Determination of Land Cover Changes and Land Use Potential of Lojing, Gua Musang Using GIS and Remote Sensing

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Abstract. A valuable tool for identifying changes in land cover is remote sensing (RS) and geographic information systems (GIS). Increased socioeconomic activity, particularly in agriculture and logging in the Lojing highlands, has led to changes in the land use in Gua Musang. The research area is in Lojing, which is located between latitudes of N 4° 52' 12.52" to N 4° 49' 31.26" and longitudes of E101° 48' 49.62" to E101° 48' 49.62''. This research focused on land cover changes of Lojing which were determined using Landsat 4-5 TM satellite imageries within a time interval of year 2009 and 2019. To ascertain land use changes in the research area and its environs, Maximum Likelihood Classification (MLC) was chosen as the classification technique. Results indicate that the agriculture occupy the greatest area. Over the past ten years, forest area has fallen by 15.555 % while agricultural land has expanded by 9.987 %. In contrast, vegetation has grown by 3.764 %, while the extent of barren land has increased by 2.108 % since 2009. The GIS-based weighted overlay method (WOM) was used to build the land use potential map for the Lojing area to ensure the best possible land use. Due to its topography, geology, and climate, the study area has a high potential for conversion to agricultural land, according to Landsat satellite analysis. As a conclusion, an important data source for research on regional planning is the determination of land use potential by taking the capability of the land and other features into consideration.

1 Introduction

The way people use the land, and its resources is referred to as land use. The study of land cover focuses on the physical or natural status of the Earth's surface. According to [1], land cover refers to the topography, soil, groundwater, surface water, and human structures as well as the biophysical aspects present on the top of the earth and its underneath. It shows that the earth's surface has both natural and man-made coatings. It's not always clear and obvious how land use and land cover are related to one another. All types of land covers may serve a range of purposes, even if a single use for land may need the maintenance of multiple different land covers.

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Land use and land cover (LULC) are among the most important anthropogenic causes of changing the environment on all spatial and temporal dimensions. These changes embrace human populations' greatest environmental concerns today such as global warming, polluted water, diminished biodiversity, soil degradation, and contamination of the air. The LULC has a detrimental effect on the community [2].

For gathering or involving extensive data about the nation's natural resources, remote sensing techniques are particularly helpful. The Malaysian Ministry of Agriculture employed airborne image analysis to map land use in Peninsular Malaysia. With the increasing accessibility of excellent quality photographs from satellites and the development of the country's land management abilities, remote sensing and Geographic Information Systems (GIS) have the power to collect and improve information on natural resources [3].The integration of GIS and remote sensing analytical tools has been demonstrated by [4] as a useful technique for assessing and understanding both the temporal and spatial patterns of land cover changes and providing vital data for development and planning, especially in arid regions.

Remote sensing and GIS systems are among modern technologies that offer an effective technique for monitoring and documenting changes in land use and land coverage [5]. Remote sensing uses several multi-date photos to identify and track LULC changes. Different human behaviours and climatic factors are to blame for the changes in land use and cover. The principal use of satellite images by LULC for remote sensing assists in the detection of change, depending on a satisfactory understanding of the visual system, terrain attributes, and approach applied to achieve the objectives [6]. A remote sensing technique for image processing and classification offers a slightly broad categorization in which the land cover was identified by a single digit. Producing the spectral signature for each type of land cover takes place in this stage [7].

The land use changes in the Lojing area are the main focus of this study. Due to the accelerated growth of agriculture and urban-related activities since the 1990s, Lojing has attracted attention throughout time. Unfortunately, uncontrolled human activity such as settlement, managed forest and pastures had negative effects on the environment, residents, and the ecology in the study area. These could result in a geohazard such mass wasting, debris flow, or landslides. Humans must limit their activities that have a negative impact on the earth in order to stop these geohazards from getting worse.

2 Materials and Methodology

2.1 Study Area

One of Kelantan's largest districts is Gua Musang. Lojing, Gua Musang covered an area of 25,435 hectares (ha) and located in Kelantan's West Province (Figure 1). Lojing's elevations ensure a temperature ranging from 18 ° C to 25 ° C [8]. Most residents of the Lojing region come from one of the Orang Asli tribes, primarily the Temiar tribe of the Senoi nations.

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Fig.1. Gua Musang, Kelantan, Malaysia (Maps of Malaysia, 2016)

2.2 Determination of Land Cover Changes

Landsat 5 Thematic Mapper (TM) taken on January 21st, year 2009 (path 127, row 057) and August 29th year 2019 (path 127, row 057) were used to determine land cover changes in Lojing, Gua Musang, and surrounding areas. Their characteristics are shown in Table 1.

Table 1. Characteristics of TM Landsat satellite imageries

Technical properties	**Year 2009 & 2019**
Source	USGS
Spatial Resolution	30 meter
Radiometric Resolution	8 bit
Projection	UTM
Datum	WGS84

2.2.1 Image Processing

A popular package of software called Environment for Visualising Image (ENVI) is used to study and investigate the geographic data. Each photo would be supplied in a format of seven distinct bands and as a whole frame, correcting image attributes as per LANDSAT TM. Using ENVI (version 5.1) software, data and information content of satellite imageries for both years were visualized. The study area covering approximately 25km^2 was extracted as a subset from the Landsat images. The subset was shown in the Figure 2 (a) & (b). While radiometric correction was used to rectify any anomalous sensor response over the image,

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geometric correction was used to correct geometric distortion brought on by the Earth's rotation and other imaging conditions such as oblique viewing [9].

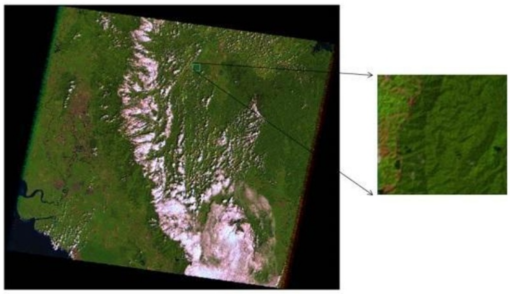

Fig. 2(a). Subset of 2009

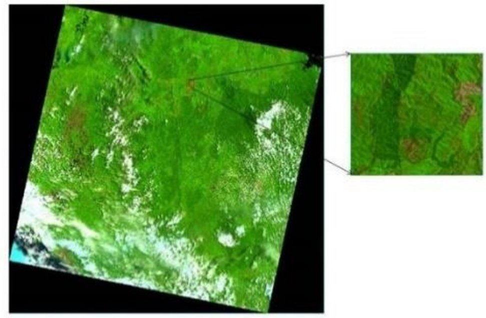

Fig. 2(b). Subset of 2019

2.2.2 Image Enhancement and Classification

Unsupervised recognised photos, false tone materials, and fields were used to acquire training data and testing for the picture classification and accuracy assessment. Red = 7, Green = 3, and Blue = 2 bands were used to create false colours for both Landsat images. It was easier to understand how to distinguish between the objects from the false-color composite image [10]. The false-color image of 2009 and 2019 is displayed in Figure 3.

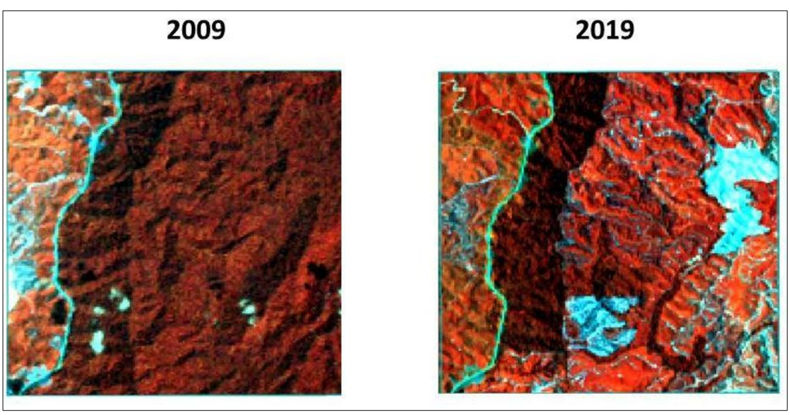

Fig. 3. False color of Landsat image of 2009 and 2019

The next conversion technique used to transform the initial image data into thematic data is image categorization. Image classifications are a valuable technique for gathering subject-matter data because they locate and measure specific segments of the electromagnetic field band that are diffusing or reflecting from the topography of the earth and preserve these data points into bands of spectrum [11].

To classify land cover using the Maximum Likelihood Classification (MLC) approach under supervised classification, the datasets from Landsat TM satellite imageries were imported into ENVI 5.1. Thus, ENVI 5.1 Software was used to create the land use maps for

2009 and 2019. Additionally, the data and statistics were forecasted using the similar software. Both unsupervised and supervised classification, which assigns land cover classifications to individual pixels, were used. Each class in supervised classification is determined based on how closely it resembles another class in the training set using the spectral signature defined in the training set. The training sets were divided into four groups: vegetation, agriculture, barren land, and forests. Utilising this classification, the land cover maps for 2009 and 2019 were created.

2.3 Determination of Land Use Potential

GIS technique was proved to perform relatively well for the integration of topographic maps, numerical soil maps, and digital geological maps in order to create the usage potential map for the research region. When employing the map overlay approach during the experiments, all numerical data was projected as UTM and the datum as ED50 since all numerical data requires a consistent projection and datum variable. The natural factors of thematic maps produced by the Multicriteria Decision Analysis Module of ArcGIS software, their sub-units, and the values corresponding to those units were employed, and reclassification was applied. The land use potential map was created using the Weighted Overlay Method (WOM), which evaluates inputs with various values or unit types to conduct an integrated analysis.

3 Results and Discussion

3.1 Land Cover Changes

Using the weighted overlay method, the land cover identified by Maximum Likelihood classification was transformed to create a map of land cover changes between 2009 and 2019. The land cover map for 2009 and 2019 is shown in Figure 4. Table 2 shows changes in land use from the years 2009 to 2019.

The agricultural land in the Lojing area was used as cultivated land and cropland for an agriculture plantation, as evidenced by the changes in the land cover. The region that is most appropriate for agricultural land can be found to the east of the study area. The agricultural area includes cropland, cultivated land, rubber tree plantations, and palm oil plantations.

Table 2. Statistics of land use changes of the study area from 2009 to 2019

Categories	2009		2019		Variation (km^2)
	km^2	%	km^2	%	
Forest	20.924	81.903	5.369	20.770	-15.555
Agriculture	1.729	6.767	11.716	45.321	9.987
Vegetation	2.318	9.075	6.082	23. 527	3.764
Barren land	0.576	2.255	2.684	10.382	2.108

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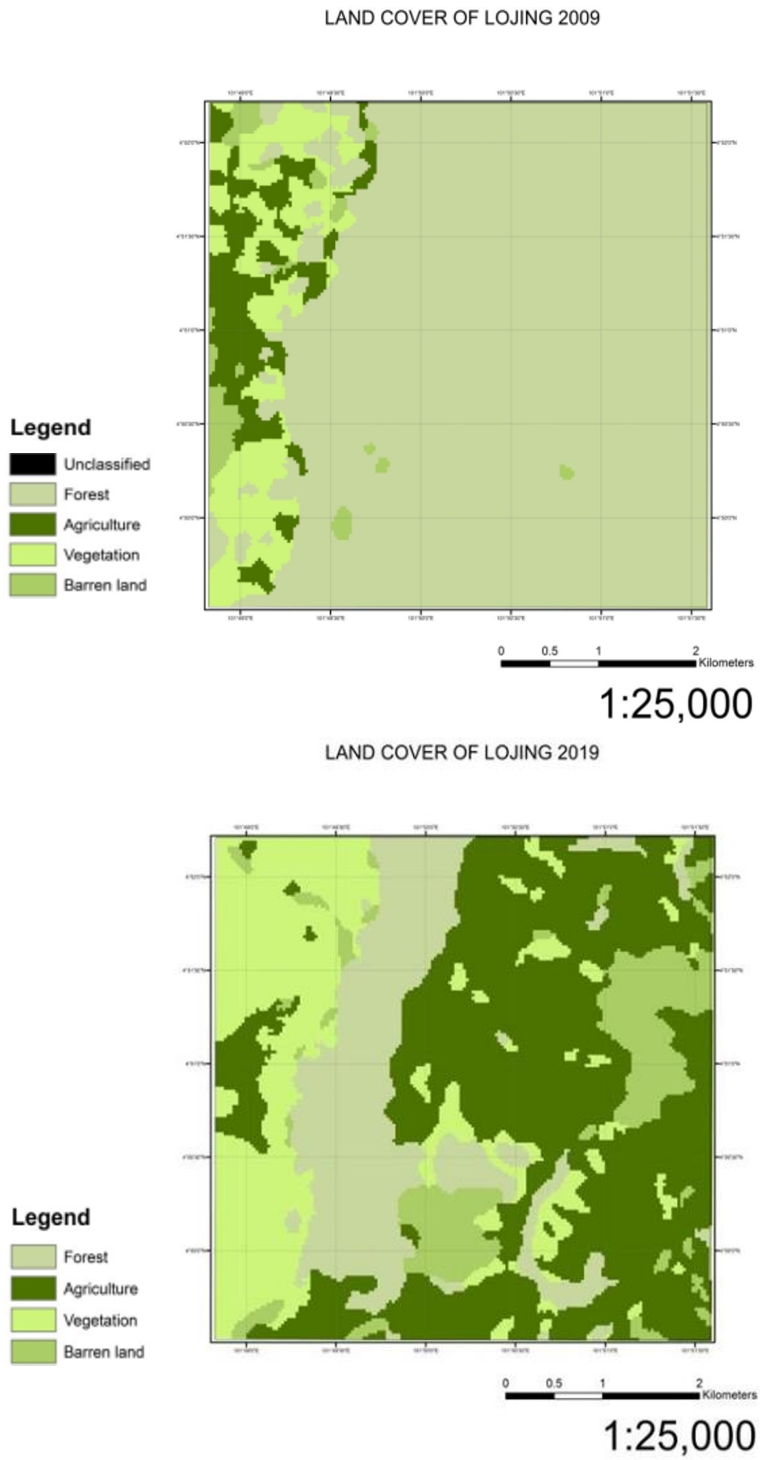

Fig. 4. Land Cover Changes of Lojing within 10 years interval a) 2009 and b)2019

Based on land cover changes in Table 2, agriculture land increased about 9.987 %. Due to a rise in socioeconomic activities, including forestry and agriculture in the Lojing highlands, Lojing has experienced changes in its land use. Vegetation shows the same positive trends where it increases to 23.527 % in the year 2019 compared to 9.075 % in the year 2009. It is supported by findings from [12] where after ten years, there were changes in the forests that were turned into agricultural land in Gua Musang and Lojing district (2004 – 2014). The area shows a significant decrease in forest cover of 15.555%. Deforestation activity provided cultivated areas for the agriculture plantation, and it would have some impact on the Lojing ecosystem. Deforestation caused soil erosion, which had a negative impact on the rivers within the Lojing area. In the meantime, the barren land has grown by around 10.382 %. Deforestation operations in the study area also contributed to the barren land. Works by [13] have revealed that the chronological rate and spatial extent of forest degradation in Gua Musang are likely to have been significantly impacted by timber exploitation, agricultural land expansion, urban growth, and inadequate governance systems.

3.2 Land Use Potential

According to [3], the northern portion of the Gua Musang district experienced rapid land use change, with roughly 36% of the changes being linked to the conversion of shrub, oil palm, and rubber land uses. Land use potential map of Lojing, Gua Musang (Figure 5), will have a higher potential to become agricultural rather than forest area. About 57.91% of the study area's land was used for agriculture.

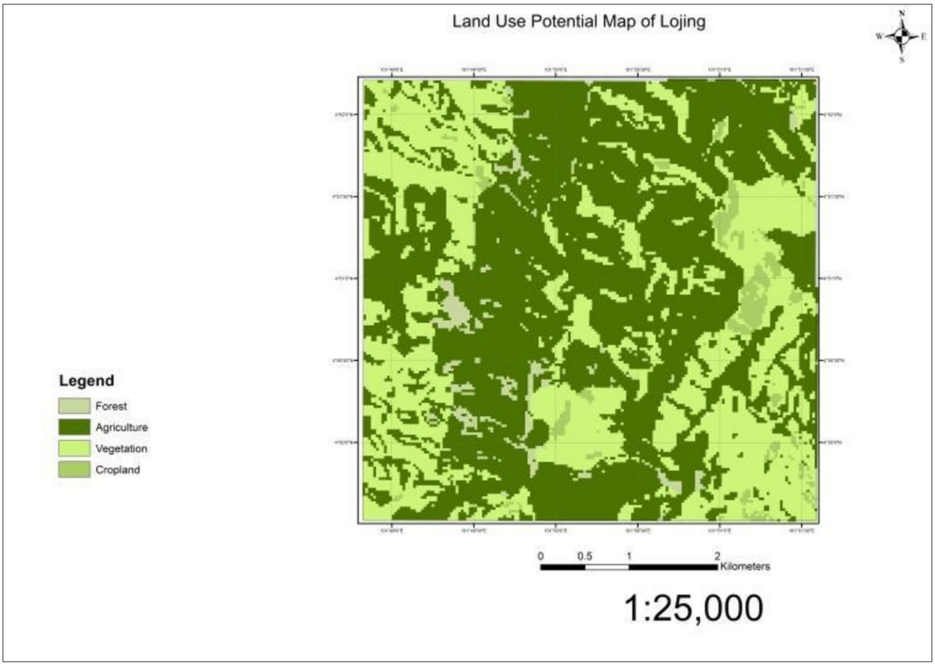

Fig. 5. Land use Potential of Lojing, Gua Musang

4 Conclusion

The land use changes in Lojing were discovered utilizing the remote sensing analysis and the ISODATA classification and Maximum Likelihood Classification (MLC) techniques. The research area's agricultural areas are seen to occupy the largest area based on the findings. With the use of the reference table and the land cover map, it is possible to see that, over the past ten years, the forest in the Lojing area has fallen by about 15.555%, whilst agriculture has expanded significantly by 9.9873% and vegetation inside the study area has increased by 3.764%. Other than that, over the past ten years, the area of bare land has marginally expanded by 2.108%. The Lojing land use potential map was successfully created using both Envi 5.1 and the weighted overlay method. According to the findings of the land use potential analysis, the study area and its surroundings have a significant chance of becoming agricultural land.

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