MAPPING OF EMERGING DEFORESTATION IN KELANTAN USING GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

by

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DECLARATION

I declare that this thesis entitled “Mapping of deforestation in Kelantan Using Geographical Information System (GIS)” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

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APPROVAL

"I/ We hereby declare that I/ we have read this thesis and in our opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Natural resources) with Honors"

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Date	:	……..

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Mapping of Emerging Deforestation Hot Spots in Kelantan using Geographical Information System (GIS)

ABSTRACT

Abstract: Tropical forest has been heavily exploited from the past few decades due to many factors to satisfy human needs. Kelantan is one of the state in Malaysia that significantly lost their forest cover for the past decades. This paper calculated the annual rates of deforestation in Kelantan and identify the emerging hot spots in Kelantan using Geographical Information System (GIS) between year 2007 until 2016. Secondary data in forms of statistical data from year 2007 until 2016 was gathered from Forestry Department Peninsular Malaysia (JPSM) website, Kelantan State Forestry Department (JPNK), non-government organization (NGO) and through website searching then the analysed data was presented through bar graphs and an emerging deforestation hot spot map by using Microsoft Excel and ArcGIS Version 10.3 respectively. The results show that Gua Musang has the most deforested area for the past 10 years with a total of 172,894 ha or 2.11% of land followed by Kuala Krai and Tanah Merah with 44,434 ha (1.95%) and 14,824 ha (1.73%) respectively. The findings of this paper will be useful for the forestry management to manage the forest in Kelantan.

Pemetaan Kawasan Titik Panas Penebangan Hutan di Kelantan Menggunakan Sistem Maklumat Geografi (SMG)

ABSTRAK

Abstrak: Hutan tropika telah banyak dieksploitasi sejak beberapa dekad yang lalu disebabkan oleh beberapa faktor untuk memenuhi keperluan manusia. Kelantan adalah salah satu negeri di Malaysia yang kehilangan banyak kawasan berhutan sejak beberapa dekad yang lalu. Kajian ini menghitung kadar tahunan penebangan hutan di Kelantan dan mengenal pasti titik panas yang di Kelantan menggunakan Sistem Maklumat Geografi (SMG) antara tahun 2007 hingga 2016. Data sekunder dalam bentuk data statistik dari tahun 2007 hingga 2016 telah dikumpulkan dari laman web Jabatan Perhutanan Semenanjung Malaysia (JPSM), Jabatan Perhutanan Negeri Kelantan (JPNK), organisasi bukan kerajaan (NGO) dan melalui pencarian laman web kemudian data yang dianalisis telah dibentangkan menerusi grafik bar dan peta titik panas dengan menggunakan Microsoft Excel dan ArcGIS Versi 10.3. Hasil kajian menunjukkan bahawa Gua Musang mempunyai kawasan yang paling banyak ditebang sejak 10 tahun lalu dengan jumlah keseluruhan 172,894 ha atau 2.11% diikuti Kuala Krai dan Tanah Merah masing-masing dengan 44,434 ha (1.95%) dan 14.824 ha (1.73%). Penemuan daripada kajian ini berguna bagi pihak penguasa perhutanan untuk menguruskan hutan di Kelantan.

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LIST OF ABBREVIATIONS

ESA	Environmental Sensitive Area
FAO	Food and Agriculture Organization
FDPM	Forestry Department Peninsular Malaysia
GHG	Greenhouse Gases
GIS	Geographical Information System
JPSM	Jabatan Perhutanan Semenanjung Malaysia
JPNK	Jabatan Perhutanan Negeri Kelantan
KSFD	Kelantan State Forestry Department
NGO	Non-Government Organization
PRF	Permanent Reserve Forest
SMG	Sistem Maklumat Geografi
TPA	Total Protected Area

LIST OF SYMBOLS

ha	hectare
%	percentage
^{o}	degree

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Tropical forest has been vigorously abused in the course of recent decades because of many factor to fulfill human needs (Ramankutty et al., 2008). The role of tropical rain forest is not restricted for producing timber but also for ecological security, erosion control and provision for numerous environmental needs and has generally added to the social financial improvement (Erwin, 2000). Losing of tropical forest has cause unfavorable effect towards the environment, including proliferate greenhouse gases emissions, losing of biodiversity and reducing other ecosystem functions such as carbon storage and water catchment area (Foley et al., 2007).

In 2016, forest covers in Peninsular Malaysia was 5.89 million ha, which cover about 44.7% of its land area. Out of this, 4.92 million ha falls under Permanent Reserved Forest (PRF), 0.58 million ha is Totally Protected Area (TPA) and the remaining 0.39 million ha belongs to state or alienated land (Hamdan et al., 2016). Oil palm and rubber plantations expansion has been discovered the most distinguished components that trigger forest loss in Peninsular Malaysia, especially in the states of Pahang, Terengganu, Johor and Kelantan (Hamdan et al., 2016).

Kelantan is one of the state in Malaysia that significantly lost their forest cover for the past decades. Forest in Kelantan are being destroyed at alarming rates. This results in loss of habitat in many flora and fauna and indigenous people which is from Temiar tribe that mostly was found in Kelantan lost their place to live.

GIS and remote sensing image analysis have helps people to see a clearer view about what happening to the earth's surfaces, particularly land use and land changes to detect deforestation area. Geographic Information System (GIS) is a computer application designed to collect, store, visualize, integrate, analyze and share the geographic information about location on or the surface of the Earth, with less time, cost and energy consumed (Goodchild, 1992). In this study, GIS application was used to determine deforestation in Kelantan.

1.2 Problem Statement

In Malaysia, the need for new dimension of land mapping is getting more important. The demand for storage, analysis, and display of complex and voluminous environmental data in recent years is increasing. Due to lack of data analysis and report done, this study was conducted in order to monitor and quantify the rate of deforestation in Kelantan. The data that was provided by Forestry Department Peninsular Malaysia (FDPM) was used to calculate the deforestation rates that happened in Kelantan. This study identified the need to synthesis what is known about areas of rapid land-cover change in Kelantan to evaluate how the provision of ecosystem goods and services has changed over the past few decades. Plus, this study was done to identify the current status of forest cover in Kelantan. A map of deforestation hot spot can be generated to see more clearly the changes of forest cover occurs in Kelantan.

1.3 Objectives

The objectives of this study were to:

1) To calculate the annual rates of deforestation in Kelantan.

2) To identify emerging deforestation in Kelantan using Geographical Information System (GIS) between years 2007 until 2016.

1.4 Scope of Study

This study focused on calculating the loss of forest cover that happened in Kelantan from year 2007 until 2016. Data was collected from Forestry Department Peninsular Malaysia (FDPM) website, Kelantan State Forestry Department (KSFD) website, non-government organization (NGO), and through website searching. Statistical data that was gathered then was analyzed by using Microsoft Excel. After that, using Geographical Information System (GIS) the map of the deforested area in Kelantan was produced.

1.5 Significant of Study

This study calculates the rate of forest cover changes in Kelantan from year 2007 until 2016. From that data and statistic gathered, a map of total deforested area in Kelantan was produced. The results could help in environmental sensitive area (ESA) and buffer zones protection and conserved form deforestation. The resulting map could give a clearer pictures of the condition of Kelantan forest to the public. Hence increase the awareness to the public to protect the forest in Kelantan. Moreover, from the map produced the rates of annual deforestation was determined. This deforestation trend can help to monitor and reduce the number of logging activities so that the natural resources will be conserved for future generations.

CHAPTER 2

LITERATURE REVIEW

2.1 Malaysia Forest

Between the tropics of Cancer and Capricorn, at 23.5^{o} north and 23^{o} south of the equator, the earth is in constant summer. The countries that lies within and around this equator include parts of North America, South America, Africa, Asia and Australia only have two seasons which is wet and hot throughout the year. Malaysia is one of the Southeast Asia country that have this kind of climate. Therefore, forest in Malaysia is known as tropical rain forest. Tropical rain forests have vast trees that are green all year because of the reliable amounts of rain that they get and the trees grow consistently throughout the year (Elias and Tobin, 2011). In Malaysia, forest can be define as land covering more than 0.5 ha with trees greater than 5 m and a crown cover of more than 30% or trees able to extent these thresholds in situ (FDPM, 2016). This perennial forest is profuse, inspirational, and endless source of new scientific breakthrough.

Tropical rain forest allows the tress to grow all year makes the trees in tropical rain forest very large (Ramankutty et al., 2008). Larger trees mean accumulations of biomass in the ecosystem. Biomass is made up from 50% of carbon, means the higher biomass in the forest the more carbon it holds. Tropical rain forests contain a lot of trees thus if the area was deforested, it will release an excessive amount of carbon in the atmosphere as carbon dioxide. Along these lines, the nations that deforested most of their rain forest can produce abnormal amounts of carbon emanations.

Based on 2016 Annual Report FDPM, Peninsular Malaysia has total land area of 13,184,629 ha of lands. From that number, total forested area that peninsular Malaysia had is 5,773,363 ha and the remaining 7,411,266 ha of lands is non-forested area. Permanent reserve forest (PRF) in Peninsular Malaysia is 4,924,153 ha and state land forest has total of 259,217 ha of lands.

For Kelantan, it has 812,196 hectares or about 53.8% of forested land and 698,304 hectares or 46.22% of non-forested land from a total of 1,510,500 hectares of land. It has 635,437 hectares of PRF, 166,842 hectares of forest plantations, 103,082 hectares of wildlife reserve and 73,677 hectares of state land forest. The area opened for logging is 2,625 hectares of land while 5,417 hectares of land was annual allowable cut for PRF.

2.2 Deforestation

Covering about 33% of the earth's land surface, forest giving numerous ecological advantage incorporating a significant part in the hydrological cycle, soil restoration, and prevention from environmental change and conservation of biodiversity (Sheram, 1993). Food and Agriculture Organization (FAO) (2011) states that the conversion of forest to another land use or the long-term reduction of the tree canopy below the minimum 10 % threshold. Deforestation is the transformation of forest to an alternative permanent non-woodland use towards farming area, pasturing area or city expansion (van Kooten and Bulte, 2000). Deforestation is predominantly a worry for the emergent nations of the tropics (Myers, 1994) as it is reducing the expanse of the tropical rain forests (Barraclough and Ghimire, 2000) causing biodiversity loss and decrease the environmental quality (Angelsen et al., 1999).

Forest loss is one of the factor that was calculated in land use change of every developing country (FAO, 2001; Achard et al, 2002; Defries et al, 2002). During the 1990s, forest cover changes were considerably incessant in the tropics than in alternate parts of the world.

2.3 Causes of Deforestation

Farmers, loggers, developers are some of the agents that facilitate deforestation (Chakravarty et al., 2012). These agents are forces by the causes of the deforestation that drives the agents to clear the forests.

Palm oil production has twofold than the past few decades, commanding the worldwide market for vegetable oil (FAO, 2011). Most palm oil is requiring substantial modern industrial plantations thus driving tropical deforestation in Malaysia and Indonesia (Saxon and Roquemore, 2011). Palm oil plantations are regularly accustomed on land converted from swamp forests. Depleting of wetlands means the peaty soils carbon-rich decompose, discharging substantial measure of harmful gases. Thus, the diversification of plantations onto fertilize soils is a significant source of the discharges that increase the temperature of the atmosphere.

Palm oil is a product from the fruits and seed kernels of the oil palm tree *Elaeis guineensis*, which is originated from West Africa (Greenpeace, 2007). This consumable oil is generally utilized for cooking in economically developing countries and in huge number of broadly utilized items in the food production, and in addition for cleansers, detergents, lubricants, and beauty care products. It was likewise has been created as a feedstock for biodiesel fuels. National markets in Indonesia, Malaysia, Nigeria, and Thailand addressed their own issues, utilize 24% of global yield. Since the essential buyer base in these locales is expansive and developing, significant diminishments in the generation of palm oil could possibly prompt higher worldwide consumable oil costs (FAS, 2010).

Malaysia was the first to rule the world creation of Integrated agro-industrial palm oil ventures besides than Indonesia. Tropical land involved by palm oil plantations expanded from about 1.55 million hectares in 1980 to about 12.2 million

hectares in 2009 (IFC, 2011). Throughout the years 1990 to 2005, no less than 55% of plantation development in Malaysia and its neighbor country, Indonesia require purposive deforestation (Koh and Wilcove 2008) while the transformation of essential woodlands to palm oil plantations represented in excess of 10% of deforestation in Indonesia and Malaysia in between year 1990 and 2010 (Koh et al., 2011). Palm oil plantation industry seen forest loss as a little compensation for the monetary advantages that the industry gives to countryside farmers and labors, and its contribution to the worldwide food security (World Growth, 2010).

Forest exploitation brings in money into the Malaysia economy as besides than oil palm plantation, timber harvesting produce RM 75 million per year, that what makes deforestation is hard to stop (Fisher et al., 2011). From an experiment conducted, it is estimated that all the process involved in producing palm produce 860 kilograms of carbon dioxide emissions (Chase and Henson 2010). That process has the similar measures of emanations discharged by copying 98 gallons of fuel burning (EPA, 2010).

Plantations are a one of the methods that can help in lessening the deforestation rate. The certainty that plantations evacuate a massive amount of timber from natural forests does not reduced the amount of deforestation rate, but instead into more deforestation. Without a doubt, it is expected that expansion of agricultural land is the fundamental drivers of forest loss in the tropics might substitute forestry in the remaining natural forests (Cossalter and Pye-Smith, 2003). The influence of timber plantations could thus emerge to be pretty damaging to tropical forest ecological communities (Kartodiharhjo and Griffiths, 1996).

Developing the country involved land to denote the infrastructures imperative to reinforce expanding community be made by deforestation (Mather, 1991; Sands,

2005). Tropical rain forests are the key factor of infrastructure expansion for fossil fuels exploitation or logging businesses which automatically emanate the diversification of the road system and the establishment of roads in untouched areas (Kaimowitz and Angelsen, 1998). The development of these infrastructure development is of global affect, considering tropical forest loss for approximately 20% of human-made carbon discharged annihilate worldwide remarkable carbon sinks and around 21% of tropical forests have been gone globally since 1980 (Bawa et al., 2004). For native society, the occurrence of evolution usually means the elimination or transformation of their traditional lifestyles and the interruption of their social institutions mostly with their deportation from their hereditary area (Schmink and Wood, 1992).

2.4 Impacts of deforestation

The transformation of current land use areas in Malaysia multiplied the greenhouse gases (GHG) productions and added the worldwide environmental revolution as the number of forest area decreasing (Hamdan et al., 2016). Forest is important because it bears food sources and produce useful products that can fulfil human needs and that what makes the forest in danger (Rolett and Diamond 2004).

Not only can intensify the accumulation of carbon dioxide, CO_2 in the atmosphere, deforestation also can change the global conversion of energy through the meteorological processes (Pinker, 1980). Carbon dioxide that was released from the deforestation activity acts as sponge in the atmosphere that absorbs thermal infrared radiation in the atmosphere thus affecting the temperature of the surrounding as the radiation was trapped on earth's atmosphere (Charney, 1975: Rowntree, 1988: Gupta et al., 2005).

Forest loss influencing local and global climate by affecting the wind flows, water vapor flows and absorption of the solar energy (Chomitz et al., 2007). It also disrupts normal weather pattern that will affect all living things on the earth (Lawton et al., 2001). Due to global deforestation, release of the roughly 2 billion tons of carbon dioxide which is equivalent to an estimated 25% was discharged from burning of fossil fuels (Asdrasko, 1990; Houghton, 2005)

Deforestation also affecting the worldwide water cycle (Brunjinzeel, 2004). Urban water protection is the potentially one of the most significant services that forest provides (Chomitz et al., 2007). Forests acts as a vigorous representative to filter the runoff or passively by exchanging for housing or farm that generate runoff (Dudley and Stolton, 2003). When the area is deforested, watersheds can no longer tolerate and regulate water flows from rivers and streams.

Forest especially tropical forest work as depository of biodiversity and subsequently deforestation, fragmentation and degradation destroy the biodiversity as a whole and habitat for migratory species including the endangered ones, some of which have still to be catalogued. About two third of every single known species was supported by tropical forest and it also contain 65% of the world's 10,000 endangered species (Myers and Mittermeier, 2000). The biodiversity of the forested area need to be preserve and conserve until more research can be done to study about the important of the various flora and fauna (Anon., 1994). These include local climate change comprising response outcomes that could hypothetically change rain forests into savannahs and the development of new viruses as the emerging trade in bush meat increases interaction between human and animals (Anon., 2005). Another negative consequences of deforestation are escalating in the number of events of human-wildlife conflicts striking hard the achievement of management in a way distance the people's involvement in conservation.

2.5 Application of GIS

An arrangement of apparatus for gathering, storing, regaining at will, converting, and presenting spatial data from the actual world for a specific set of resolutions (Burrough, 1998). Goodchild (1997) offers some useful concepts that help with the definition of GIS. Firstly, Geographical Information is information about places on the Earth's surface that include global positioning systems (GPS), remote sensing and geographical information system (GIS). Moreover, GIS are both computer system and software that have many different manifestations and used for a great variety of applications. Therefore, geographic information science is the science behind GIS technology.

Today, the growth of Web-based GIS applications, such as Google Earth and Google Maps, has meant that many people are using GIS technology every day. GIS applications can now be found everywhere and support a very diverse range of activities. (Heywood et al., 2011). Forest area that is most reachable to human are getting deteriorated due to land use patterns, urban strategy, roads development and other factors that related to the developments. The socio-demographic factors and the land utilization patterns are recognized and obtained from the remote sensing images using GIS application. By GIS application, as the support for planning and management, means a great step towards a greater capability of forestry administration.

CHAPTER 3

MATERIALS AND METHOD

3.1 Study Area

This research was carried out in Kelantan that is situated in the north-east of Peninsular Malaysia. Kelantan is located at 6.1254^{o} N, 102.2381^{o} E that is bordered by Narathiwat Province of Thailand to the north, Terengganu to the south-east, Perak to the west and Pahang to the south. Kelantan covers an area of 1.51 million ha from total of 13.18 million ha of Peninsular Malaysia (FDPM, 2016). From year 2016, total forested area in Kelantan are 812,916 ha and its total Permanent Reserve Forest (PRF) are 635,437 ha (FDPM, 2016). Kelantan consists of 10 districts which are Bachok, Gua Musang, Jeli, Kota Bharu, Kuala Krai, Machang, Pasir Mas, Pasir Puteh, Tanah Merah and Tumpat (Figure 3.1).

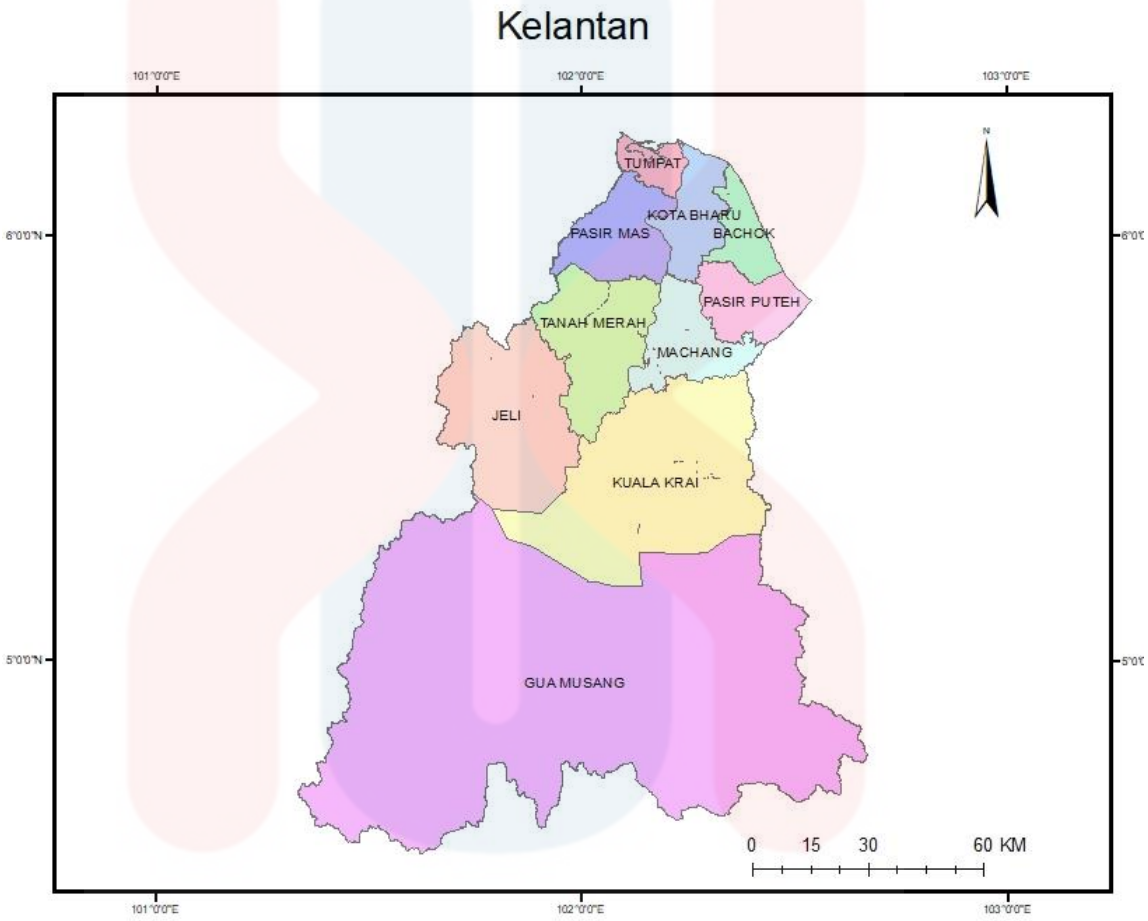

Figure 3.1: Kelantan with 10 districts.

3.2 Materials

3.2.1 Secondary data

Statistical data was collected and downloaded from Forestry Department Peninsular Malaysia (FDPM) website, Kelantan State Forestry Department (KSFD), non-government organization (NGO), and through website searching. The data retrieved was from year 2007 until year 2016. The data obtained was then used to analyzed the trend of deforestation in Kelantan. Some of the data that was gathered was total forested area, non-forested area, permanent forest reserved, annual allowable cuts, and total area open for logging. The raw data that have been analyzed then was calculated to get the annual rate of deforestation and its trend.

3.2.2 Analysis Software

Using raw data tabulated in Microsoft Excel, total deforested area, average, and percentage of deforested area were calculated. Based on the data, a map of emerging of deforestation in Kelantan was created using GIS software (ArcGIS v10.3) by ESRI.

3.3 Methods

3.3.1 Data Analysis

The number of deforestation area from year 2007 until 2016 was arranged and analyzed using Microsoft Excel. From the data gathered, total deforested area, non – forested area, PFR, annual allowable cutting and area open for logging was calculated to get the average, percentage and the trend of the deforested area for the past 10 years. Next, the latitude and longitude of location was exported into the ArcGIS software for mapping purposes.

3.3.2 Deforestation Mapping

The 10 years data of total deforested area was analyzed using IDW method in the Arc toolbox in ArcGIS software to produce a map of emerging deforestation hot spot in Kelantan. Graphs that shows the total forested area, PRF, averages and percentages of deforested area from the past 10 years were also calculated and presented. Figure 3.2 showed the flow chart of the study starts from data collection to end results.

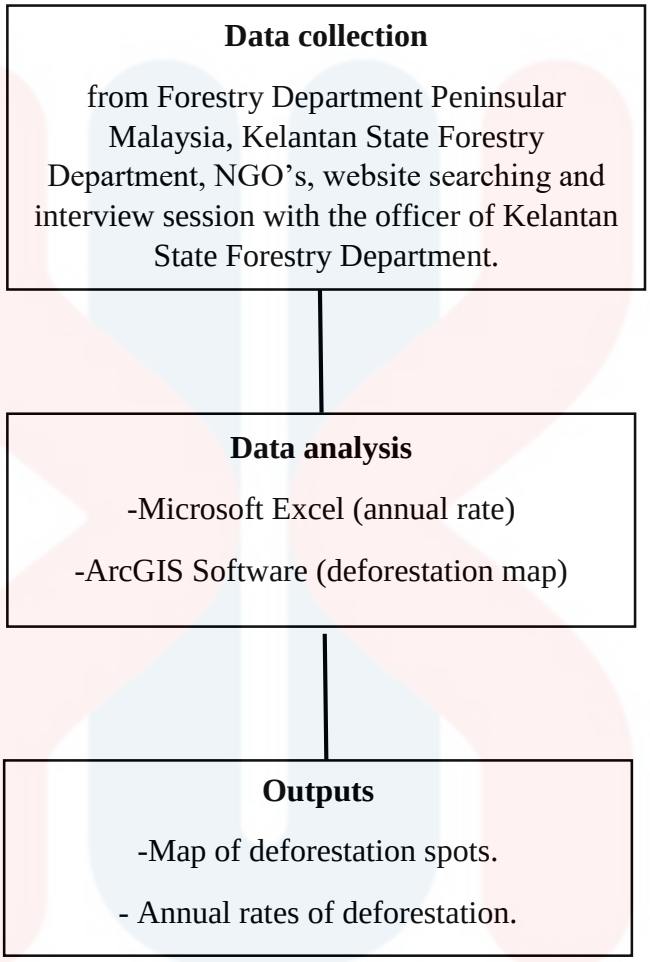

Figure 3.2: Flowchart of the study.

CHAPTER 4

RESULTS AND DISCUSSION

Based on the data collected, forested and non-forested area are shown in Figure 4.1.

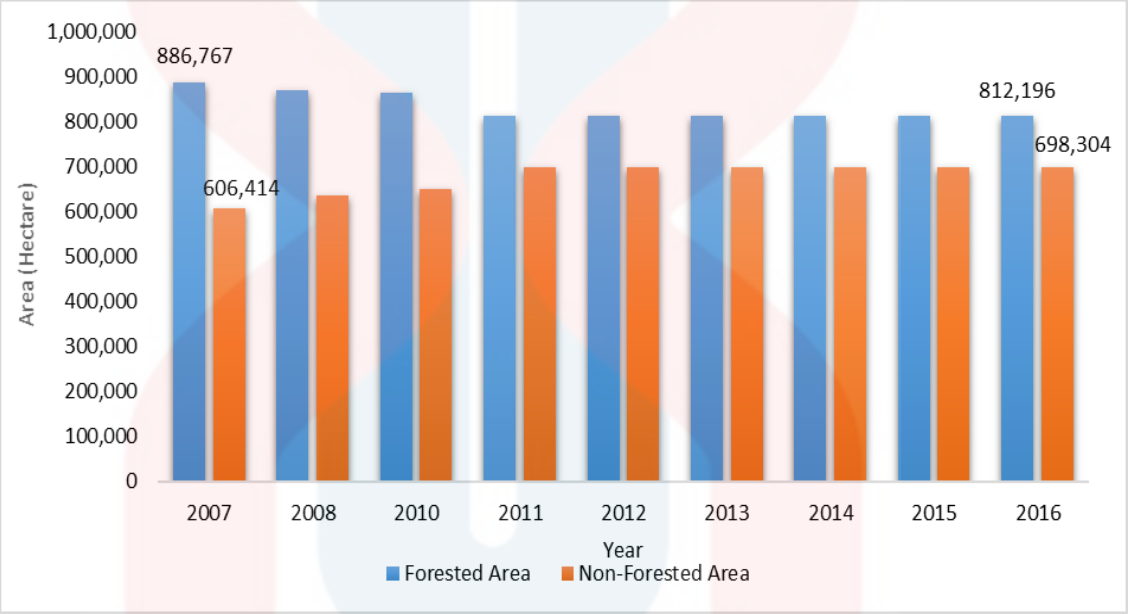

Figure 4.1: Total forested area in Kelantan.

(Source: Annual Report Forestry department peninsular Malaysia (FDPM) from year 2007 until 2016)

From the past 10 years, total forested area in Kelantan decline from 886,767 ha to 812,196 ha which is 8.4%. It shows that Kelantan lost 0.84% of its forest per year. Non- forested area increases from 606,414 ha to 698,304 ha or 15.15%. At year 2007 until 2010, forested land accounts declining from 886,767 ha to 862,196 ha. The percentage of the forested area for year 2007 was 59.4%, on 2008 and 2009 was 57.8%, and followed by 2010 with 57%.

The year 2011 is the beginning of the Tenth Malaysia Plan. Starting from year 2011 until year 2016, there is the constant forested area which is 812,196 ha of 53.8%.

Forested area decrease while non – forested area increase prove that deforestation in Kelantan is increases.

Out of the total forested area, there is a part of land that is called Permanent Reserve Forest (PRF).

Figure 4.2: Permanent Forest Reserve (PFR) in Kelantan from year 2007 until 2016.

(Source: Annual Report Forestry department peninsular Malaysia (FDPM) from year 2007 until 2016)

At the end of 2007, out of the total of forested area, 623,849 ha or 76.8% are PRF gazette under National Forestry Act 1984. From year 2007 to 2008, the number of PRF is declining by 0.93% from total area of 629,687 ha to 623,849 ha. The PRF constants from year 2008 until 2015 with a total of 623,849 ha of lands. At the end of 2016, the number rose by 1.86% which is from 623,849 ha to 635,437 ha of PRF.

In 2016 starts the Eleventh Malaysian Plan. Therefore, KSFD has implemented many programs, projects and forestry activities in accordance with the Malaysia development progress to achieve green growth through Strategic Thrust 4, namely Pursuing Green Growth for sustainability and Resilience. Management of PRF areas for water supply is one of FDPM seven key forest development projects. This explain why at the end of 2016, the PRF in Kelantan rose by 1.86%.

From the PRF, there is a quota for annual allowable cuts. Annual allowable cuts meaning the number of land that can be deforested from the total area of PRF for each year. While area open for logging means the area of land that can be forested from the forested area for each year.

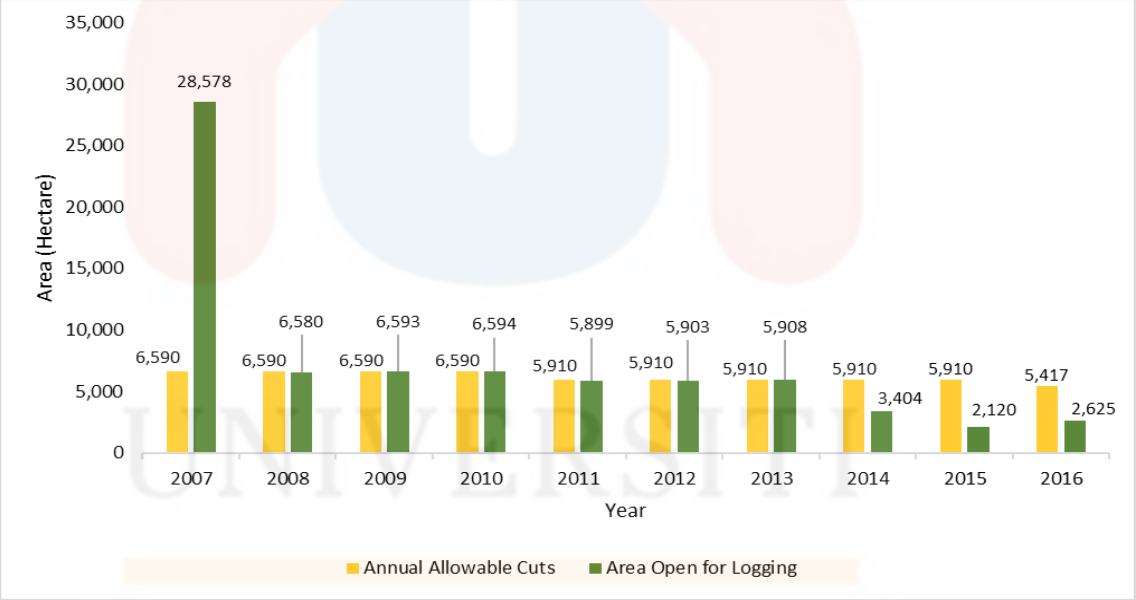

Figure 4.3: Annual allowable cuts and area open for logging from year 2007 until 2016.

(Source: Annual Report Forestry department peninsular Malaysia (FDPM) from year 2007 until 2016)

Annual allowable cuts were constant from 2007 until 2010 with 6,590 ha of lands. It starts decrease from 2010 to 2011 from 6,590 ha to 5,910 ha or 10.3%. it then

constants from 2010 until 2015. In 2016, it declines by 8.3% which is from 5,910 ha to 5,417 ha.

Area open for logging can be seen to decrease exponentially from year 2007 to 2008 which is from 28,578 ha to 6,580 ha or 77%. The difference of area opens for logging for 2007 to 2016 was 90.8% with the different of 25,953 ha.

To be more specific, the deforested area for each districts in Kelantan was shown in Figure 4.4.

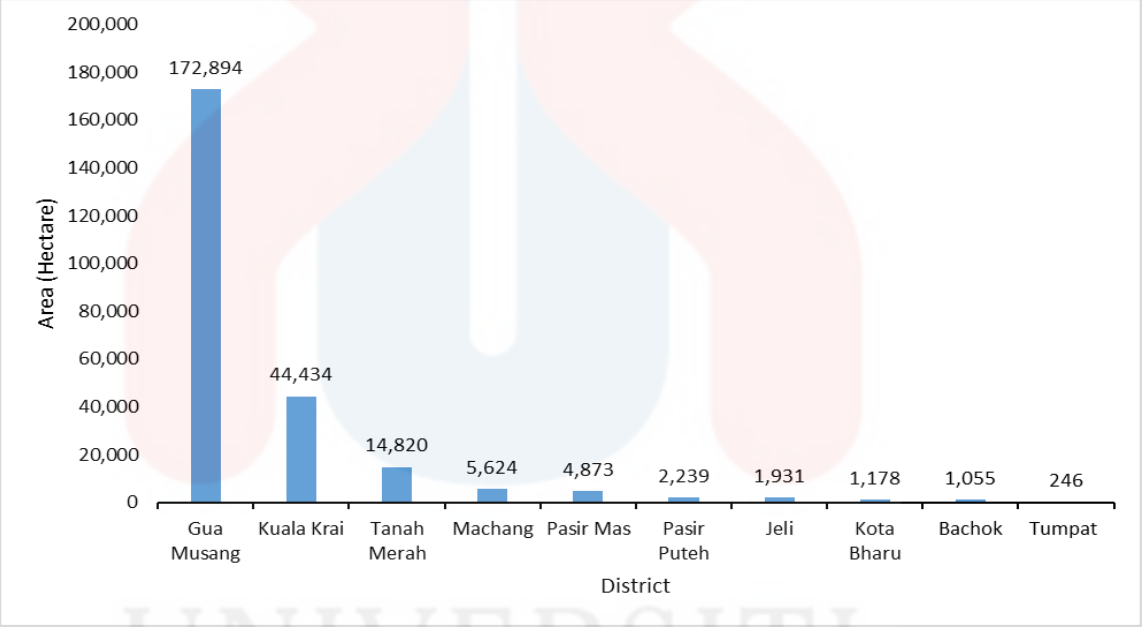

Figure 4.4: Total deforested area of each district from year 2007 until 2016

Gua Musang is the largest district in Kelantan with a total of 816, 725 ha. It shows the most deforested area from the past 10 years with a total of 172, 894 ha or 2.11% of land followed by Kuala Krai and Tanah Merah with 44, 434 ha or 1.95% and 14, 824 ha or 1.73% respectively.

Next, the data was manipulated in ArcGIS software to get a map of emerging deforestation in Kelantan. By using the IDW method in ArcGIS. The map produce is shown in Figure 4.5.

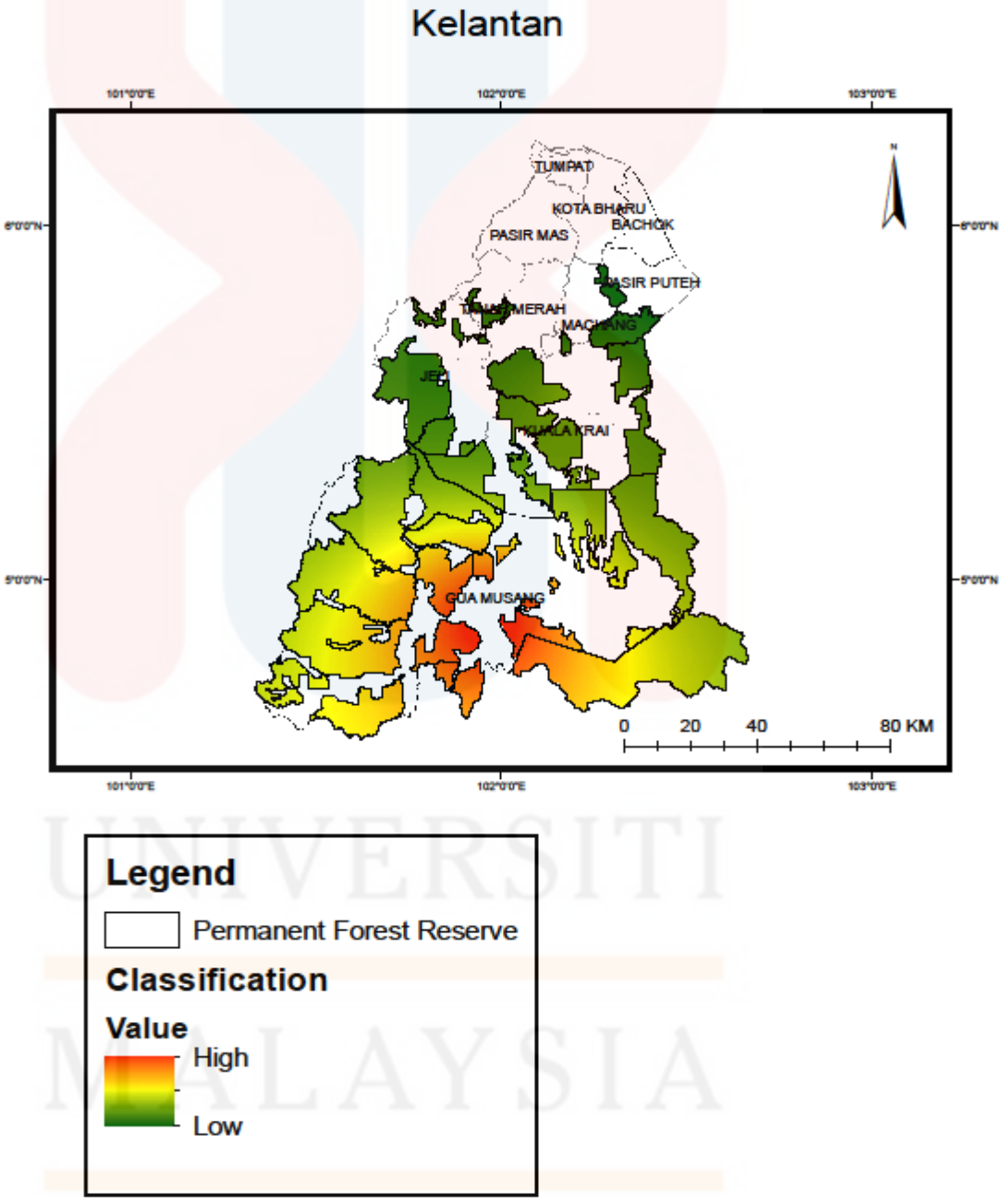

Figure 4.5: Deforestation in Kelantan.

Kelantan loss an average of 46.23% of forest from year 2007 until 2016. As shown in the map above, the most deforested area is Gua Musang followed by Kuala Krai, Tanah Merah, Machang, Pasir Mas, Pasir Puteh, Jeli, Kota Bharu, Bachok and Tumpat. Gua Musang is the largest district in Kelantan with a total area of 816,725 ha which is it was the most deforested area. Gua Musang is expected to be explored for its forest sources since it still has a lot of forested area than other districts.

Tumpat and Bachok have a mangrove forest which is why it has the smallest number of deforested area. Mangrove forest is one of the protected area in Malaysia as it acts as the protection for the coastal area from waves that can erode the soils.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The integration of GIS applications could help in analyzed the emerging of deforestation hot spot in Kelantan from year 2007 until 2016. This study showed that, from year 2007 until 2016, total forested area in Kelantan declining from 886,767 ha to 812,196 ha which is 8.4%. differences. Non- forested area inclining from 606,414 ha to 698,304 ha or 15.15%. PRF from year 2007 until 2008 decreasing from 629,687 ha to 623,849 ha and it is constant until year 2016 it starts to rose to 635,437 ha. For annual allowable cuts and area open for logging shows decreasing pattern which is from 6,590 ha to 5,417 ha and from 28,578 ha to 2,625 respectively. To be more notably, Gua Musang was the most deforested area followed by Kuala Krai and Tanah Merah with 172,894 ha, 44,434 ha and 14,480 ha respectively.

5.2 Recommendations

The study of emerging deforestation hot spots plays vital role as the forests plays an important role to keep the environmental functions. Sustainable forest management and good practices can be done to ensure the sustainability of forest in Kelantan. Each hectare of forest that was cut down for its timber need to be replanting of another trees. Besides, the authorities need to be more alert with the existence of illegal loggers in Kelantan forest.

In order to improve this study, it was suggested that remote sensing analysis is included to obtain a higher accuracy results about the emerging deforestation hot spots in the future.

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APPENDIX A

ACTIVITY

Data Gathering	Start: 20th July 2018 Finish: 31st October 2018
Data Analysis	Start: 15th October 2018 Finish: 8th November 2018