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DEVELOPMENT OF REMOTE SENSING SYSTEM IN LAND OBSERVATION AND SUSTAINABILITY OF PUTRAJAYA USING ARCGIS

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Bachelor of Electronics Engineering Technology with Honours

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DEVELOPMENT OF REMOTE SENSING SYSTEM IN LAND OBSERVATION AND SUSTAINABILITY OF PUTRAJAYA USING ARCGIS

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A project report submitted
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DEDICATION

I dedicate my thesis to my friends and family, who have always been extremely supportive of me and assisted me in successfully completing my senior project. In addition, I'd like to dedicate my thesis to my mentor, Ir. Dr. Mohd Muzafar Bin Ismail, who is always giving me advise on how to enhance my performance in my PSM 2. I appreciate your support in completing this project.

ABSTRACT

Putrajaya is Malaysia's federal administrative centre and the country's administrative and governmental core. It is around 25 km south of Kuala Lumpur, Malaysia's capital city. Putrajaya was established to relieve congestion in Kuala Lumpur and to offer a designated place for government offices and organisations. Putrajaya represents Malaysia's dedication to modernism and efficient government, with a well-planned metropolitan environment that emphasises green living. The main purpose of this project is to analyze the changes that happen in Putrajaya especially in terms of urbanisation. The study of land cover of an urban region is useful to ensure the continued viability of the area and tracking the ways in which it has changed throughout the year. Several satellite images were used in this study to conduct the analysis of the soil cover of Putrajaya's urban areas. We compared three different satellite images taken in Putrajaya for different years of 2014, 2016 and 2021 so that we could track the progress of urbanization. The results showed that urban areas can maintain their sustainable status and sustainability within seven years. In order to maintain the capacity and sustainability of Putrajaya, this study highlights the need or make an idea of the need to take into account the impact of environmental change.

ABSTRAK

Putrajaya ialah pusat pentadbiran persekutuan Malaysia dan teras pentadbiran dan kerajaan negara. Ia adalah sekitar 25 km ke selatan Kuala Lumpur, ibu kota Malaysia. Putrajaya ditubuhkan untuk mengurangkan kesesakan di Kuala Lumpur dan menawarkan tempat yang ditetapkan untuk pejabat dan organisasi kerajaan. Putrajaya mewakili dedikasi Malaysia terhadap modenisme dan kerajaan yang cekap, dengan persekitaran metropolitan yang terancang yang menekankan kehidupan hijau. Tujuan utama projek ini adalah untuk menganalisis perubahan yang berlaku di Putrajaya khususnya dari segi urbanisasi. Kajian liputan tanah kawasan bandar berguna untuk memastikan daya maju berterusan kawasan itu dan mengambil kira perubahan persekitaran sepanjang tahun. Beberapa imej satelit yang digunakan dalam kajian ini untuk menjalankan analisis litupan tanah kawasan bandar Putrajaya. Kami membandingkan tiga gambar satelit berbeza yang diambil di Putrajaya untuk tahun berbeza iaitu 2014, 2016 dan 2021 supaya kami dapat menjejaki perkembangan urbanisasi. Hasil kajian menunjukkan kawasan bandar dapat mengekalkan status mampan dan kelestariannya dalam tempoh tujuh tahun. Bagi mengekalkan kapasiti dan kelestarian Putrajaya, kajian ini mengetengahkan keperluan atau membuat idea mengenai keperluan untuk mengambil kira kesan perubahan alam sekitar.

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CHAPTER 1

INTRODUCTION

1.1 Background

Putrajaya has expanded dramatically in the last few decades. It is beneficial to analyse an urban area's land cover in order to ensure the area's long-term viability and to assess how it has developed over time. As a result, a system for tracking density changes in Putrajaya over a 5-10 year period has been devised to assist in solving the problem and creating and maintaining a sustainable Putrajaya for the future. Remote sensing has been employed as a method, relying on the measurement of reflected and emitted radiation from a distance to identify and monitor physical properties of a region. This technique typically involves the use of satellites or aircraft to capture sophisticated images, enabling researchers to discern various Earth features. In this project, remote sensing is employed exclusively for land monitoring and sustainability initiatives in Putrajaya. The term used in remote sensing to depict land observation is "land use monitoring."

Land use is linked to the purpose of the land, whether for recreation, animal habitat, or agriculture. Land use applications require both baseline mapping and ongoing monitoring because timely information is essential to evaluate the current distribution of land in various uses and identify changes from year to year. This understanding will contribute to the development of solutions that address the challenges of balancing conservation, competing usage, and developmental demands. The loss or interruption of agricultural land, urban expansion, and forest decline are among the issues prompting land use studies. Putrajaya stands out as one of the fastest-developing metropolitan areas in terms of population and economic growth. Over the past 5-10 years, it has experienced remarkable expansion, transforming into a renowned tourist destination and a significant financial and economic center in Southeast Asia. Given its pivotal role in Malaysia, it is crucial to monitor land density and sustainability in Putrajaya. The findings of this study will be compared to those of earlier studies conducted in the last 5-10 years, which will be concluded at the end of this research.

1.2 Problem Statement

Land observation has evolved as a method for monitoring the long-term viability of land, agriculture, and other resources. However, this technique has limitations including a high cost, a large research area, and a lengthy time period. As a researcher, these kinds of situations will make the study more difficult to finish and have an indirect impact on the study's results.

In recent years, the country's deteriorating economic status, paired with worldwide inflationary trends, has become a critical component in practically every research project. To reduce operational costs, the majority of enterprises in the country have used cost-cutting methods This circumstance highlights the severity of the worsening economic situationSeveral costs have been identified in this study as a result of the failure to implement technologies such as remote sensing. Various expenses have been discovered, including those related to transportation, equipment, housing, and food and beverage expenditures. With the availability of remote sensing, these costs can be significantly reduced, if not eliminated altogether.

Putrajaya has a total land area of 49 square kilometres. Collecting data in this location is challenging due to time constraints. Additionally, the workforce is likely to expand in this region, indirectly increasing the research costs. Moreover, with the accumulation of more data, the risk of mistakes also grows.

Collecting data for a large research area is time-consuming, and the travel to the study site can be expensive. However, researchers often tend to take on more work than their available time and resources allow. A typical error is defining a too big research location. The ideal size of a research region is influenced by factors such as the amount of time and money available, the number of personnel in the field, the time needed for data collection, and the mode of transport accessible in the area. For example, agricultural regions often have several roads, but regions of wilderness will need some walking. Each of these variables should be carefully investigated and may need to be altered when precise observation and data collection approaches become apparent. A broader research topic does not automatically guarantee a more successful undertaking. Instead of dividing efforts across a large region with fewer data points, focusing on a smaller area and working more intensively can enhance the quality of project output.

1.3 Project Objectives

i) To observe the sustainability the land of Putrajaya

ii) To determine the changes of the environmental and geographical of Putrajaya for land management purpose.

iii) To analyze the variation and changes that occur in Putrajaya land due to its development.

1.4 Scopes

The urbanization area that will be focused on Putrajaya. The main source to be used in this project is images of remote sensing from different internet sources. Different images of remote sensing such as images of satellite from United States Geological Survey (USGS) will be used to compare the changes of the land cover of the urbanization in 3 different years. USGS which is a website or platform that provided free images of satellite from the United States. After we collect the data of images satellites from the USGS, the data is converted into the ArcGIS to classified clearly for the different types of land cover. On other hand, the data will be collected, and then an analysis of the data will be performed and analyze the area urban as well as any changes of others by different parameters which is urban area, forest, bare land and water bodies in 3 different years.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Remote sensing is a scientific field that encompasses a wide variety of data and technologies used for observing, analyzing, and interpreting terrestrial and atmospheric events. Its primary data sources are measurements and images obtained from aerial and space platforms. In my project, we utilize remote sensing tools to monitor land sustainability in Putrajaya. This section emphasizes the researcher's background, facts, theory, previous studies, and the relationship between the researcher's techniques. This section will also integrate relevant studies from journals, publications, research papers, and other sources. The scope of the literature review will encompass the history of remote sensing, the types of remote sensing, the data collection strategy, and a summary of all collected data. Conducting a literature review before commencing assessment work is crucial to acquire essential data and information, as well as insights from comparable projects completed by others. Sources include previous theses, journals, conference papers, books, and the Internet. This chapter combines and discusses all of the relevant subjects.

2.2 Global issues and sustainability

Urbanisation contributes to the development of land areas that were formerly covered with trees and other plants that help reduce the hazards of natural disasters. Because of urbanisation, more trees are being cut down, resulting in fewer plants to absorb carbon dioxide. According to the article, Putrajaya has a lot of pavement and little greenery. As a result, the cooling benefit provided by tree shadowing is negligible, leading to environmental issues such as urban heat islands and surface water runoff.[1] In the following [2], Putrajaya has experienced fast expansion in urbanisation and infrastructural development. The modifications to the city's surface by human activities have impacted the wind flow, distribution of air temperature, and the exchange of momentum, heat, and moisture in the area. Additionally, the original natural vegetation in the city has been substituted with surfaces engineered with asphalt, leading to a modification of the environmental surface energy balance.

2.3 History of remote sensing

The invention of flying gave rise to the modern discipline of remote sensing. G. Tourna chon (alias Nadar) photographed Paris from his balloon in 1858.[3] Carrier pigeons, kites, rockets, and unmanned balloons were all used for early photographs. These early individual photographs, with the exception of 6 balloons, were not especially valuable for mapmaking or scientific purposes. Beginning with World War I, schematic aerial photography was developed for military surveillance and reconnaissance, with deployment of modified combat aircraft such as the P-51, P-38, RB-66, and F-4C, or specially developed collection platforms such as the U2/TR-1, SR-71, A-5, and OV-1 series for both overhead and stand-off collection escalating during the Cold War. Sensor pods that are becoming smaller, such as those used by law enforcement and the military on both human and unmanned vehicles, are a relatively recent invention. This method has the benefit of needing little changes to an existing aircraft. Infrared, conventional, Doppler, and synthetic aperture radar imaging approaches will be developed in the future. While the term remote sensing was established in the late 1950s, it was Evelyn Pruitt, a scientist at the Office of Naval Research, who coined the phrase.[4] Her concept encompasses aerial photography as well as photos captured by contemporary sensor systems. This term has evolved to refer to the act of observing, measuring, and distinguishing items without physically touching them.

2.4 Types of remote sensing

2.4.1 Passive remote sensing

Passive remote sensing in the optical domain (visible through thermal) is based on two radiation sources. A remote sensing device gathers solar energy in the visible to shortwave infrared range. A part of the radiation received by a sensor is reflected at the earth's surface, while another component is dispersed by the atmosphere and never reaches the surface of the earth. Thermal radiation produced directly by materials on Earth interacts with self-emitted thermal radiation in the atmosphere as it propagates higher in the thermal infrared spectrum. [5]

2.4.2 Active remote sensing

Active remote sensing requires the emission of a coherent electromagnetic wave at a target, which can vary from celestial objects to the Earth. The time it takes for the transmitted EM wave to return (or arrive if the receiver and transmitter are in separate locations) to the receiver, as well as the phase information of the returning EM wave. In some applications, both active and passive antennas are interested in polarisation, but radar gains extra information via the Doppler shift. Due to EM waves move at the speed of light, the time between transmission and reception of the EM wave may be used to calculate range, with the altimeter being an essential component of this type of radar (Radio Detection and Ranging but is no longer capitalised). Scatter metres measure the intensity and polarity of the returned electromagnetic wave, which interacts with the target by scattering rather than absorption/emission. The fourth type includes imaging radars that use Doppler shift to dramatically increase ground resolution. [5]

2.5 History of urban planning

The history of urban planning is highlighted in this article by the author.[6] It began with the towns of Harappa, Lothal, and Mohenjo-Daro, which the earliest civilisation in the Indus Valley is today known as north-western India and Pakistan. These locations are the first instances of planned towns that were managed, according to archaeologists. The largest example of idealised urban planning in the ancient Mediterranean world was the new city of Alexandria, which Alexander the Great commissioned Hippodamus to design. The city's regularity was made possible by its level location close to the Nile's mouth. Hippodamus, who is credited with being the "Father of City Planning" for creating Miletus, was born in Greece in the year 407 BC. The "Father of City Planning" is regarded as Hippodamus. Future Greek and Roman city planning was built on the Hippodamian, sometimes referred to as the grid pattern. The ancient Romans used a cohesive system for city planning that had been developed for both civic and military defence. The basic plan was for a central plaza to house municipal services to be surrounded by a compact, rectilinear grid of streets, and then a wall to surround the entire edifice to offer protection. In order to save travel time, two routes that ran parallel to one other crossed the square grid and passed through the central plaza. The city was often bisected by a river that provided transportation, sewage disposal, and access to water. The Romans built their towns using a very rational technique, and Turin is one of the places in Europe where remnants of these constructions may be seen.[6]

2.6 Urbanization in Malaysia

According to an article Malaysia, for example, has only witnessed a slight rise in its urban population when compared to other nations such as Argentina or Brazil. In 1975, Malaysia's cities housed 3.76 million people, accounting for 37.6 percent of the country's total population. In 2000, the population of Malaysia was expected to be 22.3 million with urban area more than 57 percent of the population.[7]

Table 2.1: Urbanizations trends, size and growth of urban areas 1975-2025 of selected developing nations.

Country	1975		2000		2025	
	Total in Thousands (0000)	%Urban Dwellers	Total in Thousands (0000)	%Urban in Dwellers	Total In Thousands (0000)	%Urban Dwellers
Argentina	21029	80.73	32762	89.94	43083	93.39
Brazil	66065	61.65	141979	81.21	204791	88.94
Indonesia	26259	19.36	85819	40.34	167393	60.74
Malaysia	4616	37.65	12820	57.49	22942	72.65
Mexico	36948	62.76	79580	77.71	117222	85.82
Philippines	15294	35.56	44005	59.01	77622	74.26
South Africa	12314	47.79	24550	53.12	48673	68.60
Thailand	6244	15.10	13555	21.90	28756	60.74

In this article, the author also highlighted the significance of regulating or managing urban growth by focusing on supporting or guiding urban expansion towards existing conurbations such as Kuala Lumpur, Georgetown, and Johor Bahru. The largest urban area in Peninsular Malaysia with population more than 10,000 people are displayed in Figure 2.1.

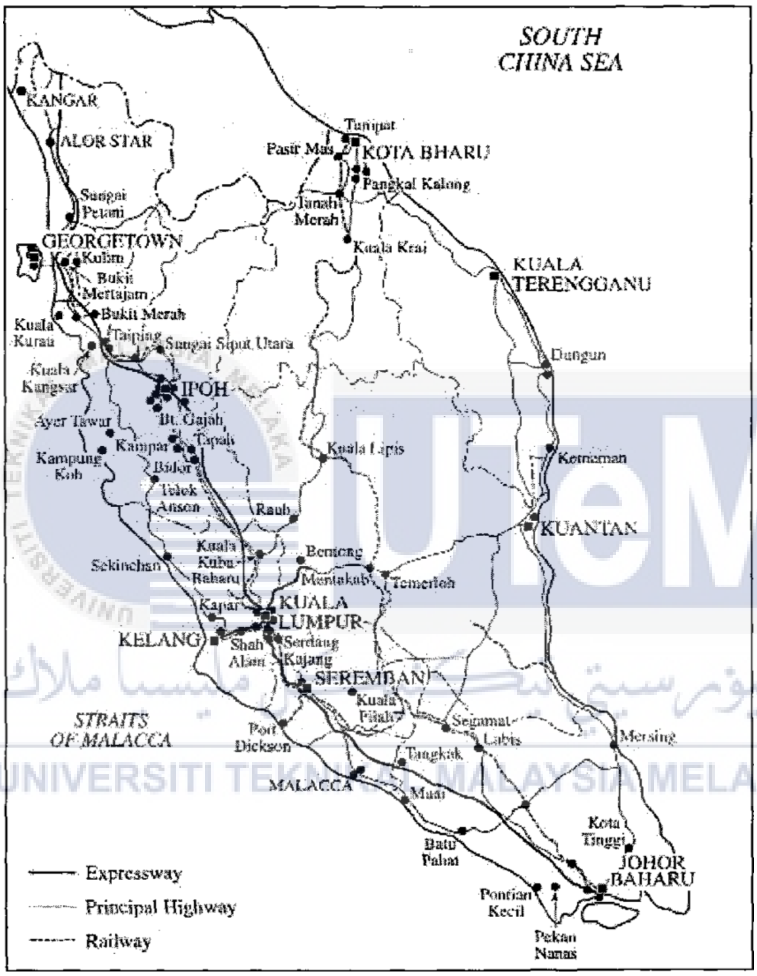


Figure 2.1 Major urban areas in Malaysia, town shown in capital letters are towns with population exceeding 10,000 people.

The level of urbanization in each state from 1970 to 2000 is presented in table 2.2. Except for the Federal Territory (Kuala Lumpur and Labuan), Penang and Selangor have become the most urbanised states in Malaysia, with more than 80% urbanisation (Department of Statistics, Malaysia, 2000). The primary reason of this issue is the shift of young people from more rural to more industrialised metropolitan areas. [7]

Table 2.2: Urbanisation trends, size and growth of urban areas 1975-2025 of selected developing nations

State	Urbanization Level				
	1970	**1980**	**1990**	**1995**	**2000**
Johor	26.3	35.2	48.0	51.8	56.4
Kedah	12.6	14.4	33.1	36.9	42.1
Kelantan	14.1	28.1	33.7	35.7	39.4
Melaka	25.1	23.4	39.4	44.0	49.8
Negeri Sembilan	21.6	32.6	42.5	44.7	47.6
Pahang	19.0	26.1	30.6	31.9	33.7
Perak	27.5	32.2	54.3	60.5	67.8
Perlis	-	8.9	26.7	30.4	35.3
Pulau Pinang	51.0	47.5	75.3	80.6	86.1
Sabah	16.9	19.9	32.8	35.2	38.2
Sarawak	15.5	18.0	38.0	43.4	50.5
Selangor	27.0	42.9	44.6	45.1	45.7
Terengganu	27.0	42.9	44.6	45.1	45.7
Kuala Lumpur (Federal Territory)	100.00	100.00	100.00	100.00	100.00

2.7 The scale and scope of urbanization

Asia is currently undergoing urbanization on a scale that has never been seen before in the annals of human history. This results in several issues, the most significant of which being the question of how around 1.1 billion people who are expected to be added to the population of Asian cities in the next 25 years can be fed, housed, and given jobs in a manner that is environmentally friendly. Meeting the requirements of these people may appear to be an almost insurmountable challenge for many Asian countries due to the inadequacy of their governing structures, the deplorable environmental conditions that already prevail in many urban areas, and the gaps in infrastructure and service provision that already exist. In 1950, there were over 232 million people living in urban areas across Asia, which represented approximately 17% of the total population. In the following 55 years, up until 2005, the urban population more than six-and-a-half times increased, reaching 1,562 million people and accounting for 40% of the total population. By 2030, it is expected that 2,664 million people, or roughly 55 percent of the Asia-Pacific region's population, will be living in cities. This represents an increase in the urban population of more than 70%, or 1,100 million people, over the next 25 years (Table 2.3). During the same time period, it is anticipated that the population of rural areas will decrease by 6%, or 133 million people. The majority of the continent's projected population growth will take place in the region's urban areas.[8]

Table 2.3: Urbanization trends in Asia, 1950-2030

	GDP per capita (PPP, $) 2003	Population (million) 2005	Urban Population (million) 2005	Proportion Urban (%) 1950	(%) 2005	(%) 2030	Estimated Increase i Urban Population (million) 2005–2030	(%) 2005–203
World		6,453.6	3,172.0	29	49	61	1,772.7	56
Asia		3,917.5	1,562.1	17	40	55	1,102.2	71
Malaysia	9,512	25.3	16.5	20	65	78	10.8	66
Thailand	7,595	64.1	20.8	17	33	47	14.6	70
PRC	5,003	1,322.3	536.0	13	41	61	341.6	64
Philippines	4,321	82.8	51.8	27	63	76	34.8	67
Sri Lanka	3,778	19.4	4.1	14	21	30	2.4	59
Indonesia	3,361	225.3	107.9	12	48	68	80.0	74
India	2,892	1,096.9	315.3	17	29	41	270.8	86
Viet Nam	2,490	83.6	22.3	12	27	43	24.5	110
Pakistan	2,097	161.2	56.1	18	35	50	79.3	141
Cambodia	2,078	14.8	2.9	10	20	37	5.8	197
Bangladesh	1,770	152.6	38.1	4	25	39	48.4	127
Lao PDR	1,759	5.9	1.3	7	22	38	2.3	177

2.8 Urbanization in Putrajaya

With an expanse of 4,931 hectares, Putrajaya comprises about one-third of Kuala Lumpur's size. Initially projected to reach a population of 330,000 by 2010, it currently accommodates 500,000 people during the daytime. To meet the needs of this population, there are currently plans for 67,000 residences, comprising single-family homes, row houses, and condominiums. It spans 3.8 million square meters within the governmental sector and has a total area of 3.4 million square meters, distributed among the commercial land usage in each of the eight precincts.[9] Regarding the allocation of land use, Putrajaya features a substantial percentage designated for government institutions (53%), commercial land use (29%), and a notably expansive green area. Putrajaya functions as Malaysia's administrative center (38%), with residential districts and a diplomatic enclave situated at the periphery. The central area, comprising 14 cores, is dedicated to government use, mixed development, and various sectors encompassing civic, cultural, commercial, sporting, and recreational facilities[8].

2.9 Effect of urbanization

Urbanisation has both positive and negative consequences. All three have a social, environmental, and economic impact. Globalisation has had an unequal influence on cities, with positive as well as negative implications. Positives include increasing affluence, greater democracy, and better education. Cities have less evaporative cooling than rural places, hence they have higher temperatures. One of the detrimental consequences of urbanisation is large-scale deforestation. The subject of whether urbanisation is beneficial or detrimental to a country is debatable.[9] Urbanisation has resulted in a phenomena that brings both benefits and problems. Many metropolitan regions are experiencing severe development issues. Urbanisation increases the burden on resources, habitats, and ecosystems. Often, cities are ill-equipped to deal with the issues that arise as a result of fast urbanization.[10]

2.10 Remote sensing in urbanisation and sustainability

According to Cockx et al.[11], the inclusion of information on landcover and land use acquired from remote sensing data is a key stage in the process of calibrating many urban development models. Van van Voorde examined satellite pictures.[12] They reached this conclusion after examining the association between the two. Investigations of evolving patterns of land cover and land use, as well as studies of urban sprawl, are examples of classification-based approaches often used to follow the evolution of metropolitan regions. The Landsat imaging satellite, which has a medium resolution, has been widely utilised to identify urban change. Yang and Liu estimated urban impermeable surfaces, which were utilised to describe the growth of urban areas. The calculation of urban impermeable surfaces by Yang and Liu was used to describe the growth of urban space.[13] The characterised of the long-term trends and patterns of urban sprawl based on landscape metrics using multi-stage Landsat Multi-Spectral Scanner (MSS), Thematic Mapper (TM), and Extended Thematic Mapper (ETM) images.[14] Multi-temporal Landsat TM images to classify the vegetation using an NDVI-based classification to determine the general pattern of changes.[15] Long-term trends in urban evolution may be discerned using remote sensing timeseries data. However, at this level of spatial precision, mapping specific inner-city areas for the purposes of studying urban expansion or identifying minor changes is a considerable challenge.[16]

2.11 Data landsat

The physical environment of Putrajaya has been impacted by the city's fast development. It was chosen to investigate the impact of urbanisation growth and how it affected the regional climate from 1999 to 2011. A planned city that is at least 85% developed is suitable for climate research because it offers the chance to create urban planning regulations to address the problems caused by urbanisation and the UHI it generates. A planned city offers not only the chance to address the problems brought on by urbanisation, but it also serves as a vital repository for information on the seasonal temperature variations. The research employs a wide range of materials and methods to accommodate all aspects of the study and to replicate the urbanisation processes that have occurred over time. A land use and land cover dataset created from LANDSAT images for each of the years studied (1999, 2003, 2007, and 2011) was adapted to the MODIS 33-category categorization system. The topography of the area has also been revised. Remote sensing and Google Earth photographs are used to represent the land-use-land-cover (LULC) categories. These images are often used to identify certain places.[17]

Urban development maps were produced using Landsat TM and LOI images from 1997, 2007, and 2017. In the context of the GIS, augmentation techniques were used to produce a precise categorization. After that, the Landsat images were divided into the three groupings of metropolitan areas, green fields, and surface water using a technique called as maximum likelihood. In order to assess the correctness of the accuracy evaluation, Google Earth was utilised to check whether the land-use categorization is acceptable.[18]

2.12 Removing thick cloud

In this article, they performed a Landsat-8 simulation experiment. They employed 10 pairs of patches from both t1 and t2 for their testing images. Every image has the same dimensions, which are 256 pixels on each side. To make things as simple as possible, just the second, third, and fourth bands have been chosen for the experiment. The pictures have a spatial resolution of 30 metres. They extended a piece of the findings that focuses on a river to perform a more complete examination. The spectral distortion visible in the enlarged area is created by WLR and MNPSI, which basically clone the spectral information from O2 to the cloud area of O1. This may be seen in the enlarged area.[19]

In this article, the experiment is done out on 11 well-aligned Landsat-8 OLI images with 512 by 512 pixel resolution. The test employs three bands (bands 2, 3, and 4) of these images, each with a different degree of cloud cover. The cloud pixel percentages that make up the simulated pictures are as follows: 1.34%,3.92%,10.35%,19.74%,34.84%. Both HaLRTC and FaLRTC recreate the cloud-contaminated pixel using information from the cloud-free section of the target picture, and their PSNR value curves are quite similar.[20]

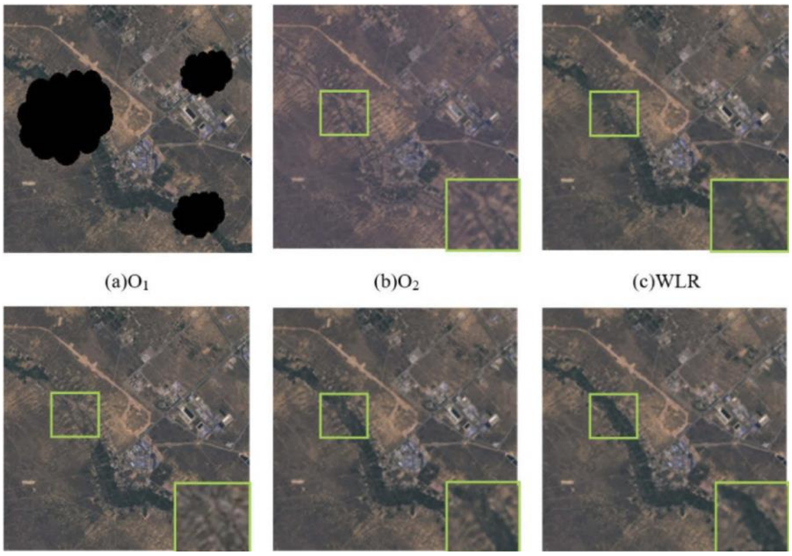


Figure 2.2: Simulation experiment results from Landsat-8 data

Table 2.4: The PSNR,SSIM,AG,CE

Index	FaLRTC	HaLRTC	TRPCA	TVLRSDC	TOS	TSSTO
PSNR	43.20	43.42	36.30	49.98	47.75	**52.25**
SSIM	0.9644	0.9634	0.9010	0.9976	0.9943	**0.9989**
CE	3.24×10^{-4}	1.55×10^{-3}	6.45×10^{-2}	8.59×10^{-5}	2.84×10^{-4}	$\mathbf{8.09\times10^{-5}}$
FD	1153.77	1144.97	940.56	1159.46	1148.95	**1171.05**

2.13 Software used in urbanisation (ArcGIS)

In this article, the author was doing research on urban sprawl and how to manage urbanisation in Malaysia. A various type of software was used to accomplish this research. Some of the software they used is ERDAS and ArcGIS. The data obtained from satellites was the major source, while the data obtained from other sources was secondary. The satellite data comprises photos captured by the SPOT-5 in the year 2012. The supplementary data, on the other hand, included things like topographic maps, land use maps, road maps, contour lines, and urban maps. ERDAS, ArcGIS, MapInfo, E-cognition, and SPSS were some of the pieces of software that were utilised in the process of computing and analysing the raw data as well as producing the findings.[21]

Table 2.5: Data sources of the study

Type of Data	Year of Acquisition/Publication
Spot-5 images (2.5 meter)	2012
Topographic Maps	2010
Land Use Maps	2010
Road Map	2010
Contour Line	2010
Urban Map	2010
Vector Data	2010

The author has conducted research on identifying the loss of urban green space and changes to land cover in this subsequent article. Every piece of information required has been obtained and converted to digital formats. Now that these data are available, it is simple to use them in the data processing carried out by Digital image Processing System as well as Geographic Information System. The Kuala Lumpur administrative borders, highways, and administrative boundary map are created using topo-sheet and other readily accessible maps and numerous thematic layers created using the ArcGIS software system.

The ERDAS envision 2011 software system was the main digital image processing tool while the geographic system used was the ArcGIS software system.[22]

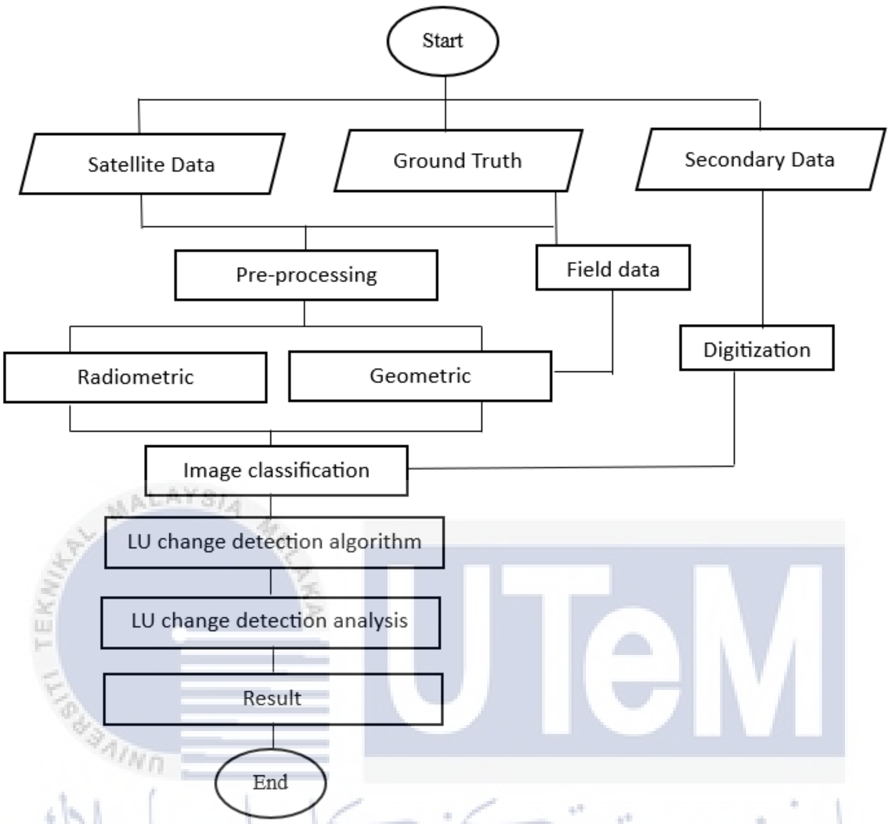


Figure 2.3: Flowchart of data processing adopted in the study

2.14 Tables of summarization of literature review

Ref/Year	Method	Important point
[1]/2016	• Pavement and little greenery	• More trees are being cut down, resulting in fewer plants to absorb carbon dioxide. • Leading to environmental issues such as urban heat islands and surface water runoff
[2]/2005	• Infrastructural development	• Modifications to the city's surface by human activities

		have impacted the wind flow, distribution of air temperature.
[3]/2014	• Aerial photography • Schematic aerial photography	• In 1858, G. Tourna chon (alias Nadar) photographed Paris from his balloon. • Also utilized for early photographs were carrierpigeons, kites,rockets, and unmanned balloons • Imaging methods will include infrared, conventional,Doppler, and synthetic aperture radar
[4]/2022	• The process of viewing, measuring, and recognizing objects without having physical touch with them	• Evelyn Pruitt, a scientist at the Office of Naval Research, invented the phrase remote sensing
[5]/2022	• Optical regime (visible through thermal) relies on two sources of radiation • Needs emitting a coherent electromagnetic wave at a target, which can range from astronomical objects to the earth	• A remote sensing device collects energy from the sun in the visible to shortwave infrared spectrum • The time it takes for the sent EM wave to return (or arrive if the receiver and transmitter are at different places) to the receiver, and the phase information of the returning EM wave
[6]/2011	• Urban planning	• The ancient Romans adopted a unified system that had been created for both military defense and civil comfort
[7]/2013	• Data collecting	• Importance of controlling or

		managing urban development by focusing on supporting or directing urban expansion towards existing conurbations, including Kuala Lumpur, Georgetown, and Johor Bahru.
[8]/2006	• Data survey	• Asia is currently undergoing urbanization on a scale that has never been seen before in the annals of human history • Putrajaya has a high percentage of land used for government institutions (53%), commercial land use (29%), and a comparatively high amount of green area.
[9]/2012	• Data survey	• The positives sides of urbanization are included rising prosperity, increased democracy, and improved education. • The negatives side is deforestation
[10]/2013	• Data survey	• Urbanization is occurring at such a rapid pace city are not equipped to manage the attendant concerns
[11]/2014	• Remote sensing image	• Remote sensing data is an essential step in the process of calibrating many urban growth models
[12]/2011	• Examinations of satellite image	• Investigations of shifting patterns of land cover and land use, as well as studies of urban sprawl, are examples

		of the classification-based methodologies that are commonly employed to track the growth of metropolitan areas.
[13]/2005	• Landsat imaging satellite	• The Landsat imaging satellite, which has a medium resolution, has been extensively used for urban change detection
[14]/2006	• Landsat Multi-Spectral Scanner (MSS), Thematic Mapper (TM), and Extended Thematic Mapper (ETM)	• To characterise the long-term trends and patterns of urban sprawl based on landscape metrics
[15]/2010	• Landsat TM picture	• A normalized difference vegetation index (NDVI) based classification was utilized by Du et al to establish the overall trend of changes using a time-series of multi-temporal Landsat TM pictures
[16]/2012	• Remote sensing	• Mapping certain inner-city locations for the purpose of observing urban growth or detecting subtle changes presents a significant challenge.
[17]/2016	• Landsat image	• A planned city that is at least 85 percent complete in its development is ideal for climate research because it provides the opportunity to design urban planning
[18]/2018	• Landsat TM image • LOI imagery	• Maximum likelihood was implemented to categorise Landsat photos into the following three groups which is urban areas, green fields,

		and surface water.
[19]/2022	• Landsat-8 simulation	• Only the second, third, and fourth bands have been selected for the experiment to keep things as straightforward as possible
[20]/2020	• TSSTO method	• Both HaLRTC and FaLRTC reconstruct the cloud-contaminated pixel by using information from the cloud-free portion of the target image, the curves of PSNR values for
[21]/2016	• Remote sensing software	• ERDAS, ArcGIS, MapInfo, E-cognition, and SPSS were some of the pieces of software that were utilised in the process of computing and analysing the raw data as well as producing the findings
[22]/2013	• Remote sensing software	• ArcGIS software system is the geographic system used to generate various thematic layers

2.15 Summary

The reference table is summarised in this section. To start, references 1 through 3 mostly cover the history of remote sensing, while references 4 and 5 discuss the history of urban planning. Second, the data gathering and data surveying utilising a remote sensing system are discussed from the 5th reference to the 8th reference. How to interpret satellite images from different satellite types, such Landsat-8, is the main topic of the third section of the table. The 9th reference through the 8th reference are included in this section. The software used in this study, ArcGIS and ERDAS, is included in the 19th and 20th references as the last section of this table. All of these sources served as a guide and source of information for this project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, we analysed the project's completion process by outlining, organising, and carrying it out it in various ways. The project's completion process is covered in this chapter. The planning that was done for this project to achieve the objectives listed in the preceding chapter 1 is shown in this chapter. The history of remote sensing photos, the software that is used to process such images, and the procedures involved will all be covered in this chapter. The steps in the description of the technique are listed one after another in succession.

3.2 Project workflow

One of the essential components that must be carried out during the planning stage of this project is the establishment of a timeline for its associated steps and particulars. Figure 3.1 depicts a simple and easy-to-understand structure for demonstrating process planning. This project planning helps the research to draft the idea of the project and ensure that the research is able to finish the project smoothly.

Starting with identifying the problems by discussing the problems that are facing by urbanization and sustainability in Putrajaya. The process of establishing goals comes in at second step on this flowchart. This objective setting helps us to identify the purpose of the project to be done. The first chapter covers both of these steps in detail.

The third part of the project's total time allocated is termed "Literature Review," and its major objective is to study reliable and respectable articles and journals obtained on the internet. With the assistance of several tables and figures, we will provide a summary of the literature review in this chapter. In this chapter, we will present a summary of the literature study using various tables and figures.This chapter allows researchers to obtain more detailed information about the titles of their projects, as well as the methods of carrying out the project, such as the decision of which software or hardware to use, as well as other aspects that will act as alternative supports while the project is being carried out.

The decision-making processes for the project's study area, software, and Landsat all take place in the fourth and fifth steps of the flowchart, respectively. Decision A decision will be made after the selection has been made. In the event that the verdict on the selection is affirmative, the procedure continues on to the locating of data obtained through remote sensing. On the other hand, if the verdict is negative, the procedure loops back around to the literature review to do additional research. If the verdict on the selection is affirmative, the procedure continues to the locating of data obtained through remote sensing. On the other hand, if the verdict is negative, the procedure loops back around to the literature review to do additional research.

In the next step, which is identifying the data that remote sensing has collected, there are a few things that need to be done, which will be explained and considered. In this step, the preparation and processing of the remote sensing images are described. The topics that are included in this discussion include the source of the remote sensing imagery, the types of Landsat data that will be used, the method of cloud removal, and image categorization. The images that have been classified according to land cover are then subjected to editing and mapping in an effort to produce images with greater clarity.

Following editing and mapping, the eighth and ninth processes are data collecting and analysis. Data will be collected, and then analysed, during which time we will observe and identify the urban area, as well as any changes that have occurred over the course of the previous year. This flowchart is completed by writing a project report and integrating all of the various chapters into one comprehensive report.

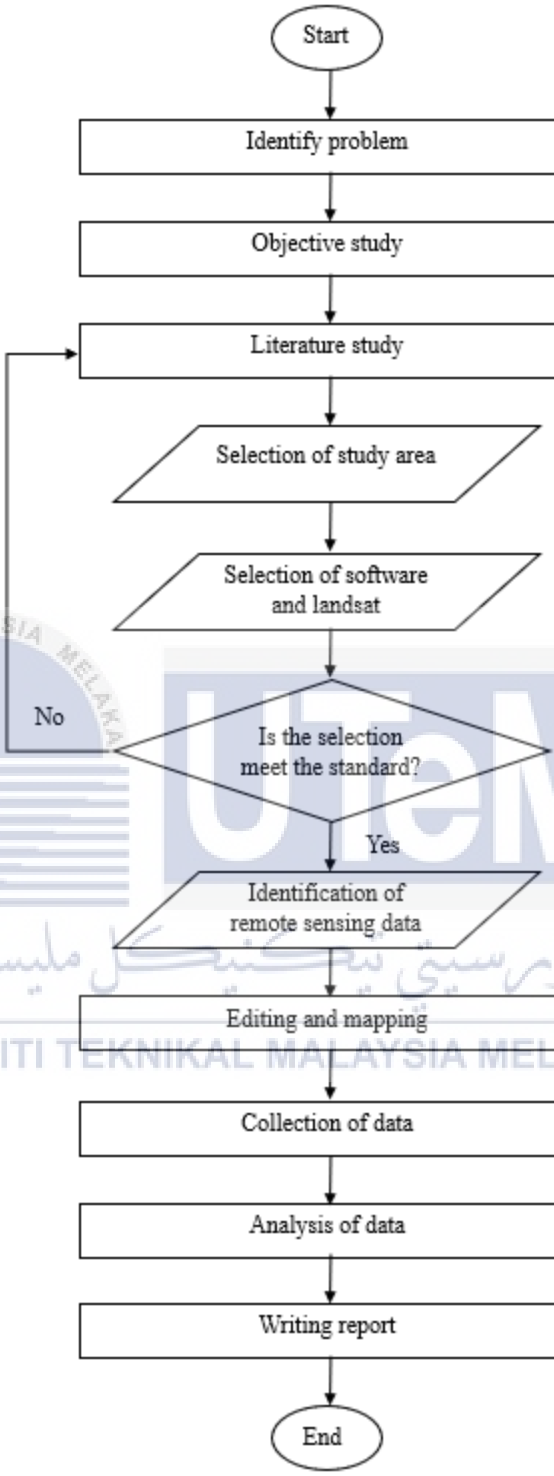


Figure 3.1: Project flowchart

3.3 Study area (Putrajaya)

The initial step in this undertaking involves the selection of a location. Putrajaya, designated as the Federal Territory of Malaysia and situated in Wilayah Persekutuan 33 Putrajaya, will be the primary focus for the research project's exploration of the region. Positioned at coordinates 2.9264° N, 101.6964° E, Putrajaya serves as the primary site for the administrative headquarters of the Malaysian government. In 1999, it took over from Kuala Lumpur as the designated administrative centre for the Malaysian government. This occurred due to the elevated population density and congestion present in Kuala Lumpur. Putrajaya has experienced rapid growth and an augmented population owing to its function as the government's administrative hub. This is attributed to the extensive development of infrastructure, encompassing facilities essential for governmental administration. Additionally, Putrajaya has evolved into a tourist attraction with distinctive buildings, contributing to heightened density and congestion in the area.

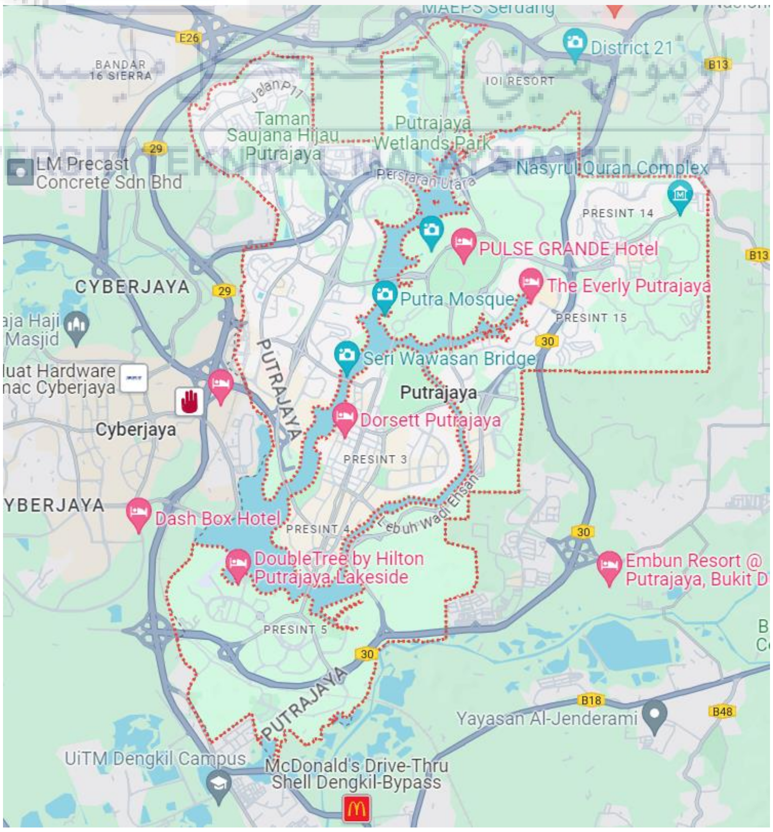


Figure 3.2: Map of Putrajaya

3.4 Software

The software applications that will be used in this project for the purpose of processing remote sensing images is ArcGIS.

3.4.1 ArcGIS

ArcGIS, as seen in Figure 3.3, is a piece of software that belongs to the category of geographic information systems (GIS). The Environmental System Research Institute (Esri) is in responsible of preserving the maps and other geographic information accessible via this system. The creation of maps, the collecting of geographic data, the analysis of map information, the dissemination and discovery of geographical information, mapping used in a range of applications, and the administration of geographical information recorded in a database are all examples of geographical information management. ArcGIS contains desktop software products such as ArcReader, ArcMap, ArcScene, ArcGlobe, ArcCatalog, and ArcGIS Pro. ArcGIS is made up of these programmes. This project will make use of ArcMap, a piece of desktop software that allows users to explore and alter geographical data in dimensions two and three. ArcMap can aid in the creation of maps with dimensions other than three. ArcGlobe is used to show large amounts of data connected to global 3D datasets, while ArcCatalog is used to manage GIS data and manipulate tasks. Furthermore, ArcGlobe is utilised to present data connected to global 3D databases.

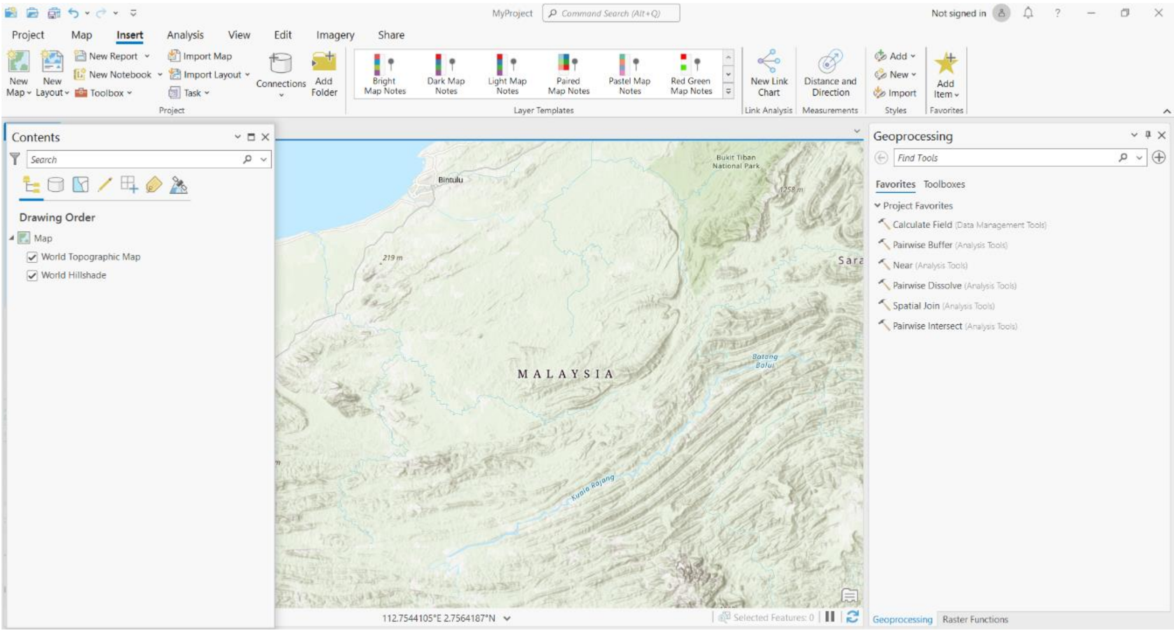


Figure 3.3: ArcGIS pro software

3.5 Identification of remote sensing data

The Malaysian Space Agency and reputable websites serve as the sources for the photographs of remote sensing that are collected here. In this chapter, we will go over the process that is used to obtain the photos from the sources. This phase is completed when we have selected the software to use and the Landsat images to analyze, as well as the area to be studied. The straightforward flowchart of the process of identifying remote sensing data is depicted in figure 3.4.

Beginning with the selection of sources of remote sensing pictures, which include the Malaysian Space Agency and the USGS platform, both of which give a variety of data types including Landsat 5,7, and 8, the first step is complete. The second phase is called the selection of satellite data, and it is during this step that the decision on the sort of data that will be used will be made.

Following the verification that kinds of data will be applied, the data is next forwarded to be pre-processed. After the photographs have been pre-processed, a determination will be made as to whether cloud coverings or shadows obstruct the remote sensing images and whether they can generate clear images. If the answer to the question is determined to be yes, the next step in the process is the categorization of the photographs. If the question is answered in the negative, the procedure will revert to the removal of clouds phase in order to investigate other or improved methods for clearing the sky of cloud cover.

The process of categorizing photos constitutes the final stage of the flowchart. This step also involves the making of a decision. It will then go to the end if the images are classified clearly for the different types of land cover. Nevertheless, if the images do not classify clearly, the flow will return to the process of image classification.

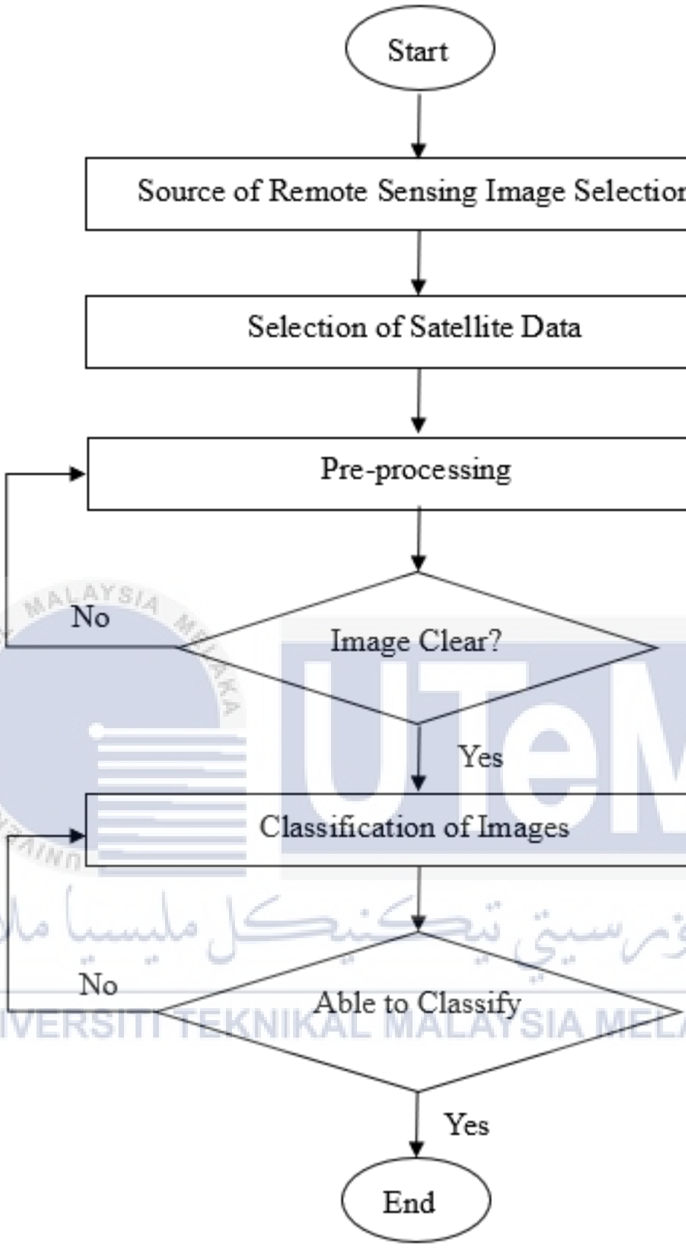


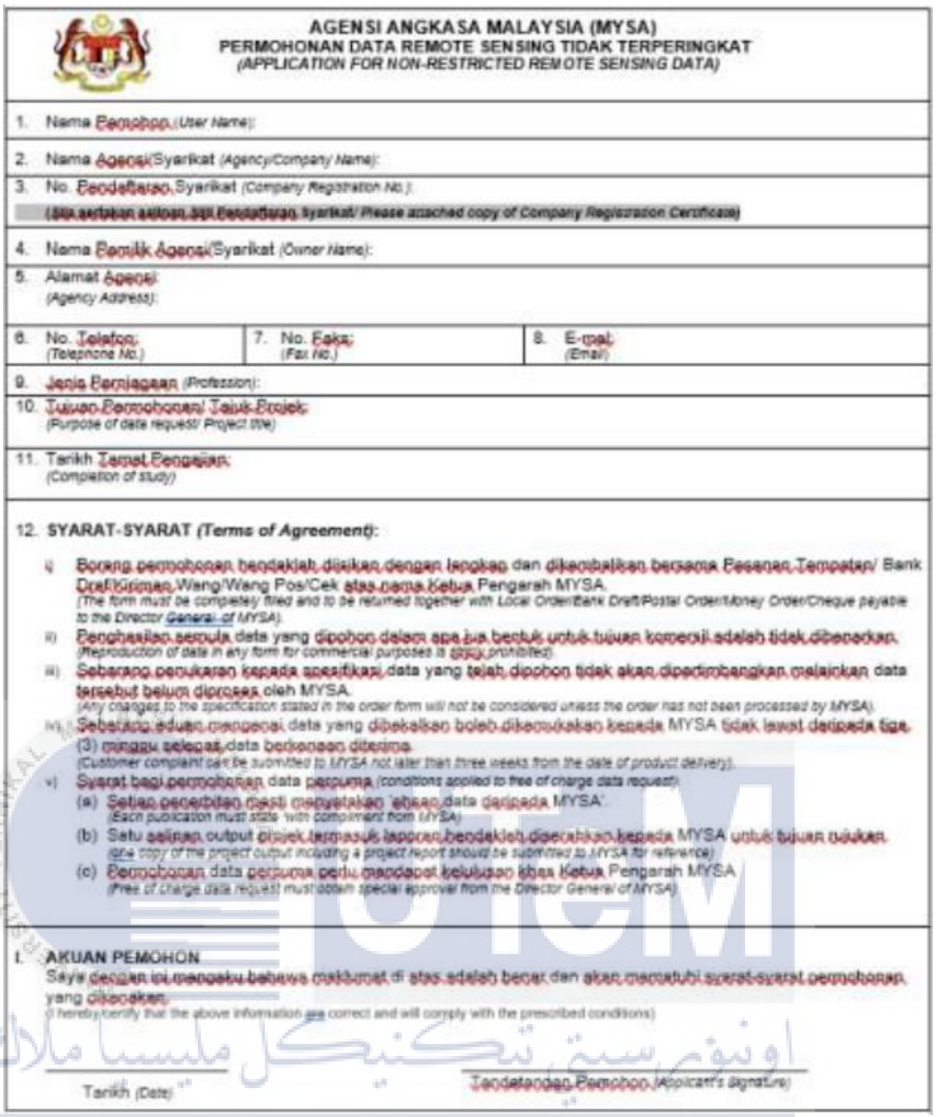
Figure 3.4: Flowchart of identification data of remote sensing

3.6 Identifications data of remote sensing

This project will utilize remote sensing pictures sourced from the websites of the United States Geological Survey (USGS) and the Malaysian Space Agency (MYSA).

a) **Malaysian Space Agency (MYSA)**

The agency that is responsible for remote sensing in Malaysia is the Malaysia Remote Sensing Agency or has been called 'Agency Remote Sensing Malaysia' in Bahasa Malaysia. This department is under the Ministry of Science, Technology and Science of Malaysia but in 2019, the government of Malaysia had merged MRSA and ANGKASA to form a Malaysia Space Agency (MYSA)Services that provide by the Malaysia Space Agency (MYSA)There are 3 main types of services will be provided by the agency: Free images of remote sensing of satellite which is under education and research purpose, remote sensing images that are under restricted area and remote sensing satellites images that are under the non-restricted area. A few procedures are needed to be done to get the latest or old remote images for the project from the Malaysia Space Agency (MYSA). Application forms such as Figure 3.5 and Figure 3.6 are the 'Application for Non-restricted Remote Sensing Data' and 'Application for Restricted Remote Sensing Data' are needed to be filled up and signed by the authorizer of Universiti Teknikal Malaysia Melaka. Copy of identity card, the coordinate of research area (AOI), sizes of satellite data, resolution of images, types of images, the format of images, and level of data processing are the aspects that needed to be confirmed before sending the e-mail to the authorizer.



AGENSI ANGKASA MALAYSIA (MYSA)
PERMOHONAN DATA REMOTE SENSING TIDAK TERPERINGKAT
(APPLICATION FOR NON-RESTRICTED REMOTE SENSING DATA)

1. Nama Pemohon *(User Name)*:
2. Nama Agensi/Syarikat *(Agency/Company Name)*:
3. No. Pendaftaran Syarikat *(Company Registration No.)*:
   (Sila sertakan salinan Sijil Pendaftaran Syarikat/ *Please attached copy of Company Registration Certificate*)
4. Nama Pemilik Agensi/Syarikat *(Owner Name)*:
5. Alamat Agensi *(Agency Address)*:

6. No. Telefon *(Telephone No.)*	7. No. Faks *(Fax No.)*	8. E-mel *(Email)*

9. Jenis Perniagaan *(Profession)*:
10. Tujuan Permohonan/ Tajuk Projek *(Purpose of data request/ Project title)*
11. Tarikh Tamat Pengajian *(Completion of study)*

12. **SYARAT-SYARAT *(Terms of Agreement)*:**

i) Borang permohonan hendaklah diisikan dengan lengkap dan dikembalikan bersama Pesanan Tempatan/ Bank Draf/Kiriman Wang/Wang Pos/Cek atas nama Ketua Pengarah MYSA.
(The form must be completely filled and to be returned together with Local Order/Bank Draft/Postal Order/Money Order/Cheque payable to the Director General of MYSA).

ii) Penghasilan semula data yang dipohon dalam apa jua bentuk untuk tujuan komersil adalah tidak dibenarkan.
(Reproduction of data in any form for commercial purposes is strictly prohibited)

iii) Sebarang perubahan kepada spesifikasi data yang telah dipohon tidak akan dipertimbangkan melainkan data tersebut belum diproses oleh MYSA.
(Any changes to the specification stated in the order form will not be considered unless the order has not been processed by MYSA).

iv) Sebarang aduan mengenai data yang dibekalkan boleh dikemukakan kepada MYSA tidak lewat daripada tiga (3) minggu selepas data berkenaan diterima.
(Customer complaint can be submitted to MYSA not later than three weeks from the date of product delivery).

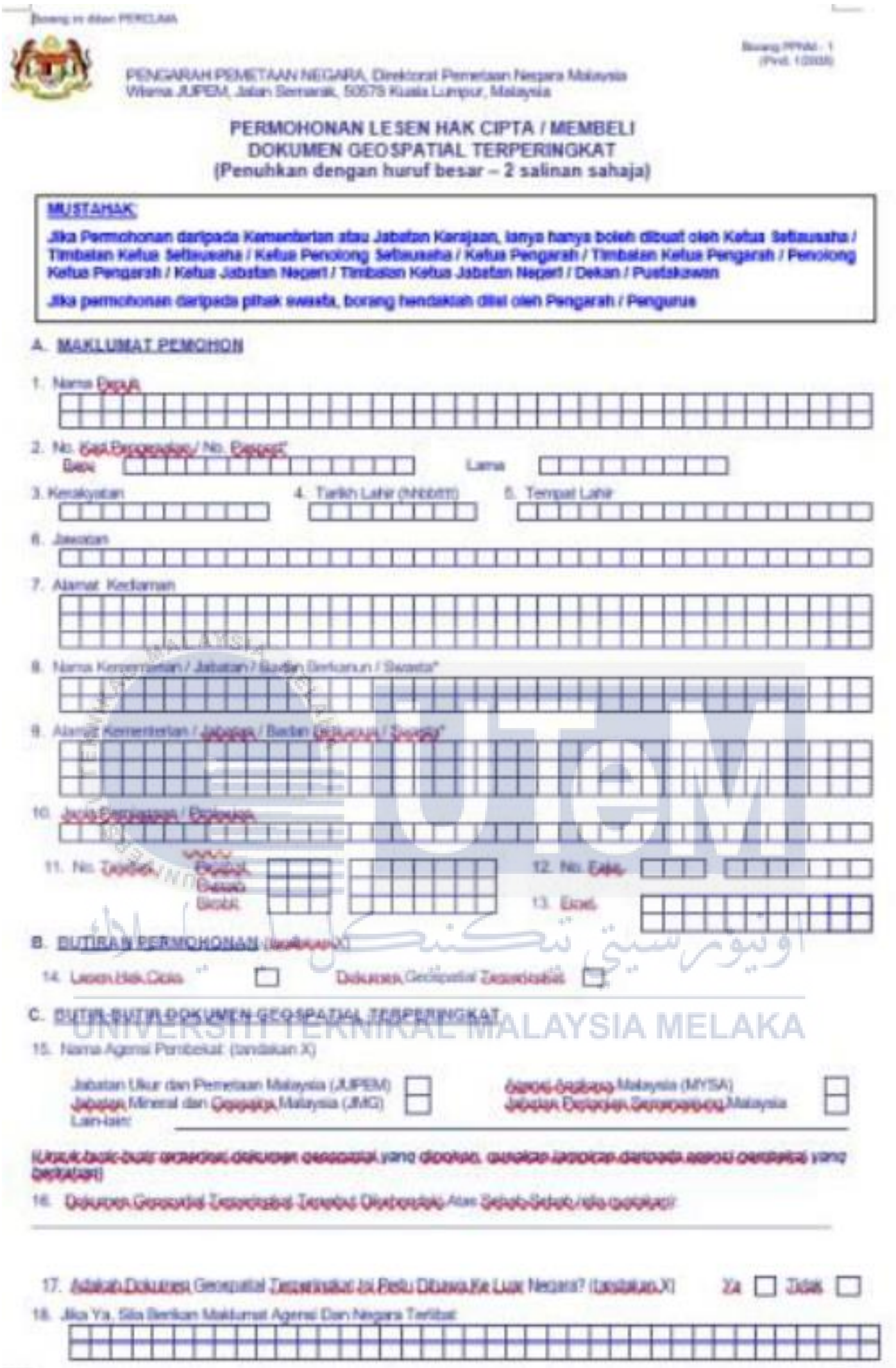
v) Syarat bagi permohonan data percuma *(conditions applied to free of charge data request)*
(a) Setiap penerbitan mesti menyatakan 'ehsan data daripada MYSA'.
(Each publication must state 'with compliment from MYSA')
(b) Satu salinan output projek termasuk laporan hendaklah diserahkan kepada MYSA untuk tujuan rujukan.
(one copy of the project output including a project report should be submitted to MYSA for reference)
(c) Permohonan data percuma perlu mendapat kelulusan khas Ketua Pengarah MYSA
(Free of charge data request must obtain special approval from the Director General of MYSA)

I. **AKUAN PEMOHON**
Saya dengan ini mengaku bahawa maklumat di atas adalah benar dan akan mematuhi syarat-syarat permohonan yang ditetapkan.
(I hereby certify that the above information are correct and will comply with the prescribed conditions)

Tarikh *(Date)*

Tandatangan Pemohon *(Applicant's signature)*

Figure 3.5: Application form for non-restricted remote sensing data



PENGARAH PEMETAAN NEGARA, Direktorat Pemetaan Negara Malaysia
Wisma JUPEM, Jalan Semarak, 50578 Kuala Lumpur, Malaysia

PERMOHONAN LESEN HAK CIPTA / MEMBELI
DOKUMEN GEOSPATIAL TERPERINGKAT
(Penuhkan dengan huruf besar – 2 salinan sahaja)

MUSTAHAK:

Jika Permohonan daripada Kementerian atau Jabatan Kerajaan, ianya hanya boleh dibuat oleh Ketua Setiausaha / Timbalan Ketua Setiausaha / Ketua Penolong Setiausaha / Ketua Pengarah / Timbalan Ketua Pengarah / Penolong Ketua Pengarah / Ketua Jabatan Negeri / Timbalan Ketua Jabatan Negeri / Dekan / Pustakawan

Jika permohonan daripada pihak swasta, borang hendaklah diisi oleh Pengarah / Pengurus

A. MAKLUMAT PEMOHON

1. Nama Penuh
2. No. Kad Pengenalan / No. Pasport* Baru / Lama
3. Kerakyatan
4. Tarikh Lahir (hhbbtt)
5. Tempat Lahir
6. Jawatan
7. Alamat Kediaman
8. Nama Kementerian / Jabatan / Badan Berkanun / Swasta*
9. Alamat Kementerian / Jabatan / Badan Berkanun / Swasta*
10. Jenis Perniagaan / Pekerjaan
11. No. Telefon Pejabat / Rumah / Bimbit
12. No. Faks
13. Emel

B. BUTIRAN PERMOHONAN

14. Lesen Hak Cipta / Dokumen Geospatial Terperingkat

C. BUTIR-BUTIR DOKUMEN GEOSPATIAL TERPERINGKAT

15. Nama Agensi Pembekal (tandakan X)

Jabatan Ukur dan Pemetaan Malaysia (JUPEM)
Jabatan Mineral dan Geosains Malaysia (JMG)
Agensi Angkasa Malaysia (MYSA)
Lain-lain:

16. Dokumen Geospatial Terperingkat Tersebut Dikehendaki Atas Sebab-Sebab / Isu (sebutkan)

17. Adakah Dokumen Geospatial Terperingkat Ini Perlu Dibawa Ke Luar Negara? (tandakan X) Ya / Tidak
18. Jika Ya, Sila Berikan Maklumat Agensi Dan Negara Terlibat

Figure 3.6: Application form for restricted remote sensing data

b) **USGS website**

Another source that will be used in this research paper is the United States Geological Survey (USGS). United States Geological Survey (USGS) USGS is a platform or website that provides a source of images of the satellite. An example of the website is given in Figure 3.7. The ability provided by the USGS Earth Explorer (EE) tool is querying, searching, ordering of images of satellite, aerial photographs, products that are related to cartography from various types of sources. This tool of Earth Explorer provides missions of Landsat and a few other data providers. This tool will also provide access to data products that are related to MODIS land. These data products are delivered by the NASA 47 Terra and Aqua missions, whereas the data products delivered by the United States and its territories from the NASA ASTER mission are referred to as ASTER level-1B. Prior to beginning the process of downloading the data, there is a series of steps that need to be completed. In order to download the data from the website, you will first need to register for an account with the US Geological Survey. It is necessary to determine the areas of interest (AOI) by employing an address, coordinates, or the view of the map as a box of bounding, and this is followed by the setting of ranges of data that are required to be established from one period to another. Once all of the processes have been finished, the results can be downloaded without any problems.

Figure 3.7: Earth Explorer-USGS website

3.7 Selection of satellite data

Landsat-5 Thematic Mapper (TM), Landsat-7 Enhanced Thematic Mapper (ETM+), and Landsat-8 Operational Land Imager are the three different varieties of Landsat that will be used to acquire the majority of the photos for this project (OLI). The Landsat-8 Operational Land Image (OLI) and Thermal Infrared Sensor (TIRS), which is composed of 11 bands, delivers observation data that is placed on the surface of the Earth. This data is used to assist in the taking of measurements, as well as monitoring, mapping, and analysing the surface of the land and water. This can be done by analysing the data. There are eight different spectral bands that make up the Landsat 7 Enhanced Thematic Mapper (ETM+) satellite. Because it contains a multispectral scanning radiometer and offers services including the provision of high-resolution information regarding the surface of the Earth and the detection of VNIR, SWIR, LWIR, and panchromatic bands emanating from the Earth when it is illuminated by sunlight, this particular Landsat is being utilised in this project. The Landsat-8 Operational Land Imager (OLI) is nearly identical to the Landsat-7 Operational Land Imager (OLI), with the exception that it includes two additional spectral bands. Because of the capabilities that these three different Landsat picture types possess, they are utilised for the various projects. Images can be downloaded completely free of charge from the USGS website. Within a single epoch, a minimum of 23 different Landsat images are utilised. To complete the sequence, more than 69 individual scenes of Landsat pictures are used. Because the photos could have some clouds on them, you'll need more than one Landsat image from the same scenes and the same year in order to remove the clouds.

Table 3.1: Landsat-8 bands

Band	Wavelength	Useful for mapping
Band 1 – coastal aerosol	0.43-0.45	coastal and aerosol studies
Band 2 – blue	0.45-0.51	Bathymetric mapping, distinguishing soil from vegetation and deciduous from coniferous vegetation
Band 3 - green	0.53-0.59	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 4 - red	0.64-0.67	Discriminates vegetation slopes
Band 5 - Near Infrared (NIR)	085.-0.88	Emphasizes biomass content and shorelines
Band 6 - Short-wave Infrared (SWIR) 1	1.57-1.65	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 7 - Short-wave Infrared (SWIR) 2	2.11-2.29	Improved moisture content of soil and vegetation and thin cloud penetration
Band 8 - Panchromatic	.50-.68	15 meter resolution, sharper image definition
Band 9 – Cirrus	1.36 -1.38	Improved detection of cirrus cloud contamination
Band 10 – TIRS 1	10.60 – 11.19	100 meter resolution, thermal mapping and estimated soil moisture
Band 11 – TIRS 2	11.5-12.51	100 meter resolution, Improved thermal mapping and estimated soil moisture

3.8 Pre-processing

Before the image classification process, pre-processing such as radiometric correction, composite band of 1-7, and extract the study area are applied to the Landsat 8 image. These stages include radiometric correction, composite band of 1-11, and extraction of the research region. The software known as ArcGIS Pro enables all of these procedures to be carried out in their entirety. The initial phase, known as pre-processing, of the Landsat photos is broken down into three stages. In accordance with Figure 3.8, the first step is the radiometric correction, the second step is the composite band of 1-11, and the third and final step is to extract the research region.

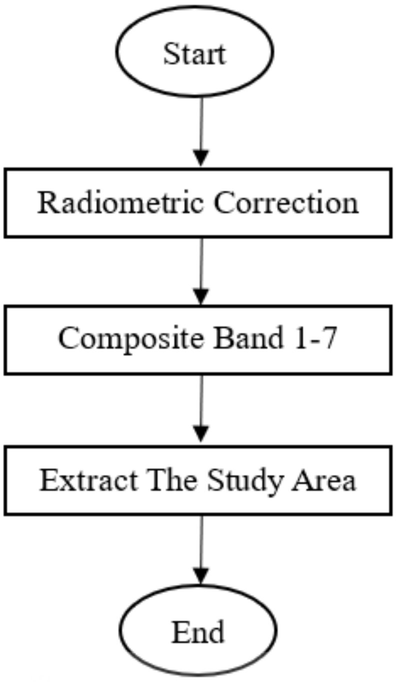


Figure 3.8: Pre-processing flowchart

3.8.1 Radiometric correction

Radiometric correction is defined as the processing of images of digital that is used to improve the fidelity of the brightness value magnitudes. On the other hand, it can be described as the process that is used to improve the radiometric quality of the data. This process can be applied on the band 1 of Landsat 8 by divide the image of band 1 with sine of sun elevation of the image. The formula can be shown by the Figure 3.9 and can be applied by using the raster calculator that is used as a tool in ArcGIS Pro.

$$\frac{Image\ of\ Band\ 1}{Sin(\ value\ of\ sun\ elevation)}$$

Figure 3.9: Radiometric correction formula

3.8.2 Composite bands 1-7

Composite bands of 1 to 7 is the process that combine the images of band 1 – band 7 of Landsat 8 into a single image. This process will be applied the radiometric correction in order to get a brighter and clear image. The tool that is used for the composite band of the images is called composite band in ArcGIS. This tool is used to create a single raster from multiple bands. Figure 3.10 illustrates the process of composing bands 1-7 into composite images, using Landsat 8 as an example.

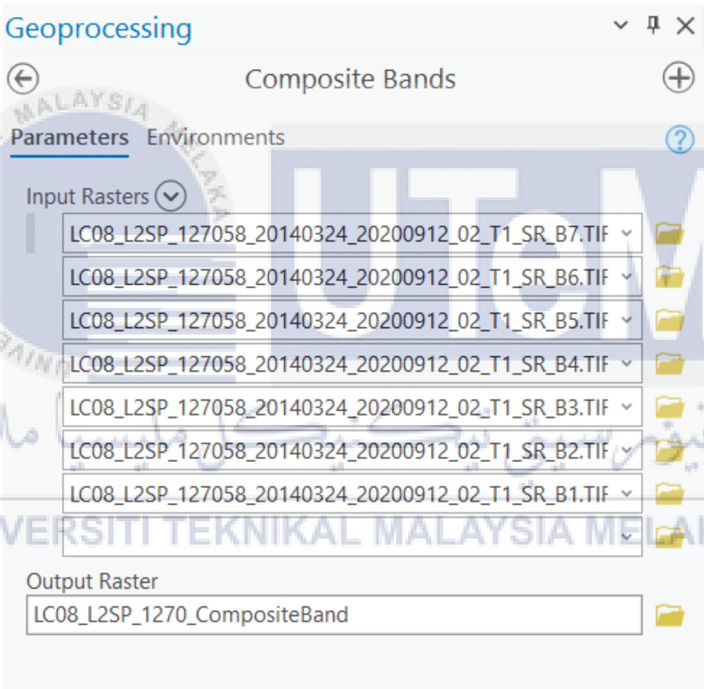


Figure 3.10: Composite band of Landsat-8

3.8.3 Extracting the study area

Extraction of the research region by extracting it from a raster dataset, mosaic data set, or picture service layer by cutting out the appropriate section. Using the Clip Raster tool found in ArcGIS, these processes can be completed successfully. This procedure is mostly used to extract the area of study from the satellite photos and delete the areas of the images that are not relevant to the investigation. In order to complete this operation, a layer of shape files will be used. Utilizing Google Earth Pro and then using ArcGIS to transform the resulting kml file into a shape file allows for the creation of this shape file. Before converting it from a kml file to a layer file, the process of extracting the study region from Google Earth Pro is illustrated in Figure 3.11. The clip raster tool in ArcGIS is what's used to complete the clipping procedure. In Figure 3.12, you can see the tool that is utilised in the clipping procedure that is performed in ArcGIS. The process uses an image of the composite band as its input, and the output of the process is a polygon shape file with the name study area. The input of the process is the image of the composite band.

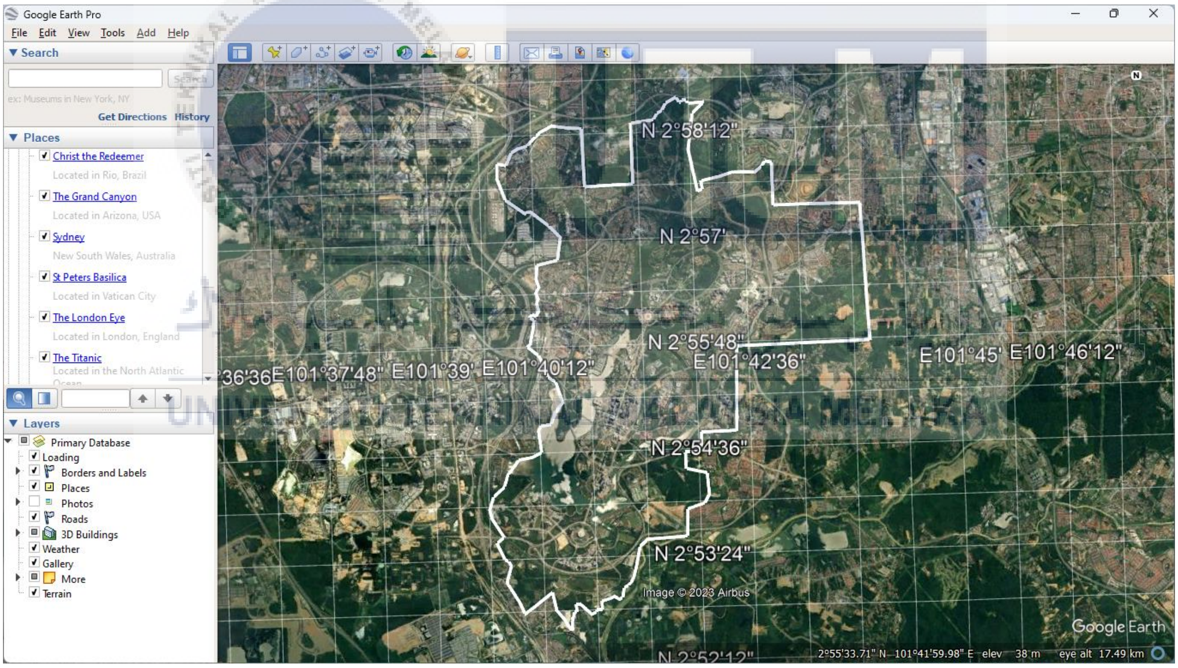


Figure 3.11: Extracting study area from Google Earth Pro

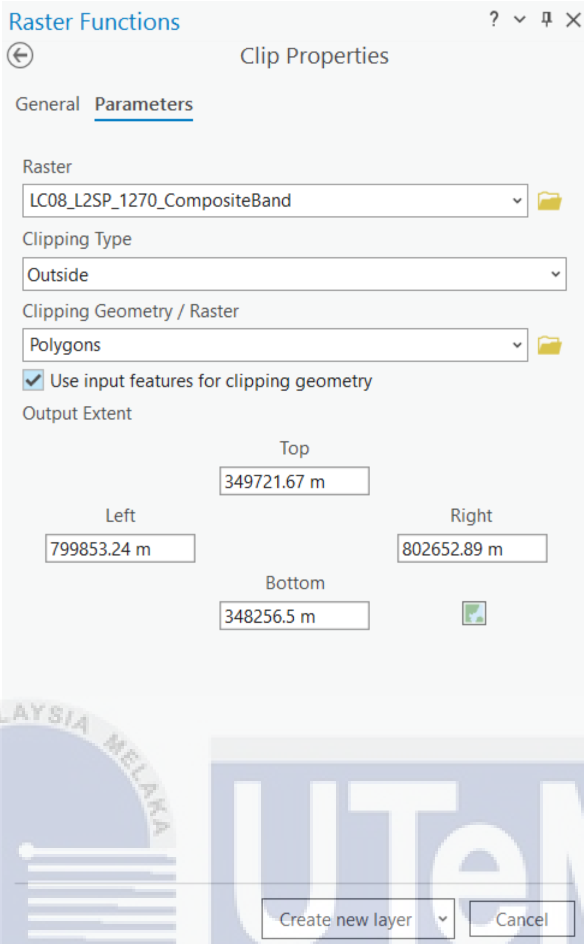


Figure 3.12: Process of extraction of study area in ArcGIS with shapefile

3.9 Spatial data editing and urbanization mapping

After the images have been identified, they will undergo additional processing to refine the methods and enhance their accuracy. This technique can be carried out manually on the vector shapefile category using the interpretation provided by the GIS application.

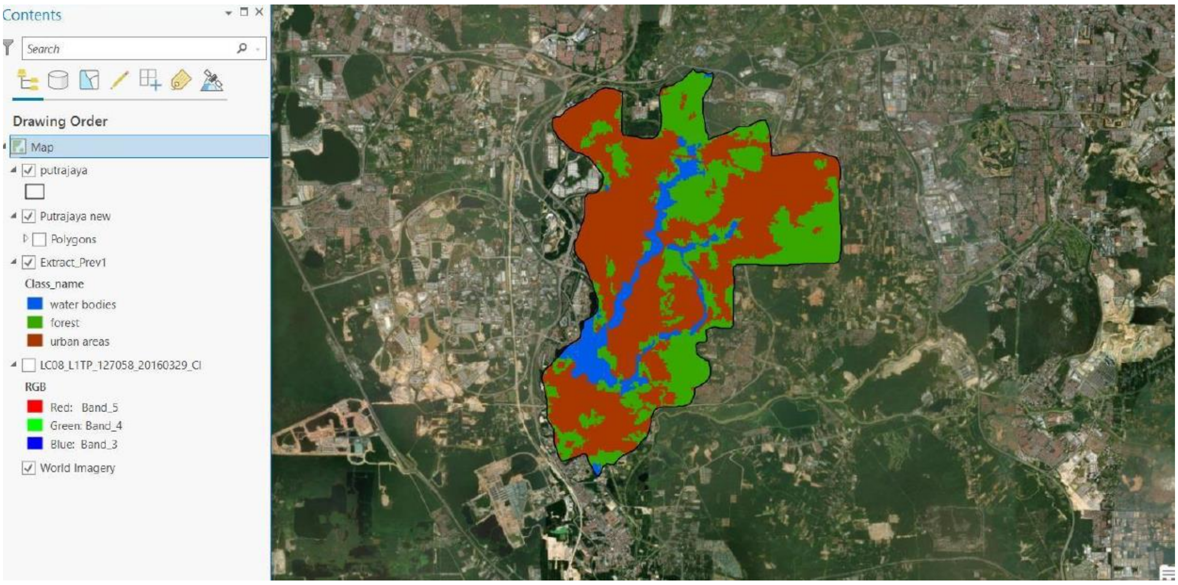


Figure 3.13: Classification of land use and buildings of Putrajaya

3.10 Collection of data

The data findings are obtained following the editing and mapping of urbanization. Data refers to the facts and numbers derived from urbanization mapping, which are used for analysis and references. Data collection is a method that aids researchers in gathering critical information for research advancements and project assessment. Various methodologies related to calculation, measurement, and observation are employed during the data collection process. The data from the findings will be utilized to track the urbanization of Putrajaya, which spans 124 square kilometres. Modified images are also preserved to trace the progress of urbanization over time.

3.11 Data analysis

This is the final stage before the report is completed, during which researchers will examine data by tracking changes in urbanization over time to establish its long-term sustainability. Data analysis assists researchers in determining project outcomes through a technique that involves data analysis, visualization, inspection, data arrangement, and conclusion. The data in this study may be evaluated by comparing the changes in urbanization that have occurred during the researcher's chosen monitoring period. Monitoring the proportion of significant urbanization is one of the strategies used to maintain sustainability in Putrajaya. One of the objectives of the data analysis will be to identify the factors causing the density of urbanization to either decrease or increase.

3.12 Summary

This project is executed in accordance with the flowchart in Figure 3.1, ensuring the smooth progression of the project and the timely accomplishment of its objectives. The main focus of this chapter is on utilizing software to process data collected from various remote sensing sources. The success of the project is defined by editing, data collection, and data analysis. Additionally, this chapter covers various remote sensing sources, Landsat types, mapping software, pre-processing techniques, and classification techniques.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

Following the explanation of the method used in Chapter 3, the project findings will be provided for consideration in this chapter. The intended outcome and the strategy for obtaining the expected result will be discussed in this chapter.

4.2 Pre-processing of the images

This subtopic focuses on the preprocessing procedure, encompassing radiometric correction, composite band creation, and the extraction of the research region.

4.2.1 Radiometric correction

A radiometric adjustment will be implemented in the preprocessing step of image production. Unlike geometric correction, which enhances the relative spatial or absolute locational elements of picture brightness values, it was not performed in this project. The purpose of geometric correction is to improve the magnitudes of the brightness values, but in this case, it is excluded. This decision is based on certain enhancements made to the data processing in Landsat Collection 2 Level-2, and details can be found on the USGS website. Radiometric correction is applied to the lowest resolution band of Landsat images, band 1. Figures 4.1 and 4.2 show the photos captured before and after the radiometric correction operation. Figure 4.1 was taken before the radiometric adjustment, while Figure 4.2 was taken after the radiometric correction was applied. In comparison to the first image, the second image clearly depicts items or land usage.

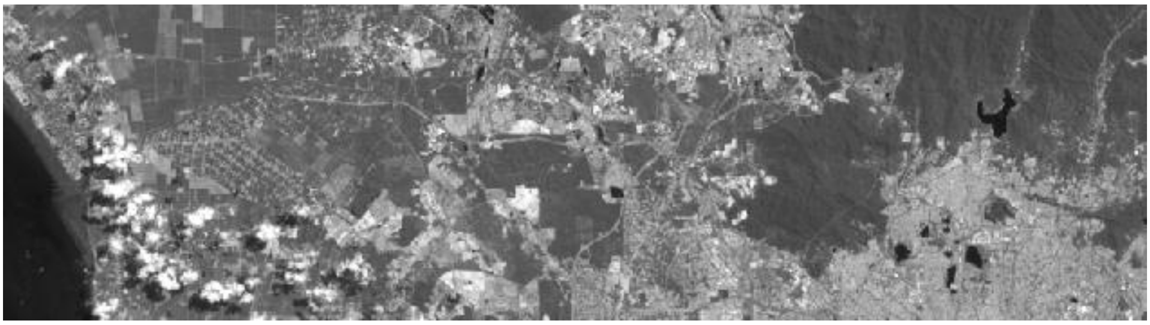


Figure 4.1: Image before radiometric correction

Figure 4.2: Image after radiometric correction

4.2.2 Composite of band 1 – band 7

The third stage in the picture pre-processing is the construction of the composite band. A Landsat composite band, such as Landsat 8 or Landsat 7, is the result of the integration of bands 1 through 7. Figures 4.4 and 4.5 show Landsat 8 pictures before and after the composite band. Figure 4.4 shows the picture before the composite band, and Figure 4.5 shows the image after the composite band. Following the composite band, other combinations of three bands can be utilised for categorization purposes. These combinations can be substituted for the composite band. Table 4.1 shows that Landsat 8 has a combination band with three unique types of bands. Bands 5, 6, and 4 can, for example, be used to distinguish between various types of land use and water, whereas bands 4, 3, and 2 can be used to indicate natural colour. Figures 4.4 and 4.5 illustrate an example of a combination band for (a Land/water and Natural colour). The brighter shade of blue represents the urban area, while the darker shade of blue represents the bodies of water. Figure 4.4 depicts the natural colour of numerous features such as cities, highways, and vegetation.

Table 4.1: Band combination for Landsat-8

Composite Name	Bands
Natural Colour	4 3 2
False Colour	7 6 4
Color Infrared (vegetation)	5 4 3
Agriculture	6 5 2
Healthy Vegetation	5 6 2
Land/Water	5 6 4
Natural With Atmospheric Removal	7 5 3
Shortwave Infrared	7 5 4
Vegetation Analysis	6 5 4

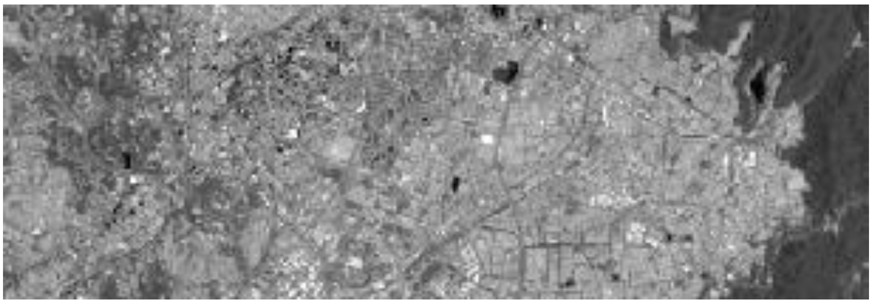


Figure 4.3: Image before band composite

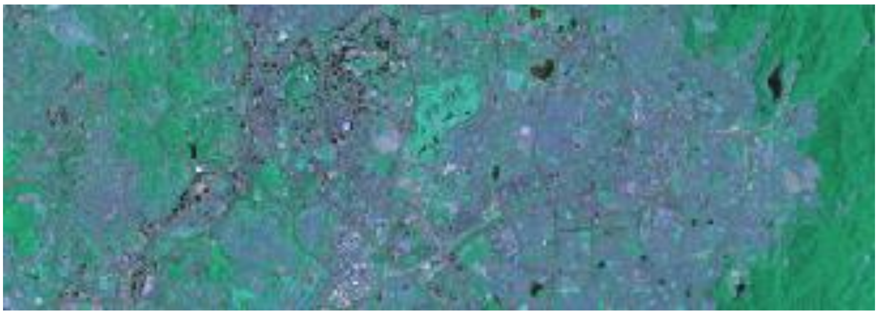


Figure 4.4: Image after band composite

Figure 4.5: Combination band land/water

4.2.3 Extract the study area

After the radiometric correction and composite band procedures are completed, the pictures undergo further processing, which includes the extraction of the research area. This is accomplished in ArcGIS using the clipping tool. Figures 4.6 and 4.7 depict the status of the image before and after clipping.

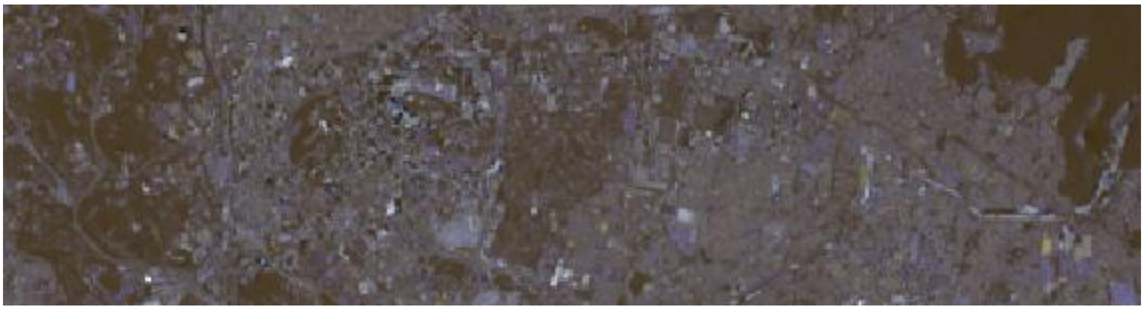


Figure 4.6: Image satellite before clipping

Figure 4.7: Image of satellite after clipping

4.3 Image classification

After the process of preprocessing is completed, training samples are taken from the image. More than a hundred separate samples are extracted from the image and organized based on pixel classifications. Figure 4.9 illustrates the examples that were used to illustrate various sorts of classes using various colour schemes. The colour yellow is used to represent undeveloped terrain, green represents forest areas, red represents metropolitan areas, and blue represents water body. In order to complete the process of classification, you will need to utilize the classify tool, which separates pixels into a range category as seen in figure 4.9. The photos that were taken before and after the classification are displayed in figure 4.8 and figure 4.9. Figure 4.8 shows the original photograph that was taken before the classification and figure 4.9 shows the photograph that was taken after classification. Figure 4.9 illustrates the clear that different colours are separated in different areas based on the training sample of the classes. After the classification process is completes, a table will be created, and the area of each class will be identified there. The table of classes, organised according to the classes that have been set, can be found in figure 4.11. The table provides the answer to the question of the area. The area is shown in the unit of square kilometers as the unit of measurement.

Figure 4.8: Image before classifications

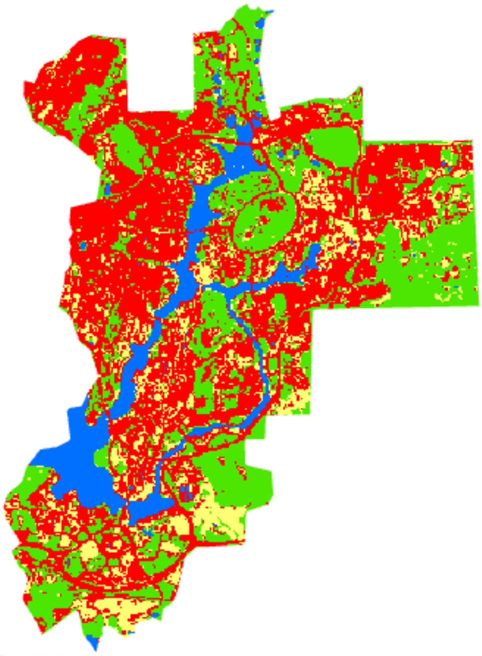


Figure 4.9: Image of satellite after classifications

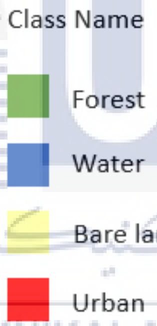


Figure 4.10: Classification name

FID	Shape *	Class_name	Area
0	Polygon	Bare land	6 sqKm
1	Polygon	Forest	15 sqKm
2	Polygon	Urban area	21 sqKm
3	Polygon	Water	4 sqKm

Figure 4.11: Table of area for classifications

4.4 Result and tabulation

Table 4.2 contains a tabulation of the findings of the region in Putrajaya for each categorization. The results of the Putrajaya region are tabulated in the following table according to the categories of water bodies, forest, bare land, and urban area in 2014, 2016, and 2021, respectively. In the following table, the results of the Putrajaya area are tabulated according to the categories of water bodies, forest, bare land, and urban area in 2014, 2016, and 2021 respectively. Figure 4.13 reveals that after a span of just 7 years, the area covered by urban area expanded from 19 square kilometers to 21 square kilometers in between 2014 and 2016 while the area increase more from 21 square kilometers to 27 square kilometers from 2016 to 2021. Between the years 2014 and 2016, there was a marginal reduction of 2 square kilometers in the amount of land covered by urban area. On the other hand, the total land area used for forests purposes in Putrajaya was 10 square kilometers in the year 2014, 15 square kilometers in the year 2016, and 10 square kilometers in the year 2021 respectively. Over the course of seven years, there was an increase and decrease of 5 square kilometers. In addition to this, the total area of the bare land of 13 square kilometers in 2014 and in 2016 decrease to 6. Following to bare land decrease to 5 square kilometers in 2021. The area of the water bodies did not change in year 2014 to year 2021, as it remained the same at 4 square kilometers over this span of time. The photos of Putrajaya following the classification are shown in Figures 4.12, 4.13, and 4.14. The area with water bodies is shown by the blue colour, whereas forests area is shown by the lighter green. The red colour patches represent the urban area, the yellow colour patches represent the bare land.

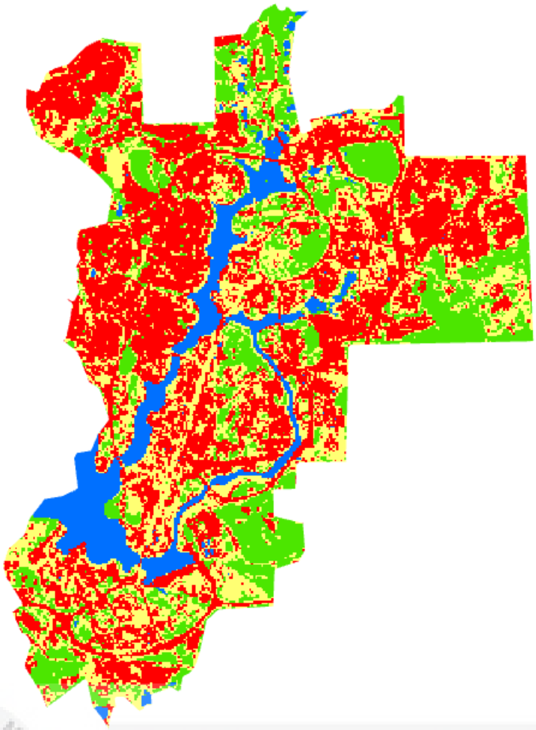


Figure 4.12: Image of Putrajaya after classifications in 2014

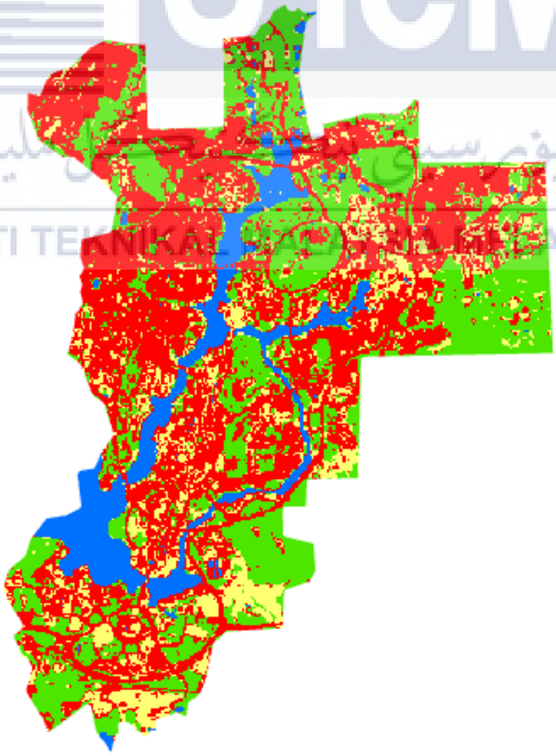


Figure 4.13: Image of Putrajaya after classifications in 2016

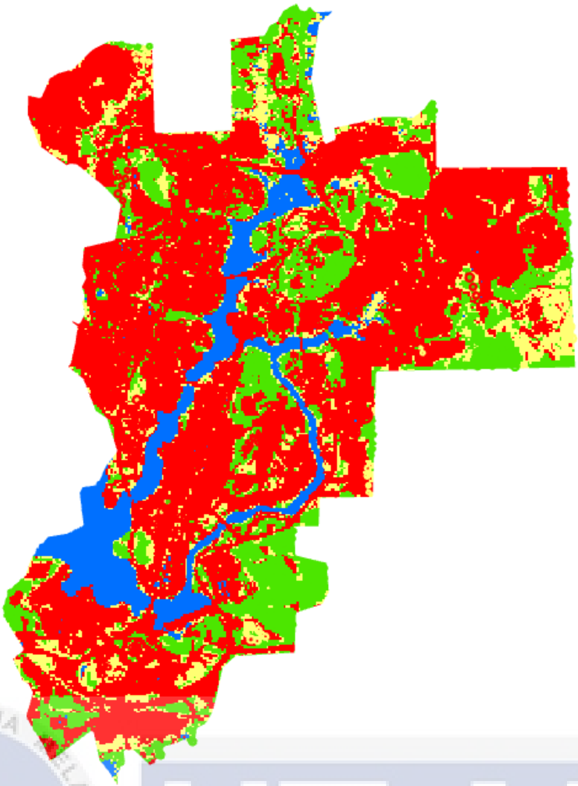


Figure 4.14: Image of Putrajaya after classifications in 2021

Table 4.2: Extent for all the classes in Putrajaya

	Area (sqkm)		
Class name	**2014**	**2016**	**2021**
Urban area	19	21	27
Water body	4	4	4
Forest	10	15	10
Bare land	13	6	5

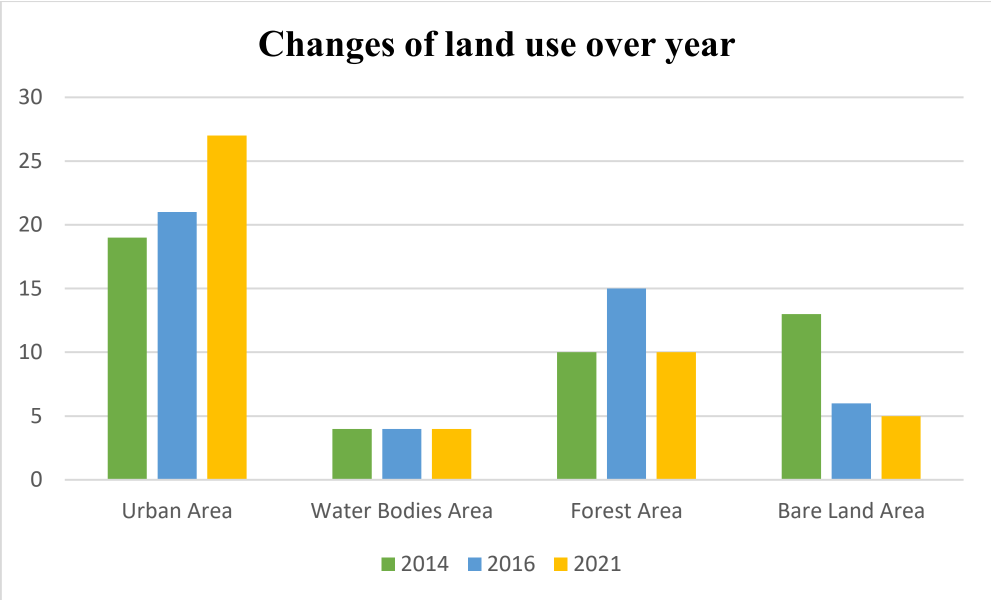


Figure 4.15: Graph of area in Putrajaya

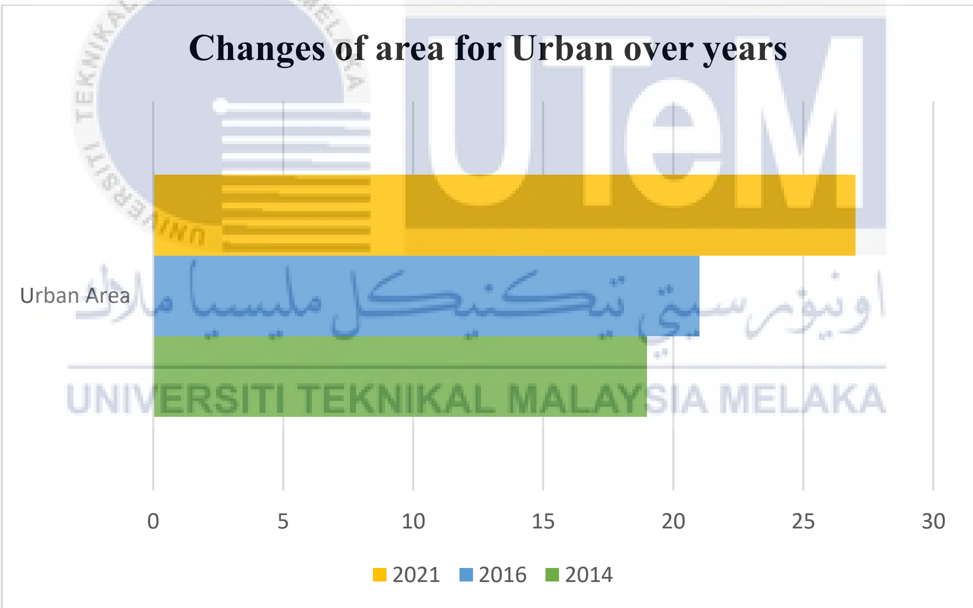


Figure 4.16: Graph of area for urban area

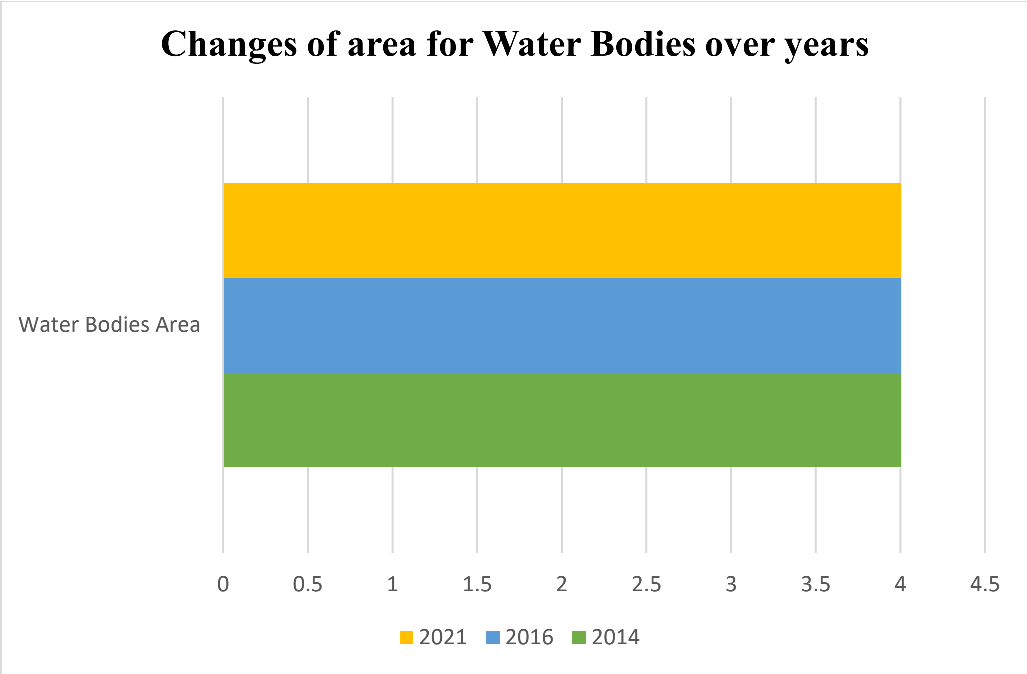


Figure 4.17: Graph of area for water bodies

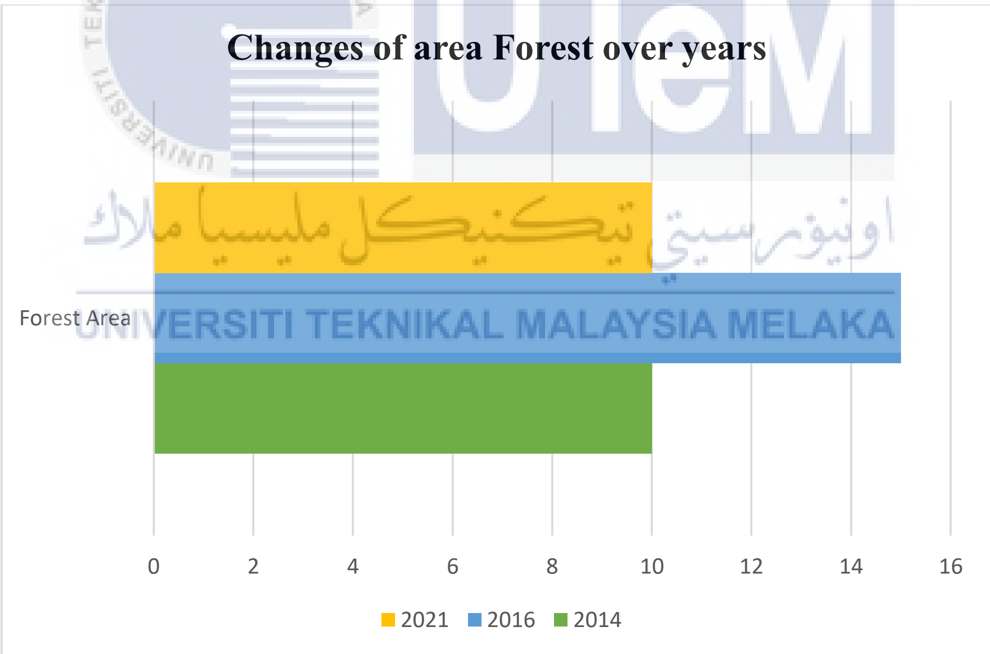


Figure 4.18: Graph of area for forest

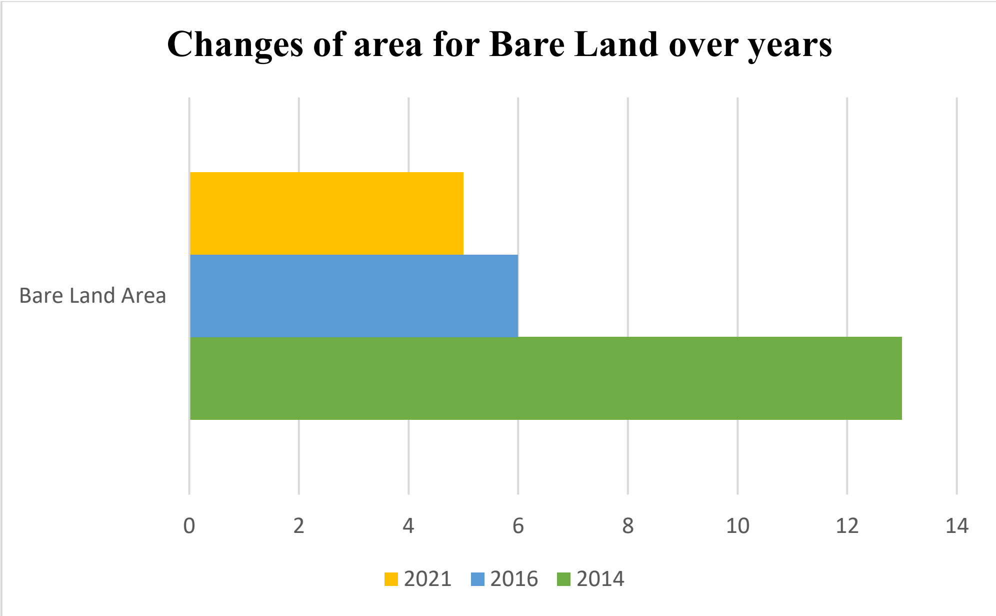


Figure 4.19: Graph of area for bare land

4.5 Summary

The project results were discussed based on the differences in images before and after the pre-processing, clipping, image categorization, and debate on the extent and changes of the metropolitan area throughout the years. Clouds were not removed throughout the pre-processing procedure since this could affect image accuracy. The extents and changes of Putrajaya were compared in 2014, 2016, and 2021. All of the results were tabulated, graphed, and recorded.

CHAPTER 5

CONCLUSION

5.1 Conclusion

The study of this project has successfully assessed the state of Putrajaya and identified the changes and extent of urbanisation over the course of a year. The objectives stated in Chapter 1 have been fulfilled, namely determining environmental and geographical changes. The research conducted suggests that the Malaysian government should always do their share to keep Putrajaya viable and conduct regular inspections of urbanisation there. Implementing more green farm architecture is one of the most effective ways to safeguard urban sustainability. This architecture will benefit not just the current generation, but also future generations. In Malaysia, the integration of Landsat data with the appropriate GIS approach has tremendous potential for use in the fields of mapping and monitoring urbanisation. The remote sensor technology has a strong potential of detecting significant changes in urbanisation, which can help us avert more environmental harm in Malaysia. Some authorities will find this useful in establishing the reason for the quickness with which changes are occurring in urban regions. On the other hand, the findings of this inquiry indicated that the mapping and monitoring techniques generated from Landsat are extremely useful. This technique delivers reliable and trustworthy answers for the distribution of urban areas in terms of both the qualitative and quantitative components of the issue. It is possible to evaluate the degrees of accuracy held by the various classifications of land cover by using the government's Iplan. Landsat's different missions' remote sensing data are an exceptionally important tool for tracking how urbanisation have evolved over time.

Based on the findings of this research, it has been encouraged that the Malaysian government should always do all possible to keep the urbanisation ecology in good form. In the fields of mapping and monitoring urbanisation in Malaysia, the use of Landsat data in conjunction with the appropriate GIS approach provides a substantial amount of untapped potential. The researchers may notice that there are cloud covers on the images, but they can be removed using the F mask algorithm's methods. The level of accuracy and precision required varies depending on the application's unique aims. The remote sensing technique has a high capability of detecting big changes in the ecosystem, which will assist us in preventing additional harm to the environment in Malaysia.

5.2 Recommendations

This thesis only focuses on three parameters which are urban areas, water bodies and bare land. Therefore, this research challenges need to be highlighted to achieve the target which can be improved whereas in order to manage and analyse huge volumes of geographical data, geographic information systems (GIS) are striving to include big data technologies into their application software. The phrase "big data" refers to huge volumes of data generated by sources such as social media platforms, mobile devices, smart cities, and the Internet of Things.

5.3 Summary

This chapter was entirely devoted to discussing and forming conclusions about the project's numerous successes. This chapter also provided a number of concepts and recommendations for further enhancing the approach of recognising changes in Malaysian urbanisation.

REFERENCES

[1] Morris, K. I., Chan, A., Salleh, S. A., Ooi, M. C. G., Oozeer, M. Y., & Abakr, Y. A. (2016). Numerical study on the urbanisation of Putrajaya and its interaction with the local climate, over a decade. https://doi.org/10.1016/j.uclim.2016.02.001

[2] X. Yang and Z. Liu, "Use of satellite-derived landscape imperviousness index to characterize urban spatial growth," *Computers, Environment and Urban Systems*, vol. 29, no. 5 SPEC. ISS., pp. 524–540, 2005, doi: 10.1016/j.compenvurbsys.2005.01.005.

[3] "History of Aerial Photography - Professional Aerial Photographers Association Intl." https://papa.clubexpress.com/content.aspx?page_id=22&club_id=808138&module_id=158950 (accessed Jun. 05, 2022).

[4] "NASA - What is Remote Sensing?" https://www.nasa.gov/audience/forstudents/postsecondary/features/F_What_is_Remote_Sensing_prt.htm (accessed Jun. 05, 2022).

[5] "13903512-Fundamentels-of-Remote-Sensing".

[6] H. Butler, "Seminar Report Urban Planning Department Of Civil Engineering," 2011.

[7] *Application of Geographical Information Systems in Urban Land Use Planning in Malaysia* (n.d.). Scribd. https://www.scribd.com/document/71163681/Application-

[8] "Urbanization and Sustainability in Asia."

[9] D. Majumder, "A Cross-Country Analysis of the Impacts of Urbanization on the Society, Environment and Economy."

[10] Mojares, J. G. (2013). URBANIZATION AND ITS EFFECT IN THE CALABARZON AREA, PHILIPPINES. In *Mojares JGIP* (Vol. 6, Issue 10).

[11] K. Cockx, T. van de Voorde, and F. Canters, "Quantifying uncertainty in remote sensing-based urban land-use mapping," *International Journal of Applied Earth Observation and Geoinformation*, vol. 31, no. 1, pp. 154–166, Sep. 2014, doi: 10.1016/J.JAG.2014.03.016.

[12] T. van de Voorde, W. Jacquet, and F. Canters, "Mapping form and function in urban areas: An approach based on urban metrics and continuous impervious surface data," *Landscape and Urban Planning*, vol. 102, no. 3, pp. 143–155, 2011, doi: 10.1016/j.landurbplan.2011.03.017.

[13] X. Yang and Z. Liu, "Use of satellite-derived landscape imperviousness index to characterize urban spatial growth," *Computers, Environment and Urban Systems*, vol. 29, no. 5 SPEC. ISS., pp. 524–540, 2005, doi: 10.1016/j.compenvurbsys.2005.01.005.

[14] W. Ji, J. Ma, R. W. Twibell, and K. Underhill, “Characterizing urban sprawl using multi-stage remote sensing images and landscape metrics,” *Computers, Environment and Urban Systems*, vol. 30, no. 6, pp. 861–879, Nov. 2006, doi: 10.1016/J.COMPENVURBSYS.2005.09.002.

[15] P. Du, X. Li, W. Cao, Y. Luo, and H. Zhang, “Monitoring urban land cover and vegetation change by multi-temporal remote sensing information,” *Mining Science and Technology (China)*, vol. 20, no. 6, pp. 922–932, Nov. 2010, doi: 10.1016/S1674-5264(09)60308-2.

[16] A. Schneider, “Monitoring land cover change in urban and peri-urban areas using dense time stacks of Landsat satellite data and a data mining approach,” *Remote Sensing of Environment*, vol. 124, pp. 689–704, Sep. 2012, doi: 10.1016/J.RSE.2012.06.006.

[17] K. Isima Morris, A. Chan, S. Aekbal Salleh, M. Chel Gee Ooi, M. Yaasiin Oozeer, and Y. Abdalla Abakr, “Numerical study on the urbanisation of Putrajaya and its interaction with the local climate, over a decade”, doi: 10.1016/j.uclim.2016.02.00.

[18] H. M. Almdhun, S. K. Mallak, M. M. Aburas, M. A. Md Said, and S. M. Ghadiri, “Measuring and predicting urban growth patterns and trends in Putrajaya ,” in *IOP Conference Series: Earth and Environmental Science*, Aug. 2018, vol. 169, no. 1. doi: 10.1088/1755-1315/169/1/012114.

[19] Y. Zhang, C. Zhao, Y. Wu, and J. Luo, “Remote sensing image cloud removal by deep image prior with a
multitemporal constraint,” *Optics Continuum*, vol. 1, no. 2, p. 215, Feb. 2022, doi: 10.1364/optcon.439671.

[20] C. Duan, J. Pan, and R. Li, “Thick Cloud Removal of Remote Sensing Images Using Temporal Smoothness and Sparsity-Regularized Tensor Optimization.”

[21] N. A. Rosni, N. Mohd Noor, and A. Abdullah, “MANAGING URBANISATION AND URBAN SPRAWL IN MALAYSIA BY USING REMOTE SENSING AND GIS APPLICATIONS,” 2016.

[22] N. M. Noor, A. Abdullah, M. Nasrul, and H. Manzahari, “LAND COVER CHANGE DETECTION ANALYSIS ON URBAN GREEN AREA LOSS USING GIS AND REMOTE SENSING TECHNIQUES,” 2013.

APPENDICES

Appendix A: Project Gantt Chart Bachelor Degree Project 2

Project Activities	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
Draft material list									M							S
Meeting with supervisor									I							T
Test software									D							U
Analyse Result									S							D
Complete chapter 4: Result									E							Y
Complete chapter 5: Conclusion									M							W
Submit draft report									B							E
Prepare project poster									R							E
Preparation for presentation									E							K
Presentation									A							
Submit final report									K							