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Mapping Land Use Changing and Urban Growth Using Landsat Data (Study Area: Pekan, Pahang State, Malaysia)

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Abstract

The aim of this study is to investigate the land use changing and urban growth by retrieving information from the Landsat 8 satellite data. The study area is in Pekan, Pahang State, Malaysia. This study will use data taken on the year 2000 and 2013. Pre-processing algorithms were applied to improve the quality of the data, then the classification technique is performed to classify the land use for every data. The result has been analyzed to find out the land use changing and urban growth. The satellite data was classified into four land use types: urban, water, bare land, vegetation. The result shows the changing of land use in the study area in duration of 13 years and the urban growth in significant number of percentage.

Keywords: Land cover; classification; Landsat; Operational Land Imager; Region of Interest; Pekan Pahang

INTRODUCTION

Urban growth has been long considered a sign of regional economic vigor. Beside its benefit, Urban growth also increasingly gives negative impacts to ecosystem and environment, including the road traffic, air quality, loss of farming area, social fragmentation and infrastructure cost. Natural Resource Management, Planning and Monitoring programs depend on accurate information about the land cover in a region [1].

Detecting and mapping urban growth is important step to minimize the negative impacts of it and for future urban planning. The conventional way on mapping the urban is done by surveying methods, but it is time consuming and takes a lot of cost. The remote sensing data is an alternative method to provide the accurate and timely geospatial information. [2].

Satellite image data, as one source data of remote sensing, enables to perform direct observation on the land surface at repetitive intervals that is convenient for mapping and monitoring. By applying the classification technique on optical remote sensing data, remote sensing method is able to assess the accuracy of multitemporal classification, land use changing and analyze urban growth patterns [3]. This study will map the land use changing and urban growth at Pekan, Pahang State Malaysia, by applying classification technique on LANDSAT satellite data. Based on author's knowledge, there is no article has been published relating to land use and urban growth map in the study area.

STUDY AREA

Pekan is the Royal Town of the State of Pahang Darul Makmur in Malaysia Country. It is located between latitude 2º56 to 3º39′N and longitude 102º46 to 103º28′E in the centre of all Pahang districts and shares a border with Kuantan, Rompin, Maran, and, The South China Sea around Pekan districts area. Pekan is covering an area of approximately 3,805 km^2 with resident population approximately 142,716 people based on the Pekan Districts Council census in 2005 as shown in Table I [4].

Pekan, Pahang consist of 11 sub-districts or mukims there are Pekan, Kuala Pahang, Pahang Tua, Pulau Rusa, Langgar, Ganchong, Temai, Pulau Manis, Lepar, Penyor, and Bebar (Figure 1). There are three main routes from neighboring districts to access Pekan districts. The routes are 46km from Kuantan, 92 km from Rompin and 90km from Muadzam. Pekan is located 300 km from Malaysia capital, Kuala Lumpur, 268 km from Kuala Terengganu, and 278 km from Johor Baharu.

TABLE I. NUMBER OF PEKAN RESIDENT POPULATION BY MUKIMS.

No.	MUKIMS	2005
1	Pekan	41,468
2	KualaPahang	23,165
3	Pahang Tua	13,295
4	Pulau Rusa	693
5	Langgar	5,098
6	Ganchong	1,753
7	Temai	1,366
8	Pulau Manis	1,899
9	Lepar	5,731
10	Penyor	31,166
11	Bebar	17,082
	Total	**142,716**

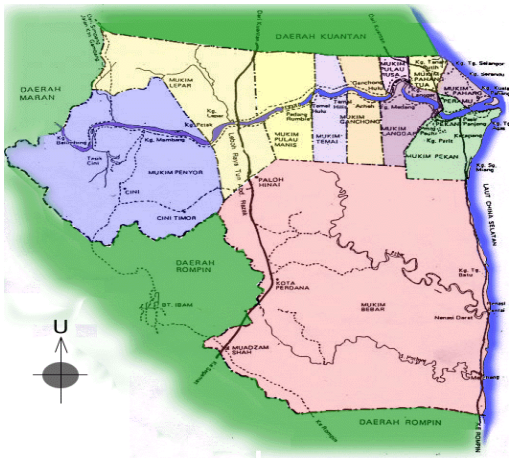

Figure 1: Pekan Land Cover area with the details of all Sub-districts or Mukims [4].

DATA AND METHOD

A. Data

Two Landsat data of study area has been collected was in year 2000 and 2013. The data was downloaded from Earth Explorer on United States Geological Survey (USGS) website. In year 2000, the least cloud cover data was collected on July 8, 2000 from Landsat 7 at path 126 and row 58. However, this data was shielded by 10 percent of clouds. For year 2013, the least cloud cover data was collected from Landsat 8 on April 15, 2013 at path 126 and row 58. This data also was shielded by 10 percent of cloud. However, the quality of the multispectral data was good and the weather was good for the two data acquisition timespans less smog appears in the atmosphere.

The pre-processing methods, such as radiance calibration, atmospheric correction and subset, has been applied to enhance the original satellite. The geo-referencing process was not conducted in this study because co-registration between Landsat 7 (ETM+) and Landsat 8 (OLI) data was satisfactory through overlaying and a visual comparison.

B. Comparison between Landsat 7 data for year 2000 and Landsat 8 data for year 2013

Landsat 8 was launched on February 11, 2013 while the data needs to compare are from year 2000 and year 2013. So, for year 2000 data need to take from Landsat 7 as the best choice after Landsat 8. To provide a more comprehensive assessment of Landsat 8 and Landsat 7 data, the data quality was evaluated through a comparison data using texture information contained in the data, which is a commonly used indicator for image quality [5][6]. The grey-level co-occurrence matrix (GLCM) was used to extract texture features for the data comparison. The GLCM is a matrix of frequencies in which two pixels are separated using a certain vector that occurred in the image. The matrix depends on the angular and distance relationships between pixels [7].

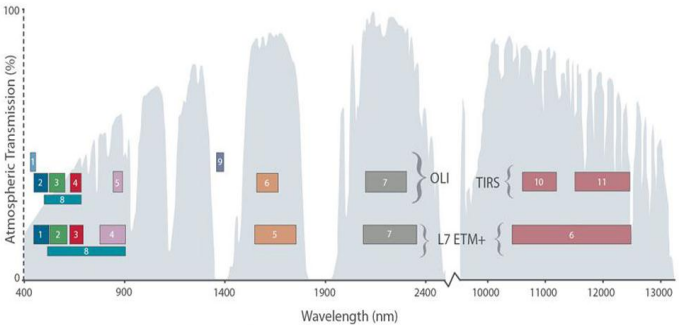

Figure 2: Bandpass wavelengths for Landsat 8 OLI and TIRS sensor, compared to Landsat 7 [8].

C. Land cover classification method

Maximum Likelihood (ML) is a supervised classification method derived from the Bayes theorem. ML has been used in this study to classify the Landsat data into four classification classes of land use (bare land, vegetation, water and urban area).

In order to perform the classification process, the training data has been collected for every classification types. Table II shows the number of the training data (TD) for every classification classes.

TABLE II. NUMBER OF TRAINING DATA (TD) AND PIXELS IN EACH CLASS TYPE USED FOR TRAINING

Class	Bare Land		Vegetation		Water		Urban	
Year	TD	Pixels	TD	Pixels	TD	Pixels	TD	Pixels
2000	42	1200	71	44886	39	27387	18	500
2013	58	3369	74	114129	42	16683	19	220

RESULTS

A. Land cover classification result in Pekan district, Pahang state, Malaysia

The main goal of this study is to detect the bare land, water, urban and vegetation area changes from 2000 to 2013 using multi-temporal satellite data, in order to monitoring the changes. ENVI software has been used for performing the digital image processing and analyzing such as radiometric correction, FLAASH atmospheric, Fmask, classification and enhancement. For image classification, maximum likelihood algorithm was applied to classify the area of interest into five classes including vegetation area, water bodies, urban area, bare land and unknown area which is considered as cloud. In this study Landsat images were used satisfactorily for the identification of area. The pre-processing for this case study start with radiometric correction, after that remove the noise

(Stripped lines) from both of the Landsat images. The next stage was clipping the images to make the processing inside the area of interest in our imageries.

The urban area, bare land area as well as vegetation area has been changed from 2000 to 2013. Urban area has been increased by 15.77% (from 177.33km^2 area to 450.67 km^2 area), however, the vegetation area has been witnessed decreasing nearly 20 percent (from 1504.48km^2 area to 1164.96^2 area) and that reflect that the population of people increased in study area. The result also show the expansion of bare land area around 3.86 percent shows the bare land. Pekan has large of Felda area that help to increase the commercial relationship and increase the population of people means new building and housing area, commercial area should be built to the new people. The results of monitoring change detection analysis are presented in the Table III, and figure 3 shows the thematic maps for each year for land use/land cover that reflect the difference in covered area.

B. Land cover classification accuracy

The classification accuracy and kappa statistics were estimated based on the validation samples and the confusion matrix of the OLI data classification results using the MLC classifiers are shown in Tables 3 and 4, respectively. The overall classification accuracies were all greater than 95%. The overall performance of the year 2000 classifier (overall accuracy 98.53%; kappa coefficient: 0.98) was slightly inferior to the year 2013 classifier (overall accuracy: 99.58%; kappa coefficient: 0.99). The Urban and Bare Land class had the nearly user and producer accuracy and the maximum confusion with the water and vegetation category (Tables IV and V). Other class types all had a better separation with each other and higher user and producer accuracies.

TABLE III. PERCENTAGE OF DIFFERENT PIXEL CLASS COVERAGE IN YEAR 2000 AND 2013

Class / Result	Bare Land	Vegetation	Water	Urban
Year 2000	2.10% (36.48km^2)	86.80% (1504.48km^2)	0.87% (15.01km^2)	10.23% (177.33km^2)
Year 2013	5.97% (103.44km^2)	67.21% (1164.96km^2)	0.82% (14.23km^2)	26.00% (450.67km^2)
Different (%)	+ 3.86	- 19.59	- 0.05	+ 15.77

TABLE IV. CONFUSION MATRIX FOR LAND COVER CLASSIFICATION WITH GROUND TRUTH (PIXELS) COVERAGE IN YEAR 2000

Mapped Class	Ground Truth (Pixels)					User Accuracy (%)
	Bare Land	Vegetation	Water	Urban	Total	
Bare land	1068	0	436	0	1504	66.63
Vegetation	0	44352	14	0	44366	99.97
Water	0	0	26937	0	26937	100.00
Urban	132	534	0	500	1166	42.48
Total	1200	44886	27387	500	73973	
Producer Accuracy (%)	89.00	98.81	98.36	100.00		

TABLE V. CONFUSION MATRIX FOR LAND COVER CLASSIFICATION WITH GROUND TRUTH (PIXELS) COVERAGE IN YEAR 2013

Mapped Class	Ground Truth (Pixels)					User Accuracy (%)
	Bare Land	Vegetation	Water	Urban	Total	
Bare land	2837	0	358	20	3215	87.83
Vegetation	0	113585	15	0	113600	99.99
Water	4	0	16302	0	16306	99.98
Urban	528	544	8	198	1278	15.49
Total	3369	114129	16683	218	134399	
Producer Accuracy (%)	84.21	99.52	97.72	90.00		

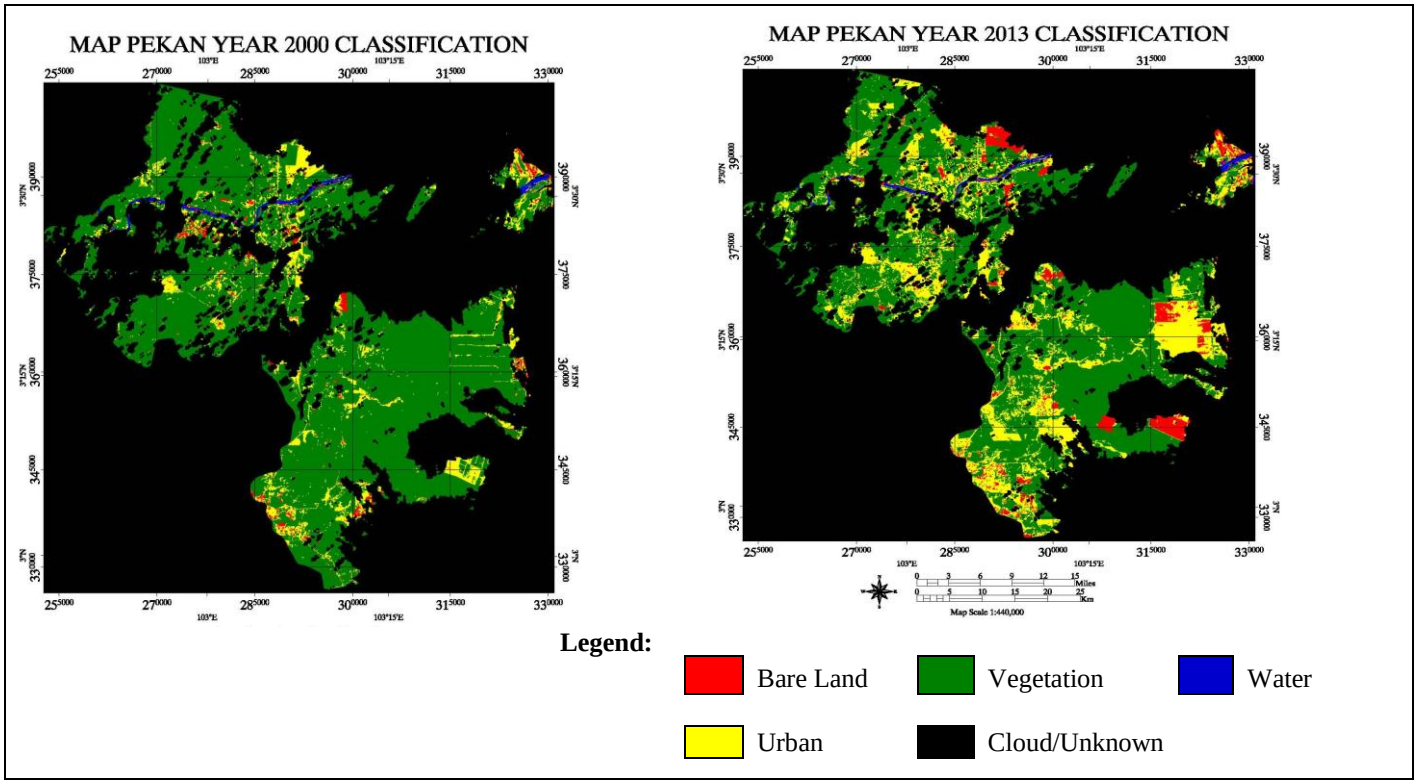

Figure 3: Pekan Land Cover Classification result for Year 2000 (up) and Year 2013 (down) using Maximum Likelihood Classifiers.

TABLE VI. CHANGE DETACTION STATISTICS FOR LAND COVER CLASSIFICATION COVERAGE FROM YEAR 2000 TO YEAR 2013

		Initial States (km^2)				
	Area	**Bare Land**	**Vegetation**	**Water**	**Urban**	**Class Total**
Final State (km^2)	**Bare land**	8.14	69.47	2.36	23.48	103.44
	Vegetation	12.43	1080.25	0.12	72.15	1164.96
	Water	1.25	0.58	12.19	0.22	14.23
	Urban	14.66	354.18	0.34	81.49	450.67
	Class Total	36.48	1504.48	15.01	177.33	0
	Class Changes	28.34	424.23	2.82	95.84	0
	Image Difference	66.96	-339.52	-0.78	273.34	0

C. Land cover Monitoring Change detection

Our analysis indicates that Pekan district in Pahang states, Malaysia country has undergone a transformation or change for several areas between year 2000 and year 2013 as shown in table IV.

Based on our analysis, Pekan area faced lots of urban growth from our review as shown in Figure 4. Approximately in year 2000 the Urban area in Pekan is 177.33km^2 and increase to 450.67km^2 in 2013.

In figure 5 shows the changes for several areas in year 2000 become urban area in year 2013. Majority of urban area in 2013 came from Vegetation area. There are 354.18km^2 of vegetation area in year 2000 transform become urban area. The distribution of vegetation area become urban is shown in green color in figure 5. There are also around 14.66km^2 bare land area (red color in figure 5) change to urban in year 2013.

CONCLUSION

This study attempted to identify such Pekan Land Cover changes between years 2000 and 2013. Remote sensing has the

capability of monitoring such changes, extracting the changes information from satellite data. For this research, we have taken Landsat images at path 126 and row 58 collected from USGS earth explorer website. The land use/land cover maps of the study area are developed by supervised classification of the images. Five classes have been identified as urban, water body, vegetation land, bare land and clouds/unknown. Over all classification accuracy for 2000 and 2013 are 98.53% and 99.58% respectively. Monitoring Change detection analysis shows that urban and bare land areas has been increased by 15.77% and 3.86%, vegetation and water areas has been decreased by 19.59% and 0.05%. Information on land use/land cover and possibilities for their optimal use essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare.

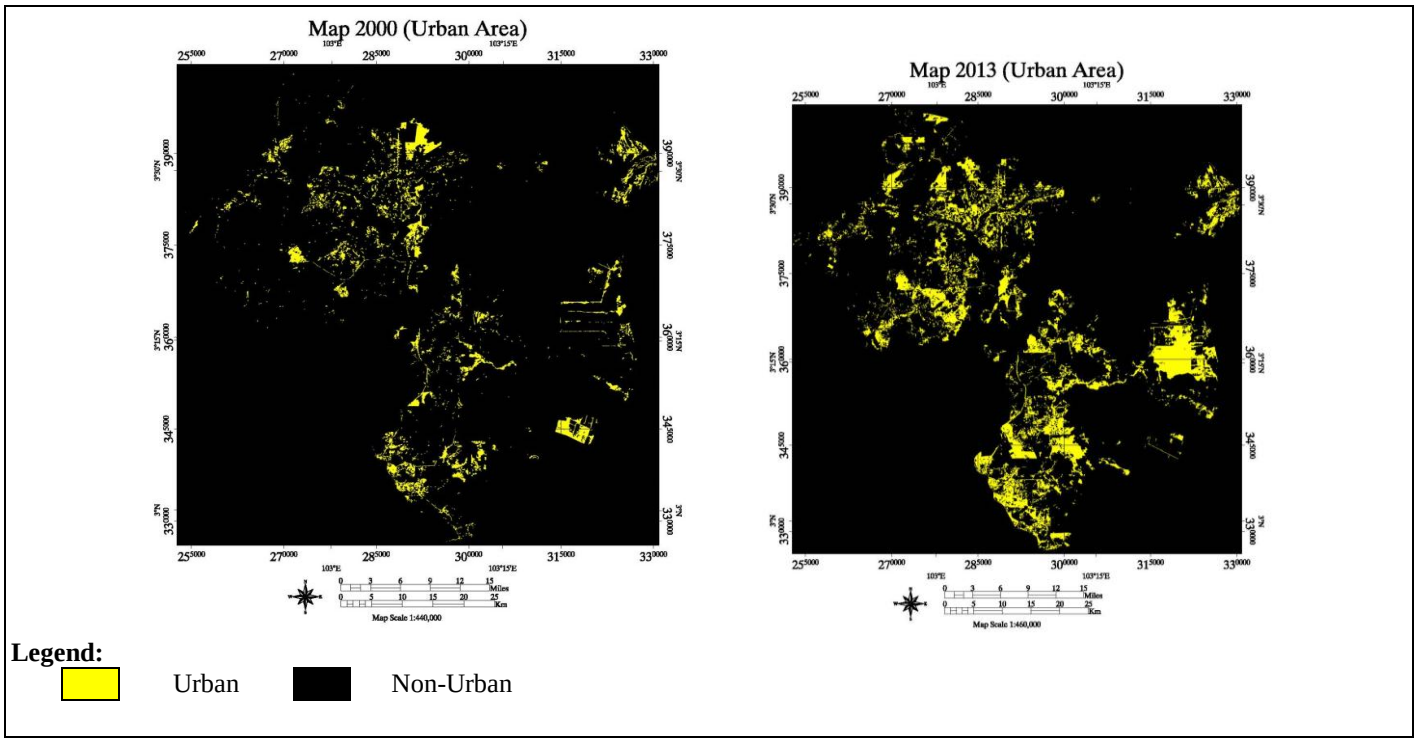

Figure 4: Pekan Urban area for Year 2000 (up) and Year 2013 (down)

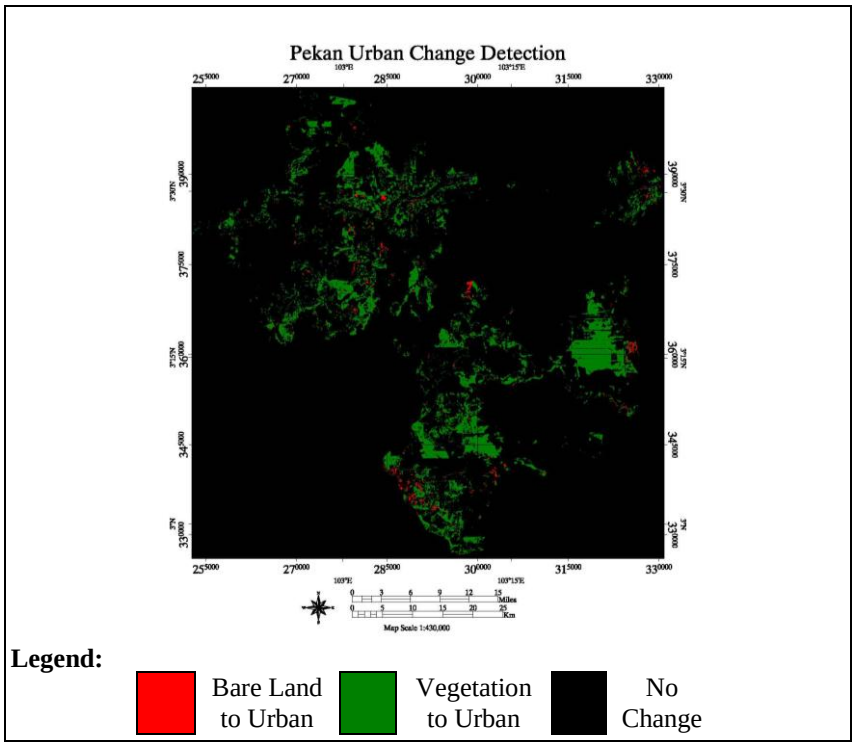

Figure 5: Pekan Change Detection Mapping to for urban area from Year 2000 to Year 2013

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REFERENCES

[1] Sahalu, A. G. (2014). *Analysys of Urban Land Use and Land Cover Changes.* Lisbon, Portugal: Universidade Nova de Lisboa.

[2] Yamaguchi, A. M. (2008). Environ Monit Assess. Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka Metropolitan of Bangladesh during 1960-2005, 237–249.

[3] Ahmad, F. (2012). A review of remote sensing data change detection:Comparison of Faisalabad and Multan Districts,Punjab Province, Pakistan. *Journal of Geography and Regional Planning Vol. 5(9)*, 236-251.

[4] Taburan Penduduk Pekan. (2012, November 24). Retrive April 11, 2015, from Majlis Daerah Pekan: http://www.mdpekan.gov.my/en/web/guest/taburan-penduduk

[5] Gadkari D. 2004. Image quality analysis using GLCM. Orlando (FL): University of Central Florida.

[6] Jiang B, Liang SL, Townshend JR, Dodson ZM. 2013. Assessment of the radiometric performance of Chinese HJ-1 satellite CCD instruments. Ieee Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 6: 840–850.

[7] Haralick RM, Shanmugam K, Dinstein I. 1973. Textural features for image classification. IEEE Transactions on Systems, Man, and Cybernetics. 3: 610–621.

[8] U.S. Department of the Interior. (2013, July 12). Frequently Asked Questions about the Landsat Missions. Retrieved April 14, 2015, from USGS - U.S. Geological Survey: http://landsat.usgs.gov/L8_band_combos.php

[9] Chen J, Zhu XL, Vogelmann JE, Gao F, Jin SM. 2011. A simple and effective method for filling gaps in Landsat ETM+ SLC-off images. Remote Sensing of Environment. 115: 1053–1064.