# GEOLOGY AND FLOOD ANALYSIS OF KUALA PERGAU TOWN, KUALA KRAI, KELANTAN

**By**

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**APPROVAL**

"I hereby declare that I have read this thesis and in ouropinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Geoscience) with Honors"

Signature : …….....

Name of Supervisor I : Ir. Arham Muchtar bin Achmad Bahar

Date : ……

## DECLARATION

I declare that this thesis entitled “GEOLOGY AND URBAN FLOOD ANALYSIS OF KUALA PERGAU TOWN” 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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Date :

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**Geologi dan analisis banjir di Bandar Kuala Pergau**

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**Abstrak** : Banjir telah menjadi fenomena tahunan di kawasan timur Semenanjung Malaysia akibat hujan lebat semasa musim tengkujuh. Walaupun ia berlaku setiap tahun, kesan yang disebabkan oleh banjir tidak dapat dikurangkan dan ia tetap menjadi ancaman besar kepada orang ramai kerana kurangnya kajian tentang cara mengurangkan kesan. Oleh itu, proses pengurusan peta bahaya yang berkesan diperlukan untuk mengatasi dan mengurangkan potensi kerugian pada masa akan datang. Fenomena banjir yang berlaku akan membawa kepada kesan yang luar biasa dari segi kemerosotan sosial, ekonomi dan alam sekitar. Baru-baru ini pada tahun 2014, Kelantan sekali lagi mengalami banjir besar yang hampir sama dengan rekod sebelumnya pada tahun 1967 dari segi skala dan keamatan. Kemudian kawasan kajian terletak di Bandar Kuala Pergau, Dabong, Kelantan. Jumlah kawasan kajian adalah 25km$^2$. Objektif kajian ini adalah untuk mengemas kini peta geologi Kuala Pergau Kelantan dengan skala 1:25 000, dan menghasilkan peta bahaya banjir dengan mengenal pasti zon banjir kawasan kajian. Pemetaan geologi yang dijalankan adalah untuk mengenal pasti semua ciri geologi yang ada di kawasan. Data selanjutnya akan diteruskan dengan pendigitan dan integrasi yang kemudian dianalisis untuk menghasilkan peta.Hasilnya menunjukkan bahawa kawasan bahaya banjir dikategorikan kepada tiga tahap iaitu yang rendah, sederhana dan tinggi untuk membezakan tahap risiko di kawasan tersebut. Oleh itu, kajian ini amat berguna untuk penduduk Kuala Pergau, untuk meningkatkan proses pengurangan banjir dan pengurusan banjir untuk pelan masa depan.

**Kata kunci** :Pemetaan geologi, Pendedahan banjir, Pegau,Kelantan

**Geology and Flood Hazard Analysis of Kuala Pergau Town**

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**Abstract** : Flood has become phenomena in an area of east coast area of Peninsular Malaysia due to heavy rainfall during monsoon season. Although it happens every year, the effects caused by flood cannot be reduced and it remains an inordinate threat to people since the flood hazard map methods apply is not comprehensive . Therefore, effective flood hazard map management process is needed in order to overcome and reduce the losses in the future. The flood phenomenon occur will leads to a tremendous effects in terms of social, economic and environmental degradation. Recently in the year 2014, Kelantan again experienced massive flood that almost the same as the previous record in 1967 in terms of scale and intensity. Thefore the study area is located at Kuala Pergau Kelantan, Kelantan. The total area of the study are is 25 km.The objectives of this study to update the geological map of the Kuala Pergau Town Kelantan with scale of 1:25 000 , and to produced flood hazard map by identifying the flood zones of study area .Geological mapping that were carried out to identify geological features that have in the study. The data is further proceed with digitizing and integration which are then analyzed to generate the map. The result show that the flood hazard area was categorized into three levels which are low, medium and high to differentiate the degree of risk at that area. Therefore , this study is very useful to the Kuala Pergai Town villagers , in order to improve flood mitigation process and flood management for future plan.

Keywords:Geological Mapping , Flood Hazard analysis , Pergau , Kelantan

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# CHAPTER 1

# INTRODUCTION

## 1.1 General background

This research entitled as 'Geology and Flood Analysis of Kuala Pergau Town, Kuala Krai, Kelantan. Kuala Pergau Town located south of Kuala Krai and the area is surrounded by hills .The population of this area which is 13, 173 in 2010 (Council 2010).This town located around 70 km northwards and Kuala Krai is located at the area of the populated flood plains in Peninsular .This area of this district around 2,287.10 km² and it's the second large district in this state. Kuala Krai has divided into 3 small districts that area Olak Jeram, Batu Mengkebang and Dabong. This research is focus on the Kuala Pergau Town ,Dabong area.

Dabong known attractive spot as tourism place that area Gunung Stong State Park like waterfall that name as Jelawang waterfall that known as one of the highest waterfalls in South East Asia. There are several mountains that can be found at Dabong that is Ayam Mountain, Stong Mountain, Baha Mountain and Beirut Mountain.

Urban analysis can be defined as a spatial progress based on human attitude according to Shimofusa (1987). In general, the process urbanization was built and develops occurring at the specific area such as basic facilities, education, living style, basic health facilities and transportation. The study area also already exists and has undergone the development phase. Based on geography term, urban is a branch of human that related with various aspects of cities. The urbanization is one of the processes to development of human population, economy status and full fill the basic need.

This analysis concerned with theories and method that concerned about the study area. Urban analysis is analysis the information from the area involved and will provided the background knowledge and important key for any urban planning in future. It does also can give the data to fix or develop the process of urbanization. Urban analysis more focuses understanding of surrounding and organization of social , economies , hazard and the urbanization that give benefit to government and citizen to build the cities. It's the formal planning before and after urbanization to make sure the development of city can give high impact in long term.

This research analysis can be measured and combined with the software that are Geological Information System (GIS). This software very useful and important because this software can visualize and analyze the spatial data at the study area. It's also can use to analysis about the process of spatial distribution. The geological map can give people more detail information about the geology features on the area. It is helpful in understanding the geological thing at the Kuala Pergau Town area. The map included the type of landform, stratigraphy and the structural geology at the study area.

Urban analysis should more concern about the several aspects such as the type of landform, landscapes, geological process or geological resources. The most important is must the recognize the type of hazard that have possibility to occur at the area such as landslide, flood and slope

failure. Using GIS software helps the process of determination potential area of the hazard and makes the zonation map.

GIS is the best software to solve and determine the result of the urban analysis .It's because according to Han and Kim (1989), GIS in urban are planning is concern about the availability of data, organizational change and staffing, planning models, visualization and it capable of integrating data for various sources to provide the important information to get the efficient result decision making in urban planning.

This research is study geo-hazard that has the relationship with urbanization. Flood is the most frequently natural phenomena that give high impact in term of human and economic loss. Its caused high damaged to agriculture, settlement and livelihood for citizen and government. Every year flooding occurring in Kelantan cause many damages like social, economy and city. These phenomena occur especially at Kelantan River and maybe induced by rainfall.

## 1.2 Study area

### 1.2.1 Location

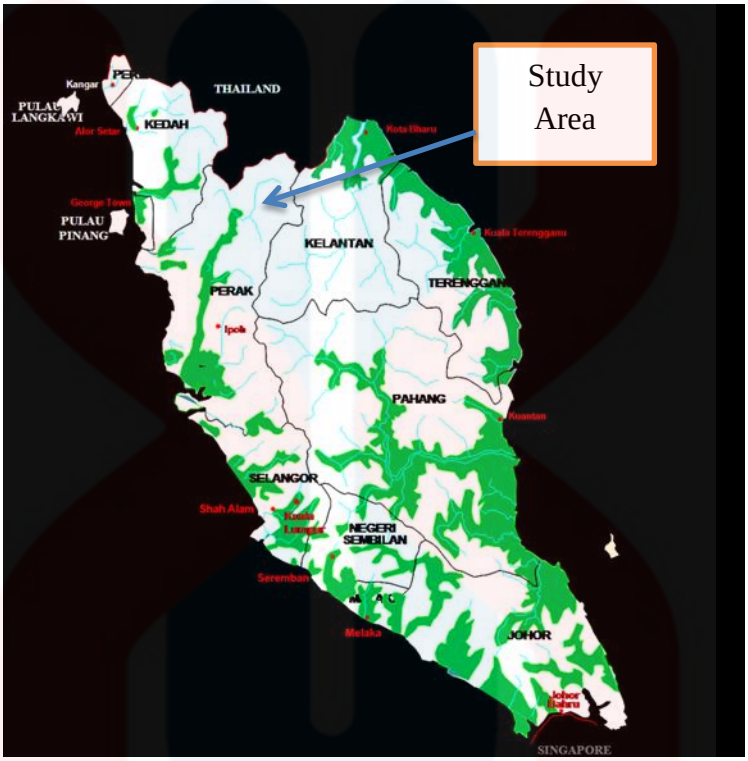



**Figure 1.1** : Location of study area

(Sources: Department of irrigation and Drainage)

The study area for geology of Kuala Pergau Town, Kelantan at the coordinate:

**Table 1 :** Coordinate of the study area

| | |
|---|---|
| A | 5°24'6.03"N<br>103° 1'0.74"E |
| B | 5°24'6.03"N<br>103° 3'43.60"E |
| C | 5°21'20.03"N<br>103° 3'43.60"E |
| D | 5°21'20.03"N |

| | |
|---|---|
| | 103° 1’0.74” E |


**Figure 1.2:** Study area of Geology of Kuala Pergau Town, Kuala Krai, Kelantan

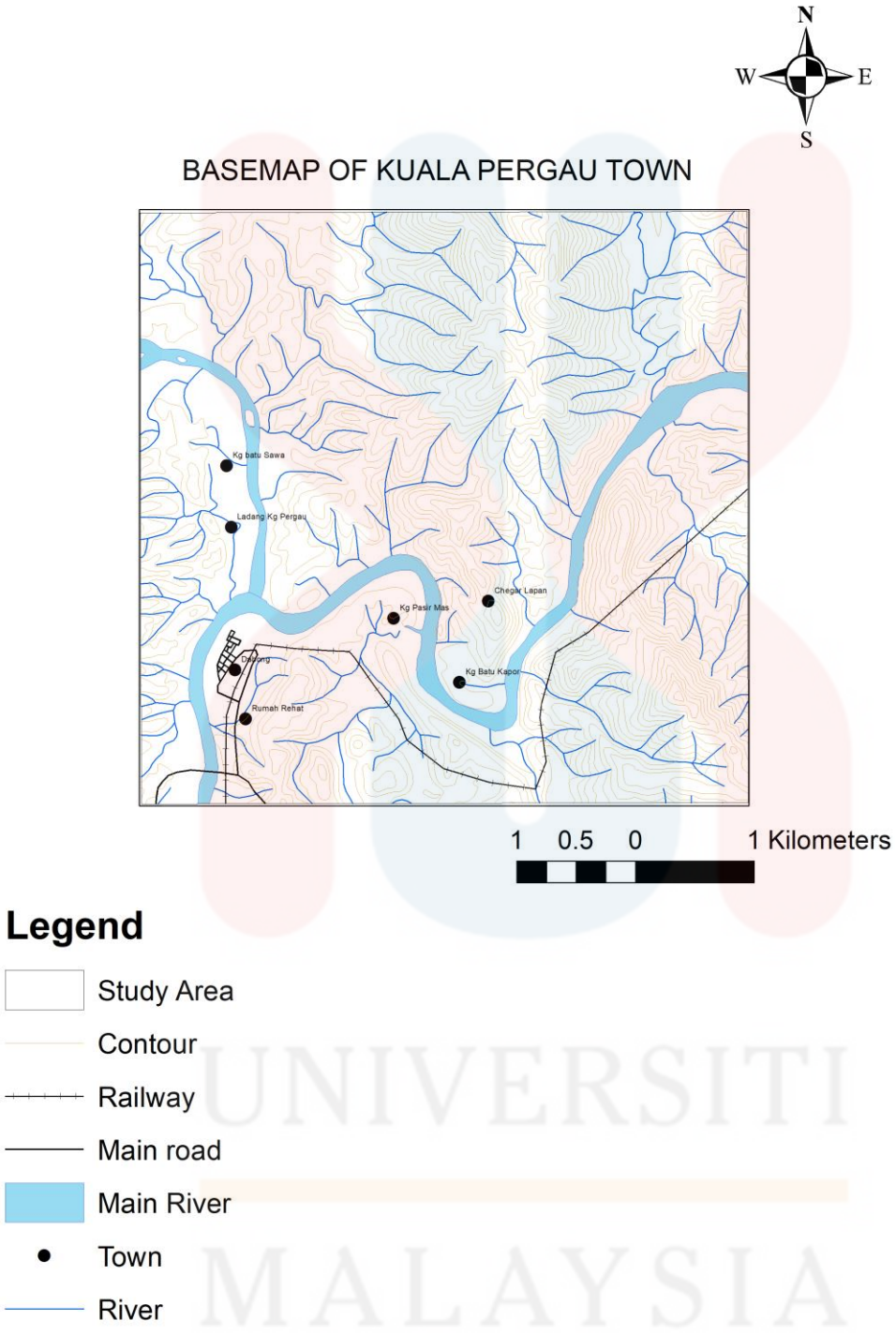



**Figure 1.3:** Base map of Kuala Pergau Town

### 1.2.2 **Road connection and accessibility**

Road is an important and main element in a daily life for reach into the few area because connect one place to another place. There are a few types of road connection such as railways, highways and river road. The driving routes also can reachable from the main road of Kuala Lipis – Merapoh if the driver is from southern Peninsular Malaysia and from the center part of Pahang. The category of road is federal road and residence.. This train travels from southern until the last station in Tumpat Kelantan. Many facilities and accommodation was provided in order to help residents in Dabong.

To reach Kuala Pergau tow, there are two main roads that can be used to get to this area. First one is the Kuala Krai road that comes from Machang and Kota Bharu. Then, second is Kuala Pergau Town that can be reached by going through Gua Musang road through Tanah Merah and Jeli.

### 1.2.3 **Demography**

Demography is the study of human population in both aspects which are quantitative and qualitative. Quantitative concerns with the composition, distribution, growth and structure of the population meanwhile qualitative emphasizes on sociological factors such as education, development, race, and wellbeing.

The estimated total population in Kelantan was 1 539 601 with population in 15, 101 km area (Department of Statistics Malaysia, 2010). Kuala Krai was populated by the total of 163,952 people in which 149,018 people are Malays, 9,862 are Chinese, 4,545 are Indians and 527 are the others is non-Malaysian Citizen such as immigrant from Bangladesh, Myammar and Indonesia settled in this state as a workers at the palm and rubber estate (UPEN Kelantan 2010). The estimated population in Kuala Pergau Town around 5,721.

**Table 1.2:** Total people distribution in Dabong (2010).

| Jajahan/ Local Authority Area | Total | Age Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 |
| Jajahan/ Local Authority Area | Total | Age Group | | | | | | | |
| | | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75 |
| M.D,Dabong | 40,659 | 4418 | 4581 | 5573 | 5010 | 3929 | 2688 | 3251 | 2161 |
| M.D,Dabong | 2045 | 2018 | 1982 | 1454 | 1235 | 900 | 900 | 705 | 616 |
| Dabong | 1,356 | 132 | 143 | 175 | 155 | 93 | 96 | 75 | 66 |
| Kemubu | 1133 | 123 | 133 | 161 | 136 | 58 | 48 | 93 | 55 |
| Manek Urai | 1638 | 133 | 195 | 241 | 228 | 111 | 94 | 69 | 75 |
| Remainder | 36532 | 3740 | 4110 | 4996 | 4491 | 3030 | 2450 | 2060 | 1965 |

(Source: Local Authority and State Malaysia)

### 1.2.4 **Land Use**

According on the government data that are Rancangan Tempatan Jajahan Kuala Krai 2020, the town have the the basic facilities to improve the social economic and industrial. The land use data can be obtained from District Council of Dabong and the software such as Google Earth. This land use planned to develop the functional and effectiveness of the town development.

The land use at this district, Dabong has been categories into a few areas such as residential area, plantation area, transportation area, infrastructure and utility and forest area. The residential area was located at the Kuala Pergau town. The public transport and Healthy Care Centre that were built by government can be found in the Dabong area. Plantation dominated in the Dabong area such as palm oil plantation, rubber plantation and planting vegetable by residents.

In Kuala Pergau Town, mostly about under alienated and another of the land is under state land status, while others are under-reserved land. As on the study area clearly, most of the land is used for rubber and forestry. Besides, there has development area which has built town for people come to process and have business

### 1.2.5 Social Economic

Services sector dominated Kelantan gross domestic product by 54% and followed by 33% of manufacturing. Agriculture contributes the gross domestic product by 9%. For this study area the foremost social economic generate income is from agricultural activity. Palm oil plantations and rubber plantation is the main social economic at the study area. Local residents continued with traditional economic activity such as fishing, hunting, collecting herb to make traditional medicines and others.

## 1.3 Problem Statement

There are not updated geological map and hazard maps for the Kuala Pergau Town area itself. This research will produce the map in 1: 25000 scales of study area for update the data of the geological features and type of hazard that occur in this area. Function of the geological map can give people information and can identify about the geological problem at the Kuala Pergau Town area. The geological mapping is crucial to be redoing as many geological processes that act on the area can give effect to the landform.

Hazard such as flooding usually occur in Kelantan state that give high impact in all aspect of life. This disaster causes more damaged in physically like population, homes, infrastructure and public thing. This disaster has made the urbanization for Kelantan state especially in Dabong stopped and took a long time to recover. Around 1 billion Ringgit Malaysia have been estimated for the infrastructure damaged. The result of this research will produce after finish identify the potential hazard on the study area, so the map can help and provide the information to district council as a reference about the situation within Dabong area.

Before any new urbanization of an area there are a several safety thing and law that need to be followed before start build any building at a new area. Geologist must start the research and investigation about the geological formation such as strength of hill, type of soil, geomorphology condition and the most important is the hazard potential of the area to help and give the suitable condition that the area is very suitable to develop into the urban areas. This disaster caused many problems in high value and there must have effecting ways or modelling to know the solution and mitigate the effect of this hazard. One of the factors this disaster become big is human activities such as uncontrolled construction building and land use changes. Duration and volume of rainfall also are the most influencing factor for flood hazard.

## 1.4 Objective of Study

1. To produce geological map of Kuala Pergau Town, Kuala Krai , Kelantan in the scale of 1: 25 000.
2. To analyze flood hazard in the study area.
3. To produce flood hazard map of study area.

## 1.5 Scope of Study

This research is to focus on the geological features at this area. Geological mapping will be conducted to determine the overall geology of the study area that have an area around of 25km² (5km × 5km). Then , analysis about factor of flood at this study area using flooding mapping. This aspect is important to the people in this area to aware about the hazard that can give high impact in their life. The output from this research, the zonation flood map can be produced to the public as a

reference. The parameter for this research area rainfall distribution, depth of river, duration of rain fall, land use, hill shade and drainage patter.

## 1.6 Significance of Study

### 1.6.1 Geological mapping

A geological map gives much essential information to help understand the processes that gives positives and negatives effects to the region of Earth in both past and present days. This information is very fundamental in order for a geologist to explore, protect and extract natural resources such as petroleum, groundwater, ores, sands, etc. Besides, geological map also act as a primary source of providing information of the distributions of different types of rocks and sediments that most probably to contain these geological resources. This research is important to produce an updated geological map of the study area and would contribute data of Kuala Pergau Town for future research and developments to government and private sectors.

### 1.6.2 Flood hazard mapping

Flood hazard maps are created to inform and increase awareness of the like hood of flooding among the public, local authorities and other organizations, especially at Kuala Pergau town area. Flood hazard analysis is known and study out about how much water that flow down a river and also figuring out where that water is going to go. Data is available to help define water volumes and flow characteristics, calculating flood extents and flood depths. It also encourages people living and working in flood-prone areas to find out more about the local flood risk and to take appropriate action. So that such flood event as 2014 effect can be overcome. Furthermore, this map also can be used as a reference for the flood management in the present and future in

order to reduce their social and economic impacts as flooding is a threat to life and leads to damage of property.

### 1.6.3 Rainfall Distribution

A general view of the rainfall distribution prior to the flood is made based on the rainfall distribution published by the Department of Irrigation and Drainage (DID) Malaysia. From the previous research rainfalls were recorded from 15 to 29 December 2014 is most heavy in this decade. The rainfalls which may contribute to the flood occur in two phases. Phase one begins from 15 December to 19 December 2014 with daily rainfall reaching up to 100 mm to 300 mm. During this time most of the rainfall was concentrated to the east coast of Peninsular Malaysia, especially the coastlines of Kelantan, Terengganu, and Pahang. Phase 2 begins from 20 to 24 of December 2014 were higher intensities of rainfall were recorded. The daily rainfall during this phase reaches up to 500 mm and was more concentrated in the middle of the peninsula especially areas center of Kelantan, Terengganu, and Perak. During this second phase, Kuala Krai, Dabong, and other areas experienced the extreme flood.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

The chapter provides a summary of the literature analysis conducted to gain an understanding of different components of studies of this research. This reviews the various literatures which provide definitions relating to the term flood hazard itself, followed by classification forms and possible causes for the initiation of such a dangerous phenomenon in and around us.

This chapter also reviews the various approaches taken to quantify flood hazard from different domains, and possible combinations to determine rather significant hazard scenarios. A literature review is important to know the formation, age of rock, plate boundaries and history of the study area that can get from previous research. The data or information can obtain from journal, book, publish, papers and scientific reports

## 2.1 Regional Geology and Tectonic Setting

According to van Hinsbergen, D et al (2018) , total land area of Peninsular Malaysia of 130,268 km² which is part of the Sundaland that include Borneo, Jawa and Sumantra as well as the intervening shallow seas which emerge a number of smaller islands. Based on Tan, B. K. (1984), Peninsular Malaysia were divided into three tectonic belts that area western belt, central belt, and eastern belt. For Kelantan state, central belt cover most of this state. This belt is around Permian – Triassic rock are the most widely distributes rock unit and rest are Jurassic / Carboniferous. The sediment rock around this state is rich with volcanoclastic rock other than clastic sediment rock and even carbonates rock. Sediment at Permian-Triassic is deposited at the sea while Jurassic / Carboniferous sediment is continental.

Kelantan shares boundaries with another state such as west Perak, south Pahang and east Terengganu and also with country like Thailand that 71 km fronting the South China Sea to the north and one of the partly the Asian continental north-west with a coastline of. This state has an area of 15,022 km that have divided into ten districts.

As regards of the regional geology, there are 3 major area is in at East Kelantan that consider as related with the research. It consists of the Kuala Krai, Olek Jeram and Dabong. For this research, Dabong used an as study area. At Dabong area, Stong Migmatite Complex was found and its formed mountainous country that lies about 8 km west of the railway town of Kemubu and Dabong. Based on Ibrahim Abdullah and Jatmika Setiawan (2003) that the area is around Late Cretaceous Kenerong Leucogranite and its enclaves was exposed at the waterfall near to electricity power stations.

## 2.2 Stratigraphy

Kelantan was described as the Palezoic formation that has been found in the central belt in Peninsular Malaysia. Upper Paleozoic rock is made of Gua Musang Formation and Aring Formation in the south of Kelantan. Upper Paleozoic sediment consists of marine Permian strata that occur as linear belts flanking Mesozoic sediments in the Central Belt and Taku Schist in Eastern of Kelantan.

The Taku Schist border as the biotite graded low or high (Macdonald 1967). According to Lim and Khoo (1976) The Taku Schist that include with the enveloping rock show a series that from chlorite to biotite and garnet area and it can be improved by mapping in the Manek Urai area. The type of metamorphism is the Barrovian types such as are zeolite, Green schist, Amphibolite and Granulite. The late intrusive of contact metamorphosed, the rock will substitute an andalusite (Macdonald 1967).

## 2.1 Structural Geology

The main structure that was formed at these areas was a Stong Complex. The Stong Complex is located in the North and consists of three type component that are Berengkat tonalite, Kenerong microgranite and Noring granite (in order of deceasing age).

The Lebir Fault Zone was formed and can be traced by the RADARSAT imagery as a borded of zones of NNW-SSE trending curvilinear lineament along Sungai Lebir near Manek Urai in Kelantan. The lineament was continuously traced to south, passing along the granite batholiths east of Sungai Lebir and western of the Gagau Formation and also the eastern margin of the Koh Formation.

The fault zone occurs at least 10km wide, the gapping between Sungai Lebir and the margin of the Taku Schist near Kuala Krai. The rocks within the fault zone were deformed into brecciated metasedimentary, flasered granites and mylonites. The structure that can be form is

slickensides and on the fault surfaces it was exposed by road cutting and indicated the sinistral movement. The fault zone has a sinistral slip based on tension fractures and drag fractures Tjia (1969).

Sinistral movement also found along the fault zone in Sungai Aring area (Aw 1990). The Lebir Fault Zone passes through the Jurassic-Cretaceous basins containing the Tembeling, Gagau and Koh Formation. The latest Trassic to Jurassic – Createceous basin were formed and deformed by strike-slip movements along the fault zone (Mustaffa 2000).

## 2.5 Historical Geology

Dabong is an area with a small town located in the southern province of Kuala Krai. The area was consisting of three types of rock distribution which are granite, limestones and phyllite with subordinate sandstones and schist. Most the type of rock found here are influences by lineament, where acid intrusive igneous rock can be found in the river side. The oldest rock here is believed that composed of phyllite, slate and shale rock.

The Triassic period donated the start of real changes that were to happen all through the Mesozoic Era especially in the appropriation of landmasses, the advancement of life and geographic dissemination of living thing. Physical atmosphere was predominately warm and dry and the Erath outside layer was moderately tranquil. Dabong composed by the Berengkat tonalite, Kenerong microgranite and Noring granite structure.

For example, the Noring granite is the biggest part of the Stong Complex, it forming in oval-shape pluton. The components are consisting such as a Terang and Belimbing hornblende bearing facies. The Noring granite is under formed and divided by distinctive pink K-feldspars.

## 2.6 Research Specification

Urbanization refers to the process where the urban area change becomes urbanization as a result of economic development, government and industrialization (Bahar, 2015). This can give the positive impact to resident to face the more challenging and competitive development in future (Lim et al, 1999).

The term of demographically is refers to the redistribution of population from the rural to urban settlements over times. Urbanization partly a corresponding the increasing of the world population but urbanization is not only focus on the total of human living place (Lowry, 1990).

The research area was experienced a process of urbanization when there are new development in the area. Based on the Average Annual Growth Rate (2000-2010), the total of people distribution in Kuala Krai is increasing by 0.99% compared to 1990-2000 is 0.11%.

There are several factors that influence the increasing number of people distribution in the study areas such as economic growth and national development, facilities, road connection and job opportunities. There are several security parameters to be considered for the establishment of an urban area. For example, the planner should do a research from a few aspects such as water resources, road connection, network accessibility, type of rock and soil.

### 2.6.1 Urban Analysis by using GIS

GIS applications used in planning agencies in the developed countries, (Yeh, 1991). Many planning department is used the GIS system to acquired mapping in the past (Wiggins and French 1990). GIS is now an operational and affordable information system for planning urbanization system.

The main function of GIS in urban planning is not only the technical issues but the availability of data, organizational changes and staffing. GIS is used for the storage of land use maps and plans socioeconomic data and environment data can be digitizing by using GIS. Planner can extract useful information from the data base through spatial query.

The planner mostly using the GIS application to improved map currency, more effective thematic map and reduced storage cost. GIS and remote sensing can be used to analysis potential hazard in the urban area. GIS can be helpful to improve analysis of the result.

### 2.6.2 Flood in Kuala Pergau Town

According to Roseli et al (2016, April), Malaysia is located at tropical zone and high precipitation area that frequently hit by flood events when it is near monsoon season. Kelantan state located adjacent to the coast of South China Sea and the expansion of settlements on plain topography, a majority of the population in Kelantan are highly exposed to floods, especially during the northeast monsoon season occurring from November to March (Chan 1997). Floods have been recorded in the state every year over the past decade Small floods are occurring every years on average while large floods are generally less occur. The December 2014 flood in Kelantan was unprecedented and the largest recorded flooding event in the century. The flood was preceded by more than a week of continuous rains, with intense raining period from 14th to 19th December 2014 with rivers exceeded the danger level by 17th December.

The most damage that can see when this hazard occurs in 2014 is loss of property, loss of life, pollution, disruption of social activity and health problem. Furthermore, if the flooding takes more time and long period the population property damage increase (Rahman & Haque, 2005). In 2014, all districts in Kelantan state was hit by this hazard. However, Kuala Krai district is the most

impact that can be seen. The economic, social live and public thing situation was very bad and takes long time to repair all damage. This disaster clearly showed when Bandar Kuala Krai cover by the concept of hazard, risk and disaster. The flooding start when level of Sungai Kelantan and its branches , Sungai Galas and Sungai Lebir , increased not like usual because the heavy rainfall on that time. It's because the river was not able to accommodate high volume of water and its spill over into the city area . Its affected human and environment in big scale At that time, the level of water around 34.17 meter which surpassed the dangerous level that 25 meter (eBanjir Negeri Kelantan).

### 2.6.3 Flood Hazard

Flooding is the phenomena and related to hazard in all country. It can occur anywhere. Flood can be defined as water overflowing onto land that usually dries. It is one of the result of heavy rainfall, but it not depend on whether events. Flood also can occur when the water level in rivers, stream, lakes that rises enough to overflow bank and inundate and adjoining land (Micahel J & Chrzastowski) . There are much type of flood that are river floods, ice-jam flood, flash floods, urban floods and coastal floods.

Hazard defined as "the extreme natural events which may affect different places single or in combination at different times over a varying return period" (Blaikie *et al.* 1994). Hazards related to geomorphological processes, such as earthquake, volcanic, eruptions, landslide and floods are called geo-hazard. Flood hazard can be measured by of their damaging values, conceived generally as flood risk, or by their impact on society, conceives usually as the loss of lives and material damage to society.

A river flood hazard results from a water level that overtop the banks-natural or artificial-of a river and threatens human life and property. Economic impact, vulnerability and flood and other

natural hazards is vital in determining potential economic impact, vulnerability and flood management policies. Increased risk as a result of climate change combine with rapid urbanization urge for further insight into the volume and distribution of economic losses.

### 2.6.4 Rainfall Distribution

Heavy rainfall is the most widely reasons for flood. Flooding might be arising because the natural watercourses do not have the capacity to convey excess water. Extraordinary rainfall together with source water that cannot saturate into the ground will be carried away down the slope as runoff. The measure of runoff depends on the amount of rain experienced in that specific region. When the water level at the river or lakes rises due surpass the limit, it will exceed to river banks and the water starts to overflow to the areas adjoining to the river or lakes, causing floods or deluge. (Department of Hydrology, 2011).

### 2.6.5 Flood hazard mapping methodologies

**Geological- Geomorphological**

Geological-geomorphological methods that were used by the arrangement and types of landforms and deposits generated during or after the flood event. Generally, according to Baker et al (1988) this method can delimit geomorphologic active areas within the stream channel and its banks, and areas prone to flood inundation within the framework of the stream's natural dynamics, their qualitative flood frequency, and even infer the order of the magnitude of certain parameters such as depth, velocity and transported sediment load. These techniques are gaining strength because they are the only ones which consider natural phenomena very difficult to model with

other techniques, such as avulsion, channel migration, or sediment transport, and take into account natural developments of the fluvial system.

### 2.6.6 Geographical Information System (GIS)

GIS software has been recognized as an effective tool to manage and analyze data from various sources in the context of comprehensive floodplain management. Adequate information and prediction capability are crucial in order to evaluate alternative scenarios for flood mitigation policies and to improve decision making processes associated with a flood (Chan, N. W., & Parker, D. J. 1996). Besides, GIS will assist in facilitating the operation of floodplain mapping and flood risk assessment.

### 2.6.7 Remote Sensing

Remote sensing will allow the user to use and access satellite imagery (Donoghue, 2002). Other than that, it can be used to examine carbon stocks and their response to human interference through deforestation, urban development and other land use changes. Remote sensor data is important in land use and land cover mapping and inventory. Remote sending data give information such as accuracy and scale to fulfil requirement for the specific. Integration of multi-source data allows remote sensors to create previously inaccessible geospatial data for monitoring and modelling. Remote sensors on the satellite, airborne platform, and a wide array of ground-based instrumentation including sensor networks, wildlife GPS collars, and the weather stations, produce sites of satellite data about the ecosystem and the species that occupy it. Satellite data can

therefore identify global Spatial (1 m to 1 km) and temporal (daily to annual) benchmarks to monitor most impacts on the environment such as climate change, disturbance, and land use.

The application of remote sensed data enabled people to analyse changes in land cover in much less time, at reasonable cost as well as with improved accuracy in involvement with GIS, offering an acceptable platform for data analysis, upgrading and retrieval. The user uses tones, shapes, texture, pattern and site association from what is basically land cover information to analyse and interpret information about land use activities. The remote sensor receives a response based on plenty of land surface features, including natural and artificial coverage.

# CHAPTER 3

# MATERIALS AND METHODOLOGY

## 3.1 Introduction

To complete this study, some materials and methods are used and conducted in order to fulfill the objectives mentioned. The methods include preliminary study, field and laboratory study, data processing and then data analysis.

A material and method were chosen to accomplish this research so that the data required for this research could be collected and analyzed. There are several different steps including the geology and the specification. Preliminary work is based on studies map studies.

Next, study about the literature and previous research papers, books, and journal as the information and as the reference that relate with this research. For the base map, its will give geomorphological information for the study area.

Second, data collection was collected during the mapping process at the study area meanwhile the rock samples were also during this time because it can save time and cost. From the data processing, the land use map, geomorphology map can be produced and have an addition data. From the processing data that get from the parameter, the zonation map will be produced and fulfill the objective of this research.

## 3.2 Materials for Geology of Kuala Pergau Town, Kuala Krai, Kelantan

The suitable material is important during this research and suitable methodology must be determined in order to analyse the result. The listed materials were used at the site to collect and record the data before doing the laboratories test. There were a few materials that related with general geology method that applied at the field.

### 3.2.1 Base Map

Base map of the study area is produced by using GPS application. This base map contains little basic information such as river, elevation of contour, main rivers and the village at the study area. It also can be used as a reference to know the topographic condition of the study area. It shows the rough idea about the study area and what point to reach; which data need to be collected and a few steps of mapping process.

### 3.2.2 ArcGIS

This software was used to produce the base map of the study area and another type of map. Arc GIS 10.0 was used in this study to create, display and analyses geospatial data. GIS was established in which both the image and graphic data are stored in a digital form, retrieved conditionally, overlaid on each other and evaluated with the use of a model.

There were several functions of GIS which is used to store and manage geographic information comprehensively and effectively. It also can display geographic information depending on the purpose of use and can to execute query, analysis and evaluation of the geographic information effectively.

While, Arc Catalog was used for browsed and explored spatial data Arc Toolbox is an interface for accessing the data conversion and analysis function. GIS was used to analyses the trend of spatial feature based on small division area. All information was presented and explained

based on the type of map. For example, the types of maps are geological map, traverse map, land use map, topography map, sampling and location map, geomorphology map and drainage map.

## 3.3 Methodology for Geological Mapping

### 3.3.1 Preliminary Study

One important step when carrying out a research study is to review the previous literature on the topic and use it as a reference to create a new study. Literature review can bring transparency to the research problem and widen the knowledge about the topic discussed while finding the achievable knowledge gaps.

Preliminary research is the crucial step before do the research. Preliminary research usually encompasses a few aspects. There is about area of study, know the area's geomorphology, the type and distribution of rock, the area's geological condition and the formation. Before doing the research, that is the basic information.

This information can get from a several types of sources like journal, thesis, test book and private sector of geology. Geomorphology is an important part and the urban area is a main objective in this research. This research needs to accomplish with a mapping method.

From the previous research and the journal, these areas are covering by little mountainous area and connecting with a main river of Kelantan such as Galas River and Pergau River. This area was recognized as a Stong Complex and based on Alexander (1965) it was identify as a result of dynamo thermal or regional metamorphic. These areas have a railway road that starting from the Kuala Lumpur Centre.

Geological mapping is a technique where the base map produced is plotted with location and attitudes of rock units, faults, folds and other geological structures are identified during mapping within the study area.

### 3.3.2 Data Processing

To produce a geological map, a software that area Geographic Information System (ArcGIS) is used. The information and data that is required during geological mapping is put into ArcGIS software and is processed. Decision-making requires information generated from spatial search and the necessary operations performed. The database and graphics were manipulated and processed to generate information for GIS analysis about the entities (spatial feature). Using ArcGIS, data was retrieved from the database such as graphics and tabular data. GIS analysis helps to determine the fitness of the database.

### 3.3.3 Data Analysis and Interpretation

All data that will be obtained from the field work observation will be analyzed. By interpret the geological features and also using the GIS to identify the potential flood zones. For the flood hazard, it can be analyzed through river capacity, runoff in the catchment area and some geological factors. Thus, the level of flood hazard can be determine either it is in the categories of low, medium, or high potential of flood prone area.

Data analysis and interpretation for this part involves the petrographic analysis of rock thin sections that has been prepared. This petrographic analysis of rock thin sections is analyzed under a polarizing microscope for further recognition and identifies the presence of minerals, porosity, alteration, microstructures, and the origin of the rock.

### 3.3.4 Report Writing

This is the last step of this research is to make a report writing about the data and results of the research only. Conclusion and recommendation from the research of this study will be made then the objectives of research have been achieved or not.

## 3.4 Methodology for Flood Analysis

The study specifically focuses on interpreting patterns of land use change in the City and satellite and demographic data based on growth. This research was using Landsat images to calculate VSW (vegetation-soil-water) index images that clearly distinguish on the image 34 between vegetation, soil and water elements. Image processing software will be used for geometric satellite data correction, supervised classification, classification accuracy assessment, land use maps, change detection, final output maps etc. GIS software was used to digitize, integrate, overlay and present spatial and non-spatial land use change data in the city.

## 3.5 Flood Hazard Mapping using GIS

A hazard map and a safety map will be created for urban analysis. Based on (Seyf1 et,al. 2006), Applying the Flood Hazard Map (FHM) is a new approach to flood damage reduction. In order to the suitability of plains for economic activities and also population concentration, most of people, without any knowledge of flood risk, attempting to build structures and facilities. Flood Hazard Map as a guide, introduces appropriate locations for structure construction and also offers the population concentration sites. Mentioned map could represent the safe way out from flood plains and escape to pre-defined secure locations. A map which could presents the flooded locations and also emergency evacuation in a simple way and graphically, is called Flood Hazard Map. Flooded location prediction, depth of floodwater, safe and secure places for evacuation, the evacuation routes during flood and dangerous locations identification could be mentioned as the main items of a flood hazard map. In many developed countries, the preparation of FHM (Flood Hazard Map) is required for industrial and populated areas and most of settlement and development plans consider FHM.

In the data analysis phase, it can be divided into several parts for analysis all the data collection. The first part is digitizing all the sub-area to produce flood hazard map at Dabong, Kelantan, digitizing all the sub-area to produce flood exposure maps at Dabong, Kelantan. The final part of data analysis is digitizing all the data to generate the map of flood vulnerability along the Galas River in Dabong, Kelantan.

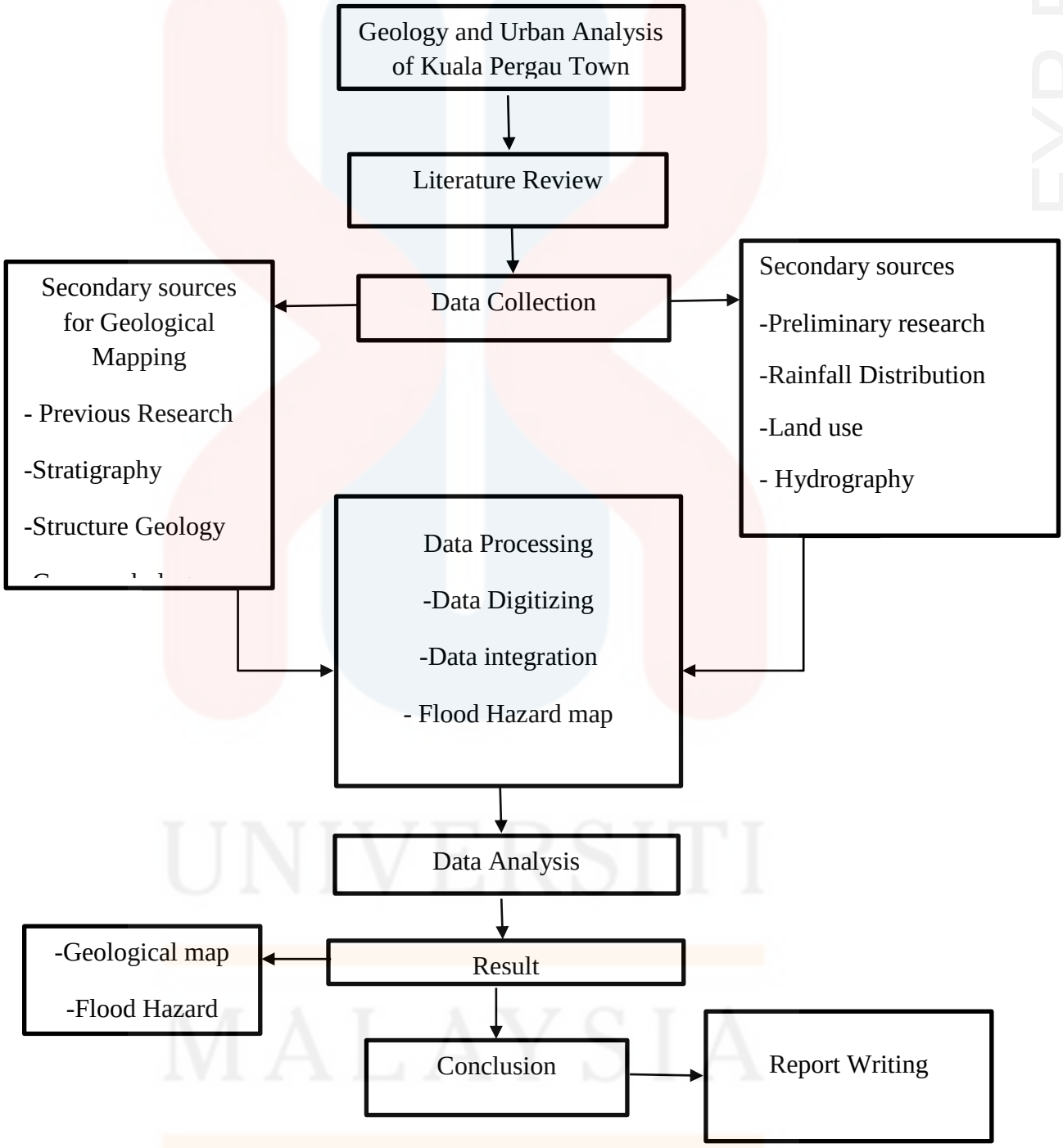
- **Digitizing all the sub-area data along Galas River in Dabong, Kelantan to produce flood hazard map.**

First phase of data analysis is digitizing all the sub-area along the Galas River in Dabong. This phase wants researcher use GIS software the layer of all sub-area in Dabong. Then, digitize all the sub-area through overlay process and compare with additions data such as hydrology data that researcher get from Department of Irrigation and Drainage System during data collection phase to identify the flood hazard in Dabong, Kelantan.

- **Digitizing all the sub-area data along the Galas River in Dabong to produce flood exposure map.**

Next, digitize all the sub- area data along Galas River in Dabong by referring topographic map of Dabong and identify all the elements that are exposed to floods. Next, digitize all the sub-area along Galas River to produce flood exposure map and related with all the elements that are exposed to floods. This base map is function as guidance when the researcher wants to digitized the extension of flood area.

**Research flowchart**



# CHAPTER 4

# GENERAL GEOLOGY

## 4.1 Introduction

This chapter discussed about the general geology that formed in this study area that Kuala Pergau Town. It will cover the information like geomorphology, stratigraphy, lithostratigraphy historical geology and also few map that related with this research. All the data were collected from the interpretation that can get from the satellite imagery like google earth and also from the previous research.

### 4.1.1 Content

General geology is analysis that gives the fact about features that form from the formation that produce the type of rock , mineral ,features that will effect to surrounding of area . This phenomena also will give effect to the urbanization that give impact from the aspect of hazard like flood and landslide. For this research , urban and flood will be discuss in the chapter of specification.

The method that use in this research by using the secondary data like from government also previous research and satellite imagery. From the satellite imagery we can get the data such as type of land use , morphology , settlement and accessibility in this study area.

### 4.1.2 Accessibility

Kuala Pergau Town were connected with one major road with other district like Jeli , Dabong , Gua Musang . To reach at this study area , there have 3 road that can reach there that area that are Jalam Dabong-Kemubu , Jalan Dabomg- Gua Musang and Jalan Sungai Sam-Dabong-Jeli. At this study area , we can conclude that to reach few place is hard because covered up with the vegetation. To reach upper part of study area , effect of the lorry that through in the vegetation area was very useful .Water transportation also is important to reach a certain area that must through Sungai Galas River .

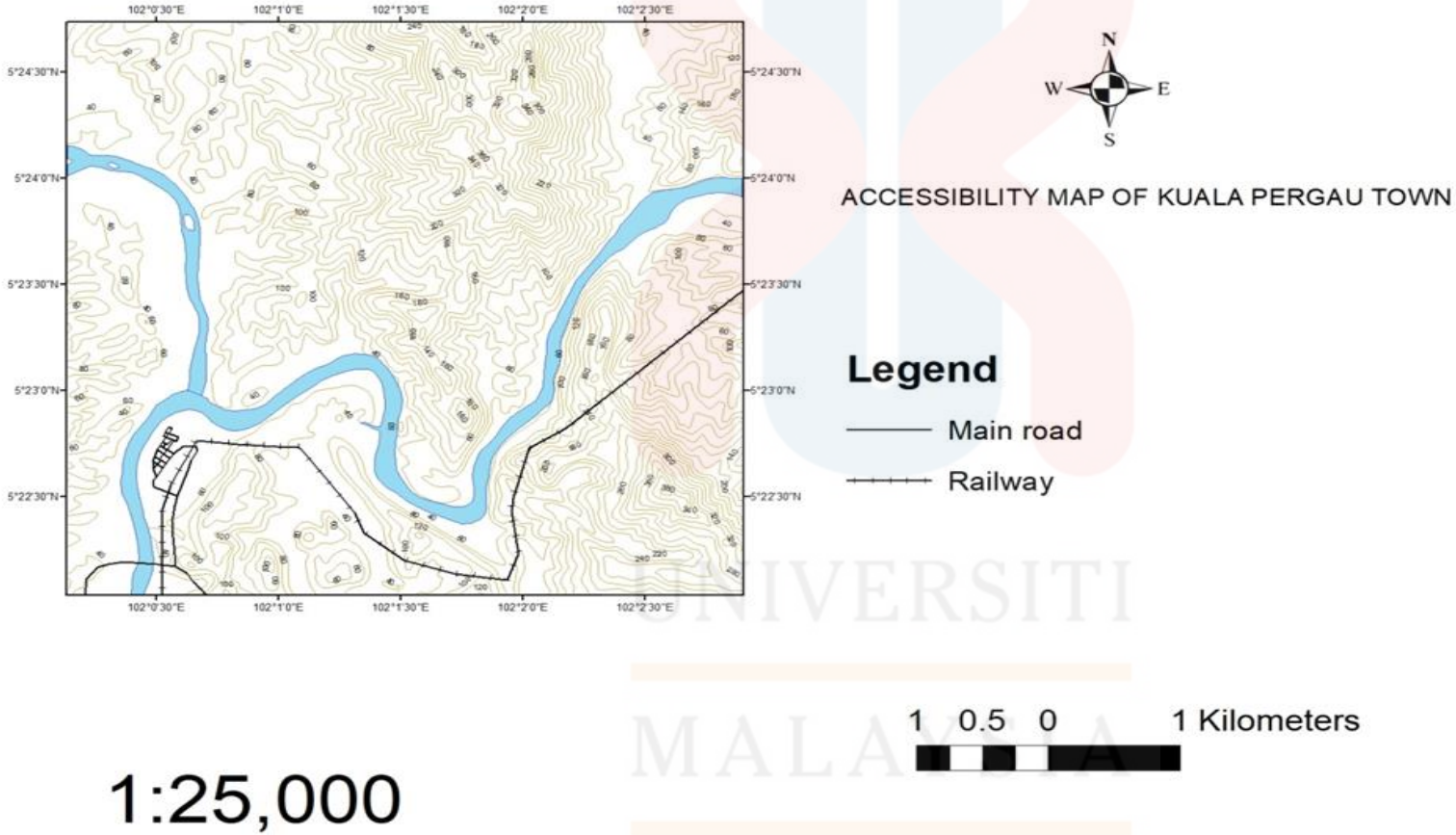



**Figure 4.1:** Accessibility of study area

### 4.1.3 Settlement

Flood map were produced to minimize the impact for our society. This map very useful to know where the suitable to do the construction and process of urbanization. The most important , this research can help village to understand the factor the flood exist in their area that rainfall intensity.The government also must do the research how to decrease the chance of this flood by using the technology in this situation.

### 4.1.4 Land use

Purpose of the land use analysis is to know what the usability the land in this research area. We know that land use can be divided into few types such as residential area , institutional area , industrial area , road greenbelt , roadside and forest. From this analysis and base map that show in Figure 1.1 ,we can conclude that are few type of land use in this research area. From this base map , we can see few village that exist like Kampung Chegar Lapan and Kampung Batu Kapor. Based on the interpretation and previous research , Kampung Chegar Lapan located at the middle study area that means above slightly of Sungai Galas. So its hard and dangerous for the villager to stay there because the only ways to reach there just use water transportation like boats. We can see its lack from the aspect of connection between this village and accessibility to reach town. From this map also we can see there is a town which is the activity point for the people. Furthermore , from the satellite image , we can see in this area that has few facility that can help people like mosque , school , police station and hospital.

From the land use map (Figure 4.2) , the research area can divided into two type that area forest area and plantation. Ladang Kampung Pegau that located at west to north part of the research area is covered up with palm plantation . Then the forest we can see its located northern part of the study area and rubber plantation exist in below part of the study area.

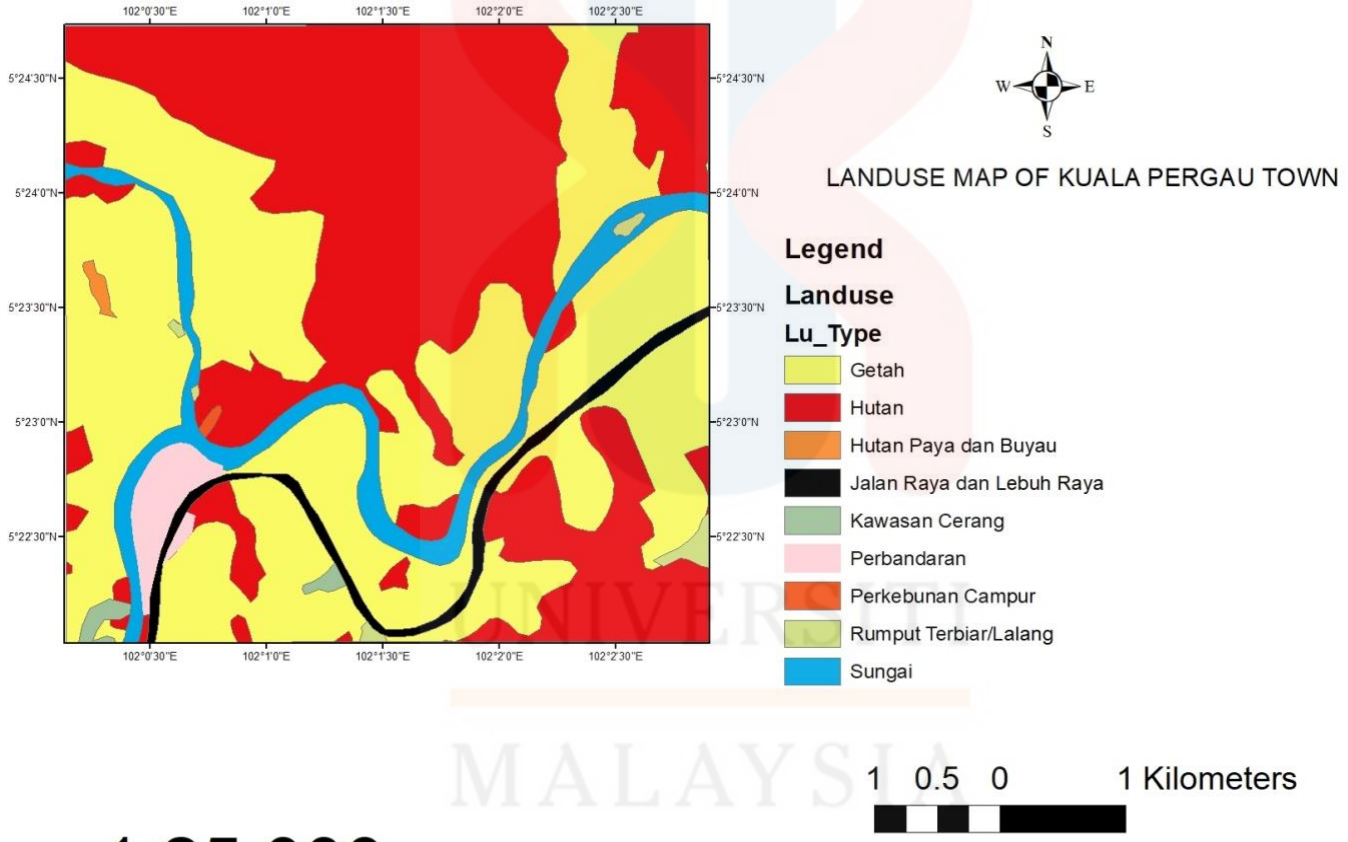



**Figure 4.2:** Land use of study area**.**

## 4.2 Geomorphology

Geomorphology analysis is based on the landform that forms at the research area. Geomorphology is study about history and related with earth surface that form from few geological process like erosion, deposition, weathering and also tectonic even or process. It will provide the information about the topographic things and also type of rock deposit in this study area.

From the analysis we can know the relationship how landform form and factor its exist in this study area. One of the recognized process is weathering process where it can be seen anywhere. Other than that, erosion process also gives effect on the earth landform along with the equilibrium and different in climate. Different processes give different influence on the landform

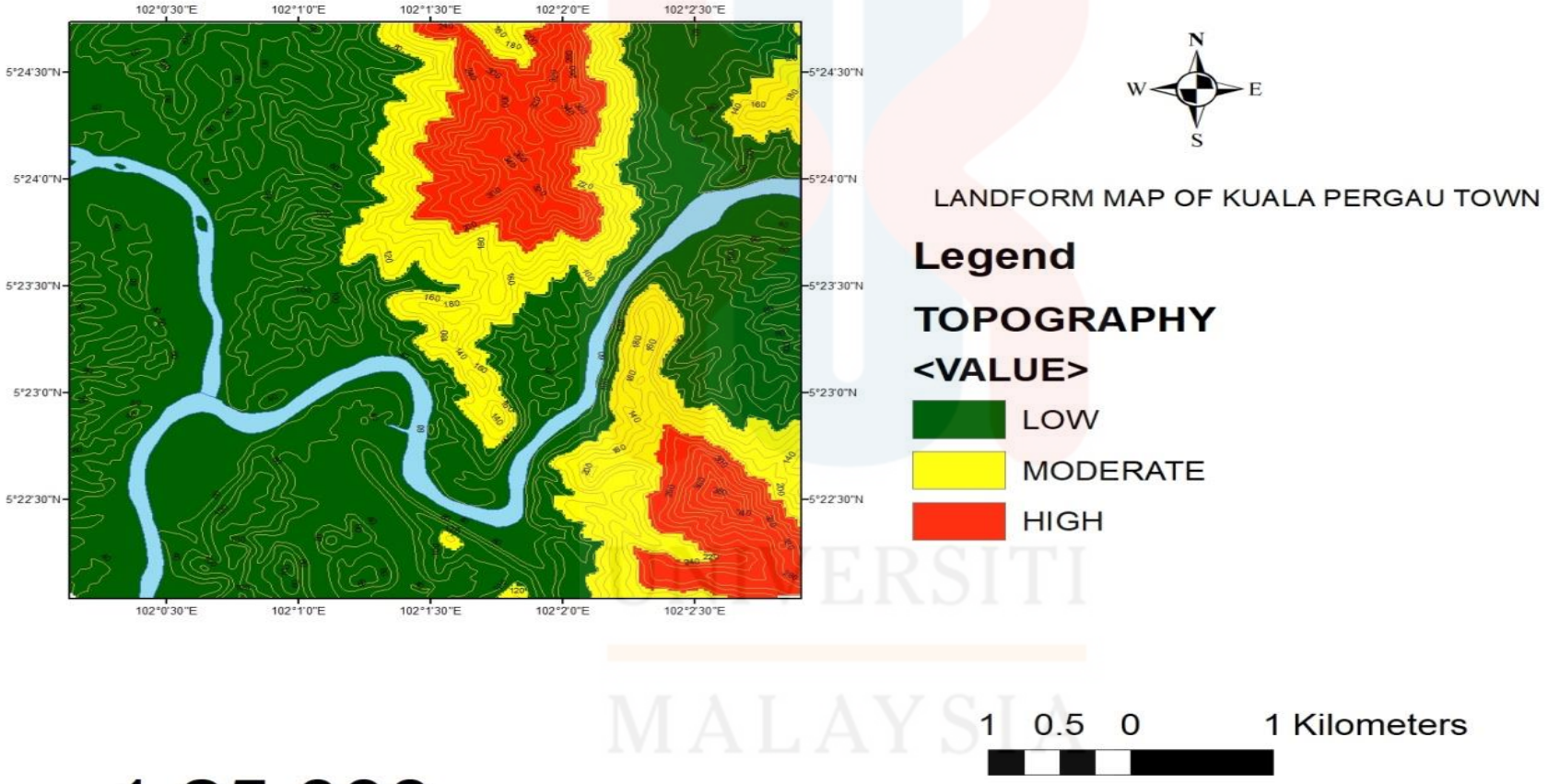



**Figure 4.3:** Landform map of study area.

### 4.2.1 Topography

Topography is the study about landform that form based on the few characteristic that are elevation , orientation , slope gradient and relief. For this research , we will be identify the landform based on the elevation to know about the unit and class of landform. To understand this thing , we must know the topographic unit based on the elevation and also the class. Based on the topography map of the study area, the lowest elevation is 20 meters meanwhile the highest recorded elevation is 380 meters. We can see from the map that there was clearly some free area without contour line which is the low land. Opposition to the lowest area, the highest elevation is believed to be a high land. From the topographic unit classification, we can say that the study area is covered from mountainous to rolling unit.

**Table 4.1:** Topographic unit classification of Peninsular Malaysia

| Mean elevation (m) *above sea level* | Topographic Unit | Class |
|---|---|---|
| >301 | Mountainous | 5 |
| 76-300 | Hilly | 4 |
| 31-75 | Undulating | 3 |
| 16-30 | Rolling | 2 |
| <15 | Low Lying | 1 |

Source(Hutchison and Tan, 2009)

### 4.2.2 Drainage Pattern

Drainage system are formed from the main river , lakes , small steam that connected to each other based on the texture and form. The characteristic and shape is depend on the factor such as type of rock , bedrock , and rock distribution. It will produce various size , pattern and shape of drainage basin. It's the system that gets the infiltration, subsurface and flow of groundwater during the rainfall. It's also important for the community and industrial area because it's the place to dispose the waste in liquid condition.

Based on the analysis of the drainage map (Figure 4.4), the drainage type that form here is dendritic pattern. It was form from three branches that commonly not in parallel or straight pattern. Main River, Sungai Galas and Sungai Pergau joined and continue with small stream near the main river.

We can the small river mostly exist in the plantation area. It one of the factor to prevent the hazard like flood and also source for the plantation for growth. This drainage also important in urbanization process to prevent hazard like landslide and flood.

From this map, we can see along the main river have the fluvial land form that can be flood plain. From this drainage system we can produce watershed because the small river flow continues with Main River. It's also can help to interpret type of rock and potential area that flood can occurred.

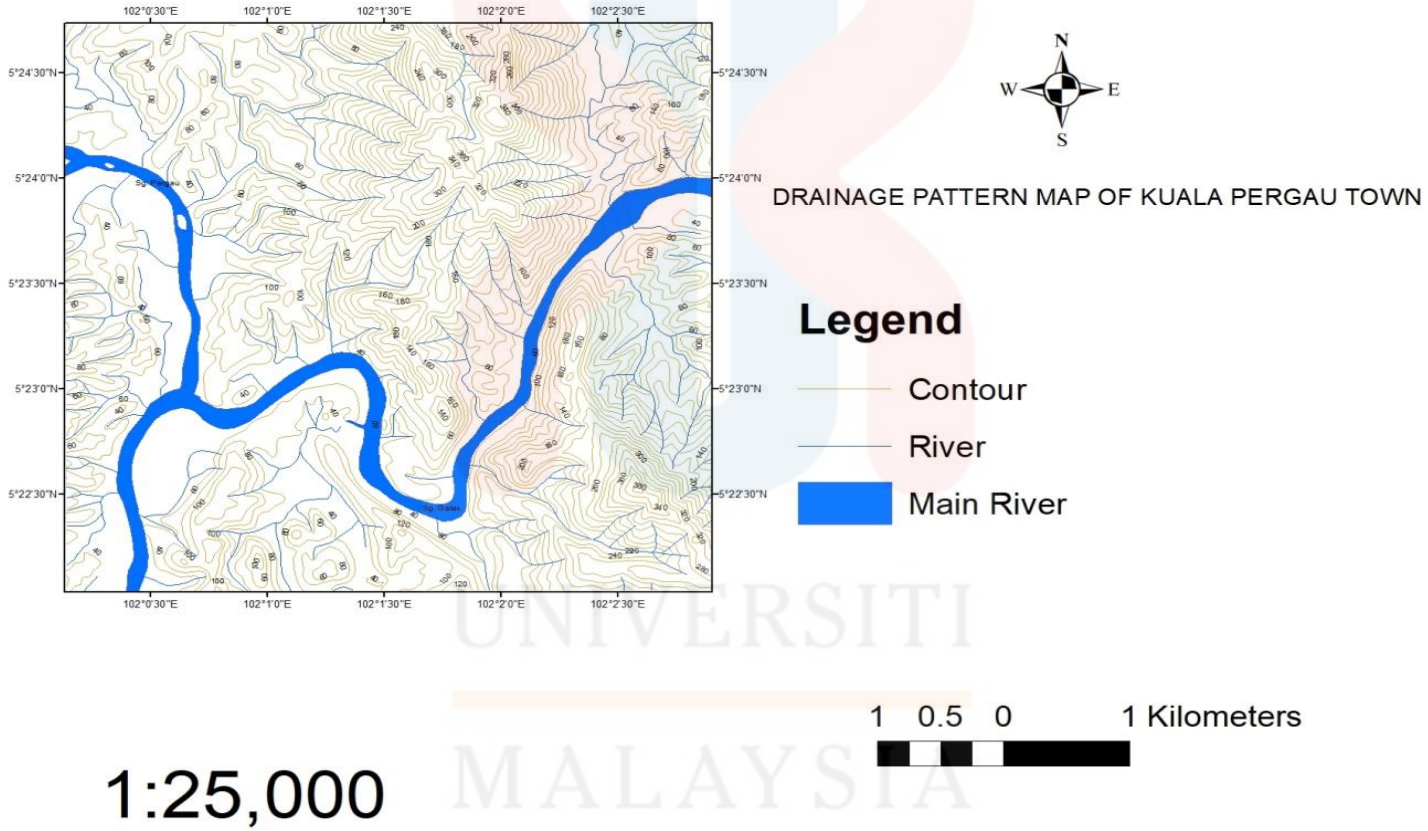



**Figure 4.4:** Drainage pattern of study area

## 4.3 LithoStratigraphy

4.3.1 Lithology

a) Alluvium unit

Alluvium is the lithology that usually exists in the stream or river. Generally, the size of alluvium is starting from cobble until pebble. At the area that alluvium deposit usually along the river and also called flood plane area. The soil here suitable for construction and also for vegetation. The alluvium units in study area are composed about 30%. This alluvium can be found in the larger scale along the major river such as Pergau River and Galas River. There are few type of rock such as sand, silt, clay and gravel that deposited where the stream slows down. The alluvium is young of depositional material and the age is Quaternary.

b)Limestone Unit.

The limestone rock was being found near with the Pergau River. These limestones are associated with the Gua Tembakau limestone. The limestone is a part of the sedimentary rock and has a coarse grain and dominated mineral is calcium carbonate. This limestone undergo the chemical weathering because it exposed with the river water and at the surface has a small crack because of the chemical weathering.

The structures that normally show at the limestone unit are bedding at limestone unit. The colour of limestone mostly milky white and grey depend on the rate of chemical weathering. The grains size of rock sample is medium grain coarse grain. The dolomite and calcite mineral also can be form during the meta-sediment processes. The age of limestone based on the literatures review is a Triassic.

c)Phyllite unit

Phyllite is one of the foliated metamorphic rocks created from the slate doing the metamorphism process. Phyllite has a similar tendency to split into sheet or slab because of the alignment of mica mineral but it grains are larger than slate. Foliation is commonly crinkled or wavy in appearance. It usually classify as a low-grade metamorphic condition and it through the regional metamorphic. The colour is commonly black to gray or greenish gray.

### 4.3.1 Stratigraphy

Lithostratigraphy use to analysis the general of rocks and estimates the extent of their age and rock character. This also uses to describe the stratigraphic term of the rock based on their characteristics, naming, classification and features.

Stratigraphy unit can be identify the rock age depend on few factor such as their lithology, petrology, mineralogy, geochemistry, fossil content and relationship between stratigraphy theories. Find the precise location of the type section, the grid reference or where appropriate can be used such as the Global Positioning System (GPS), (Rawson et al. 2002).

For the field observation, the stratigraphic unit that can be found at the field is sedimentary rock (alluvium, sandstone), meta-sediment rock (phylite) and limestone. Stratigraphy is study about geology that analysis about description, correlation and interpretation of rock layer or strata and stratified rock on and in the Earth, the relative and absolute age and the process that related between the strata.

Stratigraphy can be used to get the information about the past event and the process of rock formation. The Stong Migmatite Complex was found at the Dabong

area and it was formed mountainous country that lying about the 8km west of the railways town of Kemubu and Dabong.

**Table 4.2:** Stratigraphy column of study area

| ERA | PERIOD | FORMATION | STRATIGRAPHY COLUM | LITHOLOGY |
|---|---|---|---|---|
| CENOZOIC | QUARTENARY | | | Alluvium<br>-sand, silt , clay and gravel |
| Mesozoic | Triassic | Gua Musang Formation | | Limestone |
| | | | | Sandstone<br>-Interbedded with Conglomerate |
| Paleozoic | Carboniferous | Taku Schist | | Meta Sedimentary<br>-Phylite |

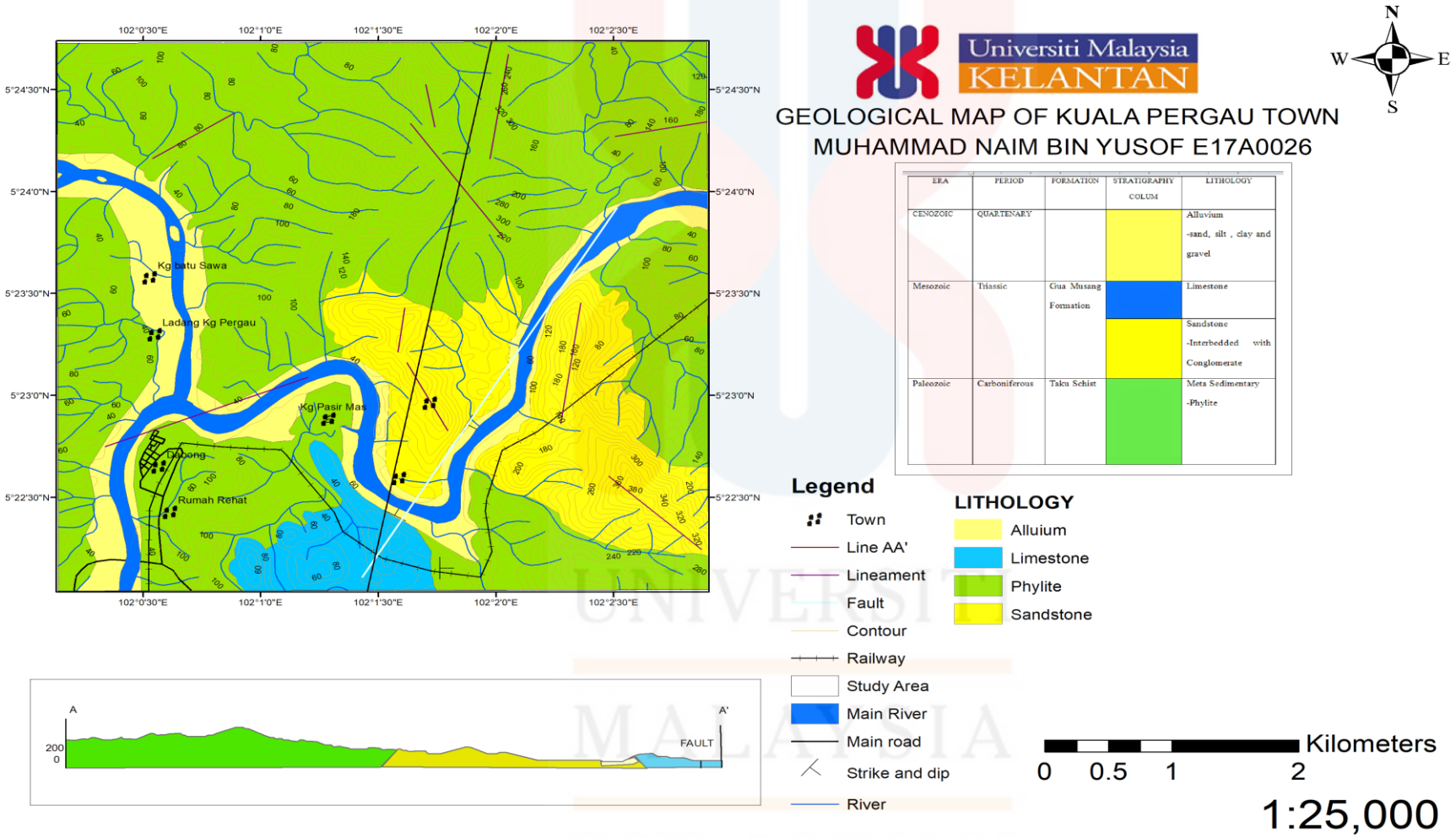



**Figure 4.5:** Cross Section of study area

### 4.3.2 Unit explanation

#### 4.3.2.1 Alluvium Unit

Alluvium unit located around the river area which occur in form of cobble size to pebble size where it is considered as easily get involved with flood hazards. This unit is commonly used for vegetation purposes but rarely used for residential development. About 35% alluvium can be found within the study area due to the present of major river, Sungai Galas. Sand, silt and gravel dominates the unit of alluvium that has been carried out throughout the river where it stops at stream

#### 4.3.2.2 Limestone unit

Limestone dominates about bottom area of the research area covered by caves. For example, Gua Tembakau which locates near to Gua Ikan and associates caves nearby. This has been an attraction for the traveller to come and visits the places. Near to Sungai Galas, karst landform can be spotted as it consists of limestone outcrop. Due to its grain is coarse, we identified it as sedimentary and has undergoes weathering process while being exposed to water and air.

## 4.4 Structural geology

4.4.1 Lineament Analysis.

Lineament defined as a pattern in a photograph, map or model of earth's surface or subsurface of earth which is stratigraphically, structurally or geophysically Caran et al. (1982). It must be linear, continuous, well expressed and related to features of the solid earth . Fault zones, igneous intrusions, shear zones, valley, fault or fold-aligned hills, streams and coastlines are some examples that contributed to lineaments.

According to Sander (2007) assumed that the origin of the fracture or sometimes data sources can be extracted from the geological structure such as tectonic lineament, geophysical lineament and another. Lineament is a one of the line of landscapes that caused by joint and fault at the basement (Hobbs, 1904).

Rose diagram software was been used to displays the directional data and the frequency of each class of force based on the lineament reading. The reading can be collect based on the map from the Google Earth. It was be used to plot the orientation of joint and dykes on the earth surface. Besides that, it also used to determine the direction of the principal stress with trends SE-NW as a SIGMA 1 and SW-NE as a SIGMA 3. If the stress in the directional SIGMA 1 indicated to normal forces that caused by tensional forces and SIGMA 3 indicate the thrust fault caused by compression force.

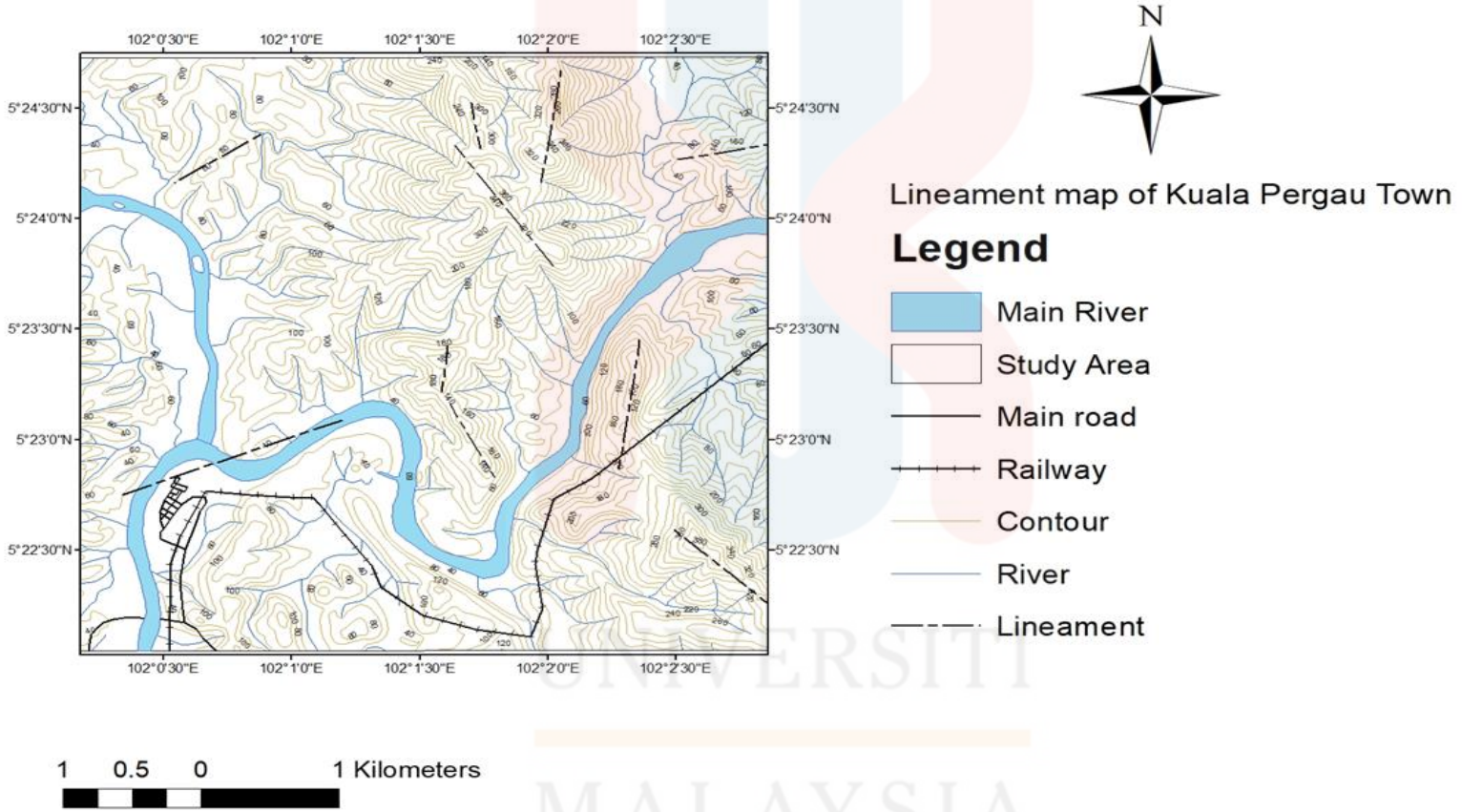



**Figure 4.6:** Lineament map of study area

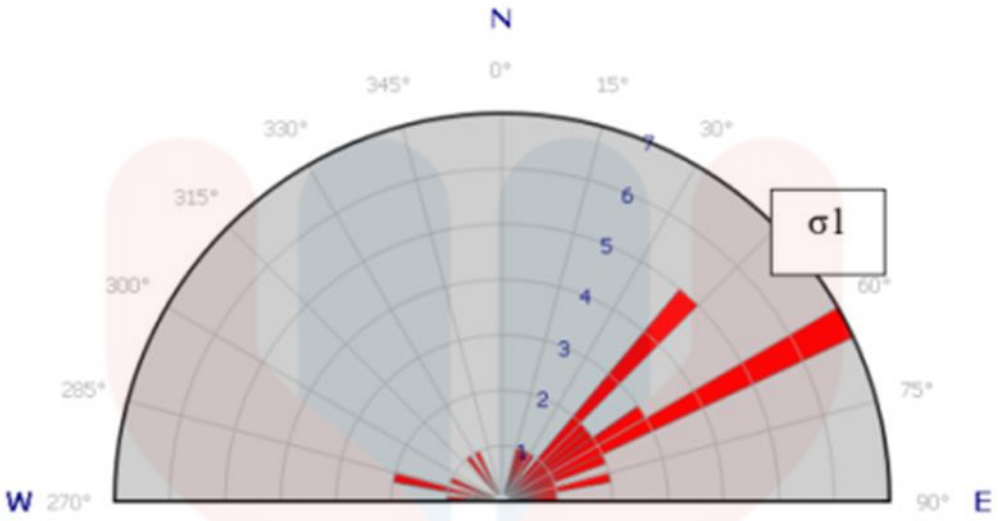



**Figure 4.7:** Rose diagram of study area

## 4.5 Historical Geology

Geological formation of Kelantan is made up of Lower Paleozoic until Quaternary. Quaternary sedimentary deposit belongs to Cenozoic formation in north Kelantan that consist of unconsolidated and consolidated boulders that underlies the coastal and inland plain. The land mass has been affected by tectonic activities during Paleozoic and Mesozoic eras due to the movement of the rock layers resulted to faulting, folding and other structures. Sedimentary rock units made up the central zone, metasedimentary rock units dominated the west zone and granite made up Main Range and the Boundary Range at the east zone.

In the study area, it has a few type of lithology such as limestone, granite, phyllite, alluvium and andesite. The oldest lithology is phyllite (Carboniferous), limestone (Triassic), granite (Triassic), andesite (Paleocene) and the youngest is alluvium (recent). Next, types of structural geology in the study area are recumbent fold, foliation and joint.Other than that, the types of hazard are flood and landslide. Landslide mostly occurs when the strength of soil decrease influences by water, weathering and ground movement.

# CHAPTER 5

# FLOOD ANALYSIS

## 5.1 Introduction

In this chapter , the purpose of this research area has been produced . There are a few area are divided to identify the level of hazard to this study area especially to urban area . Flood hazard analysis and flood zonation map were produced to identify the area that have potential hazard and also can minimize the damage in future.

## 5.2 Urban Analysis

In this research area, process urbanization mostly exist especially at the town area and also village .From the analysis , flood is the mostly hazard that happened in this area . Its because this area mostly have the low elevation and also surrounded by 2 big river that are Sungai Pergau and Sungai Galas. From the interpretation , we can see there have area that easy to flood exist that name as flood plain. Flood plain easy to identify because its along the river and also the type of lithology here are alluvium. It have a variety type of rock such as sand, silt, clay and gravel can be found along the flood plain carried by rushing streams and deposited where the stream slows down. Alluvium is one product of the stream or river. Normally, the size of alluvium is starting form cobble until pebble. Usually, the area with alluvium deposit can be considered as a flood probe area

Then, commonly process urbanization also take time if the flood exist and also can give high damage to community and also building like home. When the flood occur, the velocity of the river increase so the probability for the mass movement or landslide will be occur. Usually this hazard produced at the river bank or at the slope area. From the analysis, Mass movement also

occur depend on the erosion from rainfall intensity and velocity of river. This also can give bad impact if mass movement occur in alongside of main road .

### 5.2 Geo-hazard

#### 5.2.1 Flood hazard

Flood is an excess of water on land that normally dry and not static where in the inundation is causing by high flow, overflow of water in an established water course such as river, stream or drainage or the area where the rain fall accumulate (Vanessa et al 2008). Based on the study area, the factor of flood occurred because of the heavy rainfall. Flood depths are estimated around 60 meters from the datum. The impact of flood to urban is many houses damaged and people loss of property such as house damage. The heavy rainfall will be increase the river water in short time and level of water immediately increasing. Other than that, flood can be strike without warning occurs when the large volume of rainfalls within the short time. Flood occur when large volume of runoff quickly into the stream and rivers.

Generally, Malaysia is country that located at the area that have geologically stable region. But , that's not mean that our country is not totally free from natural disaster because Malaysia often hit by drought , landslides,haze , tsunami and especially flood (Parker,et al,1997). Flood can cause by the tsunami, snowmelt or it may be due to human activities and its also major disaster in Malaysia. The factor that always being flood in Malaysia is the unplanned urbanization and deforestation that will lead to climate change and consequently be the cause of flooding. Then, global warming will lead to the melting of polar ice caps that will give consequences in rises of sea level, so floodplains lying close to the present sea levels would be at risk from flooding

There are two major type of flood that occur in Kelantan that are Monsoon flood and flash flood. In Kelantan,,this state always facing monsoon season at the end of the year around

November until December. Kelantan always experienced which there will be overflowing heavy rainfall. For example, in the study area flood mostly happen at end of the year on November until December. The rain is non -stop every day. Kelantan, Terengganu and Pahang were easily to face with flood for every year. Nowadays, other country such as Pulau Pinang, Kedah and Perlis always face with flood at end of the year.

Generally, flood will occur depends on the rainfall density that comes in the monsoon season. The rainfall density will be huge as well and in turn will cause major flooding. Furthermore same as the other district of Kelantan, Kuala Pergau Town also experienced extreme rainfall distribution that acts as the main cause of flooding.

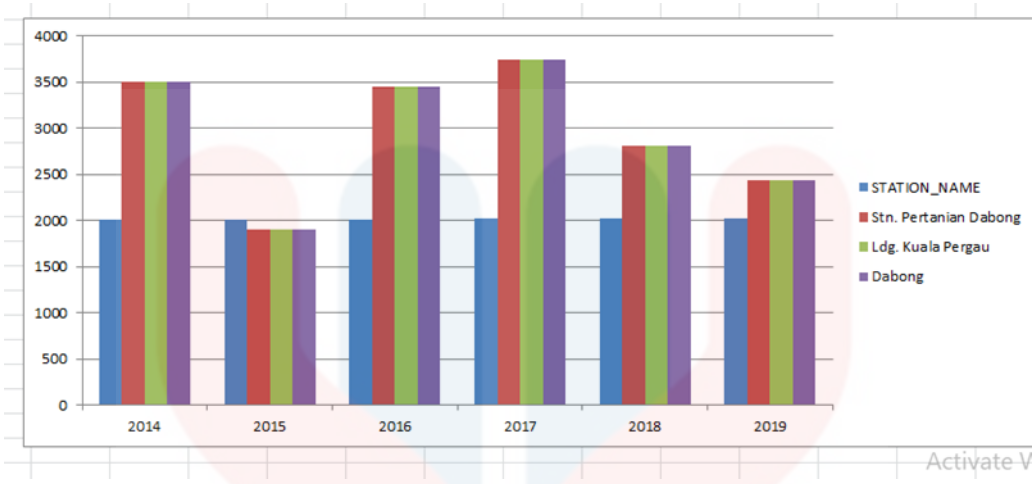



**Figure 5.1:** Yearly Rainfall in study area

The information that get from the center of strategic studies reinforce the evidence of the cause of floods is high intensity and volume high of heavy rain. From the data, rainfall records in all 13 centers across Kelantan in December 2014, do not stop for a long time period of December 17 to 25 around nine days. The record on certain days of its derivatives appears more than usual. Among them, on 17 December alone, the number of rainfall distribution recorded in all 13 centers totaled 2,596 mm and highest note is the rain measure center at Kusial, Tanah Merah by 414 mm.

**Table 5.1:** Rainfall distribution at the rain measure stations.

| Analisis Sukatan Turunan Hujan di Pusat-pusat Sukatan Turunan Hujan Negeri Kelantan, 17-25 Disember 2014 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gua Musang | | Kuala Krai | Gua Musang | Jeli | Kuala Krai | | | Tanah Merah | Kota Bharu | Tanah Merah | Pasir Mas | Pasir Puteh | Jumlah |
| Tarikh | Gunung Gagau | Kg. Aring | Kg. Laloh | Gua Musang | Kg. Jeli | Dabong | Tualang | Kuala Krai | Kusial | Jeti Kastam | Jenob | Rantau Panjang | Pasir Putih | |
| 17/12/2014 | 164 | 135 | 121 | 85 | 192 | 146 | 127 | 140 | 414 | 223 | 291 | 273 | 285 | 2596 |
| 18/12/2014 | 71 | 47 | 52 | 7 | 74 | 33 | 45 | 48 | 58 | 101 | 77 | 51 | 77 | 741 |
| 19/12/2014 | 40 | 19 | 1 | 1 | 20 | 12 | 2 | 10 | 22 | 3 | 6 | 1 | 44 | 181 |
| 20/12/2014 | 36 | 19 | 17 | 13 | 106 | 24 | 16 | 38 | 121 | 84 | 110 | 58 | 105 | 747 |
| 21/12/2014 | 302 | 128 | 77 | 65 | 70 | 78 | 82 | 78 | 99 | 32 | 96 | 59 | 23 | 1189 |
| 22/12/2014 | 478 | 294 | 208 | 212 | 130 | 243 | 227 | 155 | 83 | 12 | 70 | 20 | 29 | 2161 |
| 23/12/2014 | 515 | 13 | 0 | 116 | 39 | 154 | 164 | 24 | 27 | 5 | 46 | 13 | 4 | 1120 |
| 24/12/2014 | 159 | 0 | 0 | 0 | 160 | 101 | 112 | 211 | 261 | 40 | 181 | 77 | 60 | 1362 |
| 25/12/2014 | 32 | 0 | 0 | 0 | 60 | 0 | 8 | 22 | 18 | 6 | 15 | 17 | 10 | 188 |
| *** sumber: Portal e-Banjir Negeri Kelantan. | | | | | | | | | | | | | | |

(Source: Portal of Department of Irrigation and Drainage)

### 5.2.2 Total of annual Rainfall

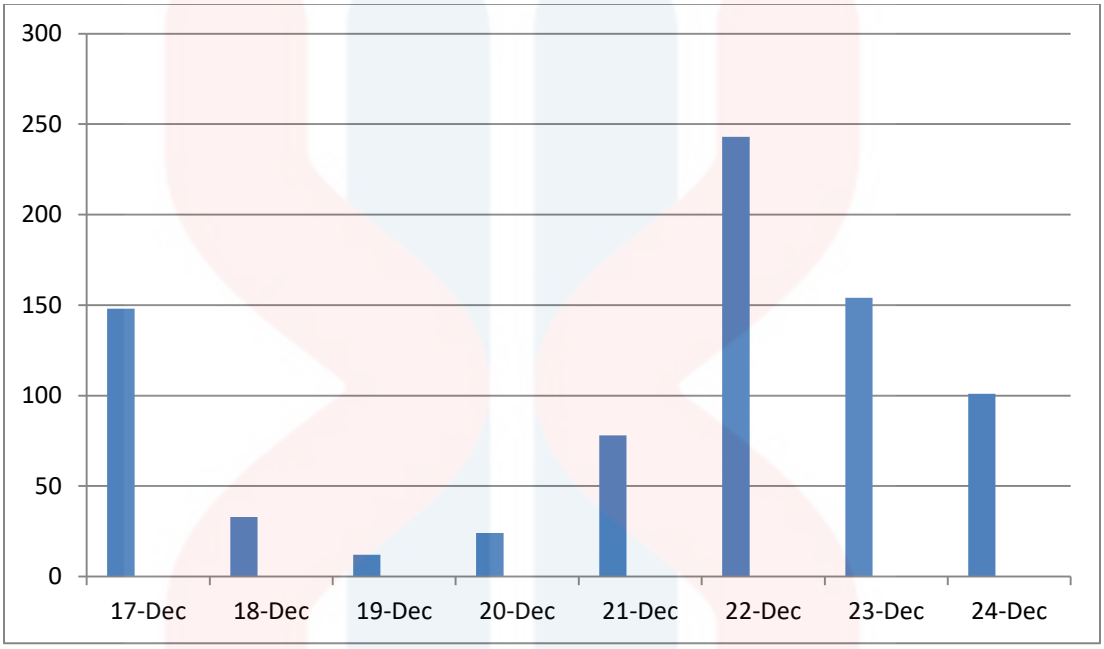



**Figure 5.2 :Total daily rainfall at Dabong during flood 2014**

(source: http://ebanjir Kelantan.gov.my)

Total annual rainfall during the flood is the most factors that effect the big flood in Dabong 2014. This hazard occur when the water from the main river that are Galas river basin arise directly from precipitation , atmospheric process that directly become to big disaster in this area. The flood exist when the intensity of rainfall that occur are well beyond the average total rainfall in this area through the process that are percepitation.(Linsley,1964).

From the Figure 5.2, it shows the total daily rainfall at Dabong during flood 2014. This figures show that on 17 December 2014 total rainfall around 146 mm and more higher as usual than 36 mm that recorded on 0.00 am on 17 December. On 18 December, from the analysis we can see that rainfall recorded around 33 mm lower than 17 December. Then, for the 19 December in

Dabong the total rainfall 12 mm. On 20 December, the rain started from 3.00 am until 11.00 am that recorded. It because the total rainfall in 20 December increase around 24.00 mm compared to 18 and 19 December 2014.

On 21 December 2014 , total daily of rainfall was recorded that around 78.00 mm. The heavy rainfall occurred from 6.00 pm until 13.00 pm on that day and from 20.00 pm and 23.00 pm.During that day, the water depth at this area that Sungai Galas was increased until 33.10 meter and pass of the alert level. Then , in 22 December we can see the total of rainfall very higher around 243.00 mm. During 22 December , this area through the heavy run along that day. Its totally affects of the depth of main river in this area. The water depth of Sungai Galas exceeds the dangerous level that around 39.96. The stream of Galas Basin started to move into the remote area.

During 23 December 2014 . the total rainfall around 154.00 mm that recorder as the second highest during this big flood in 2014. Lastly , in 24 December , the total rainfall was recorded around 101.00 mm . However , depth of Galas River Basin show the highest level around 46.47 metres.

### 5.2.3 Hyetograph of annual Rainfall in Dabong.

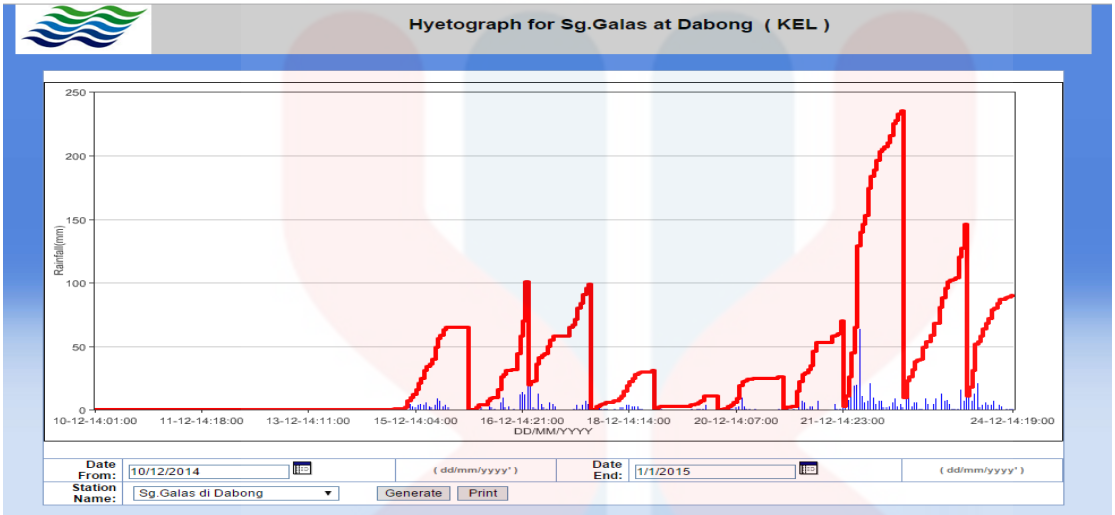



**Figure 5.3:** Hyetograph of annual rainfall for Galas River at Dabong

**(Source: http://infobanjir.water.gov.my)**

Figure 5.3 above shows the hyetograph of rainfall distribution at Sungai Galas at Dabong during 2014 flood. The hyetograph recorded the heavy rainfall started to occur from 21 December 2014 until 25 December 2014. From 21 December 2014 until 22 December, the hyetograph recorded more than 200 mm the rainfall distribution at Sungai Galas at Dabong. On 22 December, the hyetograph decreased dramatically from more than 200 mm to less than 50 mm for the next day. This is because there were no continuous rainfall occurred during that time. Then, the hyetograph suddenly increase to 150 mm during 23:00 pm on 23 December 2014. Next, the hyetograph began to decrease to less than 100 mm on 24 December 2014.

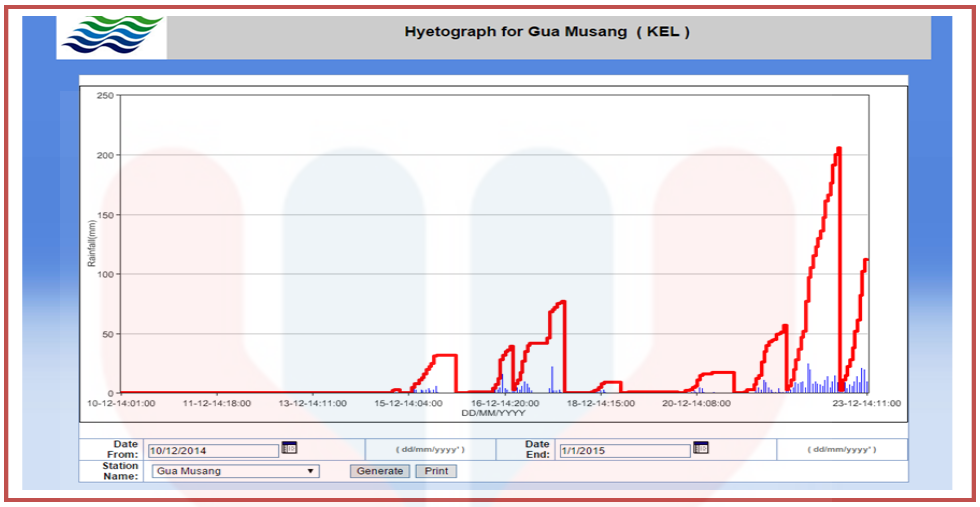



**Figure 5.4:** Hyetograph of annual rainfall for Galas River at Gua Musang Dabong

(**Source**: http://infobanjir.water.gov.my)

Figure 5.4 above shows the hyetograph of rainfall distribution at Sungai Galas at Gua Musang during 2014 flood. Its started to increase from 21 December 2014 where the rainfall distribution recorded was more normal that more 50 mm. However, the heavy and continuous rain occurred at Gua Musang .This make the hyetograph suddenly increased to more than 200 mm on 22 December 2014 until the 23 December 2014. On that time, the Galas River Basin started to overflow and the people were forced to leaves their home during that time.

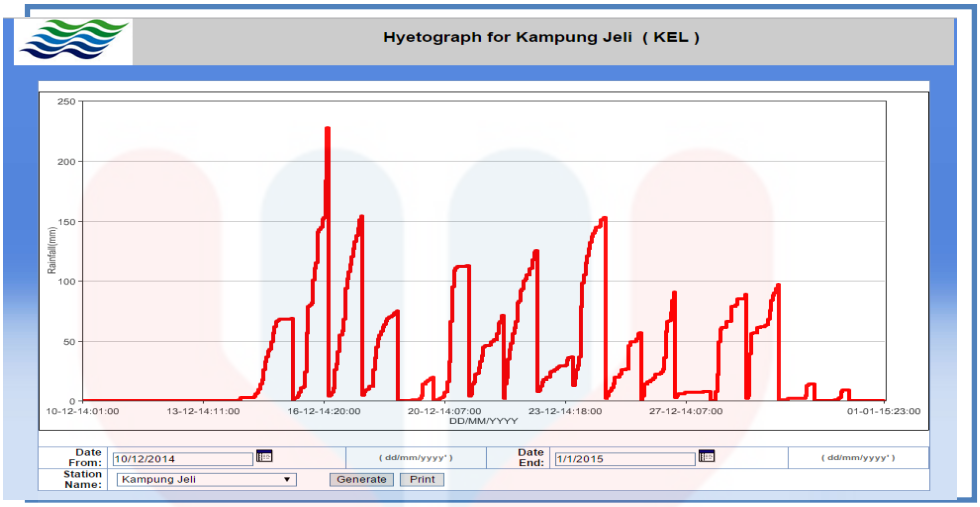



**Figure 5.5:** Hyetograph of annual rainfall for Pergau River at Jeli village Dabong

(**Source**: http://infobanjir.water.gov.my)

Figure 5.5 above shows the hyetograph of rainfall distribution at Pergau River at Jeli during 2014 flood. Basically, the hyetograph shows the fluctuated the rainfall distribution from 10 December 2014 until 1 January 2015. The highest of rainfall distribution recorded was more than 200 mm on 16 December 2014.Based on the hyetograph above, the heavy and continuous rain occurred from 16 December 2014 until 25 December 2014.

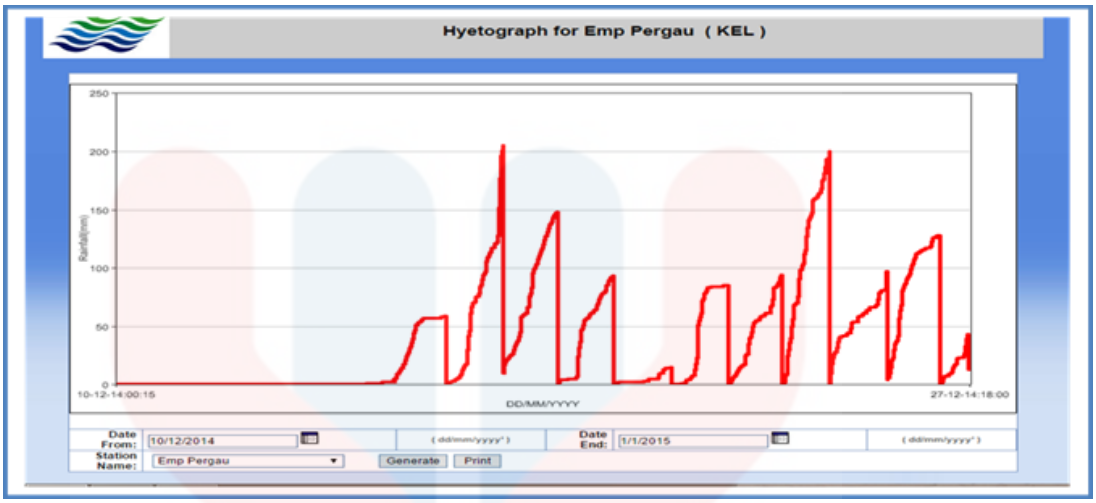



**Figure 5.6:** Hyetograph of annual rainfall for Pergau River at Pergau Dam Dabong

(**Source**: http://infobanjir.water.gov.my)

Figure 5.6 above shows the hyetograph of rainfall distribution at Pergau dam during 2014 flood. From the hyetograph, the hyetograph also shows the fluctuated the rainfall distribution recorded from 10 December 2014 until 1 December 2015. From this figure , we can analyze that Pergau river also have the highest annual rainfall around 200 m.

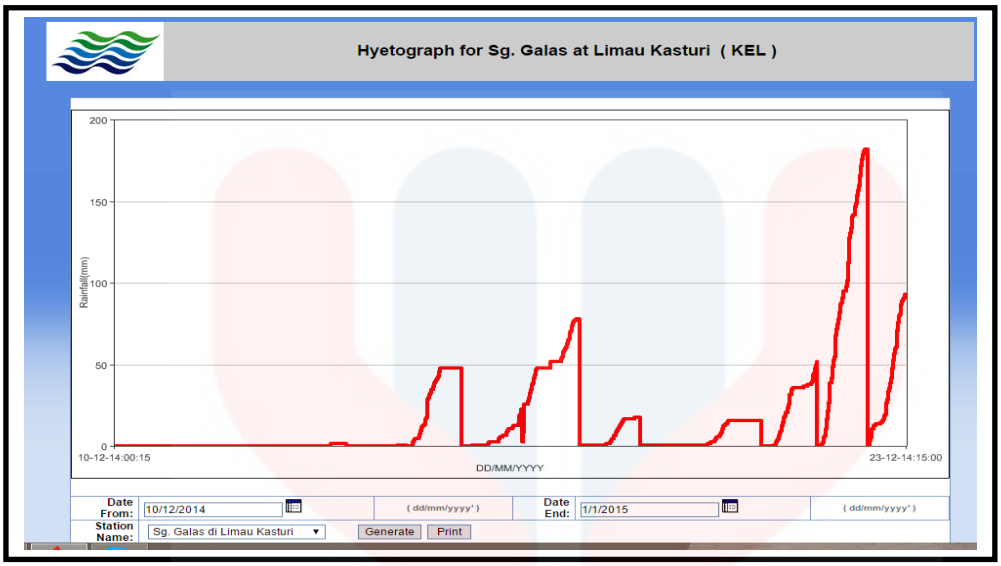



**Figure 5.7:** Hyetograph of annual rainfall for Galas River at Limau Kasturi Dabong

(**Source**: http://infobanjir.water.gov.my)

Figure 5.7 above shows the hyetograph of rainfall distribution at Sungai Galas, Limau Kasturi during 2014 flood. Overall, the hyetographs above shows the fluctuated the rainfall distribution from the 10 December 2014 until 1 January 2015. So, the rainfall distribution and date occurred can be predict accurately because of technical problem. However, the hyetograph shows the heavy rainfall occurred in Limau Kasturi area during that time.

### 5.2.4 River Catchment Area of Dabong

River catchment area is a basin shaped area of land, bounded by natural features such as hills or mountains from which surface and sub-surface water flows into stream rivers and wetlands. Water flows into, and collect in the lowest areas in the landscape (Park & Taranaki 2010). A catchment catches water which falls to earth as precipitation process , and the drainage network channels the water from throughout the catchment to mouth of a main river.

In term of river, Kelantan has a main river namely Kelantan River which has 248 kilometers length that becomes a backbone to the source water of the state. Almost all the network of river is starting from the Titiwangsa and Tahan range Titiwangsa range is the border between Perak at the Western and Pahang at the Southern while Tahan range is the boardering Terengganu in the East and South East.

Therefore, the river water of Kelantan is derived from two main tributaries namely Galas River from the West and Lebir River from the South. The length of Galas River is 178 kilometers while Lebir River is 91 kilometers. Galas River derive the source of water from the Chiku River, Betis River, Berok River, Jentera River, Pergau River, Rual River, Lang River, Kanuwing River, Balah River. Terang River, and Suda River which is the Western side and boardering with Perak. These river flows into the channel of Pergau river though up to Dabong and then entered the channel of Galas River. Galas River then flows enters the main flow of Kelantan rive (DID,2010).


**Figure 5.8:** Catchment area of Pergau River at Pergau Town

Kelantan is quite prone to floods and it is the major hazards that cause significant destruction. This is mainly related to excessive rainfall over a period of time, which means that surplus water floods river channels and banks and often breaches some portions of the river channels during such events. These rivers and their banks are a source of water for agriculture and preserve a variety of animal and plant life and often add to the overall beauty of this tropical land, ornamented with some of the world's most beautiful rainforests.

Figure 5.8 show the river catchement that caused the flood in Dabong. The main river that caused the 2014 flood in Dabong is Galas River.The Length of Galas River is 178 kilometres and had many small rivers that caused the 2014 flood in Dabong. Pergau River is a one of the stream in the region of, Kelantan It is located at the west of the Kelantan near to the border of Perak-Kelantan state, in the district of Jeli into Galas River at Dabong and lastly joined together with the Kelantan River Pergau River River, Tadoh River and Chenor River (DID, 2010).

Besides that, Nenggiri River is one of the main streams of Galas River that caused the 2014 flood in Dabong Nenggiri River is locates at the southwest of the Kelantan and also near to the border of Perak- Kelantan state, in the district of Gua Musang. The Nenggiri River also comprises of several major sub-catchment such as Lah River, Wias River, Jenera River, Perias River, Beris River, Kalau River and Berok River. Each of major sub-catchment river have their small river such as Sunggi River, Tumeh River, Beriak River, Puian River, Rekoni River, Peres River, Penis River, Yai River, Geset River, Enching River, Perolak River, Jak River, Tuil River, Ber River, Belatop River, Mengrop River, Mering River, Keyai River and Chenderoh River.

## 5.3 Flood Exposure

Malaysia is a country very prone to flood risks, mostly by nature of its physical topography and drainage. Flood extension will extent to which properties, house economic activities and infrastructure are geographically situated in food prone area (Barroca et al. 2006, McEwen et al. 2002). Flood exposure describes who and what may be harmed by the flood hazard. It including the measure of the human population, land use and infrastructure located in flood zones. A common method of measuring flood exposure is to count the number of properties of different types which occupy a floodplain or other flood risk area.

Generally, the population in Dabong tends to live in a flood prone area where the location of Dabong is clearly near to the Galas River, which one of major stream of river in Kelantan. The immensity of Galas river is 6 971 km while Pergau River is 1 303 km Pergau River also combines with the Galas River in Dabong. So, there are potential of high flood risk occur in Dabong because of the hydrological factor

Besides, the the lowest contour is 40 meter where it is the main choice of human there to build their residence at the Pekan Dabong. This could be easier for increases of water around contour of 40 meters and resulted the residence are inundated by flood water Since there are so many residents prefer to live at flood plains, they will face a very high flood risk.

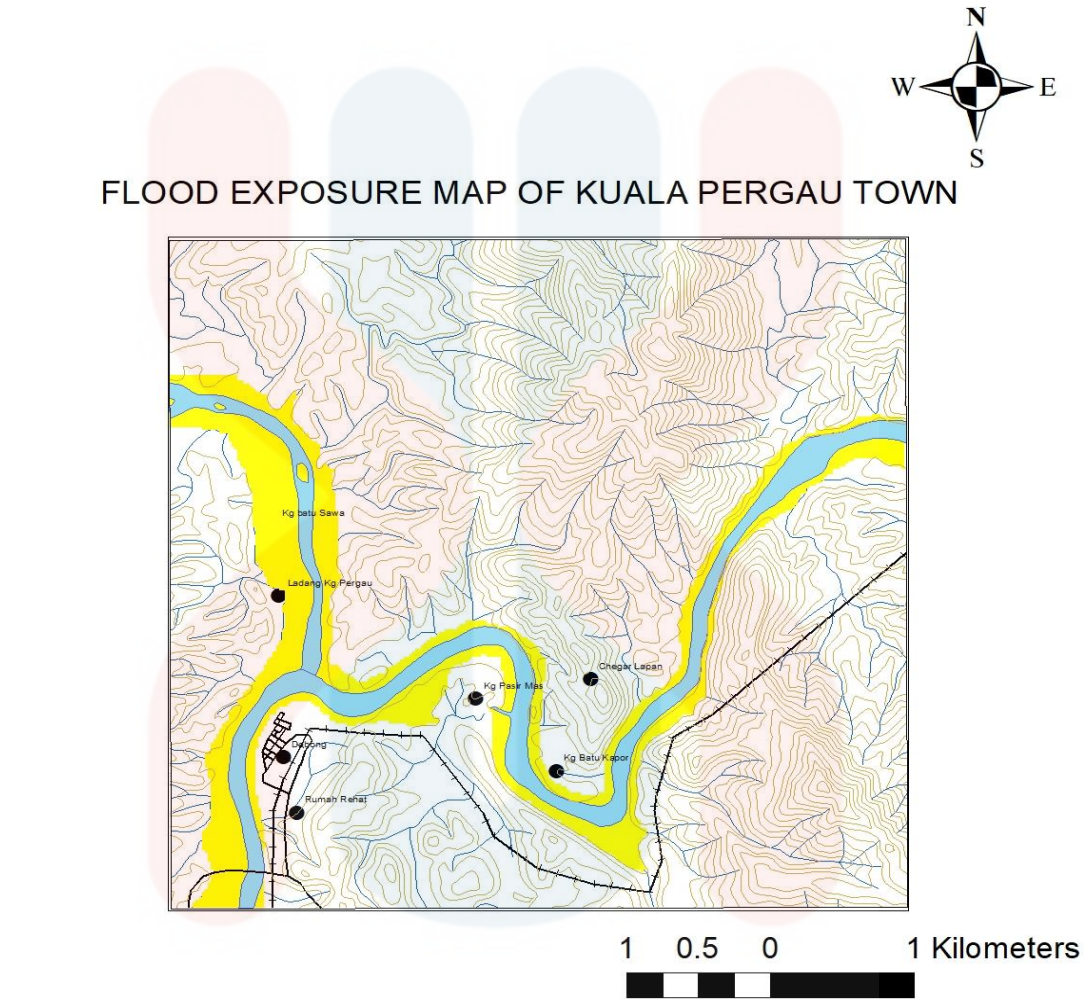



**Figure 5.9 :** Flood exposure map of Kuala Pergau

## 5.4 Flood Hazard Analysis

### 5.4.1 Hydrograph of Water Depth Level of Dabong

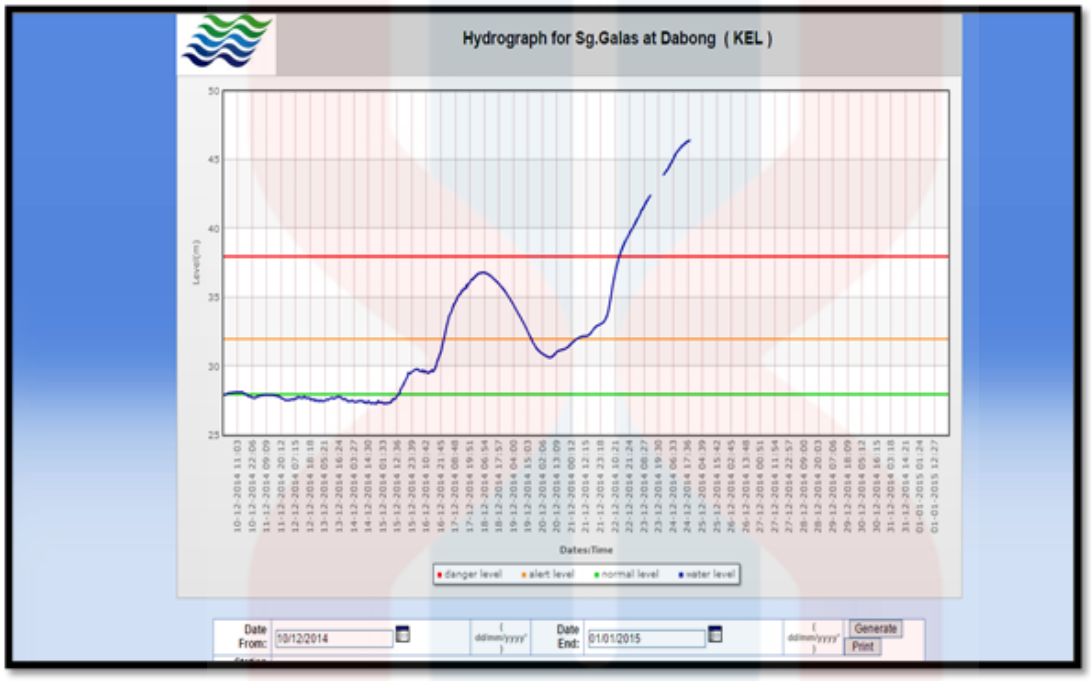



**Figure 5.10 :** Hydrograph of Galas River at Dabong

Figure 5.10 above shows the hydrograph of water depth of of Galas River at Dabong from 10 December until 1 January 2015. This hydrograph generally show us the three type of water level that are 25 m for normal level , 33 m for alert level and 38 m for the dangerous level

Based on this figure , we can get the infromation that normal level of this river at 28 mm and below during 10 December until 15 December 2014. Then , the water depth increase on the 16 December around 29 m. After that day , volume of rainfall increase and continuos along that day . It give effect for the water depth increase in dramatically on 18 December. The highest depth that wre recorded was 36 metres exceed the alert level.

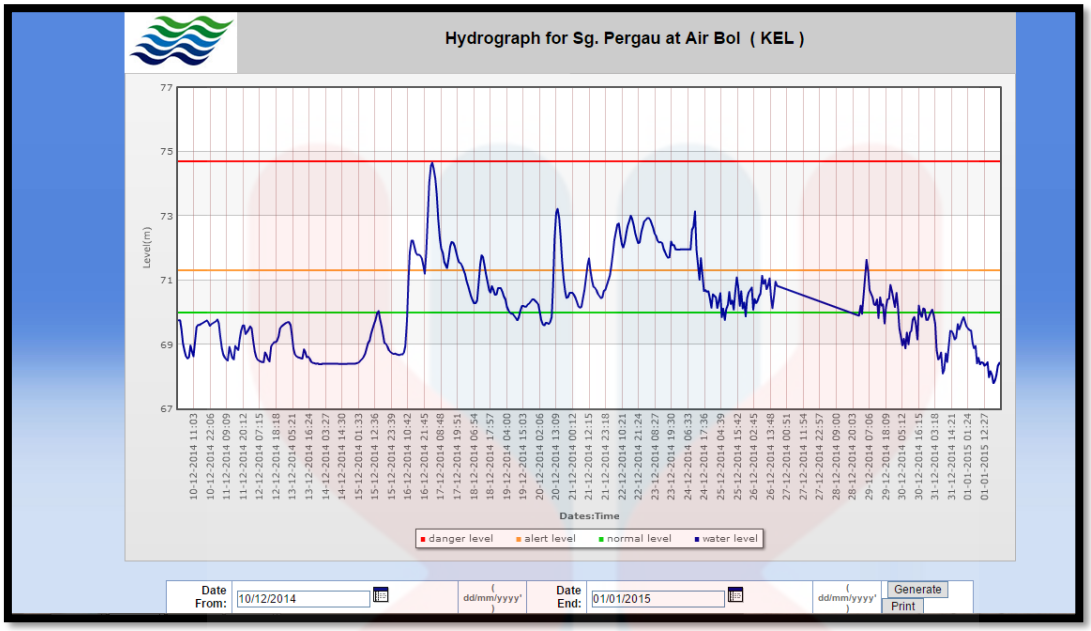



**Figure 5.11 :** Hydrograph for Pergau River at Air Bol

This figure shows the hydrograph for Pergau River at Air Bol. The hydrograph for Pergau River at Air Bol also indicates three type of level for this station, which are 70 metres for normal level, 71.5 metres for alert level and 74.8 metres for dangerous level. The water depth level of Pergau River at Air Bol was recorded under the normal level from 12 December 2014 until 15 December 2014. On the next day, the hydrograph above shows the fluctuated the water depth level or flood depth until 1 January 2015.

The heavy and continuous rain occurred from the 10:42 am on 16 December 2014 until 08:48 am on 17 December where the water depth level has achieved the dangerous level. Later, the water depth level of Pergau River at Air Bol started to decrease until 20 December 2014.

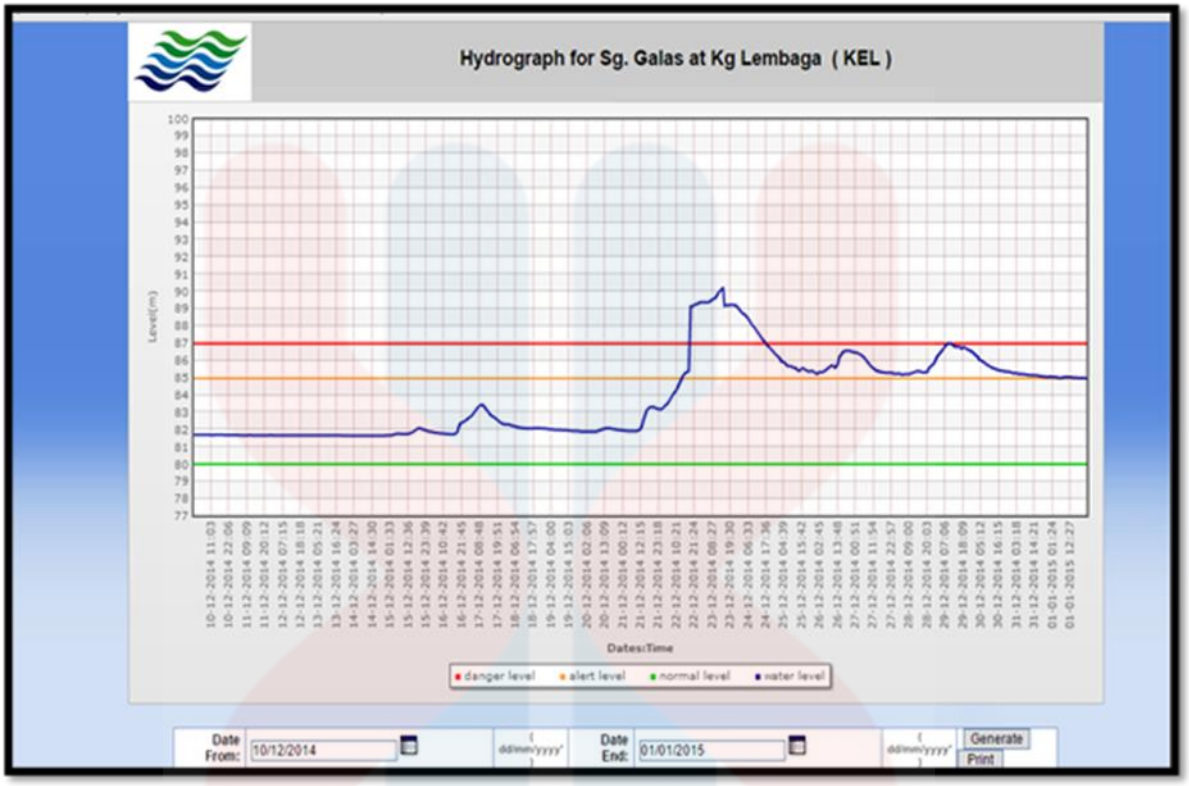



**Figure 5.12:** Hydrograph for Galas River at Lembaga Village.

Figure 5.11 above shows the hydrograph for Galas River at Lembaga Village. The hydrograph for Galas River at Lembaga Village also exhibit three type of water depth level which is 80 metres for normal level, 85 metres for alert level and 87 metres for dangerous level. Initially, the water depth has exceeded the normal level from 10 December 2014 until 16 December 2014. In the evening on 16 December 2014, the water depth level started to increase around 83 metres to 84 metres. During 21 December 2014 until 24 December 2014, the hydrograph shows the water depth level was greatly increase and exceeded the dangerous level.

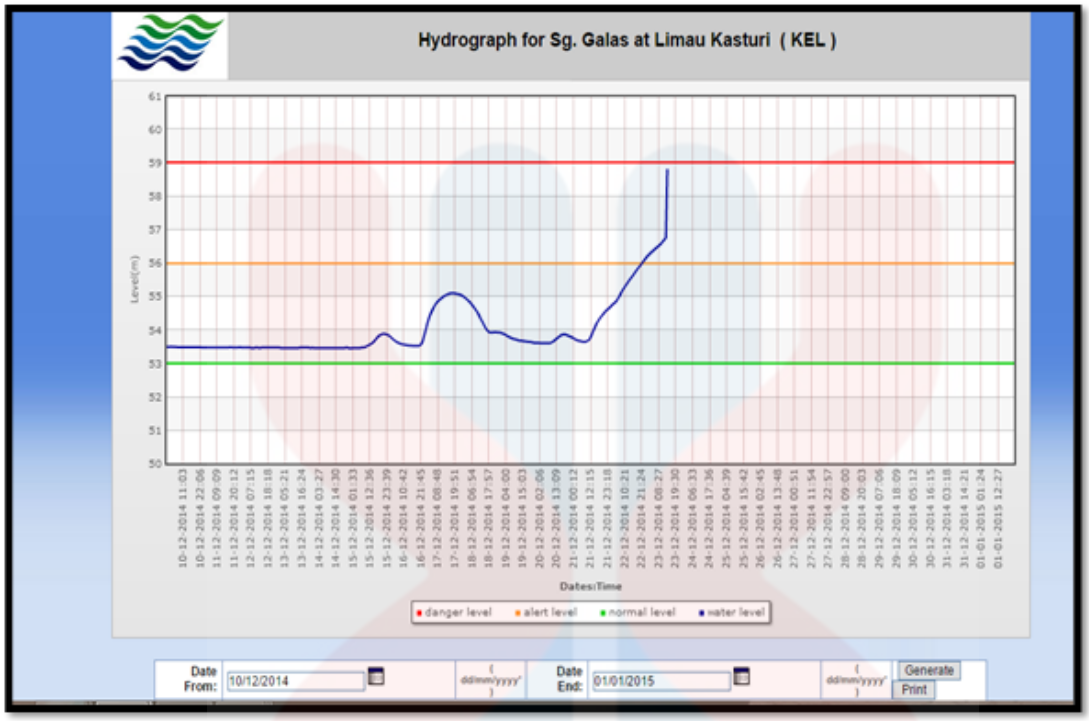



**Figure 5.13: Hydrograph for Galas River at Limau Kasturi**

Figure 5.13 above shows the hydrograph for Galas River at Limau Kasturi. Usually, the hydrograph indicates three types of water depth level, which are 53.5 metres for normal level, 56 metres for alert level and 59 metres for dangerous level. The hydrograph has exceeded the normal level initially from 10 December 2014 until 15 December 2014. On 16 December 2014, the water depth level of Galas River at Limau Kasturi slightly increased to 55 metres until 17 December 2014. However, the real date for flood occurred at Limau.

### 5.4.2 Discussion

Flood hazard is the hazard that have potential for occurring in any location depend on the factor. In this study area , this hazard exist because of the total rainfall in the Dabong catchment area has exceed the normal of total rainfall. This event can appear that cause bad impact to people or environment. This hazard can divided into two type that are natural hazard and anthropogenic hazard. Anthropogenic hazard is more to human-made event.

Human activity like uncontrolled logging of natural forest, unplanned urban development and also major change in land use can change pattern of hazard in Kuala Pergau Town. Flood Hazard map that produce will contain the water flood depth and flood risk level of each area.

During the big flood in 2014 , the water depth level of Galas River is rise dramatically and overflowed in channel. Its because the changes of pattern of hazard in behavior in Dabong catchment area that includes Galas River and Pergau river.

Along the main river in this study area that Pergau area we can see the lithology that exist here that are alluvium. This alluvium or sand used in the mining activity in this area. This source used for construction and business. Generally , we can see when the rainfall occur along the Pergau river through the precipitation process , the ecosystem in this area changed and also change the depth of the river. When the water from in this river rise higher, it will flow to the Kuala Pergau town . So when the catchment of the river is high, the depths of other river also increase.

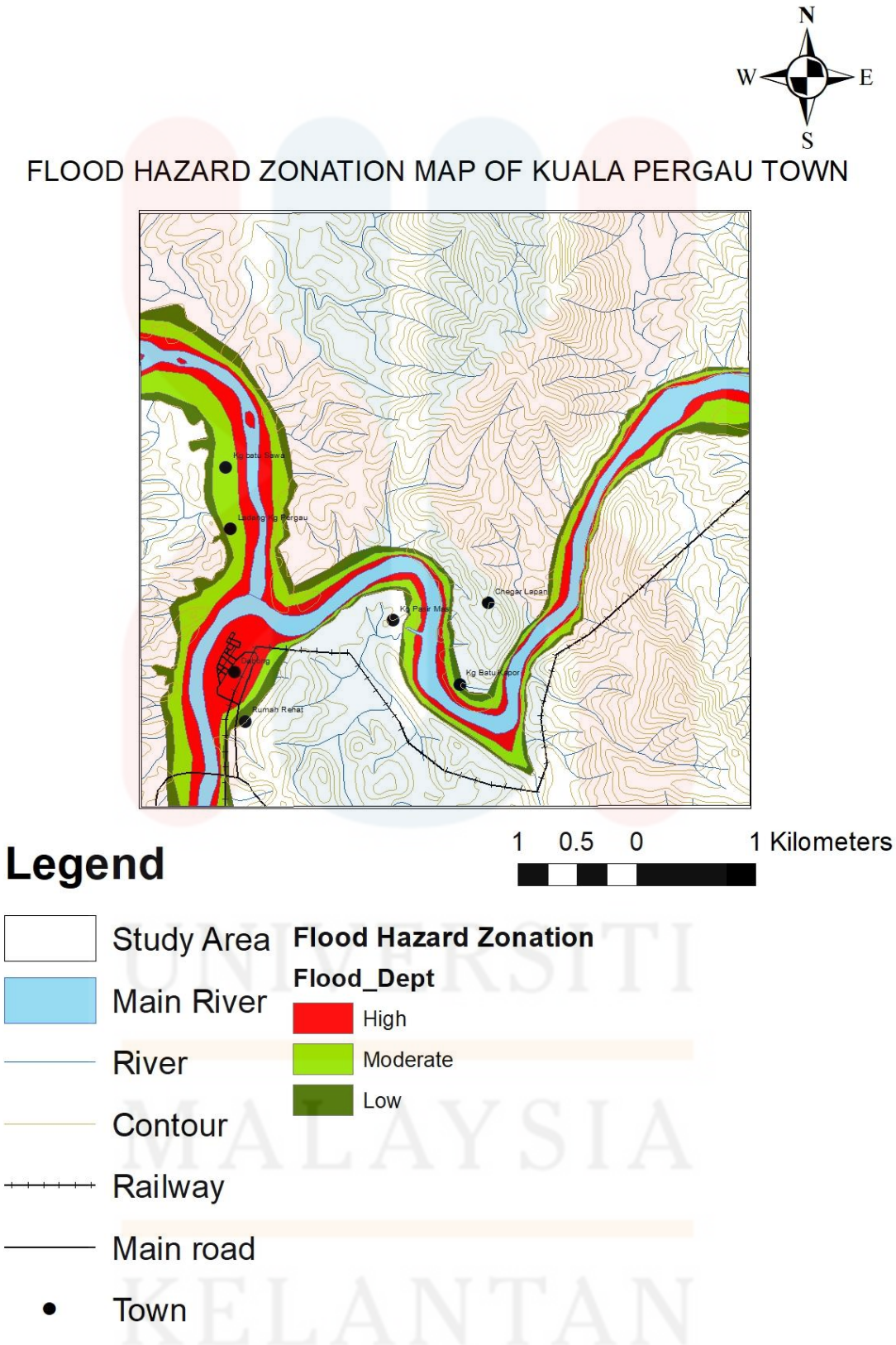



**Figure 5.14:** Flood zonation map of study area.

Figure 5.14 above shows the map of flood hazard in Dabong. Based on the map above, there are many numbers of houses or buildings that affected by flood in 2014 at Dabong. There were three area devastated by flood in 2014 namely Batu Sawa village, Batu Kapur village and also Dabong Town. The analysis from previous research and interpretation was done to these areas that affected with disaster. These areas were categorized into the flood hazard level based on the flood depth level of the Galas River and Pergau River.

**Table 5.2:** Category of flood hazard based on Galas and Pergau river depth**.**

| Area | Flood Hazard level | Flood depth |
|---|---|---|
| Dabong Town | High | 5 metres and above |
| Batu Sawa village | Moderate | 2.5 metres-5 metres |
| Batu Kapur village | Low | 1 metres and below |

Table 5.3 above shows the category of Flood Hazard Level based on Flood Depth based on the analysis that have been conducted. According to table above, there were 3 area that has affected with this disaster that are Dabong Town that categorized into the high flood hazard level, which means the flood depth were 5 metres and above during flood in 2014. Moreover, Batu Sawa village also were classified into moderate for flood hazard level and their flood depth were about 2.5 metres into 5 metres. Furthermore, Batu Kpur Village also characterized into the low level of flood hazard level and the flood depth also 1 metres and below.

# CHAPTER 6

# CONCLUSION AND RECOMMENDATION

## 6.1 CONCLUSION

Overall, this study can be implemented well in line to achieve the purpose of the study and also all the objectives as stated in the beginning of the study. As the conclusion the objective to produce geological map with scale 1:25000 was updated. The lithology and structure were observed in this area.The lithology in this study area consist of sandstone , phylite , limestone and alluvium.

Based on the previous extreme flood in 2014 , we can see most area in this study area were exposed. Flood exposure gives an exposure on population and property in Dabong such as infrastructure, daily and social activity and vital area. This phenomena will lead to flood hazard in Dabong and Galas River is the main indicator of flood occurred at Dabong. The heavy rainfall is the main cause of the flood damage in Dabong. It is because the maximum rainfall at the Dabong started from mid – October until end- December.

For flood hazard study, flood hazard level was determined by three types of level which are low, medium and high level and also relate with water depth level of Galas River in Dabong.. A map of flood hazard in Dabong is produced.

## 6.2 Recommendation

The research findings from this study give insight into future development of a flood exposure, flood hazard in Dabong. Flood occurred at Dabong from November until January in a certain time. The main indicator of flood occurrence because the heavy rainfall makes the water depth level of Galas River increased and overflowed during monsoon season.

In order to enhance the accuracy of the research on flood exposure and flood hazard Dabong, further research in Dabong should also take into the community based on hazard assessment, and exposure assessment that considers the structural measures such as water depth level of Galas River, stream flow of water in Galas River and environmental education to community in Dabong. Damage function for assessment of probable loss should be developed with different and variety methods from damage event in order to get more accuracy data about the level of flood hazard in Dabong. The most effectives approach is to plan control measures that can mitigate flood consequences in Dabong.

Next, additional data such as satellite image are able to make more effective visualization on flood hazard, flood exposure map that will be produce. Overall, the research process has been successful by produced two types of map which are flood exposure, flood hazard .

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