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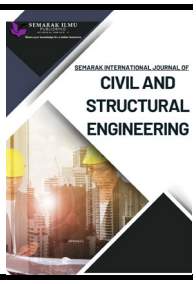

Land Use Land Cover (LULC) Changes Techniques in GIS Application: A Case Study of Sabah, Malaysia

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ABSTRACT

This study focuses on the land use land cover (LULC) changes in Kota Kinabalu city, Sabah Malaysia, in 1990 to 2020. The main objective of this study is: (i) to classify the land use land cover (LULC) in Kota Kinabalu, Sabah; and (ii) to determine the changes of LULC occur in the Kota Kinabalu, Sabah. Four feature classes had been set up namely built up area (BUA), vegetation area (VA), water bodies (WB) and open space area (OSA). Satellite imageries data are obtained from USGS Earth Explorer for Landsat 5 TM for 1990 and Landsat 8 OLI/TIRS for 2020. The integration of GIS and RS are applied to carry out the analysis of LULC. The result indicates significantly positive increase in cover area for BUA and WB, while VA and OSA are decrease. This study through LULC changes techniques proved that increase in population either through local-birth or migration will lead to an expansion of urban development, which indirectly enhance the pollution and develop possibility degradation of environmental health quality. Lastly, this study proves that integration of RS and GIS technologies provide an effective tool for urban planning and management.

1. Introduction

Urbanization can be transformed originally from a land cover of natural surface into modern structural land use surface namely buildings, roads, and 'water-resistant' surface, leading the landscape become more complex and fragmented and impacting to the cities [4]. These modifications have largely resulted in deforestation, biodiversity loss, global warming, and increase of natural disaster such as flooding [2,7,12]. These environmental-related problems are frequently link to the land use land cover (LULC) changes.

Rapid growth of population and increasing in economic value had pressuring the state to enhance in development which indirectly develop highly demand towards the land resources. This unhealthy pressuring had become major booster to the uncontrolled and improper plan of land use land cover [3]. This could happen when the agricultural land, urban land, forest land, and range land are mismanagement to create several of environmental problems such as floods, landslides, etc.

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In change detection technique, the aim is to recognize changes in digital images based on LULC approach that involve with two or more different dates [8]. Many studies had proven that post classification comparison, conventional image differentiation, image regression and digitizing manually using principal component analysis as well as multi-imageries of differentiate date classification, are precise and accurate in determination of the LULC changes in highly develop cities [9,11]. Therefore, the main objective of this study is: (i) to classify the land use land cover (LULC) in Kota Kinabalu, Sabah; and (ii) to determine the changes of LULC occur in the Kota Kinabalu, Sabah.

2. Methodology

2.1 Study Area

Kota Kinabalu, Sabah, are being selected in this study have approximately 351 km^2 coverage area and about 500 421 population located in the city. Kota Kinabalu featured a Tropical Monson climate with high temperature and considerate amount of rain and high humidity throughout the course of the year. Due to high spotted area, Kota Kinabalu becomes main economic value in the state which focuses on the industrial, commercial activities, as well as tourism attraction sector.

2.2 Data and Pre-Processing

Landsat 5 thematic mapper (TM) and Landsat 8 operational land imager (OLI) is employed to carry out the LULC change detection. In other words, both data are obtained from the USGS Earth Explorer for imageries data. In Landsat 5, the image used is year 1990, while Landsat 8 used is year 2020. These images will be processed using ENVI version 4.4. Both images data are having atmospheric correction with cloud coverage less than 10% at the study area [5].

2.3 Image Classification and Accuracy Assessment

In this study, the author had set up four (4) classes, namely built up area, vegetation area, water bodies, and open space area (Table 1). In supervised classification techniques, two dated images were independently classified and compare for the change-detection results. In other words, these methods were carried out using training area and test data for accuracy assessment of Kota Kinabalu as selected study area. Maximum Likelihood algorithm was applied to investigate the change detection for land use land cover (LULC).

Table 1
Land use land cover classification

Category	Description
Built up area (BUA)	Industrial, residential, commercial
Vegetation area (VA)	Forest, agriculture area, green area
Water bodies (WB)	River, lake, sea
Open space area (OSA)	Soil and barren area

3. Results

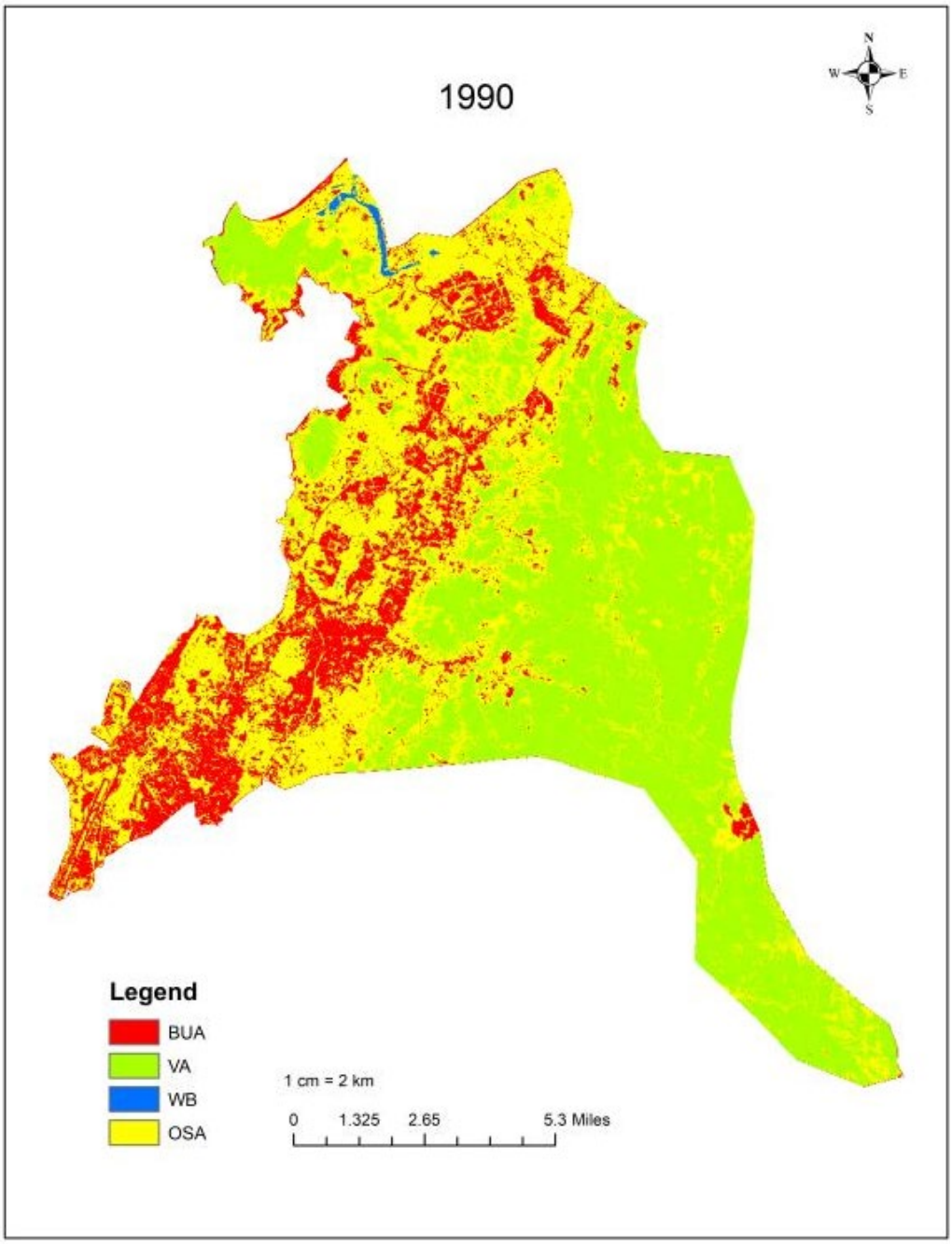
3.1 Land Use Land Cover Classification

Figure 1 indicates the land use land cover classification for BUA, VA, WB and OSA in 1990 and 2020. Based on the Table 2, the result indicates coverage area for BUA is 58467 km^2, follow by VA are 145082 km^2, WB are 1450 km^2, and OSA are 141796 km^2. After 30 years, the only coverage area that

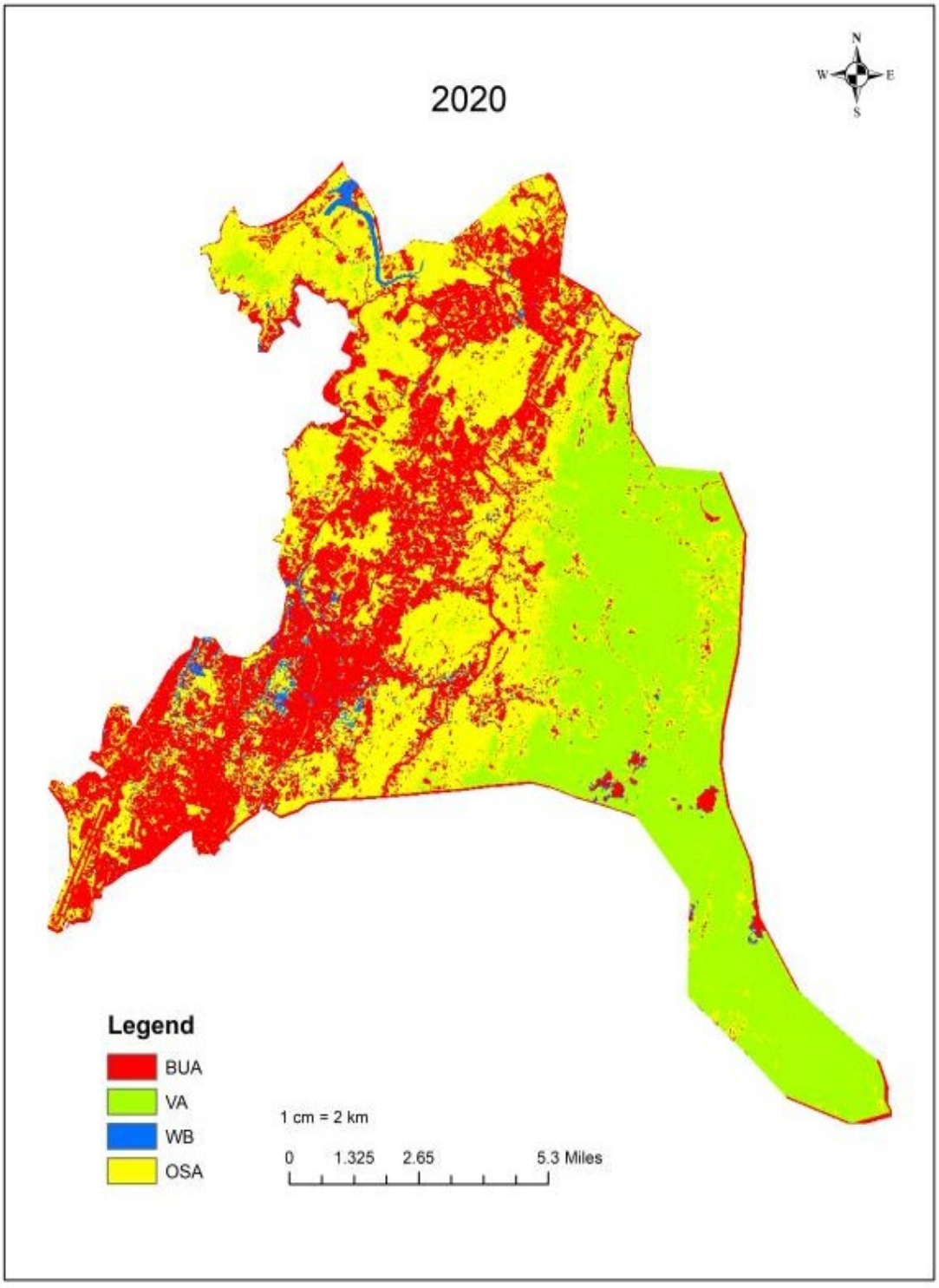
increases is BUA for about 49863 to become 108330 km^2, and WB from 1450 km^2 to become 9786 km^2. Meanwhile, VA are decrease approximately 39240 to resulted as 105842 km^2, as well as OSA decrease about 16379 to provide the outcome of 125417 km^2 (Table 2 and Figure 1).

Table 2
The LULC classification for 1990 and 2020

Category	Frequency (Area in km^2)	
	1990	2020
BUA	58467	108330
VA	145082	105842
WB	1450	9786
OSA	141796	125417



(a)



(b)

Fig. 1. The land use land cover (LULC) classification for (a)1990 and (b) 2020

In other words, majority vegetation area like forest are being converts into open space area due to the activities of deforestation activities, agriculture activities, and mining activities (Table 3 and Figure 2). Due to high demand on land resources, the open space areas are transformed into built up area for urbanization activities. This can be supported with the increment of population from 154000 with 3.36% in 1990 to 500421 with 14.10% in 2020 [1]. The development includes residential activities, industrial activities, commercial activities, transportation activities, etc. Indirectly and

without notice, these circumstances bring various environmental problems including pollution, urban heat island, global warming, and disease spread within the region. Hence, if this situation is not prevented, it will continuously degrade the environmental quality and therefore, cause disasters such as floods, landslides, as well as diseases like 'Covid-19'. LULC approach advantages in developing future sustainable planning and management, and also enable to assist authorities especially in making decision to improve the environmental and ecological conditions.

Table 3
LULC changes in Kota Kinabalu for 1990-2020

Class	LULC changes for 1990-2020 (in percentage, %) Initial State				
	BUA	VA	WB	OSA	Final State
BUA	95.205	8.615	26.056	40.970	170.846
VA	0.652	58.075	12.135	5.281	76.143
WB	0.526	1.076	5.502	4.426	11.53
OSA	3.617	32.234	56.307	49.323	141.481
Total	100	100	100	100	-

Note: Class. = Classification

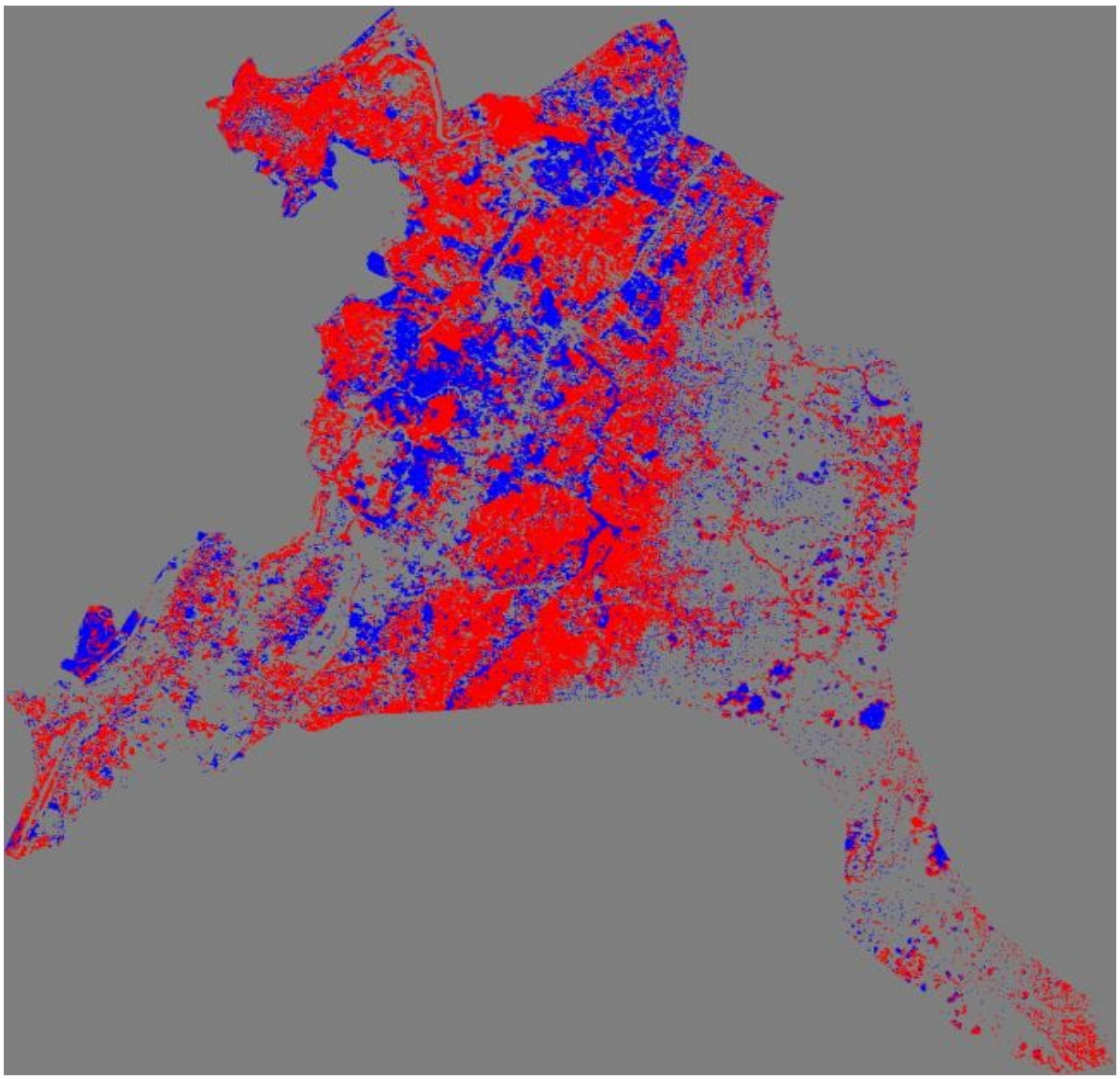


Fig. 2. The land use land cover (LULC) changes in 1990- 2020

4. Conclusions

As a summary, this research study focuses on LULC changes in Kota Kinabalu State, as a case study in Sabah, Malaysia. By applying RS and GIS technology, the results are significantly positive for built up area and water bodies to continuously increase while vegetation area and open space area are continuously decrease. This study through LULC changes techniques proved that increase in population either through local-birth or migration will lead to an expansion of urban development, which indirectly enhance the pollution and develop possibility degradation of environmental health quality [6,10]. Lastly, this study proves that integration of RS and GIS technologies provide an effective tool for urban planning and management.

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