GEOLOGY AND A STATISTICAL COMPARISON STUDY ON FLOOD EVENTS IN KUALA KRAI, KELANTAN

by

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

FACULTY OF EARTH SCIENCE

UNIVERSITI MALAYSIA KELANTAN

2021

DECLARATION

I declare that this thesis entitled "Geology and a Statistical Comparison Study on Flood Events in Kuala Krai, Kelantan" 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 : _____

Name : _____

Date : _____

APPROVAL

I/ We hereby declare that I/ we have read this thesis and in my/our opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Applied Science (Geoscience) with Honours.

Signature :_____

Name of Supervisor :_____

Date :_____

ACKNOWLEDGEMENT

Alhamdulillah's and praise for Allah Almighty. Peace and blessings be upon beloved Prophet Muhammad leaflets bearing the revelation to illuminate be universe, the companions, his family, all the scholars and lovers of Islam throughout the world.

Firstly, I wish to thank Allah for giving me the opportunity to embark on my final year project and for completing this long and challenging journey successfully. My gratitude goes to my supervisor Dr. Hajah Marinah Binti Muhammad, for her patient on me.

My appreciation goes to the Department of Irrigation and Drainage (DID) for given me the data on five station in Kuala Krai. Next, flood victim which based on the residential location in Kuala Krai, Kelantan for giving me the opportunity to interview respondents among the villagers.

Special thanks to my friends for helping me with this study. Finally, this thesis is dedicated to my family members. All your kindness and contributions during my study can only be pay by the Almighty.

GEOLOGY AND A STATISTICAL COMPARISON STUDY ON FLOOD EVENTS IN KUALA KRAI, KELANTAN

ABSTRACT

Kuala Krai is among the location that badly affected by the flood. Especially in year 2014, the geohazard of flood is vigorously and this study area is chosen because of this event. Before a statistical comparison study on flood events in Kuala Krai starting from 2014 until 2019 has been done, the geological map of the study area in Dabong, which in consisted of the certain area in Dabong, Kuala Krai has been developed. The updated geological map with the scale of 1: 25 000 has been produced by analysing the data using the ArcMap and Google Earth By using Geographical Information System (GIS) and collected data from previous research and geology company. The methods used during making the map is Analytical Hierarchy Process (AHP). In addition, analysis of the structure and geomorphology of the study area is also done through data collected. The study areas identified were metamorphic rocks, sedimentary rocks, igneous rocks and alluvial soils. Next, the secondary rainfall data starting from year 2013 to 2019 from five DID stations in Kuala Krai has been analysed spatially and temporally. By making the map of certain area in Kuala Krai by using Geographical Information System (GIS) and collected the data from Drainage Irrigation Department (DID).From the map that been created, there will be known the rainfall intensity in Kuala Krai. Hence, based on residential location of flood victim in 2014, the survey study has been conducted to collect the information regarding flood events in 2014 and following years until 2019. The collected flood events information has been analysed to identify their correlation with the rainfall intensity. The results show that the amount of rainfall and the structure of topography in Kuala Krai influence the flood event to occur.

GEOLOGI DAN KAJIAN PERBANDINGAN STATISTIK

TERHADAPBANJIR DI KUALA KRAI, KELANTAN

ABSTRAK

Kuala Krai adalah antara lokasi yang terjejas teruk kerana berlakunya banjir. Pada tahun 2014 terutamanya, berlaku geohazard banjir dengan banjir yang amat besar dan kawasan kajian ini dipilih kerana peristiwa ini. Sebelum kajian perbandingan statistik mengenai kejadian banjir di Kuala Krai bermula dari tahun 2014 hingga 2019 telah dilakukan, peta geologi kawasan kajian di Dabong, yang terdiri dari wilayah tertentu di Dabong, Kuala Krai telah dihasilkan. Peta geologi yang dikemaskini dengan skala 1: 25 000 telah dihasilkan dengan menganalisis data menggunakan ArcMap dan Google Earth Seterusnya, menggunakan Sistem Maklumat Geografi (GIS) dan mengumpulkan data dari syarikat penyelidikan dan geologi sebelumnya. Kaedah yang digunakan semasa membuat peta adalah Proses Hierarki Analitik (AHP). Selain itu, analisis struktur dan geomorfologi kawasan kajian juga dilakukan melalui data yang dikumpulkan. Kawasan kajian yang dikenal pasti adalah batuan metamorf, batuan sedimen, batuan igneus dan tanah aluvial. Seterusnya, data hujan sekunder mulai tahun 2013 hingga 2019 dari lima stesen JPS di Kuala Krai telah dianalisis secara spasial dan temporal. Dengan membuat peta kawasan tertentu di Kuala Krai dengan menggunakan Sistem Maklumat Geografi (GIS) dan mengumpulkan data dari Jabatan Pengairan Saliran (JPS). Dari peta yang telah dibuat, akan diketahui intensiti hujan di Kuala Krai. Oleh itu, berdasarkan lokasi kediaman mangsa banjir pada tahun 2014, kajian tinjauan telah dilakukan untuk mengumpulkan maklumat mengenai kejadian banjir pada tahun 2014 dan tahun-tahun berikutnya hingga 2019. Maklumat kejadian banjir yang dikumpulkan telah dianalisis untuk mengenal pasti hubungannya dengan intensiti hujan. Hasil kajian menunjukkan bahawa jumlah curahan hujan dan struktur topografi di Kuala Krai mempengaruhi kejadian banjir.

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CHAPTER 1

INTRODUCTION

1.1 General Background

Field study under Geoscience is very broad that includes general geology and geohazard that cause by hydrogeology. Geology can be defined as the knowledge of physical matter that makes up the earth, materials of the earth, all its geomorphological structures, the processes that contributes to the formations, movement and its change is any water flow that in any part of the river system dominates the natural or artificial banks (Ching et al., 2013). Generally, when a river bank is overtopped and the water extends over the flood plain flooding will cause danger to society.

On the other hand, flood which is cause because of disaster in hydrogeology discusses about the interconnections between geological processes and how it affects water. Since students were not allowed to go for field mapping the research has to be completed based on secondary data. There is another issue here as the information found on internet sources and previous studies were from some time back and not very updated.

Geologic mapping is a profoundly interpretive, science procedure that can create a scope of maps to show different features of geology including surveying on the topography and landform (Soller,2014). It is additionally basic for all work to be performed inside a geological data framework called geographical information system (GIS) so as to guarantee that input imagery and deciphered data sets keep up the equivalent geographical coordinate system. Primary input data utilized for geomorphological planning incorporate satellite imagery, DEMs and aerial photos (Smith, 2011).

Flood, is any water flow that in any part of the river system dominates the natural or artificial banks (Ching et al., 2013). Generally, when a river bank is overtopped and the water extends over the flood plain, flooding will cause danger to society.

In Kelantan, majority of the resident are highly exposed to the floods. In particular, from November to March is the northeast monsoon seasons occurred. Hence, flood have been recorded in the state every year over the decade. There is small floods and large flood. After 2014, there is small flood which is occurring every 2-3 years on average compare to large floods are generally less frequent.

Kuala Krai is considered to be one of Kelantan's flood prone areas because almost every year this area is struck by floods. This is because of the geographical condition. Kuala Krai is situated in Kelantan, which is close to the South China Sea coast. The topographic region is characterised by simple topography. With just 68 feats as the minimum elevation, 919 feats as the highest elevation and 2017 feats as the average elevation.

Flooding in Kelantan has been changed since 2014. In the last century, a small flooding event was reported. The flood lasted just a few days in a short period of time,

with significant heavy rainfall from 30 December to 2 November2016. The rivers were not reaching the amount of risk. In addition, Kuala Krai is situated close to the bank of the river.

The deadliest and greatest flood of the decade took place in 2014. There is an extreme, constant cycle of rainfall. It began between 14 December and 19 December 2014. Thus, the river surpassed the level of danger on December 17,2014. The 2014 record-setting flood was a 'tsunami-like tragedy' that effected 202,000 victims (Baharuddin et al., 2015).

Effective strategies and procedures have to be created to detect flood hazards. In this scenario, the statistical approach can be used to help reduce the water level in the flood factor in response to catastrophe risk declines within populations living in residential floods. This is because flooding has been one of the most frequent natural hazards and flood disasters, leading to catastrophe damage and devastation (Soh et al.,2017).

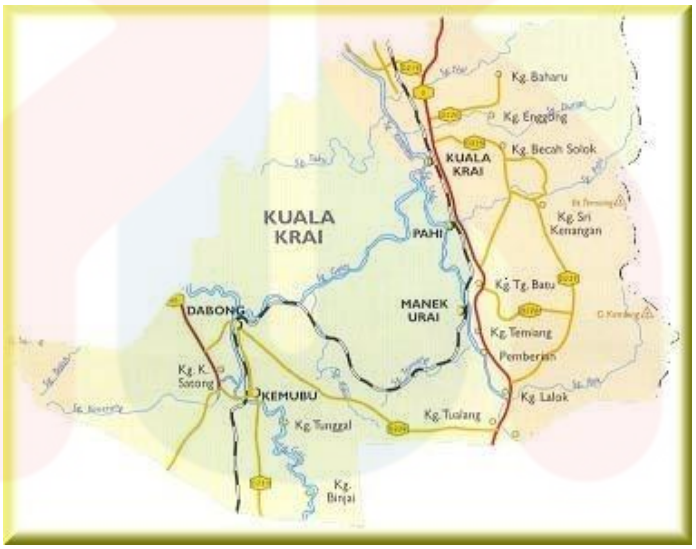
1.2 Study Area

1.2.1. Location

Kuala Krai is the one of the districts of Kelantan. The total of districts in Kelantan is 10. In Kuala Krai, there is the Sungai Kelantan. Kelantan is located in the east Malaysia, Peninsular Malaysia. The area Kuala Krai has consisted of the high area or low area. The coordinate of the Kuala Krai: 5.5406 ° N, 102.2014° E.

Mostly the high areas of Kuala Krai are such as mountain and hill. The elevation of magnitude is high there. There is always vegetation and plantation there. The forest in the high area is being called by the name of tropical rain forest.

The low-lying areas are neared by rivers. The river is come from the combination of the two rivers. The names for two rivers are the Sungai Lebir and Sungai Galas. When both are joins in, it is being calls Sungai Kelantan. These two rivers are the main river that gives effects the river in Kuala Krai. Figure 1.1 shows the location of the study area which show the area in Kuala Krai.



(Sources: JUPEM)

Figure 1.1: Location of study area in Kuala Krai

1.2.2 Road connection / accessibility

The road connection in Kuala Krai is good condition. Previously and now, the roads in small village or in the town are very easily to out. Highway. The street interfaces with a few little. streets like the residential locations, oil palm plantation and forest areas. There are three main roads to reach Dabong which can be used to get to

this area. The Batu 30 road, Paloh Raya road and Kg Bedal-Kuala Hau road are the three main roads that can be reached via Tanah Merah and Pasir Putih via Machang to Kuala Krai road. Next, highway Kota Bahru to Gua Musang is the main road in the constituency, going in the north-south direction. For west part, it goes to Jeli. There is the public transport. The public transport such as the train, taxi and buses.

1.2.3 Demography

The study area is located in Dabong, which part of the Jeli district. According to the Official portal of Dabong District Council, the total population of the area were 120,400 people which the highest amount of data recorded. Each of the population was divided by ethnic which are Malay, Chinese, India, Orang Asli and others. The percentages of Malay are 96.7%, Chinese 1%, 0.2% India, Orang Asli 0.1% and others 0.04%. Dabong area was dominated by Malay residential. Figure 1.2 show the People distribution according to race in Jeli, Kelantan.

In 2010, Jeli has a population of 89,118 people. Figure 1.2 shows the detailed people population based on ethnicity, in Jeli by year 2010, and people. The total people population in Jeli is roughly about 33,186 that consists of Bumiputera (Malays and other Bumiputera), Indians, Chinese and others according to the Department of Statistics Malaysia (2010).

There are approximately 31,606 Malays in Jeli district that symbolises it as the main ethnic group. Next, is followed by the Bumiputera clan with about 520 people, 91 Chinese, 58 Indians and other races of around 21 people. Furthermore, there are also about 890 foreigners staying in Jeli district. Population according to gender by

year 2010. The population data of Kelantan is getting it from website Department of Statistics Malaysia.

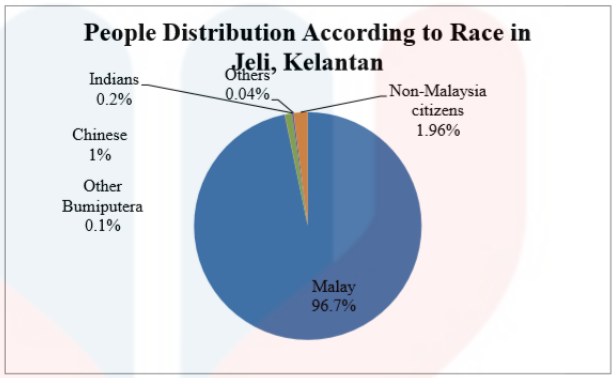


Figure 1.2: People distribution according to race in Jeli, Kelantan.

1.2.4. Land use

In Kuala Krai, is known by the plantation area. The plantations are the rubber plant, palm oil plant and according Tuan Pah Rokiah & Hamidi (2016) showed that the growth of land use in the Kelantan basin for 1984 is less diversified or, in other words, it is not complex where only few patterns of land use are classified as rubber, coconut, oil palm, vegetables, etc. The trend of land use development is moderate in order to demonstrate that the barrier to growth in the area of the Kelantan Basin was not as vibrant as in the 1980s.

It involves in a big scale. Large-scale agricultural operations, including rubber, oil palm and agriculture, have resulted in technological advances. Several areas of forest reserve and rubber plantations were cut down and replanted, as well as existing palm oil. This makes the change of the geomorphology. This is one of the factors for flooding to occur frequently.

1.2.5 Social Economic

The citizen mostly is involved in plantation which is in estate or rubber estate. The location of our study area at palm plantation area. The citizen mostly focused on the oil palm plantations which one of their source incomes. Next, as observed there are farmers who are involved in reaping the harvest in palm plantation and as well as the rubber plantation.

1.3 Problem Statement

The geological data in the study area has fewer geomorphological information. The updated geologic maps of the study area can be produced through geological mapping and observation.

Heavy rainfall brought by the Northeast monsoon starting from November to March every year is the main caused of flood in some places of Kelantan including Kuala Krai. It is categorized as annual flood as it occurs every year during Monsoon season which caused a lot of damage. Although every year Kuala Krai is hit by floods, the level or condition of floods is different.

In the last 100 years, there have been four major floods that hit Kelantan which is happened in 1926, 1967, 2004 and the most recent was in 2014. Most of Kelantan major historical flood events occurred were related to the north-east monsoon season which carries abundant of rainfall to the east-coast and Kuala Krai was badly affected area.

Records were also reported to on heavy rainfall amount and events have an increasing trend. Therefore, it is important to relate current flood events to historical

rainfall record to provide facts on the rarity and the extreme level of the rainfall causing floods. This study attempts to response to this issue through a statistical comparison study of flood events in Kuala Krai and following years and identify the relationship between flood occurrence and rainfall intensity.

1.4 Objective

The main aim of this study is to gather the primary data of 2019 flooding in Kuala Krai based on primary flooding data collected in 2014 due to the Kelantan Big Yellow flood event. Two objectives from this main aim have been developed for this study which are: -

1. To update the geological map of the study area in Dabong, in scale 1: 25,000.
2. To spatially and temporally analyse the rainfall distribution in Kuala Krai from year 2013 to 2019.
3. To determine the relationship between flood occurrence and rainfall intensity.

1.5 Scope of Study.

The research focused on the flood event in Kuala Krai from year 2014 to 2019. The studied involves fifty respondents from the Kuala Krai that were also Kelantan big yellow flood event victims. These survey sampling also focused on the certain location in the Kuala Krai. The locations that are involved such as Sungai Durian, Kubang Lebur, Aur Duri and some other chosen area.

From face to face interview the accurate situations and data of flood events of the mentioned year was gathered. The comparative analysis of those mentioned years

of flood events was intended. This study also involved analysed on secondary data from DID. The rainfall data of five stations in Kuala Krai from year 2013 until 2019 are gathered and spatially and temporally analysed using ArcGIS and SPSS. From those analysis the relationship between flood events and rainfall intensity then identified.

However, to full fill as a geoscience student, one of the areas in Dabong, Kuala Krai has chosen and it was covered about 5 km X 5 km per square as the study area. The coordinates for this study area are 5° 27’34’’ N, 5°25’ 0’’N,101°56’30’’ E and 101°53’30’’E. Dabong is also being called as Kuala Krai Selatan. The size of Dabong is as same as a small town.

1.6 Significant of Study

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter will discuss on the introduction, regional geology and tectonic setting, stratigraphy, structural geology, historical geology and research specification. This chapter discusses the literature review of a previous study conducted in the area surrounding the study, or a similar study used by previous researchers. The objective of the review of the literature is to justify the methodology and procedure to be used for the purpose of this study. This covered the regional geology including the Dabong area stratigraphy and structural geology with a specification. The regional geology was summarizing about Peninsular Malaysia including geomorphology, structural geology, stratigraphy, lithology and topography and its history. This section will clarify about materials and techniques had done in previous research in order to accomplish the research targets.

2.2 Regional Geology and Tectonic Setting

Mostly in the Peninsular Malaysia, the Triassic Indonesian orogeny is one of the tectonic setting. This an extension post-dating orogenic event.

Dabong which is a part near from the Gua Musang. Therefore, it has the similarity on the regional geology and tectonic setting Gua Musang. The sediment in the northern Peninsular Malaysia. This is proven on the build -up subsequent of the Indonesian orogeny. Tectonically, certain portions of the Sunda Shield which is shaped by Peninsular Malaysia consists of Borneo, Sumatra and Java including mediating shallow oceans from which various little islands were developed (Raj, 2009).

The regional geology of Kelantan comprises of a central zone of sedimentary and metasedimentary rocks encompassed on the west and east by stones of the Main Range and Boundary Range individually (Goh et al., 2006). In Dabong, the granitic rocks and a few enclaves of sedimentary or potentially metasedimentary rocks for the most part secured the range (Adriansyah et al., 2015). Dabong area is situated in the Kelantan state, explicitly at Main Range, the foundation of Peninsular Malaysia.

2.3 Stratigraphy

Stratigraphy is involved studying about the strata and layering (stratification) of rock layer. This part divided to the several subfields such as lithostratigraphy, biostratigraphy, sequence of rock, and chronostratigraphic.

Stratigraphy is the most concerned will focused about the sequence of lithology of the study area and deformation formed due the formation occurs. Research area consists of rocks from Permian until Triassic.

Stratigraphy in Dabong is Permo-Trias formation composed of main several rock which extended to North Kelantan and North Pahang (Shafeea,2004).

There is the volcanic rock. Recently, the layering involves of the alluvium, slate and granite. The reassess the usage of the informal ‘Gua Musang Formation’.

This is help for the future rank elevation, formalisation and clearer understanding on the stratigraphy in Dabong.

Telong formation are mainly argillite associated with some tuffs in southern Kelantan's Aring River area. It spreads westward into the Gua Musang Formation. Hence the stratigraphy of Dabong is very similar towards the Gua Musang formation. The term was named after the rock sequence in the Sungai Aring area, Kelantan, along a portion of the Sungai Telong. by Aw (1990). The Telong formation consists primarily of metasementary rocks of argillite, low grade, and metavolcanic rocks.

The Gua Musang formation in South Kelantan – North Pahang was mapped to describe Middle Permian to Late Triassic argillite, carbonate, and pyroclastic/volcanic facies within Gua Musang area (Yin 1965).

According to Welbourn (1917), the primary peninsular volcanic rocks are present in Kelantan and Pahang, thus the earlier name is 'Pahang Volcanic series. They consisted of dominantly pyroclastic, agglomerate with minimum lava flow and tuff. The magma composition varies from acidic to intermediate types

The iron ore basically occurs on or near the crest of the north-south which in Dabong aligned ridges, and, where undisturbed by precious mining, takes the form of massive outcrops and the large boulders (MacDonald, 1967).

The Telong Formation, where this is absent, are unconforming overlaid. The type locality along the Relai River and Nuar River is a tributary of the Lebir River. (Khoo, 1983).In south Kelantan, the Aring Formation is predominantly pyroclastic sequence.

An age ranging from late Carboniferous to early Triassic is indicated by fossil evidence. The total formulation thickness is 3,000 metres and the top portion of about

1,000 meters, interbedded with slate, tuffaceous limestone, limestone, is designated as the Paloh member.

2.4 Structural Geology

Structure in Dabong would be analysed based on satellite imagery. With the satellite imagery the kind of the structure can be analyses and interpret. There are such as fault and joint. Structural geology studies about any geological structures that was shaped during the rock formation.

There are numerous elements that add to the development of structural geology, for example, tectonic activity, the energy forces, sediment deposition and others. The structural geology can take place either before the development of rocks, during and after the rock formation. Structures happen in various settings and have encountered numerous changes in strain and stress.

There are structures represent the discontinuities of rock mass (Hutchison and Tan, 2009). Primary and secondary geologic features are noticeably found in the central and Northern Kelantan. The most dominant geologic structures are beddings, dykes, veins, joints, folds and brecciation. There are many factors contributing to the formation of structural geology such as the tectonic process, the deposition of sediments and the stress caused by the earth's energy.

According to (Mazlan *et al*. (1999a), the regional gravity and structural analyses concludes the axial deep of Malay basin continental crust is around 25 to 30km thick and was formed during early Tertiary crustal extension because of strike-slip movement following a major shear zone trending NW-SE. crustal extension are normal faults and also half-graben features.

Lineament is a simple or complex linear feature that can be mapped, whereby the parts are arranged in a rectilinear or curvilinear form and said to be reflected by a subsurface phenomenon (O' Leary *et al*., 1976). Based on Shake and McHone (1987), lineaments are straight or gently curving features found at the surface of Earth.

There are two main types of lineament which is positive and negative, referring to ridge trends and river valleys respectively. The slightly curved and sub-parallel lineaments indicate foliation or bedding trends, depending on rock type (crystalline or limestone) while circular features may delineate ring dykes (Koch and Mather 1997)

Structural of Kelantan are boundary by olistostrom in the west and Lebir Fault Zone in the east. Gua Musang Formation is mainly separate in Kelantan. Main fold of Gua Musang

2.5 Historical Geology

Historical geology is known as the study of geological history of the earth that happened many years before. it is essential to understand the historical geology of the study area as all the geomorphological land forms and geological processes that modified the earth is said to be occurred in the past as well as in the present and even future (Skinner et al., 2002).

Kuala Krai is the district that involved in of the Gua Musang formation. The distance location of Kuala Krai to Gua Musang is 115.9 km. Hence, Kuala Krai and Gua Musang are not impossible to have the same kind properties of the rock.

It is also related to the Principle of Uniformitarianism that says the present is the key to the past. Similarly, in this research the geological hazard events and land

forms found at Dabong and Kuala Krai areas are definitely believed to be related to pre-historic ages.

Kelantan lies on Peninsular Malaysia 's Eastern Belt. The sediments range from Carboniferous to Permian age, and are distributed from east Kelantan through Terengganu and east Pahang to southeast Johor. In the central of upper Paleozoic rock are Gua Musang and Aring Formation at south, while Taku schist at east, and south are the Raub group in west Pahang (Hutchison, 2009).

2.6 Research Specification

In last decades, in flood event generated by climate changes which during December until March because the monsoon change bringing the rainfall (Ranzi et al., 2002). In Kuala Krai, the heavy rainfall in certain month creates the flood. In Coimbatore, India, many researchers use on rainfall analysis using GIS software to performed spatial analysis of rainfall variation using GIS (Bhargava,2013). They analysed variation of monthly rainfall, mean annual rainfall. In Kuala Krai, five data from Department of irrigation and Drainage (DID) were analysed.

According to Yusop et al. (2018), understanding the duration of the flood and the flood depth will show the characteristics of the flood occurrence. The flood duration can be determined by understanding the flood depth of the rainy day by the distribution and collecting data from the questionnaires. The analysis of the flood case by questionnaire sampling in China in Jingdezhen City notes that the flood feature must be taken into account in order to minimize the bad impact of the flood on the residential location.

In this research project, the case of flooding depends on the occurrence of rainfall. This is also the goal of recognizing the cause of the flood in Kuala Krai. It is necessary to know the cause of the flood and it is possible to minimize the risk of flood-related hazard effects and increase awareness of the flood. (Mileti, 1999; 2007, Merz, et al.).

In Switzerland, flood depth is a measurement to get known about the damaged that create by the flood (Pistrika &et all, 2014). In Kuala Krai, the residential location by the face to face interviewed, the flood depth is measured and the calculation for flood damaged can be measured.

Information on the temporal and spatial distribution of rainfall is important for a variety of applications in hydrology and water resources management (Campling et al. 2011). The five-station data are analyse by using the SPSS and map was created by using Google Earth.

In Malaysia which have the Peninsular and Borneo area, both which being called by the winter season when it come the December and November month which the heavy rainfall occurred (Chen & et al., 2013). Hence, Kuala Krai is the area which located at the peninsular Malaysia.

The World Meteorological Organization (WMO) the data of heavy rainfall is being collected and being using the spatial data. The peninsular Malaysia location showed that the distribution of the heavy rainfall is the main caused for the flood during the November until December.

By using the GIS, the map of spatial can be created in England, the map shows the location of the heavy rainfall crate the prone area of flooding (Alexender&etall.2014). Through the GIS the map of the three Mukim is create the comparison on the flood residential location is being created.

According to Khalid et al. (2015) assessed the effectiveness of Early Warning System in Cameron Highland flood disaster which is occurred in 23 October.2013. The responses from flood victims affirmed that the Early Warning System was alert them for occurring flood event. Hence, for the preparation of the flood event in Kuala Krai must has the Early Warning System.

Soil type will help to determine how much water receive by the Certain soil types such as sandy soils are very free draining and rainfall on sandy soil is likely to be absorbed by the ground. However, soils containing clay can be almost impermeable and therefore rainfall on clay soils will run off and contribute to flood volumes. Mostly in Kuala Krai the soil is clay. It contributes to flood easily because of kind of soil.

Land use will contribute to the volume of water reaching the river, in a similar way to clay soils. Rainfall on roofs, 35 pavement and roads will be collected by rivers with no absorption into groundwater (Vishwas et. al, 2002). This also create the flood in year 2014. The land use without any good management occurred in this area.

The clearing of land for agriculture in some areas of Ulu Kelantan has caused many trees to be cut down, resulting in the loss of 'natural fortress' (Hamzah, 2015; Mohmadisa, 2016). Furthermore, in hydrological processes, the emphasis of opening a forest to the idea of one type of plant or 'monoculture' does not replace the functions of tropical forest plants (Mohmadisa et al., 22 2016). The amount of water that not intercepted by the plant will fall to the ground and so are the flow line of the trees. Hence, the water accumulates and the flood occurred.

From the Drainage Irrigation Department (DID) state that the floods are considered to be the worst flood disaster that continues to terrorize up to Kuala Krai, resulting from combined water from three rivers that meet in Kemubu, Kuala Krai, which forms Sungai Kelantan, Lebir, Nenggiri and Galas River.

Floods in Peninsular Malaysia are also caused by surface factors such as low-lying topography, poor drainage system and design, coastal areas located below high tide level and the loss of natural retention areas resulting from urbanization (Sathiamurthy et al., 2007). Mostly, in Manik Urai the topography in that area is low – lying area and near to river.

In last decades, in flood event generated by climate changes which during December until March because the monsoon change bringing the rainfall (Ranzi et al., 2002). In Kuala Krai, the heavy rainfall in certain month creates the flood. In Coimbatore, India, many researchers use on rainfall analysis using GIS software to performed spatial analysis of rainfall variation using GIS (Bhargava,2013). They analysed variation of monthly rainfall, mean annual rainfall. In Kuala Krai, five data from Department of irrigation and Drainage (DID) were analysed.

According to Yusop et al. (2018), understanding the duration of the flood and the flood depth will show the characteristics of the flood occurrence. The flood duration can be determined by understanding the flood depth of the rainy day by the distribution and collecting data from the questionnaires. The analysis of the flood case by questionnaire sampling in China in Jingdezhen City notes that the flood feature must be taken into account in order to minimize the bad impact of the flood on the residential location.

In this research project, the case of flooding depends on the occurrence of rainfall. This is also the goal of recognizing the cause of the flood in Kuala Krai. It is necessary to know the cause of the flood and it is possible to minimize the risk of flood-related hazard effects and increase awareness of the flood. (Mileti, 1999; 2007, Merz, et al.).

In Switzerland, flood depth is a measurement to get known about the damaged that create by the flood (Pistrika &et all, 2014). In Kuala Krai, the residential location by the face to face interviewed, the flood depth is measured and the calculation for flood damaged can be measured.

Information on the temporal and spatial distribution of rainfall is important for a variety of applications in hydrology and water resources management (Campling et al. 2011). The five-station data are analyse by using the SPSS and map was created by using Google Earth.

In Malaysia which have the Peninsular and Borneo area, both which being called by the winter season when it come the December and November month which the heavy rainfall occurred (Chen & et al., 2013). Hence, Kuala Krai is the area which located at the peninsular Malaysia.

The World Meteorological Organization (WMO) the data of heavy rainfall is being collected and being using the spatial data. The peninsular Malaysia location showed that the distribution of the heavy rainfall is the main caused for the flood during the November until December.

By using the GIS, the map of spatial can be created in England, the map shows the location of the heavy rainfall crate the prone area of flooding (Alexender&etall.2014). Through the GIS the map of the three Mukim is create the comparison on the flood residential location is being created.

According to Khalid et al. (2015) assessed the effectiveness of Early Warning System in Cameron Highland flood disaster which is occurred in 23 October.2013. The responses from flood victims affirmed that the Early Warning System was alert them for occurring flood event. Hence, for the preparation of the flood event in Kuala Krai must has the Early Warning System.

Soil type will help to determine how much water receive by the Certain soil types such as sandy soils are very free draining and rainfall on sandy soil is likely to be absorbed by the ground. However, soils containing clay can be almost impermeable and therefore rainfall on clay soils will run off and contribute to flood volumes. Mostly in Kuala Krai the soil is clay. It contributes to flood easily because of kind of soil.

Land use will contribute to the volume of water reaching the river, in a similar way to clay soils. Rainfall on roofs, 35 pavement and roads will be collected by rivers with no absorption into groundwater (Vishwas et. al, 2002). This also create the flood in year 2014. The land use without any good management occurred in this area.

The clearing of land for agriculture in some areas of Ulu Kelantan has caused many trees to be cut down, resulting in the loss of 'natural fortress' (Hamzah, 2015; Mohmadisa, 2016). Furthermore, in hydrological processes, the emphasis of opening a forest to the idea of one type of plant or 'monoculture' does not replace the functions of tropical forest plants (Mohmadisa et al., 22 2016). The amount of water that not intercepted by the plant will fall to the ground and so are the flow line of the trees. Hence, the water accumulates and the flood occurred.

From the Drainage Irrigation Department (DID) state that the floods are considered to be the worst flood disaster that continues to terrorize up to Kuala Krai, resulting from combined water from three rivers that meet in Kemubu, Kuala Krai, which forms Sungai Kelantan, Lebir, Nenggiri and Galas River.

Floods in Peninsular Malaysia are also caused by surface factors such as low-lying topography, poor drainage system and design, coastal areas located below high tide level and the loss of natural retention areas resulting from urbanization (Sathiamurthy et al., 2007). Mostly, in Manik Urai the topography in that area is low – lying area and near to river.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

This chapter clearly defines the research methods used to conduct the study and provides a general framework for this research. This chapter presents details of the research design, material and equipment, description of the methodology which are consist of the preliminary studies, field studies, data processing and data analysis and interpretation while conducting the research.

3.2 Materials

1. Laptop.
2. Data collection of survey questionnaire and interview at 50 persons.
3. ArcGIS MAP, ArcMap and Google Earth software.
4. SPSS statistics software.
5. Data from Department of Irrigation and Drainage (DID) and Department of Survey and Mapping in Malaysia (JUPEM).

3.3 Methodology

Based on the secondary data, remote sensing such as the imagery satellite, aerial photo and topographic map from another previous researcher. This will help to update the map of the study area in Dabong. The software that being used are ArcGIS Map, Google Earth and ArcMap software.

Most of the commonly used data in the study related to flood mitigation and flood risk analysis are secondary data from flood – related government agencies and spatial datasets from satellite image without any investigation on the real situation through field visit of the flood-prone area. Therefore, this study has been guided by both type of data which is primary and secondary data. The secondary data from Department of Irrigation and Drainage to get the distribution of rainfall from 2013 until 2019.Those data will be analysed using Microsoft Excel and SPSS statistical. The statistical method to ensure trustworthy findings with a high level of reliability. This paper aims to identify which catchment characteristic or input in variables in Linear and Spatial Regression models that the most effective and efficient in estimating flood

During a flood event it is often difficult to get accurate information about the flood extent and the people affected. This information is very important for disaster risk reduction management and crisis relief organizations. Most common way to collect that information through a field visit immediately after the flood event. This has been done in Kuala Krai after six-month of 2014 yellow flood event in Kelantan with 50 respondents have been interview. By searching the residential location of flood victim this study will continued to collect more information on flooding in Kuala Krai area with them that related to after 2014 flood events as well as counter check the information of flooding in Kuala Krai area with them that related on 2014. Through

this brief interview from each of the households, data on flood- depths and flood-durations will measure and collect. The position of all sampling location will also record using Garmin handheld Global Positioning System (GPS). Hence, using the same device the elevation of each points and distance of each houses to the nearest river will also measure. Other parameters such as demographic information of respondent as flood victims and percentage of damage with the total loss due to the flood event area also gathered through this face-to-face interview.

The observation of nominal or categorical variables that related to social and economic status will collect through household face to face interview by using the developed survey questionnaire during the field visit. The flood occurrence and the raining day had been asked at the residential location of flood victim to analysis those types of variable descriptive. Descriptive statistics uses the data to provide descriptions of the population, either through numerical calculations such as frequency analysis with graphs or table. The type of descriptive statistic is to measure the frequency of data. This test will automatically be computed by using any statistical software.

3.3.1 Preliminary Studies

Preliminary study is based on the rainfall distribution at five station near residential location flood victim in Kuala Krai. The trend analysis on rainfall distribution from year 2013 until 2019 is being analyses. The name of five stations is JPS Kuala Krai, Ladang Kuala Nal, Ladang Lapan Kabu, Kampung Lalok and Ladang Kuala Gris. Next, the interview of the 50 persons at residential location in Kuala Krai and the best statistical method through the past review. This is very useful to identify the high potential method that has been done by other researched. The relevant

experimental, descriptive, theoretical and analytical techniques used in the research should be revised, outlined and repeated. From the revision of the paper, the literature review can be created. The data of statistical method can be collects by the interviewing of person.

3.3.2 Field Studies

This method that will used in this research consist of the conceptual framework which is the quantitative data. This is gaining by the delivery questionnaires and face to face interview. The map interpretation which involves the interpretation of the geomorphology and topography in the residential location of flood victim. The interpretation of the amount of rainfall in the Kuala Krai area from the secondary data. This is very useful for to identify the amount of rainfall and the occurrence of flood event in Kuala Krai.

3.3.3 Data Processing

The data reliability used the alpha Cronbach's. This involved the data quantitative method. It will useful for asses reliability of the face-to-face interview. This involved the SPSS statistics software.

3.3.4 Data Analysis and Interpretation

The updated the map in Dabong ArcGIS, ArcMap and Google Earth, the map can be updated. Figure1 indicates research workflow to update map in Dabong Next,

the spatially and temporally analyses the rainfall distribution in Kuala Krai from year 2013 to 2019 was analysed in graph through the Microsoft Excel Worksheet and SPSS statistics software. The location amount distribution of rainfall in Kuala Krai will be performed through the map by using the ArcGIS. Figure 2 show the research work flow to spatially and temporally analyse the rainfall distribution in Kuala Krai from year 2013 to 2019.

Data acquisition was by the delivered of the questionnaire survey and the face to face interviewed. The data had been gathered and the was interpreted by the SPSS statistics software. Figure 3.3 indicate research work flow for the questionnaire survey.

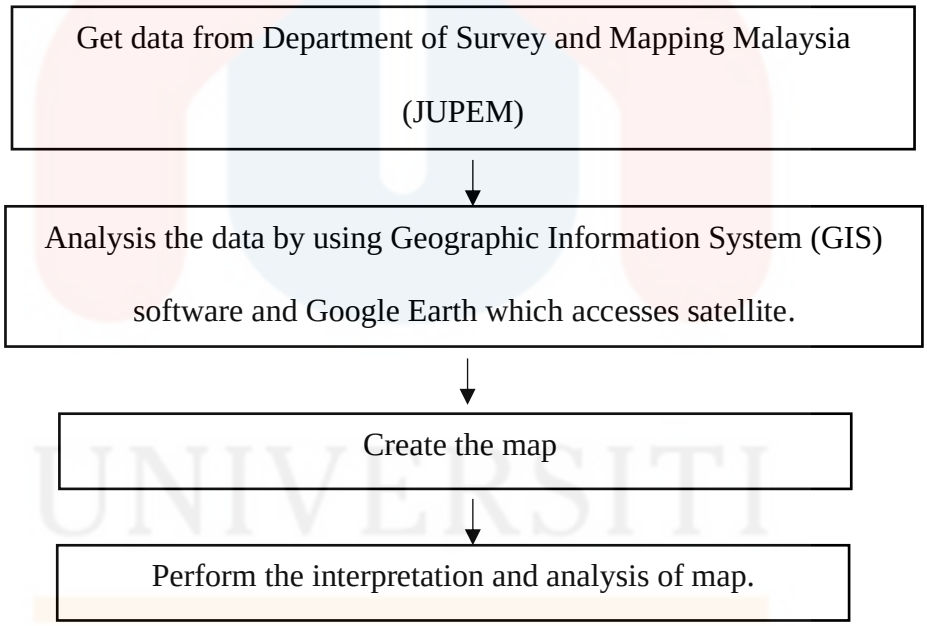

Figure 3.1: Research work flow to update map in Dabong.

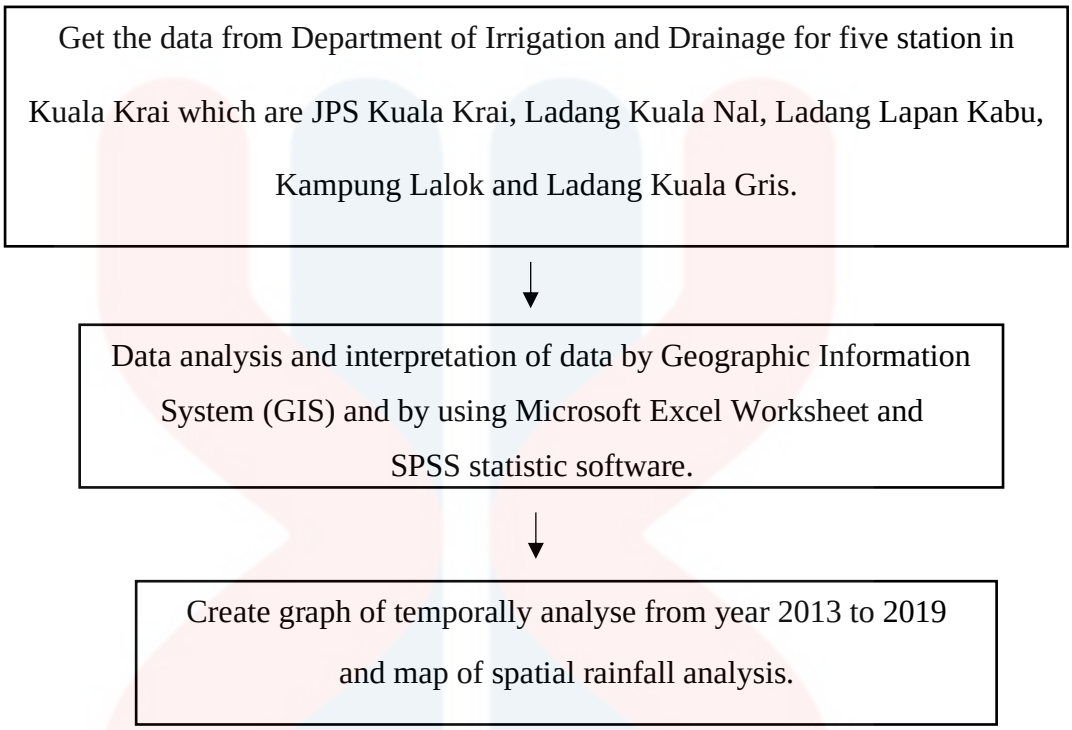

Figure 3.2: Research work flow to spatially and temporally analyse the rainfall distribution in Kuala Krai from year 2013 to2019

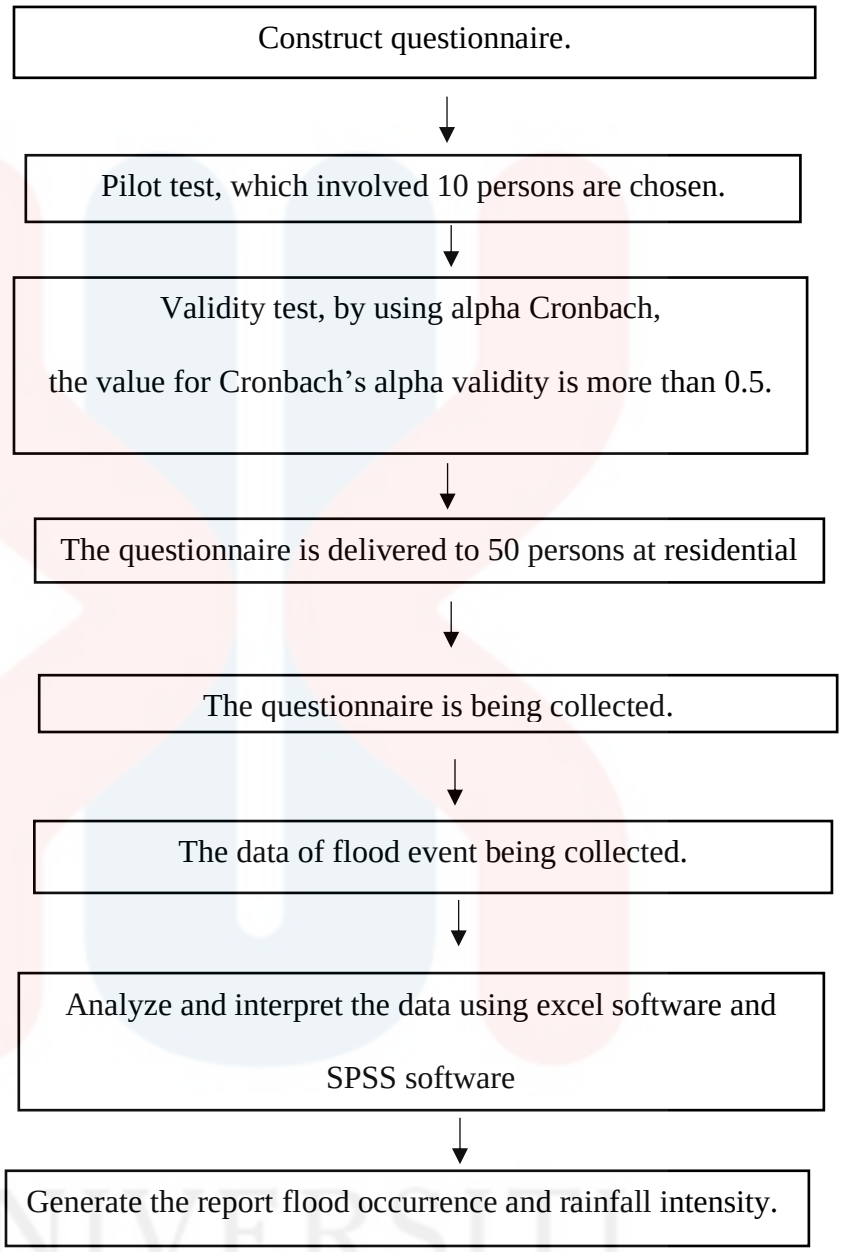

Figure 3.3: Research work flow for questionnaire survey.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

In this chapter, which is involve the general geology on the study area in Dabong. The main geology that will discuss on this chapters are geomorphologic process, drainage pattern, lithostratigraphic, structural geology which are fault and fold, historical geology and also a few types of map that important and must to be discussed in this research. With the helpful information about the general geology will be update the geological map.

4.1.1 Accessibility

The accessibility for the field trip in Dabong, is very easy to travel in the study area. This because there is, the small road that used by the villager to connect to each other. The main transportation are car and motorcycle

Figure 4.1: The figure shows the small road in Dabong.

4.1.2 Settlement

Elizabeth Thompson 2017, state that settlement in certain area is the study on the human population such as gender, age, religion and size and the process that happen through their population changes. By this data, there are some will be related with analysis data on the specification later.

Next, the recent data that get from Majlis Daerah Dabong is changes. The latest data get from Majlis Daerah Dabong is shown the three main races there. There are Malay, Chinese and Indian. The population of Dabong peoples shows an increasing trend for the recent years.

The value of citizen in Dabong the value is 15 000.

4.1.3 Forestry

Next, for the land cover aspect, almost sixty- five percent of the area are cover with oil palm plantation and forest, while the remaining area are classified as develop urban area as shown on land cover map. This aspect will be further discussing on the next chapter.

This map has been prepared by using data from Majlis Daerah Dabong or from Department of Surveying and Mapping (JUPEM). The main forestry in the study area which affect the planning aspect vacant, agriculture land, reserve forest, and residential are considered.

4.2 Geomorphology

4.2.1 Geomorphologic Classification

Landform of the study area is the main important for geomorphology analysis which is in Dabong. The analysis of the geomorphology of the certain area based on the earth form, which is detailed on the factor that create it formation and exist of the landform. It will discuss on the cause and the process to become the landform.

There are three of the cause that contribute to the formation landform in Dabong. There are erosion and weathering, morphocronology and hydromorphology.

Based on the rainfall data, Dabong which is located in the peninsular Malaysia. Hence throughout of the year, it will receive rain which is water. As known, water is the agent for the occurrence of weathering and the erosion on the landform.

The morphocronology is the age landform of the study area is related to the time. This can be evaluated by the through the existence of the fossil. The fossil content has two type. There are two type of fossils are trace fossil or body fossil. Hence, the age landform of the study area can be corelate to the age of fossil.

The geomorphology in this study area involves of the hilly, mountainous and low lying. This kind of the landform which is depend on the value of the elevation. The value elevation is the main guidance to classify the type of the landforms.

The topographic of elevation. Mostly elevation in Dabong hilly which are around in 76-300. Table 4.1 show the topographic unit based on elevation.

Table 4.1: The topographic unit based on elevation

Description	Elevation
Low lying	Less than 15 m above sea level
Hilly	76 - 300 m
Mountainous	More than 301 m

(Source Raj, 2009)

Base map

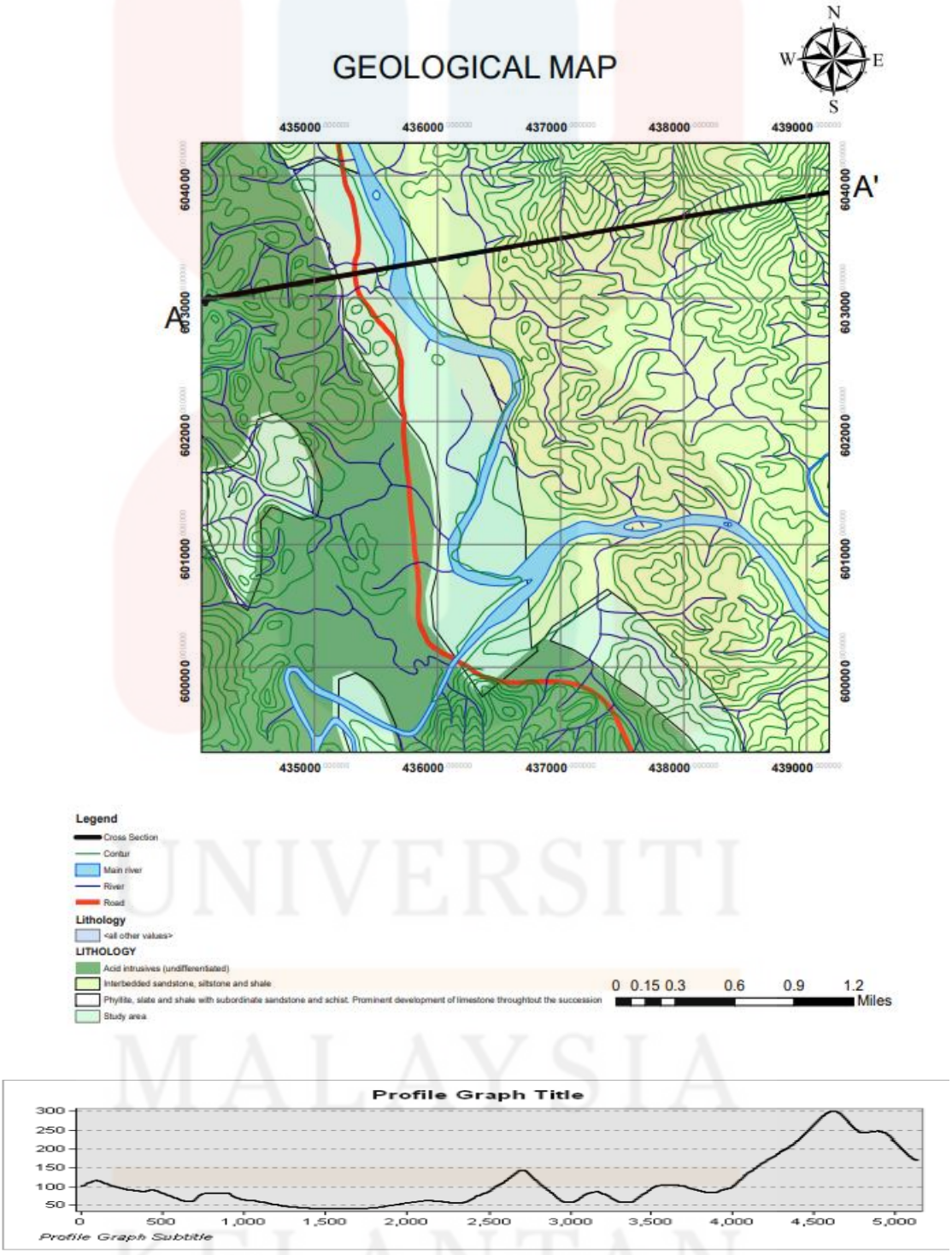

Figure 4.2: Base map

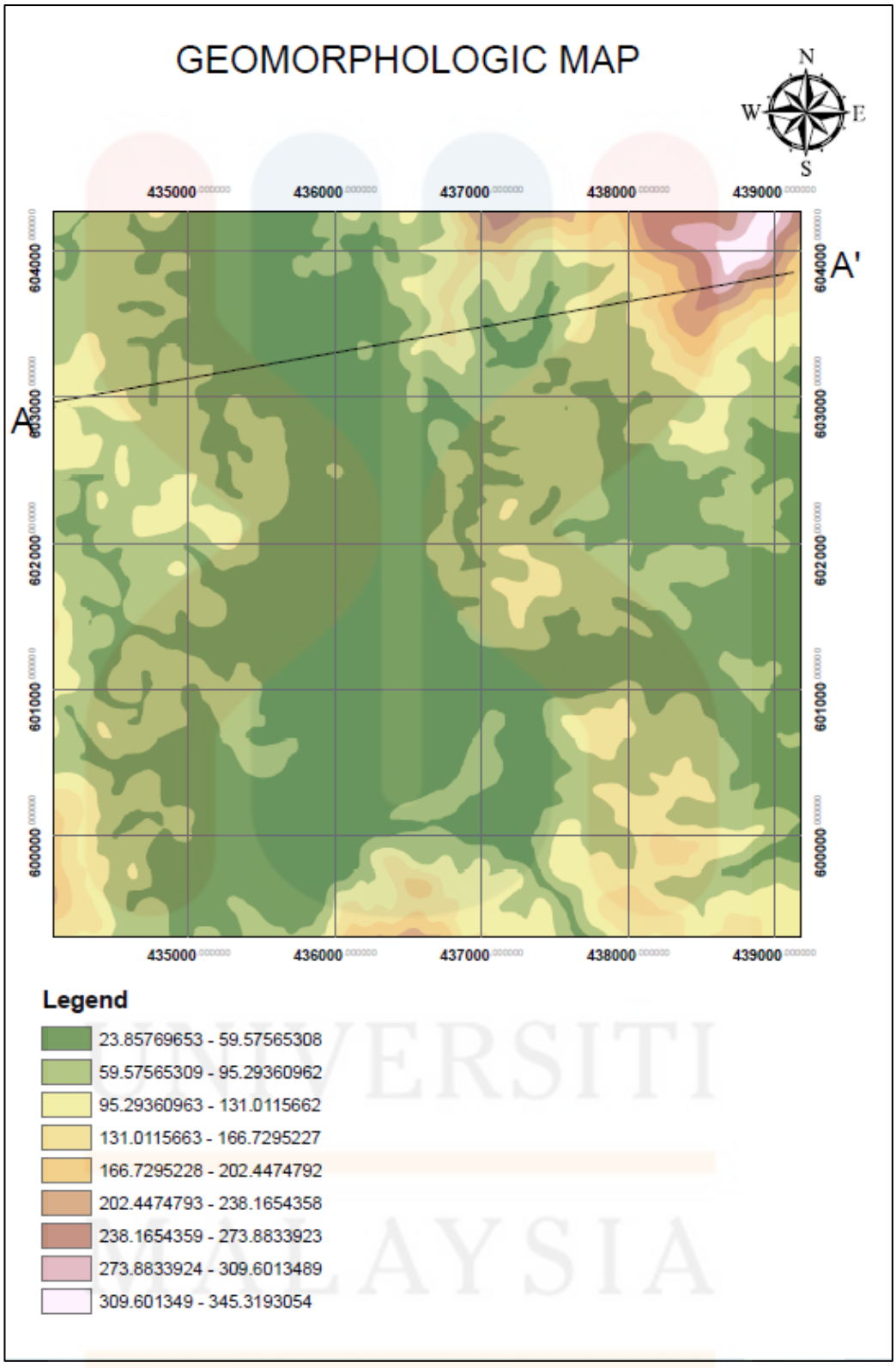

Figure 4.3: The figure shows the Geomorphic Map.

4.2.2 Drainage Pattern

Drainage system is a pattern is form by streams, river and lakes in a particular drainage system. A drainage system also important in the existence of flood as it control the management of flood depth. This system also usually receives infiltration, run-off, sub-surface and groundwater flow during rainfall. Drainage system can be classified into different size, pattern and shape of the drainage basin that found in the area.

There are, dendritic, trellis, rectangular, angular, annular and radial. Each of the pattern and shape also own their special geometric and topography characteristic as shows in Figure 4.4. According to Gibson U.C and Singer R.D (1971) in the manual of water well stated that drainage pattern can help in identify the rock type or formation in the area, recharge and potential area of groundwater pressure.

In Dabong, the drainage that been found are dendritic and sub-dendritic.

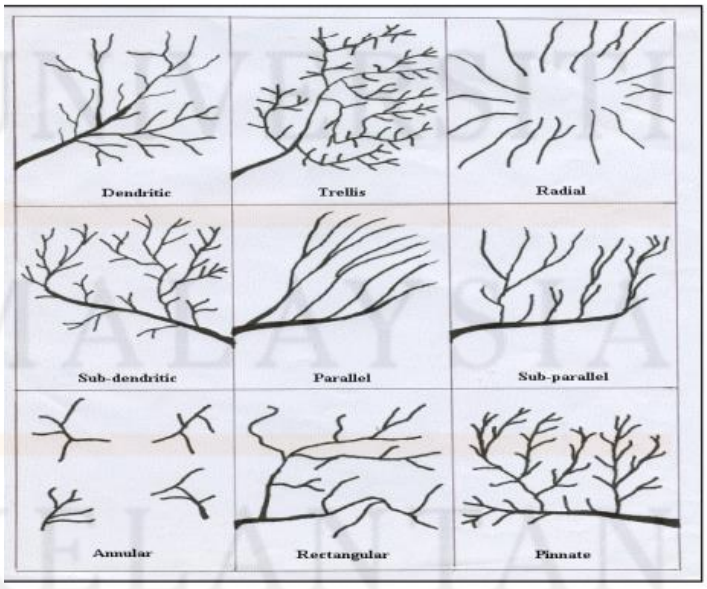

Figure 4.4: Water drainage

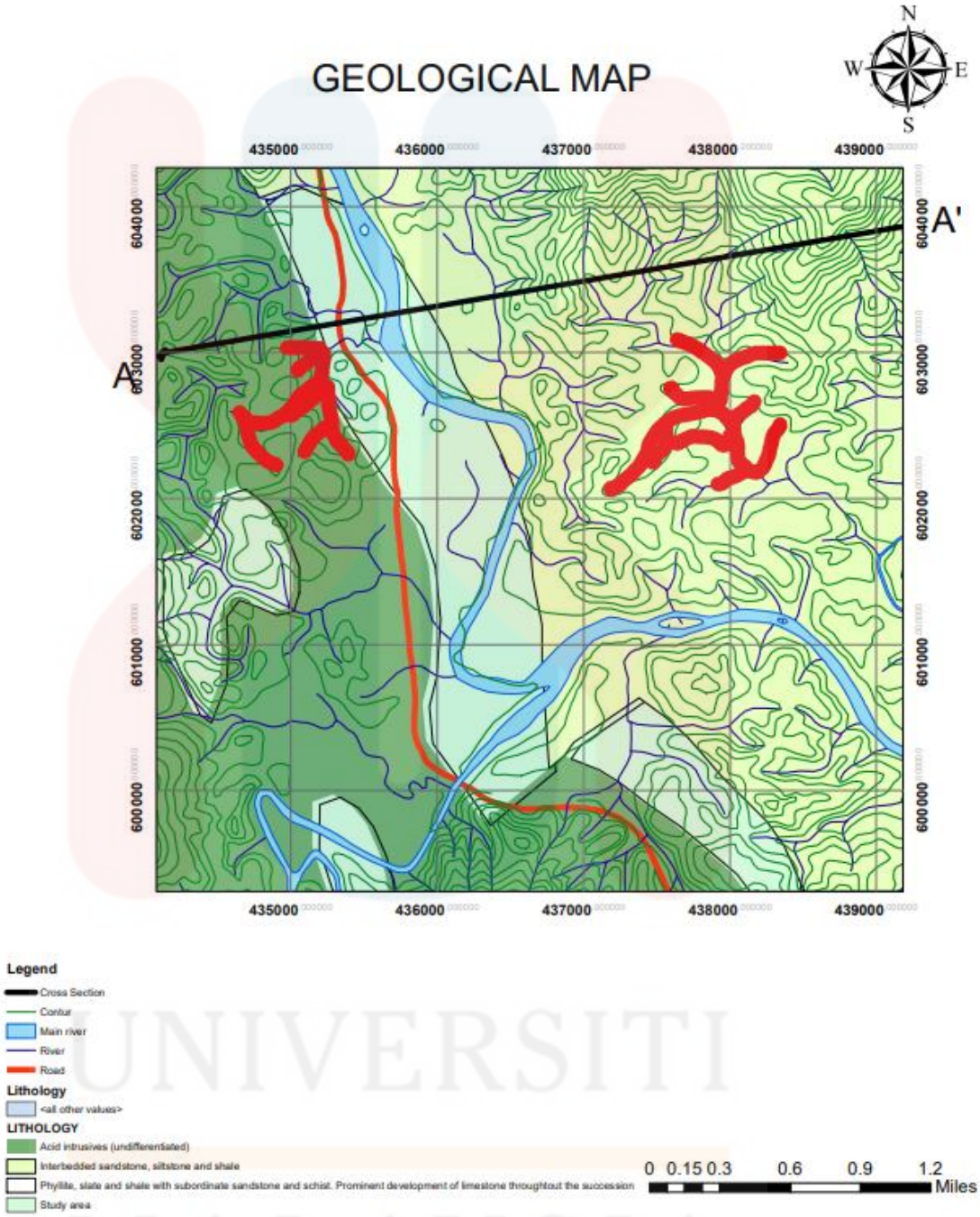

Figure 4.5: Drainage map.

4.2.3 Stratigraphy

The stratigraphic unit can be found is igneous rock (granite), and meta-sediment rock (slate, phyllite and some of schist). Stratigraphy is a study of geology that describe, interpret and correlate rock layer or strata on the Earth. It also studies the relative and absolute age and the process that related between the stratified rock.

4.2.4 Unit Explanation

The stratigraphy of the study area rearranges the rock unit from the oldest in the bottom to the youngest in upper. The age of the formation is from Pre-Mesozoic up to the Cretaceous ages. The oldest rock is meta-sediment (rock dominated with slate and shale, some phyllite) which in period of Middle Permian, then limestone with part of marble rock and the youngest in strata is sandstone with present of some mudstone and siltstone in period of Late Permian. As for the granite rock, it put on the upper strata in the stratigraphic column because from field mapping, the observations show that rock intrudes the other rock, make it as the younger one in this study area formation.

4.3 Structural Geology

Structural geology can be identified by study the lineament analysis lined in the study area. Lineament indicate the line of straight line of the landform, for example river, stream, valley peak of hill or mountain.

4.3.1 Fault

The important of fault in describing the formation of an area, because the process of mechanism deform the actual or original stratified rock. It can be major or minor fault and usually fault can be interpreted from previous study of lineament line. There can be categorized into few types, which is normal, reverse and strike-slip fault. In addition, the indication of fault in the field can be recognized through its process effect, such as slicken line on the rock side (slicken side).

4.3.2 Fold

There can be categorized into two type of classification, which is syncline and anti-cline shape. The indication of fold in the field can be recognized through its process effect, such as compressional force from any directions.

4.3.3 Mechanism Structure

Fold structures also important in describing the formation of an area, because the process of mechanism deform the actual or original stratified rock.

4.4 Historical Geology

Dabong is an in progress developed town located in the southern province in the Kelantan. This area composed of dominantly rocks of granite and meta sediment in industrial area. Most of the rock type found there are influences by lineament or

fault. The oldest rock is believed composed of granite. The Triassic period donated the start of real changes that happen to all through the Mesozoic Era especially in the appropriation of landmasses. Physical atmosphere is predominantly warm and dry.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Rainfall station and sample residential location

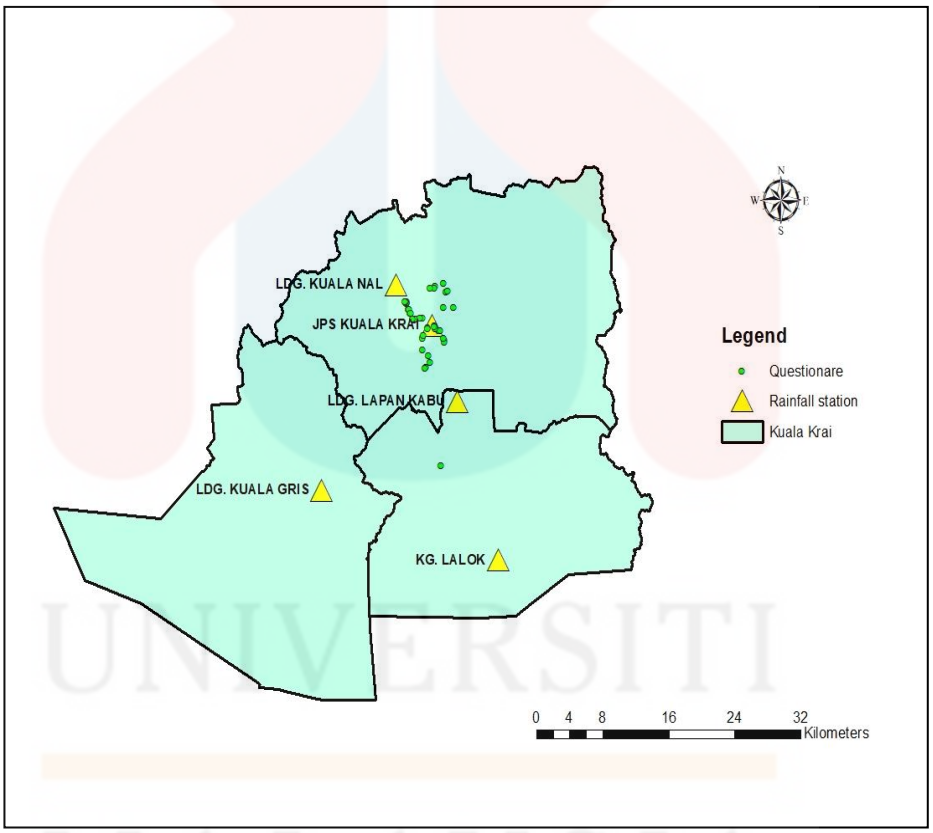

Figure 5.1: Map of residential and rainfall station location of study area.

Based on the figure 5.1, there are five station in the district in Kuala Krai. The five station are JPS Kuala Krai, Ladang Kuala Nal, Ladang Lapan Kabu, Kampung Lalok and Ladang Kuala Gris. Kuala Krai district consisting of the three sub-districts (mukims).

The three sub-districts are Mukim Dabong, Mukim Manek Urai and Mukim Guchil. Ladang Kuala Gris station is located in Mukim Dabong, Kampung Lalok station is located in Laloh, Mukim Manek Urai and Ladang Kuala Nal, JPS Kuala Krai and Ladang Lapan Kabu which are located in Mukim Guchil.

Fifty respondents are chosen based on by the interviewing the residential location of the flood victims in year 2014. The delivery of questionnaire, collect the questionnaires and face to face interview occurred at the Mukim Guchil. The event of flood during year 2014 until 2019 is been asking during the collecting data.

5.2 Rainfall Distribution Analysis

The analysis of rainfall distribution 2013 to 2019 by using secondary data from DID has been done and the monthly average rainfall intensity is shown in Figure 5.2. It is clearly showing that, during December of year 2014, the average monthly rainfall intensity very high. According the data from Department of Irrigation and Drainage (DID), the JPS Kuala Krai station cannot collect the amount of rainfall in January 2014 because the machine to collect the data was broken and the December 2014, the amount of rainfall is very high and cannot be calculated by the machine. In Ladang Kabu Station, the machine also broken during March ,2016 so there is not result for that month. Hence, three months data was not collected

Based on year 2013 to 2019, the highest average monthly rainfall intensity occurred during December 2014 and 2016. This situation caused occurrence of the flood events name as “Yellow Flood” in December 2014 and December 2016 in Kuala Krai. The flood occurred because amount of rainfall intensity is very high which around 50 until 60 mm/ month.

However, from the January 2015 until October 2016 and January 2017 until December 2019, the trend analysis show that monthly rainfall intensity is normal.

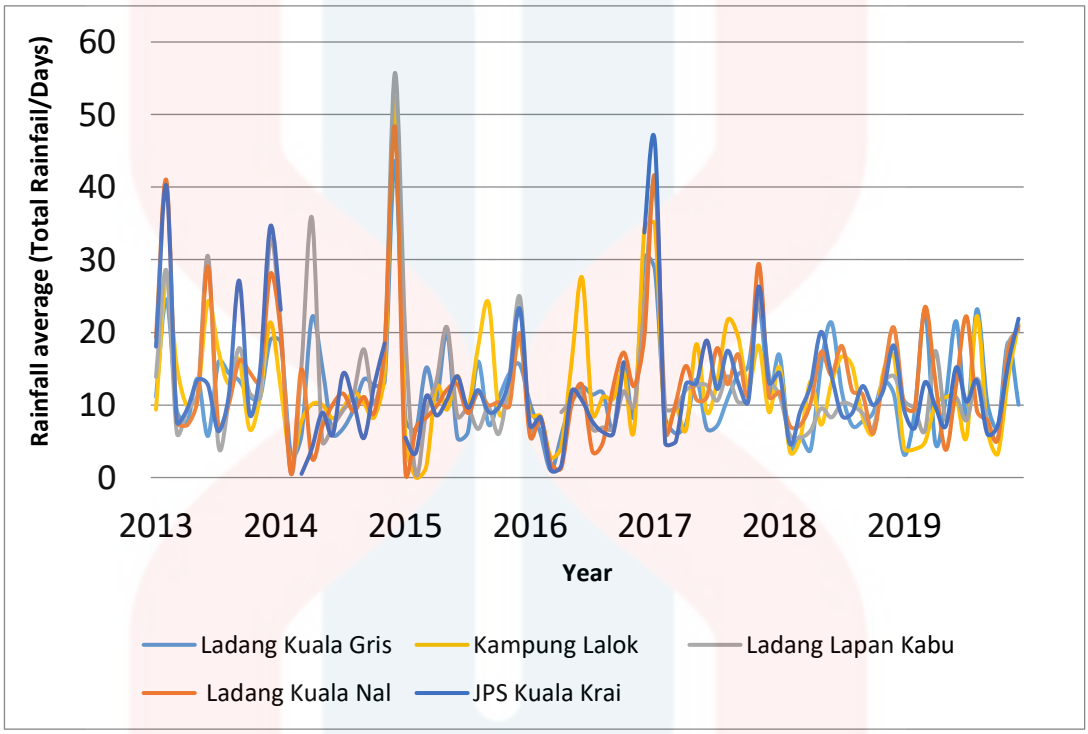

Figure 5.2: Average monthly rainfall intensity of five rainfall station in Kuala Krai from 2013 to 2019.

5.3 Spatial Analysis

Rainfall distribution in Kuala Krai has also been spatially investigated and has been visualized in Figure 5.3. From the figure it is clearly shows that the location residential area of the flood victim respondent is not in flood area because the amount of rainfall is the lowest among the Mukims.

In year 2014, the distribution of the rainfall in each Mukim in Kuala Krai is very high. Based on the five station, Ladang Lapan Kabu, Kampung Lalok and Ladang Kuala Gris show the highest amount of rainfall and follow by another two stations. Hence, the whole district Kuala Krai is immersed by water.

Mukim Dabong receive the highest rainfall during year 2014, 2016, 2019 since the Mukim is located in flood event. The river namely as Sungai Kelantan also main cause the flood occurred. In addition, the topography of this area is low land.

Ladang Kuala Nal, in year 2018 and 2019, the machine at the station shows the highest amount of rainfall compared to the other mukim. According to (Sinar Harian,2019), the location occurred of the flood event.

Mukim Guchil receive the highest rainfall in year 2017 compare to other mukim. The data is taken from JPS Kuala Krai station. Luckily there is no residential location of flood victim in 2014 was immersed. However, Mukim Dabong has no flood event occurred because of the amount of rainfall is low.

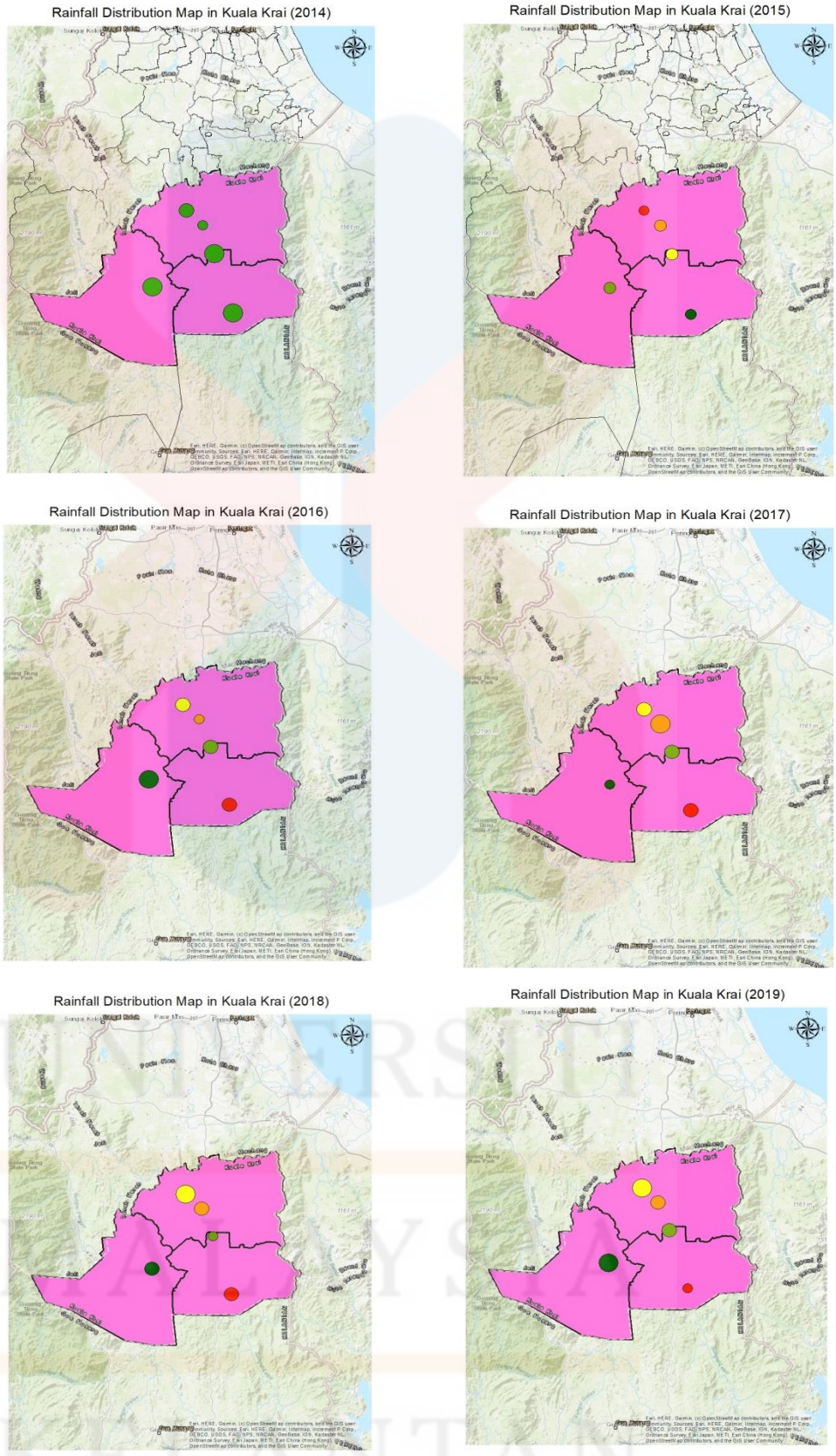

Figure 5.3: Spatial analysis on Rainfall Distribution in Kuala Krai from 2014 to 2019

5.4 Comparative Study on Flood Event.

In this section the results on comparative study of flood events in Kuala Krai starting from 2014 onwards will be discussed. The analysis is used primary data that has been collected by using questionnaire survey that has been constructed to answer the last objective of this study. The reliability of the questionnaire has been determined beforehand trough pilot study. Table 5.1 show the significant of the instrument with the value of Cronbach's Alpha > 0.5. With the value it can be said that this questionnaire is reliable and can be used in this study.

Table 5.1: Reliability test of the questionnaire

Cronbach's Alpha	Number of items
0.606	48

5.4.1 Demographic of Flood Victims

There are fifty respondents of this study where their housing location is shown in 5.1. This is based on the previous flood victims of year 2014 where 32% of the respondents are male and the rest are female and their age is ranging 24 to 61 years and above and on average of the age is 41 until 51 years old. Another socio-demographic data that have been analysed in this study are village, race, religion, marital status, education, job, family and income.

The village which are involves in this study are Batu Mengkebang, Dusun Nyior, Aur Duri, Batu Lada is category as village 1. Village 2 which are Tualang, Geale and Bekok. Village 3 are Kampung Gatal, KTM, Hamzah. Village 4 are Sedek,

Sungai Durian, Kampung Tengah and the village 5 which is Kampung Rahmat. Mostly the data was collected in Kampung Tuala, Jalan Geale and Kampung Bekok.

In this study area, the flood victim has no formal education. This is proven by their job status which not involve of any formal job. Most of them are self-employment, which has no higher income. The flood victims are farmer and breeder. The respondents come from different residency. Several results on demographic background of the flood victims are shown in Table 5.2, 5.3, 5.4 and 5.5.

Table 5.2: Gender.

Gender	Frequency	Percentage
Male	16	32.0
Female	34	68.0
Total	**50**	**100.0**

Table 5.3: Marital status

Marital Status	Frequency	Percentage (%)
Single	7	14.0
Married	38	6.0
Single parent	2	4.0
Widow	3	6.0
Total	**50**	**100.0**

Table 5.4: Education

Education	Frequency	Percentage (%)
No formal education	22	44.0
Primary school	4	8.0
High school	20	40.0
Total	**50**	**100.0**

Table 5.5: Income

Income status	Frequency	Percentage (%)
Less than RM 500	24	48.0
RM 501- RM 1000	18	36.0
RM 1001 - RM 3000	5	10.0
RM 3001 - RM 6000	3	6.0
Total	**50**	**100.0**

5.4.2 Flood Events in Kuala Krai for Year 2014 Onwards.

Flood event 2014 is one of the extreme flood events that occurred in Kelantan. In Kuala Krai, flood event collected using the questionnaire by asking the residential location of the flood occurrence, flood depth and raining day during 2014 and onwards.

In 2014, Kuala Krai had been immersed by flood. The cause because of the heavy rainfall and continuous raining. All three sub-district (mukim) which are involve with flooding. The highest water level depth is as high as the building in Kuala Krai.

Onwards year, the residential location Mukim Guchil for flood interviewed were not involved in any flood event. Although that, the other two mukim always immersed in the flood. In year 2016, the heavy rainfall, hence other two mukim,

Mukim Manik Urai and Mukim Dabong were flooding. From the Department Irrigation Drainage, heavy rainfall had occurred in 2016 in the middle December.

Table 5.6: Occurrence of flood 2014 and onwards.

Occurrence flood	**Percentage (%)**	
	2014	**Onwards 2014**
Yes	100	0
No	0	100
Total	**100**	**100.0**

The flood damage is measure by the hydrological factor. There are two type of hydrological factor in this study of flood damages are flood duration and flood depth. These two data floods duration and flood depth has been collected. In Negland, Netherland, has used the flood depth and flood duration during the assessment of the flood risk in Netherland (Meyer V et all, 2005).

The rate of the flood damage is counting by used the depth of the flood. The flood damage is the rate of contamination of the flooding area, along flood period (Thieken.et.al.2004). The finding reported that, the most of the flood victim has said the highest flood period which are 8 -14 days. Hence, the rate of flood contamination is very high.

Overalls of this study, the depth of flood is important in measure the damage that cause by the flood. In addition, the depth of flood is function as the input to the damage assessment model. Delft Hydraulics Institute, has developed on calculate the damage that create by the flood by create the model extend of flooded area and to identify the spatial distribution of flood depth by using the flood depth. Hence, it very important to measure and calculate the flood depth. From the 2014 flood victim

interview, the depth of flood water started with an increase from one foot in the first hour and for keep going to increase for the next hour.

From the data, the occurrence of the flood is not existence at the residential area in the year 2016. The normal river level of the study area, the water on the river did not move out from the river. The depth of the water river is at normal. The water depth that caused by the accumulation of rainfall is just 1 inch to 2 inches. Hence, there is no shortcut of electricity and the shortage of the clean water before and after the flood that happened in study area. But in Kuala Krai the two others mukim, Mukim Dabong and Mukim Manik Urai had been flooded the total damaged had absolutely happen in that area.

From the research area, it shows that effect for the flooding is road connection among the villager in Kuala Krai is break. This show the road is being immersed by the flood. Based from other researcher, there are common effects of flooding which are flood damage towards the house, damage of the furniture and the electric appliance. The main damaged that caused by the flood is the house. Therefore, it is recommended that the house in Kuala Krai area should be create in the best idea that can face the flood.

Table 5.7: Flood depth 2014

Hours	**Flood depth (inch)**	**Frequency**	**Percentage (%)**
1	0 -12	50	100.0
2	13-26	50	100.0
3	26-39	50	100.0

Table 5.8: Flood depth onwards 2014

Hours	Flood depth (inch)	Frequency	Percentage (%)
1	0 -12	50	100.0
2	0-12	50	100.0
3	0-12	50	100.0

Based on the data, the raining day before the flood occur is around one until seven days. The second from data is 8 until 14 days. This is more valid. This prove by the intense rainfall which is started from 15 December to 25 December 2014 (Zulkifli Yussof et al., 2016). Based on the reports by the National Oceanic and Atmospheric (NOAA), the raining days which is prolonged or non -stop generate the flood to occur in year 2014. Definition of Madden Julian Oscillation (MJO) is a climate pattern that occur at tropical region. As Malaysian is a tropical region, so during 2014 the existence of MJO during the December. It occurred for 30 until 60 days. The existence of MJO create the rainfall.

From this data, the heavy rain period before the flood occur is around a week and more than a week. The causing the rainfall heavily were shown by the Tokyo Climate Centre report that the heavy rainfall occur at the peninsular belt Malaysia. Every year, the North-east monsoon usually bring the heavy rainfall which is started early in September until January to the East – coast of the Peninsular Malaysia. The existence of monsoon is created by the movement of wind. The movement of wind is influenced by the difference pressure of the ocean and the land. The movement of winds were help by the Coriolis effects to form North - east monsoon. Then, the most

of heavy rainfall were had happen in December 2014. This is the main contributing to the flood.

According Ching.et all, (2013), by the geological map Malaysia is located over 4800 km of coastline, as the result of that is the weather along the coastline is affected by the continuous rain. Hence, the rainfall distribution in Malaysia is influenced by the two category which are topography which are location Malaysia on the earth and the monsoon wind which bring the rainfall. The flood in Kuala Krai is affected by combination of physical structure which is near to the main river in Kelantan and the elevation and Kelantan is very near to the sea apart from the very heavy rainfall received during the monsoon period.

From the Meteorology Malaysian data, the heavy rainfall for the heavy rain period in 2016 is around one week only which is the end of December.

From (Sinar Harian,2014) state that the heavy rainfall will start occurred on 18. December.2014 until few days. Hence, the river water level depth on the 18. December.2014 increased. The raining day for the recently year are involved in three days. The rainfall heavily happened non- stop and continuously.

The (Malay Mail Saturday, 19 Dec 2016), state that the Malaysian Meteorological Department (Meteorology Malaysia) today issued a yellow-level weather alert. This yellow alert defined heavy rain expected in several areas in Kelantan, Pahang and Sabah. From the new, it said strong north easterly winds of 40 to 50 kilometres per hour, with waves up to 3.5 metres high are expected in the waters of Kelantan, Terengganu and Pahang during the period.

Based on the data, the raining day before the flood occur is around one until seven days. The second from data is 8 until 14 days. This is more valid. This prove by the intense rainfall which is started from 15 December to 25 December 2014 (Yussof

et al., 2016). Based on the reports by the National Oceanic and Atmospheric (NOAA), the raining days which is prolonged or non -stop generate the flood to occur in year 2014. Definition of Madden Julian Oscillation (MJO) is a climate pattern that occur at tropical region. As Malaysian is a tropical region, so during 2014 the existence of MJO during the December. It occurred for 30 until 60 days. The existence of MJO create the rainfall.

Table 5.9: Raining day before occurrence of flood 2014

Number of Days	Frequency	Percentage (%)
1 - 7 days	2	4.0
8 - 14 days	31	62.0
15 - 21 days	17	34.0
Total	**50**	**100.0**

Table 5.10: Flood event onwards 2014

Number of Days	Frequency	Percentage (%)
1 - 7 days	34	68.0
8 - 14 days	16	62.0
15 - 21 days	0	0.0
Total	**50**	**100.0**

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study was conducted to determine the amount of rainfall and characteristics of flood event in year 2014 until 2019 in Kuala Krai, Kelantan. In 2014 flood give a lot of impact towards the flood victim compared to the onward flood event. Through this research attempt, to increase preparedness capabilities towards flood disasters. The expected results of this study clarify the scenario of how the evacuation aid related to flooding can be controlled in the future for better planning. In general, the damaged of flood is influenced by the flood depth and the duration of flood occur. Many researchers used this data to create a modelling. Therefore, it can be suggested that further inclusive research which large scale is needed to relate to the factors characteristics that influenced the flood risk in Kelantan. As a conclusion, hopefully, this study will become a good reference to manage on the risk of flood in certain area. Because with the developing technologies, the flood risk can be controlled and reduce the impact of flood towards the residential location. The effect of the flood can make a lot of total loss such a house and life. Nowadays, technology has no bounds and bearing in warning system of flood. Therefore, is need for more study to be done in

order to avoid flood risk and find causing factors and to create necessary protective interventions toward it.

6.2 Recommendation

The suggested opinion for future study and research is to include and relate the trend analysis of rainfall distribution must be create by the researcher. Geological aspect in determine the potential flood area of data from 'type of hydrology' and 'stream analysis' can be use in the flood risk analysis to strengthen the result. In addition, the environmental parameters also can be added as a precaution step flood warning to manage the occurrence of flood risk., thus it is suggested the next researcher should use better satellite image to produce overall projection result.

REFERENCES

Alexander, M., Viavattene, C., Faulkner, H., & Priest, S. (2011). A GIS-based flood risk assessment tool: supporting flood incident management at the local scale. *Flood Hazard Research Centre, Middlesex University, London*.

Alias, N. E., Salim, N. A., Taib, S. M., Mohd Yusof, M. B., Saari, R., Adli Ramli, M. W., & Yuzir, A. (2020). Community responses on effective flood dissemination warnings—A case study of the December 2014 Kelantan Flood, Malaysia. *Journal of Flood Risk Management,* 13, e12552.

Bradford, R. A., O'Sullivan, J. J., Van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J & Mariani, S. (2012). Risk perception--issues for flood management in Europe. Natural Hazards & Earth System Sciences, 12(7).

Chen, T. C., Tsay, J. D., Yen, M. C., & Matsumoto, J. (2013). The winter rainfall of Malaysia. *Journal of climate*, *26*(3), 936-958.

Chen, Y. R., Yeh, C. H., & Yu, B. (2011). Integrated application of the analytic hierarchy process and the geographic information system for flood risk assessment and flood plain management in Taiwan. *Natural Hazards*, 59(3), 1261-1276.

De Silva, M. M. G. T., & Kawasaki, A. (2020). A local-scale analysis to understand differences in socioeconomic factors affecting economic loss due to floods among different communities. *International Journal of Disaster Risk Reduction*, 47, 101526.

Gasim, M. B., Toriman, M. E., & Abdullahi, M. G. (2014). Floods in Malaysia historical reviews, causes, effects and mitigations approach. *International Journal of Interdisciplinary Research and Innovations*, 2(4), 59-65.

Khalid, M. S. Bin, & Shafiai, S. B. (2015). Flood Disaster Management in Malaysia: An Evaluation of the Effectiveness Flood Delivery System. *International Journal of Social Science and Humanity*, *5*(4), 398–402.

Merz, B., Kreibich, H., Schwarze, R., & Thieken, A. (2010). Review article" Assessment of economic flood damage". *Natural Hazards and Earth System Sciences*, 10(8), 1697.

National Research Council. (2015). Tying flood insurance to flood risk for low-lying structures in the floodplain. *National Academies Press.*

Nayan, N., Mahat, H., Hashim, M., Saleh, Y., Rahaman, Z. A., & See, K. L. (2017). Flood Aftermath Impact on Business: A Case Study of Kuala Krai, Kelantan, Malaysia. *International Journal of Academic Research in Business and Social Sciences*, *7*(6), 836–845.

Nur, W., Wan, T., Nor, H., Zakaria, H., & Nazir, M. (2015). Knowledge sharing and lesson learned from flood disaster: A case in Kelantan. *Journal of Information Systems Research and Innovation*, 9(2), 1-10.

Pistrika, A., Tsakiris, G., & Nalbantis, I. (2014). Flood depth-damage functions for built environment. *Environmental Processes,1*(4), 553-572.

Romali, N. S., Yusop, Z., Sulaiman, M., & Ismail, Z. (2018). Flood risk assessment: A review of flood damage estimation model for Malaysia. *Jurnal Teknologi*, 80(3).

Soh, T. S. N. F. T., Kamarudin, M. K. A., Juahir, H., Gasim, M. B., & Abdullah, S. N. F. (2017). Flood Management Using Data Driver Index: A Case Study in Kelantan, Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 7(11).

Wang, Z., Wang, H., Huang, J., Kang, J., & Han, D. (2018). Analysis of the public

flood risk perception in a flood-prone city: The case of Jingdezhen city in China. Water, 10(11), 1577.

APPENDIX A

Questionnaire

COMPARISON OF FLOOD EVENT ON 2014 UNTIL 2019

STUDY AREA: KUALA KRAI

Section 1: Demographic information

1. Name: _____
2. Address 2014: _____
3. Address after 2014 : _____
4. House Coordinate 2014 : lat (_____), log (_____)
5. House Coordinate after 2014: lat (_____), log (_____)
6. Age: _____ years

   ☐ 30 years ☐ 31-40 years ☐ 41-50 year ☐ 50-60 year ☐ 61 years and above

7. Gender

   ☐ Man ☐ Woman
8. Race

   ☐ Malay ☐ Chinese ☐ India ☐ Others, state _____
9. Religion

   ☐ Islam ☐ Hindu ☐ Buddha ☐ Kristian

   ☐ Others, State _____
10. Coordinate location: _____
11. Marital status:

    ☐ Single ☐ Married ☐ Widowed
12. Level of education

    ☐ No formal education ..... ☐ Graduated from primary school

    ☐ Graduated from high school ☐ IPT
13. Your main job now

    ☐ Not working ☐ Farmer ☐ Breeders ☐ Civil servants

    ☐ Private ☐ Self-work, state _____
14. What is the number of dependents in house?

    ☐ 1-4 people ☐ 5-7 people ☐ 8-10 people ☐ more than 10 people
15. Total household income per month

    ☐ Less than RM 500 ☐ RM501-RM1000 ☐ RM1001-3000

    ☐ RM 3001- RM6000 ☐ RM 6001- RM10 000 ☐ More than RM10 000

Section 2: Flood information 2014

1. How many days of rain before the water level rose / floods occurred in 2014?
   _____days
2. What was the duration of the floods occurring in 2014?
   _____ days
3. How many days did you evacuated temporarily at the evacuation center:
   _____ days
4. How long was the heavy rainy day before the flood:
   _____ days
5. How many hours / days when your house was flooded before being evacuated:
   _____ hours / days
6. What was the height of the flood water level in the first hour : _____ meter
7. What was the height of the flood water level in the second hour : _____ meter
8. What was the height of the flood water level in the third hour : _____ meter
9. What was the height of the flood water level before being evacuated :
   _____meter
10. How many days were the electricity supply being cut off before the floods occurred?
    _____ days.
11. Distance of the house to the river: _____meter
12. Government's aids during floods: ☐ Money ☐ Food ☐ Shelter
    ☐ Other, state: _____
13. Government's aids after floods: ☐ Money ☐ House ☐ Tools ☐ School needs
    ☐ Kitchen needs ☐ Other, state :_____

Section 3: Flood information after 2014

1. Did the floods occur in Kuala Krai area after 2014? ☐ Yes, ☐ No
2. Were you being evacuated after 2014: ☐ Yes ☐ No
3. Was the water level after 2014 worse than in 2014?
   ☐ Yes ☐ No
4. What was the water level of the nearest river: _____meter
5. What was the water level if there was a flood: _____cm
6. How many days of rain happened before the water level rose / floods occurred
   :_____ day(s)
7. What was the height of the flood's water level in the first hour : _____ meter
8. What was the height of the flood's water level in the second hour: _____ meter
9. What was the height of the flood's water level in the third hour : _____ meter
10. What was the highest water level before evacuation :_____meter
11. How many days before the flood receded :_____days
12. Was the front area around the house being submerged: ☐Yes ☐ No
13. Was the surrounding area being submerged / flooded: ☐Yes ☐No
14. Did you get any floods' aids after 2014 ? ☐ Yes ☐ No
15. Did you get clean water supply? ☐ Yes ☐ No
16. How long was the clean water supply being disrupted: _____ day(s)
17. How many days were the electricity supply cut off before the flood occurred :
    _____days

Section 4: General Section

1. Does floods occur annually in your area: ☐ Yes ☐ No
2. Are you an annual flood victim? ☐ Yes ☐ No
3. Are you an annual resident of a flood relief Centre? ☐ Yes ☐ No
4. What is your preparation if the heavy rain does not stop / the river's water level rise:
   ☐ Buy food supplies ☐ Move belongings to a higher ground
   ☐ Save important documents
5. Are your family worries when the monsoon season arrives? ☐ Yes ☐ No
6. Do you allow your children to play in the flood? ☐ Yes ☐ No
7. Do you consider floods a common occurrence and not dangerous? ☐ Yes ☐ No
8. Usually, your family will evacuate when the flood:
   ☐ begins to flood your front area
   ☐ begins to enter your house
   ☐ reaches hip level in your house
   ☐ reaches the roof level of your house
   ☐ submerged the entire house
9. Who is your first contact if your house is being submerged in the flood?
   ☐ Neighbour ☐ Family ☐ Village Chief ☐ Police / Fire Brigade
10. Is there any drainage system being provided by the government?
    ☐ Yes ☐ No

Appendix B

Flooding event