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Analysing Land-use Land Cover (LULC) and Development Change in Nearby University Campuses' Area: A Case of Universiti Teknologi MARA Negeri Sembilan, Malaysia

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Abstract: After 20 years of establishment, the number of Universiti Teknologi MARA (UiTM) campuses across Malaysia has reached 35 in number. Although the campuses' development of campuses had somehow made the location widely known as one of the education hubs in Malaysia, there exist doubts about the extent of development of each campus in an area that can benefit the locality. The focus of this paper is assessing the land-use changes due to the development of three campuses of UiTM Negeri Sembilan from 1999 to 2019. This study uses satellite images, GIS technology, and web-based maps applications as data collection tools. Two aspects were assessed, viz; Land-use Land Cover (LULC) and change detection. The result shows an increasing pattern of LULC. Also, the land conversion occurred more in Seremban compared to UiTM Kuala Pilah and Rembau. Change detection analysis in this paper reveals that the green area is declining via a higher percentage of deforestation and urbanization. Land-use change detection technique is confirmed as an effective method for measuring and evaluating urban development operations and their effect. Therefore, this research emphasized that LULC and change detection analysis results beneficial in identifying the development impact and important to facilitate strategize steps and policies in averting the affected areas from pollution and deforestation side effects. This study also suggests that such research extended to more Institutes of Higher Learning in Malaysia and South East Asia. The findings should be valuable to researchers, town planners, university administrators, and local authorities alike and contribute towards sustainable land-use planning and management in Malaysia in the near future.

Keywords: Satellite images, geographic information systems, land use land cover, change detection, urbanization

1. Introduction

Universiti Teknologi MARA has been around since 1956 and was better known as Dewan Latihan RIDA, which later evolved to become Maktab MARA in 1965. In 1967, this became Institut Teknologi MARA. The institution continued to be recognized as Institut Teknologi MARA (ITM) until August 20, 1999, when it was proclaimed as a full-fledged university by the then Prime Minister of Malaysia. The change of status entitled the institution, formerly known as ITM, to be listed as a new public university in Malaysia, and be given the name Universiti Teknologi MARA, abbreviated as UiTM.

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For the past 20 years since UiTM has been declared as a university, there have been a lot of significant changes in every aspect of providing the Malays training that will make them highly skilled workers, which will subsequently spur the economic development of the nation. Currently, there are around 35 campuses of UiTM in Malaysia with 4 of them situated in West Malaysia while thirty-one (31) campuses are in Peninsular Malaysia. Peninsular Malaysia stretches about 980 km from Perlis to Johor in which UiTM campuses have been spread in every state. As of June 2020, statistics from UiTM Transformation Division show that there are more than 17,000 staff and 169,000 students across Malaysia. In Negeri Sembilan, there are 3 UiTM campuses namely Kuala Pilah, Seremban and Rembau which were established in 1999, 2014 and 2017 respectively. The establishment of UiTM Negeri Sembilan has somehow benefited its community and society.

Michael [1] expressed the opinion that institutes of higher learning (IHLs) can greatly affect their surrounding communities and many universities and colleges need to undergo studies to state this economic impact. The most obvious manner in which IHL affects their local economy is through employment and the direct purchase of goods and services. IHLs also act on their neighborhoods in indirect ways, such as by developing real estate. However, the author also argues that little is known in terms of whether the impact studies conducted were not exaggerated or incorrectly state the economic impact of that development of IHLs. There are still doubts on the extent of development of an IHL in an area that can give economical, social and ecological impacts to the locality and community.

Many studies [2],[3],[4],[5],[6],[7],[8],[9] use data on LULC acquired from satellite images and remote sensing in tracking the development and changes which occur in an area. Remote sensing technology as an efficient surface investigation method was introduced in China for such purpose three decades ago. In the end of 1980s, CSLA sponsored the program to analyze land-use status in Northwest China using Landsat TM imagery. Later in 1996, time series of Landsat TM data were analyzed to monitor urban expansion in 17 metropolitan areas including Beijing. Many cases of misuse of cultivated land and illegal constructions were exposed through this investigation, which urged the China government to implement a strict protection policy for cultivated land.

The technique to monitor land-use transitions using remote sensing imagery was tested and improved in the following years. In 1999, the newly founded MLR launched the Program of National Land-use Change monitoring through remote sensing. The objective of the program was to investigate the transition from cultivated land to construction land in 66 metropolitan areas around China using Landsat TM and SPOT imagery between 1998 and 1999. Since then, the Program has been carried out continuously for seven years and provides fundamental information on land-use change at the national scale for Central Government policymaking. The success of this Program demonstrates that remote sensing can act as an operational technology serving land management in China. The same concept is currently being applied in Malaysia and implemented in UiTM to see the real-time changes of urban growth.

PLANMalaysia [10] defines urbanization as a process of change and application of urban characteristics to an area. This process involves the migration of rural populations to urban areas that generates changes in social and economic activities, values and lifestyles. Urbanization also impacted physical development which can be seen in terms of land use change that occurs in rural areas [11].This process of urbanization often results in sporadic development beyond the city boundaries and into the fringes of urban areas and smaller towns creating pressure on natural resources, the environment as well as the communities [12].In recent years, the land-use change detection technique has also become an important indicator for evaluating urban growth patterns and their effects on different categories of land-use in Malaysia such as restoration and conversion of wetland into industrial or housing areas.

UiTM’s 20 years of establishment has given an impact on the land cover change from physical, economic and social perspectives, for Malaysia in general and Negeri Sembilan in particular. This study aims to assess the land-use changes towards the significant development of three campuses of UiTM Negeri Sembilan viz. Seremban, Kuala Pilah and Rembau. This study focuses on two aspects:

1. Land-use Land Cover (LULC)
2. Change Detection

The outcome of this study will produce input that may well guide other institutional researchers who are working in a similar field, especially on institutions of higher learning (IHL) establishment. It not only provides more geospatial data, but also aids the community towards being aware of the progress taking place, and can help further improve the areas’ physical, economic and social aspects. The case of UiTM Negeri Sembilan can be illustrative of the impact of an establishment of an IHL in an area. As mentioned by scholars [13, 14,15,16], knowledge of LULC and potential applications is critical for the selection, design, and implementation of programmes to fulfil rising demands for fundamental human needs and wellbeing. Data from remote sensing satellites has become increasingly important in describing the earth's features, managing natural resources, and monitoring environmental change in recent years.

2. Literature Review

Studies [2, 17] explained that satellite images are known as an important tool to infer LULC all over the world and are used to detect changes and developments of almost any region in the world and possibly assess anthropogenic impacts. The LULC changes between the two dates are provided via digital change detection to identify the differences [18]. The research by Scharsich et al. [2] also shows that combining information on a recent land cover with change detection allows us to understand the temporal development of studied areas. Consistently, the results by Zhao & Feng

[7] confirmed the applicability and effectiveness of the combined method of remote sensing and GIS technology but also revealed notable spatio-temporal dynamics and evolution-induced land-use change throughout the different periods.

Change detection is a method or process of manipulating, managing, maintaining, and monitoring the ‘‘most current" spatial distribution of land resources [19]. Many change factors can occur in locality development. Zhao, Huang, & Song [3] stated that phenological changes of the land surface are naturally common. Changes could occur on the natural land surface because of various disturbances, e.g., forest fire or flood. Moreover, due to seasonal change, water bodies may dry out, presenting land cover-like changes in a satellite image. The constantly changing terrain is the primary cause of global environmental change and a key concern for global sustainability[20].

The studies by Bessah et al.,[4] on the effect of LULC activities, specifically, agricultural, in Ghana, concluded that the decisions of developing an area by increasing the LULC will affect the future landscape. Not only cropland and plantation rates are increasing, but the result of the paper also mentioned that the community also has plans to increase their farm size in the future. Consequently, savanna woodland and forest will continue to undergo conversion by this high proportion of farmers to meet the targeted level of production. This calls for appropriate LULC conservation policies to maintain and improve the available land cover and their ecosystems for sustainable development.

Nurda, Noguchi, and Ahamed [8] conducted a change detection analysis based on LULC in forest areas in Indonesia. The study notes that it is also necessary to increase the growth of the economy and, on the other hand, the sustainability of forests through improving the resilience of forest coverage. The researchers pointed out that forest coverage must be estimated periodically to detect these changes. The change detection analysis has the advantage of visualizing the dynamics of changes in forest and deforestation processes. The change detection analysis gives advantages of determining the nature, biodiversity, extent, and rate of land-cover changes, as well as aiding future planning and land management, such as plantation, urbanization, water management and extending the land. In the studies, change detection analysis was done in four categories: urban, waterbody, vegetation and forest, for six types of forest zones. A negative value indicates a decrease in change detection while a positive value shows an increase in the change detection class. Their result reported all increasing results.

On the other hand, Wizor and Eludonyi [9] and Debnath et.al [21] emphasize that increasing human population, industrialization, and urbanization activities give an impact on the natural resources need. They also become a major driving force to the shift that LULC experiences. By the same token, the establishment of an IHL in an area can spark development in three aspects; economy, society, and environment [6]. On the other hand, Mahamud et al. [22] identified three major elements that promote urban development: physical, socioeconomic, and environmental factors. Distance to the workplace, low-cost housing, and distance to public facilities, to name a few.

Sipple, Francis and Fidducia [5] in their studies to see if village economic indicators vary with the concentration and distance of public schools from the center of the village, found strong support for the hypothesis that schools are important to the economic vitality of rural communities. The researchers found out that housing values, per-capita income, and household income significantly and positively increase, indicating that the presence of a school promotes and enhances community vitality.

3. Methodology

Three campuses of UiTM in Negeri Sembilan state were involved in the study namely; Seremban (2.6743° N, 101.9355° E), Kuala Pilah (2.7890° N, 102.2180° E), and Rembau (2.5120° N, 102.0611° E). Negeri Sembilan is located in Peninsular Malaysia and covers 6,686 km2 land area (Fig. 1) This study analysed data from satellite image interpretation and digital image processing, analysis for land-use categorization using geographical information system (GIS), geospatial web-based maps applications, and the production of the map. This research applies the various techniques of statistics, remote sensing, and GIS. The United States Geological Survey (USGS) satellite imagery was used to check the accuracy between remotely sensed data and verification from the ground truth.

In this study, the focus was given on the stages that involve data collection (on-site), satellite image interpretation and digital image processing, analysis for land use categorization using geographical information system (GIS), geospatial web-based maps applications and the production of the map. This study applied the various techniques of statistics, remote sensing, and GIS. The United State Geological Survey (USGS) satellite imagery was used to check the accuracy between remotely sensed data and verification from the ground truth.

The combination of unsupervised and supervised classification used in this study is the most common method in remote sensing image classification of land use land cover (LULC) of urban growth study. Supervised classification is based on the concept of selecting sample pixels in an image that are representative of particular classes and then directing the image processing software to use these training sites as guides for the classification of all other pixels in the image. The selection of appropriate training areas is focused on the familiarity of the analysts with the geographical region and their awareness of the specific types of surface cover present in the image. Meanwhile, unsupervised classification is where the groupings of pixels with similar features are focused on algorithm processing of an image without having sample classes. The computer uses techniques to classify which pixels are connected to each other and organize them into groups.

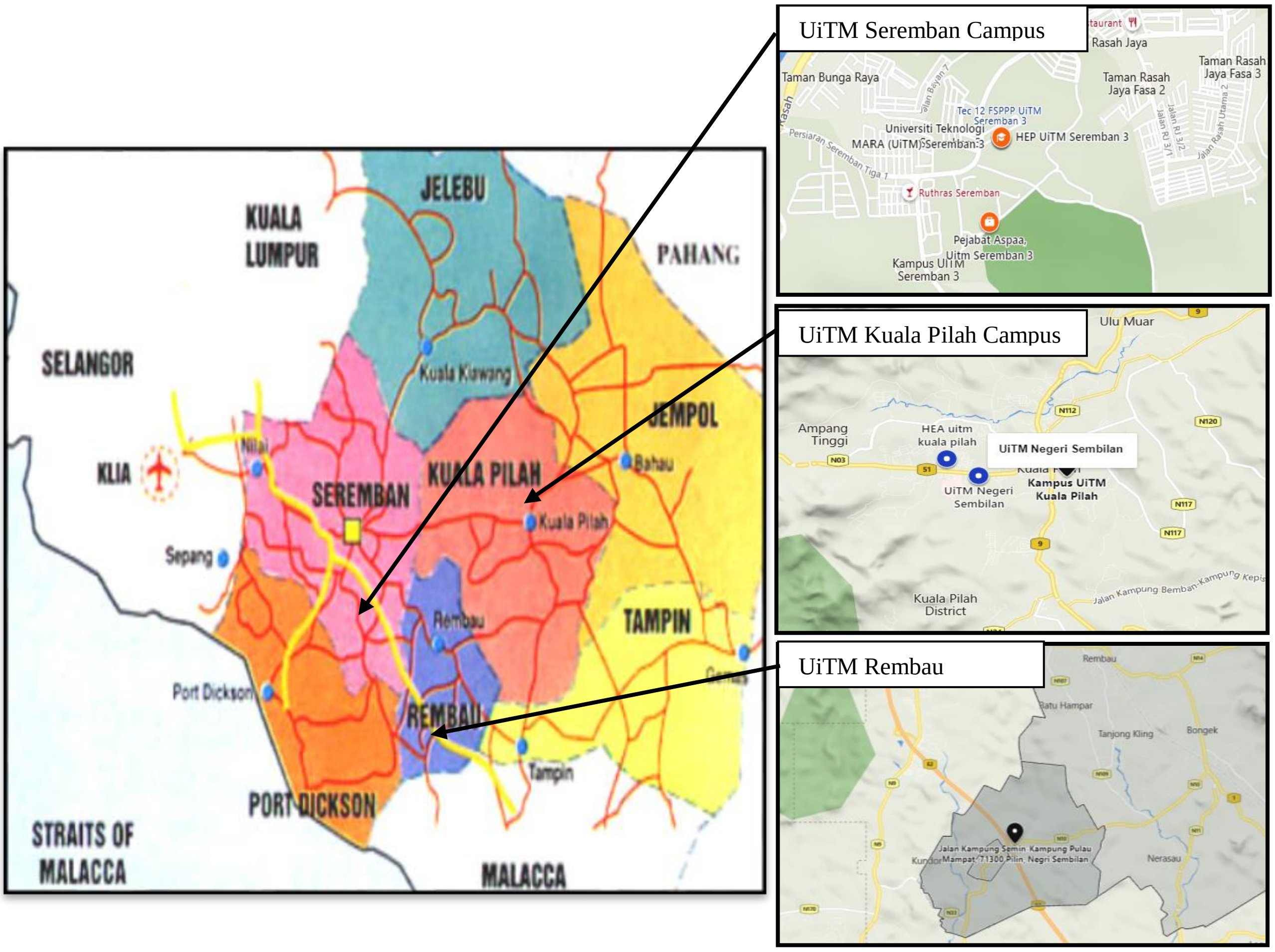

Fig. 1 -Map of UiTM Seremban, Kuala Pilah and Rembau campuses

3.1 Data Acquisition of Satellite Data and GIS Layers

From the various available techniques for assessing and detecting land use and land cover change, the most f used among them is the GIS and remote sensing technique [23,24]. The main input data for this research is the satellite remote sensing data known as Landsat ranging from Landsat Thematic Mapper (TM), Landsat ETM+ (Enhanced Thematic Mapper), and Landsat Operational Land Imager (OLI) and Sentinel data. Different series of Landsat images were used to capture the three temporal years of the LULC assessment condition of 1999, 2009, and 2019. All the data can be freely accessed and downloaded from the USGS Earth Explorer website (https://earthexplorer.usgs.gov/). Imagery acquired from sensors with different spectral, spatial, and radiometric characteristics was used in the analysis. More specifically, the multispectral (excluding the thermal bands-TIR) and panchromatic bands) components of Landsat TM, Landsat ETM+, and Sentinel-2 imageries. The details of every sensor Landsat series characteristics (resolutions) as shown in Table 1.

Table 1- Specification of each landsat series and sentinel data

Sensor	Year of Acquisition	Spatial Resolution Multi/Pan	Radiometric Resolution
Landsat TM	1999,2009,2019	R, G, B, NIR, SWIR1, SWIR2- 30m TIR- 120m	8-bits
Landsat ETM+	1999,2009,2019	R, G, B, NIR, SWIR1, SWIR2- 30m TIR- 60m, PAN- 15m	8-bits
Landsat OLI	2019	Coastal/Aerosol, R, G, B, NIR, SWIR1, SWIR2, TIR1, Cirrus – 30m TIR2- 100m, TIR- 100m, PAN- 15m	16-bits
Sentinel-2	2019	Coastal aerosol (60m), R, G, B, NIR (10m), Red-edge1, Red-edge 2, Red-edge 3, Red-edge4 (20m), Water vapour (60m), SWIR1 (60m), SWIR2, SWIR3 (20m)	16-bits

Apart from that, the GIS layer in shapefile format was also obtained from Open Street Map (OSM) website (https://www.openstreetmap.org/export#map=9/5.4738/102.6041). The data consisted of a road layer, boundary layer, and polygon to represent several land-use/land cover (LULC) in the vector file format. The OSM data layer was used as a baseline map for the derived LULC classification and change detection maps.

3.2 Digital Image Processing

Image processing is a method to perform some operations on an image, to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be an image or characteristics/features associated with that image. Image processing in this study includes the following three steps:

1. Importing the image via image acquisition tools;
2. Analyzing and manipulating the image;
3. Output in which results can be an altered image or report that is based on image analysis.

For each campus, there are two areas of image analysis conducted namely i) LULC and ii) Change Detection

3.3 Land-use Land Cover (LULC)

LULC data refer to data that is produced by classifying raw satellite data into "land-use and land cover" (LULC) categories based on the return value of the satellite image. LULC data are most commonly in the form of a raster or grid data structure, with each cell having a value that corresponds to a certain classification. Satellite imagery Landsat 8 Oli was acquired in three (3) different years; 1999, 2009, and 2019. All of this data was obtained from USGS website; https://earthexplorer.usgs.gov/. Then, a supervised classification method was conducted using training areas and performs an accuracy assessment. The Maximum Likelihood Algorithm was employed to detect land cover types in ERDAS Imagine software. Five (5) LULC classes were established as a result of Image Classification processing. The descriptions of these land cover classes are presented in Table 2.

Table 2 - Detail classification scheme

Code	Land Cover Type	Description
1	Bare Soil	Land without greens and buildings
2	Developed Area	Temporary and permanent buildings, houses, villages and artificial infrastructures
3	Forest	Area covered with trees and undergrowth
4	Mixed Vegetation	Agriculture, shrublands, etc.
5	Water Bodies	River, permanent open water, lakes and reservoirs

3.4 Change Detection

Change Detection can be defined as the process of identifying differences in the state of an object or phenomenon by observing it at different times [9]. The goal of change detection is to discern those areas on digital images that depict change in the feature of interest between two or more image dates. Change detection in this study has been conducted using supervised classification. The analysis identifies the classes into which those pixels changed in the final output. Table 3 explains the detailed classification scheme used for change detection as the analysis identifies the classes into which those pixels changed in the final state image. The land-use change detection is identified in 3 categories of time series; 1999-2009(10years), 2009- 2019 (10 years) and 1999-2019 (20 years).

Table 3 - Detail classification scheme used for change detection

Code	Type of Changes	Description
1	No Change	Land-use class or feature from initial state remains the same at final state.
2	Afforestation	Any land-use class or feature from initial state changes into forest.
3	Deforestation	Forest changes into any land-use class or feature at final state.
4	Urbanization	Any land-use class or feature from initial state changes into developed area.
5	Bare Soil	Any land-use class or feature from initial state changes into bare soil.
7	Vegetation	Any land-use class or feature from initial state changes into vegetation.
8	Water Bodies	Any land-use class or feature from initial state changes into water bodies.

Based on the image of the map analysis, the development area for the three campuses year 1999, 2009 and 2019 was observed and analysed. Ratio Development per Area of UiTM is then calculated to find out the ratio of every 1-hectare area of each UiTM campus as compared to the developed land in its surrounding of five kilometres offset in a year, for the three consecutive years.

4. Result and Discussion

4.1 UiTM Seremban Campus

Land-use Land Cover (LULC): Fig. 2 illustrates the Land-use Land Cover (LULC) map of UiTM Seremban with an offset of 5 km from UiTM boundary. The LULC map was created using the ERDAS Imagine Software. It covers a 20 year time frame with 10 year interval which is 1999, 2009 and 2019. Table 4 represents the area of each land-use land cover category of the three different years. It can be seen that the highest area of water bodies covered in the study area is in 2019 with an area of 141.59ha. Meanwhile, the year 1999 and year 2009 covers the land with an area of 147.60ha and 141.593ha respectively. The area of the developed area continued to increase in 20 years - it covered 1435.14ha in the year 1999 and increasing to 3937.34ha for the year 2019. Forest areas have decreased from the year 1999 to 2009 with an area of 4481.10ha to 253.36ha due to the increasing mixed agriculture activity in the year 2009. However, from the year 2009 to 2019 the forest area increased from 253.26ha to 1329.15ha.

Mixed agriculture activity shows a fluctuation in the result as in the year 1999 the area covered was about 3343.14 ha - this increased to 7470.99ha in the year 2009 and decreased from the year 2009 to 2019 with an area of 7470.99ha and 5162.44ha respectively. The bare Soil class also shows a fluctuation in the 20 year time frame. The result shows that the areas covered were 17ha, 588.06ha and 803.61ha respectively in the years 1999, 2009 and 2019. Overall, most of the used land within these 5 kilometres in the area studies from 1999 to 2019 is covered with mixed agriculture. This shows that most of the area are used for agriculture purpose.

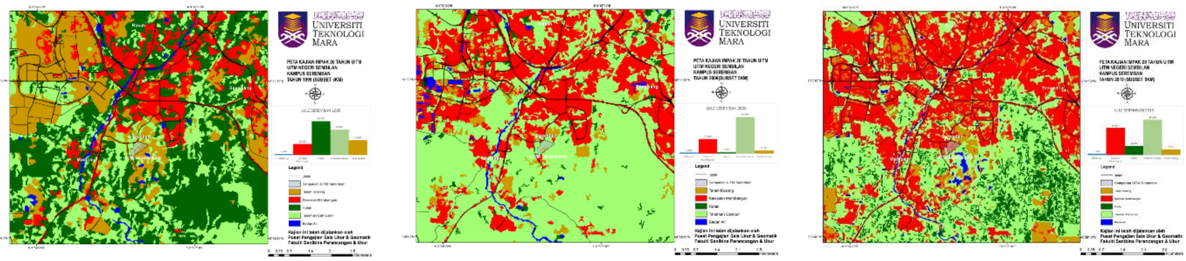

Fig. 2 - LULC map for the year 1999, 2009 and 2019 respectively with an Offset of 5km radius from UiTM's boundary

Table 4 - Summary of land-use/ land cover area for the year 1999, 2009 and 2019 (5km)

Code	Land Use Classes	1999		2009		2019	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
1	Water Bodies	147.6	1.29	189.9	1.66	141.593	1.24
2	Developed Area	1435.14	12.58	2903.94	25.46	3937.34	34.62
3	Forest	4481.1	39.29	253.26	2.22	1329.14	11.69
4	Mixed Agriculture	3343.14	29.31	7470.99	65.50	5162.44	45.39
9	Bare Soil	1999.17	17.53	588.06	5.16	803.61	7.07

Change Detection: Table 5 shows all the changes from 1999 to 2019, with changes from 'other land covered' or 'land-used' to another. Figure 3 summarizes change detection for UiTM Seremban in 20 years. For the 10 year time frame, from 1999 to 2009 it can be identified that the 3 major land changes within the 10 year time frame are top-tier by deforestation, no change and vegetation with an area of 41.63 per cent, 41.36 per cent and 10.24 per cent respectively. Compared to the next 10 years from 2009 to 2019, the highest land changes are no changes, urbanization and afforestation with an area of 60.76 per cent, 13.6 per cent and 11.40 per cent respectively.

Green area is an asset of an urban area and it is an important factor to sustain life and living in any rapidly growing cities such as Seremban. The rapid depletion of green areas in recent years might result in adverse conditions in urban areas and their surrounding areas. The loss of green areas brought many problems and harm to the area and population, thus drastic action must be taken by the local authority. Initiatives should be taken by various government and non-government organizations to avert the area from the negative effects of urban pollution and deforestation, but the situation seems to overdo the expected rate of change and expansion. Green area is dynamic, and spatial metrics analysis is imperative for understanding the landscape ecological conditions of the urban green area. The result in change detection reveals that the green area in Seremban is declining via a higher percentage in deforestation and urbanization (Fig. 3). The green area will continue to decline if there is no specific measure taken by the local authority. Comprehending the results of data classifications and explanation of the green area changes based on relevant information shows that the increase of built-up area and sprawl development patterns are factors that contribute to changes of green area in Malaysia.

Table 5 - Area (Hectare) of Change Detection UiTM Seremban (5km Radius)

	Water Bodies (WB)			Development Area (DA)			Forest (F)			Mixed Agriculture (MA)			Bare Soil (BS)		
	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19
WB	59.22	39.58	42.37	17.19	84.02	28.44	10.53	2.84	2.12	58.50	59.18	73.19	2.16	3.35	1.40
DA	12.24	14.13	8.64	1178.73	2340.40	1164.08	26.28	6.39	0.81	196.29	355.61	172.94	21.60	180.65	83.86
F	41.94	14.69	45.99	522.09	50.22	956.12	127.26	32.51	745.16	3594.96	132.03	2489.87	194.85	23.27	225.77
MA	43.47	70.52	27.90	226.71	1162.98	655.70	54.63	1266.32	531.41	2804.67	4426.13	1846.64	213.66	524.23	274.79
BS	33.03	2.68	16.70	959.22	299.72	1133.01	34.56	21.08	49.66	816.57	189.50	579.80	155.79	72.11	217.80

Note: WB: Water Bodies DA: Developed Areas F: Forest A: Agriculture BS: Bare Soil

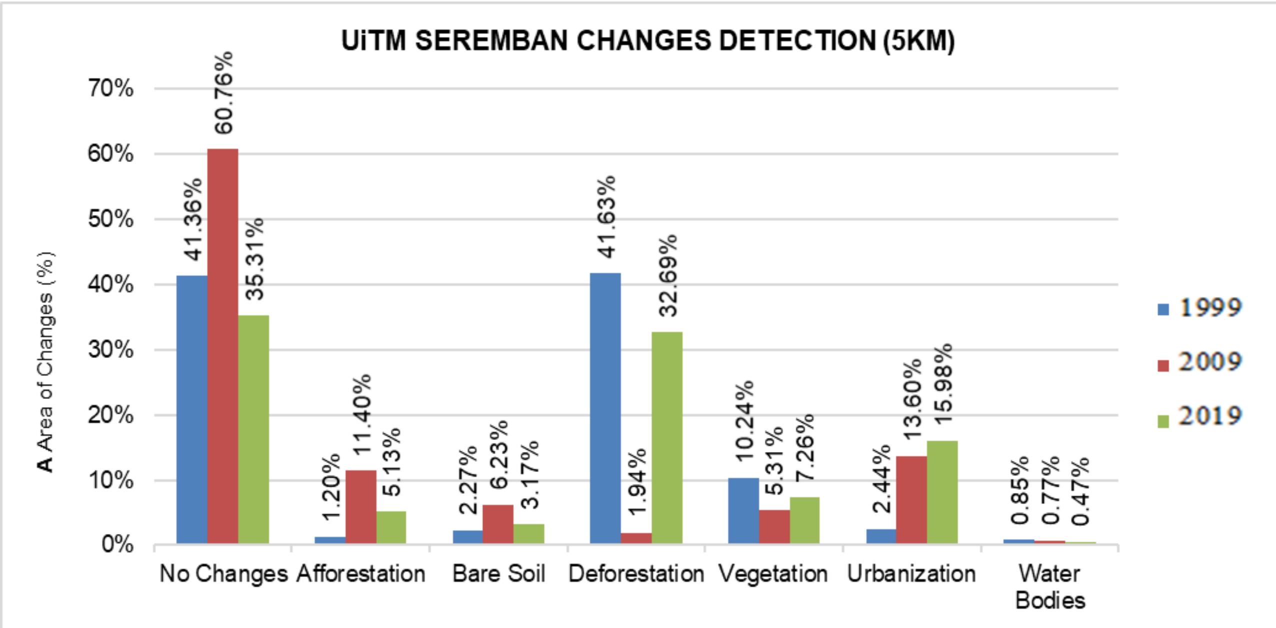

Fig. 3 - Change detection for UiTM Seremban in 20 years (5km Radius)

The UiTM Seremban Campus was launched on the 19th of January 2011. UiTM Seremban has become one of the factors that influence the development in the Seremban area. Within the 20 year time frame, the land conversion into the developed area is quite significant. The conversions of the land into developed areas can be seen along the Seremban Road where UiTM Seremban is located. The land-use conversions are mainly for human settlements and commercial activities. The developed area within 5 kilometers from UiTM Seremban has increased from 1999 to 2019. This shows that the areas are developing from time to time.

The developed areas include features such as temporary and permanent buildings, houses, villages and artificial infrastructures (including roads and highways). In Fig. 3, an increased percentage urbanization from 2.44 per cent (1999) to 15.98 per cent (2019) shows that the areas within 5 kilometers in UiTM Seremban campus have given significant effects in terms of contributing to the development within the area. The increasing number of students has also given an effect on the area because those students need good infrastructure such as roads to enable them access to the campus or the town of Seremban. The good infrastructure also leads to an increase in the population of people that live within the area; indirectly contributing to the development of the area of Seremban. Thus, it can be said that the increment of the developed areas within the offset is due to the existence of UiTM Seremban (built-in 2011). The impact is more significant in 2019 as larger developments are identified.

4.2 UiTM Kuala Pilah Campus

Land-use Land Cover (LULC): Fig. 4 illustrates the Land-use Land Cover (LULC) map of UiTM Kuala Pilah with an offset of 5 km from UiTM boundary. The LULC map was created using ERDAS Imagine Software. It covers a 20 year time frame with 10- year intervals, at the years 1999, 2009 and 2019. Table 6 represents the area of each land-use land cover category of the three different years.

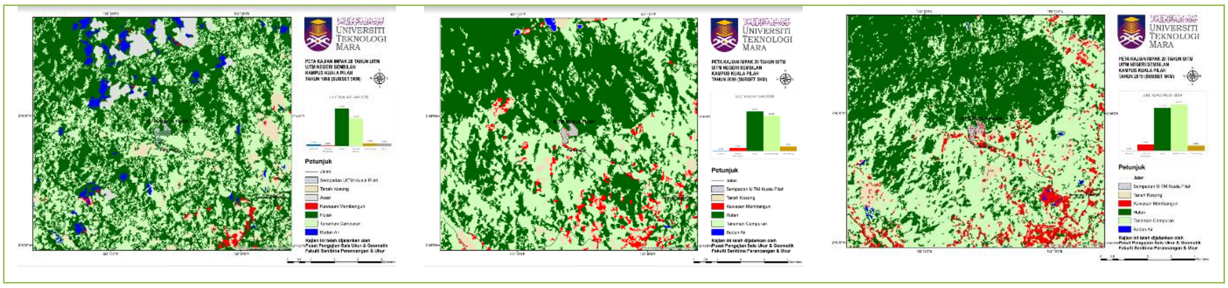

Fig. 4 - LULC map for year 1999, 2009 and 2019 respectively with an offset of 5km radius from UiTM's boundary

Table 6 - Summary of Land-use/Land Cover Area for Year 1999, 2009 and 2019 (5km)

Code	Land Use Classes	1999		2009		2019	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
1	Water Bodies	304.38	2.48	61.38	0.50	24.10	0.20
2	Developed Area	127.80	1.04	428.67	3.49	800.89	6.54
3	Forest	6,275.52	51.08	5,890.32	47.94	5,185.98	42.33
4	Mixed Agriculture	4,622.49	37.62	5,218.92	42.48	5,619.85	45.87
5	Bare Soil	530.64	4.32	686.61	5.59	621.86	5.08

It can be seen that the highest area of water bodies covered is in 1999 with an area of 304.38 hectares meanwhile year 2009 and year 2019 covers the land with an area of 61.38 hectares and 24.10 respectively. The developed area continues to increase in 20 years, covering 127.80 hectares in the year 1999, with continual expansion until 800.887 hectares for the year 2019. While the area of other land-use increased, the forest area, however, continues to decrease, from 6275.52 hectares in the year 1999 to 5185.98 hectares in the year 2019. However, the mixed vegetation area continued to increase from the year 1999 to 2019 with an area of 4622.49 hectares to 5619.85 hectares respectively. Over the first ten (10) years, the bare soil area has not changed significantly where the area was within 530.64 hectares in the year 1999, which increased to 686.61 hectares in the year 2009, but slightly decreased to 621.855 hectares in the year 2019. Obviously, the LULC changes have mostly occurred in forestry and vegetation areas in the 20-year time frame. In the year 2019, the highest use of land is covered by vegetation compared to the year 1999 where the highest use of land is forestry.

Change Detection: Table 7 shows all the changes from 1999 to 2019 which change from 'other land covered' or 'land-used' to another. Figure 5 summarizes the change detection for UiTM Kuala Pilah in 20 years. For the 10- year time frame, from 1999 to 2009, it can be identified that the 3 major land changes by top-tier were No Change, Deforestation, and Afforestation with an area of 54.87 per cent, 18.86 per cent and 17.99 per cent respectively. For the next 9 years from 2009 to 2019, the 3 major land changes remain the same as 1999 to 2009, with the highest land change being No Change, Deforestation, and Afforestation with an area of 60.37 per cent, 16.95 per cent and 11.35 per cent respectively.

Table 7 - Area (Hectare) of change detection UiTM Kuala Pilah (5km Radius)

	Water Bodies (WB)			Development Area (DA)			Forest (F)			Mixed Agriculture (MA)			Bare Soil (BS)		
	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19
WB	2.07	0	0.92	9	1.78	7.31	208.89	48.42	211.97	60.39	7.52	78.37	24.03	3.08	4.82
DA	0	1.55	0.32	52.2	149.69	79.52	18.81	65.57	18.18	34.56	178.97	22.21	22.23	32.54	7.58
F	41.94	9.97	12.85	206.55	149.56	393.01	3737.16	3795.12	3295.78	2008.62	1758.53	2336.26	0	158.72	218.07
MA	6.03	9.36	7.63	92.43	387.65	226.98	1598.49	1082.52	1301.47	2684.79	3376.4	2747.86	281.25	351.52	327.35
BS	11.25	3.22	1.98	64.98	112.21	93.67	64.35	194.36	62.3	298.26	298.44	308.72	91.8	76.01	63.11

Note: WB: Water Bodies DA: Developed Areas F: Forest A: Agriculture BS: Bare Soil

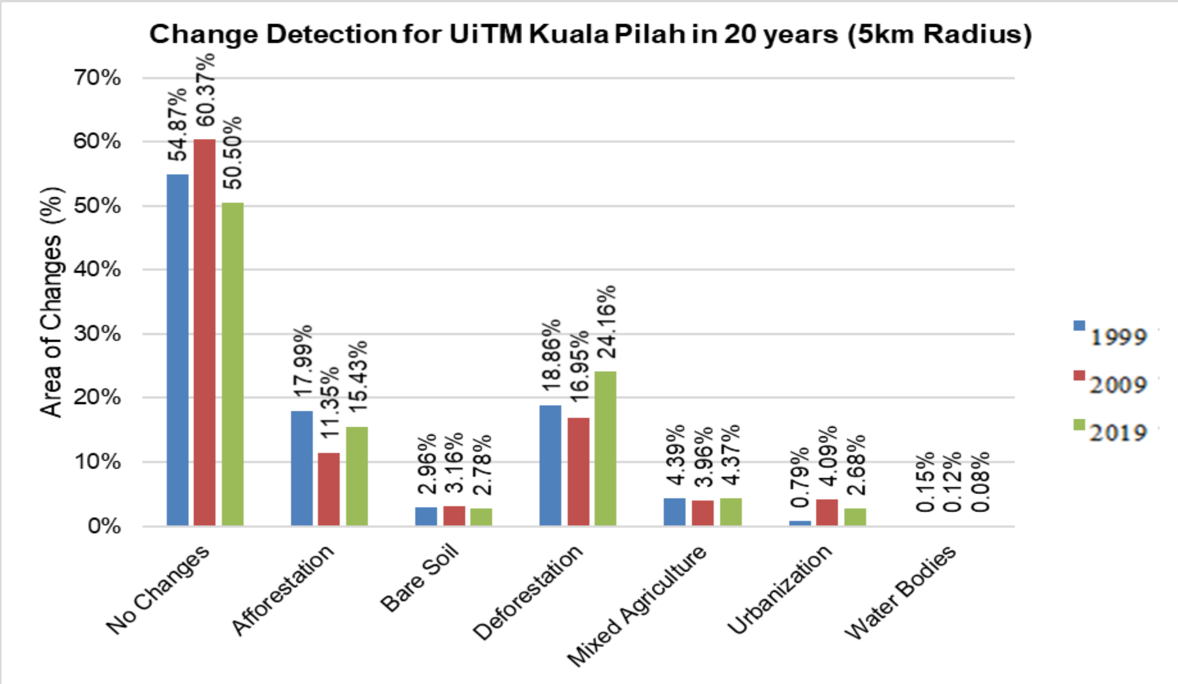

Fig. 5 - Change detection for UiTM Kuala Pilah in 20 years (5km Radius)

UiTM Kuala Pilah was launched on 1 January 2009. UiTM Kuala Pilah has become one of the factors that influence the development in the Kuala Pilah area. Within a 20-year period, the land conversion into the developed area is quite significant. The conversions of the land into developed areas can be seen along with the Kuala Pilah areas where UiTM Kuala Pilah is located. The land-use conversions are mainly human settlements and business areas. In Figures 5 above, different colors represent different years of development. In 1999, a lack of attention on the area resulted from the inexistence of major attractions for urbanization. Temporary and permanent buildings, houses, villages and artificial infrastructures, including roads and highways were minimal.

Although the development is less (2.68 per cent) than that of the development in the Seremban campus (15.98 per cent), the urbanization of the area can be seen as more housing and premises are built within the 5km radius. This demonstrates the increasing housing need and population migration in the area. The presence of UiTM in the location sparked the interest of its staff, students as well UiTM guests to either buy or rent houses in the vicinity. Moreover, the requirement for nearby facilities and services such as restaurants, grocery shops, and laundry services also increased and continues to increase.

4.3 UiTM Rembau Campus

Land-use Land Cover (LULC): Fig. 6 illustrates the Land-use Land Cover (LULC) map of UiTM Rembau with an offset of 5 km from UiTM boundary. The LULC map was created using ERDAS Imagine Software. It covers a 20-year time frame with 10-year intervals, at years 1999, 2009 and 2019. Table 8 represents the area of each land-use land cover category of the three different years.

It can be seen that the highest area of water bodies covered is in 2009 with an area of 131.31 hectares- meanwhile, years 1999 and 2019 show covered the land with an area of 3.69 hectares and 92.67 hectares respectively. The developed area continued increasing within 20 years; it covered 105.66 hectares in the year 1999 and continued increasing until 418.815 hectares for the year 2019. While the area of other land-use increased, the forest area continued to decrease from 4250.97 hectares in the year 1999 to 1191.89 hectares in the year 2019. However, mixed agriculture areas have fluctuation results as the area increased from year 1999 to 2009 and decreased from 2009 to 2019 with an area of 5684.58 hectares, 8669.52 hectares and 8531.03 hectares respectively. Similarly, the existence of bare soil areas is the result of fluctuation areas for the years 1999, 2009 and 2019 with an area of 1777.32 hectares,930.6 hectares and 1587.98 hectares respectively.

It can be seen that the LULC changes have mostly occurred in forestry and vegetation areas in a 20- year time frame. In 2019, similar to UiTM Kuala Pilah, the highest use of land is covered by vegetation compared to year 1999 where the highest use of land is forestry.

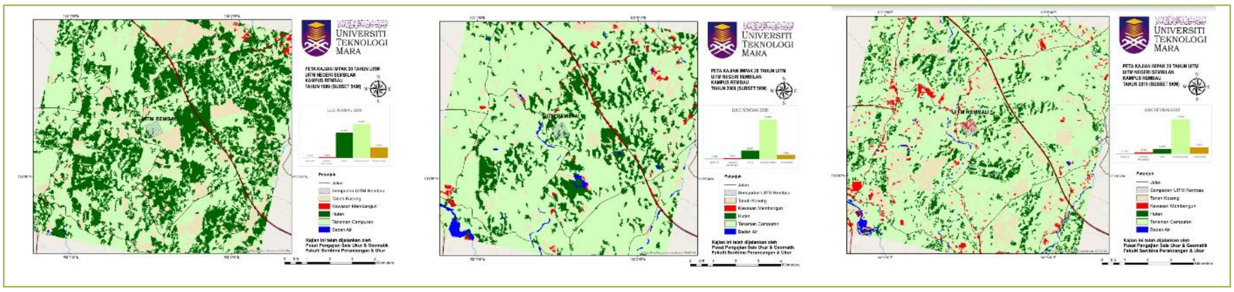

Fig. 6 - LULC map for the year 1999, 2009 and 2019 respectively with an offset of 5km radius from UiTM's boundary

Table 8 - Summary of land-use/ land cover area for the year 1999, 2009 and 2019 (5km)

Code	Land-use Classes	1999		2009		2019	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
1	Water Bodies	3.69	0.03	131.31	1.11	92.6775	0.78
2	Developed Area	105.66	0.89	223.2	1.89	418.815	3.54
3	Forest	4250.97	35.96	1867.59	15.80	1191.89	10.08
4	Agriculture	5684.58	48.08	8669.52	73.33	8531.03	72.16
9	Bare Soil	1777.32	15.03	930.60	7.87	1587.98	13.43

Change Detection: Table 9 shows all the changes from 1999 to 2019 which change from 'other land covered' or 'land-used' to another. Fig. 7 summarizes the change detection for UiTM Rembau in 20 years. For the 10-year time frame, from 1999 to 2009, it can be identified that the 3 major land changes within the 10 year time frame are top-tier by No Change, Deforestation, and Afforestation with an area of 53.14 per cent, 26.62 per cent and 6.32 per cent respectively. For to the next 10 years from 2009 to 2019, the 3 major land changes remain the same as that for between years 1999 to 2009, where the highest land changes are No Change, Deforestation, and Afforestation with an area of 57.74 per cent, 14.45 per cent and 8.72 per cent respectively

Table 9- Area (Hectare) of Change Detection UiTM Rembau (5km Radius)

	Water Bodies (WB)			Development Area (DA)			Forest (F)			Mixed Agriculture (MA)			Bare Soil (BS)		
	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19	99- 09	09- 19	99 -19
WB	2.34	44.10	1.89	0.00	7.74	0.00	0.00	14.04	0.45	0.54	51.23	1.35	0.81	13.79	0.00
DA	1.17	0.83	0.52	55.53	80.01	43.70	17.28	1.06	1.89	25.47	98.15	47.93	6.21	42.62	11.41
F	49.32	5.63	33.10	60.39	48.85	108.11	1125.00	160.61	520.25	2634.93	1353.67	3069.22	381.33	297.29	514.64
MA	51.57	37.80	38.36	28.62	185.87	131.56	532.98	979.79	529.49	4792.86	6376.79	4182.14	278.55	1077.19	794.99
BS	26.91	4.14	18.63	78.66	95.56	134.66	192.33	34.52	137.93	1215.72	639.20	1218.40	263.70	155.84	265.68

Note: WB: Water Bodies DA: Developed Areas F: Forest A: Agriculture BS: Bare Soil

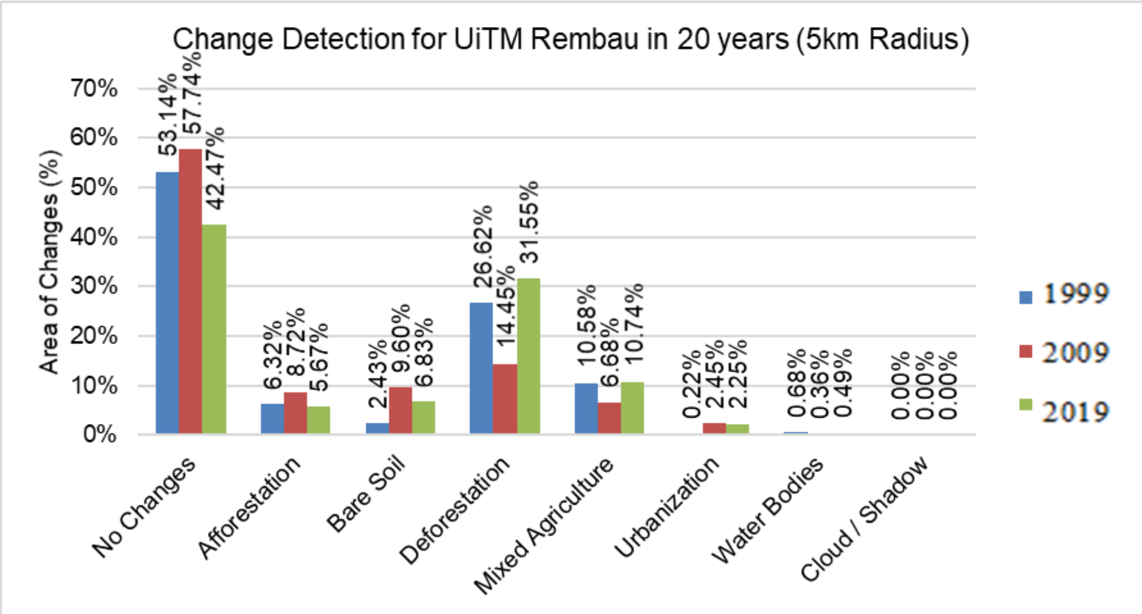

Fig. 7 - Change detection for UiTM Rembau in 20 years (5km Radius)

UiTM Rembau was launched on 26 August 2013. UiTM Rembau has also become one of the factors that influence the development in the Rembau area. It is noticeable that within 20 years the area has undergone a dynamic process of development. The change is visible through the satellite images is taken in 1999, 2009 and 2019. The transformations of the land into urbanized areas is visible along the Rembau district, where UiTM Rembau is situated. Urbanized areas within 5 kilometers from UiTM Rembau are growing from 1999 to 2019 as can be observes in Figure 7. The rate is less 2.25 per cent than the development in Kuala Pilah and Seremban with the increasing percentages of 2.68 per cent and 15.98 per cent respectively in 2019.

Since the campus had officially started operating and receiving students only in January 2017, the number of students and staff intake has yet to reach the maximum capacity of the building. Thus, it is expected that the population and the development in nearby areas will keep growing year by year. Similar to UiTM Kuala Pilah development progress, the first 10-year development is less than the next 10 years of the campus's establishment. Clearly, it can be said that the increment of the developed areas within the offset is due to the existence of UiTM Rembau (built-in 2013).

This study is to evaluate the impact of LULC change on developed areas and urbanization around UiTM campuses by using a remote-sensing technique. The result showed that a major LULC change in all areas of UiTM campuses is the conversion of forest land or agricultural land into urbanized areas. People start to migrate from other towns and places to facilitate the demand growth around UiTM campuses. The development has been slowly and positively increasing in the past 20 years. The conversion occurred more in the core region of Seremban compared to UiTM Kuala Pilah and Rembau. This development comprised of residential, commercials and industrial areas mostly. This indicates that population growth, industrial development and economic growth are the predominant drivers of urban expansion in Malaysia.

Aligned with the findings by Nurda et al., [8] change detection analysis has the advantage to visualize the dynamics of changes such as deforestation and afforestation as presented in the findings. Agricultural sustainability will be affected by increasing urban development in Malaysia in the long term. The change detection analysis could help to create new policy spaces for IHL development in an area, to be included in the designing of national and sub-national policies.

A strong positive relationship exists between increased urban and open areas because of the need for cleared lands for new development processes. The land-use change detection technique is an effective method for measuring and evaluating urban development operations and their effect on the sustainability of lands, which should be considered as a supporting tool to achieve sustainable development requirements, particularly in Peninsular Malaysia and generally Malaysia.

This also study confirms the applicability and effectiveness of the combined method of satellite image and GIS technology to detect changes and developments across time and is consistent with previous studies [2], [7]. For the past 20 years, there are a lot of significant changes in the nearby area development of UiTM campuses. For Negeri Sembilan UiTM campuses, this paper shows a similar result by Bessah et al., [4] that the decisions of developing an area by increasing the LULC will affect the future landscape. Indeed, the development of UiTM campuses has somehow increased the human population and industrialization of the locality. For instance, in terms of the local economy via employment opportunities and through direct purchase of goods and services. The result echoes the studies by Michael [1] and Wizor & Eludonyi [9].

5. Conclusion

Development on Institutes of Higher Learning has triggered built-up land uses such as housing, transportation, institutions and public facilities as well as infrastructure and utilities. Land use changes in rural areas, on the other hand, contribute to the conversion of agricultural land to various types of urban land uses. This study used satellite image interpretation and digital image processing to show the land use changes that happened in Seremban, Kuala Pilah, and Rembau through time and space. The pattern of change and suitability of land use is a phenomenon that needs to be investigated in order to develop a comprehensive scenario of suburban/urban land use in the future. The precise measurement of elements that can contribute to land use changes is also necessary in order to examine factors that drive land use changes more effectively. Agriculture, forest, and water bodies, which are easy targets for development pressure, must be planned, managed, and monitored in order to accomplish sustainable land development. Indeed, the complicated relationship between the creation of IHLs and land use shows that, in order to better understand urban activities and their spatial impact on land use, we need to conduct a variety of spatial interaction analyses.

There is limited scope in this research on LULC studies. Recommendations for future studies are to make further extension by having collaboration between the government and the community. Generating data from both parties provide a clearer picture of the development in the area of studies. Besides that, it is suggested for future studies that the data generated is on a bigger scale, for instance, involving IHL in Malaysia or even South East Asia, to increase the accuracy and generalizability of the results.

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