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Urban Landscape Changes and Land Use Patterns: The Impact of Mass Rapid Transit (MRT) System Construction in the Context of Development in the Klang Valley between 2010 and 2020

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Abstract

The Klang Valley is a city located within the state of Selangor. As known, Selangor is home to 7.8 million residents and continues to grow steadily over time. This population increase has led to a rise in private vehicle ownership on the roads, with approximately 500,000 new vehicle registrations occurring each year. This increase in vehicles has paved the way for rail transportation to operate more extensively to alleviate traffic congestion in the Klang Valley area. Rail transportation provided in and around the Klang Valley area, such as the MRT, will play a crucial role in reducing these traffic issues. However, the construction of the MRT system in the area has spurred the process of urbanization. Therefore, the objective of this study is to analyze the changes in urban landscape and land use patterns in the Klang Valley area for the years 2010 and 2020 about the impact of the construction of the MRT system. Land use data used for this study includes land use maps of the Klang Valley area for the years 2010 and 2020. Land use in the study area has been categorized into five classification types: built-up areas, open land, forests, agriculture, and water bodies. The study results, using ArcGIS 10.8, indicate that changes in land use patterns occurred during the construction of the MRT system, with much development and infrastructure being built in the vicinity of MRT stations. The findings of this study suggest that the process of urbanization in the Klang Valley area has been actively occurring with the existence of the MRT system. The MRT system has influenced land use patterns, urban growth, and infrastructure development in the Klang Valley. Therefore, this study is crucial in examining the changes in land use patterns that occur in the Klang Valley with the implementation of the MRT system.

Keywords: Mass Rapid Transit (MRT), Landuse, Urban, Transportation, Malaysia

Introduction

Across the globe, mass transit carried 53 billion passengers in 2017, witnessing an increase of approximately 9 billion passengers since 2012, with most of this growth occurring in Asia and the Middle East-North Africa region. Asian transit systems carry over 26 billion passengers annually, while European routes transport more than 10 billion passengers, Latin America nearly 6 billion, and North America (U.S. and Canada) only 3.7 billion. Metro networks are most heavily utilized in Eurasia, with an average of 117 trips taken per capita last year. However, Eurasia is the only region experiencing a decline in per capita journeys (Florida, 2018). In Malaysia, according to Malaysian Transport Statistics (2021), the MRT rail transport service recorded 19,573,010 passengers in 2021 who utilized the MRT service to travel to specific destinations.

At present, the population has surged to over 32.63 million. This issue could lead to imbalances in situations such as traffic congestion and unhealthy conditions in most developing countries. Approximately 75% of urban areas in Malaysia have a very good public transportation system. The Malaysia Intelligent Transport System (MITS) Action Plan 2017–2022 was developed, citing public transportation as infrastructure for traffic management, and the Fourth Industrial Revolution (4IR) will transform the global public transportation landscape. The introduction of Rail Transportation has now become popular in the Klang Valley, with examples such as KTM Komuter, Light Rail Transit (LRT), Express Rail Link (ERL), Monorail, Mass Rapid Transit (MRT), and Skypark Link aiming to provide reasonable access within the geographical area (Syukri et al., 2022)

The issue of land use change is a common occurrence both in Malaysia and internationally. Land use changes are mostly caused by the urbanization process of an area transforming into a large city. Land use changes are closely related to basic economic principles (Borhan & Choy, 2018).The rapid urbanization process occurring in Malaysia has contributed to the increase in private vehicles, leading to traffic congestion in certain areas. Rail transportation is also one of the alternative transportation options available in a country, including Malaysia, as environmentally friendly transportation that does not rely on fossil fuels.

Transportation is one of the most crucial economic sectors for any given country. This is because it has the potential to provide benefits or advantages to the environment, society, and the economy at both local and global levels (Yahya and Safian, 2023). According to the Ministry of Transport (2022), various types of transportation are provided, including road networks, rail networks, and aviation. The transportation sector has a significant influence on sustainable development. Transportation infrastructure with complex networks is crucial for sustainable development as it connects cities and provides space for human activities, thereby contributing to the socioeconomic development of a country (Zheng et al., 2021). According to Martin et al (2021), transportation networks can facilitate urbanization processes, help generate connections, contribute to socio-economic development, and improve the quality of life for the population in a country, especially in Malaysia.

According to Talmizi and Tahir (2021) Mass Rapid Transit (MRT) or Rapid Transit Rail is known for its three main characteristics: first, "mass" meaning high carrying capacity, second, "rapid" implying quick travel times and high frequency, and finally, "transit" meaning stops at designated stations along the route. MRT can be defined as a public transportation service

capable of carrying a large number of passengers at a specific time. In Malaysia, the announcement for the MRT project was made by the former Prime Minister of Malaysia, Dato Seri Najib, in June 2010, and the MRT project was fully approved by the government in the same year, albeit in December (Berita Harian, 2016). The construction of the first MRT line began on July 8, 2011, and the full opening of the MRT line on July 17, 2017, covering a distance of 47 km for the Kajang Line, with 9.5 km of it being underground tunnels consisting of 7 underground stations (Khoo & Ooi, 2023; Kadir et al., 2020). According to the Mass Rapid Transit Corporation (2023), travel demand in the Klang Valley is estimated to reach 18 million movements per day by the year 2020. Therefore, the second MRT line, the Putrajaya Line, commenced full operations on March 16, 2023, stretching from Sungai Buloh to Serdang and ending in Putrajaya for a total distance of 57.7 km, with 13.5 km of it being underground tunnels and 10 new underground stations (Khoo & Ooi, 2023). The construction of the MRT project has been a catalyst for sustainable development and has driven economic activities in Malaysia. This is stated as such because the economic spillover from the MRT development has generated an increase in property values, with property prices expected to rise between 10 and 20 percent, and increased land use density along the corridor (New Straits Times, 2017). Therefore, the objective of this article is to analyze the land use patterns in the Klang Valley for the years 2010 and 2020 about the construction of the MRT system.

Methodology

Study Area

Lembah Klang is a metropolitan area located in Malaysia, situated in the heart of Selangor and Kuala Lumpur. Recognized as one of Malaysia's key regions, Lembah Klang serves as a central hub for economic activities, trade, and densely populated urban areas. Encompassing an area of approximately 2352 km2, the study area is defined as an urban conurbation in Western Malaysia, serving as the epicenter for the country's industry and commerce (Wahab et al., 2021). Additionally, the metropolitan area of Lembah Klang encompasses other major cities such as Petaling Jaya, Shah Alam, Klang, and more. The high population and population density contribute to making Lembah Klang one of the most densely populated metropolitan areas in Malaysia. In terms of ethnic composition, Malays make up the majority at 50.59%, followed by Indians at 11.62%, Chinese at 29.03%, other ethnic groups at 0.72%, and non-citizens at 8.04% (Department of Statistics Malaysia, 2021). The employment opportunities offered in Lembah Klang across various fields have spurred population migration, resulting in the significant population density of the major cities in the Lembah Klang area, reaching a current population of around 6 million people (Rostam, 2006). Covering an area of approximately 1,750 km2, Lembah Klang shares its borders to the north with the state of Perak, east with Pahang, south with Negeri Sembilan, and west facing the Strait of Malacca (Leong et al., 2015). Lembah Klang boasts numerous attractions for both visitors and locals, including the Shah Alam Bird Park, i-City Shah Alam, Sunway Lagoon Theme Park, and many more. The Klang River, with a length of around 120 km and covering about 1,288 square km, acts as the central water basin, spanning most of the Federal Territory of Kuala Lumpur and portions of the state of Selangor (Abd Majid et al., 2018). Additionally, the climate in the Klang Valley remains hot and humid throughout the year, with expectations of heavy rains and strong winds during the northeast monsoon (NEM), particularly in the evenings and early nights.

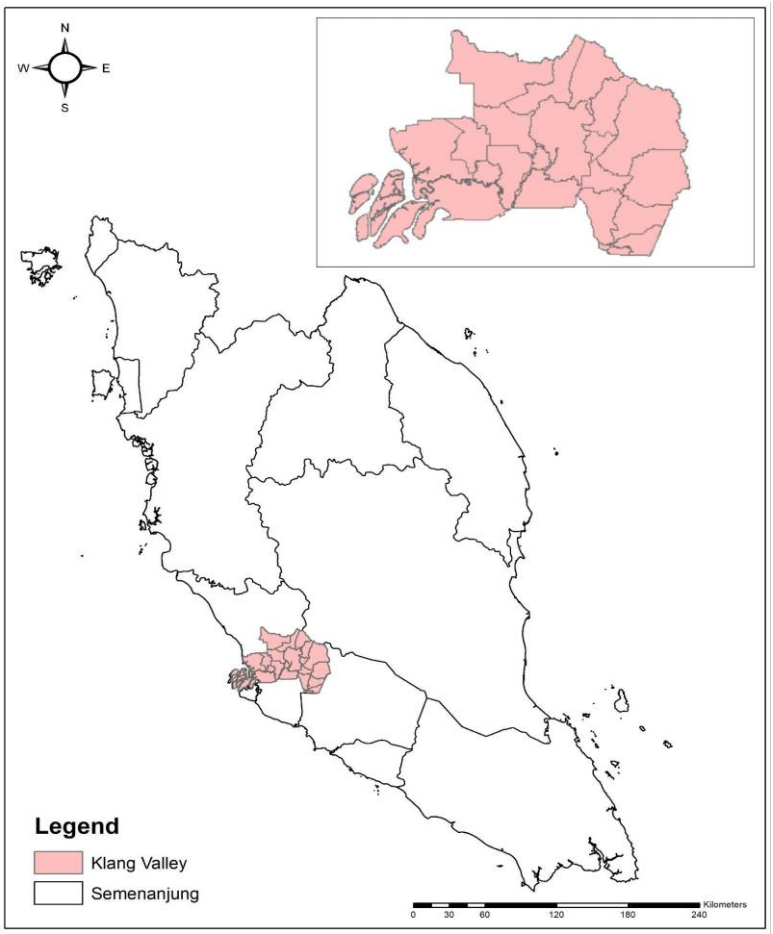


Figure 1.0: Study area,Klang Valley, Malaysia

Satellite Data

Land use and land cover (LULC) change detection was conducted using Landsat 7 ETM+ satellite imagery acquired for the study area in 2010 and 2022. Landsat 7 ETM+ data offers valuable insights into LULC dynamics over time, including urbanization, natural disasters, and other landscape alterations (Octarina et al., 2019). The imagery for both years was obtained from the U.S. Geological Survey (USGS) Earth Explorer online platform (https://earthobservatory.nasa.gov/). Notably, Landsat satellite data boasts a spatial resolution of 30 meters, making it well-suited for LULC change detection applications.

Image Processing

This study utilized Landsat imagery encompassing the state of Selangor, with a specific focus on the Klang Valley region. As depicted in Figure 2.0, the first step involved applying cloud masking to eliminate atmospheric interference from the Landsat images. Subsequently, we addressed scan line errors inherent in Landsat 7 ETM+ data by performing image correction. To isolate the Klang Valley from the broader imagery, we employed image clipping. This process leveraged a shapefile containing the Klang Valley's boundary, which was imported into a Geographic Information System (GIS) software for precise delineation.

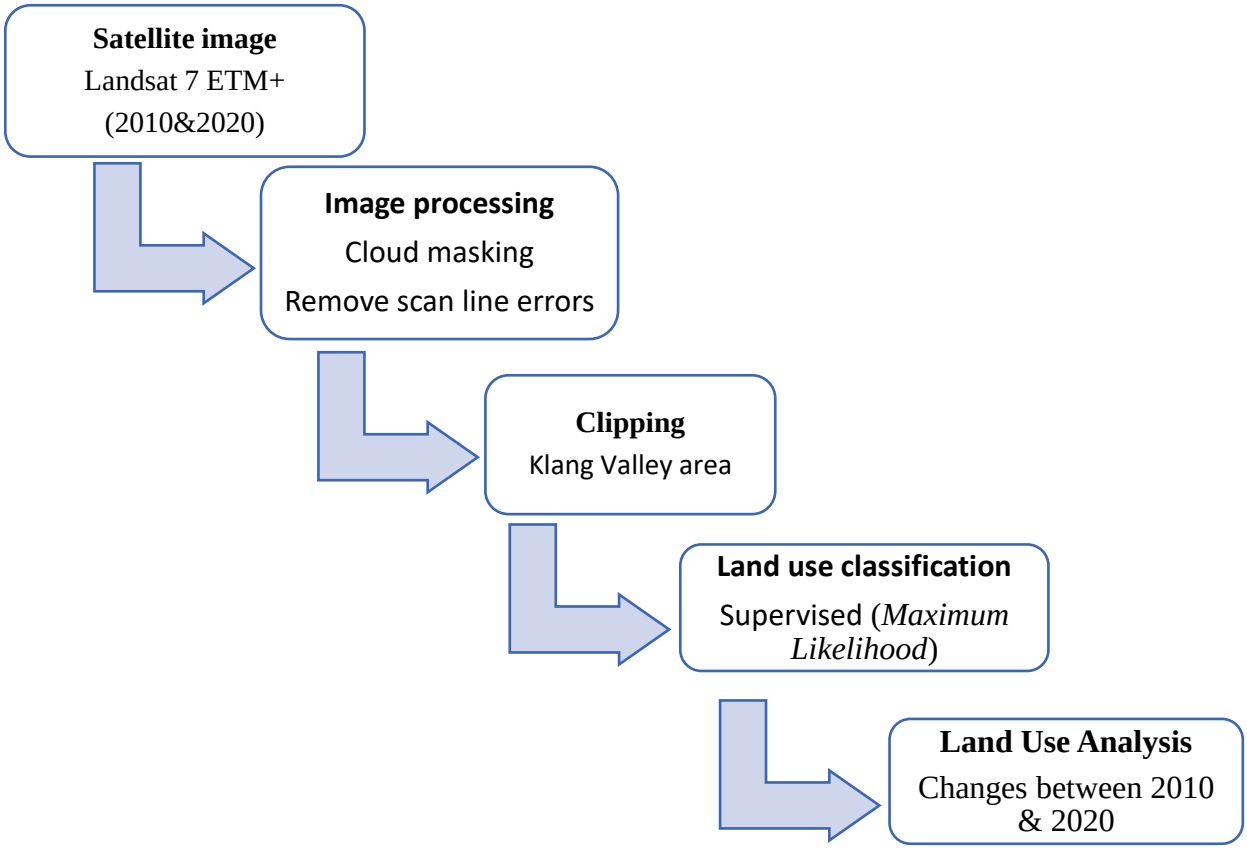


Figure 2.0: Methodology image processing

Land use Classification

There are several methods for land use classification such as supervised and unsupervised classification. In this study, the supervised classification method, specifically Maximum Likelihood, is employed to classify Landsat 7 ETM+ satellite images into land use categories using ArcGIS 10.8 software. In this process, all pixels of the satellite image are assigned to several predefined land use classes (Borhan & Choy, 2018). The resulting land use categories are divided into five classes: developed areas, bareland, forests, agriculture, and water bodies.

Result and Discussion

Table 1.0

Classification of Land Use in the Klang Valley

NO	LANDUSE TYPE	2010		2020		Land use change	
		Total (Ha)	Percentage	Total (Ha)	Percentage	Total	Percentage
1	Developed Area	56317.58	20.58	84397.59	30.02	28080.01	29.13
2	Water Bodies	11630.75	4.25	7084.75	2.52	-4546	-4.72
3	Forest	78699.45	28.76	94443.73	33.59	15744.28	16.33
4	Agriculture	40335.18	14.75	48492.79	17.25	8157.55	8.46
5	Bareland	86624.73	31.66	46763.63	16.63	-39861.1	-41.35
	TOTAL AREA	**273607.69**		**281182.50**		**96388.94**	

The process of urbanization, also known as urbanization process, has significantly impacted land use in various areas. Several growth patterns have emerged over time, notably urban development occurring both in rural and urban areas. As a result of these factors, significant changes have occurred in the Klang Valley area between 2010 and 2020. This study aims to assess the changes in land use that occurred when the first MRT system was implemented in the Klang Valley area. Additionally, it will evaluate the effects of the development that has taken place in the area on the local population.

Table 1.0 shows the increase in land use in the area is due to the presence of transportation facilities such as the MRT system, which has contributed to urban development, particularly in terms of housing, infrastructure, shopping centers, and so on. This is because the MRT system has become a primary driver of urbanization in the Klang Valley area, as it serves as a focal point for the public with the amenities it provides. Furthermore, table 1.0 shows the classification of Land Use in the Klang Valley above also shows that the land use for Bareland recorded the highest percentage in 2010, accounting for 31.66%. Meanwhile, in 2020, land use for forests recorded the highest percentage, experiencing an increase of 33.59% from 2010. Forests have seen an increase because most of the forests in the Klang Valley area have been designated as protected forests that cannot be destroyed or cleared.

In 2020, there was an increase in land use for developed areas in the Klang Valley area, amounting to 30.02% compared to 2010 (20.58%), with a corresponding land use change of 29.13%. This was attributed to the increased construction of infrastructure and housing developments following the implementation of the MRT system in the Klang Valley area. The population increase in the area, totaling 7.8 million people (BANCI, 2020) compared to 6.9 million people (BANCI, 2010), has led to a higher demand for housing and infrastructure facilities among the residents, especially in areas with MRT stations such as Kajang, Taman

Maluri, Kwasa Damansara, and others. The high demand for these amenities has contributed to the increase in land use for built-up areas in the Klang Valley, making it a focal point for the public due to its various amenities such as efficient transportation systems, shopping centers, and more. This indicates that urban land use, comprising residential areas, urban areas, utilities, and facilities, has continued to increase in 2020.

Additionally, in 2010, the land use for forest areas accounted for 28.76%, showing an increase in forest land use in 2020 to 33.59%, with a percentage change in land use of 16.33%. Meanwhile, the land use for open spaces in 2010 was 31.66%, and in 2020, it was recorded as 16.63%, with a land use change of -41.35%. This is because forest areas that have been cleared or deforested are used for agricultural, urban, industrial, and road network activities. Similarly, open space areas are utilized for developing industrial areas, tourism, or recreational activities. As depicted in the land use chart for 2010 and 2020 below, open space and forest areas have been converted into agricultural land, mainly consisting of oil palm plantations. Most open space areas in 2010 have been transformed into built-up areas by 2020, with more developments aimed at specific sectors such as tourism, industry, housing, and others. Land use changes in forest and open space areas have occurred in the Klang Valley area in both years, especially with the implementation of the MRT system, further accelerating the urbanization process there.

For agricultural land use in 2010, it accounted for 14.75%, while in 2020, it was recorded as 17.25%, with a land use change for agriculture of 8.46%. Despite the increasingly rapid urbanization process occurring in the Klang Valley, agricultural land use has still seen a slight increase in certain areas. This indicates the significance of the agricultural sector, especially in contributing to Malaysia's economy. Most of the agriculture carried out in the Klang Valley area is oil palm cultivation. This is because the land in certain areas, such as peatlands, is highly suitable for oil palm cultivation. For example, areas engaging in oil palm cultivation in the Klang Valley include Beranang, Pulau Indah, Kapar, and others. Oil palm cultivation is also the largest and most important contributor to the country's economy, boosting Malaysia's Gross Domestic Product (GDP) (Lai et al., 2020). The area of oil palm plantations in 2019 was 5.90 million hectares, representing an increase of 0.9% compared to the previous year (MPOB, 2020). It is evident that despite the vigorous urbanization process driven by the MRT system, the agricultural sector remains prioritized in this developing urban area. The figures depict the land use in Klang Valley for the years 2010 (Figure 3.0) and 2020 (Figure 3.1).

Figure 3.0: Land use in Klang Valley 2010

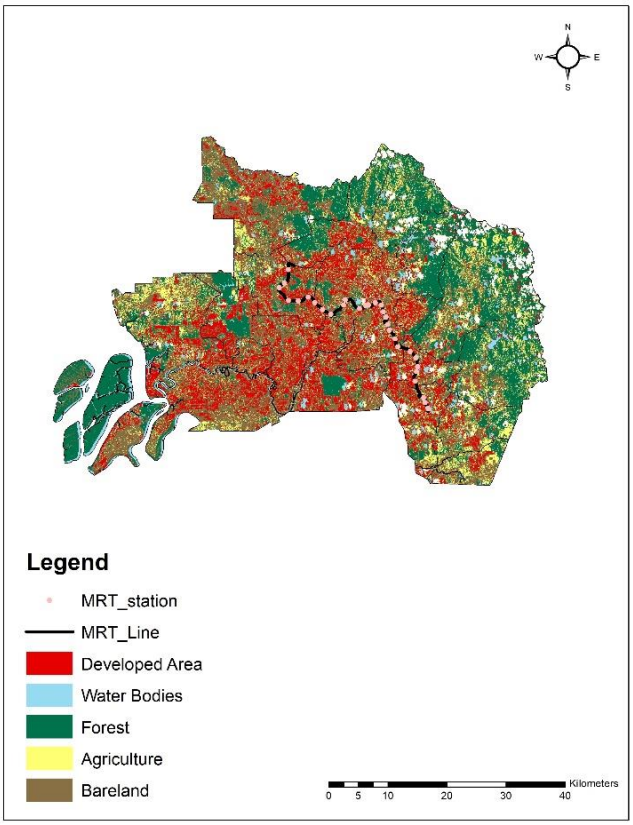
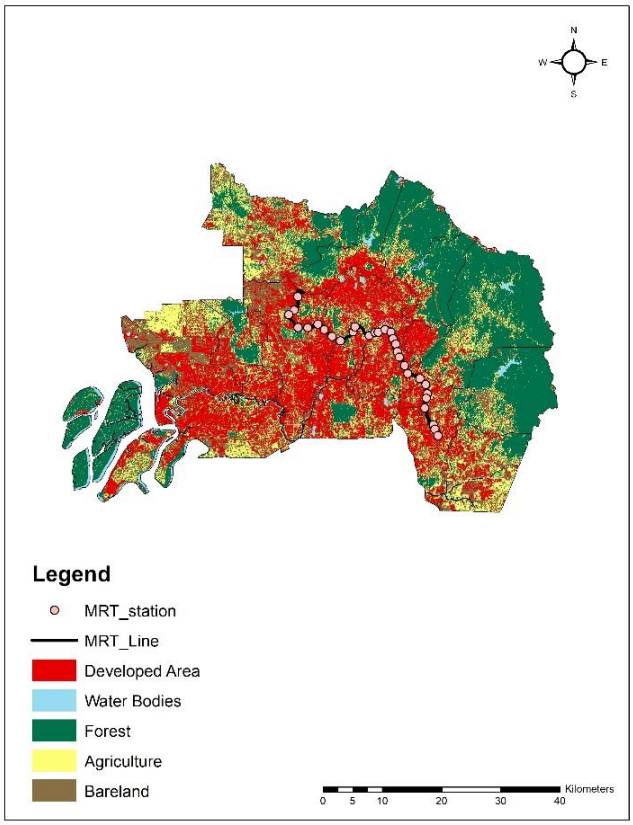


Figure 3.1: Land use in Klang Valley 2020



Conclusion

The study findings revealed that the land use for bare land experienced the highest change, totalling - 41.35%, while the land use for water bodies had the lowest change, at - 4.72%. The driving factor behind the land use change in the Klang Valley area is attributed to the construction of the MRT system, which consequently led to an increase in the population due to its convenience in reducing transportation costs and alleviating traffic congestion. Further research could be conducted on areas within the Klang Valley in the upcoming years to monitor whether land use changes persist in those areas. However, any land use changes must be carefully examined for their impacts on the human and physical environment. Additionally, land use changes can have positive effects on various sectors in Malaysia, thus boosting the country's economy. Any land use changes must comply with Environmental Impact Assessment (EIA) requirements to preserve the natural environment despite development and land use changes. Long-term observation of land use changes is crucial for assessing their effects and identifying factors influencing future changes. This study can aid decision-making processes to effectively manage and plan land use changes in the Klang Valley area more systematically, ensuring environmental sustainability. In line with SDG 11, transportation systems are vital drivers of sustainable urban development and can support the 2030 agenda towards sustainable and resilient environments.

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