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Assessing Land Use and Land Cover Change Analysis Using Remote Sensing In Kota Bharu, Kelantan

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Abstract. This study focuses on the analysis of land use change patterns in Kota Bharu as a tool for land planning and development. By doing spatial analysis with Geographical Information System (GIS) and obtaining satellite pictures through remote sensing, a pattern of land use change can be determined. Geometric correction is the initial step in the processing of satellite imagery, followed by subsetting, cloud masking, and supervised classification. Land use maps derived from supervised classification of satellite images and existing land use maps are then converted into shapefile format in ArcGIS software and the accuracy evaluation was performed. In this study, the land use change and urban land expansion index are selected using an algorithm. The overall Kappa Coefficient accuracy evaluation ranges from 80.33% to 87.31%, whilst Cohen Kappa ranges between 0.598 and 0.749. This analysis reveals a decline in forest acreage, an increase in agricultural land, and urbanisation. As a result of the growth and enhancement of infrastructure and utilities in Kota Bharu and the use of these natural resources, the amount of virgin forest and vegetation has shrunk drastically. In year 2005 was the greatest decline in forest area, with a fall of 25.29% from the previous year. According to Pearson Association research, there is a substantial negative correlation between forest and agricultural areas, which indicates that as agricultural land expands, forest reserves diminish. From year 2000 to year 2020, the urban expansion index of Kota Bharu had increased. The study revealed that progressive development in Kota Bharu encourages the sustainable use of forest land when efforts are made to rehabilitate and restore nature, hence creating a land use category in which forest and agriculture coexist.

1. Introduction

Since the launch of land use and land cover (LULC) study, land use became a global scale research program that becomes central to environmental change research. The words LULC are split into two parts that are typically used interchangeably in research [1]. Firstly, the physical surface characteristics of the earth were referred as land cover. This may include the distribution of soil, water, vegetation, and many other features on the land [2]. Next is land use, which is the way humans used their land, usually relates to economic activities run by humans such as urbanization, agriculture, logging, mining activities, oil, and infrastructure development. Earth's surface was including a variety of artificial and natural features such as ecosystems, landforms, human settlement, and engineered constructions. There was undergoing a rapid change on the earth's surface due to many activities [3]. Generally, LULC is related to any surrounding environment and any significant change of LULC can affect the quality of the ecological environment. The administrative, commercial, and financial centre is in Kota Bharu, Kelantan, with the institution's centre in Kubang Kerian and the industrial centre in Pengkalan Chepa [4]. The changes of LULC were basically driven by the increasing pressure of socioeconomic which

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resulted in uncontrolled and unplanned changes of LULC. It is also possible to increase the chances of natural disasters event such as flooding [2]. Destruction of habitat massive exploitation also can destroy natural ecological provided by them and threatening the biodiversity [5].

The uncontrolled and unplanned of LULC changes can lead to negative impact on global environment such as biodiversity destruction, greenhouse gas pollution, soil resource depletion, and global climate change [6]. LULC has performed a significant role in discovering and acquiring the topographic alterations causes which following land deprivation. Additionally, LULC offers crucial data for managing land resources and the development of those resources [7]. LULC detection analysis has been carried out a various of methodologies and techniques. However, by doing the LULC program, up-to-date and accurate information of land cover is important to managing and understanding LULC. Common tools used to monitor and analyse LULC were Remote Sensing (RS) and Geographic Information System (GIS) as it gives high accuracy in giving data and timely spatial data. Remote sensing provides an image that records land situations and updated data which can be used to simulate and analyse the data through a certain method. While managing data by storing, collecting, displaying, and analyse to detect changes commonly the expert was using GIS [1].

Kelantan is commonly hit by the monsoon floods in Malaysia almost every year. At the end of 2014, the big yellow flood event had a significant impact on the local people. Expert fund has been allocated from Malaysia Government to study flood event in Kelantan through the variety of impact assessments and aspects of groundwater quality study. However, LULC future incorporations projections were still rarely found and reported because lack of LULC study and projections for this region [8]. The application of applying LULC change detection for Kelantan can be beneficial to control urbanisation in the state especially for Kota Bharu.

The capital city of Kelantan, to attain economic viability in the manufacturing, business, tourist, and agriculture sectors, Kota Bharu's position as a regional trading centre has been enhanced. In 2016, the population of Kota Bharu was around 1.45 million people, a 12% increase from 2010 due to urban expansion. Through housing projects, the private sector is also fostering physical growth in Kota Bharu. During the urbanisation process, urban green space has been under growing strain, which has a detrimental impact on ecological services, cultural associations, psychological well-being, and the health of city people [4]. The study of LULC may help for better planning of land use on the study area.

2. Materials and Methods

2.1. Study Area

Kelantan, was located in the northeastern part of peninsular Malaysia between latitudes 4°33’ and 6°14’ North, and longitudes 101°19’ and 102°39’ [7]. The study area focused on Kota Bharu, the capital city of Kelantan as shown in Figure 1. This region was picked because of the extensive land exploitation that has occurred due to the focus on creating and advancing cities.

Satellite images data of year 2000, 2005, 2010, 2015 and 2020 was collected from United States Geological Survey (USGS) Earth Explorer. The downloaded image will be modified using image processing techniques such as cloud removal, atmospheric correction, geometric calibration, terrain correction, and others. Maximum Likelihood Classification (MLC) used to set the class in the study area. The change detraction will be run after the results of MLC is accurate enough. If the findings did not meet the expected Kappa coefficient and had lower producer and user accuracy values, the MLC would be repeated.

Figure 1. The study area of Kota Bharu, Kelantan (Source : Geocentric Datum of Malaysia)

2.2. Data Acquisition and Processing
The Landsat data of Kota Bharu was gathered from USGS Earth Explorer website. Multi-temporal analysis of satellite data is useful for change detection only when there is a strong link between spectral variation in the picture and land-cover change. Image-to-image comparisons, like map-to-map comparisons, require that variance caused by variables other than land cover be understood and, when feasible, controlled [9].

The technology of remote sensing looks to be overwhelmed by its own information explosion. To be helpful, this information must be organised and stored in a way that enables for a quick and easy search. An image's information capacity serves as a barometer for storage requirements. Image compression and compression are required for storage. 'Compression' transforms the original image into a simplified one. Compaction techniques encode data in an efficient manner by making use of statistical redundancy in the data [10].

2.3. Image Processing
Image processing is one of the steps in remote sensing. There are many ways in image processing including image restoration, image enhancement, image analysis and noise cancelling. It involves the removal of systematic degradation because of satellite systems. Some of the images have noises that are completely predictable and can be directly deleted. It also can be reduced the effect of noise by properly designed images in processing operations. The enhancement of an image is such operation as increasing selective of delineation, contrast and accentuation of edges with similar alterations [10].

2.4. Accuracy Assessment
When using a classification algorithm to analyse a remotely sensed image, the accuracy of the result is always a concern. The confusion matrix is the most often used approach for determining classification accuracy. For this study, the ground truth data will be obtained by Google Maps. The columns of the confusion matrix will represent data, whereas the rows represent categorised data [11]. In the columns of confusion matrix, there will be the diagonal cell that contains correctly identified pixels number. The sum of number on the diagonal cell can be divided to get overall accuracy (OvAc) as indicated in Equation 1:

$$OvAc = \frac{aA+bB+cC}{N} \tag{1}$$

However, the non-diagonal cell was containing classification errors that need to be assessed for accuracy of class identification. The non-diagonal cell contains two types of errors which is underestimation and

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overestimation. For underestimation error, it has omission error and user accuracy, while overestimation has commission and commission error [11]. Omission error (*Om*) are the fact that a pixel belongs to the class and has been included in another class as follows (Equation 2):

$$Om = \frac{aB+aC}{\sum a} \quad (2)$$

The omitted pixels can be found for the right and left diagonal classes. The sum of the cell will be considered an omission. While the sum will be divided by the total number of class pixels to get an omission error. Then, the user accuracy (*UsAc*) can be obtained as shown in Equation 3:

$$UaAc = \frac{aA}{\sum a} \text{ or } UsAc = 1 - Om \quad (3)$$

Commission error is when the procedure of classification assigns in the pixel in the other class that did not belong to. The pixel can be found in the column above or below the diagonal cells. The sum of these pixels can be defined as commission class. While, if the total of pixel number were divided the sum of with the sum, the commission error (*Com*) which refers to Equation 4 will be obtained and the producer accuracy (PrAc) can be identified as follows:

$$Com = \frac{bA+cA}{\sum A} \quad (4)$$

$$PrAc = \frac{aA}{\sum A} \text{ or } PrAc = 1 - Com \quad (5)$$

Another indicator for accuracy is the Kappa coefficient that measure the classification results compare to values assigned by chance. The values from 0 to1, while if the Kappa is 0, then there is no agreement between the classified image and ground data. If the Kappa coefficient is 1, then the ground data and the classified image were totally identical [11].

3. Results and Discussion

3.1. Image Pre-Processing
Five satellite images were acquired from year 2000, 2005, 2010, 2015 and 2020 are pre-processed through radiometric correction, atmospheric correction and fixing the scanline error on the Landsat 7 product.

3.1.1. Radiometric and Atmospheric Correction
The process of radiometric and atmospheric correction was conducted on the remotely sensed image from the year 2000, 2005, 2010, 2015 and 2020 that were collected from USGS Earth Explorer. Since the ML classification is based on the pixel on the image, this process is essential. It is possible to correct the Landsat collection that was produced by the USGS by rescaling the data to top of atmosphere (TOA) reflectance using radiometric rescaling coefficients that are provided in the metadata file that is delivered along with the product. The quantized and scaled Digital Numbers (DN) that represent the multispectral image data make up the Landsat Collections Level-1 data products. These DNs are also calibrated. With the help of the rescaling coefficients contained in the MTL file, reflective band DNs can be converted to TOA reflectance.

All Landsat 7 images that were collected after May 31, 2003, the date that the Scan Line Corrector (SLC) failed, are referred to as Landsat 7 ETM+ SLC-off data. Although these products are missing some data, they are still useful and maintain the same radiometric and geometric corrections as data collected before the SLC failure. Figure 2 depicted the radiometric and atmospheric correction applied on band 1 Landsat 7 ETM+ year 2000.

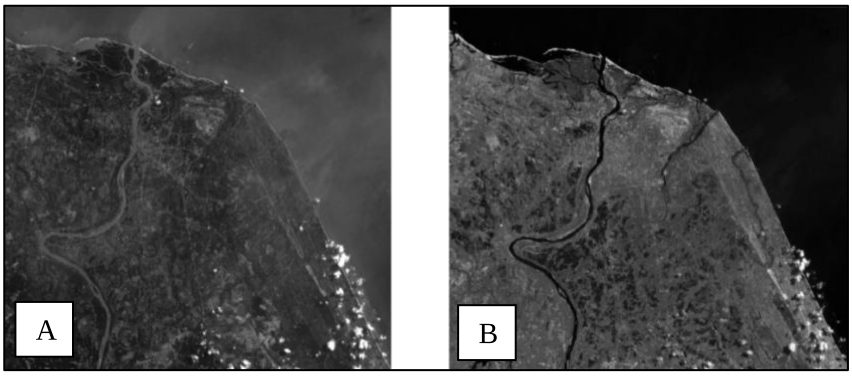

Figure 2. Comparison band 1 Landsat 7 ETM year 2000 before and after correction.

By converting DNs to a ratio of the amount of radiance reflected from a surface to the total incoming amount, surface reflectance can be calculated using atmospheric correction. This allows for comparisons to be made over the course of time. For instance, it takes into account the fact that, all other things being equal, DNs will be lower for the same surface when the solar elevation is lower, DNs will be higher for the same surface when there are more particles in the atmosphere that scatter light back to the sensor before it reaches the ground, and the slightly varying distance between the earth and the sun will be taken into account as well.

3.1.2 Cloud Masking and Image Mosaicking

The process of cloud masking and image mosaicking were conducted on the Landsat to reduce cloud cover in the image of the study area. In this study the maximum value of cloud and cloud shadow were observed and inserted in C Function of Mask (CFMask) algorithm on the template of the raster image. This process needs two or more images. In these cases, two different timelines of Landsat in years 2020, 2010 and 2005 were collected and the maximum value on the cloud pixel were observed. The CFMask function creates the temporary layer which been overlayed by mosaicking using the Blend options as shown in Figure 3.

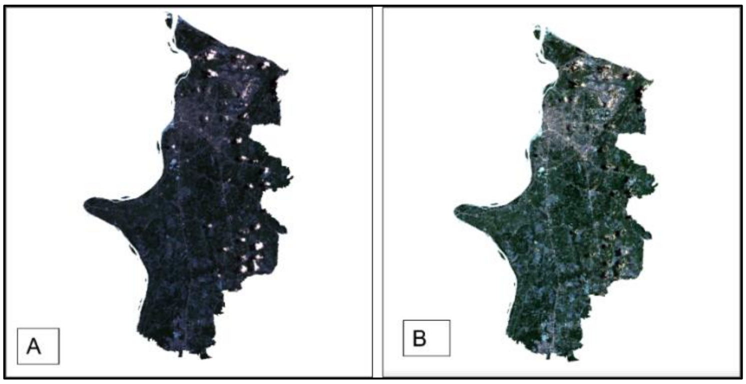

Figure 3. Image of study area before (A) and after (B) remove the cloud.

3.1.3. Scanline Fixing Result

The process of scanline fixing was run by using Landsat Toolbox and the tools fills missing data in Landsat 7 ETM+ as shown in Figure 4 below.

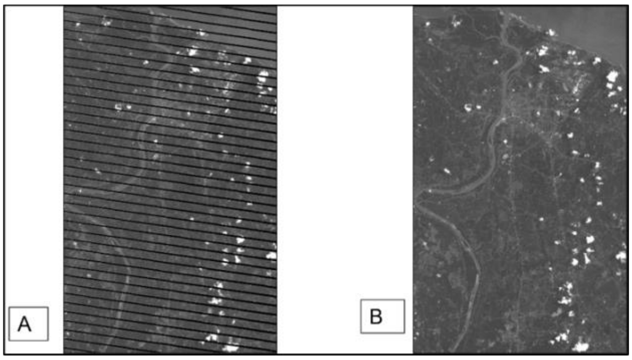

Figure 4. Image of Landsat 7 ETM+ of before(A) and after(B) scanline error fixing.

3.2 Land Use Land Cover of Kota Bharu

A total of five land use maps are produced as shown in Figure 5. These maps are standardized to the scale of 1:250,000 and the data attribute from the GIS database were transferred into Microsoft Excel software for statistical analysis.

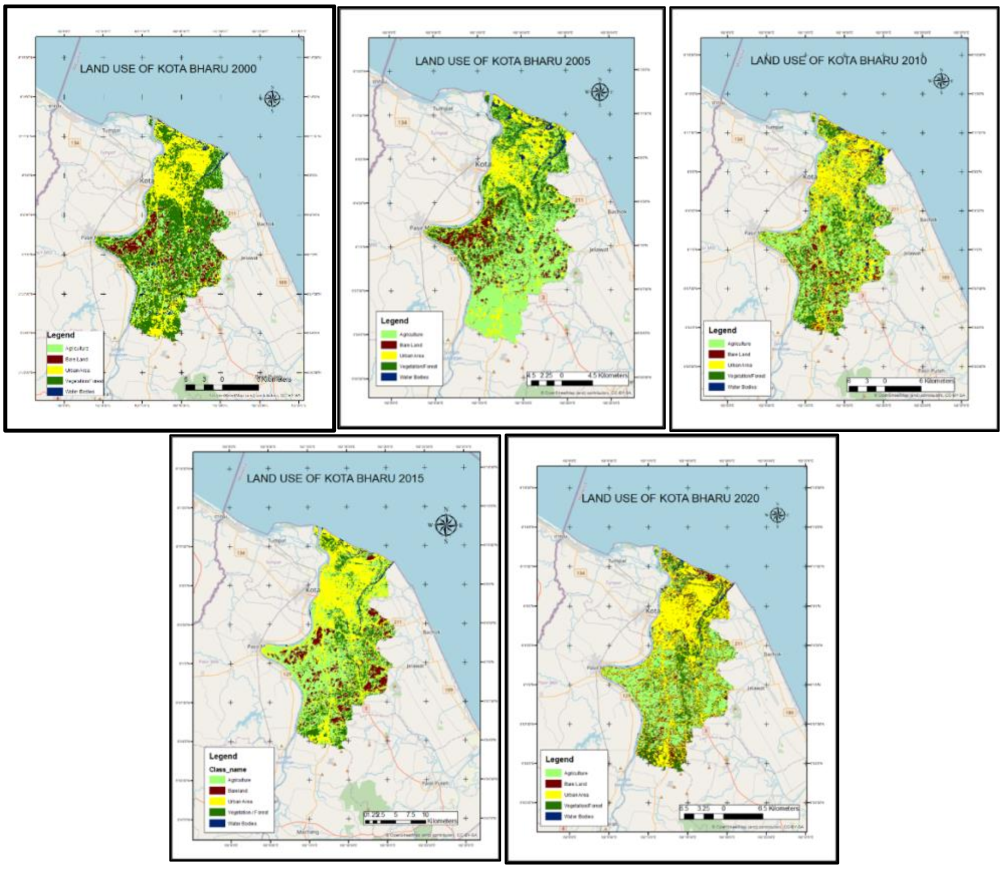

Figure 5. Land Use Map of Kota Bharu 2000, 2005, 2010, 2015 and 2020

The land use map is georeferenced, then digitized based on the shapefile of Kota Bharu and the results of the total area of each land use categories are represented and tabulated in Table 1. The total area of 395 km² Kota Bharu for year 2000 is made up of 163 km² of vegetation or forest area, followed by 109 km² of urban area, 74 km² of agricultural land, 39 km² of bare land and 10 km² of water bodies. In this year, the vegetation and forest area dominating the area in Kota Bharu with the total area of 163 km². However, the lowest area cover in this Kota Bharu was water bodies with only 3%.

Table 1. Result of Land Use Produced (2000, 2005, 2010, 2015 and 2020)

Year	**2000**		**2005**		**2010**		**2015**		**2020**	
	Area (km²)	Percent (%)	Area (km²)	Percent (%)	Area (km²)	Percent (%)	Area (km²)	Percent (%)	Area (km²)	Percent (%)
Agriculture	74	19	184	47	138	35	150	38	133	34
Bare Land	39	10	33	8	43	11	43	11	49	12
Urban Area	109	27	88	22	129	32	138	35	150	38
Vegetation/Forest	163	41	80	20	79	20	60	15	58	15
Water Bodies	10	3	10	3	6	2	4	1	5	1
TOTAL	395	100	395	100	395	100	395	100	395	100

In 2005, Kota Bharu had a total area of 395 km² of which 47 % was agricultural land, 22% was an urban area, 20% was covered in vegetation/forest, 8% was bare land, and 3% as water bodies. It shows that the area of vegetation and forest has been exploited to agriculture land by 25.29% and its made the highest covered area in this year was agriculture land. It is also the highest changes from the year 2000 to 2005.

Kota Bharu's 2010 total area is made up of 35% agricultural land, followed by 32% of the urban area, 20% of vegetation/forest, 11% of bare land, and 2% of water bodies. The highest percentage of change for the year 2005 to 2010 is agriculture land to vegetation with 12.68% but the agriculture land is standing the highest land cover. The urban area has increased by 15% whilst, water bodies has decreased by 0.4%, with 6 km² in 2010 compared to 10 km² in 2005.

In 2015, Kota Bharu has a total area of 395 km², of which 38% is agricultural land, 35% is urban area, 15% is vegetation/forest, 11% is bare land and 1% is water bodies. Agriculture land dominates the remaining other classes by 150 km² area covered. However, the highest changes for this year were urban area with 20.86% of increasing area.

Kota Bharu will have a total area of 395 km² in 2020 with 150 km² were urban area, 133 km² were agriculture, 58 km² were vegetation/forests, 49 km² were bare land, and 5 km² were water bodies. The urban area has increased by 28.57% in this year and it was the highest land cover in Kota Bharu by total of 150 km².

3.3 Accuracy Assessment

The level of precision of the maximum likelihood supervised classification using Error Matrix was assessed in terms of accuracy. This evaluation identifies both the total inaccuracy and the incorrect categorization for each category.

Table 2. Total corrected sample, overall and user accuracy.

	Total Corrected Sample	Overall Accuracy	User Accuracy
Year 2000	40	34	85%
Year 2020	40	36	90%

The total corrected sample (Table 2) is a random point located in the map to depends on the ROI in the classified image of Kota Bharu in the year 2000 and 2020. While overall accuracy is total corrected points with the producer. User Accuracy shows that the classified image on year 2020 has higher score (90%) compared to the classified image on year 2000 (85%). Cohen's Kappa turns out to be 0.598 for 2000 and 0.749 for the year 2020. Accordingly, we would say that the two maps have moderate agreements for year 2000 and for the year 2020 it has substantial level of agreement. Kappa Coefficient as in Table 3 shows 80.33% of accuracy for year 2000 and 87.31% for year 2020. Based on the results obtain in accuracy assessment, there were huge differences of agreement value for 2000 (Landsat 7 ETM+) and 2020 (Landsat 8 OLI).

Table 3. Results of Kappa Coefficient and Cohen Kappa.

	Year 2000	Year 2020
Kappa Coefficient	80.33%	87.31%
Observed agreement	0.85	0.9
Agreement of Chance	0.626	0.6
Cohen Kappa	0.598	0.749

4. Conclusion

Land use in Kota Bharu has changed significantly from year 2000 to year 2020. According to the LULC result, Kota Bharu has remained rich in agriculture areas over these years although the amount had decreased over the years. As other forms of urbanisation have grown throughout time, agricultural land and vegetation have severely reduced. Plantations of highly profitable crops, including paddy fields and oil palms, have continually expanded over time. These changes in land use patterns showed that urbanization and agriculture were the main socioeconomic activities in Kota Bharu. Urban regions in Kota Bharu also commenced developing in year 2000, it is because Kota Bharu is the administrative, commercial and financial centre so the exploitation by the developing city might has affected the changes in land use. The implementation of a new policy called "Developing with Islam" aims to meet public expectations while also safeguarding socioeconomic activity because it is crucial for Kota Bharu and the country.

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