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## **GREEN COVER TREND: TOWARDS A SUSTAINABLE CITY-CAMPUS RELATIONSHIP BETWEEN PUNCAK ALAM AND ITS VICINITY**

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### **Abstract**

Urbanisation has emerged as a significant driver of global green cover changes. In response, cities and campuses increasingly recognise the importance of integrating nature into urban environments for sustainability. This study aims to investigate the temporal and spatial changes in green cover in Puncak Alam and its surroundings. This research involves examining land-use planning documents and satellite imagery data from 2016 to 2022. At the macro level, there was a significant loss of green cover from 2013 to 2016 (13.81%) due to urban expansion. From 2016 to 2022, the decrease in green cover was smaller (6.3%), followed by an expected increase of 3.2% in 2025. At the micro level, Puncak Alam experienced a significant decrease in green cover from 2016 to 2019 (4.8%), accompanied by an increase in man-made cover (3.5%). Collaborative efforts between cities and campuses are crucial for promoting green cover and creating environmentally resilient and socially vibrant urban areas.

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## **INTRODUCTION**

Rapid urbanization poses significant challenges for global urban resilience. Malaysia, as one of South East Asia's most urbanised nations, is projected to have an urban population of 22.58 million by 2025 (JPBD 2016; PLANMalaysia, 2016). Unfortunately, the conversion of green spaces, such as forests, parks, and agricultural land for profit-driven purposes has led to their decline (Kuala et al., 2004; Maryanti et al., 2016; Richards et al., 2017). This trend is particularly pronounced in several Southeast Asian cities, where green cover is alarmingly low.

The rapid urban expansion in Malaysia poses a threat to green cover, especially protected areas (Kanniah, 2017). Despite the declining per capita green space in Malaysian cities, urban green spaces are still being converted for purposes of housing, industry, and transportation infrastructure (Kanniah, 2017; Rasli et al., 2019). This trend contributes to climate-related environmental issues, including air pollution, rising temperatures, flooding, and landslides (Kanniah, 2017; Zaman et al., 2017; Morris et al., 2015; Elmahdy & Mostafa, 2013). However, it is crucial to recognize, preserve, and protect areas of green cover as they play a vital role in providing ecosystem services and enhancing the well-being of urban populations, helping to balance the ongoing growth of built-up areas.

To achieve enhanced sustainable development, Malaysian universities, under the encouragement of the Ministry of Higher Education, are actively implementing green campus projects and establishing Centers of Excellence (Muhiddin et al., 2023). As leading higher learning institutions, it is vital for universities to translate innovative theories and environmental education into tangible actions that promote sustainability and contribute to the shaping of a sustainable future for society. This study aims to investigate the potential of a city campus to become a significant green cover within a city, and to analyze green cover trends in Puncak Alam and its surrounding areas to foster a sustainable relationship between the campus and the city.

## **CAMPUS AS “GREEN COVER”**

As demonstrated in this Land Use (LU) / Land Cover (LC) imagery study, the term "green cover" refers to vegetated areas in aerial data that are privately owned, shared, or publicly accessible for leisure and relaxation in urban settings (Kanniah, 2017). Studies conducted globally have highlighted the crucial role of green cover, including urban forests and parks, in climate change adaptation and mitigation (Selmi et al., 2016). It acts as a filter for polluted air, sequesters atmospheric CO<sub>2</sub> (Tang et al., 2016), and aids in stormwater management (Berland et al., 2017). Even small city parks contribute to cooling effects that mitigate urban heat islands (Oliveira et al., 2014). Well-designed and well-

maintained urban parks and recreational forests serve to foster social interaction, public health, and the overall well-being of urban dwellers (Donovan, 2017). Numerous studies conducted by Threlfall et al. (2017) and Karuppanan et al. (2014) reinforce the importance of urban green cover, particularly protected areas such as urban forests and parks.

Green cover in urban areas has garnered global attention due to its significant role in achieving United Nations Sustainable Development Goals (SDGs) and addressing urban climate change and population growth (Kanniah, 2017; "Millennium Development Goals Report 2014"). Universities recognize the importance of green cover for sustainability and can contribute by enhancing green spaces on their campuses and providing ecosystem services to surrounding areas. This aligns with SDG 15, which aims to protect forests, biodiversity, and promote sustainable management (Brandli et al., 2019). By having abundant green spaces, university campuses serve as vital partners in promoting sustainability and maximizing the use of green areas. By prioritizing local and regional sustainability initiatives, universities contribute to the integration of SDGs into green space planning, particularly SDG 4 for lifelong learning opportunities and SDG 15 for preserving natural resources for future generations. Education for sustainable development plays a crucial role in raising ecological awareness and fostering environmental conservation, and campus-city relationships encompass both physical and functional aspects of this (Curvelo Magdaniel et al., 2018).

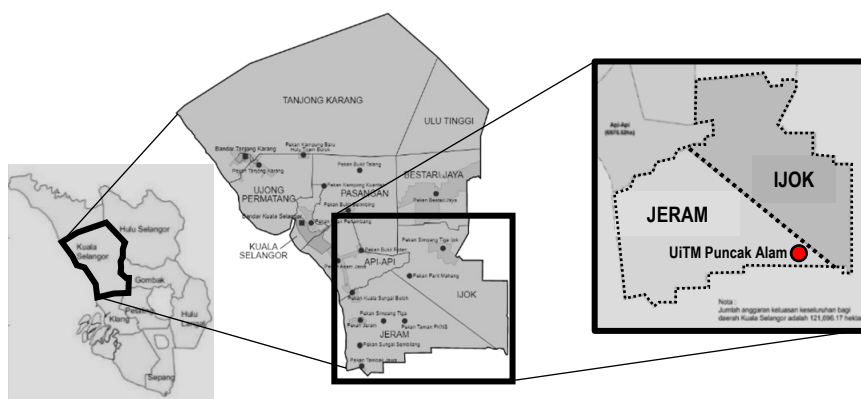
The physical relationship between a campus and its surrounding city is referred to as the campus-city connection, which can be classified into three spatial configurations: outside the city, gated within the city, and integrated with the city (Mohammed et al., 2022). These spaces play a crucial role in promoting sustainability by influencing behaviour, disseminating values and information, and translating theoretical concepts into action (Finlay & Massey, 2012). Higher Education Institutions (HEIs) bear the responsibility of educating students and supporting sustainability initiatives within the academic community (Katiliate & Staniskis, 2017). When recognized for their ecological potential, university campuses can transform into green campuses, serving as educational and scientific hubs in addressing global challenges and seeking sustainable solutions (Thomashow, 2014). Acknowledging and harnessing the ecological potential of a university campus is the initial step towards practicing sustainability.

Maximising its green spaces enables university campuses to lead the way in sustainability, providing environmental, social, and economic benefits to densely populated surrounding areas (Brandli et al., 2019). However, neglecting the ecological potential of campuses jeopardises these advantages (Jennings et al., 2016). By expanding green cover and serving as green refuges, universities can foster the local spread of a culture of sustainability, benefiting the

surrounding areas and increasing green cover per capita. Therefore, university campuses play a vital role in promoting a sustainable future and green potential.

## METHODOLOGY

Located in Bandar Puncak Alam, Mukim Jeram, Kuala Selangor, the UiTM Puncak Alam Campus is affected by the changing landscape of its surrounding areas due to the development of new township. This has resulted in a significant decline in green cover within Puncak Alam. Furthermore, Selangor as a whole has experienced forest cover loss and agriculture cover loss since 2011 (Baig et al., Takaijudin, & Zeshan, 2022). This study focuses on Bandar Puncak Alam, specifically Mukim Ijok and Jeram, to examine the trend of green cover surrounding UiTM Puncak Alam, as shown in Figure 1. The analysis also includes the micro context of green cover trends within the UiTM Puncak Alam campus.



**Figure 1** Location of Mukim Ijok and Jeram within Kuala Selangor district  
*Source: RT MDKS 2025*

Data collection for analyzing land use and green cover distribution in Mukim Ijok and Jeram utilized a content analysis method and a geographic information system (GIS) mapping approach. Content analysis was carried out to analyze land cover distribution in 2013 and projected 2025 data from *Rancangan Tempatan Majlis Daerah Kuala Selangor 2025*, enabling flexible integration in spatial analysis (Zaleckis et al., 2019). GIS mapping using Open Street Map was employed to collect data on land use mapping and green cover distribution in 2016, 2019, and 2022. To ensure accuracy, this study adopted the Majlis Perbandaran Kuala Selangor's land use/land cover (LULC) classification for green cover (natural environment) and man-made cover (built environment)

based on Kanniah's definition of green cover (2017), as presented in Table 1 below.

**Table 1: Description of LULC in Mukim Ijok and Jeram**

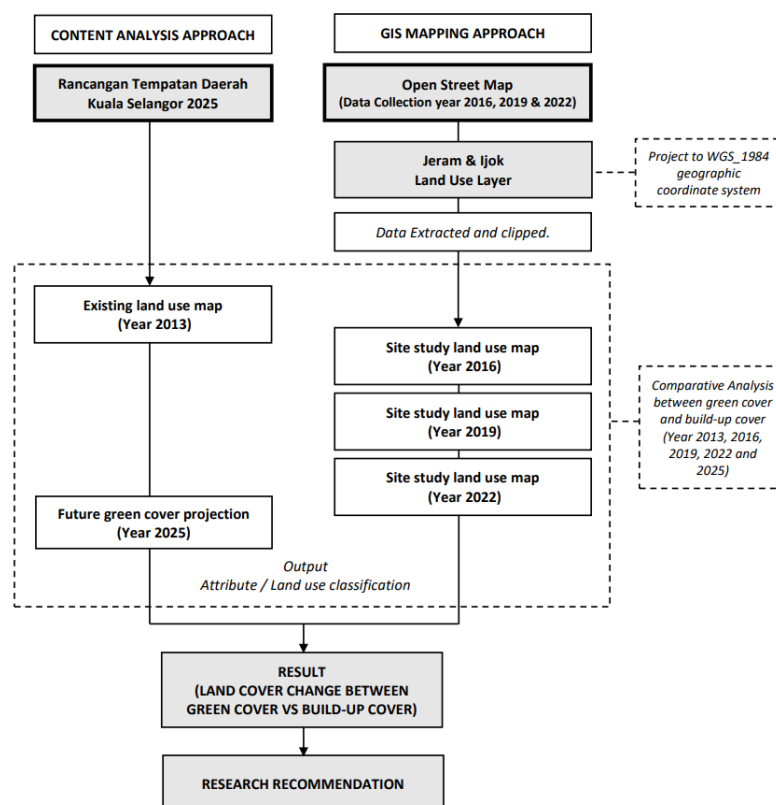
No	Land Use	2013		2025		Changes (Hectares)
		Area (hectares)	(%)	Area (hectares)	(%)	
<b>Green cover</b>						
1	Open space and recreation	502.35	1.8	534.74	1.9	32.39
2	Agriculture	20836.14	72.8	16015.27	55.9	-4820.87
3	Forest	73.83	0.3	65.55	0.2	-8.28
		21,412.31	74.9	16,615.56	58.0	(-16.9%)
<b>Man-made cover</b>						
4	Residential	1140.82	4.0	6094.66	21.3	4953.84
5	Industry	332.13	1.2	1871.41	6.5	1539.28
6	Commercial	88.41	0.3	434.38	1.5	345.97
7	Institution & Public Amenities	626.46	2.2	786.12	2.7	159.66
8	Infrastructure and Utilities	122.57	0.4	207.64	0.7	85.07
9	Transportation	2053.65	7.2	2314.5	8.1	260.85
10	Vacant Land	2542.2	8.9	60.16	0.2	-2482.04
		6906.24	24.2	11768.87	41	(+16.8%)
<b>Excluded</b>						
11	Waterbody	107.72	0.4	113.91	0.4	6.19
12	Coast/beach	199.03	0.7	127.82	0.4	-71.21
13	Aquaculture	14.69	0.1	13.84	0.0	-0.85
		321.44		255.57		
<b>TOTAL</b>		<b>28640</b>	<b>100</b>	<b>28640</b>	<b>100</b>	

*Source: Analysed from RT MDKS 2025*

This study examined land use and green cover changes in Mukim Ijok and Jeram, encompassing thirteen key land use and land cover (LULC) classes. LULC information was extracted from Open Street Map (OSM) data using visual interpretation and digital image processing techniques. Figure 2 illustrates the overall methodology employed in this study.

***Extraction of study area administrative boundary***

Extraction of the administrative boundary of the study area involved scanning and digitizing RTDKS 2023 topographical maps. Geo-referencing was performed in ArcGIS using affine transformation and nearest neighbourhood interpolation, with the datum set to WGS\_1984 and projection set to UTM. Sub-setting, mosaicking, and map digitization were conducted to extract the district boundaries within the study area.



**Figure 2:** Research methodology flow chart  
 Source: Authors, 2023

### **OSM Data Preparation (OSM)**

For the OSM data preparation, shape file maps of Malaysia for the years 2016, 2019, and 2022 were downloaded from Geofabrik's server (<http://download.geofabrik.de/asia/malaysia-singapore-brunei.html>). The extracted OSM layers were then clipped to the study area boundary. In ArcGIS software, two layers were visualized, including the boundary and land use. The reference vector data were initially projected in the WGS\_1984 geographic coordinate system (Geofabrik, n.d.).

### **Change detection by Green cover area calculation**

To detect changes in green cover, the agriculture and open land use areas were calculated for the years 2016, 2019, and 2022. The district-level change was observed by calculating the green cover area for Mukim Ijok and Jeram using the

Calculate Geometry tool. The loss of agriculture and open land between the specified consecutive time intervals was determined by comparing the classified shape files of the three consecutive years.

A comparative analysis was carried out to assess the green cover trends in Bandar Puncak Alam (Mukim Ijok and Jeram) from 2013 to 2022, along with the projected green cover for 2025. This analysis unveiled the overall land cover trend, focusing on the balance between green cover and man-made cover at the macro level in Bandar Puncak Alam. Additionally, it examined the green cover trend within the UiTM Puncak Alam campus at the micro level.

## RESULTS AND DISCUSSION

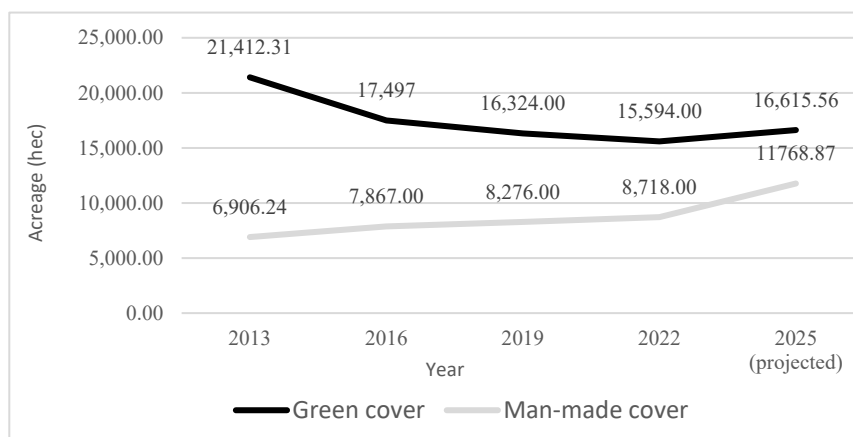
This section explores the temporal and spatial changes in green cover through macro and micro analyses of green and man-made cover between 2013 and 2025. Table 2 presents the land cover data for Mukim Ijok and Mukim Jeram in 2013, along with the projected acreage for 2025. The analysis reveals a projected 17% decrease in green cover at the Mukim level by 2025, primarily attributed to urban expansion and the conversion of natural land into built environments.

**Table 2:** Total land cover in 2013 and the projected acreage in 2025

No	Land Use	2013		2025		Changes (Hectares)
		Area (hectares)	(%)	Area (hectares)	(%)	
	<b>Green cover</b>					
	Total Green Cover	21,412.31	74.9	16,615.56	58.0	(-16.9%)
	<b>Man-made cover</b>					
	Total Man-Made Cover	6906.24	24.2	11768.87	41	(+16.8%)
	<b>Excluded</b>					
	Total excluded area (water bodies, beach, and aquaculture)	321.44		255.57		
	<b>TOTAL</b>	28640	100	28640	100	

*Source: Analysed from RT MDKS 2025*

The projected 16.8% escalation in man-made cover in 2025 signifies the growth of Puncak Alam City and its growing population. This development has led to an increased demand for housing, infrastructure, and commercial projects, causing the loss of vegetation and green spaces (RT MDKS 2025). However, the information available in Table 2 from RT MDKS 2025 only provides land cover data for 2013 and projections for 2025, making it challenging to observe the trend of land cover changes over the 12-year period.



**Figure 3:** Trend of actual land cover changes between 2013-2022 and the projected trend in 2025 for Mukim Ijok and Mukim Jeram  
 Source: Analysed from GIS Open Data (<https://download.geofabrik.de/>)

The analysis of RT MDKS 2025 land cover data and GIS open data from 2013 to 2022 provides detailed insights into land cover changes. Figure 3 illustrates the changes from 2013 to 2022 and the projected change in 2025. A significant loss of green cover was experienced from 2013 to 2016 (13.81%), followed by a smaller decrease of 6.3% from 2016 to 2022, and an expected increase of 3.2% in 2025. The connection between gradual changes in green cover and development is evident, with urbanization and infrastructure expansion contributing to the gradual decline (Douglas, 2012). Recognizing this link has enabled decision-makers, urban planners, and developers to adopt sustainable practices that preserve green spaces, striking a balance between development and sustainability for resilient cities.

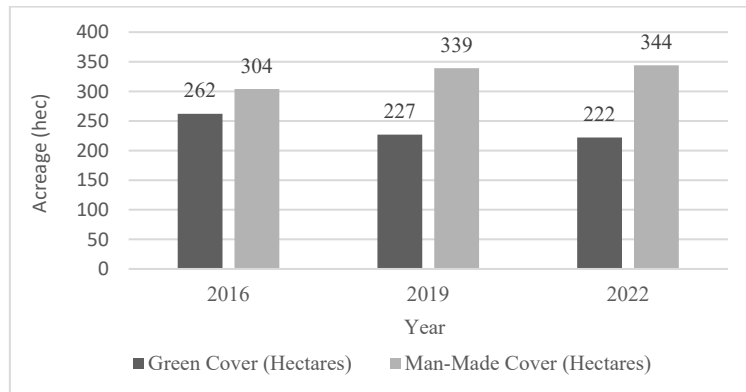
Figure 4 illustrates the spatial distribution of green land cover in Mukim Ijok and Mukim Jeram. Notable spatial patterns emerge in the distribution of green land cover between 2016 and 2022. Mukim Ijok has undergone significant changes in terms of man-made cover, particularly in the north, northwest, and southeast, including the Puncak Alam Town Centre. In contrast, Mukim Jeram, which houses UiTM Puncak Alam, shows fewer substantial changes in green cover compared to Mukim Ijok, which has been more impacted by the development of Puncak Alam Town.





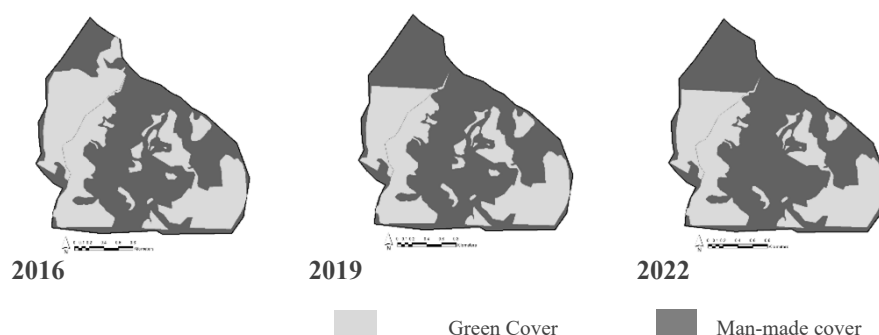
**Figure 4:** Spatial distribution of green and man-made covers between 2016-2022 of Mukim Ijok and Mukim Jeram  
*Source: Analysed from GIS Open Data (<https://download.geofabrik.de/>)*

At the macro level, the RT MDKS 2025 categorizes UiTM Puncak Alam's land cover as institutional. However, when zooming in for a micro-scale perspective by analyzing land cover changes from 2016 to 2022 (Figure 5), insights emerge into temporal changes on this campus. Between 2016 and 2019, UiTM Puncak Alam witnessed a significant 4.8% reduction in green cover and a 3.5% increase in man-made cover, primarily due to the development of the UiTM Teaching Hospital. Moving forward from 2016 to 2022, a slight 0.8% decline in green cover and a 0.5% rise in man-made cover occurred.



**Figure 5:** Temporal trend of land cover changes at UiTM Puncak Alam between 2016 to 2022  
*Source: Analysed from GIS Open Data (<https://download.geofabrik.de/>)*

Figure 6 depicts that there are no significant spatial changes in green cover and man-made cover at UiTM Puncak Alam. However, it is projected that the rapid development of Puncak Alam City will impact the northern part of the campus. Moreover, the UiTM Hospital area in the north-eastern part is influenced by the nearby development of the Hill Park commercial area. Green cover in universities offers numerous benefits to the city, including environmental improvement, biodiversity support, human health promotion, educational and research opportunities, aesthetic enhancement, cultural value, and climate resilience. The establishment of the UiTM Green Centre (UGC) in 2020 further emphasized the integration of sustainability in education, community engagement, and knowledge transfer, underscoring the importance of incorporating green spaces in urban areas and fostering a sustainable city-campus relationship (UGC, 2022).



**Figure 6:** Spatial distribution of land cover changes in UiTM Puncak Alam Campus between 2016-2022

Source: Analysed from GIS Open Data (<https://download.geofabrik.de/>)

The changes in green cover in Mukim Jeram and Mukim Ijok from 2013 to 2025 highlight the significance of urban green cover in addressing environmental challenges that arise from rapid urbanization (Song et al., 2020). Monitoring and responding to these changes assist policymakers in implementing sustainable land management and enhancing resilience. Projections of land cover changes in 2025 play a crucial role in effective urban planning, infrastructure development, and the promotion of liveability. Incorporating these projections into decision-making empowers policymakers to advance environmental sustainability, identify suitable development areas, plan essential infrastructure, and create a future landscape that is both sustainable and resilient.

In summary, understanding and addressing temporal and spatial changes in land cover at both macro and micro scales highlight the importance of partnership between universities and cities in shaping societal and economic dynamics through the application of knowledge for urban and regional improvement (Mohammed et al., 2022).

## **CONCLUSION**

The study reveals a 17% green cover reduction in Mukim areas by 2025 due to urban expansion and a 16.8% increase in man-made cover driven by Puncak Alam City's growth. Data limitations complicate tracking the 12-year trend, but examining 2013-2022 land cover data reveals fluctuations: a decline from 2013 to 2016, a lesser decrease from 2016 to 2022, and a projected 2025 increase. Recognizing the green cover-development link encourages sustainability, and this is further evident in the spatial changes in green land cover between 2016 and 2022 in Mukim Ijok and Mukim Jeram. The micro-scale analysis specifically emphasizes temporal changes at UiTM Puncak Alam, illustrating the positive impact of green spaces on cities, further supported by the sustainability efforts of the UiTM Green Centre. Monitoring green cover changes from 2013 to 2025 underscores urban green cover's role in addressing environmental challenges, guiding land management, and informing urban planning.

Continuous commitment and investment are necessary to enhance the green cover trend in city-campus sustainable relationships. Hence, future studies should consider sharing data surveys and focus group discussions with local authorities and experts. These methods enable comprehensive data collection, access to local expertise, data validation, collaboration, and co-creation of research. Engaging local authorities in the research process can generate more contextually relevant findings that can be helpful for future research and contribute to evidence-based decision-making.

In conclusion, land cover assessments highlight the vital university-city partnership, emphasizing green cover's urban importance and fostering sustainability collaborations. Universities may contribute to SDG 15 by promoting sustainability through green spaces and aligning with global sustainable goals.

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