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Research paper

Classification of Land Use/Land Cover Changes Using GIS and Remote Sensing Technique in Lake Kenyir Basin, Terengganu, Malaysia

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Abstract

Geographical information system (GIS) techniques and Remote Sensing (RS) data are fundamental in the study of land use (LU) and land cover (LC) changes and classification. The aim of this study is to map and classify the LU and LC change of Lake Kenyir Basin within 40 years' period (1976 to 2016). Multi-temporal Landsat images used are MSS 1976, 1989, ETM+ 2001 and OLI 8 2016. Supervised Classification on Maximum Likelihood Algorithm method was used in ArcGIS 10.3. The result shows three classes of LU and LC via vegetation, water body and built up area. Vegetation, which is the dominant LC found to be 100%, 88.83%, 86.15%, 81.91% in 1976, 1989, 2001 and 2016 respectively. While water body accounts for 0%, 11.17%, 12.36% and 13.62% in the years 1976, 1989, 2001 and 2016 respectively and built-up area 1.49% and 4.47 in 2001 and 2016 respectively. The predominant LC changes in the study are the water body and vegetation, the earlier increasing rapidly at the expense of the later. Therefore, proper monitoring, policies that integrate conservation of the environment are strongly recommended.

Keywords: *Land use; Land cover; Remote Sensing; GIS; Lake Kenyir Basin.*

1. Introduction

Land use/ land cover changes are, for instance, viewed as the most vital variable of change influencing environmental frameworks. With an effect on the condition that is at any rate as vast as that related to the ecological change [1, 2]. Information on land use/cover changes is essential for proper planning, monitoring and utilisation to meet the increasing demands by the human [3, 4]. Furthermore different society and human cultural behaviour affect the nature and type of land use within the environment. Also, land use/ land cover changes today possess a severe threat to the environment with the rapid population growth such as the climate change, biodiversity reduction and the pollution of air water and soil. Monitoring the consequences and impacts of land use and cover changes in sustainable development has become the principal concern to researchers globally [5-7].
Moreover, coastal managers make use of land cover data and map to appropriately understand the impacts of human use and natural phenomena of the landscape [8, 9]. Maps are useful to managers in model water quality issues, evaluate urban growth, predict and evaluate impacts from storm surges and floods, track wetland losses and possible impacts from sea level rise. Also, prioritise areas for conservation efforts and compare land cover changes with effects in the environment or to connections in socioeconomic changes such as increasing population [10].
Land use/cover is dynamic and delivers an inclusive understanding of the relationship and interaction of anthropogenic activities with the environment [11-13]. However, remote sensing offers a synoptic view and multi-temporal data for land cover mapping and land use. Solicitation of remotely sensed data made potential to study the changes in land cover at low cost, in less time and with better precision [14], in connotation with GIS that offers a suitable platform for data analysis, retrieval and update [15].
The modern technologies like RS and GIS benefit us by giving a quick and cost operative analysis for numerous applications with precision for planning. RS and GIS techniques have opened up an extensive range of avenues for operational land use and land cover mapping. RS data united with field survey data can offer a unique and hybrid database for prime mapping of land use and land cover [16].
Furthermore, with the design of RS and GIS techniques, land use and land cover mapping have given a beneficial and detailed way to recover the selection of areas designed to urban, agricultural, or industrial areas of a region [17, 18]. RS data have been one of the most significant data sources for studies of LC temporal and spatial changes. However, multi-temporal RS datasets, conveniently processed and elaborated, allow mapping and categorizing land-

scape changes, providing a useful effort to maintainable landscape planning and management [19, 20].

2. Material and Methods

2.1. StudyArea

Lake Kenyir Basin or Tasik Kenyir is the largest man-made lake in southeastern Asia. It lies on lat. 05^0 00’ 14’’ N and long. 102^0 38’ 19’’ E. It is located in Hulu Terengganu district, about 50km from Kuala Terengganu, of the 13 states in Malaysia. Kenyir Basin has more than 340 islands spread across the 38,000 hectares covered; it has more than 14 waterfalls. Lake Kenyir Basin is bordered to Kelantan from the west and Pahang in the south; it has 260 km^2 surface areas [21].

In this study, Figure 1 shows the study areas of Lake Kenyir Basin, Terengganu, Malaysia. The climate of Lake Kenyir is tropical rainforest, which is believed to be the world oldest tropical rainforest and part of Malaysia National Park. Lake Kenyir has an average monthly temperature of 23^oC to 31^oC between March to November, while the average temperature falls below in December to February during the monsoon [22]. Furthermore, Lake Kenyir is known as a tourist, and natural environment due to its flora and fauna species also provides freshwater fish of more than 300 species. The lake provides many recreational amenities and natural habitat which attracts tourists from around the globe [23]. Kenyir Dam was constructed in 1985, and provide 400 megawatts of electricity known as "Sultan Mahmud Hydro Electric Power Station".

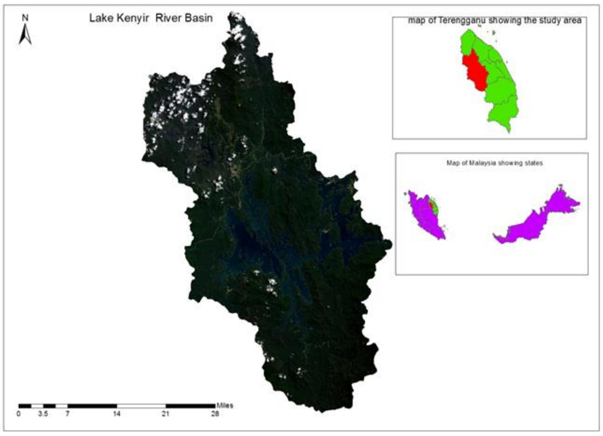

Fig. 1: Map of Lake Kenyir River basin, insert the image of Malaysian state and Terengganu districts showing the area of study

Table 1: Details of data used

YEAR	DATE	SENSOR	PATH	ROW	RESOLUTION In Metres
1976	APRIL 14	MSS	135	057	60
1978	APRIL 14	MSS	136	056	60
1989	MARCH 27	MSS	127	056	60
1989	APRIL 05	MSS	126	057	60
2001	APRIL 21	TM	127	056	30
2001	MAY 21	ETM+	126	057	30
2016	JUNE 26	OLI	126	057	30
2016	JULY 03	OLI	127	056	30

This study used two types of data sets. First RS data inform of Landsat satellite images and Ancillary data which is the ground truth data and field survey that helped to understand the setting of the study area. Landsat images of 1976, 1978, 1989, 2001 and 2016 (see Figure 2 to 5) are used from the USGS Global Visualization (https//glovis.usgs.gov). The images downloaded are as follows, Landsat 2 3, and 4 Multispectral Scanner System (MSS), Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper plus (ETM+) and Landsat OLI (Operational Land Imager). These images were selected because of the free access, low cloud cover, semi-processed to terrain level (TIF), registered and geo-corrected from the source. These data are then imported into ArcGIS 10.3 software for processing.

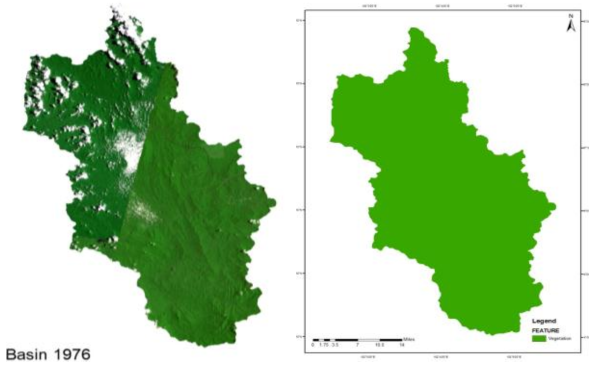

Fig. 2: LULC image of Kenyir Basin 1976

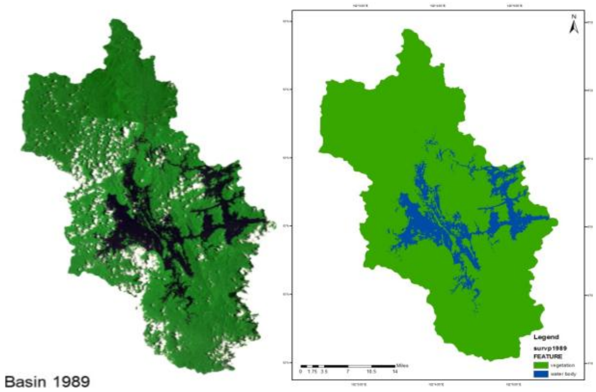

Fig. 3: LULC image of Kenyir Basin 1989

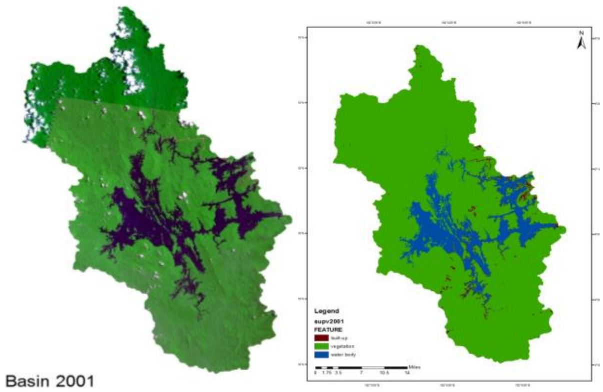

Fig. 4: LULC image of Kenyir Basin 2001

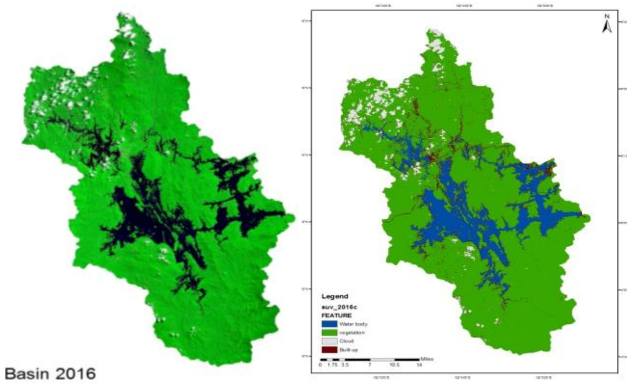

Fig. 5: LULC images of Kenyir Basin 2001

2.2 Image Processing

These involve several procedures because one Landsat images do not cover the whole Kenyir River basin, so, two images are used for each year to extract the area of study (AOS). First, after downloading, the multi-band images were reprojected to the WSG_1984_UTM_48N/47N for the upper and lower part of the AOS. Then the two Landsat images are blend to create a temporary mosaic raster which is clipped to extract the AOS.

2.3. Image Classification

At this stage, Supervised Classification Method was done using Maximum Likelihood Algorithm in ArcGIS. It used the spectral characteristics of the training samples to train the algorithms likely land cover mapping [24]. Three (3) LULC classes were classified via; 1. Vegetation- thick forest, palm plantation, shrubs and small trees, 2. Water Body- clear and unclear water 3. Built-up area- buildings and bare land.

2.4. Accuracy Assessment

These provide the user with more information on where the errors occur; it helps to determine if the classification is ok or to need to be reclassified (Dewan & Yamaguchi, 2009). We use reference points virtually identified from the Landsat image. We selected text pixel evenly across the image and used confusion matrix analysis for the overall accuracy of each Landsat image. Ten times sample is selected of each class for the total number of classes in every Landsat image. The overall accuracy images in the classification were 100% in all the four Landsat images. These were due to few numbers of classes in the Landsat image and the method adopted. These can be expressed mathematically use Equation (1):

$$OA = \sum CP \div \sum TP \times 100 \qquad (1)$$

where OA: Overall Accuracy, CP: Number of Correct Prediction and TP: Number of Total Prediction.

3. Results and Discussion

The results from the supervised classification in maximum likelihood algorithm shows the classified LULC map of Lake Kenyir Basin for years 1976, 1989, 2001 and 2017 (see in Figure 2 to 5). Figure 6 to 9 show the results of LULC of Kenyir Lake Basin for 1976 to 2016. The overall classification accuracy was 100% in all the years. Acceptable classification must attend an accuracy assessment of 90% and above [25]. Numerous researchers have applied the MLC for accurate mapping of LULC classes [8], [26] attend the standard 90% and above accuracy. Only one class of LULC was identified in 1976 which was the forest cover. This forest area is very importation to natural's ecosystem in this basin [27, 28]. This amount to the tune of 2,615 Km^2, i.e. 100% LC class for the year. While 1989, the class water body was identified, as a result of the construction of the Lake Kenyir Basin in 1986 for power generation and distribution within Terengganu and Peninsular Malaysia [23], [29]. In 1989, vegetation-covered 2,323 Km^2 while water body covers 292 Km^2 which translate to 88.83% and 11.17% respectively. By the year 2001, another LULC class was identified, this LU is a Built-up area, which covers 39 Km^2 translating to 1.49%, due to the increase in visitors for recreation [30], reducing the vegetation and to 2,353 Km^2 water body increasing to 323 Km^2 which give 86.15% and 12.36% respectively. By the year 2016 the three identified LULC change by land mass to vegetation 2,142.11Km^2, water body 355.94Km^2 and built-up 116.95 Km^2 which translate to 81.91%, 13.62% and 4.47% respectively. Moreover, in the year 2016 during the analysis, the cloud was classified as a class due to its presence in the Landsat data. Fortunately, it only appeared as a sub cover under the forest; cloud covers 96.72 Km^2 within the forest cover as seen in Figure 5.

Table 2: Area and percentage of change in LULC change in the study area from 1976 to 2016

Years	1976		1989		2001		2016	
	KM^2	In %	KM^2	In %	KM^2	In %	KM^2	In %
Built-up	0	0	0	0	39	1.49	116.95	4.47
Vegetation	2,615	100	2,323	88.83	2,253	86.15	2,142.11	81.91
Water Body	0	0	292	11.17	323	12.36	355.94	13.62
Total	2,615	100	2,615	100	2,615	100	2615	100

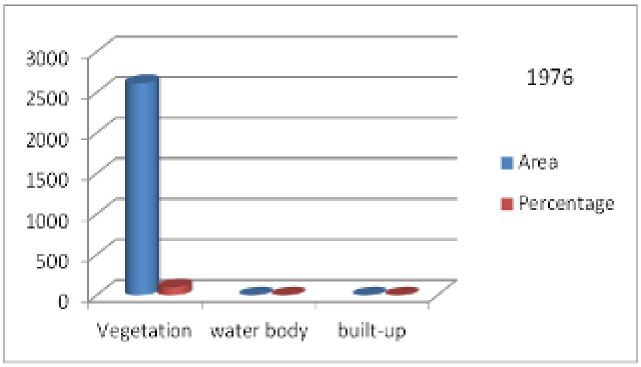

Fig. 6: LULC of Kenyir Lake Basin 1976

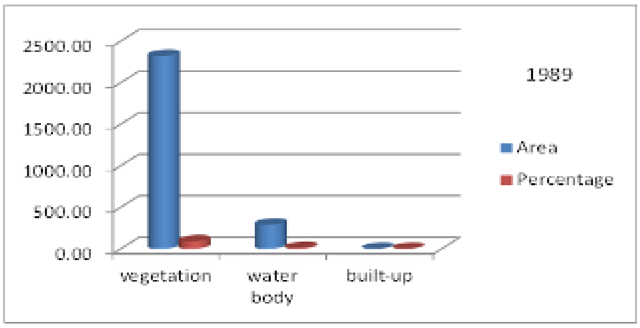

Fig. 7: LULC of Kenyir Lake Basin 1989

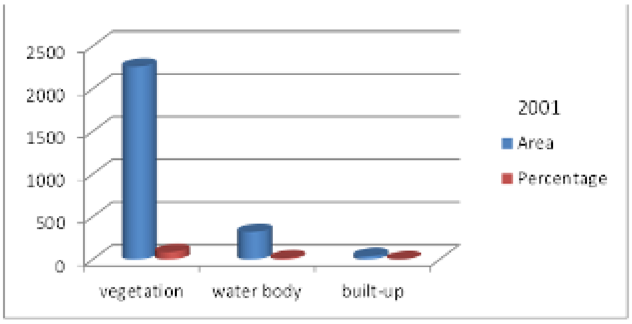

Fig. 8: LULC of Kenyir Lake Basin 2001

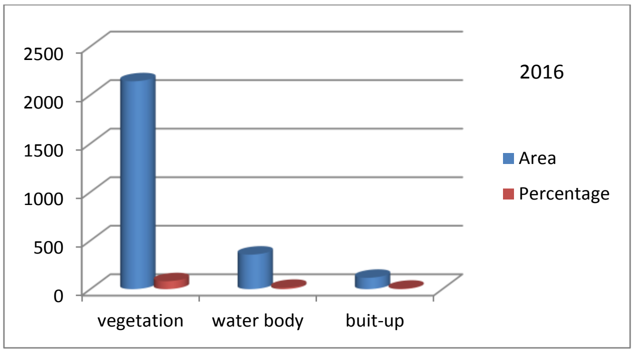

Fig. 9: LULC of Kenyir Lake Basin 2016

4. Conclusion

Conclusively, we can say Kenyir Lake Basin has three LULC classes from 1976 to 2016 which are built-up areas, vegetation and water body. The water body and built-up were observed to be changing in the positive directions, i.e. are increasing while the vegetation cover decreases accordingly. It is also clear that changes within the basin are occurring at a lower rate which is very good for the environment. Furthermo re, RS data and GIS tools provide extensive opportunities to carry out the LULC classification and change studies easily and a lower cost, as this will be difficult using conventional methods. The results of the study will be useful for environmental managers, nature conservation and relevant government agencies in policies and decision making regarding LULC and classification in Kenyir Lake Basin.

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