UNIVERSITI TEKNOLOGI MARA

BURN SEVERITY IN KUALA LANGAT FOREST USING REMOTE SENSING TECHNIQUE

MAHFUZAH BINTI JAFFAR

BSc

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MAHFUZAH BINTI JAFFAR

Thesis submitted in fulfillment
of the requirements for the degree of
Bachelor of Surveying Science and Geomatics
(Honours)

Faculty of Architecture, Planning and Surveying

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 11 July 2018 to conduct the final examination of Mahfuzah Binti Jaffar in her Choose your degree. thesis entitled "Burn Severity In Kuala Langat Forest using Remote Sensing Technique" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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ABSTRACT

Fire severity can be mapped using Landsat satellite imagery to detect changes in forest-fired structures. The purpose of this study is to study the severity of the burn using remote sensing techniques. The objective of this study is to identify the severity of fire in Kuala Langat forest, to determine the surface temperature and to determine the greenness that grows in the forest of Kuala Langat. Landsat satellite image is used to calculate the Normalized Burn (NBR) ratio referring to the near infrared range (NIR) and the short wave infrared range (SWIR). Changes in NBR from prefire to postfire determine the value of dNBR to estimate the severity of the burned forests. Surface temperatures are identified in the Kuala Langat Forest during dry and regular seasons. Normalized Difference Vegetation Index (NDVI) is used to study images only after the fire and image 2 years after the fire to determine the level of green forest of Kuala Langat. All methods are processed in Erdas 2014 and ArcGIS versions. Burned severity classes maps, land surface temperature maps and map of Normalized Difference Vegetation Index Kuala Langat Forest are produced.

ACKNOWLEDGEMENT

Firstly I am grateful to Allah S.W.T because with His blessing, knowledge and permission, I am able to complete this final year dissertation. It reflects the work that I performed during my studies at the Department of Surveying Science and Geomatics, Universiti Teknologi MARA Perlis. I would like to express gratitude to my supervisor, Madam Siti Aminah Bt Anshah who has continuously monitor and guide me in regard to this research. Without her supervision and constant help this dissertation would not have been possible to be completed. Furthermore, thanks to my lecturer for the subject of Project Dissertation II (SUG691), Sr Erniza Suhana Binti Mokhtar for her guidance, encouragement and lecture throughout this research. A special thanks to my fellow friends for helping me with this project. You guys made my journey to complete this dissertation became so meaningful. Finally, this thesis is dedicated to my loving parents for the prayer and determination to educate me. This piece of victory is dedicated to both of you. To myself, thank you for being strong and patient for all this time.

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LIST OF SYMBOLS

Symbols

L	Top of Atmospheric Spectral Radiance in watts/(m2*srad*µm)
Lmax	Respective Band on Maximum Spectral Radiance
Lmin	Respective Band on Minimum Spectral Radiance
DNmax	

LIST OF ABBREVIATIONS

Abbreviations

USGS	United States Geological Survey
NBR	Normalized Burn Ratio
dNBR	Difference Normalized Burn Ratio
NIR	Near Infrared
SWIR	Shortwave Infrared
LST	Land surface Temperature
NDVI	Normalized Difference Vegetation Index

LIST OF NOMENCLATURE

Nomenclatures

CHAPTER ONE
INTRODUCTION

1.1 Research Background

Burn severity is interchangeably to describe fire effect on ecosystem. Burn severity can defined as the degree of ecological change caused by fire. Burn severity is often reserved for describing the effect of the fire over extended time frames of weeks to decades (Lentile et al. 2006; Keeley et al. 2008).

Fuel, its physical definitions are living or dead biomaterials, which contribute to the spread, intensity and severity of a fire (Arroyo et al., 2008). The characteristics of fuel in forest fires and bushes are determined by moisture content, size and shape, quantity and position on a surface. Humidity content is a critical factor to be taken into account in most fire-modelling systems (Rothermel et al., 1986). The moisture content of a fuel determines the time taken for the fire to occur. Living plants that contain high moisture content will slow down the process of fire. The process requires a high temperature to convert moisture to water vapour through the heat process with the purpose of drying the fuel. The amount of fuel present on a surface will affect the rate and direction of the fire occurring (Mullins, 1999). The moisture content in the fuel has a high correlation relationship with daily temperature (Chandler et al., 1983). This means indirectly, weather plays an important role in determining the moisture content of a fuel. When the El-Nino phenomenon occurred in 1997 and 1998 in Southeast Asia, prolonged drought caused the moisture content of a plant to become less and hence the control of the fires. The same conditions occurred in 2008, 2010 and 2014 where prolonged dry conditions caused humidity for less plants. Moisture content also has a connection to the energy required to burn from the surface of the earth (Surface Fire) to a fire involving the Crown (Van Wagner, 1967). Knowledge of fuel conditions is very important because it is a major component that needs to be identified in a fire. In Malaysia, forest fires are also commonplace, and are often the issue of forest management. In addition to controlling the fire, there is less strategic action to address it integratively.

The study is to determine the burn severity forest using Remote Sensing technique. The study is also uses image satellite. The study is also use image satellite. These data will be processed using ERDAS image software. In this study are involves several stages such as data collection, data processing and data analysis. In the end in this study the map will show.

1.2 Research Gap

In this research, to study burn severity using remote sensing technique. There are also researches that had been done regarding that burn severity. Table 1.1 shows research gap.

NO	AUTHOR	YEAR	TITLE	RESULT AND ANALYSIS	RESEARCH GAP
1	William L. Baker	2015	Are High-Severity Fires Burning at Much Higher Rates Recently than Historically in Dry-Forest Landscapes of the Western USA?	Comparison of recent and historical high-severity fire rotations shows that high-severity fire is not occurring in dry forests at rates that are exceptionally high relative to the range of historical rates.	Analysis forest fire based on different forest fire severity.
2	Joseph D. White1, Kevin C. Ryan2, Carl C. Key3, and	2015	Remote Sensing of Forest Fire Severity and Vegetation Recovery	Single date analysis of burned areas are relevant for describing the physical nature of the disturbance.	

	Steven W. Running1				
3	Montealegre, Antonio Luis Lamelas, María Teresa Tanase, Mihai A. De la Riva, Juan	2014	Forest Fire Severity Assessment Using ALS Data in a Mediterranean Environment	The lack of pre-fire forest structure information can be a handicap that could be solved by periodical acquisition of ALS datasets in the coming years.	Analysis forest fire based on different forest fire severity.
4	Suliman, M D H Mahmud, M Reba, M N M S, L W	2014	Mapping and Analysis of Forest and Land Fire Potential Using Geospatial Technology and Mathematical Modeling	This study has demonstrated the development of geospatial technology and WebGIS in helping disaster management and operators face the threat of forest fires and land.	

Table 1. 1 Research Gap

1.3 Problem Statement

The forest is an area covered with green trees. Forest is also a habitat of many flora and fauna in the world. Forests provide a variety of interests to humans. The importance of forests is to supply human raw materials to industrial and residential development. In addition, forests should be maintained to provide a balance of natural ecosystems. The forest is a natural rain forest area. There are many factors that contribute to the increased risk of fire in Kuala Langat, such as high temperatures and prolonged periods of drought, strong winds, soil configuration and highly flammable plants.

Remote sensing has been identified as an effective and effective tool for monitoring and preventing forest fires. According to Ahmad et al. (2017) satellite remote sensing techniques can provide efficient and economical resources to obtain timely data for the development and management of our natural resources. Through the use of remote sensing technology and GIS, forest can be monitored daily. Satellite remote sensing is ideal for assessing the extent to which biomass burning is also a prerequisite for estimating emissions on a regional and global scale. This information can help the authorities to better understand the impact of fire on climate change. Better remote surveillance techniques also have the potential to certify longer fire scars and provide estimates of their severity of fire.

This study will use data obtained remotely. The results of this study can help in making early decisions and planning to manage the forest effectively. This will have a significant impact on cost, manpower and time consuming to monitor the plantation. This study was conducted to assist farmers, Department of Agriculture and the public to manage forest.

1.4 Aim

To study the burn severity in Kuala Langat forest using remote sensing technique.

1.5 Objectives

The objectives of this study are as below:

(a) To identify the burn severity at Kuala Langat forest.
(b) To determine the land surface temperature.
(c) To determine growing greenness at Kuala Langat forest

1.6 Significance of Study

The study was selected at Kuala Langat forest. An area of importance for biodiversity conservation supporting rare species like the Malayan Sun Bear and the black form of the clouded leopard. The forest is also of significant importance to local aboriginal (Orang Asli) communities that have lived in the area. This study area is using satellite image remote sensing data that is Landsat. The satellite image Landsat is free download and can cover this study area. This study area was selected because forest fires often occur at this site. Therefore, this study can help and guide the forestry department to plan and preserve the forest.

1.7 SUMMARY

In developing a research for burn forest Kuala Langat forest using Remote Sensing and Arcgis approach, this dissertation consists of five main chapters which are as stated below:

1.6.1 CHAPTER 1: INTRODUCTION

Provides the dissertation background, defines the statement of problems, and explains the aim and objectives of the dissertation. Objective must be legible and clear to achieve the project successfully. The expected results were provided and the methodology adopted for this dissertation was also supplied briefly. In overall it gives first illustration of what this study is about.

1.6.2 CHAPTER 2: LITERATURE REVIEW

Highlighted literatures reviews and gives theoretical background related to the subject of the dissertation. This chapter is to enhance author’s background to understand more about the topic covered. The purpose of this section is to elaborate the related theory to achieve the aim of statement..

1.6.3 CHAPTER 3: METHODOLOGY

It is intended to elaborate the methodologies made in developing the aim and objectives in this study by using Remote Sensing approach. Planning and the selection method to be used is the most important to achieve the objectives of this study. Each of procedures needs to follow step by step without any skipping the methodology flow work. All of the process will be explain in details.

1.6.4 CHAPTER 4: RESULT AND ANALYSIS

This chapter will cover the result and analysis from the project to produce the final output for future decision. The results were map, graph, table, and diagram about allocation of public waste bin analysis. All the result that gets from the processing will be explained and analyses. Analysis will be based on the aim and the objective that states before.

1.6.5 CHAPTER 5: CONCLUSION AND RECOMMENDATION

This chapter is the final chapter of this research. This section is about conclusion and recommendation for the whole research. The conclusion of the project is based on the overall concept and result. This chapter describes the achievement of project dissertation based on objectives from the previous chapter. Besides that, concludes the study as a whole and gives some recommendations and discussion for further study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Highlighted literatures reviews and gives theoretical background related to the subject of the dissertation. This chapter is to enhance author's background to understand more about the topic covered. The purpose of this section is to elaborate the related theory to achieve the aim of statement. It consists of theory of capability of Remote Sensing to estimate burn severity forest.

This chapter will explain in details the literature review that involve in this study and sources of information that have been obtained which are from internet, book, journal and previous thesis that are related to this project. Before proceed with methodology, all the ideas and terminology that came from this chapter must be understood clearly. It is important in order to make sure that the workflow of this study run smoothly.

2.2 Forest

Forest is a very valuable natural treasure especially to the life of fauna and flora. Forest is also a major contributor to valuable timber such as cengal, meranti, belian and teak. These woods are very valuable for the furniture industry. Forest is very important to our lives. Forests can also be used as rain water catchment areas. In addition, the Forest serves as a habitat for a variety of flora and fauna. The forest is able to save flora and fauna because of the extinction of flora and fauna associated with forests. This indirectly maintains ecosystem equilibrium. Meanwhile, forests also play a role as a global warming controller. Global warming occurs because of the pollution and human attitude that does not love the environment. Therefore, the level of heat in the world can be reduced so that we do not heat up. Forest is a source of livelihood, especially the Orang Asli. Therefore, forest products such as herbs, rattan, timber and medicines can be sought with the existence of forests. Traditional medical practices can also be expanded if the forests are well maintained. In conclusion, forests should be carefully maintained by every resident of the earth. The forest can provide us with peace of mind with a green evergreen forest. Therefore, forest areas must be expanded and conserved for all future.

2.3 Cause Fire Forest

Forest fires are usually caused by dry weather or weather that is not accompanied by rain. Most forest fires caused by human activity can be considered accidental fires. One of the most important human activity that can cause forest fires is the use of fires to clean the soil, which can sometimes be handled. Occasionally, travelers and pedestrians may leave potential sources of ignition such as campfire or burning cigarettes in the jungle, which can burn fire.

2.4 Effect of fire forest

Forest fires can affect climate and weather to a great extent, besides causing severe damage to valuable trees. Wildfires can increase the level of greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbons), and thereby increase pollution and global warming. However, they are also an important part of the ecosystem, and many plants depend on the heat and smoke generated by wildfires for their growth and reproduction. But large wildfires can cause extensive damage to the ecosystem, which again highlights the importance of effective control and prevention of forest fires.

2.5 OVERVIEW OF REMOTE SENSING TECHNIQUE IN FOREST FIRE

According to Schoennagel, there are five major factors which influence the burning process and dynamic of the forest such as climate condition, topography, ignition agents, forest fuels and human activities. Otherwise, the impact of establishing an appropriate structure and composition as a result was the impact climate conditions, plant ecosystems and human life, and vegetation responds and adapts to changes in the surroundings. As with any attempt involving different disciplines, an understanding of the terminology used throughout the study of the process and phenomenon of post-fire effects and forest patterns is essential within this review. In addition, variety of terms was used to describe the fire characteristics and effects. The current review is related with some of these terms which is pre-fire environment, fire environment, active fire, post-fire environment, fire regimes defined by fire intensity, fire and burn severity, season of burn, type of fire and burned size and shape.

Fire-Related Environment	Parameter	Definition of Parameter
Pre-environment	-	The environmental characteristics of a pre-burning site.
Fire environment: The environmental characteristics of a site during a fire. This is the state involved with active fire.	Fire frequency/fire recurrence	The rate of umber of fires in a specified area. Temporal aspect of fire regimes.
	Fire intensity	A quantified of fire behavior by releasing energy such as heat and temperature from burning organic matter.
Post-environment: The environmental characteristics of a site after a fire, including both short and long-term effects.	Perimeter of burned area	The measurement of after burning effects in terms of dimension which exaggerated by fire or spatial extent of fire effect
	Fire severity	The scale of environmental alteration caused straightly by fire flow immediately after a fire event (short term and initial assessment)
	Burn severity	The degree of environmental change caused by fire severity, assessed by a certain amount of time elapsed in post-fire (an extended assessment).
	Forest structure	Arrangement and distribution of post-fire interaction in the forest (e.g., tree height and diameter (Leaf Area Index).
	Forest composition	Richness of species and abundance characteristic after the burning.
	Forest function	Forest regeneration on production of organic matter after the burning.
	Forest succession	Recovery of vegetation in different stages.

Table 2. 1Definitions of fire-related environments and parameters used to measure fire/post-fire effect and forest patterns

2.6 AVAILABLE SATELLITE-SENSOR PLATFORMS

Several remote sensing satellites are now available, providing suitable imagery for forest fire research and fire monitoring operations. Each satellite sensor platform is characterized by the wavelengths bands used in image acquisition, spatial resolution of the sensor, the coverage area and as often as certain locations on the surface of the earth can be illustrated by the imaging system. Satellite sensors systems commonly used in fire detection and monitoring:

	NOAA-AVHRR	DMSP-OLS	TERRA-MODIS	LANDSAT-TM	SPOT-HRV/HVIR
Spectral Band	1: red 2: NIR 3:MWIR 4,5: thermal	1: visible 2: thermal	36 bands covering visible, NIR, SWIR, MWIR and thermal IR	1: blue 2: green 3: red 4: NIR 5, 7: SWIR 6:thermal Panchromatic Band	1: green 2: red 3:NIR 4:SWIR Panchromatic Band
Swath	c.2000 km	c.2000 km	c. 2000 km	c. 100 km	c. 60 km
Spatial Resolution	1 km	2.7 km	Two 250m bands and five 500m bands in visible, NIR and SWIR; 1km in MWIR and thermal IR	30m (multispectral); 15m (panchromatic)	20m (multispectral); 10m (panchromatic
Temporal Frequency	daily	daily	daily	Once in 16 days	Almost daily with 3 satellite
Application	Detection	Detection	Detection of	Detection and	Detection of

	of thermal emissions from active fires (hot spots)	of light emission from night-time fires	thermal emissions from active fires; burn scars mapping; vegetation/land cover mapping	mapping of burn scars; vegetation classification and mapping	active fires; accurate location of fires; detection and mapping of burn scars; vegetation classification and mapping

Table 2. 2 Commonly used satellite sensor for forest fire detection and monitoring.

2.7 LANDSAT 8

Landsat 8 is a continuation of Landsat's mission for the first time being a satellite observers of the earth since 1972 (Landsat 1). Landsat 1, originally named Earth Resources Technology Satellite 1, was launched on July 23, 1972 and commenced operations until January 6, 1978. The successor of Landsat 2 launched January 22, 1975, operating until January 22, 1981. Landsat 3 launched March 5, 1978 ended March 31, 1983; Landsat 4 was launched July 16, 1982, was halted in 1993. Landsat 5 launched March 1, 1984 is still functioning until now but has suffered heavy disturbances since November 2011, due to this disruption, on December 26, 2012, USGS announced that Landsat 5 will be disabled. In contrast to 5 generations of its predecessors, Landsat 6 which was launched October 5, 1993 failed to reach orbit. While Landsat 7 launched on April 15, 1999, it still works despite the damage since May 2003.

2.7.1 Landsat Characteristics 8

Landsat 8 is a continuation of the land area 7 and is not a new satellite and with a new specification. This is evident from its characteristics similar to landsat 7, both its resolution (spatial, temporal, spectral), correction methods, flying altitudes and the characteristics of sensors carried. There are just a few additions that are the refinement points of the 7th latitude such as the number of bands, the lowest spectromagnetic wave spectrum range that the sensor can capture and the bit value (Digital Number value range) of each image pixel.

As published by the USGS, the 8 landed satellite flew at an altitude of 705 km from the earth's surface and has an area of 170 km x 183 km (similar to the previous Landsat version). NASA owns its newest landed satellite version of its new 5-year mission (5-year OLI sensor and 3-year TIRS sensor). No possibility of land productive age 8 can be longer than the declared age as occurred in the landmark 5 (TM) initially targeted to only operate 3 years but it turns out that until 2012 it still works.

Landsat 8 satellite has an on board Operational Land Imager (OLI) sensor and Thermal Infrared Sensor (TIRS) with a total of 11 channels. Among the canals, 9 channels (bands 1-9) are on OLI and 2 others (bands 10 and 11) on TIRS. Most channels have specification similar to Landsat 7. Channel types, wavelength and spatial resolution of each band on Landsat 8 compared to Landsat 7.

2.7.2 Landsat Usage 8

Landsat 8 mission is Earth surface monitoring, understanding and managing the resources needed to preserve human sustainability such as water and forest food, monitoring environmental impacts and changes, and so on. Landsat 8 imagery is known to have 11 bands. Among them Visible band, Near Infrared (NIR), Short Wave Infrared (SWIR), Panchromatic and Thermal. Bands 1,2,3,4,5,6,7 and 9 have spatial resolution of 30 meters, band 8 has a spatial resolution of 15 meters, while bands 10 and 11 spatial resolution are 100 meters. From each band it has its own use. To perform analysis of the Landsat Image, a band combination is needed to get the image display according to the theme or purpose of the analysis. Details of each band's use are as follows

BANDS	TYPE BANDS	WAVELENGTH(MICROMETRES)	RESOLUTION
Band 1	Ultra blue	0.435-0.451	30
Band 2	Blue	0.452-0.512	30
Band 3	Green	0.533-0.590	30
Band 4	Red	0.636-0.673	30
Band 5	Near infra-red	0.851-0.879	30
Band 6	Shortwave infra-red 1	1.566-1.651	30
Band 7	Shortwave infra-red 2	2.107-2.294	15
Band 8	Panchromatic	0.503-0.676	30
Band 9	Cirrus	1.363-1.384	30
Band 10	Thermal infrared 1	10.60-11.19	30
Band 11	Thermal infrared 2	11.50-12.51	30

Table 2. 3 Landsat 8 specification

2.8 PRE-PROCESSING OF SATELLITE IMAGE

Image pre-processing is an initial and compulsory process performed to any remotely sensed data before further step forward are taking place. This process may affect the result of image resampling and other process in this study. Once an image is generated and received from a satellite instrument, and before it can be analysis, it must go through a number of pre-processing steps. Most pre-processing algorithms will be designed or at least adapted to deal with the specific dataset they are being run on and to the final application. The images are pre-processed to correct for various atmospheric, radiometric and geometric effects, then images are processed and analysis for the specific application for which the data is being used.

2.9 RADIOMETRIC CORRECTION

Radiometric correction is in pre-processing. It also carried out when an image data is recorded by the sensors contain errors in the measured brightness values of the pixels. The purpose of radiometric correction is to reduce or correct digital numbers of images. It is particularly important when comparing data sets over a multiple time period. The correction is necessary due to variations in scene illumination and viewing geometry, atmospheric conditions, and sensor noise and response. It also includes correcting the data for sensors irregularities and unwanted sensors, or atmospheric noise and converting the data that can accurately represent the reflected or emitted radiation measured by sensor.

There are several types of radiometric corrections which are sun elevation and earth-sun distance corrections, haze reduction, noise removal, sun angle correction and absolute radiometric correction. The purpose of radiometric correction is to reduce or correct digital numbers of image.

2.10 NORMALIZED BURN RATIO (NBR)

The Normalized burn ratio (NBR) is used to identify burned areas. The formula is similar to a normalized difference vegetation index (NDVI), except that it uses near-infrared (NIR) and shortwave-infrared (SWIR) portions of the electromagnetic spectrum (Lopez, 1991; Key and Benson, 1995). The NIR and SWIR parts of the electromagnetic spectrum are a powerful combination of bands to use for this index given vegetation reflects strongly in the NIR region of the electromagnetic spectrum and weekly in the SWIR. The NBR index was originally developed for use with Landsat TM and ETM+ bands 4 and 7, but it will work with any multispectral sensor with a NIR band between 760 - 900 nm and a SWIR band between 2080 - 2350 nm. Thus this index can be used with both Landsat 8, MODIS and other multi (and hyper) spectral sensors.

The Normalized Burn Ratio is most powerful as a tool to better understand fire extent and severity when used after calculating the difference between pre and post fire conditions. This difference is best measured using data collected immediately before the fire and then immediately after the fire. NBR is less effective if time has passed and vegetation regrowth / regeneration has begun after the fire. Once vegetation regeneration has begun, the fire scar will begin to reflect a stronger signal in the NIR portion of the spectrum because healthy plants reflect strongly in the NIR portion due to the properties of chlorophyll). Normalized Burn Ratio analysis based on satellite image will examine the ability of spectral data in determining the fire area. Normalized Burn Ratio are used for estimating the crops and forest variables by using shortwave infrared SWIR and near infrared region (NIR) from the electromagnetic spectrum.

2.11 NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

Normalized Difference Vegetation Index (NDVI) was calculated in order to determine the percent of vegetation in the two combined images. Percent of vegetation is difference between the NDVI pixel value calculated in the previous formula and subtracted from the minimum NDVI value NDVI min of 0.2 and the maximum NDVI value NDVI max of 0.5.(Boyd, 2015).

Normalized Difference Vegetation Index (NDVI) is employed in the present research study. The mean of channels 4 (0.636-0.673 μm) and 5 (0.851-0.879 μm) was obtained to get the NDVI from reflectance images. The formula for NDVI calculation for image data of Landsat 8 is shown in equation 1 (Biswajith, 2014). Vegetation indices have long been used in remote sensing for monitoring temporal changes associated with vegetation. Rock and soil classification have a broadly similar reflectance which giving NDVI are so close to ‘0’. However, NDVI values that is little higher than zero will indicates the presence of vegetation classes, moderate and high values will indicate stressed vegetation and healthy vegetation respectively; whereas near zero and negative values indicate non-vegetation class such as water, snow, built-up areas and barren land. This can be proving by inquire the pixel on the image on difference classification.

There are only active vegetation has a positive NDVI being typically between about 0.1 and 0.6 values at the higher end of the range indicating increased photosynthetic activity and a greater density of the canopy (Tarpley et. al, 1984). The following algorithm is adopted to create NDVI map:

i. Conversion of spectral reflectance values into NDVI values by computation of NDVI values for the entire study areas.

ii. Density-slicing method that measures apparent reflectance to sensor values is used for the conversion of these NDVI values to a scaled channel values.

iii. NDVI image display and production of a legend keep the threshold values.

The greenness range is divided into discrete classes by slicing the range of NDVI values into six ranges by fixing the thresholds for NDVI classification and the method used is Natural Breaks (Jenks method).

2.12 Remote Sensing

Remote sensing technology has widely used nowadays in order to monitor and detect fire. Satellite imagery can be used to identify the forest fire. Changes in spectral signatures that occur following a fire can be surrogates for identifying patterns of burned areas. When vegetation is burned, there is a drastic reduction in visible-to-near-infrared reflectance and an accompanied increase in the short and middle infrared surface reflectance of most satellite sensors (Lentile, 2006 & Miller, 2007). Burned patches are relatively easy to discriminate visually for this reason. They are complex to detect automatically, however, because of the wide range of spectral signatures and spatial heterogeneity caused by fire regimes, the type of vegetation burned and the environmental conditions (Loboda & French, 2013). Remote sensing technology is well-known as a non-destructive method to collect information about earth features such as:

- RS data may be obtained systematically over very large geographical areas rather than just single point observations
- RS data can reveal information about places that are inaccessible to human exploration.
- The systematic raster data collection in RS can remove sampling bias
- RS can provide fundamental biophysical information that can be used in other sciences
- RS is independent from the data produced elsewhere, in comparison with the other mapping sciences such as cartography or GIS.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

Methodology is a process to produce a final product. This chapter will explain in detail about the methodology, types of data, software used and the workflow that involved in this study. The satellite image processing will be discuss in detail which involving the process of image pre-processing, vegetation index application, regression analysis and many more. The whole process of the methodology in this study can be referred at Figure.

3.2 Overall methodology

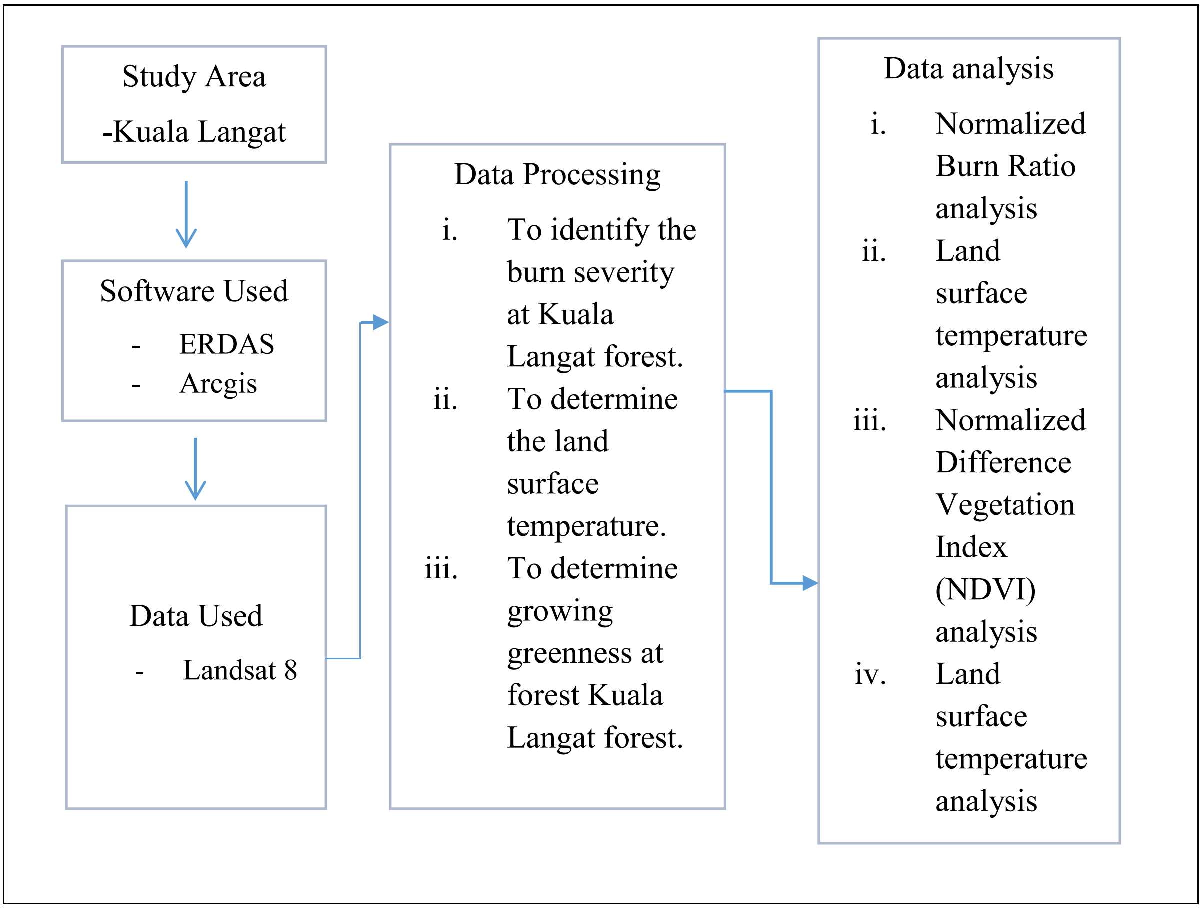

FIGURE 3. 1 Overall Methodology

3.3 Flowchart methodology

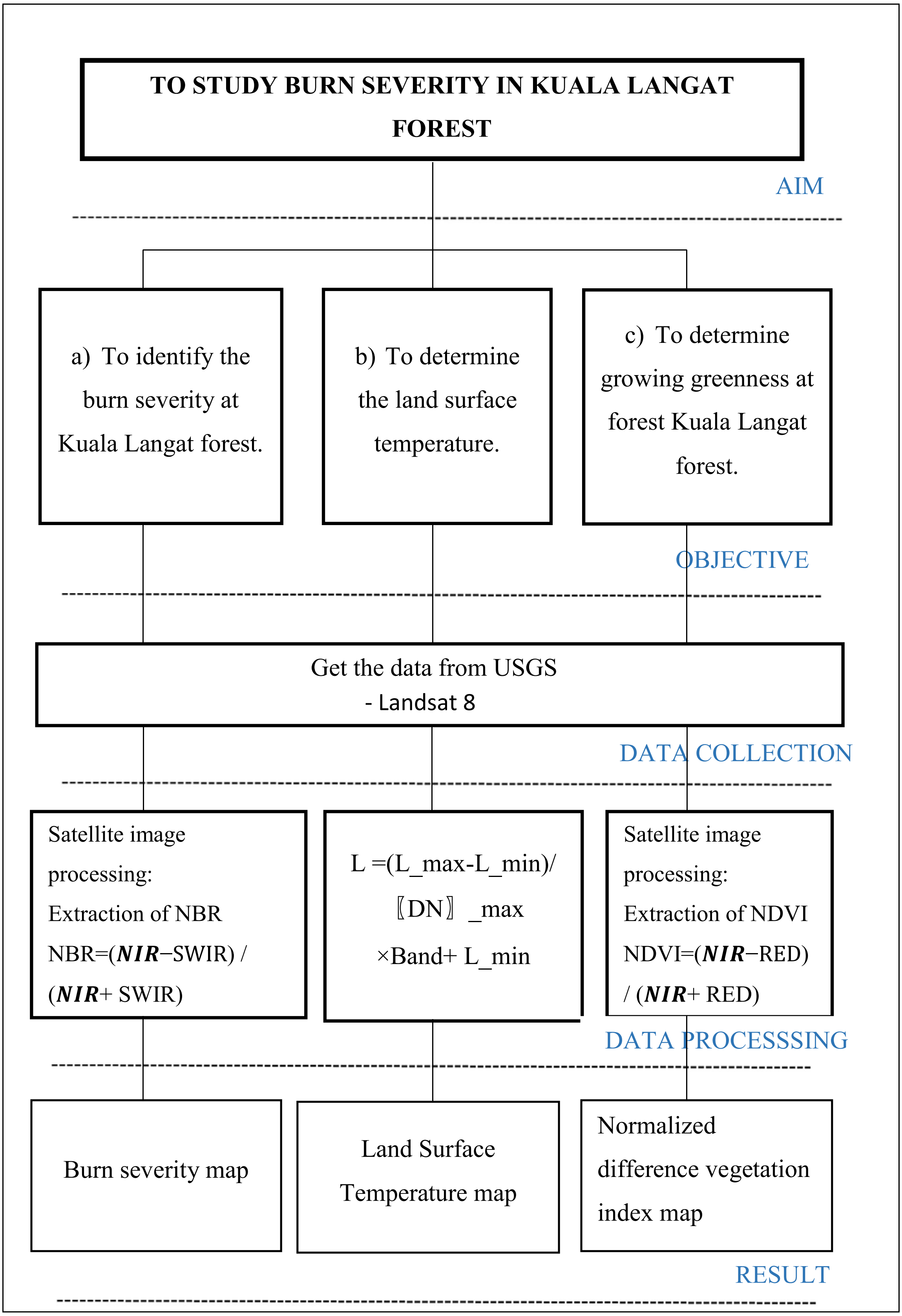

FIGURE 3. 2 Flowchart Methodology

The research methodology has been structured based on the research objectives. The first step is data collection process. There are data that had been required for this research which are satellite image of Landsat 8 for this study area. Next is the phase of data processing. The first process is do the pre-processing satellite image of the data of Landsat 8. Software ERDAS and Arcgis is used to processing the image. The digital image processing involve with the radiometric correction, subset and correction of image to eliminate the presence of noise. The Landsat 8 data will be corrected using a reference image to project the image into the RSO coordinate system with Kertau as datum. For image subset, is used to subset the Landsat 8 image based on the study area. The processing is done for determination of accessing, interpreting and analysis the result.

3.4 Study area

. The study area is Kuala Langat, forest Selangor. It is situated in the south western part of Selangor. It is bordered by the districts of Klang and Petaling to the north and Sepang to the east. Its sountherm borders forms part of Selangor's border with the state of Negeri Sembilan. This study area was selected because forest fires often occur at this site. Therefore, this study can help and guide the forestry department to plan and preserve the forest.

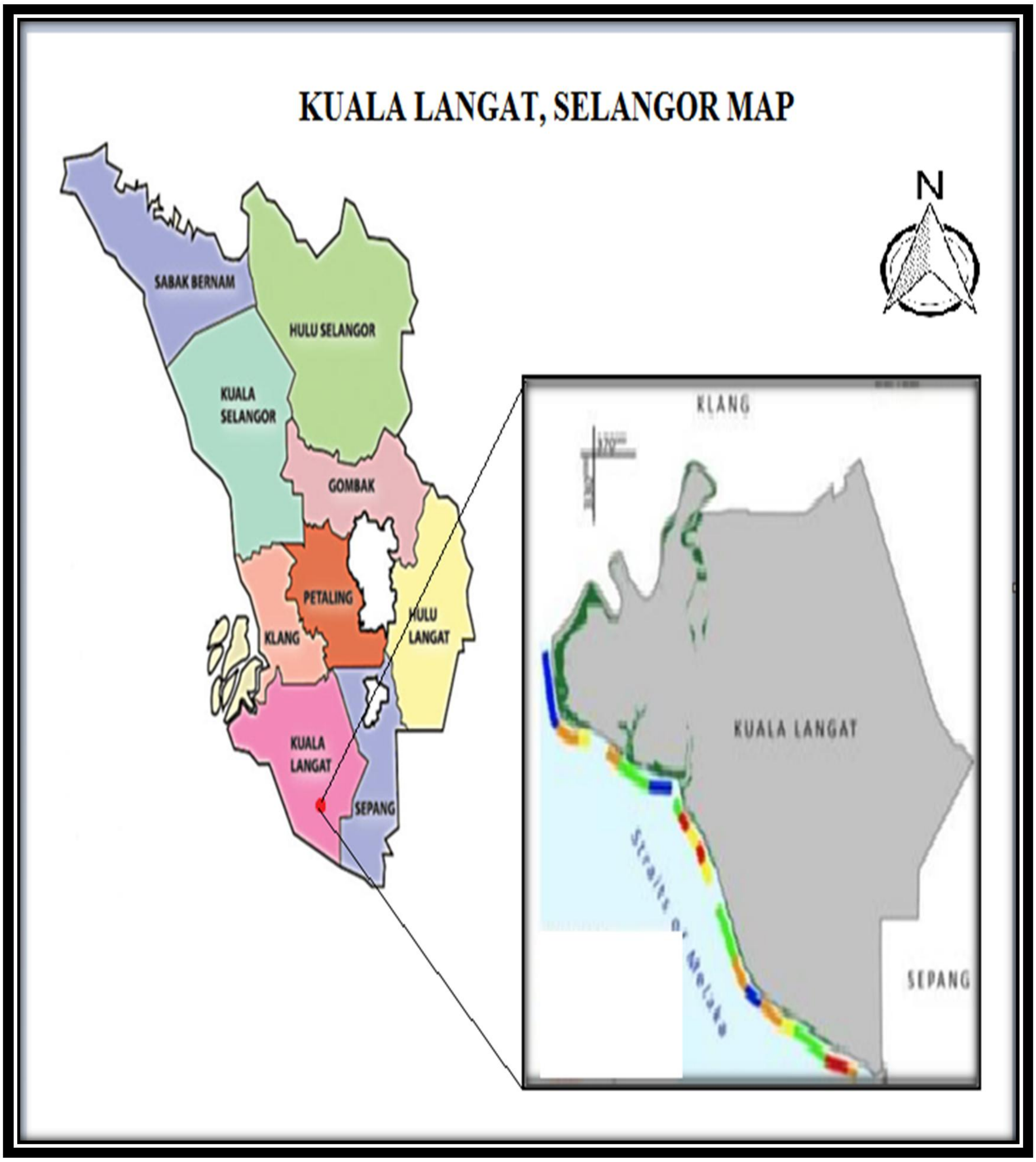

FIGURE 3. 3 Location Area

FIGURE 3. 4 Location of Study Area

3.5 Data preparation

DATA TYPE	ATTRIBUTE TABLE	SCALE	SOURCE
Landsat 8	• NBR -Band 4 and band 7 • LST -Band 10 and 11 • NDVI - band 5 and band 4	30 m	USGS website

Table 3. 1Data Preparation

3.6 **Project planning**

3.6.1 Research Tool and Insrument

The software that are used in this study are ERDAS Imagine 2013 software is used to process the satellite image Landsat. Most of the processing in this study used ERDAS and ArcGis software.

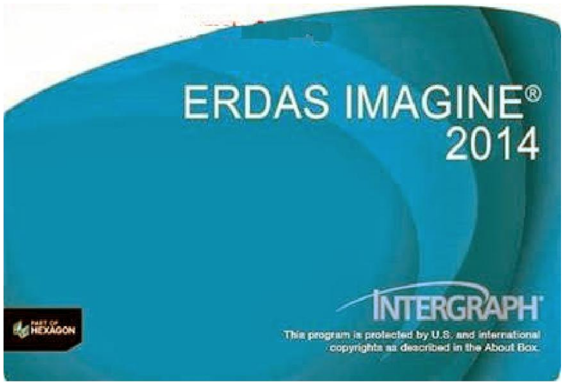

FIGURE 3. 5 Erdas Imagine Software

FIGURE 3. 6 ArcGIS Imagine Software

3.6.2 The function of software / data

NO	SOFTWARE / DATA	USING FOR
1	Arcgis 10.4	• To make map
2	ERDAS	• To make pre-processing. • Subset.
3	Landsat 8	• Using band 4 for NIR band and band 7 for SWIR band to calculate NBR. • Using band 10 and band 11 the thermal band to calculate LST. • Using band 4 the red band and band 5 the near infra-red band to calculate NDVI.

Table 3. 2 Function Software / Data

3.6.3 LANDSAT

This project required three image of Kuala Langat district which is at area Selangor. Those image is a Landsat 8 image that collected by downloading the image in a United States Geological Survey (USGS) website through yearly period. Therefore, the Landsat 8 image on 2013 until 2017 are processed to identify and investigate the analysis required. Among all of the data on the website, the image of the year is chosen due to the excessive of burning at the end of year 2014. Perhaps, the date image of year 2014 is on March 2014 is where the forest does not start to burning while the image in 2015 is the image after the burning had occurred in that area. Moreover, the image in 2016 is collected due to the regeneration of the forest after a year period end of the burning occurred. In addition, those three Landsat 8 image has a minimum cloud cover and have been projected with map projection of RSO Mercator as a datum. The format of the images accumulated area is in the GeoTiff. The data collected on that district is made due to the excessive burning on that particular forest with the dry condition of the peat land.

3.6.4 ERDAS

ERDAS IMAGINE 2014 is a professional GIS raster processing, Remote Sensing and Photogrammetry software used to extract information from satellites and aerial imagery. Easy to learn and easy to use, ERDAS IMAGINE is perfect for beginners and experts alike. Various tools allow users to analysis data from almost any source and present them in format from printed maps to 3D models, making ERDAS take a comprehensive toolbox for geographic imaging, image processing, and GIS raster requirements. ERDAS Imagine 2014 is the only software used in this project where there is the ability of this software to process satellite images and can perform analysis on satellite images.

3.6.5 ArcGIS

ArcGIS is a geographic information system (GIS) used in working with maps and geographical information. ArcGIS is used to create maps, organize geographic data, analysis mapping information, share and discover geographic information, use maps and geographical information in multiple applications, and manage geographic information in databases. In this project, ArcGIS is used to generate map production.

3.7 Data Processing

Data processing is the stage where all the process involves in order to obtain the objective of this study be highlights. Besides that, data that were used and what kind of method involves also being identify in this sub-topics. The raw data received from the satellite sensors contain flaws and deficiencies and several step of processing need to undergo to get the originality of the data. This will vary from image to image depending on the type of image format, initial conditions of the image and the information of interest and the composition of the image scene. This project requires both image to perform pre-processing technique of radiometric correction and atmospheric correction. For radiometric and atmospheric correction, the conversion from DN to Radiance and Radiance to Reflectance are applied using modeller function in ERDAS Imagine 2014 software. After that, the NBR, difference NBR, NDVI and LST will be process. The NBR and differencing NBR processing to determine the burn severity classes. The NDVI processing to determine the correlation between classes. Image classification also performs to produce land use map and finally matrix process is apply after image have been recode. The last processing is LST is to determine and compare the temperature before occurs the burn forest fire and after burning.

3.8 NORMALIZED BURN RATIO (NBR)

The Normalized Burn Ratio (NBR) was designed to highlight burned areas and estimate fire severity. The formula is similar to NDVI, except that it uses near-infrared (NIR) and shortwave-infrared (SWIR) wavelengths. Normalized Burn Ratio is frequently used to estimate burn severity. Imagery collected before a fire will have very high near infrared band values and very low mid infrared band values and a Imagery collected over a forest after a fire will have very low near infrared band values and very high mid infrared band values. Higher dNBR indicate more severe damage. Areas with negative dNBR values may indicate increased vegetation productivity following a fire. The formula used to calculate NBR is as equation :

$$NBR = NIR-SWIR / NIR+SWIR$$

The meaning of the ΔNBR values can vary by scene, and for best results interpretation in specific instances should always be based on some field assessment. However, the adjacent table from the USGS Fire Mon program can be useful as a first approximation for interpreting the NBR difference. These guidelines are then used to create a thematic burn severity layer depicting severity as unburned to low, low, moderate, high, and increased greenness (increased post-fire vegetation response).

Typically, NBR and ΔNBR images are generated shortly after a fire burns to get an initial assessment of burn severity and to support field work. During the next growing season, NBR datasets are often calculated again to assess vegetation survival and delayed mortality. Burn severity data and maps can aid in developing emergency rehabilitation and restoration plan post-fire. They can be used to estimate soil burn severity and to estimate the likely future downstream impacts due to flooding, landslides, and soil erosion. The analysis of this study will be based on the image processing in ERDAS and ARCGIS.

The result for this study will show NBR will be the best to make prediction of Kuala Langat forest. The map of Kuala Langat Forest will be produced. It is expected to make prediction of Kuala Langat forest using the remotely sensed data. This information will guide and improved management decisions to reduce input cost, harvest segregation based on quality, assist with tree health monitoring and traceability.

3.9 LAND SURFACE TEMPERATURE PROCESS

Land Surface Temperature is a process of determining the temperature value on each pixel value of the raster map. Regarding to the process, each of the pixel value will show the value of the temperature by using the inquiry tab. Besides that, the image can identify the minimum and the maximum of the temperature in the area processed.

In addition, the image can export in the ArcGIS software so that the land surface temperature image can be classified into few classes to determine the range of the area which has high temperature. In this project, the process of the image is to identify the hotspot of the area that can be in high severity in burning.

However, the process of LST in Landsat 8 image is difference compared to the other Landsat image. This can be shown in the formula provided below from the radiance conversion until the Land Surface Temperature image is produced. Plus, the value of band used is difference with the other Landsat as the thermal band of Landsat 8 is Band 10.

3.10 NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

Regarding to this project, image interpreter of spectral enhancement are used to perform the indices processing for NDVI. After image pre-processing and subset have been applied, NDVI process was performed to monitor the vegetation condition. Landsat 8 image that are very useful for vegetation monitoring will give the best result for NDVI processing. NDVI values are range from -1 to +1, with values nearest to +1 are classify as healthy vegetation and values nearest to -1 are classify as unhealthy vegetation or any NDVI value given 0 indicate no vegetation. In addition, for Landsat 8 image, the NDVI need to perform by using model maker as it sensor is not given in the indices window. By using the formula for calculating NDVI of Landsat 8 image which is:

$$NDVI= ((NIR-RED))/((NIR+RED))$$

$$NDVI= ((BAND\ 5-BAND\ 4))/((BAND\ 5+BAND\ 4))$$

After the NDVI processing is completed, the map NDVI was produce.

3.11 Data processing

Data processing is the stage where all the process involves in order to obtain the objective of this study be highlights. Besides that, data that were used and what kind of method involves also being identify in this sub-topics. The raw data received from the satellite sensors contain flaws and deficiencies and several step of processing need to undergo to get the originality of the data. This will vary from image to image depending on the type of image format, initial conditions of the image and the information of interest and the composition of the image scene. This project requires both image to perform pre-processing technique of radiometric correction and atmospheric correction.

For radiometric and atmospheric correction, the conversion from DN to Radiance and Radiance to Reflectance are applied using modeller function in ERDAS Imagine 2014 software. After that, the NBR, difference NBR, LST and NDVI will be process. All the result will be map. The NBR and differencing NBR processing to determine the burn severity classes. The end of the LST is to determine and compare the temperature before occurs the burn forest fire and after burning. The last processing is NDVI processing is to determine the NDVI classes in Kuala Langat forest.

3.12 LAYER STACKING

In this process, the image layer stack that will be process need to proceed first before subset the image into the area needed. The layer stack process is a process where the serial of band will be combined for the further process purpose. First of all the layer stack window is open from the spectral in the raster tab. Then the input data will be choosing through each band by fitting the format of Tiff file. This is due to the format data download from USGS is in Tiff format. Each band has its purpose to identify the vegetation, soil, thermal, temperature and much more. As the output of the file is in image format (*.img), the image of the raster will be produced due to the layer stack processing (see image). For the information, this project is using only three bands (4, 5 & 6) in processing the NDVI and Land Surface Temperature analysis.

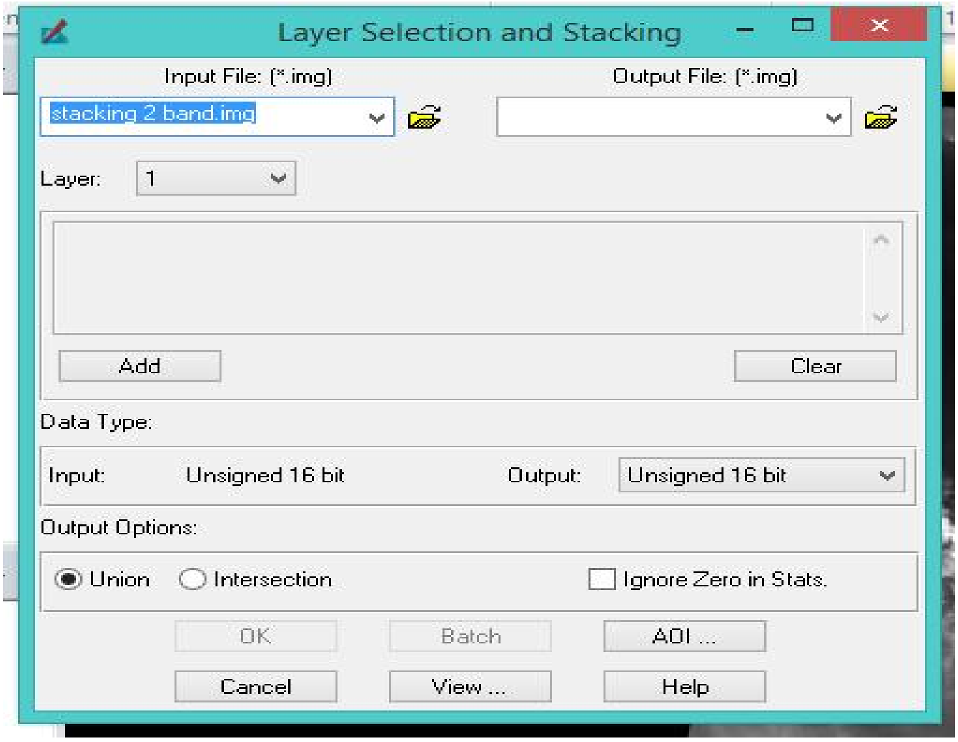

FIGURE 3. 7 Layer Stacking in Processing

3.13 IMAGE PRE-PROCESSING

Image pre-processing is an initial and compulsory process performed to any remotely sensed data before further step forward are taking place. This process may affect the result of image resampling and other process in this study.

3.14 SUBSET

Subset process is needed if only areas of interest are required, so that only image that is related to the project is appearing. Subset is making to the both images at same size or same coordinate at each edge of image, so that analysis or comparison can be made from this image. The most important thing is the coordinate of each edge need to be identified according to the projection required for the output map at the end of the process. The data download is in WGS 1984 UTM Zone 47. Therefore, the coordinate of the subset should be in the desired coordinate by following the map file. The output for this process is only in unsigned 8 bit only.

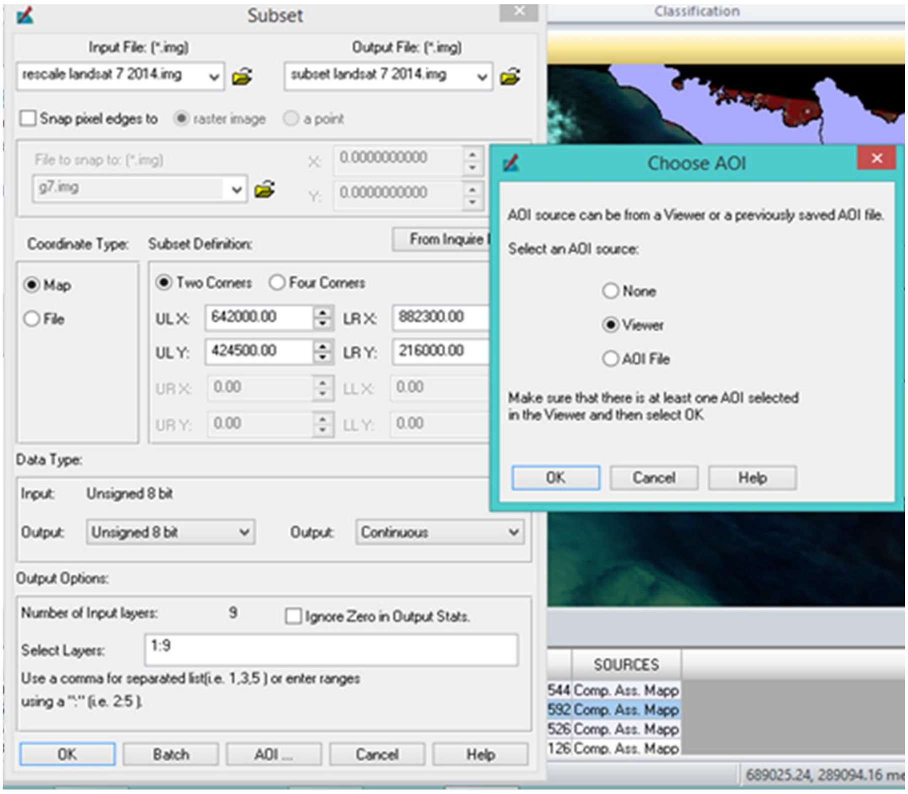

FIGURE 3. 8 Subset

3.15 CALCULATED NBR

After that uses Normalized Burn Ratio (NBR) calculation. NBR calculated is uses to measures of burn severity from pre and post-fire Landsat. Differencing the NBR between pre- and post-fire scenes allows for isolating burned from unburned areas.

NBR = NIR-SWIR / NIR +SWIR

$$dNBR = NBRprefire - NBRpostfire$$

ΔNBR	Burn Severity
< -0.25	High post-fire regrowth
-0.25 to -0.1	Low post-fire regrowth
-0.1 to +0.1	Unburned
0.1 to 0.27	Low-severity burn

ΔNBR	Burn Severity
0.27 to 0.44	Moderate-low severity burn
0.44 to 0.66	Moderate-high severity burn
> 0.66	High-severity burn

Table 3. 3 Burn Severity Classes

3.16 LAND SURFACE TEMPERATURE

The model maker was use for the land surface temperature (LST) to produce. In order to achieve the LST image, the method is split into two sections which are to produce brightness temperature (BT) for band 10 and band 11 and also the mean and difference of the land surface of emissivity. Band 10 and band 11 is required to process the image as the role of this band is Thermal Infrared 1 and Thermal Infrared 2 (TIR-1 and TIR-2). The range for this band is 10.60-11.19 μm and 11.50-12.51 μm. However, the technology of collaboration by NASA and USGS shows the condition and the result of band 11 is not stable as it is the new band of the TIRS-2. Therefore, they will establish the new Landsat 9 at the end of December 2019. According to the Md Shahid Latif in his articles report of Land Surface Temperature Retrival of Landsat 8 Data Using Split Window Algorithm in A Case Study of Ranchi District, there are seven steps required to complete the task of LST. Therefore, each task has their role regarding to the formula indicator given so that the image operation is perform through each step.

Step 1: Identification of Top of Atmospheric Spectral Radiance of TIRS Band 10 and 11 and OLI sensor of Band 2-5 individually using the algorithm given below. The function of this algorithm is to transform the raw image data into spectral radiance image. Therefore, by using ERDAS IMAGINE 2014 the implementation of model maker algorithm of Equation 1,

$$\boxed{L = \frac{L_{max} - L_{min}}{DN_{max}} \times Band + L_{min}} \quad (1)$$

Where:

L = Top of Atmospheric Spectral Radiance in watts/(m2*srad*μm)

Lmax = Respective Band on Maximum Spectral Radiance

Lmin = Respective Band on Minimum Spectral Radiance

DNmax = Qcal max – Qcal min

= Differentiation of maximum and minimum of sensor calibration

Step 2: Identification of Brightness Temperature (TB) of Band 10 and 11. Brightness Temperature is the electromagnetic radiation traveling upward from the top of the Earth's atmosphere. Thermal calibration process can be done by converting thermal DN values of raw thermal bands of TIR sensor into TOA Spectral Radiance. After using Brightness Temperature equation shown in Equation 2 we got Brightness Temperature (TB) band as shown in Figure 2. By using ERDAS IMAGINE 2014 model maker was implement algorithm in Equation 2.

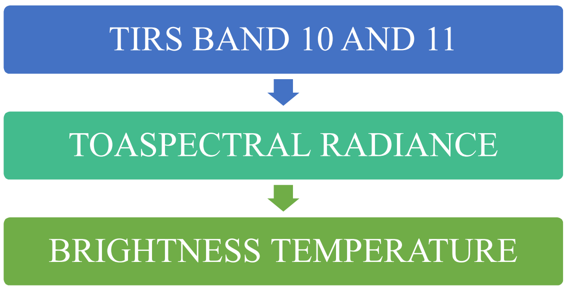

FIGURE 3. 9 Brightness Temperature Process

$$\boxed{TB = \frac{K2}{\log(1+\frac{K1}{L})} - 273.15} \qquad (2)$$

Where:

TB = Brightness Temperature

K1 and K2 = Thermal constant bands from the image file of metadata

L = Top of Atmospheric Spectral Radiance layer

3.17 NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

Regarding to this project, image interpreter of spectral enhancement are used to perform the indices processing for NDVI. After image pre-processing and subset have been applied, NDVI process was performed to monitor the vegetation condition. Landsat 7 image that are very useful for vegetation monitoring will give the best result for NDVI processing. NDVI values are range from -1 to +1, with values nearest to +1 are classify as healthy vegetation and values nearest to -1 are classify as unhealthy vegetation or any NDVI value given 0 indicate no vegetation. By using the formula for calculating NDVI of Landsat 8 image which is:

$$\boxed{NDVI = \frac{(NIR - RED)}{(NIR + RED)}}$$

$$\boxed{NDVI = \frac{(BAND\ 4 - BAND\ 3)}{(BAND\ 4 + BAND\ 3)}}$$

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter will explain the results of research which has been carried out based upon the methodology discussed in Chapter 3. The result and further analysis that had been made based on the methodology on the previous chapter until it being done. The aim of this project is to study burn severity in Kuala Langat forest using remote sensing technique.

4.2 BURN SEVERITY MAP IN KUALA LANGAT FOREST

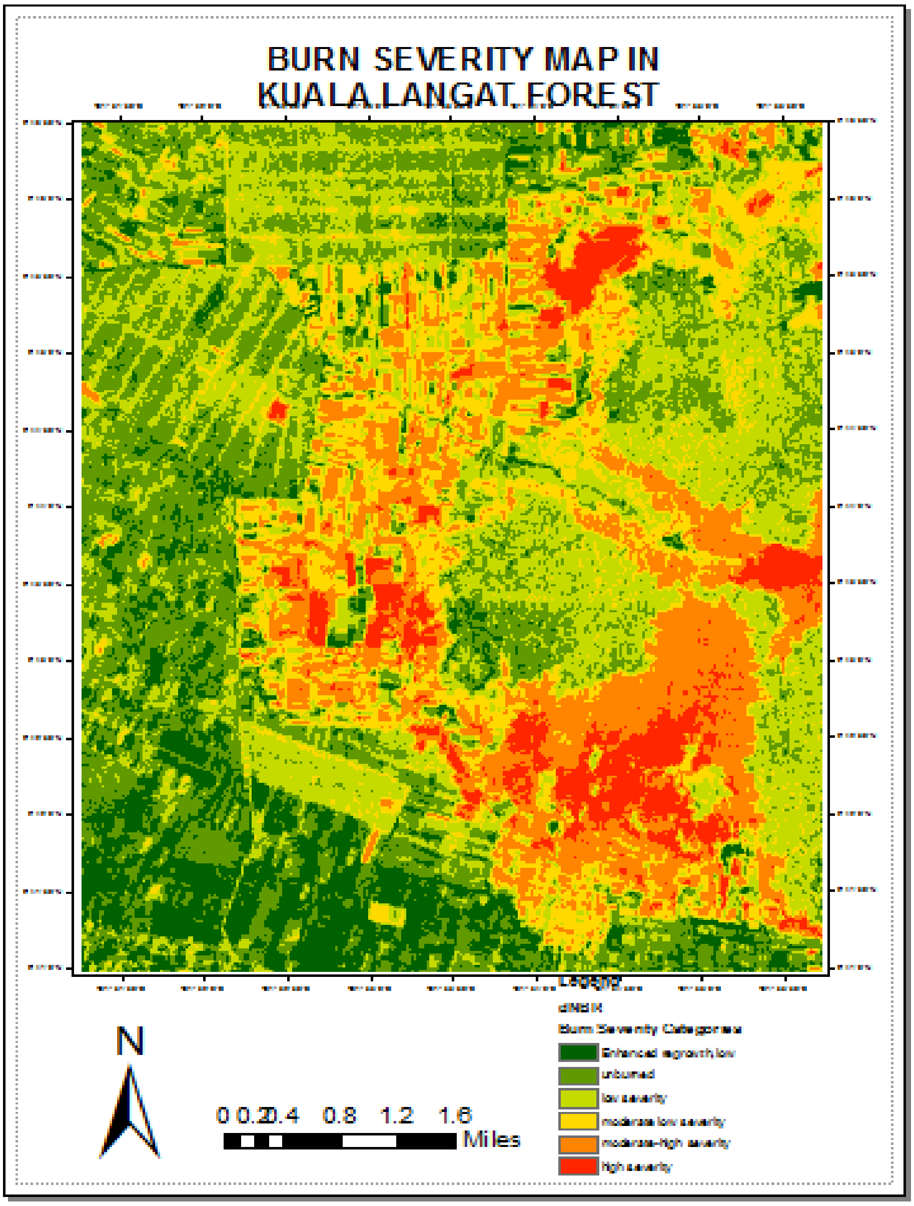

Figure 4. 1 Burn Severity Map in Kuala Langat forest

The map above show that the burn severity map in Kuala Langat forest. The map was produced after processing difference normalized burn ratio. The map show the burn severity map by categories. There are enhanced regrowth, unburned, low severity, moderate low severity, moderate high severity and high severity. The dark green represent enhanced regrowth categories and the red colour represented the high severity of the burn severity categories. Burn severity maps can aid in developing emergency rehabilitation and restoration plan. The map also can use to predict the area fire burning for future Kuala Langat forest.

4.3 LAND SURFACE TEMP

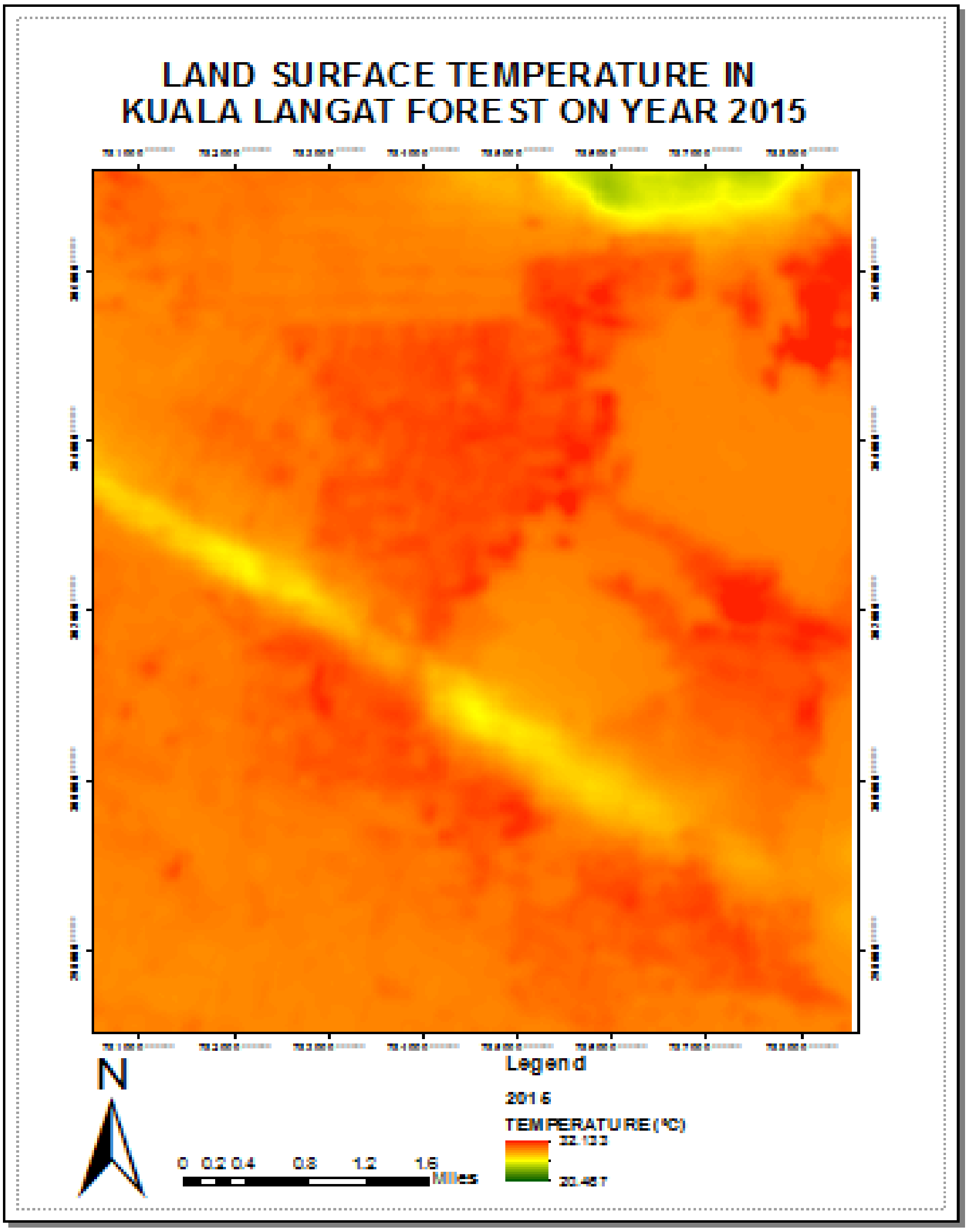

Figure 4. 2 Land Surface Temperature Map in Kuala Langat forest in Year 2015

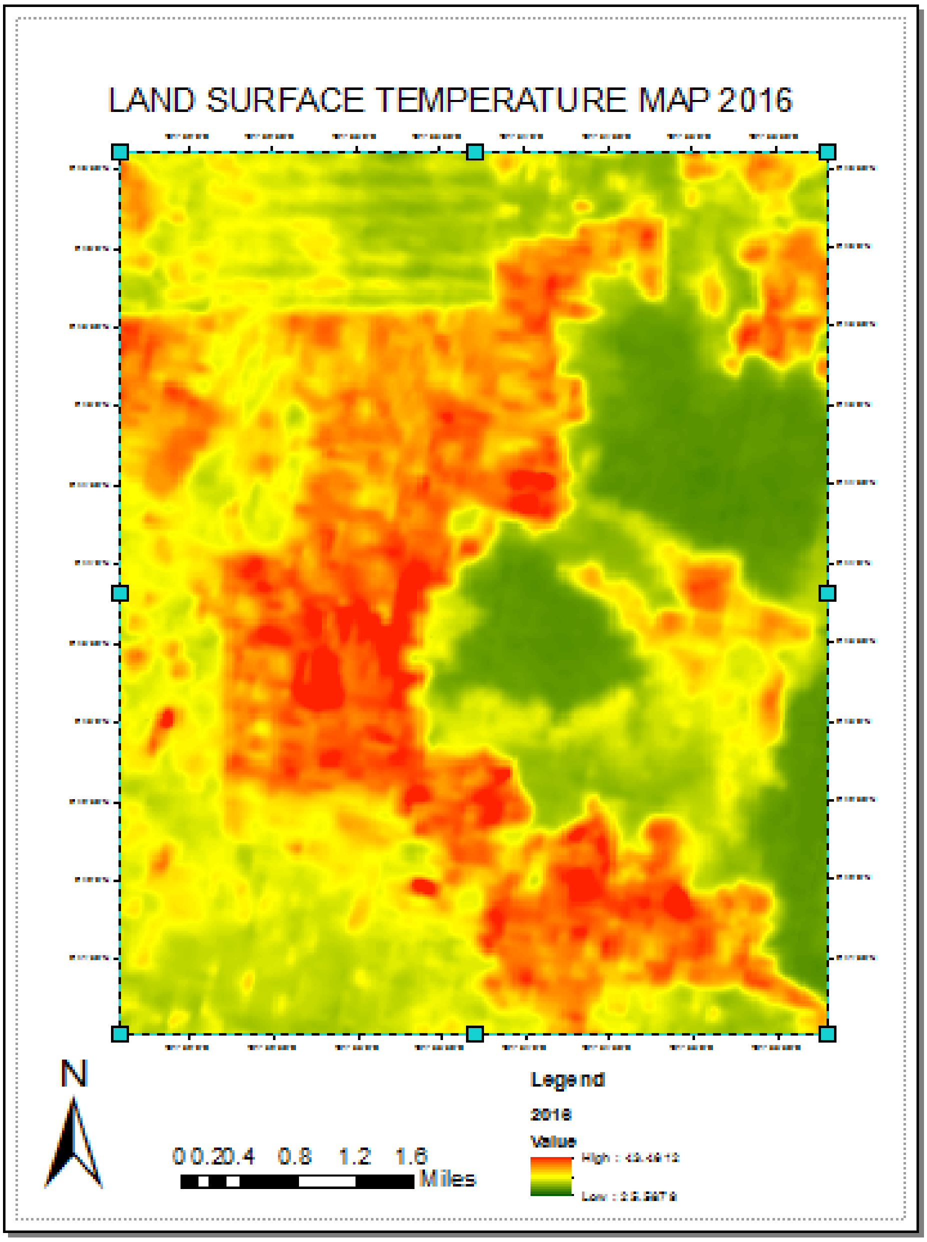

Figure 4. 3 Land Surface Temperature Map in Kuala Langat Forest in Year 2016

Based on result land surface temperature in 2016, the high temperature is 43.4612 (^{0}c) and low temperature is 25.5879 (^{0}c). For 2015 the high temperature is 32.133 (^{0}c) and low value is 20.467 (^{0}c). In 2015 the value show that the normal temperature in Kuala Langat. The map on 2016 is high value because occurs dry seasons. The dry seasons will make high temperature through will make fire forest. The red colour show that the high value, the yellow colour is middle value and green colour is low temperature. The temperature change for this study area is characterized by two monsoon regimes. There are Northeast monsoon and Southwest monsoon regimes. Southwest monsoon from late May to September. Northeast monsoon from November to March. Northeast monsoon brings low temperature and high humidity. The southwest has relatively high temperature and low humidity. The high temperature can impacting the environment and health as a result of increasing temperature. Increase global temperature continued causes global instability. Climate patterns are becoming more unpredictable and beyond expectations than normal climate patterns.

4.4 NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

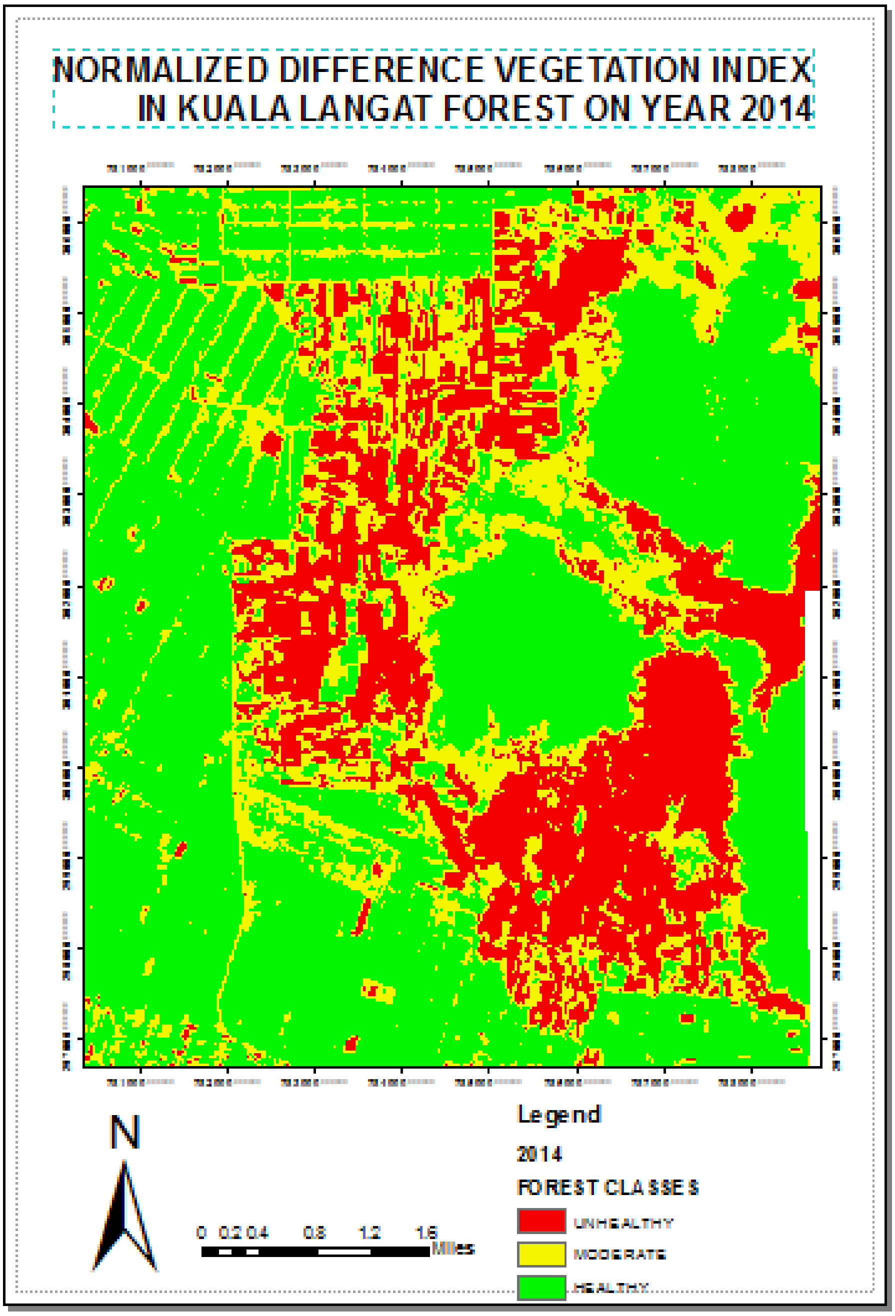

Figure 4. 4 Normalized Difference Vegetation Index Map in Kuala Langat Forest in Year 2014

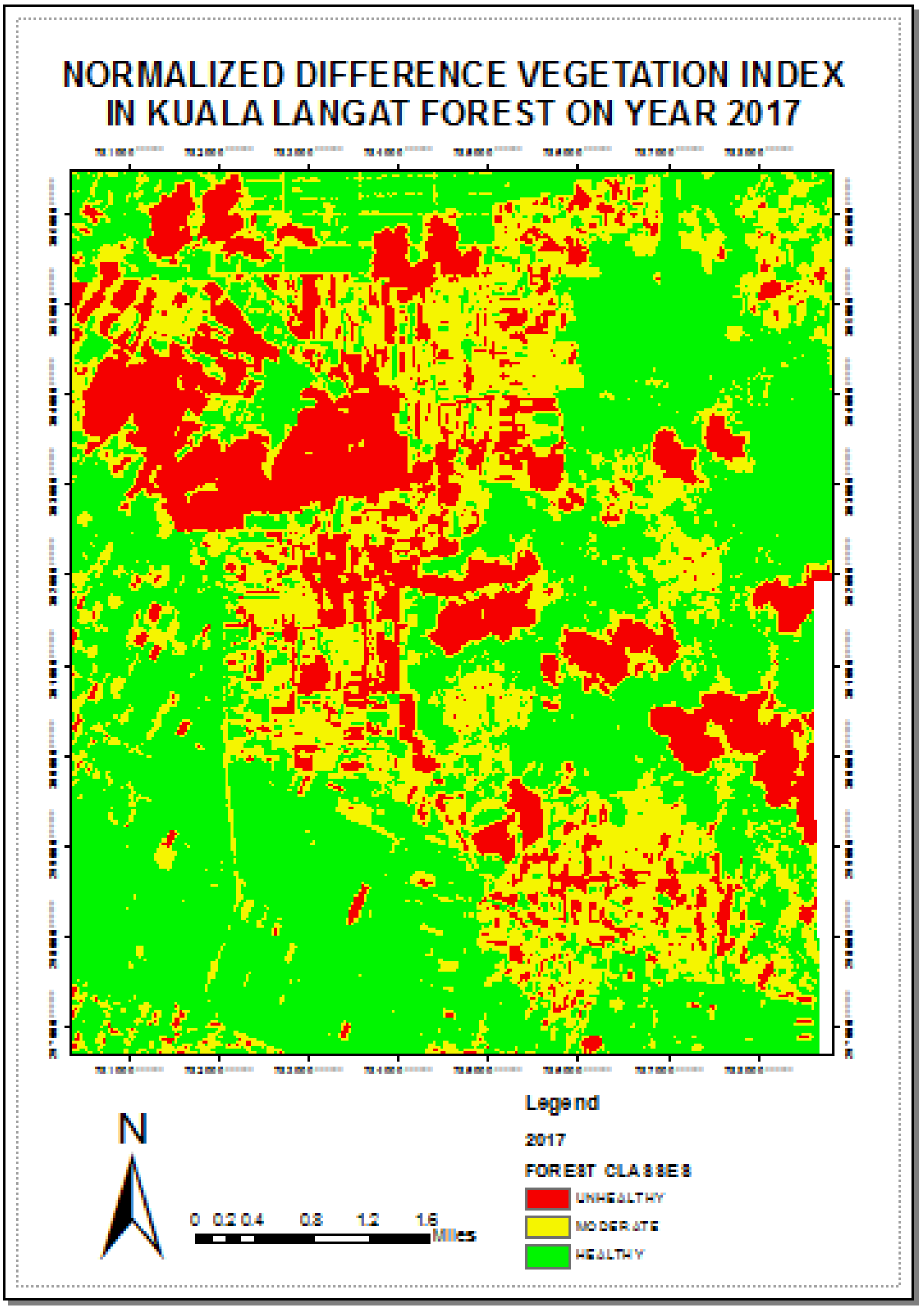

Figure 4. 5 Normalized Difference Vegetation Index In Kuala Langat Forest on Year 2017

Figure 4. 6 Compartment of the Kuala Langat Forest Reserve

Figure 4. 7 Compartment Part in South Kuala Langat Forest

PART	GROWTH OF FOREST AREA BY REFER COMPARTMENT FROM YEAR 2014 TO 2017
1	DECREASED
2	SOME DECREASED
3	SOME DECREASED AND SOME INCREASED
4	UNCHANGED.

Table 4. 1 The compartment in South Kuala Langat Forest Based on Growth Forest Between from Image 2014 and 2017

Based on the figure above show the normalized difference vegetation index map in Kuala Langat on 2014 and 2017. There are three colour show in the map. The red colour show the unhealthy forest, yellow colour is the moderate and green is show the health forest. The map on the 2014 show the image in burn fire forest and the map on the 2017 shown the image after fire forest in Kuala Langat. The result focused on overall forest cover change in the study area, which was identified from both of the images the forest growing in moderately after fire burning forest. The figure 4.9 show that the compartment position in south Kuala Langat forest reserve. The compartment is divide into 4 parts. Actually the compartment is divide into small part by plan Kuala Langat Forest but in this study was generalize into big part. Based on compartment position in South Kuala Langat Forest Reserve, the overall NDVI for two year change detection the decreased, some decreased, some increased and unchanged that show on table 4.1. According to the analysis above, the area of category of NDVI map some decreased is in large area. While the growing forest some increased is to the smallest area in south Kuala Langat forest Reserve. The certain part unstable growth forest maybe because often occurs fire forest.

CHAPTER FIVE CONCLUSION

5.1 INTRODUCTION

In this chapter, the major and significant aspects involved in this project are concluded. The conclusion will summaries all the aim, objective and the recommendation that can be useful to improve the research in the future application development are needs. The whole analysis from previous chapters are gathered and simplified into a full view sentences that appropriate with the aim of this study. For the recommendation phase, it included suggestions or proposal to be taken as the best action for the future.

5.2 CONCLUSION

As a conclusion, all of the objectives of this study has been achieved. The main reason of using remote sensing in the burn severity is to utilize an easier way of determination. This study show that Landsat data had successfully to identify burn severity in Kuala Langat, Selangor thus prove that remote sensing technique is suitable.

The results has proved that remote sensing is an effective technique to identify the burn severity in Kuala Langat which can be applied in a wide area. The data remote sensing free download available.

5.3 RECOMMENDATION

There are several issues that can be considered for future studies. This study has been carried out to burn severity in Kuala Langat forest on year 2013 and 2014. The best result can be obtained if the analysis of the burn severity is done for a longer period of time and using the high resolution satellite image. In the present study, the types of forest in Kuala Langat forest are not taken into consideration. Further research study on this topic should be carried out with consideration of above mentioned.

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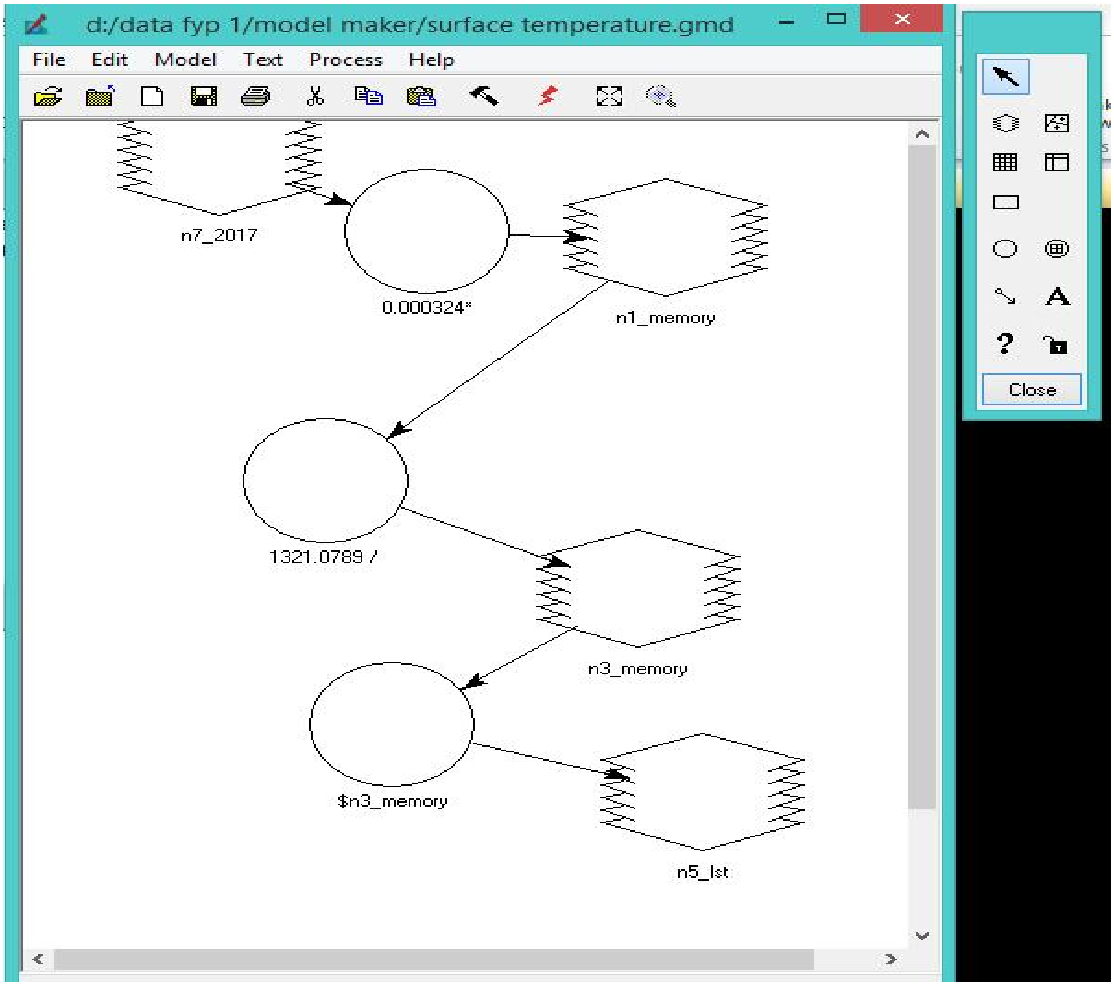
APPENDICES

APPENDIX 1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1321.0789 /
n3_memory
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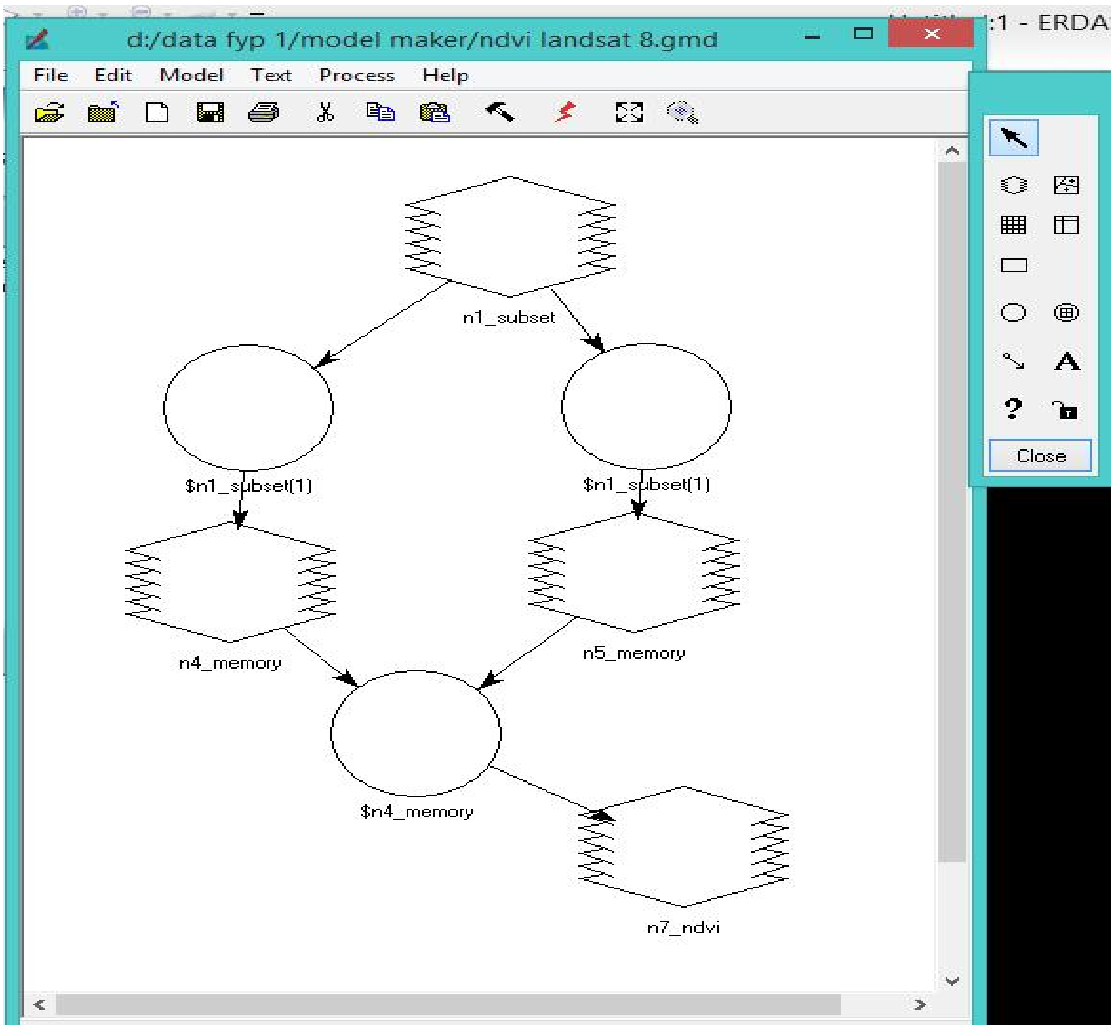
n5_lst
Close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Model
Text
Process
Help
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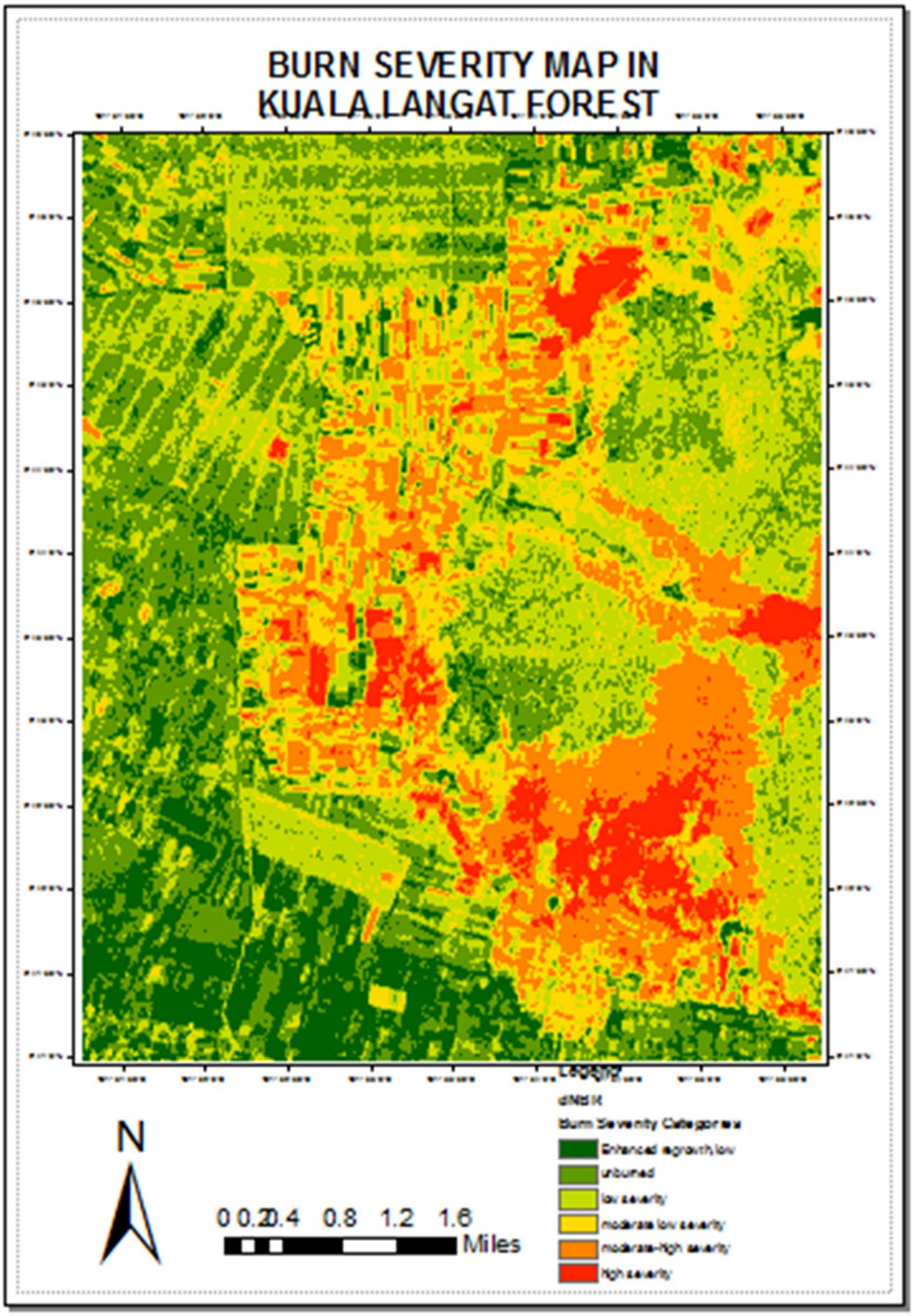
$n1_subset(1)
n4_memory
n5_memory
$n4_memory
n7_ndvi
Close

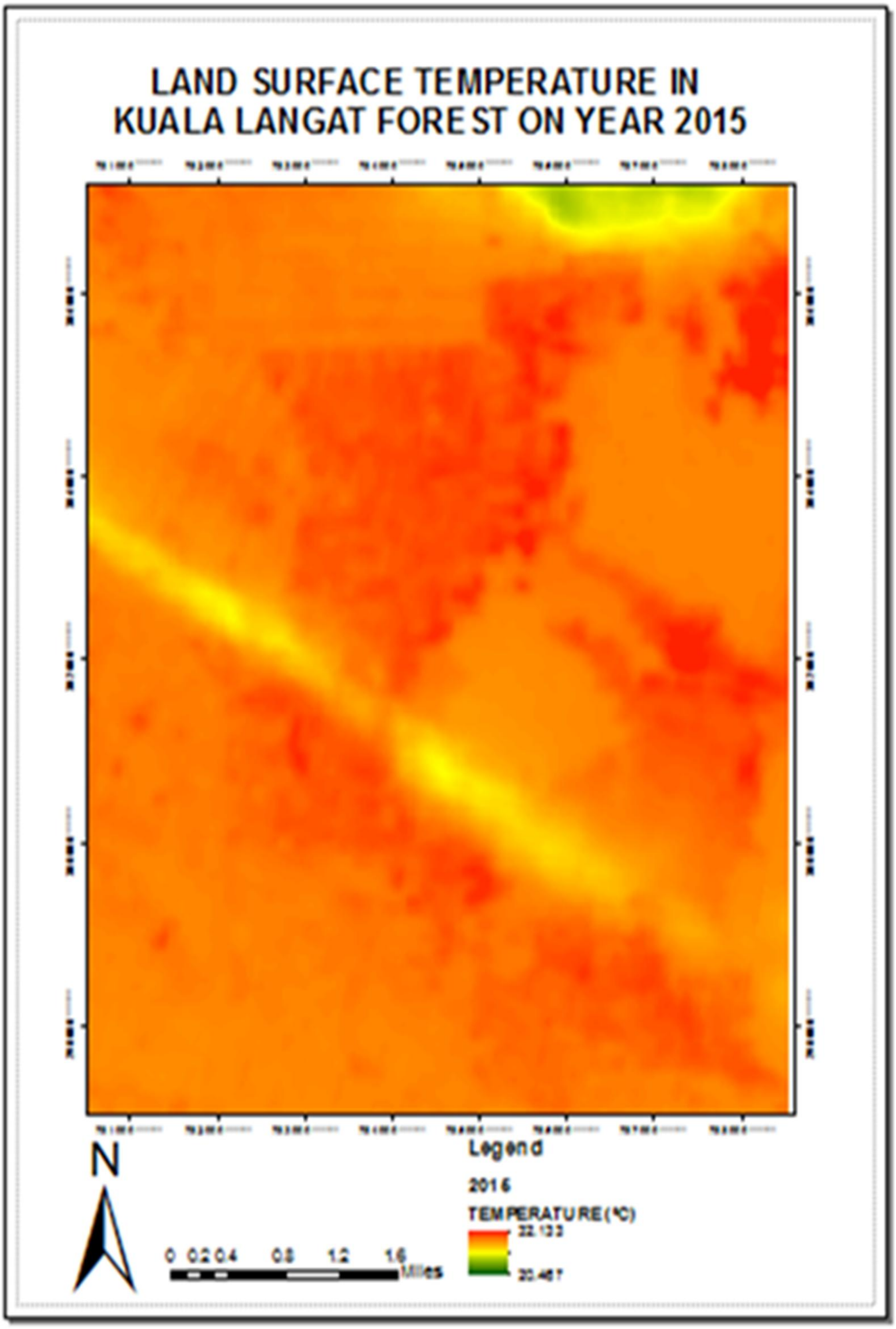
APPENDIX 2

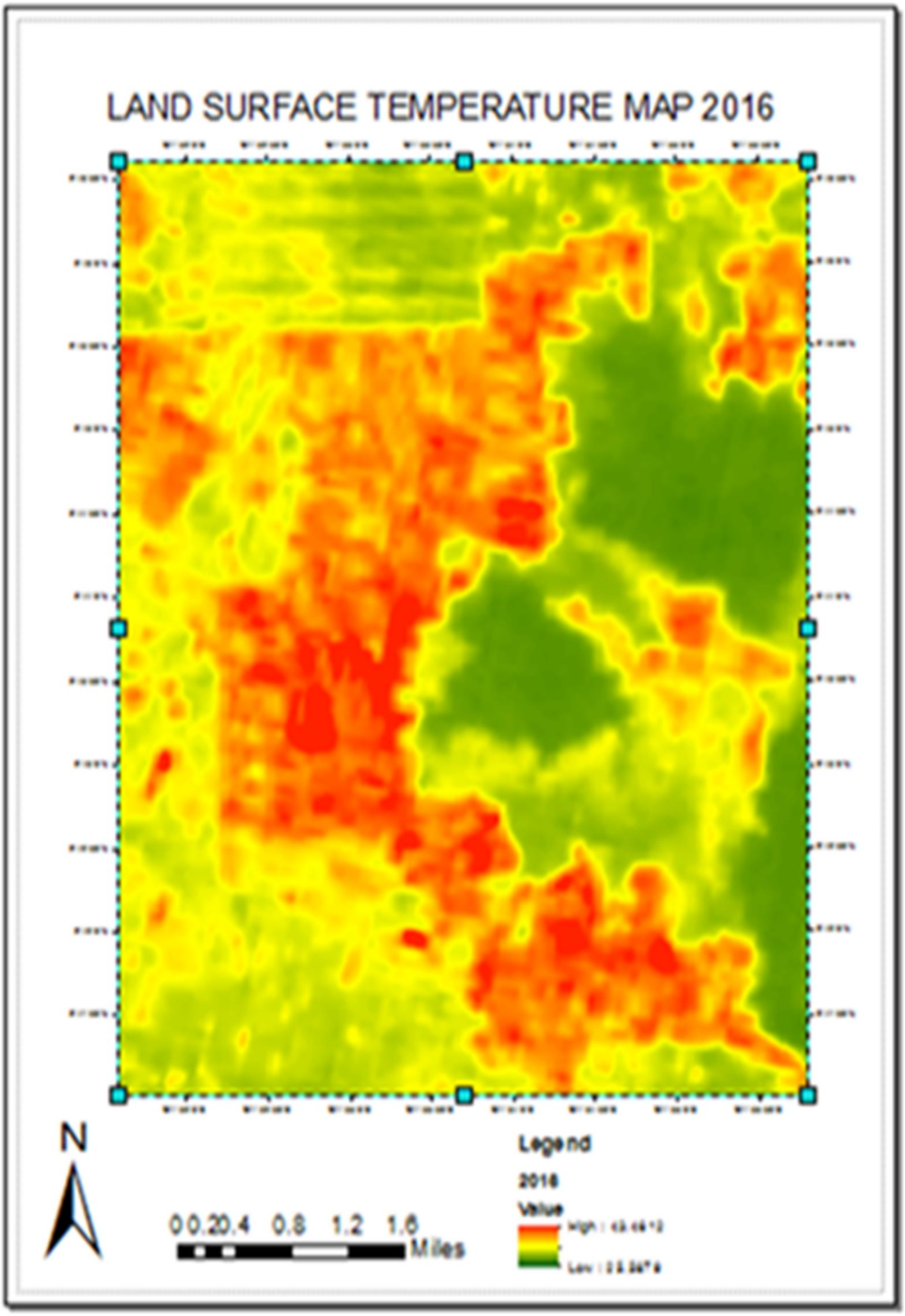
Table of Parameters Used in Data Processing

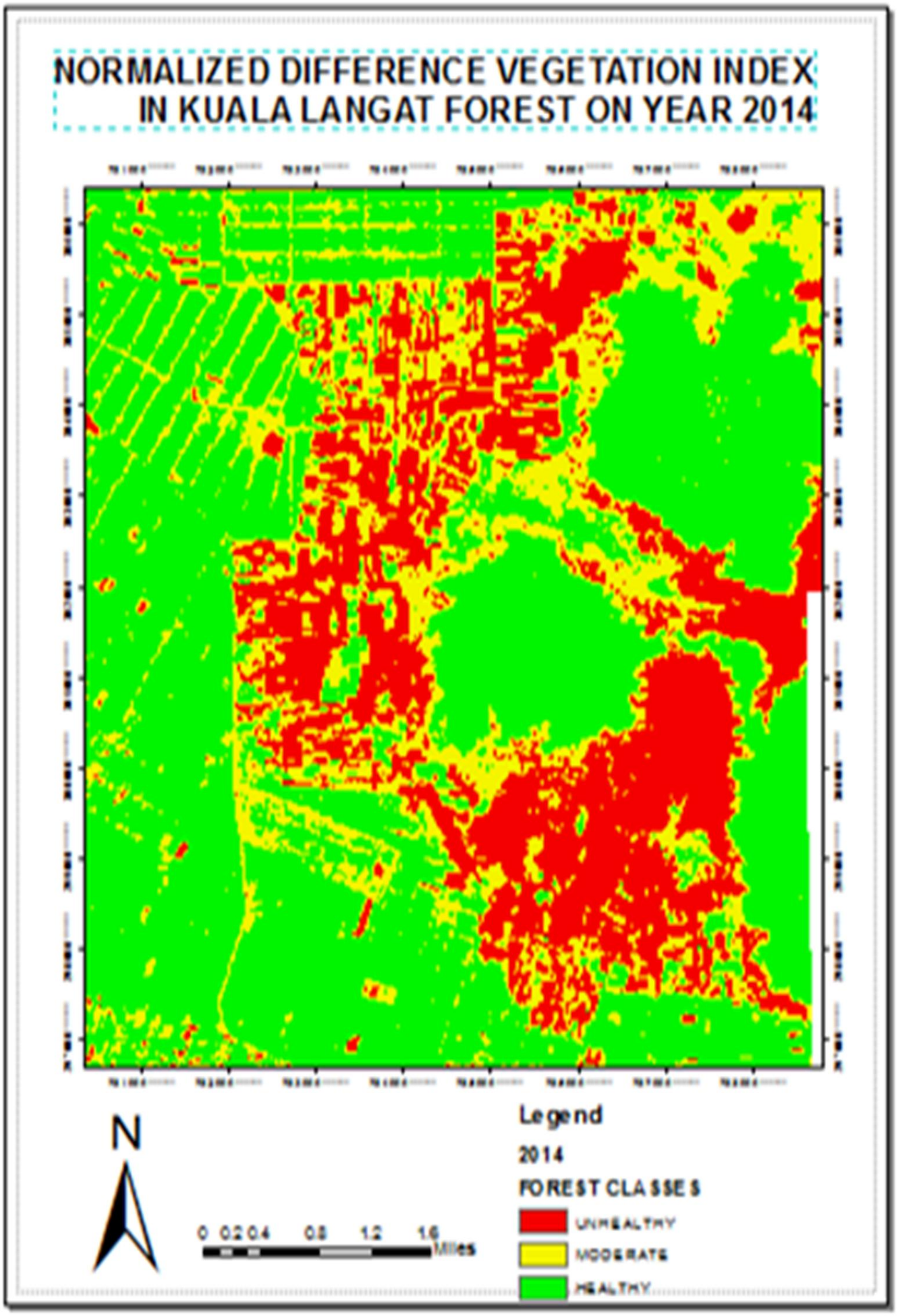
NO	Formula	Description
1	$NBR = \frac{NIR - SWIR}{NIR + SWIR}$	For burn area and estimate fire severity
2	$dNBR = Prepost - Postfire$	Use to measure of burn severity form the pre fire and post fire
3	$L = \frac{L_{max} - L_{min}}{DN_{max}} \times Band + L_{min}$	To determining the top of Atmospheric Spectral Radiance in watts/(m2*srad*µm)
4	$TB = \frac{K2}{\log(1 + \frac{K1}{L})} - 273.15$	To calculate the brightness temperature
5	$NDVI = \frac{NIR - RED}{NIR + RED}$	To determine the level forest

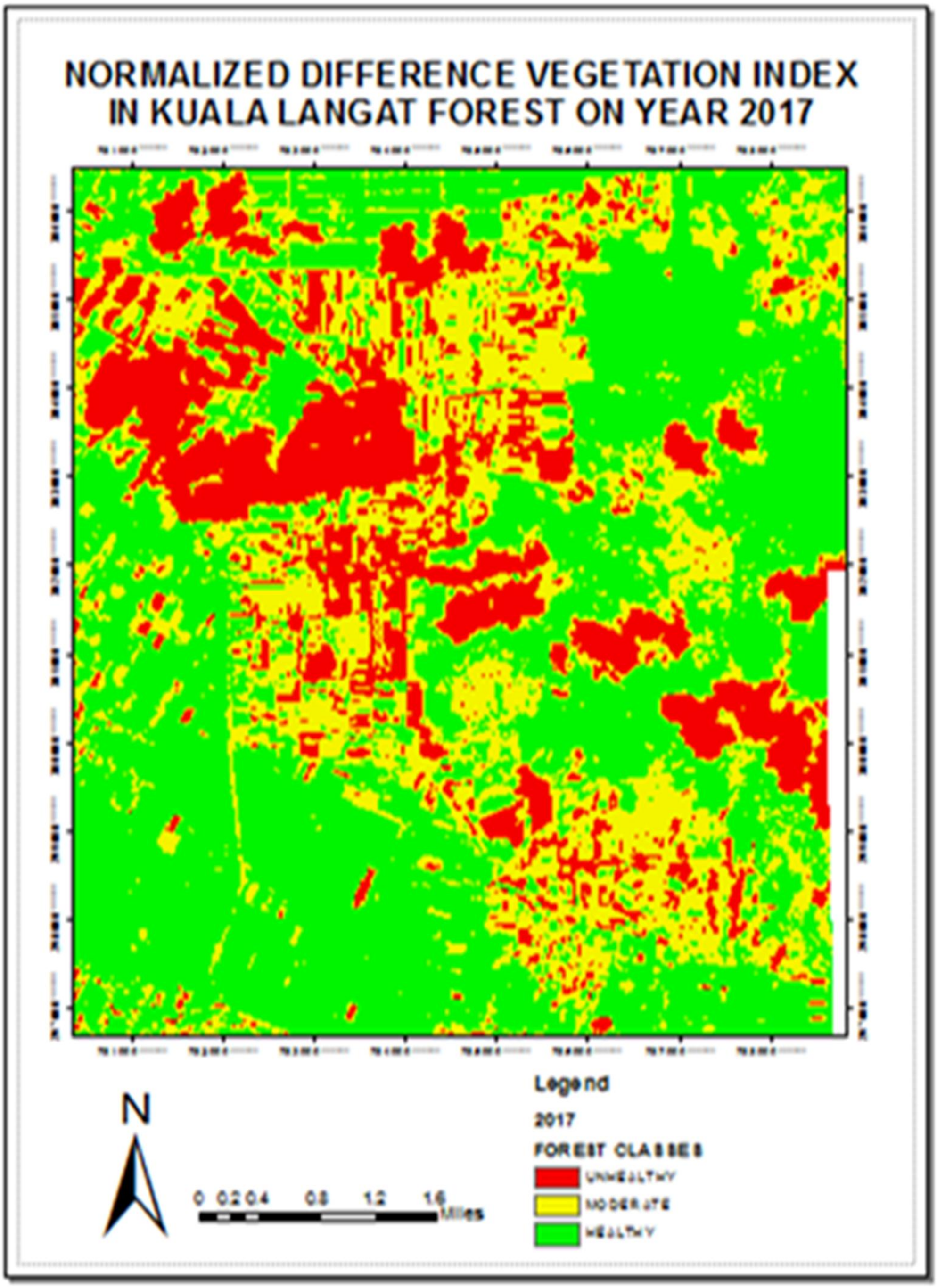


BURN SEVERITY MAP IN
KUALA LANGAT FOREST
Legend
dNBR
Burn Severity Categories
Enhanced regrowth,low
unburned
low severity
moderate low severity
moderate-high severity
high severity
N
0 0.2 0.4 0.8 1.2 1.6
Miles


LAND SURFACE TEMPERATURE IN
KUALA LANGAT FOREST ON YEAR 2015
N
0 0.2 0.4 0.8 1.2 1.6
Miles
Legend
2016
TEMPERATURE (°C)
22.133
20.467


LAND SURFACE TEMPERATURE MAP 2016
N
0 0.20.4 0.8 1.2 1.6
Miles
Legend
2016
Value


NORMALIZED DIFFERENCE VEGETATION INDEX
IN KUALA LANGAT FOREST ON YEAR 2014
N
0 0.2 0.4 0.8 1.2 1.6
Miles
Legend
2014
FOREST CLASSES
UNHEALTHY
MODERATE
HEALTHY


NORMALIZED DIFFERENCE VEGETATION INDEX
IN KUALA LANGAT FOREST ON YEAR 2017
N
0 0.2 0.4 0.8 1.2 1.6
Miles
Legend
2017
FOREST CLASSES
UNHEALTHY
MODERATE
HEALTHY