The area with buildings for use as residential or public and private services including industrial enterprises
2. Paddy Field (A1)	Rice cultivation area
3. Crop Field (A2)	The area for cultivating paddy fields such as sugarcane, cassava and other field crops
4. Perennial and Orchard(A3)	The area of planting perennial and orchards such as rubber, oil palm.Eucalyptus and other fruit trees
5. Forest Land (F)	The forest area in Pang Sida Park, Ta Phraya National Park, Wildlife Sanctuary, Khao Ang Ruenai and outside the park area / wildlife sanctuary
6. Water Body (W)	The natural and man-made water sources include canal, stream, swamp, weir and catchment
7. Miscellaneous Land (M)	The areas other than the areas mentioned above Looks open to see the soil, garbage dumping area, under construction or being filled area, Including waste areas

(3.2) The researchers mixed colors of satellite image data from LANDSAT 5 TM by using band 1, 2 and 4 to classify water body forest land, urban and built-in land and miscellaneous land, band 2 4 and 5 paddy field, crop field and perennial and orchard. Similarly, the researchers obtained the image data from LAMDSAT 8 OLI band 2, 3 and 4 to classify perennial and orchard and crop field, band 3, 4 and 5 to classify water body and forest land and band 4, 5 and 6 for paddy field, urban and built-in land and miscellaneous land. The researchers then classified the land use via Object-based image classification methods [11] [14] by creating objects with image Segmentation.

(3.3) The researchers verified the accuracy of the land use classification obtained from the translation of satellite image data and the type of land use in the actual area by field survey in order to collect sample points in the actual area using the GPS device to evaluate the accuracy that must be in the overall (Overall Accuracy) from the map that has been evaluated (Evaluated Map) with the reference map in the assessment (Reference Map) based on the land use map 2006 and 2013 from the Land Development Department by comparing with field data and considering the Kappa statistics.

(3.4) The researchers analyzed land use changes by using the results of overlay techniques in 2006 and 2014 in order to obtain a map of land use changes in the study area.

IV. Results of study

1) Land use in 2006

From the classification of land use in 2006, it was found that the paddy fields had the largest area of 1,984,722.72 rai, accounted for 44.13 percent, followed by forest lands with an area of 894,240.13 rai or 19.88 percent. rai accounted for 10.53 percent, while other types of land use as shown in Table III, the results of data classification were accurate, overall 69.46% and Kappa value was 0.61.

From the utilization map 2006 (Figure 1),it was found that the forest lands appeared in the upper and lower parts of Sa Kaeo province, which was a national park and wildlife sanctuary while the central area of the province had various land uses. Most of them were paddy lands, while other areas also appeared, including field crops, perennials and orchards, urban and build-up lands, water bodies and forest lands as shown in Figure 1

2) Land use in 2014

In 2014, the field crops had the largest area of 1,599,777.97 rai, accounted for 35.56 percent, followed by paddy fields with an area of 1,225,790.40 rai or 27.25 percent. The forest lands were 901,881.10 rai accounted for 20.06 per each, while other types of land use were shown in Table III, the results of land use classification were accurate in overall at 77.42% and Kappa statistics account for 0.73.

From the utilization map 2014 (Figure 2), it was found that the upper and lower parts of the province were mostly forest lands while the central area of the province was a land that had a variety of uses .Most of them are field crops followed by a paddy fields with other uses, such as perennials and orchards, urban and build-up lands, water bodies, forest lands and miscellaneous areas as shown in Figure 2.

TABLE III. Land use between 2006- 2014

Land use	2006		2014	
	Area (rai)	Percent	Area(rai)	Percent
U	473,795.42	10.53	222,796.67	4.96
A1	1,984,722.72	44.13	1,225,790.40	27.25
A2	387,599.34	8.62	1,599,777.97	35.56
A3	442,016.17	9.83	268,132.43	5.96
F	894,240.13	19.88	901,881.10	20.06
W	210,927.78	2.32	231,728.23	5.15
M	104,150.94	4.69	47,345.70	1.06
Total	**4,497,452.50**	**100.00**	**4,497,452.50**	**100.00**
Overall Accuracy %)	**69.46**		**77.42**	
Kappa Statistics	**0.61**		**0.73**	

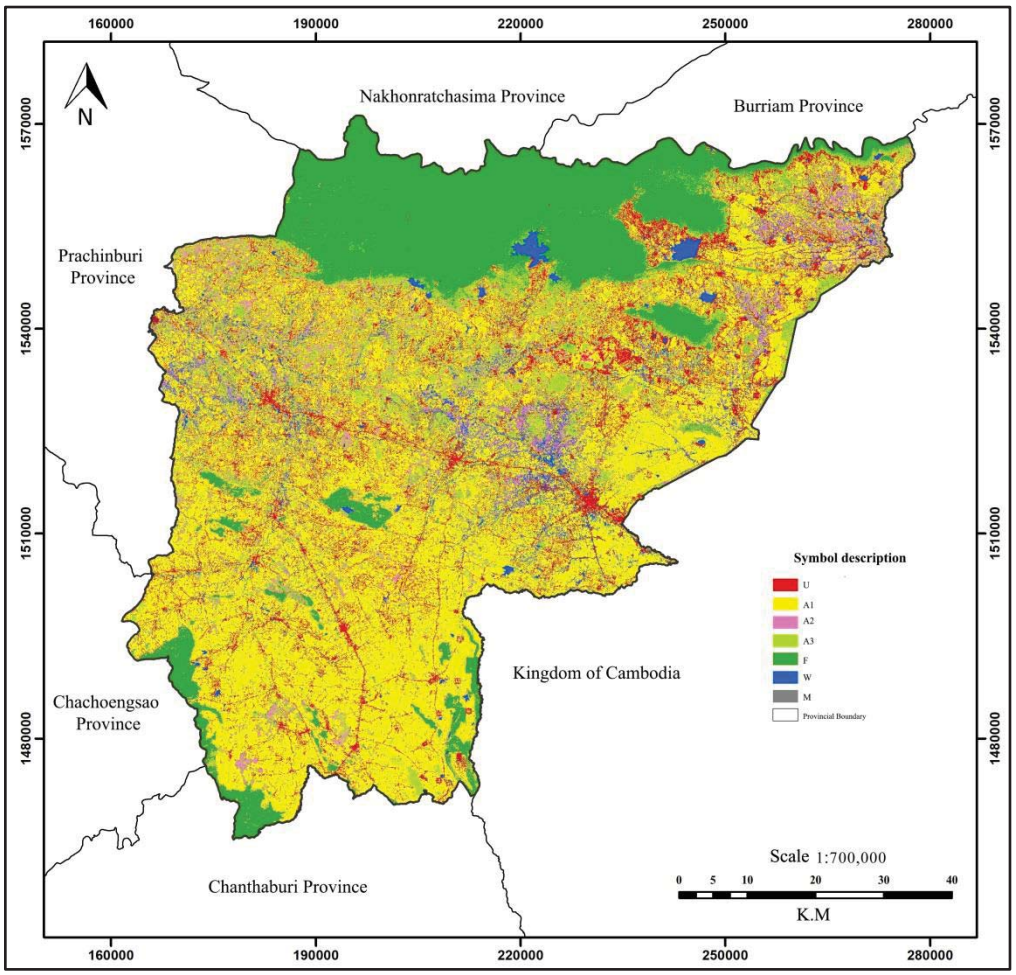

Figure 1. Map of land use in 2006

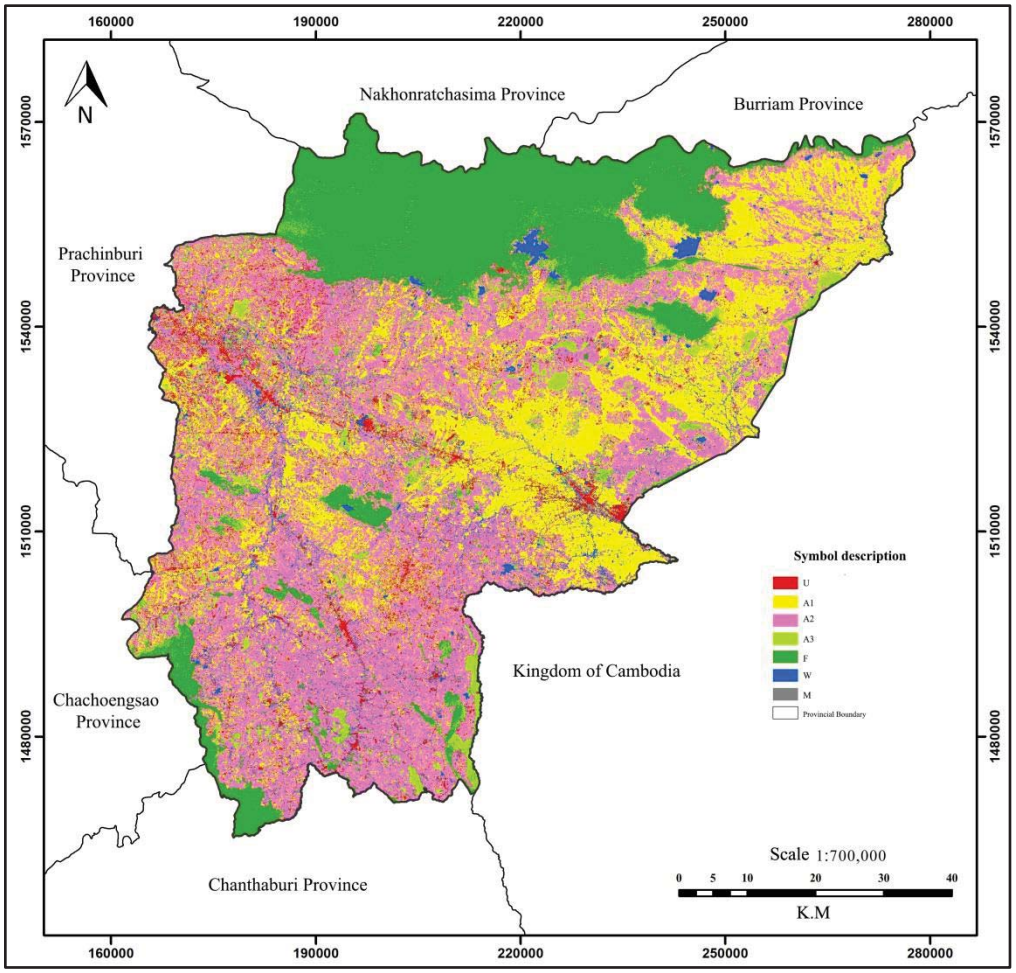

Figure 2. Map of land use in 2014

3) Land Use Change between 2009-2014

From the analysis of land use changes between 2006 and 2014, it was found that the field crops were the most changed with an increase of 1,212,178.63 rai, or 26.95 percent, followed by water bodies, with an increase of 20,800.45 rai or 0.46 percent, while the forest lands had the same area size of 7,935.90 rai, accounted for 0.18 percent of the total area. By contrast, land use changes that were decreased included paddy fields with a decrease of 758,932.32 rai or 16.87 percent, followed by urban and built-in lands found that the area decreased by 250,998.75 rai or 5.58 percent, the area of perennial and orchards decreased by 173,883.74 rai or 3.87 percent and the miscellaneous land decreased by 56,805.24 rai or 3.63 percent as shown in Table IV.

From Figure 3 , it was found that the most changed areas were in the central part of the province from paddy fields to field crops while most forest lands appeared in the upper and lower parts of the province, which also had more area. Most of the paddy fields with reduced areas were in the middle to the lower part of Sa Kaeo province.

TABLE IV. Land use changes in Sa Kaeo province

Land Use	Area (Rai)			Percent
	2006	2014	Change	
U	473,795.42	222,796.67	-250,998.75	5.58
A1	1,984,722.72	1,225,790.40	-758,932.32	16.87
A2	387,599.34	1,599,777.97	1,212,178.63	26.95
A3	442,016.17	268,132.43	-173,883.74	3.87
F	894,240.13	901,881.10	7,640.97	0.17
W	210,927.78	231,728.23	20,800.45	0.46
M	104,150.94	47,345.70	-56,805.24	1.26
Total	**4,497,452.50**	**4,497,452.50**	**2,481,240.10**	

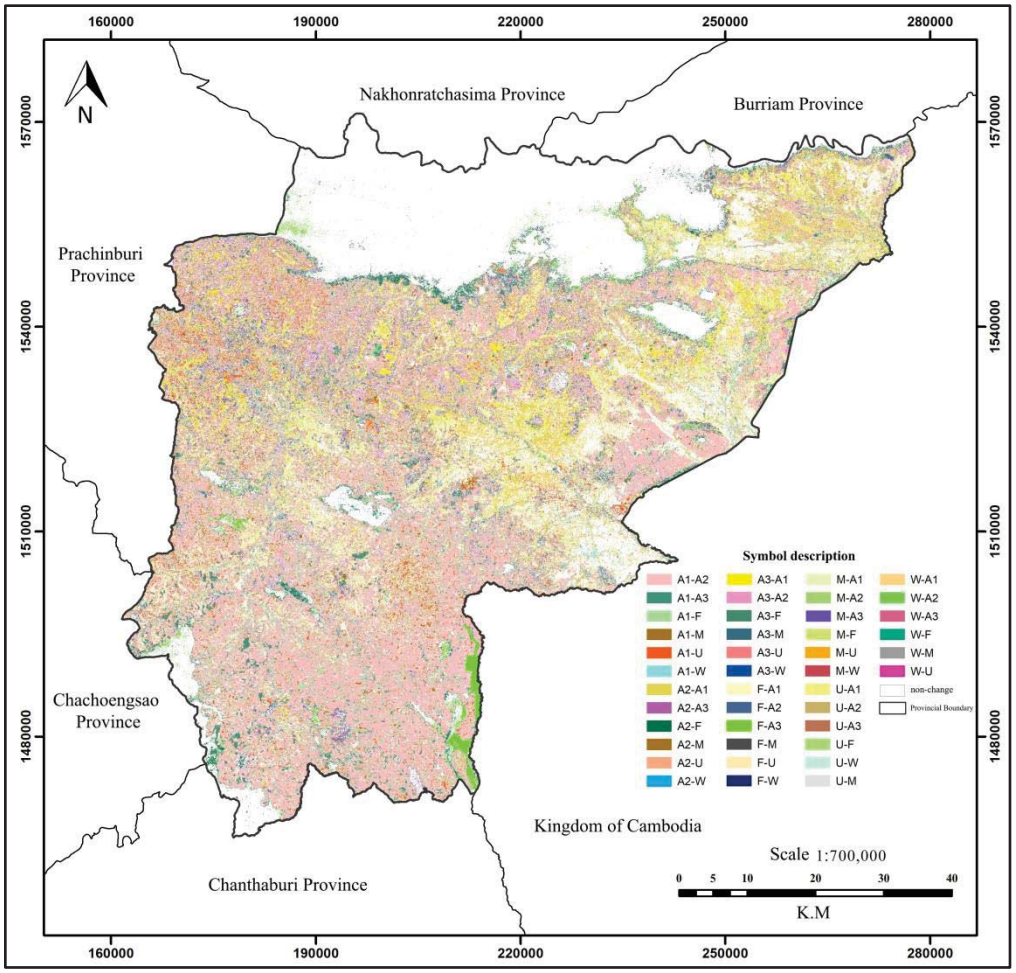

Figure 3. Map of the land use changes between 2006-2014

V. Discussion and Conclusion

The study of land use in 2006 of Sa Kaeo province found that forest lands were accounted for 19.88 percent of the province area which had area size similar to the Department of Forestry's report [16]. Differently, in 2014, it was found from the classification of land use, that there were 20.06 percent of the forest lands, while the Forest Department report states that the area of forest land was accounted for 21.53 percent [17].

Land use that had the most incremental changes was field crop which was accounted for 26.93 while paddy field had the largest decrease accounted for 16.87 percent. It was found that the paddy fields changed to the field crops most. From the agricultural productivity report of the Office of Agricultural Economics [18] It was found that the area of field crops and field crops productivity in Sa Kaeo province in 2014 increased from the previous year. In 2006, the reported that the price of agricultural products in Sa Kaeo province increased continuously between 2003-2014. The price of rice was not stable [19]. Therefore, the price of agricultural products may be an important factor and motivates farmers to grow more crops.

From the study of land use including changes in land use in Sa Kaeo province can be used to manage and plan land use within the province, in particular, the policy from the government that designated Sa Kaeo province as the Special Economic Zone of Sa Kaeo to improve the quality of life of people, promote trade and investment especially the issue that need to be proceeded immediately such as the development of infrastructure like roads. However, the consequences that may arise are the expansion of the community and the construction of roads while other forms of land such as agricultural areas that may be reduced that will affect the transition from agricultural society to industrial society in the future. Therefore, Sa Kaeo province needs the development that may result in changes in land use, it should be clearly planned and determined polices which may be in the form of a city plan However, in the development of areas which may lead to changes in land use, people and stakeholders should participate and express opinions so that various developments run smoothly and achieve the goals set.

VI. Acknowledgement

This study was accomplished with support from the Faculty of Geographics, Burapa university that supported the software for processing and the Regional Center for Space and Geo-Informatics Technology, Eastern Region, that provided Administrative Information of sub-district district and province of Sa

Kaeo province including LANDSAT 5 TM and LANDSAT 8 OLI satellite image information from the website http://earthexplorer.usgs.gov for this study .The researchers would like to thank you for this opportunity.

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