

Application of Geo-informatics Technology to Study Land Use Changes for Agriculture at Wang Wiset District, Trang Province

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ABSTRACT

The research aimed to study of land use for agricultural purposes in Wang Wiset District of Trang Province occurred in 1993 and 2019 using satellite images acquired from LANDSAT 5 in 1993 and LANDSAT 8 in 2019. The satellite images were interpreted and analyzed with a computer. The method of supervised classification and normalized difference vegetation index (NDVI) and to study the land use changes for agriculture by the information on land uses from both time periods was compared to identify changes in land uses by union overlay function.

The study of land use for agriculture in 1993 indicated that the majority of land use was for the cultivation of perennial with the area coverage of 314.12 km² (65.84%), followed by 73.27 km² (15.34%) of forests land, and 53.96 km² (11.31%) of miscellaneous lands. Meanwhile, in 2019, the majority of land use was for the cultivation of perennial with the area coverage of 383.54 km² (80.37%) followed by 50.99 km² (10.69%) of forests land, and 15.62 km² (3.27%) of urban and built-up land, respectively. In 2019, The Kappa statistic was used in the analysis of data obtained from field survey in 2019 with the result of 0.75 and overall accuracy at 80%, which considered the moderate level. The analysis of changes in land uses for agricultural purposes which occurred during the last 26 years from 1993 to 2019 exhibited the alteration from previous paddy field, forests, and miscellaneous lands in 1993 to the additional 69.42 km² of perennial cultivation areas, additional 0.97 km² of orchard cultivation areas, additional 6.55 km² of urban and built-up land, and additional 0.01 km² of poultry farm house. Meanwhile, there were the diminishing in the following areas: 22.28 km² of forests land. Forest lands have the most reduced areas. In which the forest land has been changed to an agricultural land of 13.26 km² (9.41%), 41.89 km² of miscellaneous lands, and 10.62 km² of paddy field lands. This was due to the emerged para rubber and oil palms as the primary industrial crops of Trang Province and these crops yielded the higher value products which yielded the highest value among the southern provinces along the Andaman coast. Thus provoked the locals to alter their land use from the previous paddy field and trespassed and clear cut the forests to seize the prohibited lands for unauthorized para rubber and oil palms cultivations steadily increasing.

Keywords: Agriculture, Geo-informatics, Land use Change

INTRODUCTION

Land use is essential for agricultural occupations. The increase in population along with economic and social growth and various aspects of the country's development has resulted in diminishing natural resources. This is especially true in the rural regions where agricultural areas are insufficient and eventually caused the intrusions into forests to utilize the lands for agricultural purposes and deterioration of natural resources and environments as a result [1]. The Royal Decree in 1993 regulated the forests in Khao Pra - Bang Kram of Khlong Thom District in Krabi Province, Wang Wiset and Sikao District of Trang Province as Wildlife Sanctuary. Furthermore, the Decree revoked forest concessions and discontinued land reform operations for farmers in Wang Wiset District of Trang Province. Two main industrial crops of Trang Province, Para Rubber (*Hevea brasiliensis*) and Oil Palm (*Elaeis guineensis*) which yielded the highest value among the southern provinces along the Andaman coast were cultivated in the regulated areas. Para Rubber became the province's primary industrial crop since 2005 to present [2] and thus provoked the locals to trespass and clear cut the forests to seize the prohibited lands for unauthorized farming and the locals have since increasingly cultivated para rubber and oil palms. The deterioration of natural resources and environments may occur anywhere. The modern geo-informatics technology has been applied to survey, monitor, and inspect geographical changes due to its decent advanced abilities and accuracy of the provided results. Geo-

informatics is the fast and affordable approach in addressing geographical problems. Providing such various benefits, the author thus adopted geo-informatics technology for the survey and classification of land uses for agricultural purposes and the monitoring of changes that occurred in the alterations of lands from previous paddy field to the cultivation of para rubber and oil palms. It was an interest of the author to apply geo-informatics technology in the observation of changes occurred in land uses for agricultural purposes at Wang Wiset District of Trang Province and to make a comparison of such changes between the year 1993 and 2019 to provide the insights regarding changes in land uses for associated authorities to apply in the land management and stipulate the strict actions for the supervision and protection of forests against the unauthorized intrusions and exploitations.

METHODOLOGY

The data and instruments used in the study were satellite images in the territory of Wang Wiset District of Trang Province acquired from LANDSAT 5 (as of April 10, 1993) and LANDSAT 8 (as of March 11, 2019), computer, printer, GPS, digital camera, and geo-informatics software.

Methodologies: the author studied land uses for agricultural purposes in Wang Wiset District of Trang Province that occurred in 1993 and 2019 using satellite images acquired from LANDSAT 5 in 1993 and LANDSAT 8 in 2019. The satellite images were interpreted and analyzed with a computer. The method of supervised classification and normalized difference vegetation index (NDVI) were applied in the examination of alterations that occurred from land uses for agricultural purposes in Wang Wiset District of Trang Province during 1993 and 2019. The information on land use from both time periods was compared to identify changes in land uses by Union Overlay Function in Figures 1 and 2.

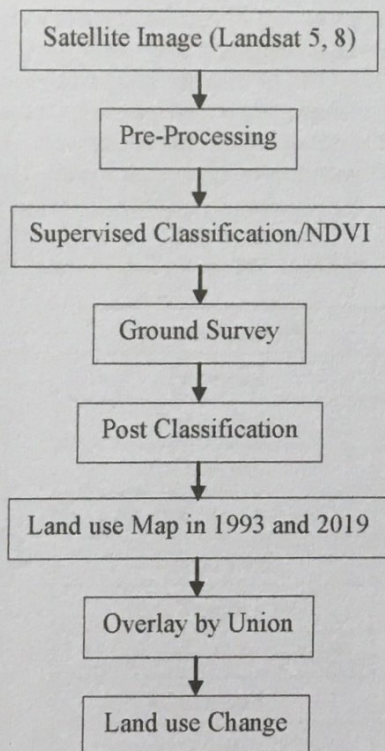


Figure 1 Chart showing the process of study the Land Use Changes for Agriculture at Wang Wiset District, Trang Province in 1993 and 2019

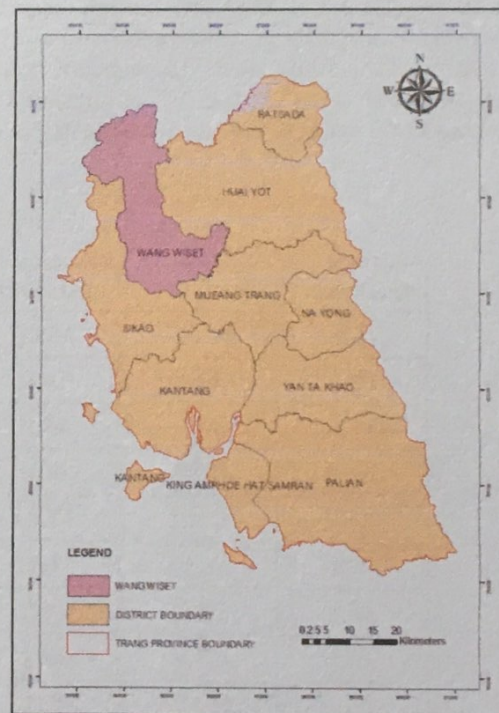


Figure 2 Study Area

RESULTS AND DISCUSSIONS

1. Result of land uses for agricultural purposes in Wang Wiset District of Trang Province in 1993 and 2019

According to the modification of the satellite imagery interpretation using the supervised classification and the vegetation index analysis, the lowest and the highest normalized difference vegetation index (NDVI) were reported as -1 and 0.4 in 1993, and -0.1 and 0.6 in 2019. The difference of NDVI between time points is in good agreement with the previous report Parinya Sakkanayok et al., (2008) [3] which revealed the lowest and the highest NDVI as -1 and 0.2 in 2006, and -0.4 and 0.4 in 2008. The NDVI of the identical type of land cover is different. The NDVI of -1 – 0.29 indicates an absence of the land cover e.g. water body and agricultural area. The NDVI of 0.3 – 0.59 represents the low vegetation land cover because of the difference between the environment and air humidity due to the regular changes in the land utilization for agriculture.

Data classification of agricultural areas. The research results can be classified into 8 types of land use which are perennial, paddy field, orchard, poultry farm house, forest land, miscellaneous land, urban and built-up land and water body. In corresponding with the previous report [3], the land use classification is divided into 8 types which are paddy field, grassland, mixed horticulture, para rubber, perennial, forest land, mangrove forest and shrimp farm. In 1993, it was found that the most use of land for perennial areas, followed by paddy field and orchard and in 2019, it was found that land use for agriculture, perennials areas at the most followed by the orchard, paddy field and Poultry farm house respectively











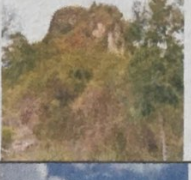





The study of land use for agricultural purposes in Wang Wiset District of Trang Province occurred in 1993 indicated that the majority of land uses was for the cultivation of perennial with the area coverage of 314.12 km² (65.84%), followed by 73.27 km² (15.34%) of forests land, and 53.96 km² (11.31%) of miscellaneous lands. Meanwhile, in 2019, the majority of land uses was for the cultivation of perennial with the area coverage of 383.54 km² (80.37%) followed by 50.99 km² (10.69%) of forests land, and 15.62 km² (3.27%) of urban and built-up land, respectively. The Kappa statistic was used in the analysis of data obtained from field research in 2019 with the result of 0.75 and overall accuracy at 80%, which considered the moderate level which corresponds with the previous report Khampeera, T et al., (2007) [4] found that the overall accuracy of the classification is 94.90% and kappa statistics is 0.93 and has been checked with the land use data of the Land Development Department shows that this classification of land use is at a moderate level. Follow in Tables 1, 2 and 3.

Table 1 Data of Land use in 1993 and 2019

Types of land use	1993 (km ²)	Percentage	2019 (km ²)	Percentage
Perennial	314.12	65.84	383.54	80.37
Paddy field	11.56	2.42	0.94	0.20
Orchard	3.51	0.74	4.48	0.94
Poultry farm house	0.00	0.00	0.01	0.002
Forest land	73.27	15.34	50.99	10.69
Miscellaneous land	53.96	11.31	11.87	2.49
Urban and Built-up land	9.07	1.90	15.62	3.27
Water Body	11.68	2.45	9.72	2.03
Total	477.17	100	477.17	100

Field survey data checking by going to the area on December 9-10, 2019 as in Table 2

Table 2 Field survey data collection

Coordinates	Types of land use	Field Survey	Sattelite image
X : 546121 Y : 848140	Para Rubber		
X : 534571 Y : 864869	Oil Palms		
X : 549915 Y : 848264	Paddy field		
X : 539571 Y : 855777	Orchard		
X : 552555 Y : 844817	Water Body		
X : 551825 Y : 844650	Forest land		
X : 550665 Y : 847384	Urban and Built-up land		
X : 542726 Y : 855405	Miscellaneous land		

The examination and the analysis of field survey data with the data collected from the satellite imagery interpretation demonstrated the similar area characteristics. The information of the changes in land utilization is shown in Table 3.

Table 3 Field survey data for land use in Wang Wiset District, Trang Province.

Land use Classification	Ground Survey							Total
	A3	A1	A4	F	U	M	W	
A3	4	0	1	0	0	0	0	5
A1	0	2	0	0	0	1	0	3
A4	0	0	2	0	0	0	0	2
F	1	0	0	8	0	1	0	10
U	0	0	0	0	10	0	0	10
M	1	0	1	1	0	7	0	10
W	1	0	0	0	0	2	7	10
Total	7	2	3	9	10	11	7	50

Overall Accuracy from field survey = 80 %

Kappa Coefficient = 0.75

Note:

Urban and Built-up land: U, Forest land: F, Miscellaneous land: M, Water Body: W

Paddy field: A1, Perennial: A3, Orchard: A4, Poultry farm house: A7

2. Land use change for agriculture at Wang Wiset District, Trang Province, 1993 and 2019

The analysis of change in land use for agricultural purposes in Wang Wiset District of Trang Province occurred during the last 26 years from 1993 to 2019 exhibited the alteration from the previous paddy field, forests, and miscellaneous land in 1993 to the additional 69.42 km² of perennial cultivation areas in accordance with Geo-Informatics and Space Technology Center (Southern) (2012) [5], revealing that the Songkhla Lake Basin area has reduced the area of 25.30 % by changing to para rubber, orchard and oil palm. Additional 0.97 km² of orchard cultivation area, additional 6.55 km² of urban and built-up land, and additional 0.01 km² of poultry farm house. Meanwhile, the diminishing of 22.28 km² of forests land. This is in accordance with Natthapong Puangkaew et al., (2016) [6] stating that the forest area has the most reduced area, at where the forest area has been changed to an agricultural area of 13.26 km² (9.41%), 42.09 km² of miscellaneous areas, 10.62 km² of paddy field area. There was a 91.87 % decrease in paddy field area and 30.41 % decrease in forest area. It indicated that such mentioned areas had changed to be the most perennial area such as rubber, oil palm. In accordance with Khamphue, T et al. (2007) [4], revealing that the change of paddy field area to rubber plantation area was 31.66 % followed by changing to an area of 1.21% fruit plantation. At Phatthalung District, paddy field area changed to rubber planting area of 23.68%, and 1.96 km² of water body area.

Such change was due to the emerged para rubber and oil palms as the primary industrial crops of Trang Province and these crops yielded the higher value products among the southern provinces along the Andaman coast. Thus provoked the locals to altered their land uses from the previous paddy field and trespassed and clear cut the forests to seize the prohibited lands for unauthorized para rubber and oil palms cultivations steadily increasing as presented in Table 4 and Figure 3.

Table 4 The analysis of changes in land uses for agricultural

Types of land use	Land use change	Percentage
Perennial	+ 69.42	22.10
Paddy field	- 10.62	91.87
Orchard	+ 0.97	27.64
Poultry farm house	+ 0.01	0.002
Forest land	- 22.28	30.41
Miscellaneous land	- 42.09	78.00
Urban and Built-up land	+ 6.55	72.22
Water Body	- 1.96	16.78

Note: + Increase / - Decrease

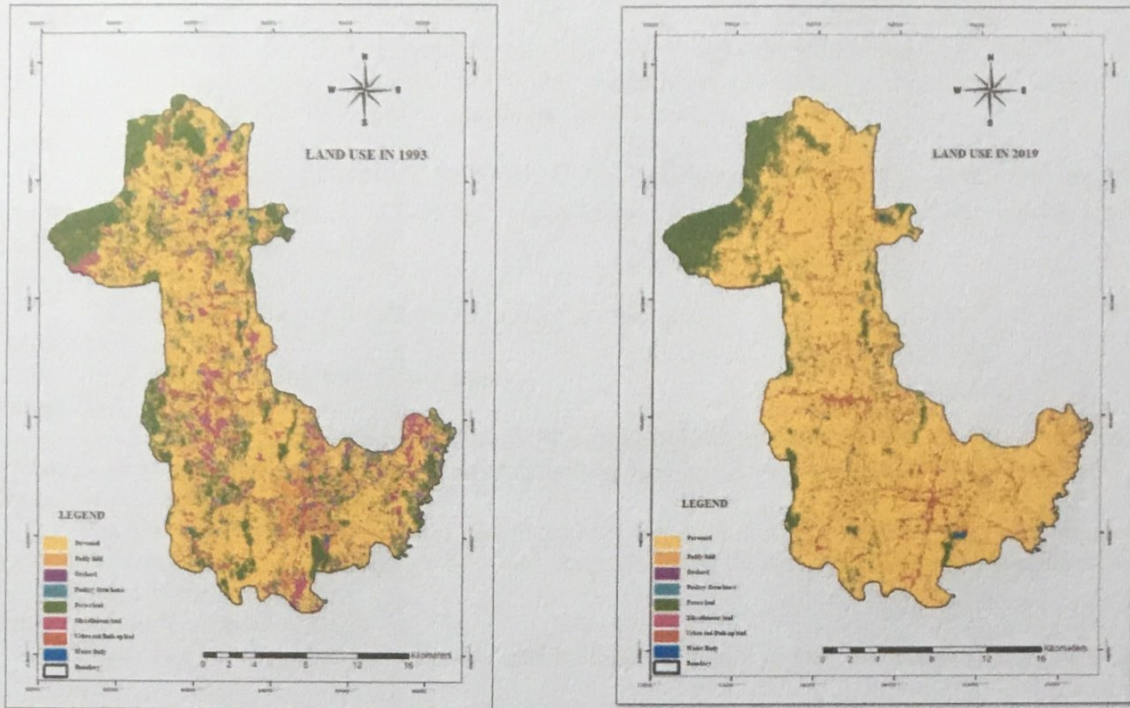


Figure 3 Land use in 1993 and 2019

Information of changes in land use Wang Wiset District, Trang Province, between 1993 to 2019, obtained from the study in a tabular form as shown in Table 5.

Table 5 Comparative data of land use change Wang Wiset District, Trang Province, in 1993 and 2019

Land Use		2019 (km ²)								
		Agricultural Land				F	M	U	W	Total
1993 (km ²)		A3	A1	A4	A7	F	M	U	W	Total
Agricultural Land	A3	313.27	0.00	0.67	0.01	0.00	0.01	0.16	0.00	314.12
	A1	9.33	0.93	0.11	0.00	0.00	0.33	0.78	0.08	11.56
	A4	0.00	0.00	3.51	0.00	0.00	0.00	0.00	0.00	3.51
	A7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F		20.73	0.00	0.01	0.00	50.90	0.00	1.61	0.02	73.27
M		40.20	0.01	0.15	0.00	0.09	9.45	4.00	0.06	53.96
U		0.00	0.00	0.01	0.00	0.00	0.00	9.06	0.00	9.07
W		0.01	0.00	0.02	0.00	0.00	2.08	0.01	9.56	11.68
Total		383.54	0.94	4.48	0.01	50.99	11.87	15.62	9.72	477.17

Note:

Urban and Built-up land: U, Forest land: F, Miscellaneous land: M, Water Body: W
Paddy field: A1, Perennial: A3, Orchard: A4, Poultry farm house: A7

Perennial

The perennial area is still a perennial area of 313.27 km² and changed to other areas as follows, 0.67 km² of orchard, a poultry farm house area of 0.01 km², forest area of 0.40 km², a miscellaneous area of 0.01 km², urban and built-up land of 0.16 km², water body of 0.01 km².

Paddy field

The paddy field is still a paddy field of 0.93 km² and changed to other areas as follows: perennial area of 9.33 km², area of orchard of 0.11 km², miscellaneous area of 0.33 km², urban and built-up land of 0.78 km², and water area of 0.08 km².

Orchard

The orchard area is still 3.51 km². No change to other areas

Poultry farm house

No changes in poultry farm house areas

Forest land

The forest land is still a forest land of 50.90 km² and changed to other areas as follows: perennial area of 20.73 km², orchard of 0.01 km². Urban and built-up land of 1.16 km², and water body of 0.02 km².

Miscellaneous land

Miscellaneous land is still 9.45 km² and changed to other areas as follows, 40.20 km² perennial area, paddy field area of 0.01 km², orchard of 0.15 km², forest area of 0.09 km², urban and built-up land of 4.00 km² and water body of 0.06 km².

Urban and built-up land

Urban and built-up lands are still urban and built-up lands of 9.06 km², and changed to orchard area of 0.01 km².

Water body

The water body is still 9.56 km², and changed to other areas as follows; perennial area of 0.01 km², 0.02 km² of orchard, miscellaneous area of 2.08 km² and urban and built-up land of 0.01 km².

Noting that there are various organizations deal with the same land use type. For example; for forest protection e.g. the Royal Forest Department and Department of National Parks, Wildlife and Plant Conservation. Moreover, the integration of the central departments and the local organizations area is needed. Furthermore, people living in the local area should cooperate and monitor to protect the forest. Nevertheless, the strict preventive measure of protected areas with the penalty for the offender is also important. Regarding the Forest Act, B.E. 2484 (1941) of section 54 and 54, no person shall construct, reclaim, burn forest, or do any manner whatsoever to destroy forest, or hold, or possess forest for himself or other person without the permission. In the National Reserved Forest Act, B.E. 2507 (1964) of section 14, no person shall hold or possess land, live, make a construction, reclaim, burn forest, or do any matter whatsoever with purport to harm or decay a condition of national reserved forest without the permission. For the Wildlife Reservation and Protection Act, B.E. 2535 (1992) of section 37, no person shall enter a wildlife sanctuary without the permission; while section 38, no person shall possess, occupy the land, or build up, or any other means whatsoever to construct, or cut, fell, reclaim, burn, or destroy trees or any other flora without the permission from the authorities [7]. Furthermore, the consecutive monitoring of change should be performed to protect and manage the forest. Also, the preventive measure is strongly required for further management of land utilization.

The study on the land utilization for agriculture revealed that the agricultural area is increasing while the forest area is decreasing. To prevent an increase of agricultural area in the protected area and further decrease of forest area, the cooperation among many line agencies both central and local sectors as well as with the communities are strongly required.

CONCLUSION

The adoption of geo-informatics technology to study the changes that occurred in land uses for agricultural purposes at Wang Wiset District of Trang Province indicated that the majority of land uses was for the cultivation of perennial plants: para rubber and oil palms. The alteration of agricultural land uses also resulted in the diminishing of paddy field areas (at 91.87%) and forests (at 30.41%). The altered areas have been dominated by the cultivation of perennial plants.

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