Developing a Vulnerability Map of Paddy Field Affected by Rainfall Variability in Pasir Mas, Kelantan

By

AZLEENA BINTI AZMI

E16A0032

A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Sustainable Science) with Honours

FACULTY OF EARTH SCIENCE

UNIVERSITI MALAYSIA KELANTAN

2020

DECLARATIONS

I hereby declare that the thesis entitled "Developing AVulnerable Map Of Paddy Field Affected by Rainfall Variability in Pasir Mas. Kelantan" is the result of my own research which excludes the ones stated in the references. The thesis written has not being accepted for any degree and it is not concurrently submitted in candidature of any other degree.

Signature : ____________________

Name : AZLEENA BINTI AZMI

Date : ____________________

ACKNOWLEDGEMENTS

First and foremost, thanks to Almighty for his blessings throughout the preparation of this thesis. I am very thankful for having Dr. Amal Najihah binti Muhammad Nor as my supervisor and Dr.Muhamad Azhahar bin Abas as my co-supervisor. Dr Amal Najihah and Dr. Azahar had helped me a lot throughout this tough journey by giving me full guidance especially on stimulating ideas, giving suggestions on things that is needed to be improvise and also full encouragement throughout this thesis writing and processing period. Besides that, I would also want to sent my gratitudes to my friends who has helped me a lot in completing this thesis which are Asya Sabreena binti Mohd Fuad, Ameer Sabrin bin Muhammad Shukri, Nur Aisyah binti Azmi, Hong Xie Zin, Siti Zulaikha binti Fakuruddin, Nur Aniza Binti Mohamad Hanan, Hazryna Binti Hisham, Khairatun Nisaa' Binti Abu Bakar, Nadia Natasya binti Abd Rahman and Nur Afiqah Binti Zulkiffilee. Without their support and guidence my thesis would not be able to be completed. Those are the ones who were always there through my ups and downs in my journey of completing this thesis. Last but not least, special thanks goes to University Malaysia Kelantan for giving me the opportunity to complete and conduct this study as it is a part of my requirements in completing my bachelor degree in Bachelor of Applied Science (Sustainable Science) with Hons.

Developing A Vulnerable Map Of Paddy Field Affected by Rainfall Variability in Pasir Mas, Kelantan.

ABSTRACT

In this era, the term vulnerability which emphasize the meaning of an area or object which are at high risk to the exposure of treats are one of the main current issues which are closely related to the environmental change that will lead to further disruptions including the changes on land use land cover (LULC).Therefore this study is conducted to identify 1) the LULC in Pasir Mas and to 2) develop a vulnerable map of paddy farmers based on the LULC map. Practically this study will identify the most vulnerable area in Pasir Mas which are most vulnerable towards the distribution of rainfall that might lead to flood occurrence and give adverse impact to agriculture sector and induced changes in farmer's net income. In this study, three satellite images are being processed for the year of 2004, 2007 and 2011 and were analysed by using Remote Sensing and Geological Information System (GIS).Next, the rainfall map of Pasir Mas were produced to show the distribution of rainfall. The land use data and the total rainfall data were then being used to produce this vulnerable map. The LULC map were mainly divided to 5 major classes which are the agriculture, forest, water bodies, cleared land and built up that also revealed the agriculture sector and forest are two main land cover in Pasir Mas. The vulnerable map of paddy farmers shows the relationship between rainfall distribution and LULC that also indicates the highest amount of rainfall distribution is on the land cover of agriculture and forest. Thus, when the amount of rainfall at the area is high, it will gives effect on the socio-economic variable of paddy farmers specifically farmer's net income. For future use, this vulnerable map is for the reference of those interested parties who are down to propose adaptations and mitigation steps to help the society to have better awareness and preparedness while dealing with the environmental changes that were induced from the high rainfall variability.

Pemetaan Peta Tahap Keterencaman Sawah Padi Dipengaruhi oleh Kepelbagaian Hujan di Pasir Mas,Kelantan

ABSTRAK

Dalam era ini, istilah tahap keterancaman yang memberi penekanan terhadap sesuatu kawasan atau objek yang berisiko tinggi kepada pendedahan terhadap sebarang ancaman adalah salah satu isu semasa yang berkait rapat dengan perubahan alam yang merangkumi perubahan pada penutup tanah guna tanah (LULC). Oleh yang demikian, kajian ini dijalankan untuk 1) mengenalpasti LULC di Pasir Mas dan 2) pemetaan tahap keterencaman sawah padi berdasarkan peta LULC. Dalam kajian ini, tiga imej satelit telah diproses bagi tahun 2004,2007 dan 2011 dan dianalisis dengan menggunakan Sistem Penderiaan Jarak Jauh dan GIS. Seterusnya, peta hujan di kawasan Pasir Mas adalah bagi menunjukkan kawasan taburan hujan di setiap kawasan.Data penggunaan tanah and taburan hujan kemudian digunakan untutujuan pemetaan peta keterancaman petani. LULC dibahagikan kepada 5 kelas utama iaitu pertanian, hutan, kawasan perairan, tanah lapang dan kawasan pembangunan yang juga menunjukan sektor pertanian dan hutan adalah dua kawasan tanah utama yang melitupi bumi di Pasir Mas. Peta tahap keterancaman petani juga menunjukkan hubungan antara taburan hujan dan LULC yang juga menunjukkan jumlah tertinggi taburan hujan adalah pada kawasan litup bumi bagi kelas pertanian dan hutan. Oleh itu, apabila jumlah hujan di kawasan itu meningkat, ia akan memberi kesan kepada pembolehubah sosio-ekonomi petani, khususnya pendapatan bersih petani. Pemetaaan peta tahap keterancaman petani bercadang untuk dijadikan sebagai panduan kepada badan-badan yang berminat untuk menyumbangkan cara pengadaptasian dan cara menangani dalam membantu masyarakat menghadapi perubahan alam sekitar yang disebabkan oleh taburan hujan yang tinggi.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

RS	Remote Sensing
GIS	Geographical Information System
WHO	World Health Organization
AAL	Annual Average Loss
GDP	Gross Domestic Product
FAO	Food And Agriculture Organization
USGS	United States Geological Survey
LPGS	Level 1 Product Generation System
LULC	Land Use Land Cover
.shp	Shapefile
ROI	Region of Interest
TM	Thematic Mapper

LIST OF SYMBOLS

Nt	Net revenue
Cp	Crop Net Production
Rd	Dry Season Rainfall
Rr	Rainy Season Rainfall
Edu	Education
Gen	Gender
CA	Cropland Area
Wh	Household Working
Irri	Irrigation System
Gs	Government Support
Mcrop	Multiple Crop
Ha	Hectra
mm	millimetre
RM	Ringgit Malaysia
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Vulnerability is the term that shows how a group of people or an organization which is unable to cope from the impact of natural disasters such as flash floods (WHO,2002).The poor community are more likely to have higher chances to be exposed to threats and potential hazards as they have lack of resources to cope when disaster such as earthquakes and flash floods occur. Every year the occurrence of natural disasters are rising linking with the increase of the impact and frequency of the disaster to occur. In Malaysia, the agriculture sector is dominant in sustaining and maintaining our society livelihoods besides contributing to our country economy wealth.

Moving forward, the dominant highlighted natural phenomenon in Malaysia is regarding flood disaster which is the most significant natural threat in our country. This phenomenon are among the most prevalent of natural situation which leads to huge loss in economic loss and impact human daily activities and wellbeing. The

(Table 1.0) shows the example of Average Annual Loss by hazard in between the year of 2005- 2014:

Table 1.1 Average Annual Loss by Hazard

Hazard	Absolute [Million US$]	Capital stock [%]	GFCF [%]	Social expenditure [%]	Total Reserves [%]	Gross Savings [%]
Earthquake	10.49	0.001	0.012	0.038	0.008	0.011
Storm Surge	0.52	0.000	0.001	0.002	0.000	0.001
Tsunami	5.52	0.000	0.007	0.020	0.004	0.006
Flood	1,271.09	0.109	1.511	4.555	0.953	1.312
Multi-Hazard	1,287.62	0.110	1.531	4.614	0.965	1.329

Source from: Prevention Web-Malaysia Disaster and Risk Profile (Probabilistic Risk Result)

The frequency of Malaysia as one of the Asian countries to face this flash flood phenomenon is high. The heavy monsoonal and convective rainfall, the flat topography of Peninsular Malaysia other than human activities such as agricultural activities, the release of greenhouse gases, urbanisation, illegal logging and open burning are reasons that contributes to the change in climate which exacerbate the risk of flooding. In Malaysia, there are two basic types of floods which are the flash and monsoonal floods. Flash floods usually occurs due to the heavy rainfall associated with severe thunderstorm by a period of time less than six hours. On the other hand, these floods are due to prolonged heavy widespread of rainfall.

Why does this situation occur? We clearly know that the location and position of Peninsular Malaysia itself is located at latitude between roughly 1º0’0’’N to 7º0’0’’N and 100º0’0’’E to 105º0’0’’E .So, normally, the location are located or situated makes them being real near at the equatorial line. Besides that, there are two main and beautiful oceans that surrounds the Peninsular Malaysia which are South China Sea on the East and Malacca Strait on the West. Thus, the Malaysian society will be facing through and widely exposed to the high humidity. Humidity is the measure of moisture amount in the air.

The following diagram shown the results and records of the average monthly precipitation (FIGURE 1.1) and rainy days (FIGURE1.2) over the year.

The average monthly precipitation over the year

This is the mean monthly precipitation, including rain,

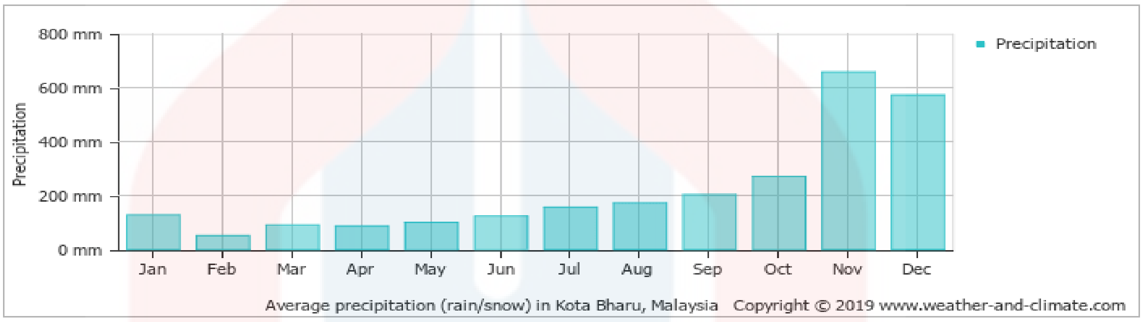

Figure 1.2 Average Monthly Precipitation Over the Year

Average monthly rainy days over the year

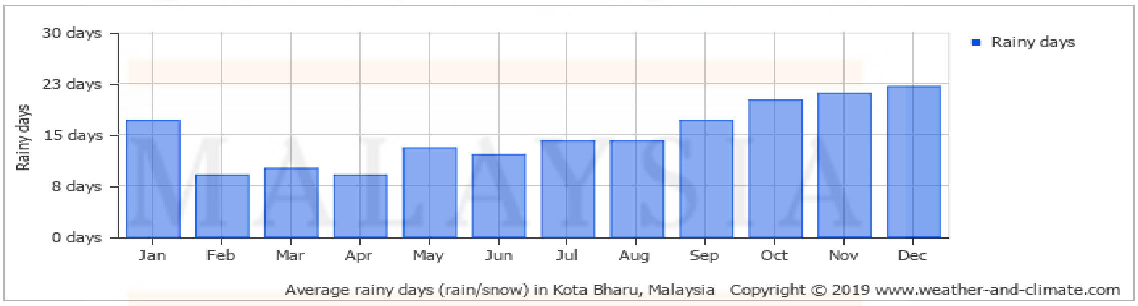

Figure 1.3 Average Monthly Rainy Days Over the Year

1.2 Problem Statement

First and foremost, the agriculture sector is highly dependant towards the spatial and temporal distribution of monsoonal rainfall. Rainfall is one of the prominent climatic factor which influence the growth of crop production. In Malaysia, there are many main source for the generation of income for our society for instance through fisheries and agriculture. Essentially one of the dominant supply is thru agricultural manufacturing in which profits are being generated through plantations of palm oil, paddy and further. So essentially farmers family in reality relies upon on their crop yield and crop land so that you can preserve and keep their livelihoods. As said with the aid of the branch of Statistic Malaysia, the agriculture sector contributed 8.2 constant with cent or RM96.0 billion to the Gross domestic Product (GDP) in 2017. Exports and imports of agriculture quarter amounted to RM126,587 million and RM95,218 million respectively with the exchange stability of RM31,369 million.. It has also stated that there was an increase in the year of 2017 compared to 2016 for the production of export and import.

Moving forward, the flood in 2014 took place in Kelantan became the worst in Malaysia known as the massive Yellow Flood and have destroyed and damaged almost all of the infrastructure together with bridges, road and drainages because of monsoonal season that's the North-East monsoon which usually takes region at some stage in November until March. This became a record-putting rainfall of 1 295 mm, same to the amount of rain commonly seen in a span of sixty four days. As an end result, the water tiers of 3 fundamental rivers, the Sungai Galas in Dabong, the Sungai Lebir in Tualang and the Sungai Kelantan, upward thrust appreciably above the water degrees and have become taken into consideration a huge deal with and dangerous. In conjunction with this, the society should have prepared with mitigation steps and preparedness to face this phenomenon.

1.3 Objectives

1. To classify land use in 2004, 2007 and 2011 in Pasir Mas, Kelantan
2. To classify the area which are high prone to changes due to high rainfall variability
3. To produce a vulnerable map of paddy field in Pasir Mas Kelantan

1.4 Scope of Study

This study mainly focusses on the factors that will give adverse impact towards the net revenue of the paddy farmers in Kelantan which specifically focuses on the main district of Pasir Mas, Kelantan. It is an approach on how the paddy farmers can cope with the impact of climate change specifically the rainfall distribution on their net revenue and production of paddy. Figure 1.3 below shows the research framework for my study:

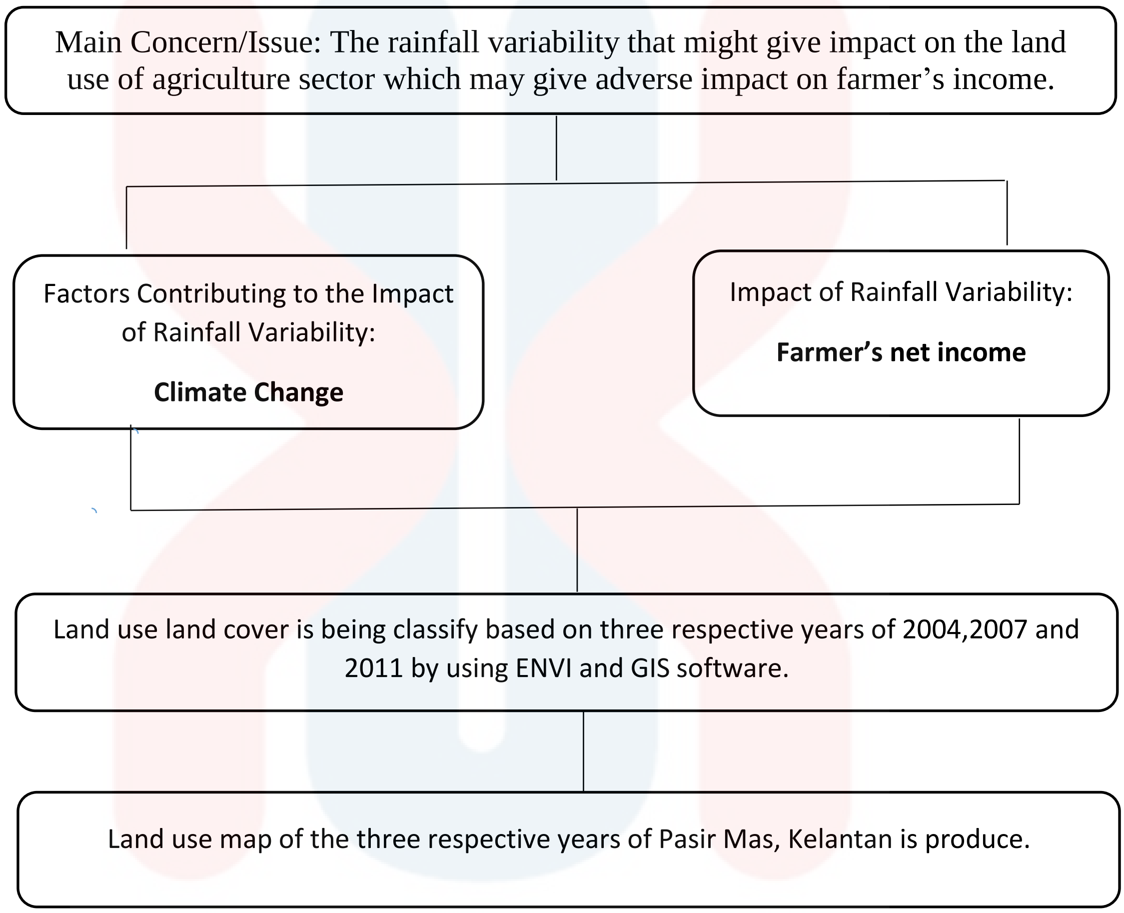

Figure 1.4 : Research Framework

1.5 Significance of Study

This study will produce a vulnerability map of farmers regarding the impact of rainfall variability on the farmer's net income in Pasir Mas, Kelantan. In this study, the classification of land use land cover has been analyse to differentiate the area of forest, agriculture, built up areas, water bodies and also cleared land. As we know, agriculture sector is one of the main source of income for the society in Pasir Mas, Kelantan. The data that will be obtained from this study will be beneficial for a proper and more effective management for the governments and other related bodies. It might also be important for the sustainability planning for this area. Next, this study provides the area which are most likely to be affected due to the rainfall variability thus earlier mitigation steps can be proposed by the governments in order to avoid any further loss that will be faced by the farmers. Practically the issues that arises from the environment can be solved in a more proper and stratergic manner.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Asia is one of the developing countries which has difficulties to adapt with changes related to changes in our climate (Francisco, 2008). Transferring forward, there'll constantly be a pleasing and bad elements for each motion that has or is probably taken, it is important for the resource available to be well centred to the community who wants and need them, specifically those placed in the areas willing inside the route which are prone towards the changes of weather (Arief Yusof, 2009).

2.2 Agriculture in Malaysia

Agriculture are one of the dominant source of income in Malaysia. Globally, by 2050 the expected demands on food will rise up to 9.1 billion and in fact to get access to this food , livelihoods and improve economically , there should be major shift in the agricultural production system, (FAO, 2009). The rural region gives livelihoods for many human beings, in particular the rural population in growing international locations. enhancing the productiveness of the arena is an essential intention for most policymakers as arable land is constrained. For that reason, public and private zone investments in the agriculture zone are vital to increase new technology. Agricultural funding consists of authorities expenditures on agricultural infrastructure inclusive of irrigation and drainage, education in agriculture and research and development. Rice is the principle staple meals, besides wheat, for most of the populace inside the international, in particular in Asia. however, most rice is ate up within the United States of America wherein it is produced, with best 7 consistent with cent of general rice output being internationally traded in 2010 (FAO, 2011).

2.3 Impact of Rainfall Variability on Agriculture Production

Agriculture products are one of the main contributors of the increase in Malaysia's economic growth through the production of palm oil, paddy, corn basically the sources of food. Rainfall variability is the fluctuations of rainfall occurrence annually or seasonally above or below a long term normal value. Rainfall is defined as a critical index of climatological investigation and has major impacts on flora and fauna, as well as ecological setting and water resources management of any area (Mercy, I.C.,2015)

In Kelantan, we had already acknowledge that it is one of the most prominent state that is prone towards the occurrence of flash flood , This is due to rainfall variability and monsoon that occurred. The impact of rainfall variability and droughts can be devastating to the people of Kelantan. The most recent flood occurred is on December 2017 which takes place in a few districts of Kelantan such as Pasir Mas and Tumpat. This has led to huge damage such as the disruptions of roads, infrastructures and their land that they use for agriculture purposes.

2.4 Floods in Malaysia

Floods are one of the natural phenomenon that often occurs in our country due to the change in climate such as the monsoon, the rainfall pattern, global warming and more. As stated by (Balek ,1983) , Flooding is a herbal phenomenon which can be closely relate to a few main elements which are precipitation, the measure in temperature either its cold or hot, wind and other natural related factors on our Earth. In truth, flooding is a herbal catastrophe that still reap 40 in keeping with cent to 50 in step with cent of all sorts of failures inflicting deaths in the global (Diaz et.al, 2010) Malaysia gets a median annual rainfall of 3000 mm.

Other than the time period floods, flash flood can be described as the ones flood activities wherein the upward thrust in water is both throughout or inside some hours of the rainfall that produces the upward thrust. Consequently, flash floods arise within small catchments, where the response time of the drainage basin is short.

2.5 Extreme Rainfall Distribution

As all have been aware that the increase in rainfall amount have eventually raised society's concern which might resulted in the alteration of the climate. The upward thrust in each frequency and intensity of severe precipitation events are the predominant impacts with the intention to result in international warming. Severe rainfall occurrences in quick temporal scales over a protracted duration will finally result in massive floods The boom in large flood cases, consisting of flash flood and landslides in the final decade, is due to the boom in rainfall intensities. Increasing development showed the rise in the total quantity of rainfall and the frequency of wet days in the course of the northeast monsoon which will eventually give rise to the growing trend of rainfall intensity.

2.6 Climate Change in Malaysia

The present pattern of rainfall in Malaysia has been a source of threat to the society, especially those who live in flood prone areas. Recently, due to the climate change and rapid opening of forested areas, the floods that occurred are in increasing state and severities (Chan, 2015). Subsequent, climate exchange can be defined due to the reality, the changes inside the u.s.a. of a weather that can be diagnosed (e.g. the usage of statistical test) by using changes in the advocate and/or the range of its houses (IPCC, 2001). Moving ahead, it is totally based on the UNFCC (1992), climate exchange may be described because of the truth, the trade of weather which may be attributed straight away or not directly to human sports activities. Activities that changes the composition of the worldwide environment and that is in addition to herbal climate variability decided over similar intervals. Globally so many places have been reported forecasting the gradual warming of the planet with an increase in the global temperature of 1.8-4.00C (average 3.00C) during the next century (IPCC, 2007). Furthermore, the increase in atmospheric concentration of climate-related greenhouse gases will change the temperature, which indirectly increase the chances for the society to face danger (McNutt, 2015; Schuur et al., 2013). In climate change issue, Malaysia is the fourth largest emitter of greenhouse gases in ASEAN, that shows contribution of 0.52% of the world‘s carbon emissions. In conjunction with this climate change, the impacts would be on rise of sea level , reduction on crop yields, spreading of diseases which leads to loss in habitat of flora and fauna in their ecosystem, a rise in statistical number of flood phenomenon ,shorelines are being eroded , bleaching of the coral reefs and last but no least are higher occurrence of droughts (Haliza, 2009). Climate change gives adverse impact on human health through a range of direct or indirect exposures. Directly through extreme events of fire, flooding and heat waves, while indirectly when climate affects some environmental parameters (Hanna and Spickett, 2011). Climate plays a main position in determining plants yield. Environmental stressors together with drought, high temperature and air pollution are main limiting factors to crop productiveness in the tropics (Ariffin et al., 2003). Agriculture in Malaysia contributes about 3.6% of GNP and as a minimum a 3rd of the United States of America's populace depends to the agriculture area for their livelihood. The impact of climatic stresses on crop productiveness does have an effect on agriculture enterprise in Malaysia. Meanwhile, the growing in sea level due to weather exchange could pressure the forsaking of low-lying planted areas which includes paddy, corn, coconut and others.

2.7 Vulnerability Definitions, Conceptions and Practices

Vulnerability can be defined as the disclosure of existing state of the system that are at high exposure or risk to be exposed to a natural hazard. Vulnerability is the human dimension of disasters and is the result of the range of economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in (Twigg, 2004). Balica and Wright (2010) had done a research regarding the vulnerability levels which are prone to flood disaster for 3 different spatial scales which are namely the river basin, sub-catchment and urban in the context of social, economic and environmental dimensions by using FVI model.

2.7.1 Vulnerability as A Component of Risk

The concept of vulnerability can be strongly related to the risk and risk management. The combination probability of an event and its negative consequences are known as risk (UNISDR 2016). It allows the comparison of different levels of disaster scenarios. In cases, when a person or objects are at risk , it can be related to function of related hazards, the exposure of a given entity to these hazards and finally the entity's vulnerability (Handmer, 2003).

2.7.2 The Dimensions of Vulnerability

There are three dimensions of vulnerability: exposure, sensitivity, and adaptive capacity. Exposure is the degree to which people and the things they value could be affected or “touched” by coastal hazards; sensitivity is the degree to which they could be harmed by that exposure; and adaptive capacity is the degree to which they could mitigate the potential for harm by taking action to reduce exposure or sensitivity.

The expression “things they value” not only refers to economic value and wealth, but also to places and to cultural, spiritual, and personal values. In addition, this expression refers to critical physical infrastructure such as police, emergency, and health services buildings, communication and transportation networks, public utilities, and schools and day care centres. It also refers to social infrastructure such as extended families, neighbourhood watch groups, fraternal organizations, and more. The expression even refers to such social factors as economic growth rates and economic vitality. People value some places and things for intrinsic reasons and some because they need them to function successfully in our society.

2.8 Remote Sensing and GIS

(a) Remote Sensing

Remote Sensing is basically a software program which includes all the methods of to attain photographs or different styles of from a distance regarding the way of restorative and processing the picture records, besides its electromagnetic records of Earth's floor which is said by White (1977). Consistent with the United countries (95th Plenary assembly, 3rd December, 1986), the definition of Remote Sensing can be justify into some fundamental scopes which can be the sensing of earth's floor from space by means of using the houses of electromagnetic wave emitted, reflected or diffracted by way of the sensed objects, for the reason of enhancing natural aid control, land use and the protection of the surroundings. subsequent, in keeping with JB. Campbell (1996), faraway Remote Sensing is the exercise of getting data concerning the Earth's land and water surfaces the use of pix obtained from an overhead angle, the use of electromagnetic radiation in a single or greater areas of the electromagnetic spectrum.

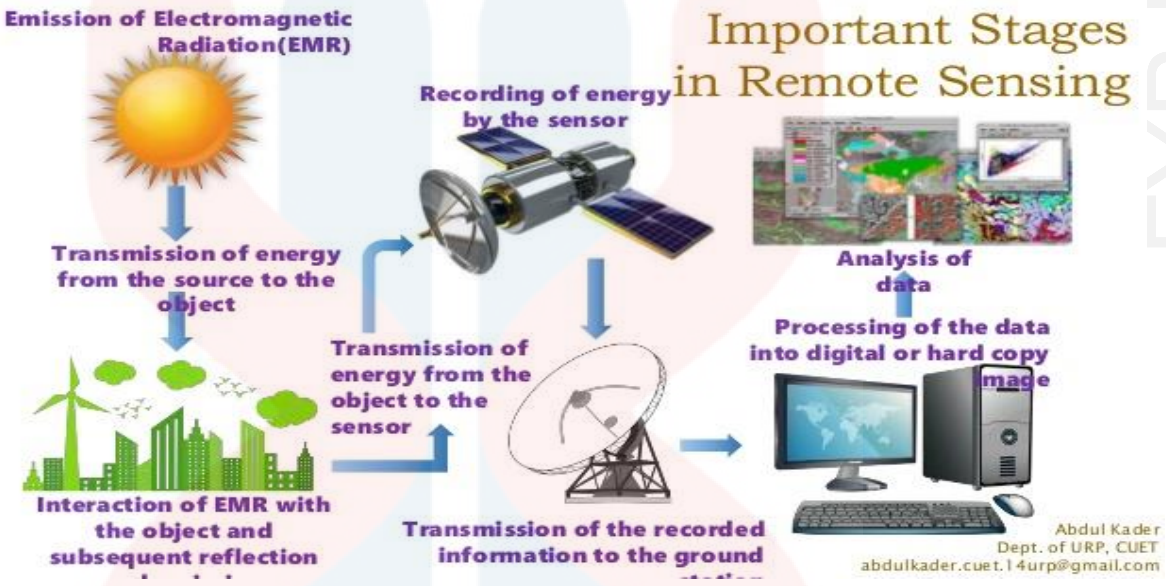

Figure 2.1 Stages of Remote Sensing

(b) Geographical Information System (GIS)

GIS as a computer-based system with four sets of geo-referenced data capabilities, visual data input, analysis of data manipulation and data output (Aronoff,1989).Besides that, the United State Geographical Survey stated that GIS is computer system analysing which enables to view various type of information and data from multiple sources. One of the example of source is from the global positioning system (GPS).

2.9 Classification of Land Use Land Cover (LULC)

The definition of land cover is fundamental, because in many existing classifications and legends it is confused with land use. Land cover is the observed (bio) physical cover on the earth's surface. Land use land cover can be defined as approach to analyse the relationship between two main related subjects which are the vegetation and rainfall variability as both of these keys are closely related to the changes that occurs to our global atmosphere changes , (Lambin, E.F, 1997). As reported by Nightingale and Phinn, there are very strong connections interrelated between the Normalized Difference Vegetation Index (NDVI) and rainfall which correlates five main land cover types which shows a positive correlation between them. When considering land cover in a very pure and strict sense, it should be confined to the description of vegetation and man-made features. Consequently, areas where the surface consists of bare rock or bare soil are land itself rather than land cover. Also, it is disputable whether water surfaces are real land cover. However, in practice, the scientific community usually includes these features within the term land cover.

2.9.1 Land Use Land Cover (LULC) Importance

The process of land use and land cover change (LULC) is very complex and takes different forms, with differences in magnitude and rate. Entire bureaus are created in world governments, purely focused on mapping and studying these changes. LULC change detection studies are usually not conducted alone whereby it is generally connected to a larger problem. Other fields where LULC change detection is required are in sustainable management programs, natural resources census and mapping, social studies, ecological studies, detecting the growth and direction of urban sprawls and exactra.

2.10 Accuracy Assessment

Accuracy measures the agreement between a standard assume to be correct and a classified image of unknown quality in the context of information extraction by image analysis (Campbell, 2007). Accuracy Assessment is basically a step that has become more essential to state the accurate distortion error that is presented in the satellite image that has being downloaded (Peacock, 2014). Accuracy assessment is an important step of any type of project in order to make specific classification regarding certain a particular subject. Basically, it will compares the supervised or unsupervised classified images to another data source whereby in this study is the comparison with the raw satellite image from the Unites States Geographical Survey (USGS) in a confusion matrix. When the images are not being categorised according to its class, classification error will tend to occur. This occurs because the pixel that belongs to a specified category is being assigned to another category. Accuracy Assessment is usually performed by comparing the map created by remote sensing (ENVI) to a reference map (satellite image from USGS) based on a different platform of information source.

From the perspective of data modelling, LULC classification methods can be grouped into parametric and nonparametric approaches. Parametric approaches, such as the minimum distance classifier, maximum likelihood classifier, and the expectation-maximization (EM) algorithm, often require proper assumptions of data distribution.

CHAPTER 3

METHODOLOGY

3.1 Research Design

This research study is a quantitative approach whereby it will be used to gather information regarding the adverse impact in the change of climate towards farmers socio-economic.

3.2 Research Study Area

This study will be conducted in a month time from June 2019 till August 2019 by using the USGS as the reference of the land use map of Kelantan for the data analysing. The (Figure 3.1) below shows the Kelantan map that would be my study area which specifies on the district of Pasir Mas,Kelantan. Lastly, the rainfall data in Pasir Mas, Kelantan will be taken from the Climatic Research Unit. Basically, Pasir Mas is located in the Northern Malaysia. Based on the Universal Transverse Mercator (UTM) states that the exact geographic coordinate system is located at 6°02°'57.62''N 102° 08' 23.53'' E. The figure below (Figure 3.1) shows the flowchart of methodology:

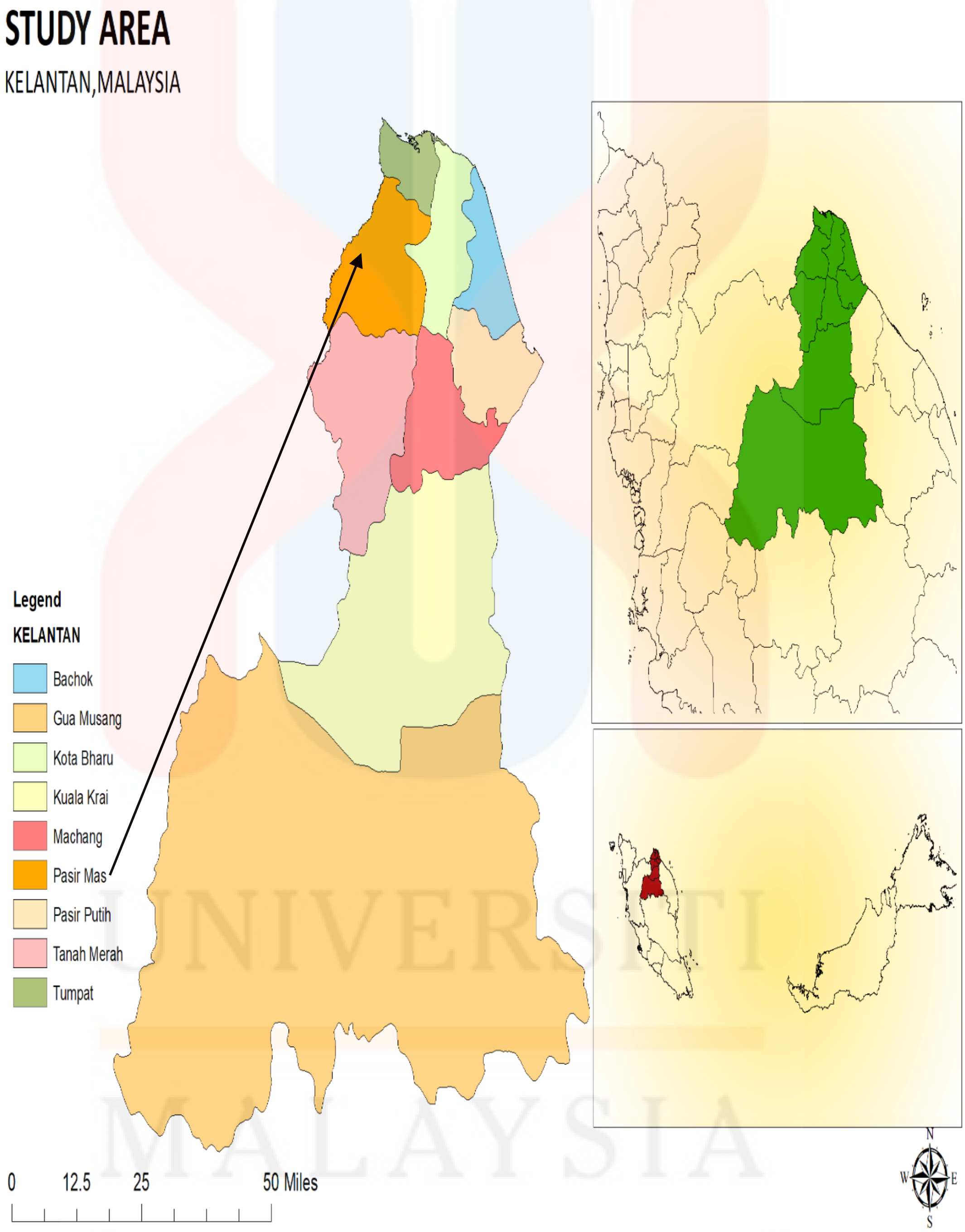

Figure 3.1 : Study Area in Pasir Mas,Kelantan

3.3 Data Collection

3.3.1 Rainfall Distribution Data

The data needed for the vulnerable map includes the rainfall data. The data being used was the imagery data which was obtained from the Climatic Research Unit This will be my secondary data. The data is being then being downloaded freely from the website of Climatic Research Unit, being transferred into excel and being converted inti ArcGIS. The data will then being clipped on with Pasir Mas boundary map. The duration for the distribution of rainfall that will be analyse is 6 cycle which is in three years time. Based on the distribution of rainfall data obtain, the impact on the main dependant variable which is the net income of farmers in Kelantan can be determine.

Next, in order to produce the vulnerable map, the satellite image (Landsat 4/5/, 7 or 8) will be downloaded from the United States Geological USGS. The Landsat Standard products will then be processed by using Level 1 Product Generation System (LPGS).

Primary data source was being collected which are the satellite imagery for 3 years that are 2004,2007 and 2011 from the United States Geological Survey .

Table 3.1 Types of Data

Types of Data	Year	Source
Landsat TM 4/5	2004	United States Geographical Survey (USGS)
Landsat 8	2007	United States Geographical Survey (USGS)
Landsat 8	2011	United States Geographical Survey (USGS)

3.3.2 Image Pre-Processing

The image processing process will start after the satellite image of the Kelantan map have been downloaded from the USGS. The Kelantan land use map will only be use as a reference map. The raw satellite images in their geometry and radiometry may contain a variety of errors. Therefore, these images must be rectified before beginning their interpretation. Image pre-processing is done before satellite images are enhanced, manipulated, interpreted and classified.

3.3.3 Image Enhancement

Image enhancement is one of the important step to improvise the original content of the data in producing a clear and perfect resolution image. There are variety of tools and software that can be used in order to proceed with image enhancement which are image editors, filters and more. In image enhancement, there are various activities that can be done which includes this four main criteria which are contrast enhancement, spatial filtering, density slicing and FCC.

Next, image enhancement techniques can be sort into two main techniques which are the spatial and frequency domain methods. The spatial domain methods usually applies directly on the pixels of the image whereby for the frequency domain methods, it operates on the Fourier transform of an image.

3.3.4 Image Classification

For the image classification, there are two main types of methods which are the unsupervised or supervised methods to categorize the pixels in an image into different classes. The unsupervised classification can be done without providing training data while for the supervised classification where training data is needed. It will then help in specifying classification method which can be spread into two main groups that are known as the highest amount of likelihood also well known as the maximum likelihood, shortest route or Spectral Angle Mapper (SAM). For the unsupervised classification in a dataset, it only managed the pixels based on statistics only. It does not require to define any training classes. For this study, the classification of image used is the supervised classification by using the approach of maximum likelihood.

3.3.5 Accuracy Assessment

Accuracy assessment is an important step to be conducted as it will display the accuracy of result of the supervised images compared to the existing data. The ground truth data act as a reference for the process of image classification for the year of 2004.2007 and 2011. After the accuracy assessment is being conducted, those processed image for the year 2004, 2007 and 2011 are being converted to another type of file which is the shapefile (.shp) following the raster formats . Three land use maps of Pasir Mas, Kelantan is then produced.

3.4 Data Analysis

3.4.1 Developing Map of Farmers

In order to develop the vulnerable map of Pasir Mas Kelantan the first step is to download the satellite image that consists of three types of data which are either the Landsat TM (Landsat 4/5), Global Land Survey (Landsat 7) or the Landsat 8 images from the United States Geological Survey (USGS). The United States Geological Survey (USGS) is a platform which provides science regarding natural hazards that posses threats towards the society and livelihoods and the health of our ecosystem and environment. The variables that will be included in the map are the climatic variables (rainfall data).Based on the Table 3.4 below , one of the main focus is regarding the impact of rainfall on the farmer's net income depending on the most vulnerable area which are prone to high rainfall. In this map we can analyse the most dominant area which are vulnerable towards the impact of rainfall variability on the LULC based on the rainfall map.

Table 3.2 Overall Variables

Variables	Description	Unit	Type of Variables
Nt	Crop Net Revenue	RM	Dependant Variable (DV)
Cp	Crop Net Production	RM	Dependant Variable (DV)
Rr	Rainy Season Rainfall	mm	Climatic Variable
Inc	Farmer's Net Income	RM	Socio-Economic Variable
Edu	Education level of household head (number of years of formal schooling)	Year	Socio-Economic Variable
Gen	Gender of household head (Male=1, Female=0)		Socio-Economic Variable
CA	Cropland area (numbers of hectares cultivated by the farmer)	ha	Socio-Economic Variable
Size	Size of the household	people	Socio-Economic Variable
Wh	Number of household working	people	Socio-Economic Variable
Irri	Irrigation system used (Active=1,Passive=0)		Socio-Economic Variable
Gs	Access to government support (No=0,Yes=1)		Socio-Economic Variable
Mcrop	Cultivated Mode (Mono=0. Poly=1)		Socio-Economic Variable

3.4.2 Analysis

3.4.2.1 Land Use Analysis

In conducting this land use analysis, land use data in the form of satellite images are being downloaded from the United States Geological Survey (USGS). Two of the images from the respective years of 2007 and 2011 are based on the Landsat 8 whereby for the data for 2004 is based on Landsat 4/5. Practically all of these downloaded data will be analyse and process by using two main software namely ENVI and the GIS. The data obtained from the USGS will be used to produce land use map for the three respective years which specifies the areas in Pasir Mas,Kelantan.

USGS provides various information in a wide range source of data. Therefore, there are few rules that needed to be follow in order to gain useful and manageable data. In order to choose the most relevant data to be analyse, the percentage of cloud scene and cloud cover need to be at least less than 10 %.This is to ensure during the analysis of the image , it is easier to clarify the pixels according to its relative class whereby there will be five main classes which are the forest, agriculture, built up area, cleared land and water bodies.

Next, the area that is being provided by the USGS encloses the whole districts in Kelantan thus, to extract the area of interest from the raw image, Global Administrative Areas (GADM) is being used. It helps to make the boundary for the specific area chosen whereby in this study is the Pasir Mas, Kelantan.

There are wide range of combination between bands that can be chosen to display the image. The bands that are being used is Band 3, Band 2 and Band 1 accordingly. The table below shows the data required for the data analysis for this study:

Table 3.3 Data Analysis

Types of data acquired	Spatial Data	Attributes
Vector	Kelantan boundary Pasir Mas boundary Rainfall	Polygon Polygon Total Rainfall
Raster	Land Use Data	Land Use Type

3.4.2.2 Spatial Analyst Tool

For the spatial analyst tool of land use maps, the images that had been completely supervised and has reached its accuracy will be export to the ArcGIS 10.3 the image will be clip on to organize its boundary area. The data will be analysed based on the total amount of the distribution of rainfall in Pasir Mas in the form of (.shp). Then the properties will be changed according to our preferences such as the colour of the map and name.

3.4.2.3 Spatial Interpolation Method (IDW)- Rainfall Map

Surface interpolation tools create a continuous of any kind of prediction on the surface from the sampled point values. The continuous surface is a representation of a raster dataset represents some measure, such as the height, concentration. Surface interpolation tools make predictions from sample measurements for all locations in an output raster dataset, whether or not a measurement has been taken at the location.

Spatial interpolation is used to take known values and interpolate them into a surface, deriving new estimated surface values. In this study, the ArcGIS Spatial Analyst tool being used is the Inverse Distance Weighted (IDW) interpolation methods whereby it is used to show the rainfall data according from the most to the least volume of rainfall of an area .

3.4.2.4 Weighted Overlay Technique (Spatial Analyst)

Next for the analysis of vulnerable map, the weighted overlay technique was being used. This method mainly overlays the three land used maps that has being produced previously with the rainfall map. Each image needs to be converted from raster to polygon and next they need to be reclassify.

The output was to produced a vulnerable map of paddy farmers which will give specification on the land use classes with the areas that are prone to high rainfall distribution. The level of vulnerability in the Pasir Mas district was being ranked from 1 to 5 which are classified as no vulnerability area, low vulnerable, moderate vulnerable, high vulnerable and very high vulnerable.

METHODOLOGY FLOWCHART

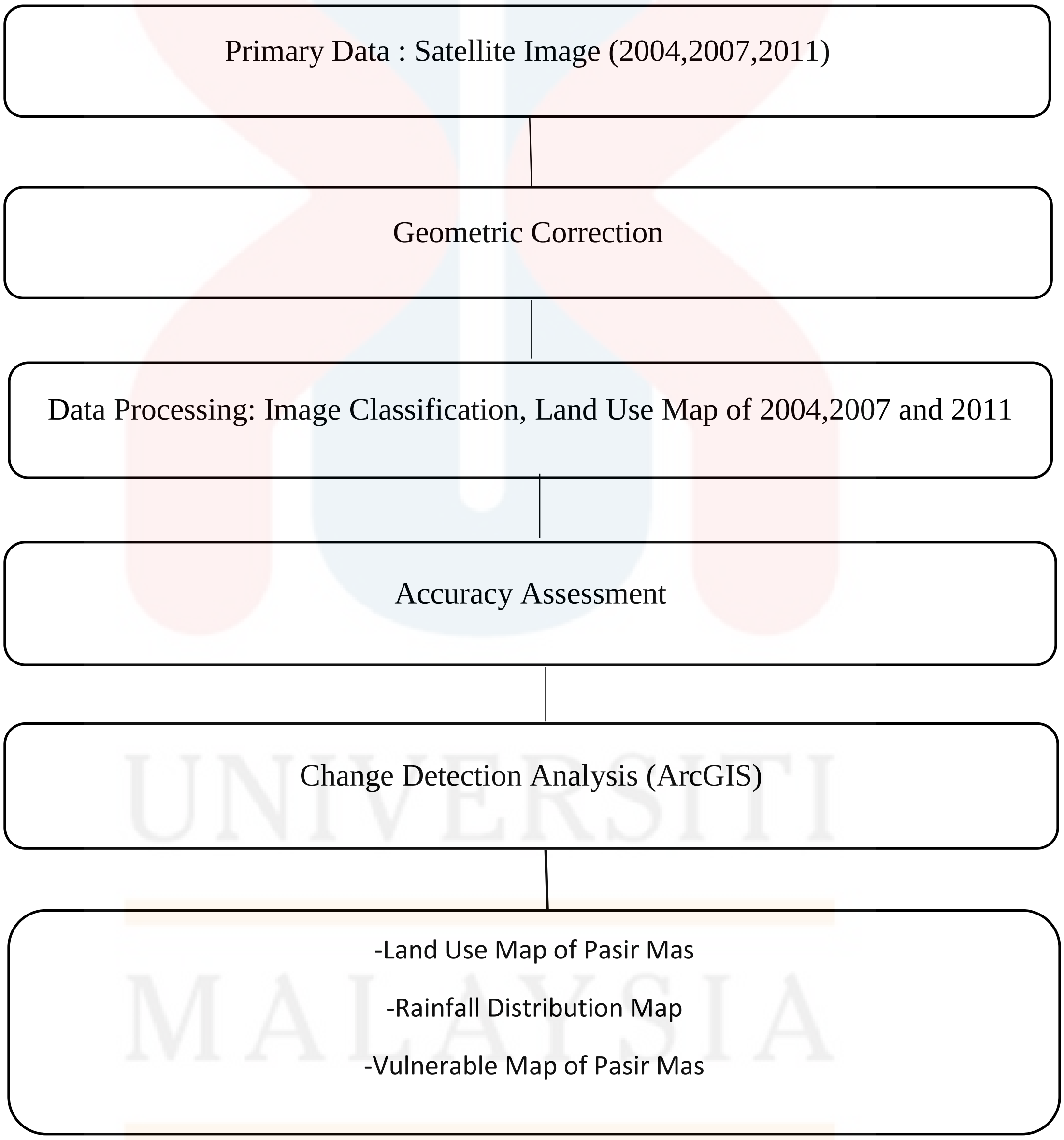

Figure 3.2 : Methodology Flowchart

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Pre Image Processing

The land use map of Kelantan being used and downloaded from the official website of (USGS) is in the year of 2004, 2007 and 2011. These satellite images are then being processed in order to enhance and improve the quality of the image. The main topics being highlighted in this research are mainly the research area, the data being collected, the steps in processing the data, the changes in land use of these and also the spatial pattern changes of LULC in Pasir Mas, Kelantan.

4.1.1 Geometric Correction

Geometric correction is the position of each picture of the image whereby it must be exact precise towards the real earth's surface location and must be following according to its geographical coordinate system (Hruska et al., 2012; Wang et al.;2015).The satellite images presented are not precisely accurate according to its geographical coordinate. Geometric corrections are being done to –correct the satellite image for its displacements and to ensure that the pixels of the image are in proper and exact position of the Earth's surface.

4.2 Result Processing

During this stage, the main point being discussed are regarding the output of the image subset, the supervised classification of the image, the enhancement and last but not least accuracy assessment of image.

4.2.1 Image Subset and Boundary

Due to the large area of the image which does not only specifies the specific research area , this satellite image was being subset by using the method of clip only by the Region of Interest (ROI).

4.2.2 Supervised Classification : Maximum Likelihood

This supervised classification maximum likelihood is used to show the difference of categories in the satellite image that had been processes. Maximum Likelihood Classification (MLC) was chosen as the best method in this study because its tendency to classify images to the correct group according to their specific criteria which they belong to and classifying pixels based on their data values to their class are highly precise and accurate (Sisodia et al.2014) The example below, shows the satellite image differences between the image before and after it has been supervised. It shows the classification of the 5 main categories which are forest (red), agriculture (green), water bodies (cyan), cleared land (yellow) and built up(purple) which can be clearly seen through its colours. Figure 4.1 below shows the example of the before and after image of the maximum likelihood classification for the year of 2011.

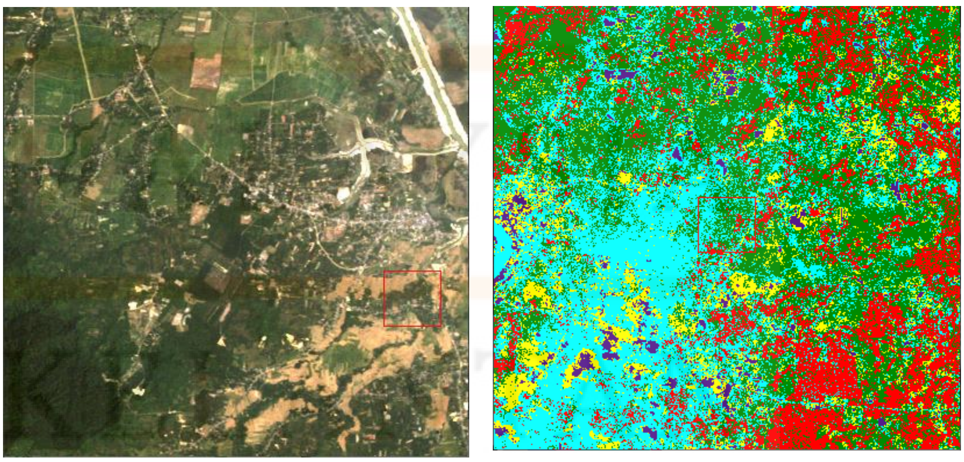

Figure 4.1 Before and After image of Maximum Likelihood Classification

4.2.3 Post Classification (Confusion Matrix)

After supervised of the image have been done, the post classification of confusion matrix is being done by using the Ground Truth ROIs . This step is being done to show the confusion matrix accuracy table that shows the reading of accuracy percentage and Kappa coefficient . The percentage showed tells the accuracy between the image that has been supervised towards the original image . The classification of the five main categories of agriculture, forest, water bodies , cleared land and built up precision and accuracy are being compared between these two raw satellite image and satellite image that has been supervised. Based on the three satellite image which are the Landsat TM OF 2004, Global Land Survey 2007 and Global Land Survey of 2011, the supervised image of Global Land Survey 2007 shows the highest accuracy and Kappa Coefficient compared to the other two images due to clearer raw satellite image that has low cloud cover and scene. When raw satellite image consists of higher percentage of cloud cover and scene, it will eventually disturb the naturality of the image thus makes it harder to be processed. Table 4.1 below shows the overall accuracy and Kappa coefficient for the three images.

Table 4.1 Overall Accuracy (%) and Kappa Coefficient

Satellite Image/Year	**Landsat TM 2004**	**Landsat 8 2007**	**Landsat 8 2011**
Overall Accuracy (%)	90.8594	93.4296	88.6934
Kappa Coefficient	0.8830	0.9020	0.8430

4.3 Land Use Map of Pasir Mas (2004, 2007 and 2011)

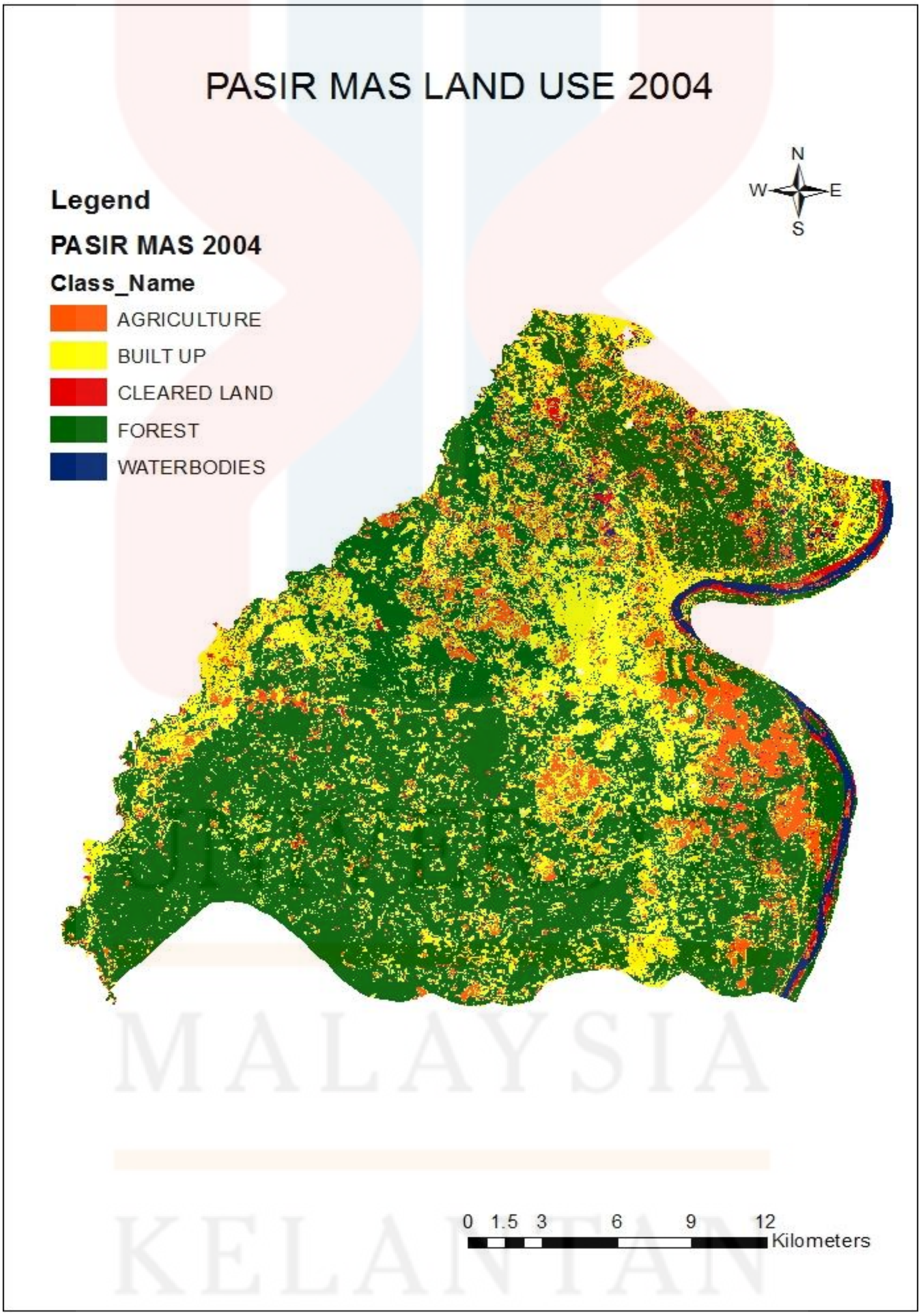

Figure 4.2 Land Use Map Of Pasir Mas 2004

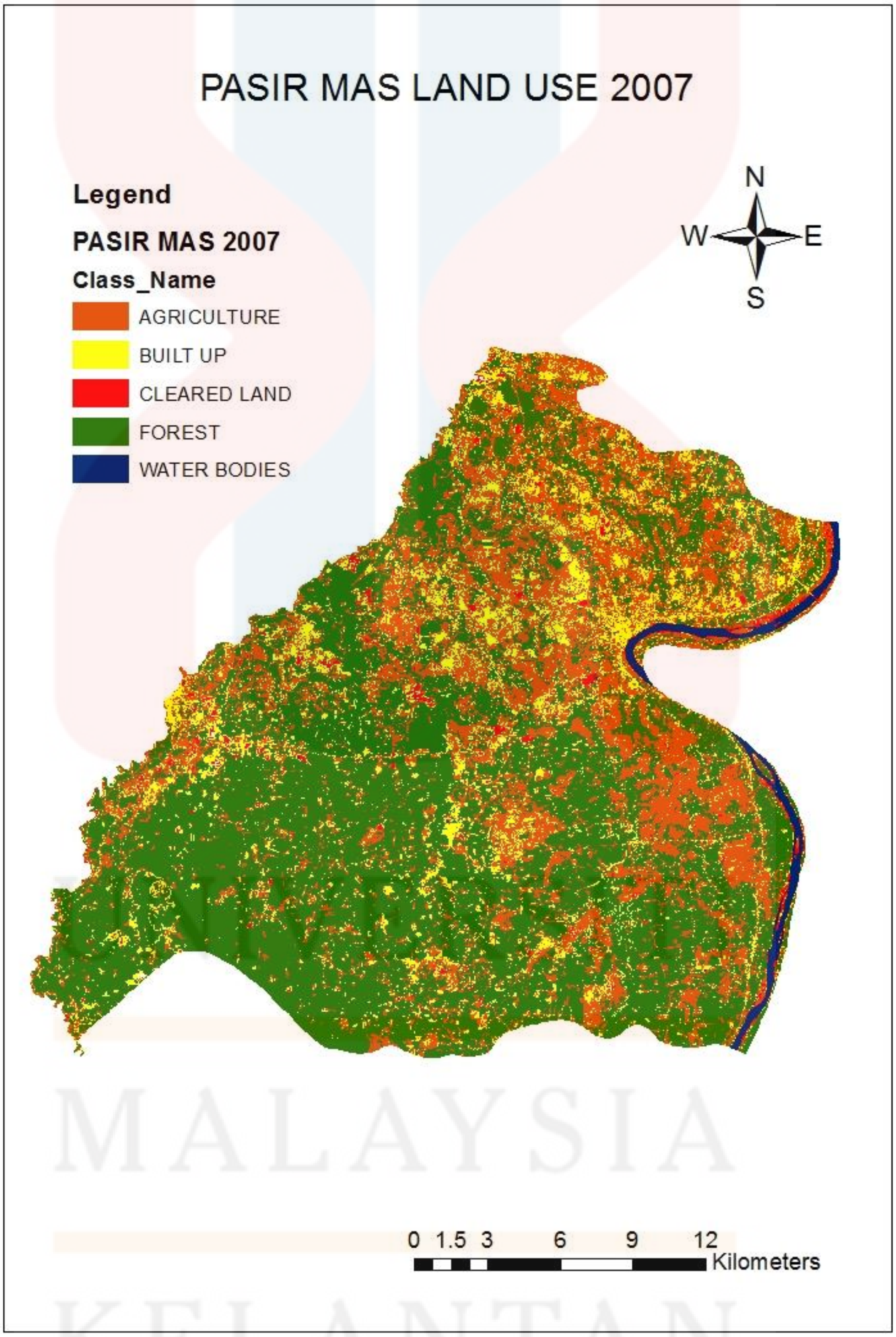

Figure 4.3 Land Use Map of Pasir Mas 2007

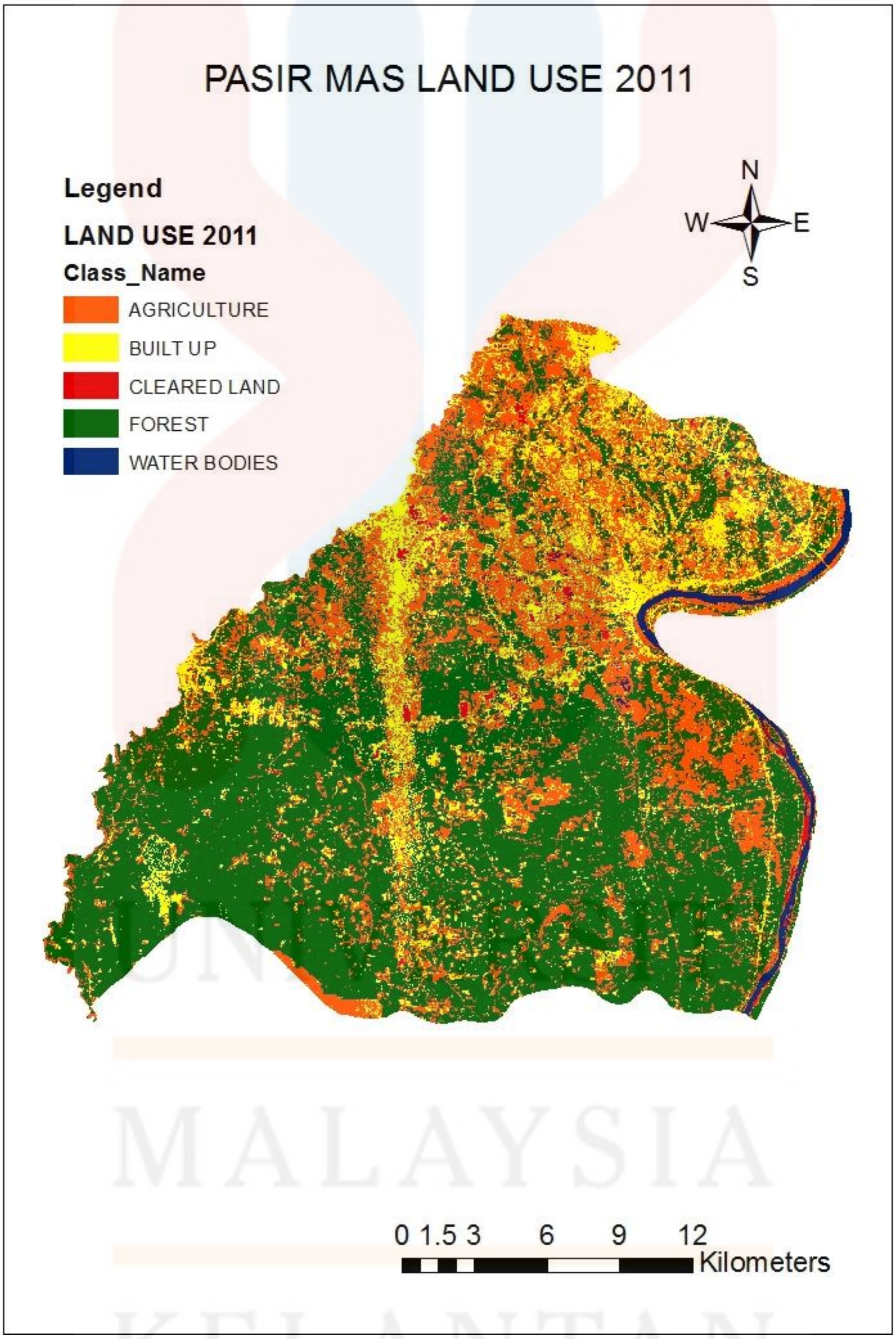

Figure 4.4 Land Use Map Of Pasir Mas 2011

4.4 Land Use Change in Pasir Mas

Based on the land use maps in the Figure 4.2,Figure 4.3 and Figure 4.4 above, the land use classes were divided into 5 main classes which are the forest, agriculture, water bodies, built up area and cleared land. The difference in land use cover can be seen through the variation of colours in the maps being produced. Based on the maps, it shows that the agriculture land use has been increasing from year to year while for the forest it shows a decreasing pattern. This is probably due to the developments that has been occurring that reduced the area of the forest whereby it has increased the area of built up , agriculture and cleared land. Land use changes such as the clearing of forest for developments and the improper management of urbanization will result in changes of the land structure that might lead to further disruptions such as flood, pollutions and landslides.

The result of the land use change were tabulated in the Table 4.1, Table 4.2 and Table 4.3 based on the year of 2004,2007 and 2011 in Pasir Mas, Kelantan. In order to differentiate and classify the land use change , post classification comparison had been done. The three respective land use maps (2004,2007 & 2011) were being overlay with the help of ArcGIS software.

a) Land Use Change in Pasir Mas 2004

Table 4.2 LULC Class Change Detection in Area(ha) and Percentage (%)

Land Use Class	**Area (ha)**	**Area (%)**
Agriculture	6721.81	0.11
Built Up Area	15762.93	0.27
Water Bodies	1516.14	0.03
Cleared Land	770.44	0.01
Forest	34592.59	0.58
Total	59363.91	1.00

b) Land Use Change in Pasir Mas 2007

Table 4.3 LULC Change Detection Class in Area (ha) and Percentage (%)

Type of Class	**Area (ha)**	**Area (%)**
Agriculture	14746.63	0.25
Built up Area	10685.50	0.18
Water Bodies	1321.43	0.02
Cleared Land	592.12	0.01
Forest	32056.51	0.54
Total	59363.91	1.00

c) Land Use Change in Pasir Mas 2011

Table 4.4 LULC Change Detection Class in Area (ha) and Percentage (%)

Land Use Class	Area (ha)	Area (%)
Agriculture	17716.18	0.30
Built Up Area	8310.94	0.14
Water Bodies	1498.75	0.03
Cleared Land	628.83	0.01
Forest	30869.2332	0.52
Total	59363.91	1.00

Based on the results above, it is shown that the agriculture land use are increasing drastically from the year 2004 to 2007 and keeps on increasing throughout the following years. This shows that agriculture sector are one of the main source of income for the community living in Pasir Mas. Thus, any disruptions on the agriculture land use will give impact on the economic growth of farmers. Next, the cleared land and forest shows decreasing pattern. This is mainly due to the urbanization and developments occurring in Pasir Mas but due to some events such as For the built up area, it also shows decreasing pattern. Kelantan district are prone to floods due to monsoonal events and heavy rain. Built up areas are decreasing because their society tend to be migrating from one country to another .

4.5 Distribution of Rainfall in Pasir Mas

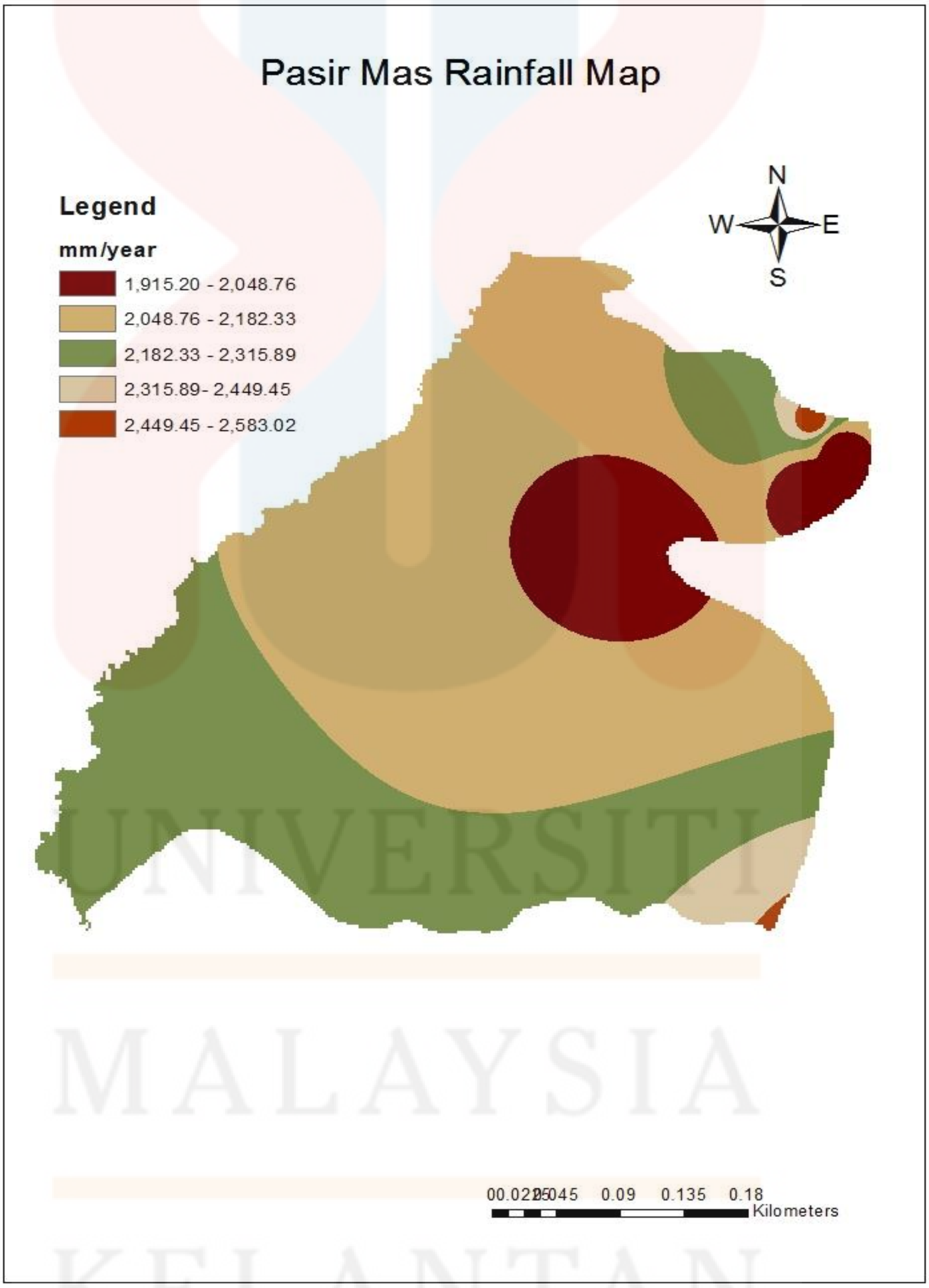

Figure 4.5 The Distribution Rainfall Map In Pasir Mas

The Figure 4.5 above shows the distribution of rainfall which was being analysed by using Inversed Distance Weighted (IDW). The distribution of rainfall is classified into 5 main classes whereby the brick red shows the lowest accumulation of rainfall towards the brick brown colour towards the highest vulnerable area which are prone to rainfall distribution.Based on the figure above, it clearly shows the distribution of rainfall in Pasir Mas, Kelantan. For the first range of rainfall it indicates the least amount of rainfall between 1915.20 mm/year- 2048.76 mm/year which is shown in the colour of brick red that covers mainly the main area of built up classes. Next, the area that receives the moderate amount of rainfall distribution in between 2182.33mm/year-2315.89mm/year specifies the area which is mainly covered by the forest. Lastly, the most area that receives the most amount of distribution rainfall covers the area between forest and agriculture. As we know the Kelantan district are well known as an area that are prone to floods occurrence which is mainly due to the monsoonal season and heavy rainfall. Heavy rainfalls are one of the essential components that lead to the changes in land use. Therefore, distribution of rainfalls can affect the combination of both land use such as the agriculture sector and forestry. Based on this study it can be stated that the amount of rainfall (mm/year) will give impact on the farmers income as the main area that dominates the highest amount of rainfall is the area covered by forest and agriculture.

4.6 Vulnerable Map of Pasir Mas based on Land Use Cover (2004,2007 and 2011)

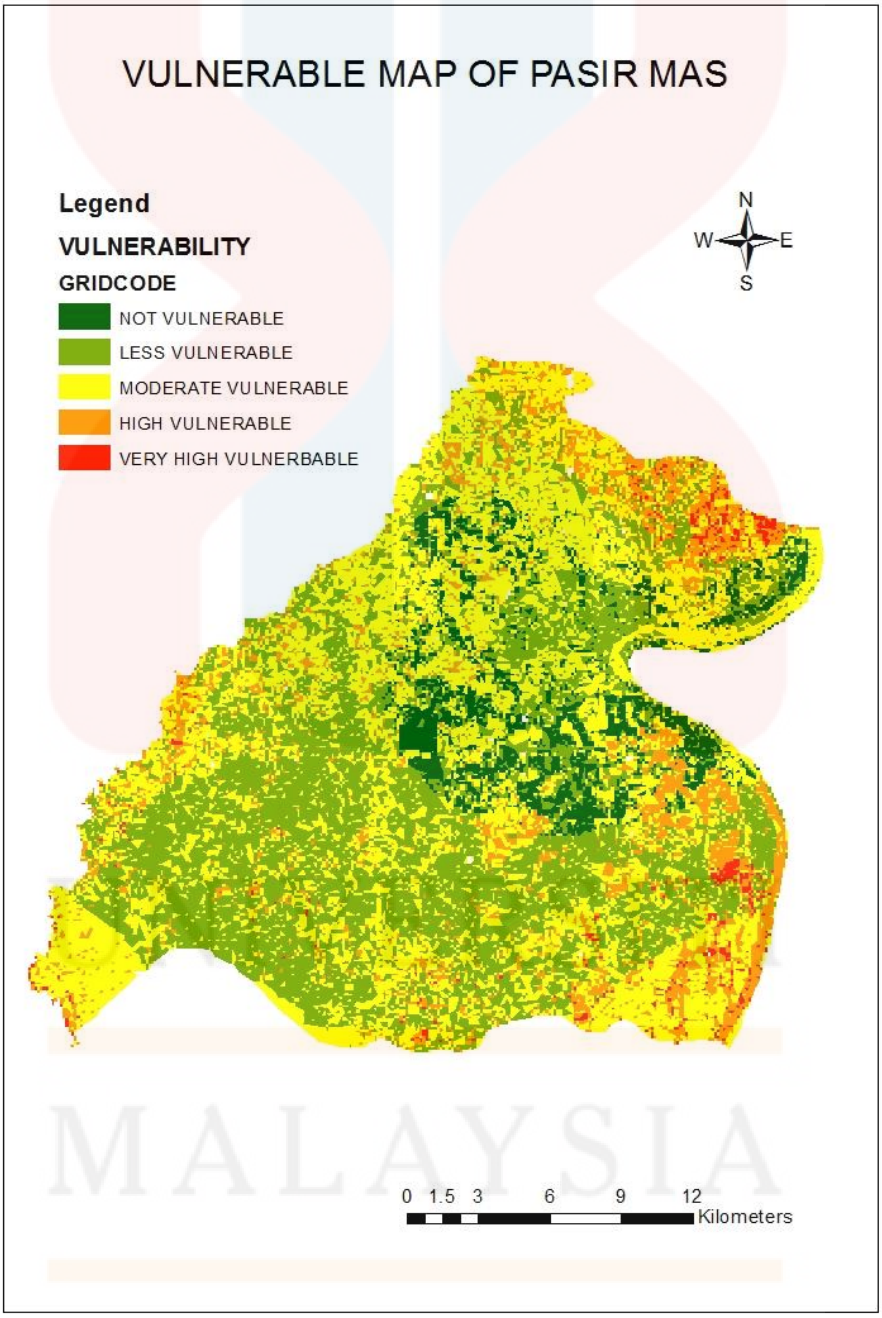

Figure 4.6 Vulnerable Map of Pasir Mas

Table 4.5 Vulnerability Rank

Colors	Rank
Dark Green	Not Vulnerable
Light Green	Low Vulnerable
Yellow	Moderate Vulnerable
Orange	High Vulnerable
Red	Very High Vulnerable

Based on the Figure 4.6 above, the range for vulnerability stages are classified into 5 main groups as shown in Table 4.4. First, the most and high vulnerable area which are highly exposed and will be affected by rainfall variability is the area in red and orange colour. This is mainly due its location which is near to the water bodies. Therefore, whenever heavy rain strikes they are the most vulnerable area which are prone to faced further disruptions. Mostly, the land cover covered by the area in orange and red are agriculture areas. The yellow colour which indicates moderate vulnerable are mostly likely covered by the forest areas and low vulnerable areas emphasize the combination area of built up and forest.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From this study, there are three main objectives that are achieved which are, to classify the land use and land cover in Pasir Mas in 2004,2007 and 2011, to produce a vulnerable map of paddy farmers and to analyse the correlation between rainfall variability and farmer's income. For the first objective, three land use maps of the year 2004,2007 and 2011 has been produced. The LULC classes are classified into 5 main classes which are the agriculture, forest, built up, water bodies and also the cleared land. The change detection of land use based on its area(ha) and percentage (%) has also been quantified. Next is producing a vulnerable map of paddy farmers which is based on the land use map of the three respective years towards rainfall distributions. It can be seen that the agriculture are highly exposed to the distribution of rainfall in Pasir Mas thus there is a correlation between farmer's income and the distribution of rainfall. Lastly, is to see the correlation between rainfall variability and farmer's income. This study has basically prove that when the amount of rainfall in a certain area increases, it will contributes changes on the land use cover and will affect the socio economic variable which in this study mainly specified on the farmer's net income.

5.2 Limitations and future recommendations

Basically, in every study conducted there will be room for errors. In this study, there are few limitations that can be improvise which includes limitation of time and errors while analysing the data.

For the first limitation is regarding time constraints. During the analysis there will be various of techniques and tools that will be involve and before analysing the users must already have knowledge regarding which type of analysis that can be used, which analyst tool must be used according to the type of data and output that they would want to produced. Therefore, it requires a longer period of time to truly adapt and understand with the related software.

Besides that, during the accuracy assessment, the user need a plenty of time to precisely analyse the pixels according to its classes or otherwise it will give effect on the reading of accuracy percentage and its Kappa coefficient. If the accuracy does not reach the minimum requirement of 80 %, the user need to re-do the process again which might take a longer time for the analysis to be completed.

Next, the errors while analysing the data which is one of the common limitations while dealing with ENVI. Satellite imagery while high cloud coverage and cloud scene will cause low performance of image classification this will lead to low production quality of maps.

Furthermore, the other limitations would be regarding the rain rate, rain intensity, surrounding temperature, the farmers awareness and knowledge regarding climate change that leads to changes in rainfall distributions.

The recommendation that could be suggested that is researchers should apply for a more advanced and high resolution satellite imagery from other sources such as the Agency of Remote Sensing (ARSM) in order to produce a more precise ,detailed and has high accuracy of final land use maps .

REFERENCES

Arief Anchory Yusof (2009). Climate Change Vulnerability Mapping for South East Asia

Aronoff, S. (1989) Geographic Information Systems: A Management Perspective.

C. Rosenzweig, et al., *Climate Change and World Food Supply* (Oxford: Oxford University Press, 1993).

Chan, N.W. (2015) Chapter 12 Impacts of Disasters and Disaster Risk Management In Malaysia: The Case of Floods. In Aldrige, D.P., Oum, S. and Sawada, Y.(Editor) Resilience and Recovery in Asian Disasters, Risks, Governance and Society. Springer (e-Book), 239-265.

Diaz, J. H. (2004). The public health impact of hurricanes and major flooding. The Journal of the Louisiana State Medical Society, 156(3), 145-150.

FAO, IIED (International Institute for Environment and Development) & IFAD (International Fund for Agricultural Development). 2009. Land grab or development opportunity? Agricultural investment and international land deals in Africa, by L. Cotula, S. Vermeulen, R. Leonard & J. Keeley. Rome, FAO and IFAD. London, IIED

FitzGerald, G., Du, W., Jamal, A., Clark, M., & Hou, X. Y. (2010). Flood fatalities in contemporary Australia (1997–2008). Emergency Medicine Australasia, 22(2), 180-186.

Foley,J. A., DeFries, R., Asner,G.P.,Barford, C., Bonan, G., Carpenter, S.R., & Helkowski, J. H. (2005). Global consequences of land use . science 309(5734), 570-574

Forman, R. T. T., M. Gordon, (1986). Landscape Ecology. John Wiley & Sons, New York. pp 619

Haliza Abdul Rahman, (2009) Global climate change and its effects on human habitat and environment in Malaysia. Malaysian Journal of Environmental Management, 10 (2).pp. 17-32. ISSN 1511-7855

IPCC, (2001),: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change ,Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881

JB.Campbell., RH Whynne., (2011), Introduction to Remote Sensing

Lanbin , E.F , (1997) Modelling and Monitoring Land-Cover Change Process in Tropical regions *Phys. Georgh.*, 21, 375-393

Mercy, I.C., 2015. Trend Analysis of Rainfall Pattern in Enugu State, Nigeria. European Journal of Statistics and Probability, 3(3): 12-18.

Nightingale , J.M,; Phinn, S.R. Assessment of relationship between

Peacock, R. (2014). Accuracy Assessment of supervised and unsupervised classification using Landsat Imagery of Little Rock, Arkansas, *Master of Science thesis Northwest Missouri State University, Maryville, MO.*

Turner, M.G.; O'Neill, R.V,; Gardner, R.H.; Milne, B.T. Effects of changing spatial scale on the analysis of landscape pattern. *Landsc. Ecol*. 1989, 3, 153-162.

UNFCCC (United Nations Framework Convention on Climate Change). 2008. Challenges and opportunities for mitigation in the agricultural sector. FCC/TP/2008/8. Bonn,Germany.

World Health Organization (2002), Environmental Health in Emergencies and Disasters: A Practical Guide.

APPENDICES

APPENDIX A

Detailes of the satellite imagery

Location	Type of satellite image	Band	Resolution	Year
Pasir Mas	Landsat TM 4/5	3,2,1	30 m	2004
	Landsat 8	3,2,1	30 m	2007
	Landsat 8	3,2,1	30 m	2011