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Socio-Economic Impacts of Land Use Changes in Lojing Highlands, Kelantan

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Abstract

The growth trajectory necessitates modifying extensive land use patterns, mainly by converting forests for alternative purposes such as large-scale agricultural farms, eco-tourism ventures, oil palm plantations, plantation forests, and urban expansion. In recent years, there has been a notable rise in the demand for agricultural products and flower cultivation in Lojing Highlands, making it a significant contributor to the country's export market. This surge in demand has positioned Lojing Highlands as a prominent region for the production and sale of these commodities, second only to Cameron Highlands. The allocation of land concessions to private entities and government-affiliated corporations has exerted significant strain on the indigenous group. The Temiar populations residing in the Lojing Highlands, whose livelihoods are reliant on the forest, have encountered significant obstacles as a result of alterations in land utilisation. The results of the study show that there was a land use change in the study area between the years 2009, 2014, and 2019. The overall accuracy of supervised classification images in 2009, 2014, and 2019 was 80.00 per cent, 86.63 per cent and 97.75 per cent, respectively. Based on respondents, the most significant causes of deforestation in the study area are accessibility factors, land use factors, government policy management factors, human factors, ecology and finally, population and socio-economic factors.

Keywords: Lojing Highlands, Temiar, Land Use Change, Deforestation

Introduction

Asia's rainforests are distinguished by their presence in the tropical regions of the continent, where year-round warmth and humidity are the norm. The tropical woods of Asia are home to a diverse range of unique plant and animal species, demonstrating an impressive degree of biodiversity. According to Jinfeng et al (2020), tropical forests can be found throughout Asia in places like Indonesia, Malaysia, Thailand, Myanmar, Laos, Cambodia, Papua New Guinea, and the Philippines.

Malaysia was identified by the Food and Agriculture Organization (FAO) as one of the countries that experienced severe deforestation between 1990 and 2020. According to the

report, Malaysia reduced its forest cover by 8.6%, equivalent to about 1.92 million hectares, from 1990 to 2010. As noted in the report, Malaysia experienced a net annual loss of 96,000 hectares of forest, or 0.43%, during the specific period (FAO, 2020). The main factors contributing to deforestation in Malaysia include logging activities, agricultural activities, mining activities, urban expansion, and the effects of climate change. The activities mentioned above have led to the depletion and degradation of many natural habitats, including lowland tropical rainforests, montane tropical rainforests, and mangroves. Deforestation in Malaysia has disastrous consequences for both ecosystems and human populations.

Kelantan is a state in Malaysia that has experienced a high rate of forest loss in the past decades. The exact amount of forest loss in Kelantan is challenging, as different sources may use other methods and definitions to measure forest cover and change. However, based on some estimates, Kelantan lost between 200,000 and 300,000 hectares of forest between 2000 and 2020 (Forestry Department of Peninsular Malaysia Report, 2021).

Land use and land cover change (LULC) is a topic of great interest and importance in environmental science. The status and function of LULC are complex and multifaceted, requiring an in-depth understanding of the various factors that contribute to this phenomenon. The concept of physiological cover and land use is concerned with regulating the physiological cover of a given land area and its use for specific purposes. Many biophysical phenomena that impact terrestrial ecosystems depend on land cover and the changes that occur there (Lang Wang et al., 2020). As various economic, social, and biophysical factors change, a corresponding change in land use and land cover will occur (Melissa et al., 2020). Changes in land cover due to land use can have many consequences. As a result, obstacles arise in advancing the goals of the global transition community, including the ability to predict changes in land use and land cover (LULC) (Varma et al., 2021).

The relationship between socio-economic factors and deforestation is characterised by its complexity and diversity. Although poverty is often cited as an important catalyst for deforestation, it is essential to acknowledge that many variables, such as population growth, urbanisation, and economic development, may also contribute to this phenomenon. Produce more food, have more resources, and grow the economy thanks to changing land uses. For example, converting forest areas into agricultural land can increase local food supplies and generate economic benefits. Similarly, converting natural grasslands into urban centres can meet the housing and infrastructure needs of a growing population (Wang et al., 2021).

In addition, the highlands are of considerable importance as an agricultural region, especially for growing fruit, vegetables and flowers. However, it should be noted that the Malaysian highlands have considerable environmental and ecological sensitivity. The region has high mountain ranges, intense impacts, unique native flora and fauna, and a culturally heterogeneous population. The main point of contact between the colder highlands is the colder highlands themselves and the lowland terrain. The Lojing Highlands regions have experienced negative environmental changes due to rapid growth and ineffective management strategies. Several notable transformations have occurred, including land use conversion from forest to urban and agricultural land, climate change, urbanisation and increased natural disasters.

Hence, the present study examined the effects of land use alteration in the Lojing Highlands region, specifically focusing on its implications for the local community, particularly the indigenous tribes, predominantly the Temiar. Shifting farming plays a crucial role in the traditional lifestyle of a minority group known as the Orang Asli tribes.

The individuals reside in houses that exhibit characteristics of semi-permanent and engage in agricultural activities that can be described as primitive at minimum. The indigenous communities residing in outlying and secluded locations have been affected by the influence of development and capitalist infiltration in their surroundings. The endeavours made by individuals are contributing to a gradual transition from traditional methods of sustaining livelihoods to the adoption of semi-intensive land utilisation practises.

The integration of cash transactions has emerged as a notable characteristic within the agricultural practices of indigenous populations residing in the remote Lojing Highlands. Efforts in the development direction necessitate the alteration of large-scale land use (LULC), namely the conversion of forests to alternative purposes such as oil palm plantations, vegetable farming, expansive plantations, and the establishment of new small towns for tourists. The proximity of Lojing Highlands to Cameron Highlands contributes to the region's reputation as a flourishing hub for vegetable cultivation. Tourists can observe the cultivation of fresh agricultural products in the presence of picturesque mountains and large-scale plantations.

Literature Review

Land use and land cover change (LULC) is a broad concept that includes changes caused by human activities on the land surface. These changes result from direct and indirect human activities to secure vital resources. Therefore, it is imperative to analyse these changes in the territory to optimise the management of natural resources and improve the general well-being of the local population.

Emmanuel et al (2021) suggested that Atwima Nwabiagya District is experiencing significant changes in LULC due to increasing population migration from Kumasi metropolis and surrounding areas, as well as urbanisation. The increasing demand for land, especially in forested areas, has put significant pressure on land cover. As a result, the socio-economic activities of the surrounding area are affected. Seven land use and land cover types (LULC) were found in the study area. These classes include open land, closed forest, cultivated land, open forest, savannah, human settlements, and water. Overall, the main variables contributing to land use and land cover change (LULCC) in the Atwima Nwabiagya district are characterised by settlement establishment driven by population growth, economic activity and a porous land ownership system.

LULC modifications, including the conversion of grasslands to croplands, the practice of fallowing croplands, and the transformation of unproductive croplands into oil palm plantations, are being implemented as mitigative strategies to address the adverse effects of soil fertility decline. In regions with significant agricultural productivity, there is a notable trend of rapid expansion of oil palm and rubber plantations, encroaching upon fertile croplands and ecologically valuable forests.

The motivation behind the spread of plantation crops is driven by the need for economic gains to improve livelihoods, often resulting in the conversion of agricultural fields and natural forest areas. Moreover, the escalating urban consumption of palm oil and its utilisation for biomass energy generation, coupled with the recent surge in global rubber latex prices, have intensified the conversion of existing natural forests, marshes, and marginal lands into extensive plantations. The significance of land use change is increasing due to the escalating occurrence of land conversion practices in various country regions (Hua et al., 2018).

Changes in LULC, whether due to natural or anthropogenic factors, have a significant influence on global and regional patterns, which in turn influence weather and climate

conditions. Devi et al (2018) conducted a study to examine the impact of climate change on the LULC models of Kanha Tiger Reserve (KTR). The reason for choosing KTR as a research location is based on the goal of examining the impact of climate change on LULC. KTR offers the advantage of having largely intact forest areas, allowing any observed changes in LULC to be attributed solely to the effects of climate change. The change study illustrated changes in the LULC model using multi-temporal satellite data over a specified period. The identified changes in different LULC land use and land cover types significantly impact the livelihoods of forest-dependent people.

The concept of assuming responsibility for one's actions and the issue of encroachment on state land is further intensified by the prevailing inheritance practises and the concurrent population growth. In South Asia, it is a prevalent custom among familial successors to partition landholding into equal sections of differing quality. The prevalence of land fragmentation is attributed to a long-standing tradition of dividing high-quality and low-quality land among family members after division. This technique has persisted for centuries. The issues of migration and the acquisition of state land are further intensified by the continuation of traditional practices and the absence of adequate social infrastructure in rural regions, as well as limited job prospects in urban areas (Tolentino et al., 2020).

Bodo et al (2021) conducted a study identifying agricultural activities and urbanisation as the primary factors contributing to human-induced deforestation and habitat loss of significant magnitude. A practical and feasible strategy for mitigating the increasingly concerning consequences of deforestation and habitat loss is the widespread implementation of environmental education throughout the global population. Environmental education is pivotal in mitigating ongoing and intentional anthropogenic activities by safeguarding existing natural forests and implementing afforestation initiatives when required.

According to the Food and Agriculture Organisation (FAO, 2020), over 90% of deforestation worldwide is attributed to agricultural expansion. Every day, farmers and loggers globally unambiguous forested lands spanning more than 50,000 acres, while the Amazon Basin alone experiences the destruction of an area comparable to almost 10,000 football fields daily. The ongoing and persistent degradation of forest ecosystems poses a significant danger to biodiversity, resulting in a decline in species richness and abundance.

Runyan et al (2020) argued that agricultural practices, mainly those implemented in developing nations, contribute to the escalation of deforestation and the subsequent loss of habitats. The practice of bush burning is commonly utilised in Nigeria as a means of clearing indigenous forests for agricultural activities.

Cattle ranching is a notable illustration of regional disparities in driving forces, as it has been recognised as a significant factor contributing to deforestation in the Amazon region while exerting a minimal impact on deforestation in Southeast Asian countries. In contrast, it is well acknowledged that the loss of forests in Southeast Asian countries like Indonesia and Malaysia can be attributed to coastal development and agricultural growth, particularly the cultivation of oil palm (Uning et al., 2020).

Pfeifer et al (2016) reported that a significant proportion of the tropical forests in Malaysian Borneo, around 80 per cent, had experienced substantial degradation due to logging activities associated with road and transit construction, as well as the extraction of timber and oil palm. The main drivers of deforestation in Peninsular Malaysia encompassed various activities, including commercial logging, infrastructure development, urbanisation, large-scale commercial agriculture plantations (specifically oil palm and rubber), the conversion of forested areas to alternative land uses such as oil palm and other industrial tree

plantations, the expansion of agribusiness, the construction of large dams, and mining operations. The fundamental elements encompass population drivers, socio-economic drivers, and legal policy and administration at the national and state levels.

Adnan et al (2021) argued that a significant portion of Malaysia's high area, spanning around 1,390 kilometres, is experiencing erosion due to rapid growth in the highland regions. In their study, Gibbs et al (2010) investigated the factors contributing to alterations in land use and land cover (LULC) inside Malaysian forests from 1990 to 2006. The researchers determined that agricultural practices played a significant role in driving the observed changes in LULC, primarily due to enhanced accessibility, suitable slopes, and good weather conditions. In a subsequent study, the group above of researchers investigated the socio-economic determinants impacting agricultural land utilisation in Malaysia. Their findings indicated that the principal factor driving agricultural land usage in Malaysia was workforce availability. Urbanisation has emerged as a prominent catalyst for forest transformation in Malaysia. Conversely, urbanisation has been acknowledged as a contributing factor to land use change in the catchment areas of Kuala Langat, Dengkil, and Klang in Peninsular Malaysia.

Land use modifications in a tropical country such as Malaysia are anticipated to lead to the depletion of tropical rainforests to attain targeted economic progress. Several variables are converging to amplify the worry regarding the deforestation of tropical rainforests in upland regions (Omran et al., 2019). The highlands are characterised as high endemic zones due to the presence of species that are exclusively adapted to survive in high-altitude environments, as exemplified by the study conducted by Calzado et al., (2018) in Spain. However, previous research has indicated that species diversity decreases as altitude increases.

The issue of deforestation has been a persistent concern in the highland regions of Malaysia, namely in the areas surrounding Cameron Highlands, Genting Highlands, and Fraser's Hill in the state of Pahang, as well as Lojing in the state of Kelantan. Land use changes in neighbouring regions will have a direct impact on the surrounding space environment. One of the most prominent outcomes is the alteration of meteorological parameters, including temperature patterns, relative humidity patterns, and rainfall distribution patterns. Perring et al. (2016) introduced a novel classification termed the hybrid category to describe alterations in land use patterns and their impact on ecosystems.

Examining Socio-economic effects is of utmost importance in comprehending the actual state of a community, including its levels of contentment, ability to adjust, and reactions to various transformations. It facilitates the dissemination of information to the community regarding the magnitude or consequences of any proposed development or alteration to the natural surroundings. Gaining insight into the perceptions of the interconnected community allows for a precise evaluation of the impacts of the change. Providing unequivocal information to individuals involved in planning, management, policy-making, and research enables them to accurately forecast, monitor, assess, and govern a specific circumstance. This document can be utilised as a reference for assessing a suitable adaptable capacity. The study of population demographics and socio-economics holds significant importance as it provides insights into the quality of life and overall resilience of a nation. Household surveys provide essential data about the health and socio-economic status of the population. According to Golden et al. (2015), this tool can offer valuable insights into the attitudes, concerns, and level of contentment within a particular local community about a given situation.

According to Matt et al (2023), it is widely thought that local populations have a disproportionate influence from events such as deforestation or climate change within a given area due to their interconnections with the surrounding ecology.

In 2020, the tourism industry in Malaysia saw an influx of 4.2 million people, contributing about 16% of the country's total employment. In addition to the above strategies, alternative methods to combat coastal deforestation or forest degradation include implementing community adaptation funds, adopting selective logging practices filters and imposing restrictions on agricultural activities in coastal areas. The Malaysian government has placed restrictions on the prospects of agricultural expansion in the Highlands since late 1996. At the same time, the Kelantan government has decided to limit any agricultural expansion in forested areas. The National Forestry Policy was implemented in Peninsular Malaysia in 1986, resulting in a reduction in annual logging activities due to the adoption of a selective logging system (Yong, 2014).

The link between socio-economic data and physiological environmental data is well established, thus allowing the possibility of linking studies on socio-economic factors of population and change land use/cover (LULC) with remote sensing data. Countless studies have been conducted globally by integrating socio-economic data with remote sensing satellite data. These studies aim to examine spatial and temporal variations associated with human activities, with the ultimate goal of promoting the implementation of adaptive ecosystem management measures. In their study conducted in Dehradun, India, Swadesh et al (2014) used IKONOS multispectral imaging to study demographic and socio-economic factors.

Kannika et al (2010) conducted a study that effectively identified potential construction sites in Bangkok, Thailand, using a combination of Landsat TM imagery and a geographic information system "GIS" technology. This approach has proven to be cost-effective and time-saving. In Deng's (2010) study, socio-economic data were combined with multi-temporal remote sensing data to examine the ongoing urbanisation process in Jiangsu province, China. Socio-economic data are used to identify the determinants of urban growth.

Research Methodology

Study area

The Lojing Highlands in Kelantan exhibit potential as a geographical site due to their favourable weather conditions and location within the Banjaran Titiwangsa, which is characterised by lush green landscapes (Figure 1). The location in question is situated within the latitudinal range of 4° 32' to 4° 47' N and the longitudinal range of 101° 20' to 101° 34' E. It encompasses a total land area of 23,435 hectares (ha). The region's altitude ranges from 800 to 1,400 metres above sea level. The land area measures 23,435 hectares, primarily characterised by natural tropical rainforests consisting of hill dipterocarp and sub-montane forests. There are two forest reserves, specifically Lojing, spanning an area of 14,339 hectares, and Sg. Berok, covering 4,041 hectares (Office of the Director of Lands and Mines, State of Kelantan, 2017). It shares borders with Cameron Highlands, Pahang, and Simpang Pulai, Perak. The Lojing Highlands exhibit a temperature range of 18°C to 25°C and are geographically linked to prominent rivers such as the Belatop River, Isos River, Jelai River, Pelau'ur River, Kenrew River, Penangau River, and Brooke River. The designation of Small Colonies Lojing as a colony was officially recorded on June 24, 2010.

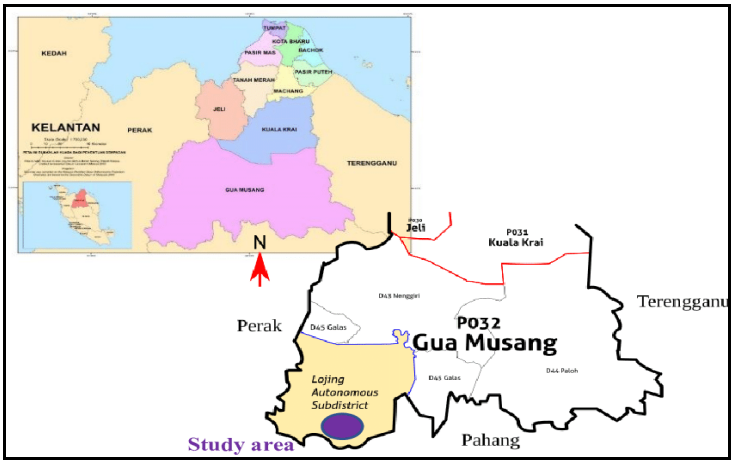

Figure 1: displays a map of the Gua Musang district, specifically highlighting the research region located within the Lojing Highlands.
(Source: Fiffy et al., 2021)

Study Approach

The researcher selected the Lojing Highlands region as the study area due to its notable surge in development in recent years, as reported by the media. These reports highlighted concerns regarding the impact of agricultural activities on the environment, as well as the socio-economic implications for the Temiar tribe, a subgroup of the Senoi tribe, residing in settlements within the area. Consequently, a multitude of land use modifications have transpired inside this region. Included in these categories are logging areas, timber plantations, oil palm plantations, large-scale agricultural farms, and several other land uses. These operations have resulted in extensive alterations to land utilisation. The effects extend beyond the environment and also encompass the local communities residing in the vicinity.

The study analysed Landsat satellite pictures (Landsat 8 OLI-TIRS). Landsat data were chosen because they have a more excellent spectral resolution (for example, R, G, B, NIR, MIR, TIR, and FIR for TM), which enables the identification of specific land cover/use categories. Landsat is only a source of free medium-resolution spatial data. As a result, it is a widely used dataset. Landsat OLI is a more recent addition to the Landsat family, including a more excellent spectral resolution. Additionally, Landsat data has a strong track record for studying global land use change since its inception (Hemati et al., 2021).

The interpretation of remote sensing data was conducted in order to generate land use maps for two distinct temporal intervals, specifically the years 2009, 2014 and 2019. The process of interpretation and classification was conducted utilising a supervised maximum likelihood classification method within the ENVI programme. Utilising the maximum likelihood classification algorithm necessitates the availability of a training region that encompasses all classes, enabling the identification and characterisation of the spectral behaviour associated with each class. In this study, the classification of six significant land use and land cover (LULC) categories was conducted. These categories include primary forest, secondary forest, oil palm plantation, infrastructural area, open space, and waterbody.

The research design employed for this study was a quantitative technique, utilising a structured questionnaire administered through a cross-sectional survey methodology. The present study employed a structured questionnaire to examine and assess the socio-economic impacts of indigenous people on land use changes in the Lojing Highlands region. Furthermore, this study included an in-depth interview methodology and field observations.

The population for this study comprised Temiar in the Lojing Highlands area. A total of four settlements of Temiar hereditary areas and two settlements for the Orang Asli Resettlement Program (RPS) established by The Department of Indigenous Persons Development (JAKOA) with an estimated population of about 8,982 individuals in 2019 lived in this study area at the time the study was carried out. The total number of households per village was based on estimates by the district office, community leaders and village heads. Table 1 shows the list of settlements and the number of populations—the population for this study comprised Temiar in the Lojing Highlands area. A total of four settlements of Temiar hereditary areas and two settlements for the Orang Asli Resettlement Program (RPS) established by The Department of Indigenous Persons Development (JAKOA) with an estimated population of about 8,982 individuals in 2019 lived in this study area at the time the study was carried out. The total number of households per village was based on estimates by the district office, community leaders and village heads.

Table 1
List of villages and number of populations

No.	Settlement area	Number of populations
1	Pos Brooke	3000
2	Pos Hendrop	767
3	Pos Tuel	904
4	Pos Blau	553
5	RPS Balar	978
6	RPS Kuala Betis	2780
	Total	8982

(Source: Gua Musang District Office, 2019)

The software application ArcGIS was employed to integrate three separate maps representing land use classifications for the years 2009, 2014, and 2019. Three change maps were generated in order to visually represent the locations and types of modifications that have taken place. A Geographic Information System (GIS) was employed to compute the alteration in land area for every category of land use throughout the enumeration period. Consequently, the rate of deforestation was quantified with the subsequent mathematical expression.

Deforestation rate: (percent per year) = $\{(F1^{2}-F^{1})/F^{1},\}/N*100$
Where, F^{1}; =Forest area in 2009, F^{2}= Forest area in 2019, N= Number of years (10 yrs)

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The purpose of this is to minimise expenses, time, and energy use. The determination of the sample size for this investigation was carried out using the technique proposed by Krejcie and Morgan (1970). The sample size was determined using the following formula:

$S = X^2NP(1-P)/d^2(n-1)+X^2P(1-P)$

Where: S represent the necessary sample size, x^2 denotes the chi-square value from the table for 1 degree of freedom at the specified confidence level, N represents the size of the population, P represents the population proportion (.5), d = the degree of accuracy expressed as a proportion (.05)

At a 95% confidence level and with a degree of freedom of 1, the chi-square value (x^2) is determined to be 3.841. The population size (N) is 8982, the population proportion (P) is 0.5, and the degree of accuracy stated as a proportion (e) is 0.05.

$$S = \frac{3.841*8982*0.5*(1-0.5)}{((0.05)^2*(8982-1)) + 3.841*0.5(1-0.5)}$$

$$S = \frac{8624.9655}{22.4525 + 0.96025}$$

$$S = 368.387 \approx 370$$

The value of S is approximately 370, denoted as 368.387.

According to the findings of Krejcie and Morgan (1970), the minimum sample size (S) required for a total population (N) of 8982 is determined to be 370 respondents. In this study, a comprehensive sample of 550 household heads was interviewed.

Section A (details the household's demography and socioeconomic status) and Section B (forest change issue, cause, impacts and responses). Section B is broken into numerous subsections according to the themes described previously. Cause' was once again subdivided into multiple sub-subsections. These causes included changes in land use, local socioeconomic and population characteristics, accessibility, policy and management, and ecological effects generated by humans.

Additionally, the part on effects is subdivided between negative and positive impacts. Section 'A' questions are primarily composed of structural questions that collect demographic and socioeconomic information about respondents, such as their age, gender, marital status, race, religion, family size, level of education, social activity, and income. In section 'B,' we assessed respondents' attitudes regarding forest change using eight statements on a five-point Likert scale. Together, these eight comments highlighted the topic of illegal forest encroachment change.

The data collected from the questionnaires in this study were analysed using Statistical Package for the Social Sciences (SPSS) version 23 and Microsoft Excel. The SPSS software is a prominent computer software package utilised for the processing and analysing of research data, particularly in the domains of social and socioeconomic research.

Results and Discussion

The classification results showed that among the five land use categories, built-up areas together occupied the majority of the land areas for all years, i.e. 81.52% (2009), 86.63% (2014) and 97.75% (2019) during the study period.

Agriculture has increased between 2009 (78.04%), 2014 (85.0%), and 2019 (98.17%), as determined by image classification comparisons for the years 2009, 2014, and 2019. In the

meantime, Oil Palm/Rubber increased between 2009 (72.20%), 2014 (89.10%), and 2019 (95.09%). Built-up increased in 2009 (80.73%), 2014 (91.7%), and 2019 (98.46%) as well. In 2009 (51.57%), 2014 (42.32%), and 2019 (40.20%), the proportion of land covered by forests decreased. This comparison table concisely summarises the performance of the image classification algorithm by comparing the classification, as well as providing detailed information regarding the occurrence of land-use change patterns in Lojing Highlands, Kelantan, from 2009 to 2019.

Forest cover is the study area's primary land use/cover category. Other agricultural, urbanisation and oil palm/rubber together account for less than 10% of land usage, with a slight rise in land use from 2009, 2014 to 2019 (Figure 2 to Figure 4). From 163,500.87 ha in 2009 to 161,366.92 ha in 2019, forest area decreased. Annually, around 334.73 hectares (2.06 per cent) of agricultural land, 6.66 hectares (1.24 per cent) of built-up land, and 41.77 hectares (4.30 per cent) of oil palm/rubber land were added. In the research area, approximately 262.96 ha (0.16 per cent) of forest land was lost.

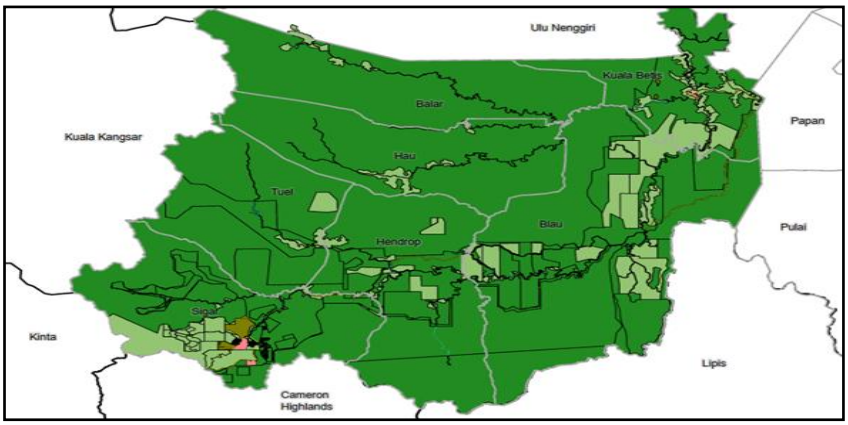

Figure 2: Land use of Lojing Highlands, Kelantan with its surrounding area for the year 2019.

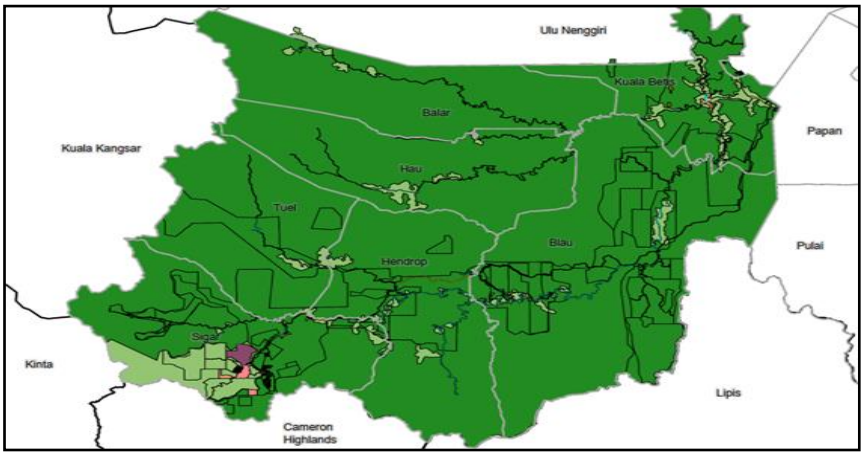

Figure 3: Land use of Lojing Highlands, Kelantan with its surrounding area for the year 2014.

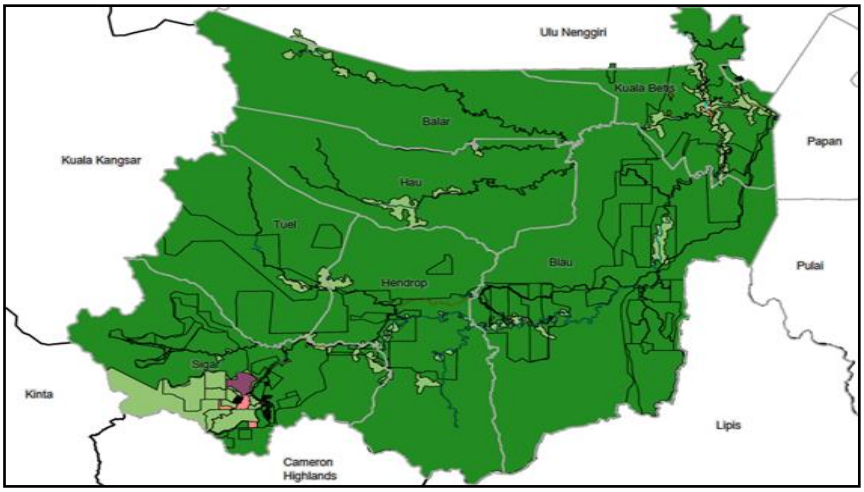

Figure 4: Land use of Lojing Highlands, Kelantan with its surrounding area for the year 2009.

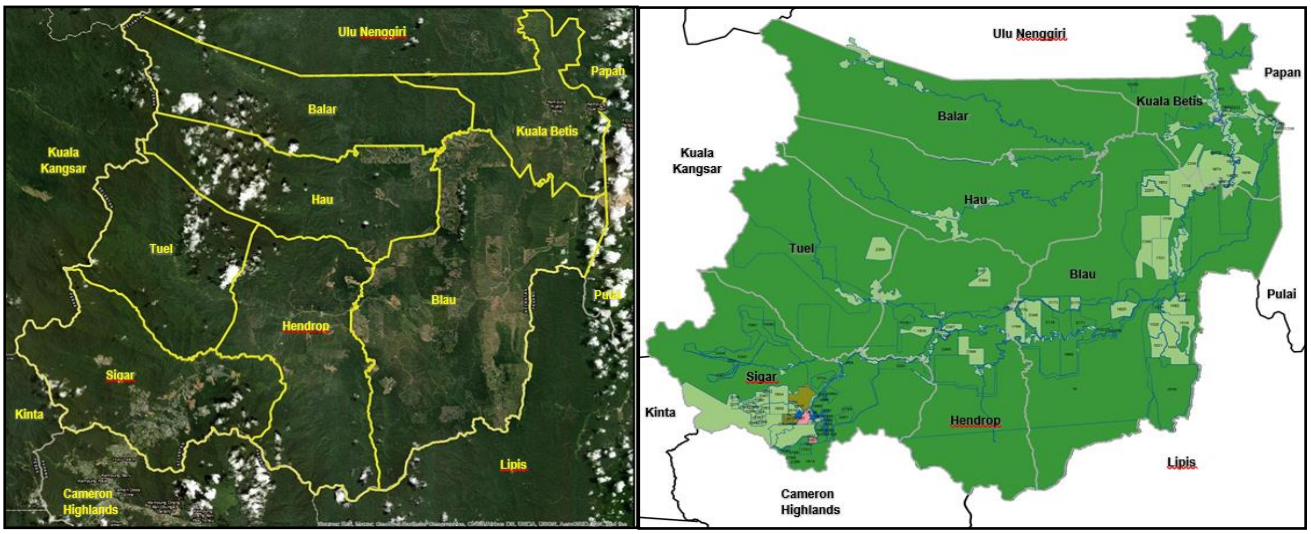

Figure 5: Shows a satellite image of the Lojing Highlands in Kelantan on the left side, while on the right side, an image of private land with its corresponding lot number is depicted. These images were captured in the year 2019.

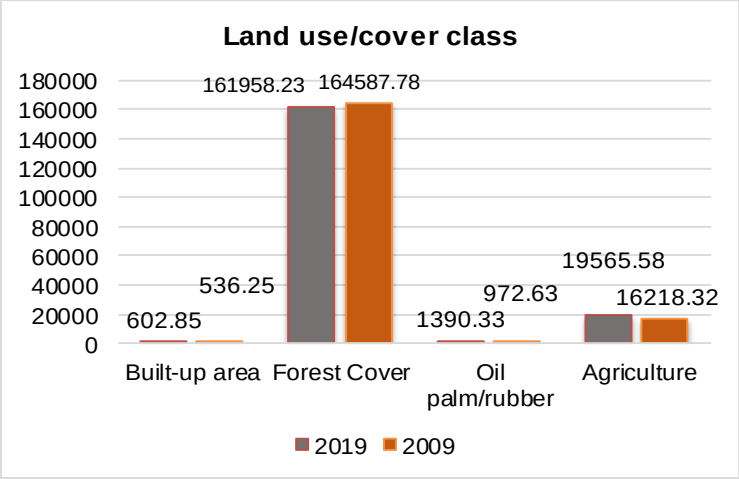

Figure 6: Pattern of LULC Change from 2009 to 2019 and data comparison from the confusion matrix for the supervised classification image.

Figure 6 compares the data from the confusion matrix for the supervised classification image from 2009 to 2019, which depicts a decrease in forest cover of 2,629.55 ha, while the agricultural sector recorded an increase of 3,347.26 ha from 2009 to 2019. One of the land use factors is the policy, and the State Government's policy is optimistic about making the Lojing Highlands the Small Administrative Centre. The Agro Cultural and Eco-Tourism Centre next to it ensures that the provision of services to the community is more organised and effective.

It shows that between 2009 and 2019, a total of 579.23 ha of land remained still undeveloped. More than 353.21 hectares of built-up area in 2019 was converted to agricultural land by 2009. This massive change from built-up to agricultural land may be due to the area's high demand for crops and vegetative farms, which were initially categorised as bare land or built-up areas in 2009 but were reclassified as farms in 2019 as the crops flourished. Forests covered an area of about 164,787.23 hectares in both 2009 and 2019. From 2009 to 2019, 138.29 hectares of built-up land have been reverted to forest cover. About 395.61 hectares of forest cover area were converted to built-up in the same period.

A total of 159,728.17 acres of land was covered with forest in both 2019 and 2009, according to the latest available data. From 2009 to 2019, around 113.51 hectares of built-up land were converted to forest cover. A small number also reduced the forest cover area to 623.52 hectares simultaneously. Changes in net forest cover occur over this period. Net forest cover was reduced to a built-up area of 33.25 hectares over this period. Forest cover was reduced by 27.15 hectares between 2009 and 2014, as 137.58 ha of it was converted to oil palm, and 131.52 ha was turned into forest cover. Together, the years 2009 and 2014 account for approximately 1,754.66 acres of oil palm land. As many as 674.66 hectares of farmland and 156.85 ha of land were converted to oil palms and built up during this period (Table 4.6). Table 4.5 shows that between 2009 and 2019, 725.65 ha of land was undeveloped. 178.71 ha of built-up land 2009 was converted to oil palm in 2009. In both 2009 and 2019, a total of 159,728.17 hectares of land was covered by forest. From 2009 to 2019, around 1149.65 hectares of forest cover were converted for development. However, only 113.51ha of the city's formerly developed land was converted to forest.

Both 2009 and 2019 are represented by the 1,754.66 acres of oil palm land. 245.32 hectares (ha) of oil palm land was developed between 2009 and 2019. During this time, 569.30 hectares of oil palm land have been converted to agricultural use. During the study period, several rubber plantations and oil palm plantations had been converted to farmland.

In the realm of employment, the study gathered data from 550 respondents. Among these, 265 individuals (48.19%) were employed in the private sector, 270 individuals (49.10%) were self-employed, and 15 individuals (2.73%) were engaged in government sector employment. The private sector encompasses various industries predominantly occupied by male individuals, such as logging companies and agriculture, including fields related to oil palm and rubber cultivation, aquatic farming, poultry farming, animal husbandry, and large-scale flower and vegetable cultivation, among others. In the self-employed sector, individuals may either be engaged in activities such as vegetable and livestock cultivation, tree nurseries, the collection and sale of forest products, or other related endeavours.

In terms of the respondents' monthly income, the data indicates that the majority of participants (97.81%) reported earning RM1500 or less per month. These respondents were primarily employed in various sectors such as oil palm plantations, agricultural/vegetable/flower farms, livestock farms, logging companies, and the government sector. Additionally, a significant proportion of respondents reported working independently

to provide for their own families. Among the respondents, eight individuals, accounting for 1.45% of the sample, reported having a monthly income ranging from RM1501 to RM2999. These respondents identified themselves as drivers operating heavy machinery, including heavy vehicles, to transport agricultural products, vegetables, cattle, and other commodities. Out of the total respondents, a mere 0.74% reported having a monthly income of RM3000 and above. These individuals are engaged in entrepreneurial activities such as managing small grocery stores and owning agricultural ventures, including vegetable cultivation, cattle rearing, and oil palm farming. Notably, the produce from their farms is marketed beyond the confines of the Lojing Highlands.

Table 2
Frequency and percent of respondents based on sources of Income

Source of income	**Frequency**	**Percent (%)**
Wages	470	85.45
Collect forest produces	56	10.18
Handicrafts	24	4.36

Most respondents, namely 470 individuals, accounting for 85.45% of the overall sample, reported their income from salaries obtained in various private employment sectors within the region. These sectors include agriculture, animal husbandry, oil palm and rubber plantations, aquatic plantations, logging, and other related industries. Out of the total sample size of 550 respondents, 56 individuals (10.18%) collect forest produce, primarily consisting of self-employed males. Additionally, 24 respondents (4.36%) participate in producing handicrafts, a domain predominantly pioneered by women. It is well acknowledged that the provision of financial aid from JAKOA serves as a significant source of income for all respondents.

Table 3
Respondent overview on factors of LULC change

No	Statement	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
B1.	Forest coverage of Lojing Highlands area is changing	0	0	0	245 44.55%	305 55.45%
B2	Forest change is due to human activities	0	0	40 7.27%	370 67.27%	140 25.45%
B3	Biodiversity is reducing	0	0	42 7.64%	450 81.82%	58 10.55%
B4	Habitats and species reducing	0	0	14 2.55%	53 9.64%	483 87.81%
B5	Income from forest reducing	0	0	32 5.82%	220 40.0%	298 54.18%
B6	Forest production reducing	0	0	24 4.36%	96 17.45%	430 78.18%
B7	Environment changing due to the forest damage	0	0	58 10.54%	375 68.18%	117 21.27%
B8	New infrastructure developed replacing forest	0	0	10 1.82%	130 23.64%	410 74.55%

Based on Table 3, the data analysis gathered by the researcher for the first statement (B1), 245 respondents (44.55%) agreed, and 305 respondents (55.45%) strongly agreed that the forest coverage of the Lojing Highlands area is changing. The local community asserts that the Lojing Highlands region has undergone significant transformations since the early 1980s. It is widely acknowledged that the area has been extensively utilised for agricultural purposes, aligning with the development objectives and policies of the Kelantan government. Furthermore, the government has endeavoured to enhance the region by providing numerous amenities and services to benefit the local population.

As for the second item of the statement (B2), it was found that 370 respondents (67.27%) agreed, 140 respondents (25.45%) strongly agreed, and 40 respondents (7.27%) were neutral with this statement whereby the forest change is due to human activities. Most participants agreed on the impact of human activities on specific biological attributes of forests, resulting in a decline in biodiversity, forest regeneration, and habitat quality. Human intervention in forest areas has numerous significant effects, including deforestation, fragmentation, grazing, clearing of forests for development, intensive land use, desertification, inappropriate forest management, agriculture, encroachment on forest land, slash and burn practises, forest fires, urbanisation, overharvesting, and degradation of natural resources. These activities collectively contribute to climate change in forested regions.

Prominently featured within this context include deforestation, desertification, industrialisation, urbanisation, and various other socio-economic processes.

On the third item of the statement (B3), data analysis shows that 450 respondents (81.82%) agreed, 58 respondents (10.55%) strongly agreed, and 42 respondents (7.64%) were neutral that the biodiversity is reducing. The respondents concur that the depletion of biodiversity is a noteworthy ecological concern with potentially far-reaching implications, including climate change within the region. According to historical records, the temperature in the Lojing Highlands during 1980 was characterised by a significantly low and consistently chilly climate. It was observed that the region was not subject to extreme weather events, as is the case in contemporary times. Presently, there is a notable increase in the frequency and duration of heavy rainfall, leading to the occurrence of flooding in places that are inhabited and explored by human populations.

While the fourth item of statements shows there were about 53 respondents (9.64%) who agreed, 483 respondents (87.81%) strongly agreed, and 14 respondents (2.25%) were neutral with the statement about the habitats and species reduction. The respondents argued that habitat loss pertains to the diminishment of available area for a specific species or a collection of species to inhabit and engage in reproductive activities. The phenomenon under consideration is a consequence of anthropogenic actions, including but not limited to agricultural practices, urban development, deforestation, extraction of natural resources, and the emission of pollutants. The depletion of natural habitats can result in the relocation or demise of creatures, leading to a decline in biodiversity and the population sizes of various species. The respondents acknowledge the presence of ecosystem exploration, posing challenges in their pursuit of animal hunting.

From the data analysis recorded, it has been noted that 220 respondents (40.00%) agreed, 298 respondents (54.18%) strongly agreed, and 11 respondents (2.25%) were neutral with the fifth item of the statement (B5) that income from the forest is reducing. As the sixth item of the statement (B6), 96 respondents (17.45%) agreed, and 430 respondents (78.18%) strongly agreed that forest production was reducing. Forests offer many economic, environmental, social, and cultural advantages to human societies. Forest resources contribute to economic growth by generating income through job opportunities and selling excess commodities and services. Nevertheless, it has been contended by responders that the decline of forest resources and the subsequent decrease in income derived from them might be attributed to deforestation, forest degradation, and several other human activities. The decline in non-timber forest products (NTFPs) in the region can be attributed to the prioritisation of the agro-tourism industry and large-scale agriculture, resulting in a reduced availability of medicinal plants, fruits, nuts, honey, and mushrooms derived from the forest.

While on the seventh item of the statement (B7) shows there were 375 respondents (68.18%) who agreed, 117 respondents (21.27%) strongly agreed, and 58 respondents (10.54%) were neutral about environmental change due to forest damage. The responder concurred with the notion that climate change exerts a substantial influence on forest ecosystems. The ecological modifications resulting from climate change are causing disruptions to natural ecosystems and species, the full extent of which is gradually becoming elucidated. Evidence shows that rising temperatures affect biodiversity while changing rainfall patterns and extreme weather events pressure species already threatened by other human activities. The threat posed by climate change to forests is expected to increase.

As for the eighth item of the statement (B8), data analysis gathered shows that 130 respondents (23.64%) agreed, 410 respondents (74.55%) strongly agreed, and 10

respondents (1.82%) were neutral that the new infrastructure developed replacing the forest. The implementation of infrastructure development within forested areas can exert a significant influence on the ecological dynamics of the forest ecosystem. The consequences include deforestation, fragmentation of habitats, and a decline in biodiversity. The respondents believe that infrastructure development encompasses a range of projects that seek to enhance the quality of life or establish essential amenities. However, these endeavours must be meticulously planned to mitigate potential adverse impacts.

Negative Impacts of LULC

The forest areas in Kelantan have a high level of biodiversity. Forests serve as vital resources for local populations, providing sustenance, economic opportunities, and access to plant-based medicinal remedies, among other benefits. Nevertheless, the local population continues to rely on forest resources due to their economic significance and the cultural inheritance passed down through generations. Furthermore, individuals continue to face challenges in altering their source of income due to their limited skill set and inadequate competencies. Any anthropogenic activity that disrupts the natural state of a forest or alters its landscape for alternative land uses has a significant impact on the local ecosystem. The ecosystem's disturbance leads to alterations in the population levels of indigenous fauna and flora within the given habitat. The local community's collection of forest products has been indirectly disrupted due to this.

Numerous areas in Malaysia, mainly rural areas and highland resorts have been affected by increasing soil pressure, housing in the highlands, tourism demand, and general greed by irresponsible developers, all of which have resulted in the lush green hills becoming barren and desert-like. When combined with other factors such as intensive development of hill slopes and hill land for agriculture, recreation, highway construction, dam construction, and other human land use, all of which have harmed the environment, upland development will harm the environment and society.

Extensive land encroachment will have a significant impact on the environment. It is due to human hands being greedy for illegally clearing land, leading to pollution, natural disasters, temperature changes, etc. River pollution needs to be taken seriously and is dangerous to humans and ecosystems because rivers are a daily human need, as are plants. This pollution occurs due to, among others, fertiliser water, poisons, and pests that seep into the soil and continue to enter the river. As water becomes cloudy and toxic, the water becomes unsafe to drink without filtering. Tringkap River, Icap River, located near Kuala Terla, has been reported as biologically dead and classified in class V. This is because elements of the use of pesticides are not allowed, such as endosulfan, aldrin, and DDE (dichlorodiphenyl dichloroethylene), which is a derivative of DDT (dichlorodiphenyltrichloroethane), which is dangerous. These chemicals have been banned as poisons worldwide and in Malaysia since 2005 under the Pesticides Act (Utusan Malaysia, 2017).

The government is estimated to have suffered a loss of RM5,245,000 per year and an estimate of the losses incurred by the government every year, and if the land in slums gets more expensive, the loss rate will increase as well. Besides that, the government had to clean up and maintain rivers caused by illegal agriculture and placement. River cleaning works, for example, in Sg Ikan and Sg Telom in Kg Raja in the district of Cameron Highlands, cost an estimated RM 19,750.00 in 2011. In addition to conservation efforts, it also involves efforts to demolish illegal agricultural areas. The total estimated amount is RM2.2 billion to restore Cameron Highlands. Hence, the loss borne by the government is not a tiny amount, even

though it will affect the economic growth of the country because the money can be used for purposes. However, it needs to be removed in order to save the environment so that it can remain vigilant and able to maintain the forest sustainability of the district.

Lojing Highlands is a district with cool temperatures suitable for agriculture. These upland areas are vulnerable to changing temperatures due to illegal, extensive land clearing. The opening of this land affected temperature changes because many of the trees caused the area to get cold. This temperature change is, in fact, due to irresponsible human hands to maintain forest sustainability. They are willing to do anything if they get what they want, like clearing land for agriculture. At the same time, they can reap huge profits due to the high demand and very worrying because there is already much sloppy land, which contributes to the increase in temperature.

In broad terms, a significant portion of land use and land cover (LULC) change can be attributed to the abandonment of government or privately owned land, which becomes susceptible to encroachment activities. The trespasser will exploit the opportunity by disregarding the legal proceedings initiated against them. Within the Lojing Highlands region, a notable presence of government-owned and privately-owned lands may be observed, many of which remain uncultivated and are particularly evident in the case of forest reserves, where the steep gradient of the terrain renders any form of development unfeasible. Encroachers perceive that the government's lack of land development activities signifies a neglectful approach towards land management. Furthermore, the causes of government land invasion such as:

A Decent Income

Lucrative revenue is one of the main factors that cause land encroachment. In Lojing Highlands, most government land intended for agriculture, such as vegetables and flowers, can provide a lucrative income to the intruder. It is because the price of vegetables and flowers will increase, especially over time peaks such as school holidays and festive seasons. For example, at this time, the trader will take the opportunity to raise prices because, during this time, tourists will come to Cameron Highlands for a holiday and at the same time will buy fresh vegetables and flowers. Agriculture in the Lojing Highlands and Cameron Highlands area is the most profitable business for them, and that is why they are willing to invade for the sake of profit without thinking about the mistake they made. Planting flowers is in high demand, such as in Hong Kong, Singapore, and others. In 2017, profit was estimated at RM800 million for the export of flowers overseas. Apart from that, they also do not have to pay TOL or land tax, and they only profit solely from agriculture without paying anything to the authorities.

Soil Fertility and Weather

Apart from a lucrative income, soil fertility and good weather are also causes of land encroachment. Intruders will do planting activities due to the fertile soil because the crop is easy to grow without incurring the high cost of buying land for planting. The fertile soil also causes the plants to be beautiful in terms of colour, and there is no need to buy many fertilisers to get the best results. In addition, the weather also plays a role as a source for the plant to become healthy. The weather in Lojing Highlands is suitable for crops because it is neither hot nor cold. The temperature in that place is between 10 and 25 degrees Celsius, suitable for plants such as flowers. This temperature will yield the best results for crops like cabbage, strawberries, flowers, durian, etc. because they need moisture to live well. Hence,

soil fertility and weather cause invaders to take advantage of opening up government land without permission. The weakness of enforcement is that it has a significant impact on encroachment on government land.

Enforcement Matters

Enforcement is significant in reducing government land encroachment activities in the area. Besides, this weakness also stems from the need for more enforcement personnel and factors on the earth's surface in the area itself. Enforcement requires many members because the land is encroached on and the area is too vast, so it takes work to take comprehensive action.

In the meantime, the land is under state jurisdiction, so other agencies, such as the police and the military, did not cooperate because they were under federal authority. These difficulties are also challenging to tackle comprehensively. The state government must ask for federal assistance to cooperate internally to eradicate land encroachment activities. In addition, the situation on the earth's surface is also a barrier to increasing enforcement. It is because, in the district, the hilly and sloping conditions make it difficult for enforcement members to take action, such as demolishing plastic houses and going into the gardens. This difficulty is in terms of carrying such equipment as iron cutters to demolish plastic houses. In addition, in terms of entering the encroachment area, i.e., the plantations, it needs to enter into a forest whose path is only muddy. Invasion is usually performed in areas that are difficult to identify and see except via satellite. Thus, the weakness of enforcement stems from a lack of members, difficulties in terms of the cooperation of other government agencies, and the terrain conditions in the area, which caused the invaders not to fear taking action against him, even if it was a criminal act.

Conclusion

The study examined the changes in land use and land cover (LULC) in Loijng Highlands, Kelantan area, from 2009 to 2019, as determined by satellite images and GIS analysis. Five primary LULC change classes were found for the study area. Built-up area/bare land, oil palm area, forest, other vegetation (primary forest, rubber, or other plants), and water bodies were the classifications. The overall accuracy of GIS photos in 2009, 2014, and 2019 was 80.00 per cent, 86.63 per cent, and 97.75 per cent, respectively. The Kappa coefficients for 2009, 2014, and 2019 were 0.92, 0.94, and 0.98, which were satisfactory.

A comprehensive depiction of the scope and scale of alterations that occurred during the period spanning from 2009 to 2019 indicates a decline of 28.31 per cent in water bodies and a loss of 1.61 per cent in forest cover between the years 2009 and 2019. Conversely, there was an increase of 12.42 per cent in built-up areas, 20.64 per cent in agricultural land, and 42.95 per cent in oil palm/rubber cultivation. Forest cover is the study area's primary land use/cover category. Urbanisation accounts for less than 10% of land usage, with a slight rise in land use from 2009, 2014, and 2019.

From 163,500.87 ha in 2009 to 161,366.92 ha in 2019, the forest area decreased. Annually, around 334.73 hectares of agricultural land, 6.66 hectares of built-up land, and 41.77 hectares of oil palm/rubber land were added. In the research area, approximately 262.96 ha of forest land was lost. In addition, it can be seen comparing the data, which depicts a decrease in forest cover of 2,629.55 ha while the agricultural sector recorded an increase of 3,347.26 ha from 2009 to 2019. One of the land use factors is the policy, and the state government's policy is optimistic to make the Lojing Highlands the small administrative centre

and The Agro Cultural and Eco-Tourism Centre next to it ensures that the provision of services to the community is more organised and effective.

Together, the years 2009 and 2014 account for approximately 1,754.66 acres of oil palm land. As many as 674.66 hectares of farmland and 156.85 ha of land were converted to oil palms and built up during this period, which shows that between 2009 and 2019, a total of 725.65 ha of land was undeveloped. A total of 178.71 ha of built-up land in 2009 was converted to oil palm/rubber. In both 2009 and 2019, a total of 159,728.17 hectares of land were covered by forest.

From 2009 to 2019, around 1149.65 hectares of forest cover were converted for development. However, only 113.51ha of the city's formerly developed land was converted to forest. Both 2009 and 2019 are represented by 1,754.66 acres of oil palm /rubber land. 245.32 hectares (ha) of oil palm land was developed between 2009 and 2019. During this time, 569.30 hectares of oil palm land have been converted to agricultural use. During the study period, several rubber plantations and oil palm plantations had been converted to farmland.

Based on the study, the most significant causes of deforestation in the study area are accessibility factors, land use factors, government policy and management factors, human factors, ecology, and finally, population and socioeconomic factors. In a positive context, respondents think deforestation has become a growing source of income, increased income (from other sources by creating new job opportunities), improved communication systems, improved overall quality of life, and new infrastructure developed for practical purposes, replacing forests and indicates indications of development in the study area.

However, specific infrastructure still needs to be completed to the same level as road facilities, health facilities, communication facilities and clean water sources. However, it is the lowest segment of the community, the landless and small-scale farmers, who are most dependent on the money gained from forest produce. The community, especially the Temiar ethnic group in the Pos Lojing Highlands settlement area, has obtained additional income from the forest, including products generated from various forest products, including those harvested for purposes such as fuel, sustenance, fodder, building materials, medical applications, and various other uses. Some individuals resort to engaging in the selling of forest goods primarily during times of crisis, such as when there is a lack of food or currency. Several income-generating activities rely on the use of forest-derived food resources, including the harvesting of fodder, legumes, fruits and fungus, which is a frequent activity. The exploitation of forest resources plays a significant role in creating additional income for many homes of residents of the six Lojing Highlands posts and contributing to the economic growth of the area.

In the meantime, some have worked in agricultural fields, palm oil, logging companies, construction sites and government agencies, as and-employment, including producing handicrafts, cultivating and selling agricultural products on a small scale such as vegetables, fruits and black pepper.

However, LULC has had an excellent positive effect in the study area. Many infrastructures have been created and contribute to improving the quality of life of the population, especially Temiar. New job opportunities have also been provided for them, becoming a new source of income. This opportunity helps them obtain various sources of income instead of relying solely on selling forest products.

Reviewer Comments

Research is meant for contribution. Please add a paragraph after conclusion, which details the theoretical and contextual contribution of this research. How is it significant to the existing knowledge and how it plays its role in context?

The investigation pertaining to land utilisation patterns in the Lojing Highlands has generated noteworthy theoretical and contextual advancements within the realm of environmental studies. The study has successfully identified the primary elements contributing to deforestation in the region. These aspects encompass accessibility, land use, government policy management, human activities, ecological considerations, and demographic and socio-economic dynamics. The study has additionally emphasised the influence of alterations in land utilisation on the indigenous community, including the Temiar tribes inhabiting the Lojing Highlands. The conclusions of this study carry substantial significance for politicians, environmental advocates, and other stakeholders engaged in the control of land use. The research has the potential to provide valuable insights for the formulation of sustainable land use policies that effectively reconcile economic growth, environmental preservation, and the safeguarding of indigenous populations.

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