GEOLOGY AND HYDROCHEMISTRY OF SHALLOW AQUIFER IN KUBANG GADONG, PASIR MAS, KELANTAN.

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2017

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GEOLOGY AND HYDROCHEMISTRY OF SHALLOW AQUIFER IN KUBANG GADONG, PASIR MAS, KELANTAN

by

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

FACULTY OF EARTH SCIENCE
UNIVERSITI MALAYSIA KELANTAN

2017

DECLARATION

I declare that this thesis entitled “Geology and Hydrochemistry of Shallow Aquifer in Kubang Gadong, Pasir Mas, 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 : ________________________________

ACKNOWLEDGEMENT

Firstly I would like to thank to Allah S.W.T. for successful this project and big appreciation to my supervisor Dr. Mohammad Muqtada Ali Khan in helping me in to make this project a success by giving so much guideline and advice. Special lecture given on this topic did help understand more about the project which should be carried out.

Besides that, I would like to thank to all staff of the Soil and Geology Laboratory for being so cooperative and helpful. They gave me a warm welcome and took good care also providing all the information and laboratory apparatus that I needed.

Last but not least, I would like to sincere thanks to my parents Md Salleh bin Konok and B.B. Noor A'in binti Asaari, family and friends for their support and help they have given me in conducting this project successfully for two semester. I would like to thank them for their opinion and point of view that they gave me during this final year project.

Deep sincere thanks to God for being there for me to take care of me and keep me safely. Thanks everyone!

GEOLOGY AND HYDROCHEMISTRY OF SHALLOW AQUIFER OF KUBANG GADONG PASIR MAS KELANTAN

Abstract

Well water is a renewable natural resources was used most people in northern part in of Kelantan state for drinking an agriculture purpose. The study area is northern part of Kelantan state lies between latitude E 06^{0}08'52.61'' and E 06^{0}04'32.88''and longitude N 102^{0}04'32.44'' and N 102^{0}09'25.95''. The present research was focused on the analysed psychochemical parameter of groundwater for quality to study the suitability of domestic well which for drinking purpose.The analyze of major ion were bicarbonate, chloride, sulphate, potassium, sodium, calcium and ferum and for in-situ parameter were pH, temperature, turbidity, total dissolve solids and electrical conductivity were determined respectively. The major cation was using Atomic Absorption Spectrometer (AAS) in Universiti Malaysia Terengganu (UMT) by ion concentration, major cation was using by titration and gravimetric analysis. The well water samples were collected in Kubang Gadong, Pasir Mas. The TDS parameter reading shows all the samples water were classifying freshwater with range 42 mg/L until 250 mg/L which permissible the standard by W.H.O. and M.O.H guideline for drinking purpose. The groundwater facies was interpreted by using piper trilinear diagram. In this study area, the classification of water dominantly show alkali bicarbonates. This can be proven by the highest value of bicarbonates.

Keyword: Hydrochemistry, shallow well, well in Kelantan Malaysia.

GEOLOGI DAN KIMIA AIR AKUIFER CETEK DI KUBANG GADONG PASIR MAS KELANTAN

Abstrak

Air telaga adalah sumber alam yang boleh diperbaharui digunakan kebanyakan orang di bahagian utara di negeri Kelantan untuk tujuan minum dan pertanian. Kawasan kajian adalah bahagian utara negeri Kelantan terletak di antara latitud E 06°8'52.61 dan E 06°04'32.88"and longitud N 102°04'32.44 " dan N 1020°9'25.95 ". Kajian masa kini telah memberi tumpuan kepada analisis parameter psycho-chemical air bawah tanah untuk mengkaji kualiti air yang baik bagi tujuan domestil dan minum. Bagi analisis ion utama adalah bikarbonat, klorida, sulfat, kalium, natrium, kalsium dan ferum dan untuk in-situ parameter adalah pH, suhu, kekeruhan, jumlah membubarkan pepejal dan kekonduksian elektrik telah ditentukan. Kation utama telah menggunakan Spektrometer Serapan Atom (AAS) di Universiti Malaysia Terengganu (UMT) dengan kepekatan ion. Kation utama telah menggunakan dengan pentitratan dan analisis gravimetrik. Sampel air juga telah dikumpulkan di kawasan Kubang Gadong, Pasir Mas. Bacaan TDS parameter menunjukkan semua air sampel yang telah mengklasifikasikan air tawar dengan anggaran bacaan 42 mg / L hingga 250 mg / L yang dibenarkan standard dengan W.H.O. dan garis panduan M.O.H untuk tujuan minum. The fasies air bawah tanah telah ditafsirkan dengan menggunakan gambar rajah piper trilinear. Di kawasan kajian ini, klasifikasi air dominan menunjukkan bikarbonat alkali. Ini dapat dibuktikan dengan nilai tertinggi bikarbonat.

Kata-kata: Kimia air, cetek, Telaga di Kelantan Malaysia.

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W.H.O	World Health Organization
M.H.O.	Ministry of Health
TDS	Total Dissolve Solvent
pH	potential of Hydrogen
HCO_3^{2-}	Bicarbonate Ion
Cl-	Chloride
SO_4^{2-}	Sulphate
Mg^{2+}	Magnesium
Ca^{2+}	Calcium
Na^{+}	Sodium
K^{+}	Potassium
Fe^{2+}	Ferum

CHAPTER 1

INTRODUCTION

1.1 General Background

Geological field mapping is the process involving map to selecting an area which have interest and identifying all the geological aspects of that area with the purpose of preparing a detailed geological report. To ensure we have the systematic work while doing geological field mapping we need have base map of study area. The tittle of the present research was Geology and Hydrochemistry of Shallow Aquifers at Kubang Gadong, Pasir Mas Kelantan.

Groundwater and surface water geochemical studies can provide a better understanding of potential water quality variations due to geology and land use practices (Edmunds and Smedley, 1996). Groundwater refer where is the water found underground whereas in the cracks and spaces in soil, sand and rock. This process might be stored in and moves slowly through geologic formation of soil, sand and rocks, is called aquifers. Groundwater is one of sources to human and all livings things where is a source of recharge for lakes, river, and wetlands and also groundwater can be occur everywhere. Water is important for mankind. In all human activities groundwater is needed and one of the very precious natural resource of earth that sustain all human activities. It is essential not only for substance of human life but also but also for the economic and social progress of region (Sitinder and Rajeshwari, 2010). Groundwater can provide sources of freshwater (Bethany et al., 2013). Besides that, groundwater was used for daily usage from urban until rural communities, irrigation of agricultures and maintain ecosystem. The groundwater existence is importance to human community and not to overemphasized (Islami et al., 2012). Daily activities water resource is supplied by domestic water company in North Kelantan area (Islami et al., 2015). In this area, there are some communities used water resource such as pumping well activities and have others people are using groundwater from shallow aquifer for domestic used and drinking purpose.

The water table of groundwater it may be deep or shallow and have factor may be rise or fall condition. A part of factor water table is raising cause heavy rains or melting snow and water table will fall because heavy pumping of groundwater supplies. Aquifers is explain as gravel, sand, sandstone, or fractured rock which can give water flow and move throughout this material. One of the examples likes limestone. The large connected spaces allow water move through these material and have permeability characteristic. The size of the spaces in the soil or rock and how well the spaces are connected are the factor of speed groundwater will allows. The hydrochemistry was study assessing the water chemistry characteristic of shallow aquifer and groundwater. To studies about groundwater and surface water geochemical can provide a better understanding of potential water quality variations due to various factors (Stumm and Morgan, 1996). To quantity and quality of groundwater resources around the world there is a growing awareness towards integrated hydrogeological studies pertaining (Kemper, 2004). According to Abdullah (1997) there are about 97% there was utilized from water supply system from surface water in Malaysia. Groundwater quality are important to human society because most of well that are generated from groundwater sources depending on the depth well and shallow well comes from surface water. Drinking water sources is suitable generally from groundwater compare to surface water due to less pollutant in groundwater (Soltan, 1997). Groundwater need to concern nowadays because several factors their qualities become deteriorate. Rapid growth in urban areas which contributes factor of water quality where exploitation of the resources as well as improper agriculture (Rajankar et al., 2009).

1.2 Problem statements

In the present study area, increase in population, this population mainly depended on own wells. To study hydrochemistry of shallow aquifer is necessary to ensure the well suitable groundwater for domestic purpose. The development of the village people which more of them depends on hand-dug well as well as from surrounding river and groundwater. To fulfill the demand of groundwater the clean water supply for the community was needed. Therefore, regulating monitory of shallow aquifer was required to fulfill the suitable requirement for drinking water. Many aquifer systems had put under stress and consequent environmental issue within the increasing in demand on groundwater resources. In coastal and multi aquifer systems such issues could be addressed through proper management of the aquifer systems for sustainability, particularly (Capaccioni et al., 2005). The groundwater development users have most people was used the domestic wells. The source was comes from confined in shallow aquifers. Probably, people in this area are using savage system where can be a part of shallow aquifers for necessary life. It is be concerned will probability have contaminated of groundwater. Hence, to overcome this happen, monitoring of groundwater impurities is the way to know the presence conditions and the suitability of water in different uses and purpose in this area.

1.3 Research objectives

The objectives of this research are:

I. To produce alluvium map of the study area with scale 1:25000.

II. To determine the physic-chemical parameter of groundwater

III. To classify the groundwater types using Piper Trilinear Diagram.

1.4 Study area

The study area was located in Kelantan which is on the east coast of Peninsular Malaysia. Kelantan was bordered by Narathiwat province of Thailand to the north, Terengganu to the south-east, Perak to the west and Pahang to the south. Kelantan area about 15,099 km^2 and have 10 districts. The study area was part of Pasir Mas area and district. It was located in Kubang Gadong area. It lies between latitude E $06^0$08’52.61’ and E $06^0$04’32.88’’and longitude N $102^0$04’32.44’’ and N $102^0$09’25.95’’. This study area covers about $64km^2$.

Kubang Gadong is one of the largest area in Pasir Mas district with high density of population. It was bordered with Kubang Sepat at the east and Bunut Susu area at the north. In the west have bordered Thailand country and in the south have Alor Pasir, Pasir Mas and Kota Bharu. Kubang Gadong area was covered about 55.86 km^2. In Kubang Gadong population was about 99% are Malay and only 1% was Chinese races. Kubang Gadong have 26070 populations. In the study area, most of the area was lowered made up by flat land, 15% is low-lying and marshy and it will flooded almost whole area of the district of Kubang Gadong which have 55.86

km^2 area. The land use was showed in variety of agriculture pattern like paddy field, fruits and others. In the figure 1.1 was showed the base map of the study area in Kubang Gadong Kelantan was covered 64 km^2.

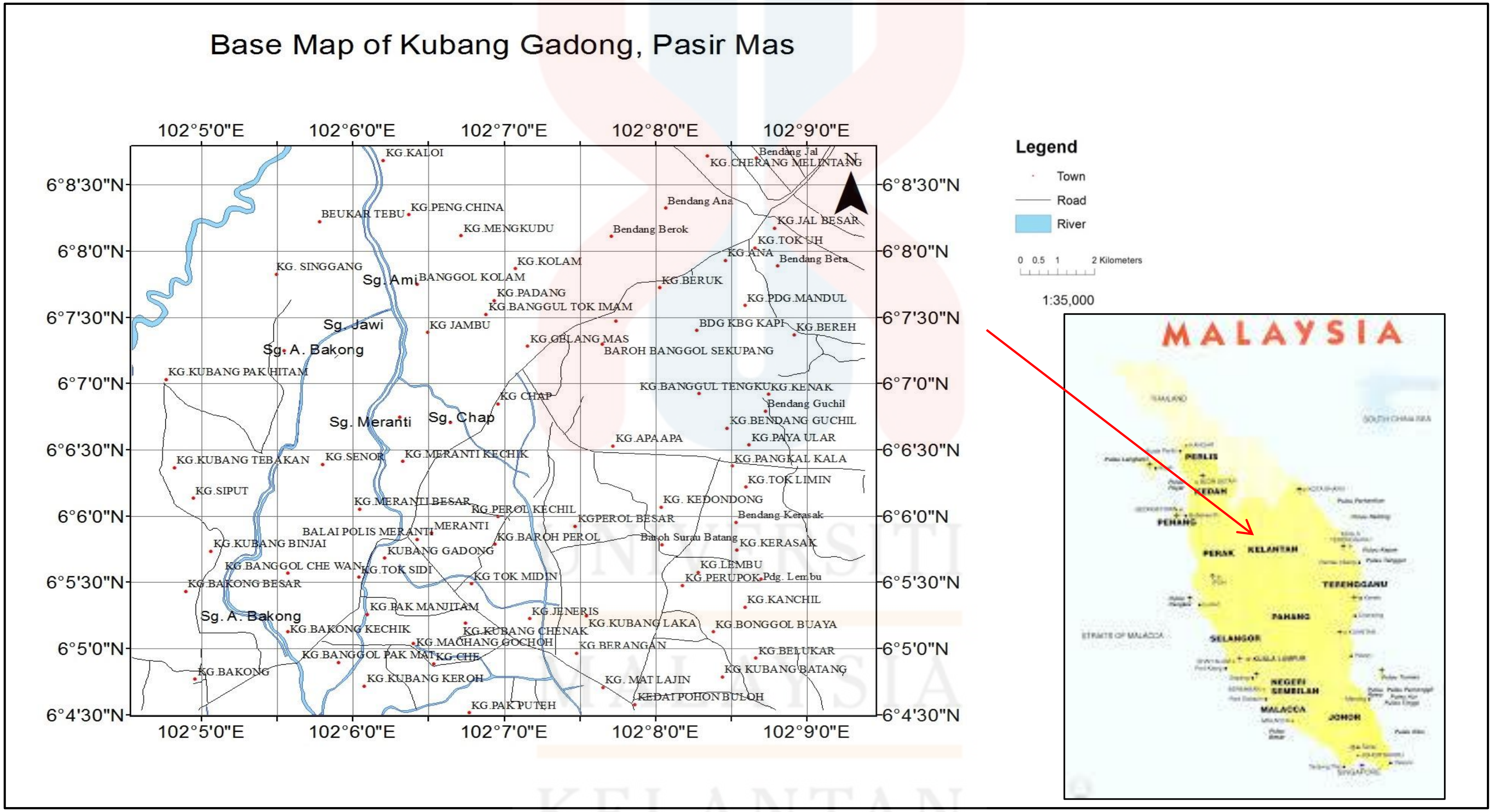


Figure 1.1: Base map of study area in Kubang Gadong, Pasir Mas Kelantan.

1.4.1 Geography

a. People distribution

Total populations based on ethnics Malay, Chinese, Indians and others, the population dominant race was Malay race, followed by Chinese race and Indians race. The detail of populations in the table 1.1 was showed the study area dominated by Malay races.

Table 1.1: The people distribution in Pasir Mas during year 2010.

Jajahan/ Local Authority Area	Malay	Chinese	Indians	Others	Total
Pasir Mas	11,063	731	9	12	11,815

Sources: (Department of Statistic Malaysia, 2010)

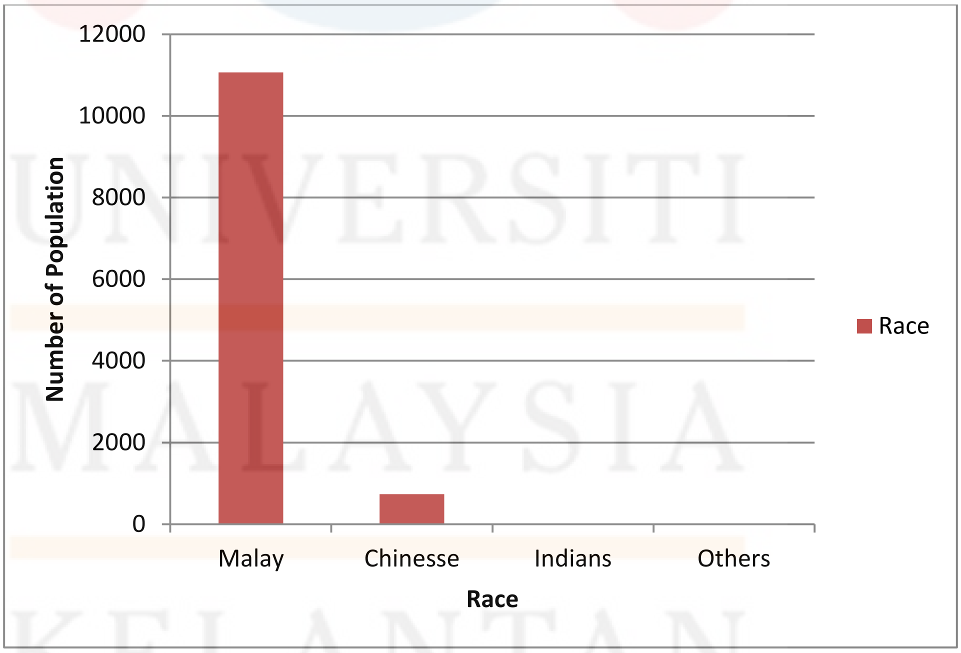


Figure 1.2: The population in Pasir Mas area.

b. Rain distribution

Rainfall data was collected from Department of Irrigation and Drainage (JPS) to show the rainfall distribution. The total rainfall of Pasir Mas district has 2780.0 mm in 2014. The higher rainfall distribution in the study area shows in December is 959.00 mm and the lowest rainfall distribution show in February and April where 00.00 mm. The table 1.2 was showed the total rainfall in Pasir Mas is 2780.0 mm.

Table 1.2: The rain distribution of Kelantan State in 2014.

Sources: (Department of Irrigation and Drainage, 2014)

Month	Total (mm)
January	135.0
February	0.0
Mac	39.0
April	0.0
May	75.0
June	193.0
July	148.0
August	166.0
September	112.0
October	367.0
November	586.0
December	959.0
Total	2780.0

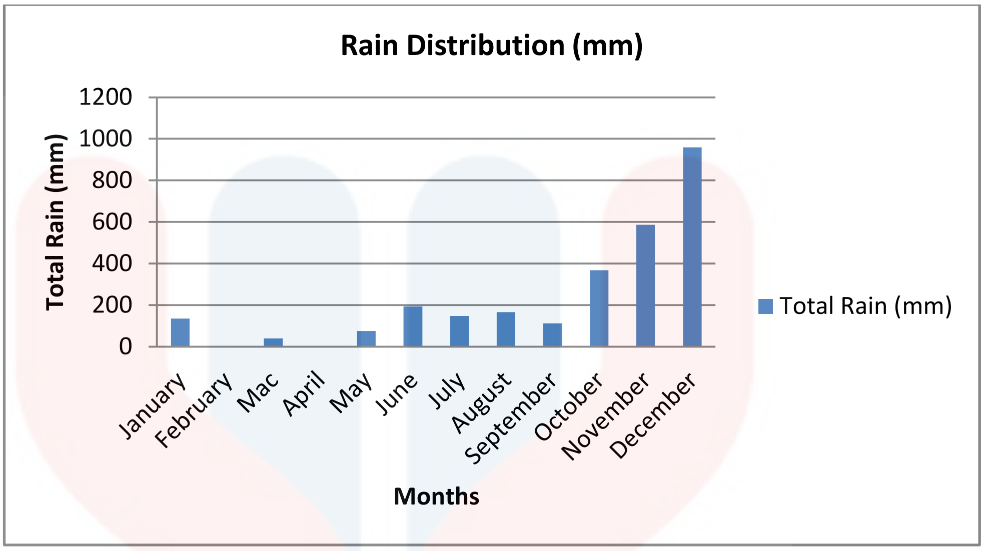


Figure 1.3: The total rain distribution (mm) in Pasir Mas district.

c. Land used

The distribution of land use was dominated by villager's house. This area was covered by house, school government buildings and shops. There were houses located closest each other and have roads for easier accessibility. The location of house was distributed and unplanned. For land use in agriculture most of the areas were covered by paddy field. The figure 1.4 was showed land distribution in Kubang Gadong area.

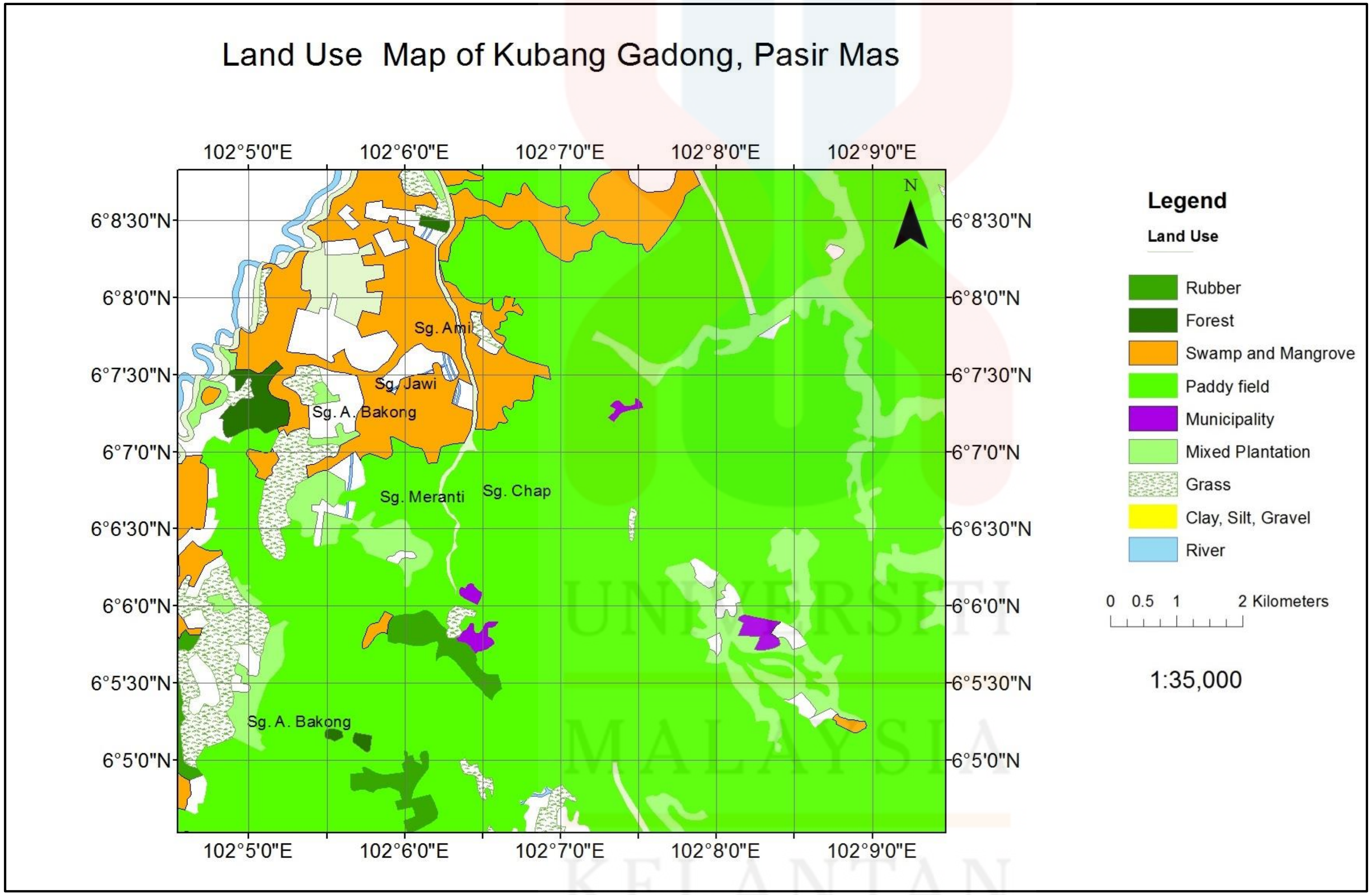


Figure 1.4: The land use map in Kubang Gadong area which agriculture likes paddy field dominated in the study area.

d. Social economic

This area was showed the plain area where located at the alluvium rich area which suitable for agriculture. These areas were huge of paddy field, farming and orchard. In this area have town in Kubang Gadong town which have a few small stall and shops. Besides, along the road in this area, have people do business likes stall foods and fruits.

e. Road connection

In this study area, the road connection not give problem to the community. There were major road and minor road for villagers to access with each other. There was town of Pasir Mas which can access and travels only 8 kilometer. There were roads that can be access for research investigation and sampling. The figure 1.5 was showed the road junction in the study area which main road to the town and figure 1.6 was showed the map connection in the study area.

Figure 1.5: The road junction in the study area which can be access for villagers to the town.

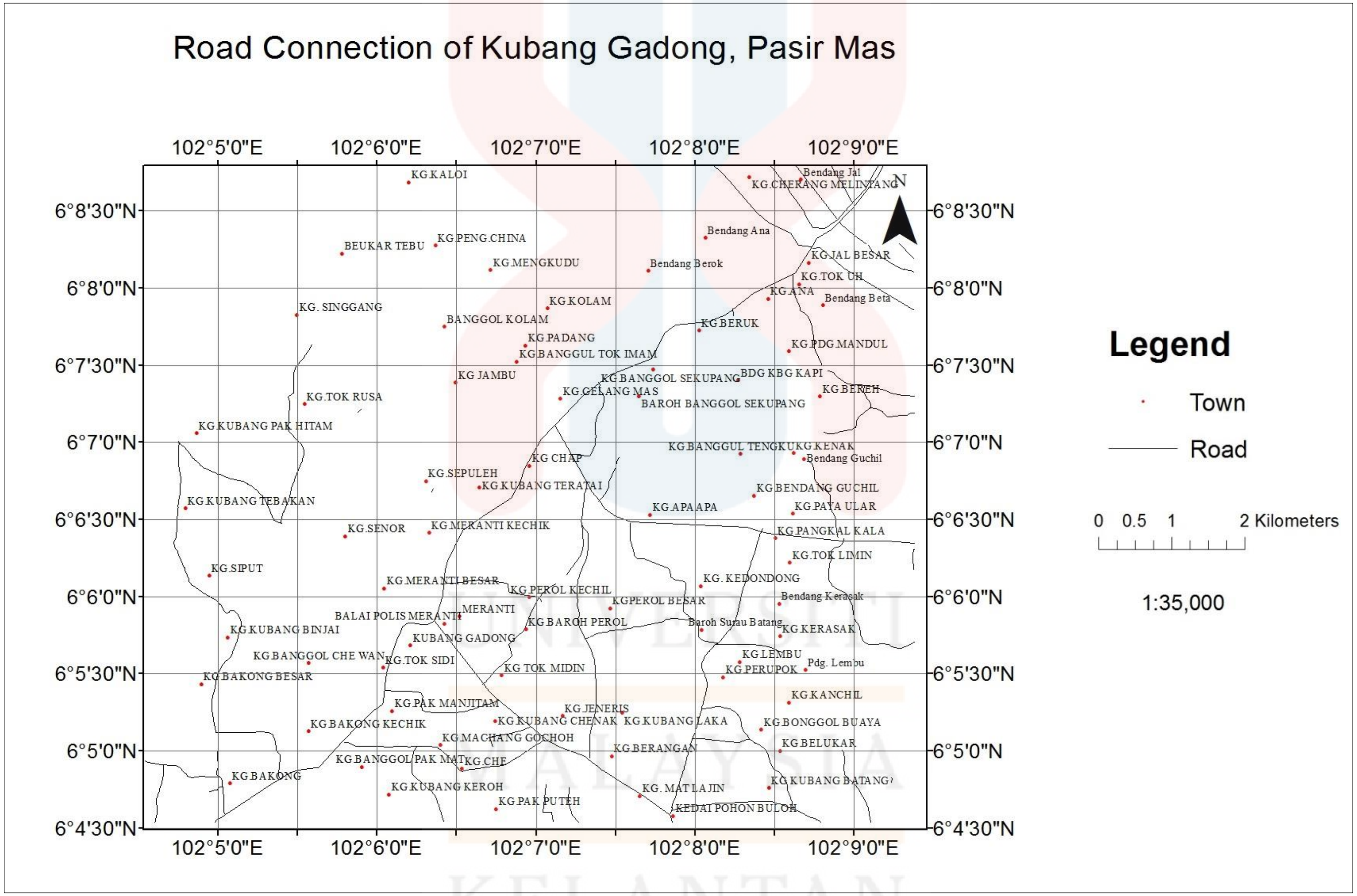


Figure 1.6: The map of road connection of Kubang Gadong area which can be access for villagers.

1.5 Scope of the study

The scope of study was produce alluvium mapping with ratio 1:25000 in this study area at Kubang Gadong, Pasir Mas Kelantan. In this research, was focusing to determine the physical and chemical characteristic of groundwater aquifer. This was determined the major ions by using Atomic Absorption Spectrometer, Gravimeter and Titrimetric methods. This show the major anion and cation in groundwater indirectly know the water quality for drinking purpose according W.H.O AND M.O.H standards. Next, this research was focused on how to classify the types of groundwater using Piper Trilinear Diagram.

1.6 Research Importance

The research are importance to produce alluvium map of study area, involving Geographical Information System (GIS) technique. This was identifying the areas which have alluvium distribution. According this research study, identify water chemistry contents are main objectives where it was useful for the communities to take a proper action about water chemistry content at shallow aquifer. Besides, it was help community increase healthy living standard and also reduces the contamination problem. Indirectly it was help increase living standard of community. During the last few decades researches on groundwater resource management and water quality have been in vogue and abundant literature is available on that. To adopt and Invent newer technologies and tools in resolving the issues it has become necessary cropped up during the same period such as aquifer contamination, over exploitation, seawater intrusion in coastal aquifer systems, land degradation, global warming etc. (Unnikrishnan et al, 2006). To improvise the aquifer management in terms of quantity and quality all over the world the newer technologies and tools are required (Satheesh and Lawrence, 2007).

1.7 Chapter's summary

In this chapter, was covered the study area about 64 km^2. The research objective to produce alluvium mapping 1:25 000. This was archive by geological alluvium mapping and use Arc GIS software to produce map. Hence, the important study of this research were determined the physical and chemical parameter in groundwater . The rising population in this area which most of them depending on hand-dug well as well from surrounding river and groundwater was curious the quality of water. Next, to classify the groundwater types by using Pipers Trilinear diagram will showing the types of groundwater from variety categories and characteristic.

In geography scope, the people distribution dominated by Malay race population followed by Chinese race, Indians race and others. Rain distribution in this area was showed the medium distribution compare to others place. Majority of people in this area were used land for agriculture and the study area rich with alluvium area suitable for agriculture. In this study area, have road access to connected town to village and town to town.

CHAPTER 2

LITERATURE REVIEWS

2.1.1 Regional Geology and Tectonic Setting

Peninsular Malaysia, with a total land area of 130,268 km^2, forms part of Sundaland, which includes Borneo, Java and Sumatra, as well as the intervening shallow seas from which emerge a number of smaller islands (Van Bemmelen, 1949). Peninsular Malaysia is an integral part of the Eurasian Plate, the South-East Asian part of which is known as Sundaland (Hutchison, 1989, 1996). According to Hutchison (1989) Peninsular Malaysia is an integral part of the Eurasian Plate, the South-East Asian part of which known as Sundaland. The Sunda Shelf, about 200 meters water depth less, is a continuation eastwards and southwards and Sumatra, Natuna, and western Borneo are integral parts of the same plate and the Sunda Shelf is common to all. Hutchison (2004, 2005) state the edge of Sunda Shelf extends North-South which a short distance east of Vietnam and then curves eastwards as long as the West Baram Line. The State of Kelantan situated in the East Coast of Peninsular Malaysia, neighbour with Thailand in the North and the States of Perak, Terengganu and Pahang in the West and South (Marzuki *et al*., 2011). The figures 2.1 shows map of Kelantan State which study area located in the north of Kelantan.

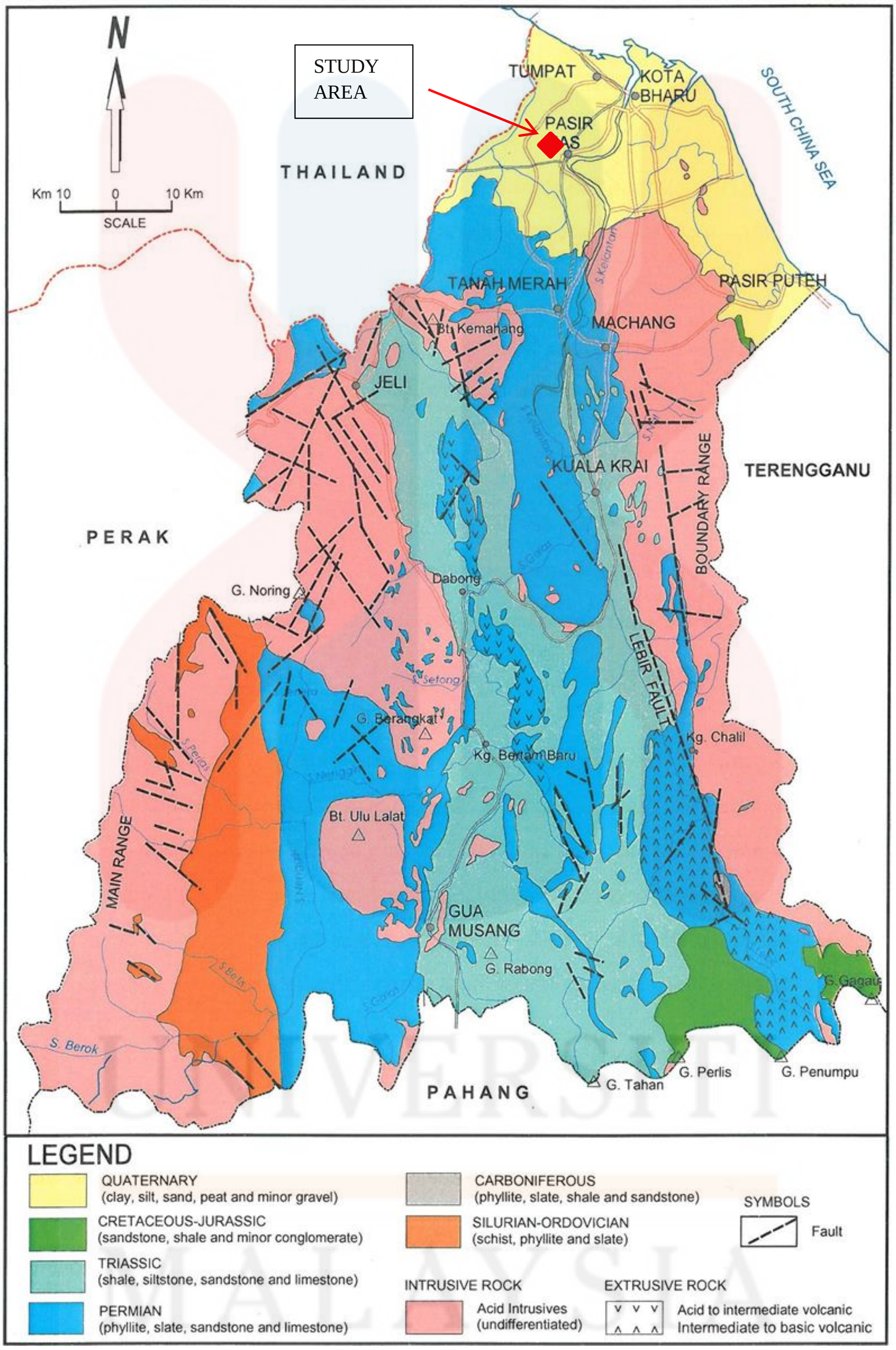


Figure 2.1: The map of the study area in Kelantan State. It is located at the north of Kelantan.

2.1.2 Regional Stratigraphy

The study area was located in central belt of Peninsular Malaysia and North of Terengganu and Kelantan. Kelantan Delta consists of three formation, which were Gula Formation, Beruas Formation and Simpang Formation (Bosch, 1986). The sand of the beach ridges ranges from moderately sorted gravelly coarse sand to poorly sorted, silty, very fine sand. The greyish green marine sandy clay and silt occur in the sales and peat may present locally. To the south of Kelantan Delta, however, stiff, white grey continental clays fills the sales (Bosch, 1988).

In the Kelantan Delta the unconsolidated sediments increase in thickness in east, with the deepest bedrock encountered at a depth of 150m (Bossch, 1986). The sediments contain of coarse gravelly sand and thin beds of clay bed at depth arranged 50-60 m although a 10-m thick clay layer occurs at depth 130 m.

2.2 Research specification review

2.2.1 Hydrogeology

Hydrogeology was defined as the study of occurrence, distribution and movement and chemistry of water all of the earth. Hydrogeology was the study of water whereas one of our important resources for our living things. The water supply was limited to use in nature and even though have plenty water on the earth, is not maybe in good condition which is not always in right place, at the right time and including in right quality. The increasing of waste chemically improper yesterday was showing in water supply today. The hydro geologist can supply information on groundwater tables, available groundwater resources and water quality aspects that example demands for engineer to know the design public and domestic water supplies, irrigation schemes, flood protection works and even office and industrial buildings (Nonner, 2002). According Tan (2009) the area in Kelantan mostly covered by volcanic rock that are mainly pyroclastic, tuff and agglomerate with minor lava flow while the lithology of the area can be identified by hard rock which have granite composition that classified ranges from acidic to intermediate. The types of lithology will influence the composition of dissolve solvent of groundwater.

2.2.2 Groundwater

During the last few decades, groundwater has become the most important objective in groundwater management. Groundwater has increasing based irrigated agriculture and drinking water supply. Groundwater was defined as the earth crust containing saturated groundwater which has water pressure is higher than atmospheric pressure. According Todd (1976) groundwater is stored and moves slowly through layer of soil, sand and rock. Groundwater is used for human activity and essential for all living things in the earth. Groundwater is stored below the ground between particles of rocks and soil, or the cracks of rocks. Basically 95% of the freshwater in this world is groundwater.

Groundwater is a precious natural asset, which requires a loving care. The quality of groundwater of an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities (Subramani *et al*., 2005).

2.2.3 Aquifer

Aquifer is store and transmits water in geologic unit at rates fast enough to supply reasonable amounts to wells. Aquifer would have intrinsic permeability in ranges from about 10^{-2}Darcy upwards. The example of rocks unit known to be aquifer are unconsolidated sands and gravels, sandstones, limestones and dolomites, basalt flows and fractured plutonic and metamorphic rocks. These materials are permeable because able to allow water to flow through with their large connected spaces (Fetter, 2000).

Hydrogeology of Kota Bharu consists of shallow aquifer (first aquifer) and deep aquifer. Hence, deep aquifer is divide into second, third and fourth aquifer. First aquifer which is dominated freshwater composed of sand and gravel with depth of 5-15m. Some places of the aquifer are confined by the surface clay.

2.2.4 Hydrochemistry

Hydrochemistry is defined as the part of hydrology which is deals with chemicals characteristics of bodies of water. Chemical and physical parameters of groundwater play an important role in assessing water quality (Kumaresan and Riyazuddin, 2006). Hydrochemistry also can identify the origin and history of water. Through hydrochemistry identification also can trace the origin and history of water. The various process in groundwater flow regime water chemistry undergoes change. The processes such as dissolution of minerals, precipitation of dissolved ions under unstable conditions and cation exchange.

2.2.5 Water Quality

Water quality can been determined when gas and solutes dissolved in water hence suspended such as floating in water (Fetter, 2000). The identifying of water quality by physical and chemical parameters in groundwater where can be stated whereas water have any alteration due to several factors such as human activities. The most important factor that concerns the quality of groundwater are human activity (Kazi *et al.*, 2009). The purpose to define water quality is a set of physicochemical parameter analysis. The acceptable and unacceptable standards can be differentiating the water quality using this parameter (Sundaram *et al.*, 2009). The water quality concept where can be major factors that must be carefully considered when evaluating the sustainable development of a given area (Jameel *et al.*, 2012). The purpose of drinking water include the water obtain in an area for community and there are specific standards that need to approved before communities can used it. The World of Health (W.H.O) and Ministry of Health (M.O.H) are responsible for the approval water quality for safe drinking purpose.

CHAPTER 3

MATERIALS AND METHODOLOGIES

3.1 Introduction

In this chapter, need to carry out the workflow of the research through flowchart which were covered the preliminary research study, materials and methods, field studies, laboratory investigation and data analysis and interpretation. The figure 3.1 was showed flowchart for methodologies investigation.

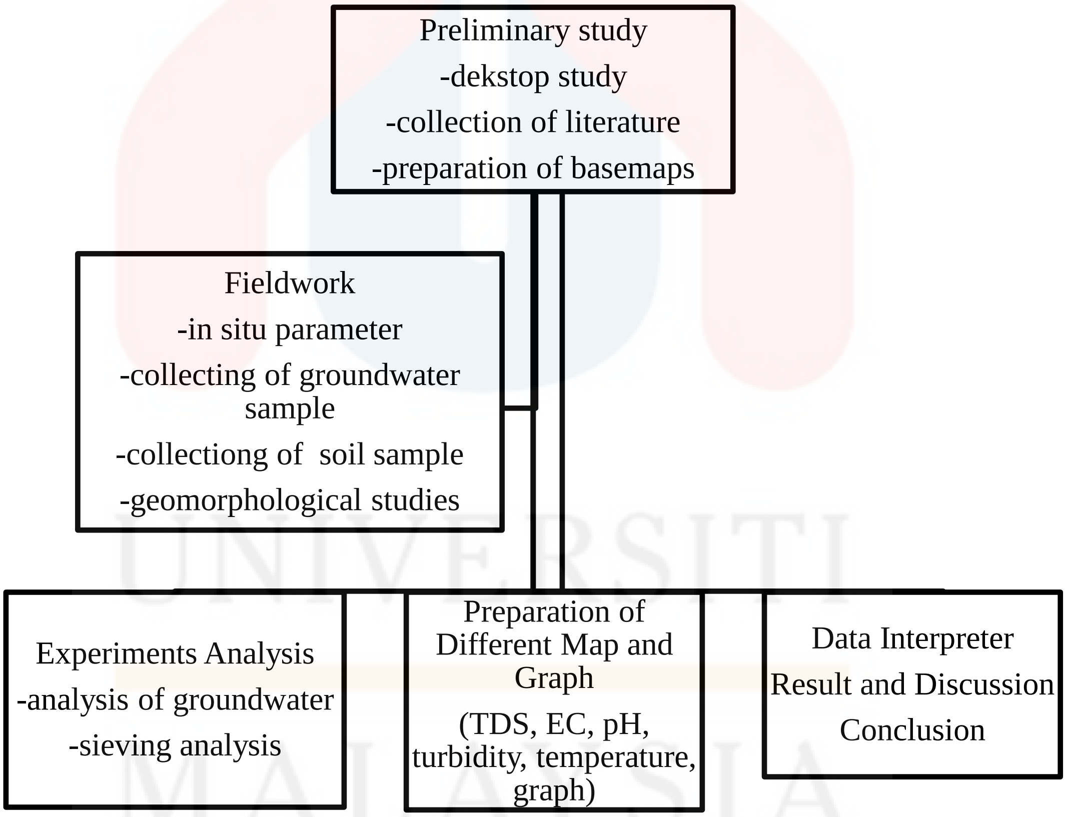


Figure 3.1: The flowchart shows the methodologies for research investigation.

3.2 Preliminary Researches

In the early stage before going to field, pre-field knowledge was needed. Before doing the research preliminary study was important to gain knowledge and idea. Based on the title final year project the paper, journal, article and others book reference are considered for makes more understand about research topic. Reading more books to make more understanding about groundwater and others related with groundwater. To know well about the research reading of previous literature was needed. The sources for literature review can get from Bulletin of the Geology Society Malaysia, and some from the unpublished technical paper from the Mineral and Geosciences Department Malaysia, library of Universiti Malaysia Kelantan and others. Basically, for the study area, the information's and data about map can get from Director of National Mapping Malaysia was obtained from JMG Kelantan and also from UMK geology lab and used as a base map. Based on the topographic map was observe and identified study area by traversing the area based on GPS reading and compass in the field. In this phase, literature review and field preparation were important activities because it will help and give some idea before starting the research.

3.3 Materials and Methods

To carry out the field work research, there were equipment's or tools required to undergo this research for get data and information. The regional map from Peninsular Malaysia was needed to identify the locality of Pasir Mas, Kelantan from Mineral and Geosciences Department.

a. Global positioning system (GPS)

It is represent us the exact time and their position that device used the radio signals from orbiting satellites.

b. Brunton / Suunto Compass

It is can shows the measurement of orientation of geological planes and lineation. The bearing direction from the compass help us to plot directly onto the map by using compass itself as a protractor.

c. Geological hammer

It is use to break off the outcrop for sampling. The pattern of the hammer is has one square faced end and one chisel end. This hammer can be used for dinging.

d. Measuring tape

This tape has multi-functions regarding from measurement grain until to thickness of bed.

e. Hand lenses

It is used to magnifying the mineral in rock and to identify characteristic of the rock in the study area.

f. Hydrochloric Acid (HCL)

To characterize the features of the rock and observe the reaction evidence of the rock.

g. Sample bags

To carry out the collected sample of rock and soil.

h. Sample bottles

It is used to keep water samples in the field.

i. Field notebook

It is used to write down the data collection at the field for future reference.

j. Base map

Base map or also known as topographic map. This will represent the study area with deals together with GPS to identify the position of the study area.

3.4 Field Studies

Field study was to establish the area of research. The area was needed to cover about $64km^2$. The field study was doing at least three times to ensure the data and collection was perfect and considered when doing lab analysis. Traverse were developed by measuring the distance, state the coordinate and mark any point that have well and soil sampling in the GPS. In the field, sample collection from groundwater and sample of soil and sand were taking by selection well distance. This is to ensure the validity and accurate result recorded. This accuracy was to fulfill requirement for research and when continues lab analysis later. Besides that, to produce alluvium map, the place that have alluvium was identify. Alluvium is product of deposited by flowing water as in riverbed, floodplain, delta or alluvial fan. Alluvium may come in condition sand, silt, clay and gravels.

The reading of measurement for in-situ parameter with the sample was recorded. Sample were considered to the lab have two divisions whereas in Situ parameter and lab experiment. In Situ parameter reading need to take at the field for the sample. The reading for In situ parameter for example pH, electric conductivities (EC), total dissolve solvent (TDS), turbidity, temperature and others.

3.4.1 Geological Alluvium Mapping

The base map of study area was being prepared. Besides, the map of specific box of Kubang Gadong was prepared. According to both map, identify and planning the traverse road for the alluvium mapping. Then, identify the location which can do alluvium mapping. Based on the map, the location of alluvium mapping was identified carefully to make sure that no leaving out area not cover or dismissed. Hence, the process to collect the fresh samples alluvium mapping. The samples were needed to undergo lab analysis for sieving. The Global Position System was used to mark the location. The geomorphologies were determined and identify. Observation the sites area of geomorphology was needed.

a) Soil Sampling

Geological alluvium mapping was identified the alluvium mapping location. Auger was used to carry out the soil sediments in 100 cm below the surface. Every the 10 cm of soil sediments was noted and was separated for doing sieving analysis and thin section.

Figure 3.2: The auger that used in alluvium mapping.

b) Water Sampling

The water samplings were carried out from all area in the research study. The sampling water was made due to availability well location. Many factors that need to be considered before water sampling such as the people surrounding use the well for domestic purpose or drinking purpose. The 15 location well water sampling in the study area and the sample were taken and transfer to 150 ml polyethene bottle that already washed with nitric acid and rinsed with distilled water for cation and others bottle not mix with any solution for anion. Hence, wrapped the bottle with aluminium foil for keep safe.

Figure 3.3: Shows how to conduct well for water sampling.

Figure 3.4: Shows the water sampling wrapped with aluminium foil.

3.4.2 In-Situ parameter

In situ was applied to measure the physical properties and some major ions. In situ can be done in the field for water sampling analysis. The physical properties was done through in-situ are example pH, electric conductivities (EC), total dissolve solvent (TDS), turbidity, temperature and others.

There were little equipment to take the reading of in-situ parameter such as multi parameter, portable pH meter and turbidimeter.

a) Portable pH meter Hanna HI 8314

The portable pH meter Hanna The HI-8314 was designed to be reliable and easy to use. The HI-8314N was also serve with the HI-1217D pre-amplified pH electrode and internal temperature sensor. By adjusting the trimmers on the front panel is a perfume one or two point for manual calibration. For this instruments to get ideal for application that require a custom calibration point. To achieve better accuracy manual calibration can be useful.

b)   YSI-556 Multi-Parameter

The YSI 556 MPS commonly measures dissolved oxygen, pH, conductivity, temperature, and Oxidation Reduction Potential or simply purchase the cable to measure electrical conductivity, and temperature if needed.

c) HACH 2100P Turbidimeter

The Hach 2100P Portable Turbidimeter was designed ease of use and accuracy in turbidity measurement. This is unique combination of advanced features and measurement innovation, giving accurate results every time.

d) Water level indicator

The water level have two condition static and drawdown modes. The purpose to perform low-flow and pump tests, or to determine the bottom of the well. It can take static level readings and then switch to drawdown mode.

3.5 Laboratory Investigations

Lab analysis was considered to identify the sample from the field. In this section, two types of sample are collected. There were sample from alluvium soil and another one from groundwater sample. Analysis of groundwater sample and surface water sample were needed through lab experiment using titration and Atomic Absorption Spectrometer (AAS). Besides that, sieving analysis was needed to divide the size of grain soil. The thin section process was provided in geology laboratory University Malaysia Kelantan. The remote sensing data were required to interpret and process by using specific software like Geological Information System (GIS). In alluvium soil, sample was taken using auger. Then, it was proceed to next step for sieving process. Groundwater sample was analyzed through selection well localities. Global Position System (GPS) was marked in every locality which samples were taken. In-situ was measured for all samples and the reading was taken. Next, the samples was stored in any clean bottle to prevent contamination and any influence effect from outside environment. To know the different types of composition of groundwater samples, every depth will be measure and record.

3.5.1 Sieving Analysis

In thin section preparation, sieving analysis was needed to divide the size of grain soil. The thin section process is provided in geology laboratory University Malaysia Kelantan. A sieve analysis usually used in civil engineering to assess particle size distribution. The characterize different form and size was needed knowledge of their particle size distribution. The soil sample was carried about 500 g to laboratory for analyzed. Hence, the sample was quartering into two division. The soil was putted on the top of sieve and starts sieving around 10 minutes. Next, other sample in same location repeated the process to get accuracy reading. The material retained on each sieve and bottom pan were weighed.

The permeability of soil based on the grain size of soil. The coarser grain size occur, the highest permeability occur at the location. The study area consist of clay, silt, sand and gravel.

Based on the graph, the grain size distribution was predicted and types of permeability were recorded. The data will interpreted based on grain size and permeability by Todd.

For the characterization of bulk goods of different forms and sizes, the knowledge of their particle size distributions is essential. The particle size distribution, i.e. the number of particles of different sizes, is responsible for important physical and chemical properties such as solubility, flow ability and surface reaction.

3.5.2 Hydrochemistry Analysis

Hydrochemistry analysis was showed the samples was collected from the well were analyzes. The samples from groundwater were collected from different well in the study area for chemical analysis. It was showed the variety properties and characteristic from different groundwater samples around the study area. The hydrochemistry analysis started to analysis based on major ions from different samples. There are example of major ions such as bicarbonate (HCO_3), sulphate (SO_4^{2-}), chloride (Cl^-), calcium (Ca^{+2}), magnesium (Mg^{2+}), potassium (K^+), sodium (Na^+) and Ferum (Fe^{+2}).

To analysis the hydrochemistry of groundwater were divided into several process. All the values from these methods was used to plotting major ions in the Piper Trilinear Diagram to know the types of groundwater facies from different samples of groundwater.

a. Atomic Absorption Spectrometer (AAS)

The atomic Absorption Spectrometer (AAS) was instruments define ways for measuring quantities of chemical characteristic of elements present in environmental samples or groundwater samples by measuring the absorbed radiation by the chemical element of interest using the absorption of optical radiation (light) by free atoms in the gases state. The first method was determined using Atomic Absorption Spectrometer (AAS) method. Through this method was determined the major ions in groundwater samples likes calcium (Ca^{2+}), potassium (K^{+}), Ferum (Fe^{2+}), sodium (Na^{+}) and magnesium (Mg^{2+}).

The standard concentration used are 4 ppm, 8 ppm, 12 ppm and 16 ppm. The distilled water is used to control the concentration is 0.00 ppm. All the sample value was recorded.

b. Gravimetric method

Gravimetric analyses is methods determination and identify analytical chemistry for the quantitative based on mass of solid. For example when water sample have solid suspended, the water known volume will filtered and the collected solids are weighed. Gravimetric method which can been identified the sulphate ($SO_4^{2-)}$ in the water content.

Barium sulphate in hydrochloric acid medium form sulpate precipitate by addition barium chloride solution. This reaction will react in boiling temperature. The precipitate was filtered, and then washed to remove the chlorides dried and weight as $BaSO_{4.}$ The methyl red indicator, barium sulphate, hydrochloric acid and solid crystal silver nitrate was prepared. The 50 ml of sample water were taken into conical flask. The methyl red was drop a few into the sample and 37% hydrochloric acid (HCL) solution added 2 ml as an indicator to pH around 4.5 – 5.0 and the colour was changes to pink. Then, the sample was boiled using hot plated and Barium

Chloride was added carefully until precipitation appeared. The precipitate was heat in 90^oC at least 2 hours. The filter paper was put the sample consist of precipitate. Then the filtered paper was wash repeatedly with warm water to get the precipitate and until the sample was free from chloride that can be tested by silver nitrate $AgNO_3$. Which can give a white turbidity when the presence of chloride. The filter paper was dried and using furnace in 800^0C to burn it in one hour. The precipitate barium sulphate was recorded and value of sulphate can be measured as shown below.

SO_4, mg/L = (mg of $BaSO_4$ x 411.5) / (ml of sample)

c. Titrimetric method

Titrimetric method or titration methods in other name was used in laboratory method of quantitative chemical analysis. It was used an identified analyze by determine the unknown concentration. Titrimetric method used to identify chloride (Cl^-) and bicarbonate (HCO_3^{2-}). Bicarbonate titration begins with beaker or conical flask contain precise water sampling volume and addition of small amount of indicator will put underneath calibration burette containing titrant. The titrant will open slowly into the water sampling and indicator in the conical flask while shake until the indicator changes colour in reaction to the titrant saturation and reflected arrival at the endpoint of the titration. The changes of colour depends on endpoint desired either single drops or more. The volume of titrant will calculate start first point drop until changes of colour in conical flask.

For bicarbonate (HCO_3^-) analysis, it can be estimate by titrate the sample by using sulphuric acid (H_2SO_4) or hydrochloric acid (HCL). Phenolphthalein is used as an indicator mixed with methyl orange. There are two case in identify the value which are phenolphthalein alkalinity (PA) and total alkalinity (TA).

The preparation for this analysis by produced four reagents which is hydrochloric acid solution, 0.1 N, sodium carbonate 0.1 N, methyl orange indicator 0.05% and phenolphthalein indicator. The process of analysis can undergo by 100 ml sampling water in conical flask will drop two of phenolphthalein. Hence, the solution remains colourless after drop indicator the phenolphtaphlein alkalinity (PA) = 0. Next, adding two drops or more methyl orange to the sample and continue titration. The water sample will change from yellow colour to pink colour at endpoint and its show total alkalinity (TA). Lastly, volume of bicarbonate (HCO3-) can be measure by using formula shown below:

$CaCO_3$, mg/L= ((B x Normality) of HCL x 1000 x 50) / (ml of sample)

For chloride analysis, 2 reagent solutions were prepared silver nitrate, 0.02 N which dissolved 3.4 g of dried $AgNO_3$ in distilled water to dissolve in 1 L solution and keep the bottle reagent in dark place. The 5 g of potassium chromate K_2CrO_4 was dissolved in 100 ml of distilled water. For titration process, 50 ml sample was put in conical flask and add 2 ml of potassium chromate solution solution. Next, the content in conical flask was titrated again with 0.02 $AgNo_3$ until red tinge colour appear. This formula below shown to calculate the value of Chloride.

Chloride, mg/L = ((ml x N) of $AgNO_3$ x 1000 x 35.5) / (ml of sample).

3.6 Data Analyses and Interpretations

In this phase, the data and information reading from experiment analysis were visualized using map and graph. These were Total Dissolve Solvent (TDS), Electric Conductivity (EC), pH, temperature, soil size distribution and graph. To classify types of groundwater the Piper Trilinear Diagram was used in this interpretation.

In this phase, data were analyze and interpreted from the result in experiments and graph. To characterized hydro-chemistry of shallow aquifers, result from Total Dissolve solvent (TDS), Electric Conductivity (EC), temperature, turbidity, pH and soil sieving was analyzed in the form of graph. Next, software also was used to produce geological alluvium map of study area by using ArcGIS. The Table 3.1 was showed TDS classification while Table 3.2 was showed classification of Electrical Conductivity.

Table 3.1: TDS Classification (Suzannah,2007)

Category	TDS (mg/l)	Benchmark
Fresh water	0 – 1000	100 %
Brackish water	1000 - 10 000	
Saline water	10 000 - 100 000	
Brine Water	>100 000	

Table 3.2: Classification of Electrical Conductivity (Suzannah,2007)

Class	EC (µS/cm at 25 ^{0}c)
Low conductivity	<500
Medium conductivity, class 1	500 – 1000
Medium conductivity, Class 2	1000 – 3000
High conductivity, Class 3	>3000

3.6.1 Groundwater Pipers Trilinear diagram

A piper trilinear diagram visualize the chemistry of water sample. In piper diagram have three division a ternary diagram in the lower left shows the cations, a ternary diagram in the lower right shows the anions, and a diamond plot in the middle shows a combination of the two. Hence, to plotting the piper diagram need to know the concentration of each of your three cation for a sample and plot them on the lower left ternary diagram, using the colored axes as guides. Repeat for anions on the lower right ternary diagram. Now, following a line parallel to the outer axis of each ternary diagram, project each point in the ternary diagrams upward until they intersect with one another in the diamond plot.

3.7 Report Writing

In this phase of results and discussion , the data and result information from the field, experiment analysis, maps and graph of Total Dissolve solvent (TDS), Electric Conductivity (EC), pH, turbidity, temperature, soil sieving were analyze. The data was interpreted by using graph Total Dissolve solvent (TDS), Electric Conductivity (EC), pH, turbidity, temperature, soil classification, and Atomic Absorption Spectrometer to determine the characteristic of hydrochemistry. The Pipers Trilinear Diagram graph was interpreted and discusses to classify types of groundwater.

In this phase of conclusion, the data and information that analyses were be conclude and transfer into report writing by following the format and the guidelines and which had been set by Faculty Of Earth Sciences, University Malaysia Kelantan.

CHAPTER 4

GENERAL GEOLOGY

4.1 Introduction

General geology is a survey of many aspect of geology, fundamental principal of physical and Earth Science including formation of rocks mineral, the formation of the universe and solar system, the structure of the earth's interior, the process of landscape and evolution of earth over time. In this general geology including geomorphology, alluvium mapping, soil Analysis, and quaternary stratigraphy.

4.2 Geomorphology

Geomorphology can be defined as to study the landform of the earth. Geomorphology is study relationship between physical features of the surface of the earth and its geological structure. Geomorphology can study the landscape and how the earth surface process including air, water and ice which can mould the landscape.

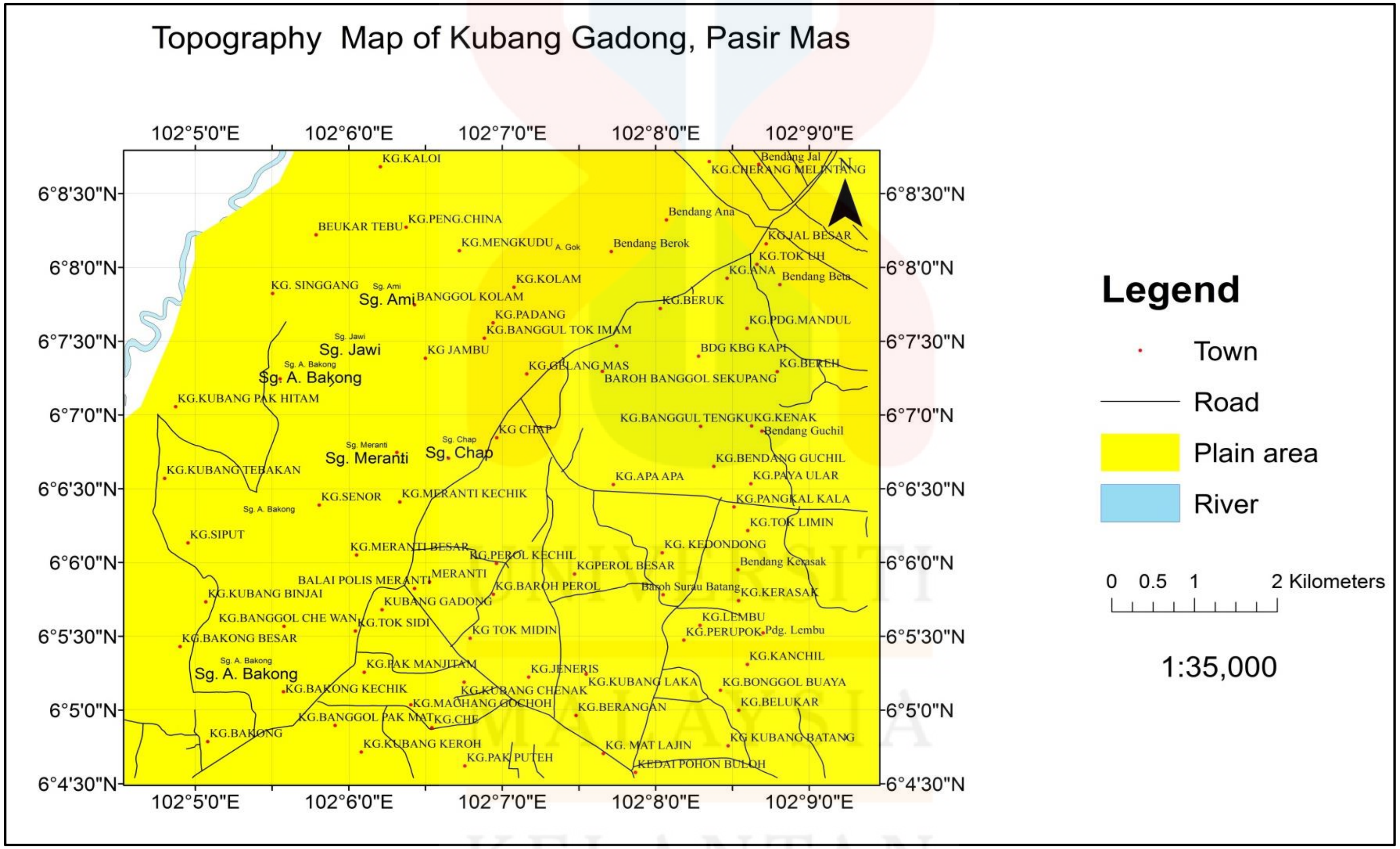


Figure 4.1: The topography map in Kubang Gadong

4.2.1 Topography

Topography is referring to study physical appearance of the natural features of the earth such as shape and features of the earth of the land area. It is includes mountains, hills, alluvium, creeks and other bumps.

Topography map in figure 4.2 shows the topography of the study area which covered by 90% of flat alluvium.

Topography in research area can been describe roughly throughout the map. In the topography map shows dominantly the study area covered by alluvium. In this study area, only have flat alluvium which have low lying area which have <15 m above sea level refer the elevation of topographic units. According to the study area will classify low land area with ranges 2.5 m. Mainly along the coast and as narrow tracts extending inland from the coastal plains have low lying areas (<15 m mean elevation) (Hutchison, 2009). In this area which have low elevation have many village possibility the villagers build their house and plantation for agriculture. This area which have low lying area might be choice people causes of in this low elevation has less steep compare to high elevation.

In this study area, have villages more than 10 villages which have higher population. There some village which have less residents. Mostly, people stay at locations which have town and river. The fluvial landform shows a river in a map. Fluvial describe form and function of stream relationship between stream and landscape surrounding. For classification of river alluvial rivers can be determined as meandering, braided, anastomose, wandering or straight. Alluvial river morphology is controlled by substrate composition, supply of sediment, discharge, vegetation and bed aggradation.

Topographic units can be classifying in five broads based on in the differences in means elevations as shown in table 4.1.

Table 4.1: The classifying topographic units. (Hutchison, 2009)

	Topographic Units	Mean Elevation (m above sea level)
1	Low lying	<15
2	Rolling	16-30
3	Undulating	31-75
4	Hilly	76-300
5	Mountainous	>301

.

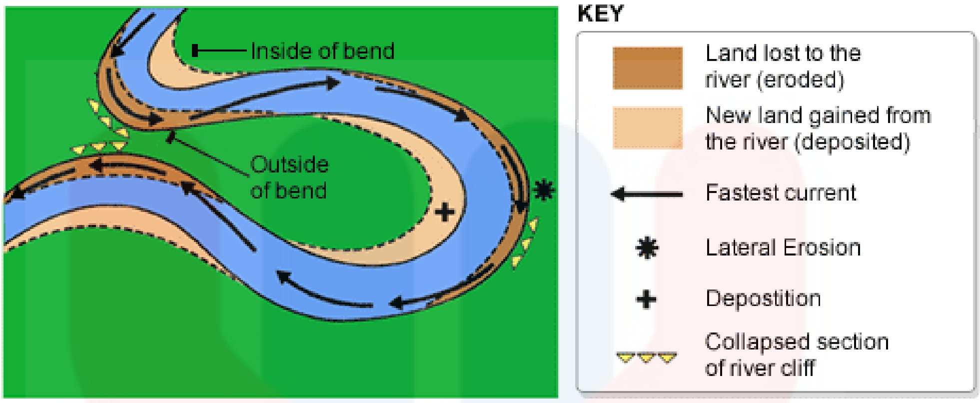
Figure 4.2: The plain area dominated by paddy field.

Drainage System

Drainage system can be describing pattern form by streams, rivers and lakes in particular of drainage basins. Based on the topography land it can be identified whereas it dominated by soft or hard rock. The drainage basins can be available found in varies area and large topographic map based on number, size, and shape of drainage basins.

Drainage system can be classify into numerous types of drainage pattern are dendritic, parallel, trellis, rectangular, radial, deranged, annular and angular drainage pattern.

For the study area represents drainage pattern in the map is meandering river and dendritic drainage pattern. Meandering river forms when moving water running in the stream erodes the outer banks. It is will widen the valleys and inner part of the river will less energy and deposits silt. The meandering course can be assume a stream of any volume which eroding sediments from outside bends and deposited them inside. Meandering river consist asymmetrical shape. The outside of each bend have the deepest part of the channel. In the deepest area the water flow faster and erodes material from river bank. In the shallow area the water starts flow slowly near the inside of each bends. It will because sediments form when slower water can't much carry and sediments will deposit hence its load on a series of point bars. There are dendritic pattern in this area. The pattern occurs in dendritic drainage is like limbs of tree when the tributary system subdivides headway. This pattern common occurs in area which have horizontal sedimentary or intrusive igneous rock when the rock mass in homogeneous.



Sources : (Bitesize)

Figure 4.3: shows the forming of meandering river.

Sources : (Wikipedia)

Figure 4.4: The dendritic drainage pattern in study area.

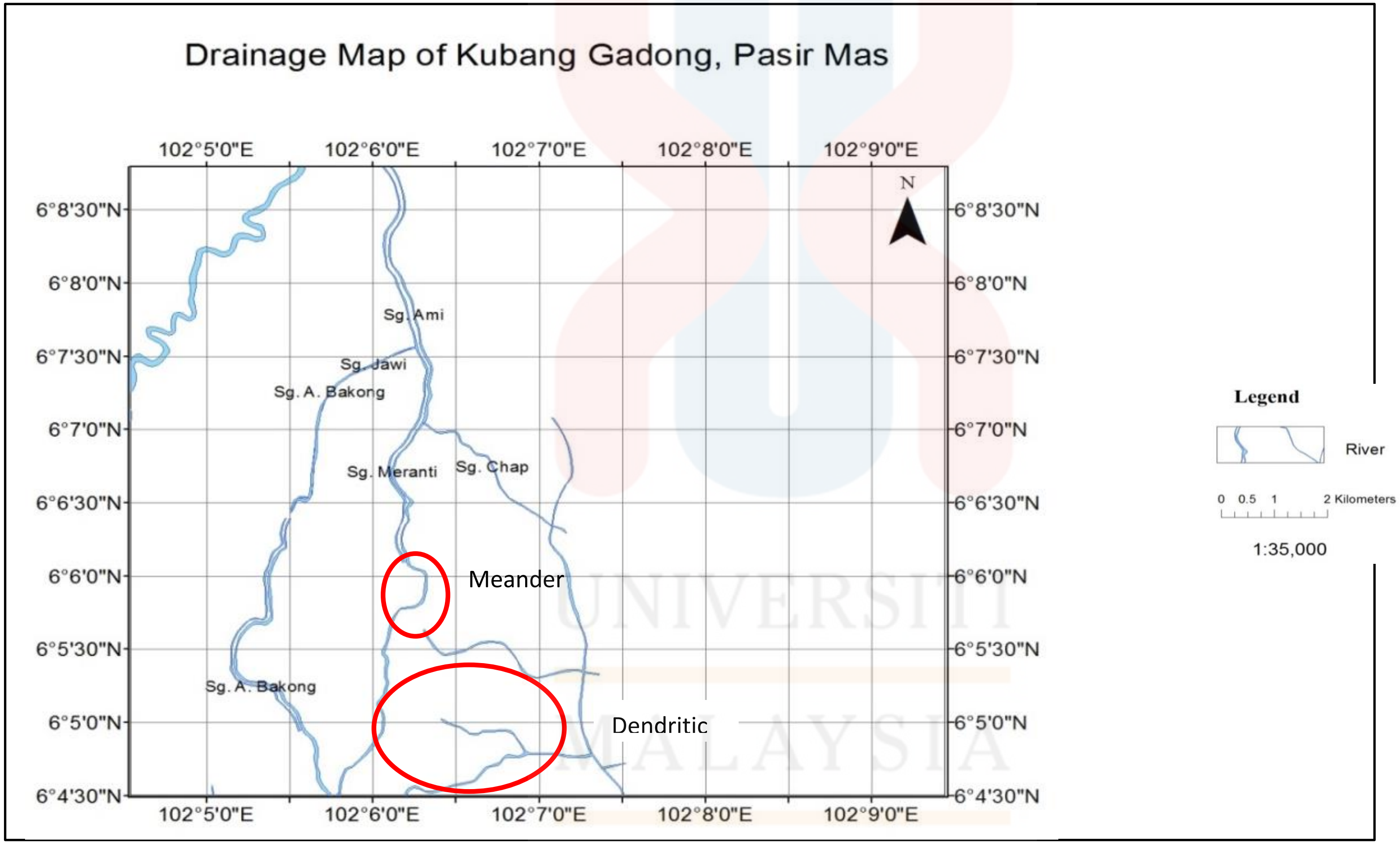


Figure 4.5: The drainage pattern in Kubang Gadong.

Figure 4.6: A river in the study area

Flood Plain

A flood plain or also known as floodplain is referred to the flat area of land adjacent to a river or stream that subjected to flooding. It stretches from the banks of river channels to the outer edges of the valley and involves flooding during high discharge of water.

In natural development of flood plains there two major processes are erosion and aggradation. The process of earth is worn away by the movement of a floodway is known as erosion of flood plain while the process of earthen material increase as the deposits sediment will describe as aggradation or alluviation of flood plain.

When the erosion occurs in river flood plain, it will know as meander. The flood plain's aggradation which from meandering stream. A aggradation is explained as wide, shallow and braided river. The alluvial flats occurred in gently rise to the valley sides. Most medium sized and major river have floodplains that formed by sedimentation inside the meanders bend (Huggett,2007).

In the study area, the flood plain area occurs along the river where the areas have low lying area and alluvium area.

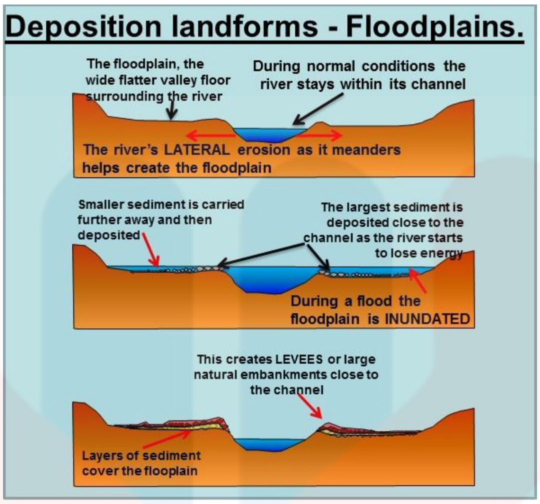


Figure 4.7: The formation of deposition sediments or also known flood plain nest the river.

Lineament

Lineament can be defined in line feature apparent and can be interpreted on geological or topographic map images and remote sensing images. A lineament in landscape is express underlying geological structure such as fault. A lineament consist varies for example fault in valley area, fault or fold-aligned hills, a straight coastline or combination all of the features.

Based on the study area, the topography was covered by flat alluvium area. The lineament is hard to find in mountain and hilly area and isn't clear ridge is present due to flat alluvial.

4.3 Alluvium Mapping

Alluvium is defined material deposit by a river. Alluvium consist of clay, silt, sand or similar detrital material which deposited by running water. Alluvium usually developed in the lower part area of a river forming floodplains and delta. But, it can deposit in any area where the river overflows its banks or where the velocity of a river is checked.

In the study area, there are three types of lithology were analyzed. There clay, silt, sand and gravel were dominated in lithology in this area. The area covered by flat alluvium which consists of sediments from quaternary age. Along the river area consist of sand, silt and clay. Then in the flat alluvium area consist of clay, humid clay, peat, and silt sediments and very fine grain of sand. There unconsolidated sediment comprises silt, medium sand, coarse grain and alternating of layer gravel.

Alluvium mapping was carried out 5 sample which the location nearest the well that taking for groundwater sampling. Each location shows varies of soil in aspects grain size and permeability. Kubang Gadong consist of flat alluvium where have clay, silt, sand and gravel. For clearly information refer table 4.2 which shown locality and coordinate of the sample.

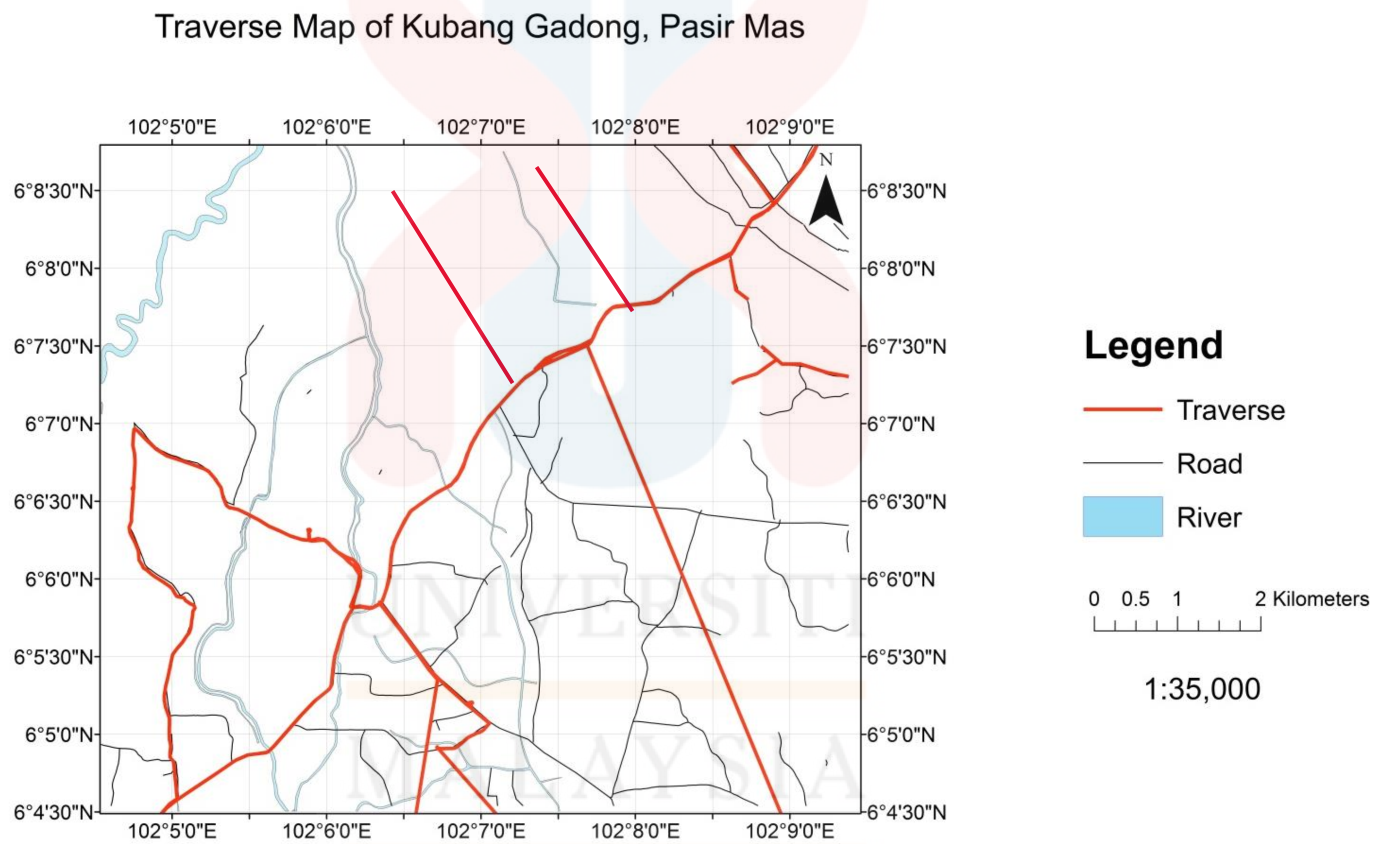


Figure 4.8: The traverse of alluvium mapping and water sampling.

Table 4.2: The sampling of soil coordinate in study area. Soil Sampling was carried out with same location nearest the well for sampling water location 1 until 5.

Soil Sample (SS)	Latitude	Longitude
SS 1 / L1	N 06º 05’ 0.5’’’	E 102º 08’ 25.5’’
SS 2 / L2	N 06º 05’ 54.3’’	E 102 º08’ 57.6’’
SS 3 /L3	N 06º 07’ 23.2’’	E 102 º08’ 51.1’’
SS 4/L4	N 06º 08’ 35.0’’	E 102 º08’ 14.3’’
SS 5/L5	N 06º 06’ 06.0’’	E 102 º08’ 14.4’’

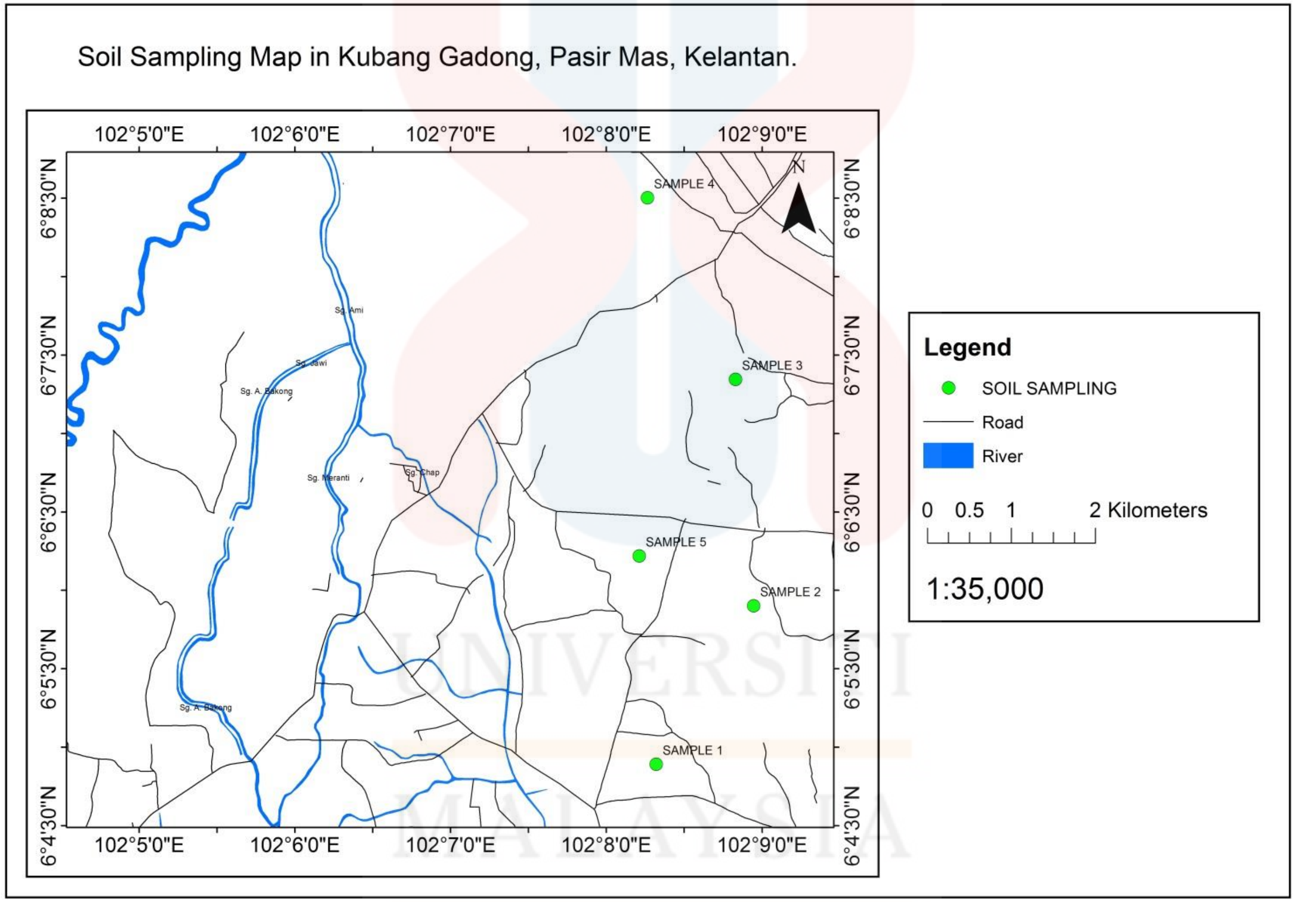


Figure 4.9: The soil map sampling in study area.

4.4 Soil analysis

Particles size analysis is the measurement of particles size of soils and distributions with the technical procedure or laboratory technique. It can determine the size range, the average or mean size of the particles whereas in a powder or liquid sample.

Measuring particle size can be classify the size of soils which have clay,silt and gravel. Particle analysis were conducted to find out the quantitative of the sample whether it has clay, silt and gravel which clay (< 0.002mm), silt (0.02~ 0.0002mm) and sand (>0.02mm).

The study area was located in Kubang Gadong area. The 5 samples were carried out to determination the permeability rate by distribution of particles size. It can show where the areas have higher potential of permeability and tend to trap more groundwater contaminants and major anion and cation. Soil texture can be describe the soil appearance or ''feel'' it. The ranges distribution of the size depends on the relatives size and shape. Soil can be divide by two coarse-grained soil which is gravel and sand and fine-grained soils have silt and clay.

4.4.1 Soil Gradation

Soil gradation classification of a coarse-grained which ranks the soil according different size particle that contain in the soil. Soil can be classified as well graded or poorly graded. Sieving analysis can determined the gradation of soil.

Table 4.3: The results of soil sample description in Kubang Gadong area.

Table 4.3: The soil sieving analysis in location 1.

IS Sieve Aperture Dimension, D (mm)	Weight Empty Sieve (g)	Weight (Sieve + Soil Sample) Shake Sample	Weight Average Retained	Retained %	Cumulative Retained %	Cumultive passing % (p)	Wentworth Size Class
2.8	553.4	573.6	20.2	10.05	10.05	89.5	Gravel
2.0	321.0	374.6	53.6	26.68	36.73	63.27	Very coarse sand
1.0	508.0	537	29.0	14.43	51.16	48.84	Very coarse sand
0.5	463.5	508.7	45.2	22.5	73.66	26.34	Coarse sand
0.3	277.5	292.9	15.4	7.67	81.33	18.67	Medium sand
0.075	258.5	296	37.5	18.67	100	0	Fine sand (silt+clay)
		200.9	100				

Table 4.4: The soil sieving analysis in location 2.

IS Sieve Aperture Dimension, D (mm)	Weight Empty Sieve (g)	Weight (Sieve + Soil Sample) Shake Sample	Weight Average Retained	Retained %	Cumulative Retained %	Cumulative passing % (p)	Wentworth Size Class
2.8	553.4	602.65	49.25	24.63	24.63	75.37	Gravel
2.0	321.0	389	68.0	34	58.63	41.37	Very coarse sand
1.0	508.0	536	28.0	14	72.63	27.37	Very coarse sand
0.5	463.5	494.5	31	15.5	88.13	11.87	Coarse sand
0.3	277.5	285.75	8.25	4.12	92.25	7.75	Medium sand
0.075	258.5	273.5	15.5	7.75	100	0	Fine sand (silt+clay)
			200				

Table 4.5: The soil sieving analysis in location 3.

IS Sieve Aperture Dimension, D (mm)	Weight Empty Sieve (g)	Weight (Sieve + Soil Sample) Shake Sample	Weight Average Retained	Retained %	Cumulative Retained %	Cumulative passing % (p)	Wentworth Size Class
2.8	553.4	576.4	23.0	9.93	9.93	90.07	Gravel
2.0	321.0	396.6	75.6	32.63	42.56	57.44	Very coarse sand
1.0	508.0	540.9	32.9	14.20	56.76	43.24	Very coarse sand
0.5	463.5	531.7	68.2	29.43	86.19	13.81	Coarse sand
0.3	277.5	288.5	11.0	4.75	90.94	9.06	Medium sand
0.075	258.5	279.5	21.0	9.06	100	0	Fine sand (silt+clay)
			231.7				

Table 4.6: The soil sieving analysis in location 4.

IS Sieve Aperture Dimension, D (mm)	Weight Empty Sieve (g)	Weight (Sieve + Soil Sample) Shake Sample	Weight Average Retained	Retained %	Cumulative Retained %	Cumulative passing % (p)	Wentworth Size Class
2.8	553.4	586.9	33.5	16.0	16.0	84.0	Gravel
2.0	321.0	375.5	54.5	26.04	42.04	57.96	Very coarse sand
1.0	508.0	531.6	23.6	11.28	53.32	46.68	Very coarse sand
0.5	463.5	537.3	73.8	35.26	88.58	11.42	Coarse sand
0.3	277.5	288	10.5	5.02	93.6	6.4	Medium sand
0.075	258.5	271.9	13.4	6.40	100	0	Fine sand (silt+clay)
			209.3				

Table 4.7: The soil sieving analysis in location 5.

IS Sieve Aperture Dimension, D (mm)	Weight Empty Sieve (g)	Weight (Sieve + Soil Sample) Shake Sample	Weight Average Retained	Retained %	Cumulative Retained %	Cumulative passing % (p)	Wentworth Size Class
2.8	553.4	597.72	44.32	22.06	22.06	77.94	Gravel
2.0	321.0	349.9	28.9	14.38	36.44	63.56	Very coarse sand
1.0	508.0	577.8	69.8	34.74	71.18	28.82	Very coarse sand
0.5	463.5	488.1	24.6	12.24	83.42	16.58	Coarse sand
0.3	277.5	297.2	19.7	9.80	93.22	6.78	Medium sand
0.075	258.5	272.1	13.6	6.78	100	0	Fine sand (silt+clay)
			200.92				

Location 1

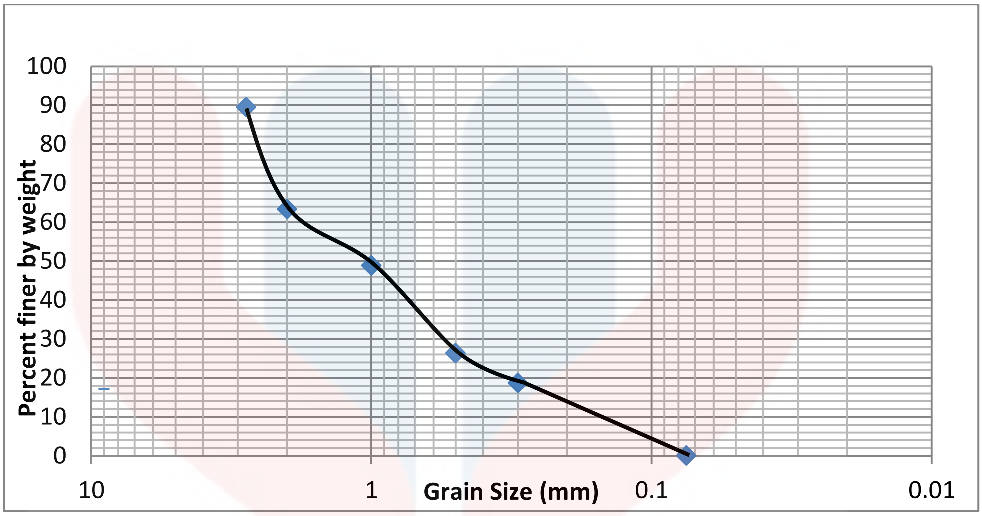


Figure 4.10: The graph grain size (mm) and Percent finer by weight in location 1.

Location 2

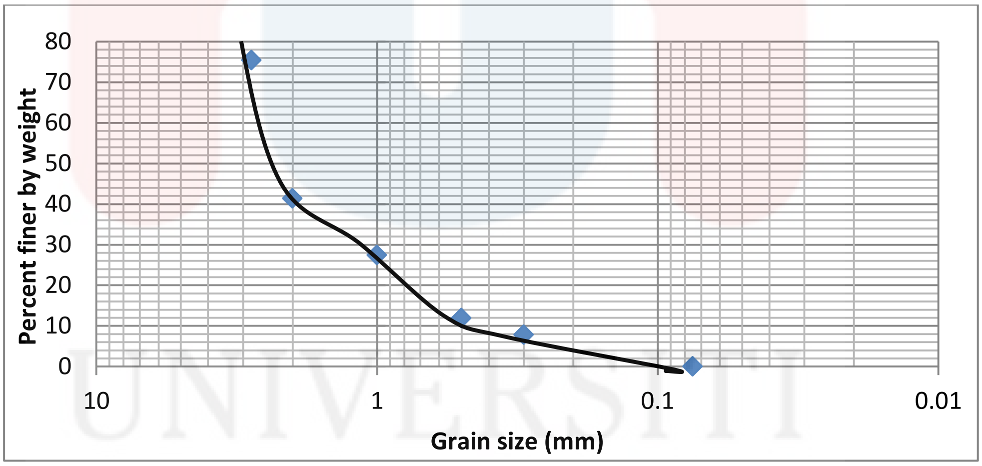


Figure 4.11: The graph grain size (mm) and Percent finer by weight in location 2.

Location 3

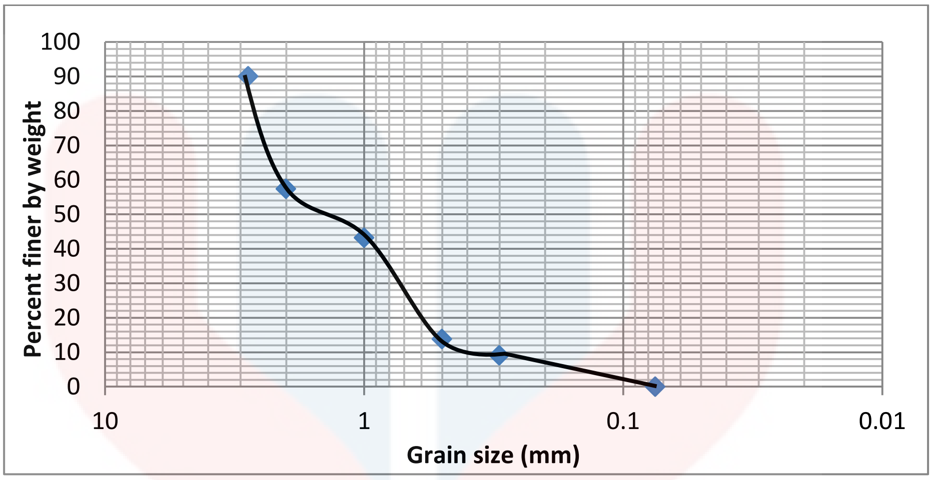


Figure 4.12: The graph grain size (mm) and Percent finer by weight in location 3.

Location 4

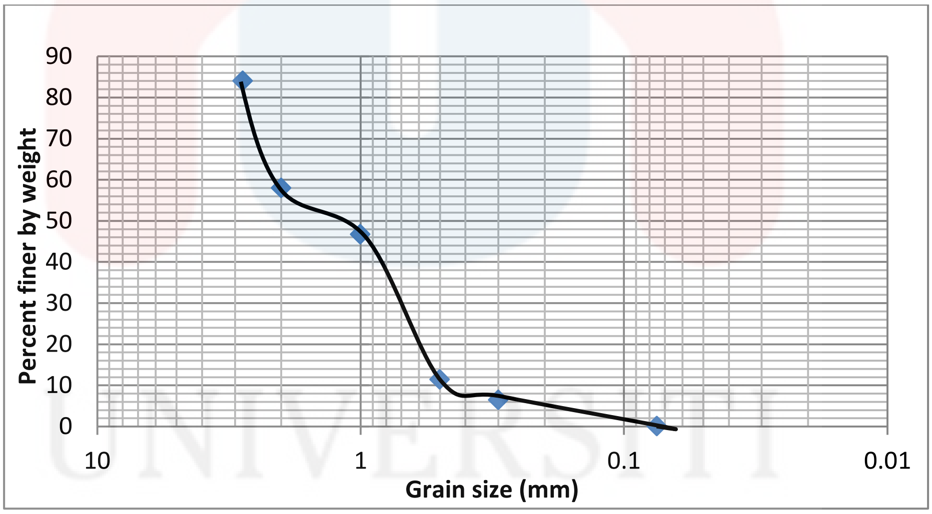


Figure 4.13: The graph grain size (mm) and Percent finer by weight in location 4.

Location 5

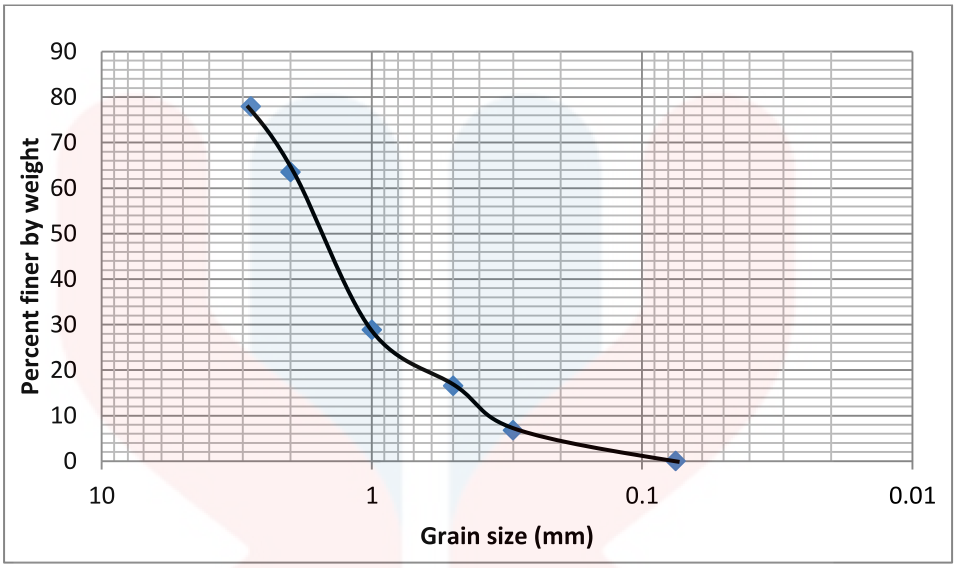


Figure 4.14: The graph grain size (mm) and Percent finer by weight in location 5.

Table 4.8: The results for uniformity coefficient.

Location	Effective size, D_{10}	Effective size, D_{60}	Uniformity Coefficient (Cu)
1	1.5	1.8	1.2
2	0.5	2.6	5.2
3	0.3	2.2	7.3
4	0.5	2.2	4.4
5	0.4	1.8	4.5

The uniformity coefficient Cu corresponding the ratio of D_{60} by $D_{10.}$ Cu will classifies as well graded soil if greater than 4 to 6 and if Cu less than 4 will considered as poorly graded uniformly graded (the soils got identical size of particles). The D_{10} corresponding to the size 10% of material be finer and 90% coarser.

Soil description can be explain using grading curve. Geometric properties of a grading curve is known grading characteristic. The uniformity coefficient cu is the average slope of the grading curve for 10% and 60% is

$$C_u = D_{60} / D_{10}$$

Based on the results for five location, the uniformity coefficient value for location 1 until location 4 have value between 4.4 to 7.3 which can be considered as well graded soil while location 1 has value 1.2 where poorly graded uniformly.

Table 4.9: The results of soil sample description in Kubang Gadong area.

Sample	Description
Sample 1	Poorly graded
Sample 2	Well graded
Sample 3	Well graded
Sample 4	Well graded
Sample 5	Well graded

Table 4.10: Alluvium soil sampling in location 1

Location 1	
Coordinate N 06º 05’ 0.5’’’ E 102º 08’ 25.5’’	
Depth 0-20 cm Dark brownish, loose sand, partly decayed organic matter 20-40 cm Dark brownish, fined grain, loose sand 40-60 cm Light brownish,fined grain,loose sand. 60-80 cm Light brownish, fined grain 80-100 Light brown, very fined grain	

Table 4.11: Alluvium soil sampling in location 2

Location 2	
Coordinate: N 06º 05’ 54.3’’ E 102 º08’ 57.6’’	
Depth 0-20 cm Dark brown, partly decayed organic matter, medium grain 20-40 cm Dark brownish, medium grain, loose sand 40-60 cm Light brownish, fine grained 60-80 Brownish, fine grained 80-100 Light brownish, fine grained	

Table 4.12: Alluvium soil sampling in location 3

Location 3	
Coordinate : N 06º 07' 23.2'' E 102 º08' 51.1''	
Depth 0-20 cm Dark colour, loose sand, partly decayed organic matter 20-40 cm Dark-lighter colour, fined grain, loose sand 40-60 cm Light brownish,fined grain,loose sand. 60-80 cm medium brownish, fined grain 80-100 light brownish, very fine grained	

Table 4.13: Alluvium soil sampling in location 4

Location 4	
Coordinate N 06º 08’ 35.0’’ E 102 º08’ 14.3’’	
Depth 0-20 cm Dark brown, partly decayed organic matter, medium grain 20-40 cm Dark brownish, medium grain, loose sand 40-60 cm Dark light colour, fine grained 60-80 Brownish, fine grained 80-100 Light brownish, fine grained	

Table 4.14: Alluvium soil sampling in location 5

Location 5	
Coordinate: N 06º 06’ 06.0’’ E 102 º08’ 14.4’’	
Depth 0-20 cm Very dark colour , partly decayed organic matter, medium grain 20-40 cm Dark colour, medium grain, loose sand 40-60 cm Dark brownish, fine grained 60-80 Brownish, fine grained 80-100 Light brownish, fine grained	

4.5 Quaternary Stratigraphy

Stratigraphy is study about layer and layering. This important in field of geology, and archaeology and provide a systematic approach to reconstruct the earth history.

The quaternary sediments in Peninsular Malaysia was reported by Scrivenor (1913b) where sandy clay deposits with scattered large clast at the base of unconsolidated sediments in Kinta Valley that occurs from mining area. In North Terengganu and Kelantan, the size of grain size for beach sorted between moderately gravelly coarse sand to poorly. In the swales, greyish green marine sandy clay and silt occur. According Bosch (1988) the South of Kelantan Delta, have stiff, white grey continental clay fills the swales.

Based on the previous research study by Bosch (1988) Simpang Formation can be seen occur by broad valley of Sungai Kelantan and its delta. The ridges occur from low winding ridges about 2-3 m high , occur that in 5 km wide zone that extends from Selinsing in the south to the Bachok-Kubang Krian road 20 km to the north. The ridges starting from wider at the west and become narrow towards the east. The beach in the south they appear whereas old or younger than the ridges beach in the south but older than the beach ridges in the north. Kelantan delta dominated unconsolidated sediment increase in thickness in eastwards. The deepest bedrock encountered the depth of 150 m which consist of coarse gravel sand andthin beds of clay beds at depth 50-60 m and 10 m thick layer occur at a depth 130 m.

a)

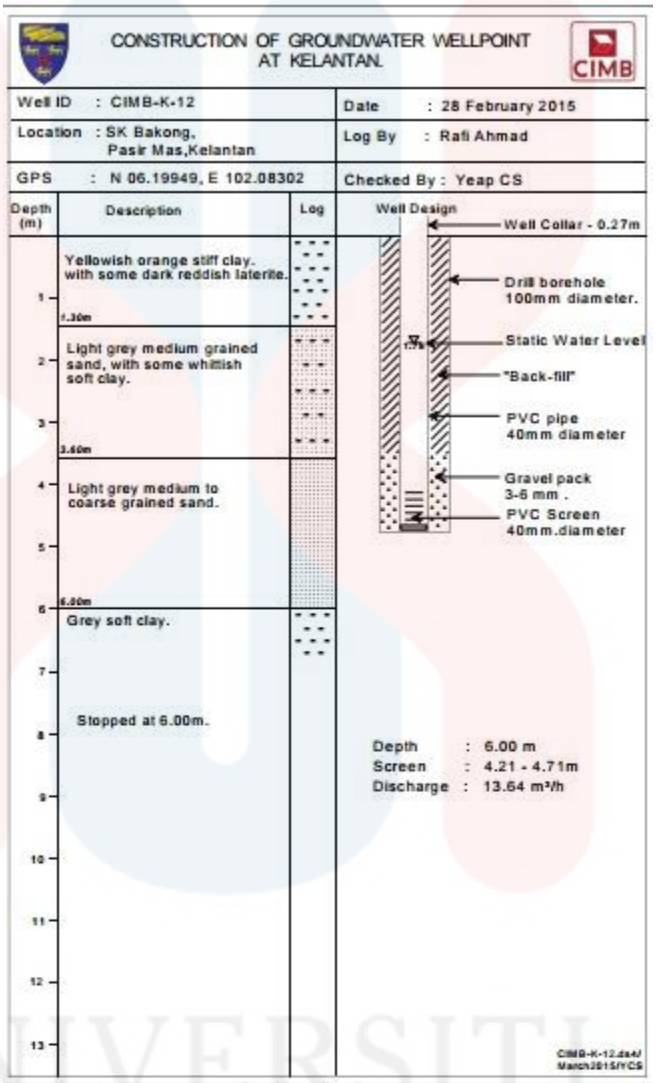


Figure 4.15: The well log in SK Bakong

Soucers: (Universiti Malaya)

b)

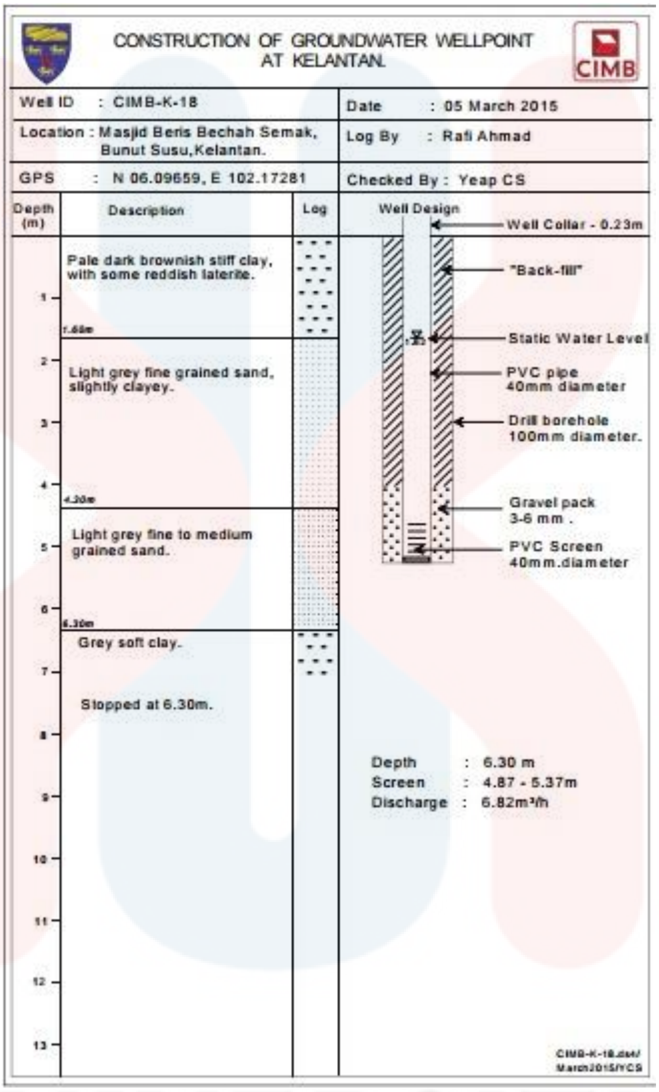


Figure 4.16: The well log in Beris Bechah

Soucers: (Universiti Malaya)

Based on the figure 4.15 and figure 4.16 the well log located nearest in the study area. From figure 4.15 in SK Bakong, the well log show from surface until 7 m. they not touch any hard rock and have some clay and sand only. In depth 1 m was found Yellowish orange stiff clay with some dark reddish laterite, in depth 2 m have light grey medium grained sand, with some whitish soft clay, in depth 4 m until 6 m have light grey medium to coarse grained sand and for depth 7 m was found grey soft clay. The good permeability for aquifer are medium grained size in depth 4m until 6m.

Based on figure 4.16 in Beris Bechah area, from surface until 7m also does not touch in any hard rock. In depth 1 m considered have Pale dark brownish stiff clay, with some reddish laterite.For depth 2 m until 4 m have light grey fine grained sand, slightly clayey and for 5 m until 6 m have Light grey fine to medium grained sand in 6 m until 7 m depth have identified grey soft clay. The well was drilled until 5 m which area have medium grained size was good in aquifer.

Based on the study area, the alluvium mapping was identified gravel, sand silt and clay.

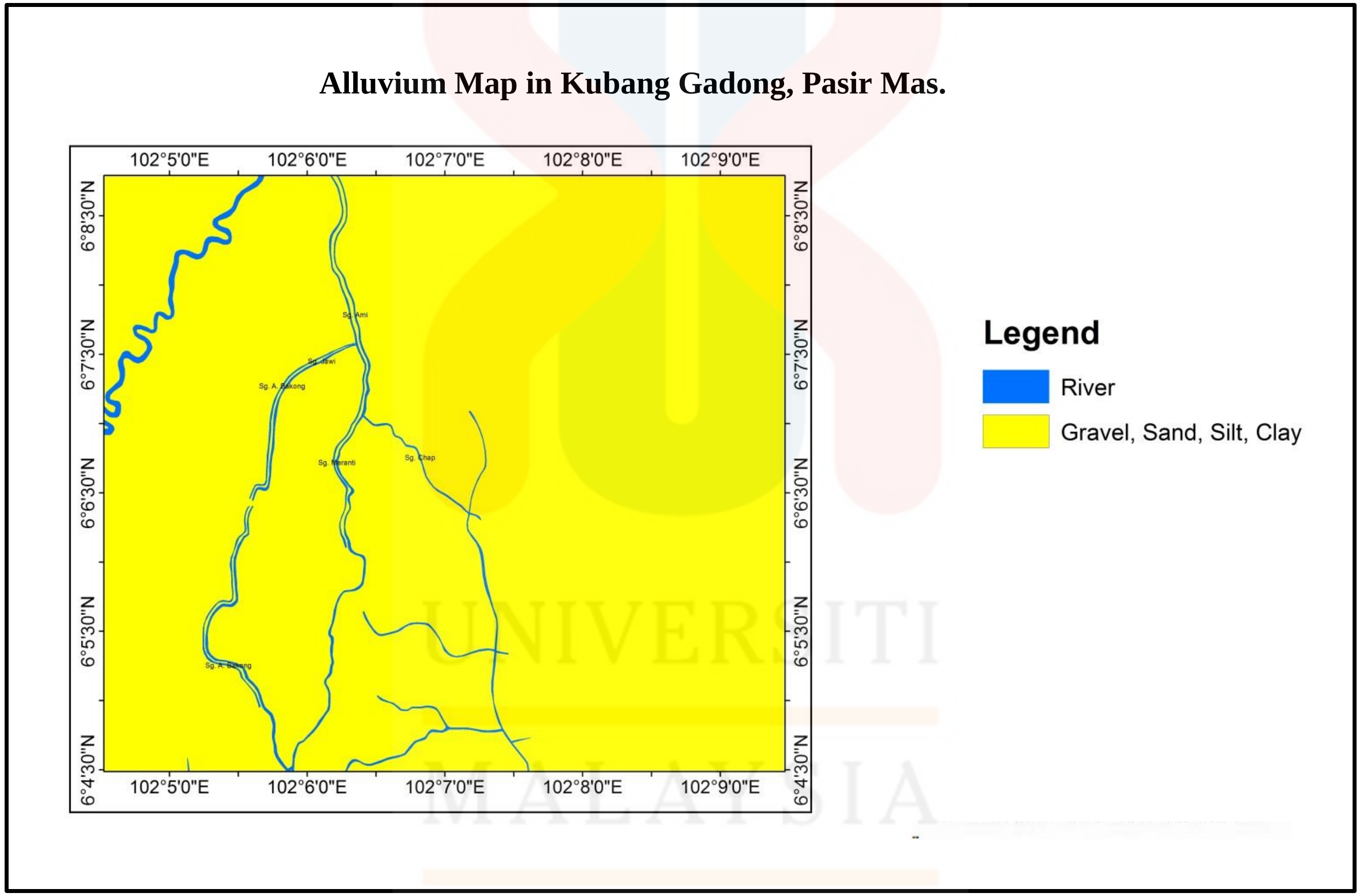


Figure 4.17: The alluvium map in study area

CHAPTER 5

HYDROCHEMISTRY OF GROUNDWATER

5.1 Introduction

Water is essential needs for human beings for the many purpose such as drinking and other domestic purpose. Groundwater contains 90% of freshwater in the world which readily available and remaining 10% to lakes, reservoirs, wetlands and rivers (Magnus U. Igboekwe *et*.al , 2011). Groundwater naturally occurring never really pure chemically from water but its invariably will dissolve some of the minerals it comes in contact with anytime. Hydrochemistry will influences the groundwater contained with dissolved minerals. There are a lot of resulted from poor management of solid waste materials such as aesthetics, pollution and environmental hazards.

Hydrochemistry of groundwater refer to analysis of major ion chemistry included calcium(Ca^{2+}), sodium(Na^{+}), Potassium (k^{+}), Magnesium (Mg^{2+}), Ferum (Fe^{2+}), Sulphate (SO_4^{2-}), Bicarbonate (HCO_3^{-}) and Chloride (Cl^{-}). To understand the effect of geochemical investigation of major ion chemistry are needed to take along the direction of flow on the groundwater in the study area (M.Senthilkumar, 2013). The determination of major ions for example Chloride (Cl^{-}) and Sulphate (SO_4^{2-}) can be affected the groundwater composition by anthropogenic activities (Khan et., al 2009).

There are external factors for instance meteorological events and pollution influenced the physic-chemical parameters such as pH and Turbidity of water. Biochemical reaction may have major influence that occurs within water.

The indicator of sudden changes in the water might be changing condition in the water. There are internal factors influence in the water body such as bacterial and plankton population. The physical characteristic of groundwater such as Electric Conductivity (EC), pH, turbidity, Total Dissolve Solids TDS), temperature are required for evaluation of physical characteristic. The values of the physicochemical parameters were correlated with the World Health Organization (WHO) and Ministry of Health (MOH).

Table 5.1: Shows coordinates of sampling location of groundwater and their monitoring data near Kubang Gadong, Pasir Mas, Kelantan.

Sample No.	Latitude	Longitude	Elevation (m)	Water Level (m)
S1	N 06º 05' 0.5''	E 102º 08' 25.5''	5	1.48
S2	N 06º 05' 54.3''	E 102 º08' 57.6''	8	1.14
S3	N 06º 07' 23.2''	E 102 º08' 51.1''	7	1.55
S4	N 06º 08' 35.0''	E 102 º08' 14.3''	21	2.09
S5	N 06º 06' 06.0''	E 102 º08' 14.4''	31	2.03
S6	N 06º 04' 58.6''	E 102 º06' 55.3''	2	1.32
S7	N 06º 05' 00.4''	E 102 º06' 10.6''	5	2.65
S8	N 06º 04' 47.3''	E 102 º04' 59.9''	3	1.56
S9	N 06º 06' 20.6''	E 102 º04' 43.3''	10	2.26
S10	N 06º 07' 02.1''	E 102 º04' 41.5''	11	2.81
S11	N 06º 06' 30.0''	E 102 º06' 0.0''	17	7.16
S12	N 06º 07' 52.0''	E 102 º06' 55.0''	24	2.3
S13	N 06º 06' 59.0''	E 102 º05' 35.5''	27	1.71
S14	N 06º 05' 07.0''	E 102 º06' 37.8''	17	1.5
S15	N 06º 07' 29.0''	E 102 º08' 25.8''	5	1.2

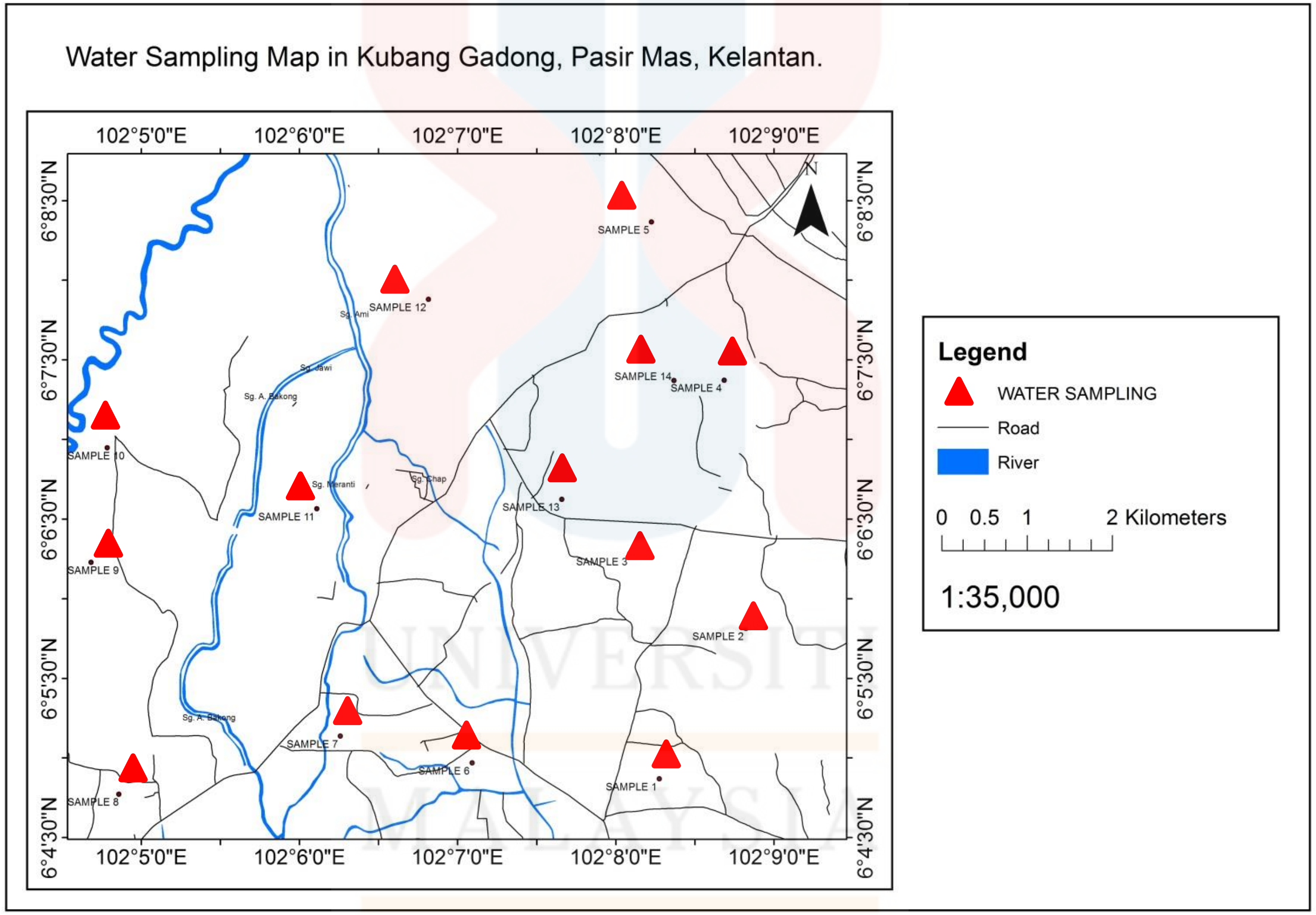


Figure 5.1: The map of water sampling in the study area.

5.2 Physical Properties of Groundwater

Physical properties of groundwater can be measure in the field by different parameters including in pH, Electric Conductivity, Total Dissolved Solids (TDS), Turbidity and Temperature. To get highest accuracy reading, different parameters were used in this research. Table 5.2 shows all the value of in situ parameter in the study area.

Table 5.2: In-situ or Physical Parameter of Groundwater Samples.

Well No.	Temperature (ºC)	pH	Electrical Conductivity (µS/cm)	TDS (mg/L)	Turbidity (NTU)
S1	29.89	5.76	104	62	2.37
S2	31.14	5.55	72	42	6.60
S3	29.99	6.14	215	127	18.0
S4	28.59	6.32	411	250	16.9
S5	27.82	5.90	135	84	9.29
S6	29.11	6.24	166	100	16.8
S7	27.99	5.93	136	84	0.55
S8	27.55	6.64	253	157	5.37
S9	27.62	6.33	218	135	5.13
S10	28.79	6.09	359	218	7.65
S11	29.41	5.38	72	43	0.56
S12	29.39	4.33	357	214	16.4
S13	30.72	5.58	71	42	13.3
S14	29.80	6.57	213	127	16.0
S15	28.99	6.55	215	125	16.0

Table 5.3: **S**hows the Standard Drinking Water Quality Guideline by (W.H.O) and (M.O.H)

Constituents	W.H.O (2000)	M.O.H (2004)
pH	6.5 to 9.5	5.5 to 9.0
TDS	1000	1000
Sodium, Na^{+}	200	200
Calcium, Ca^{2+}	200	200
Magnesium, Mg^{2+}	150	150
Potassium, K^{+}	12	30
Sulfate, SO_4^{-2}	200	250
Chloride, Cl^{-}	250	250
Bicarbonate, HCO_3^{-}	500	500

5.2.1 Physical Parameter

Total Dissolved Solid (TDS)

A total dissolved solid is one of the measures of water quality which is measure in milligrams per liter. TDS includes solutes such as calcium, magnesium, sodium and potassium cations and carbonate, hydrogen carbonate, chloride and sulfate anions.

Figure 5.2 shows the value of Total Dissolved Solids (TDS) in 15 samples with 15 locations. The highest TDS value can see in sample 4 where 250 mg/L while the lowest value in sample 2 and sample 13 are 42 mg/L. The ranges of the samples 250 mg/L to 42 mg/L. The highest value in sample 4 due to well near septic tank. Based on the classification TDS by Suzannah (2007) all water sample are below 1000 mg/L which classify as fresh water. It is represent all the samples water not influence by dissolved solids within water sample. The all sample represent all the value below 500 mg/L and 1000 mg/L due to standard WHO and MOH all value below 1000 mg/L are suitable to purpose drinking.

Factors that affected TDS level are the geology of region, climate, weathering and geological features which affect the dissolved material and transported to water system (World Health Organization,2003). According to Hantush (1961) there are variety of sources of dissolved solids comes from such as organics sources likes plankton, leaves, silt, industrial waste and septic tank.

Based on the figure 5.3, the distribution map of TDS, the TDS concentration increase towards east-south.

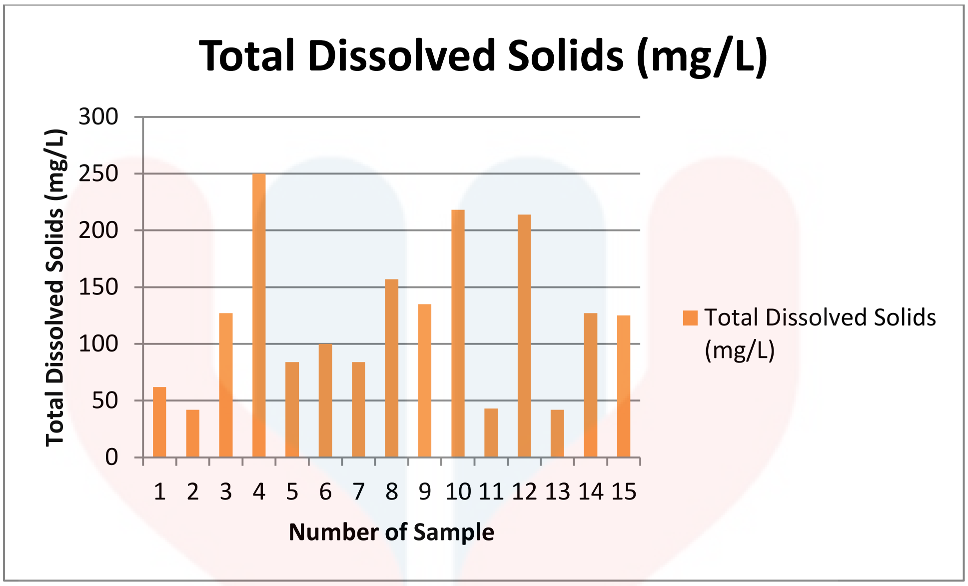


Figure 5.2: The value of Total Dissolved Solids (TDS)

Table 5.4: The TDS classification of groundwater samples. (Suzannah,2007)

Water Class	TDS (mg/L)	Sample
Fresh	<1000	All samples
Brackish	1000 – 10000	0
Saline water	10 000 – 100 000	0
Brine water	>100 000	0

Table 5.5: The criteria classification based on rank of TDS in groundwater by W.H.O and M.O.H that for drinking purpose (Vantakesh & Rajasekar, 2005).

Parameter	Rank	Criteria	Remarks	Sample
TDS	1	< =500	Acceptable by WHO and MOH standards	All sample
	2	501-1000	Acceptable by WHO and MOH standards	
	3	1000-1500	Acceptable by WHO and MOH standards	
	4	1501-2000	To be rejected	
	5	2001-5000	To be rejected	
	6	>5000	To be rejected	

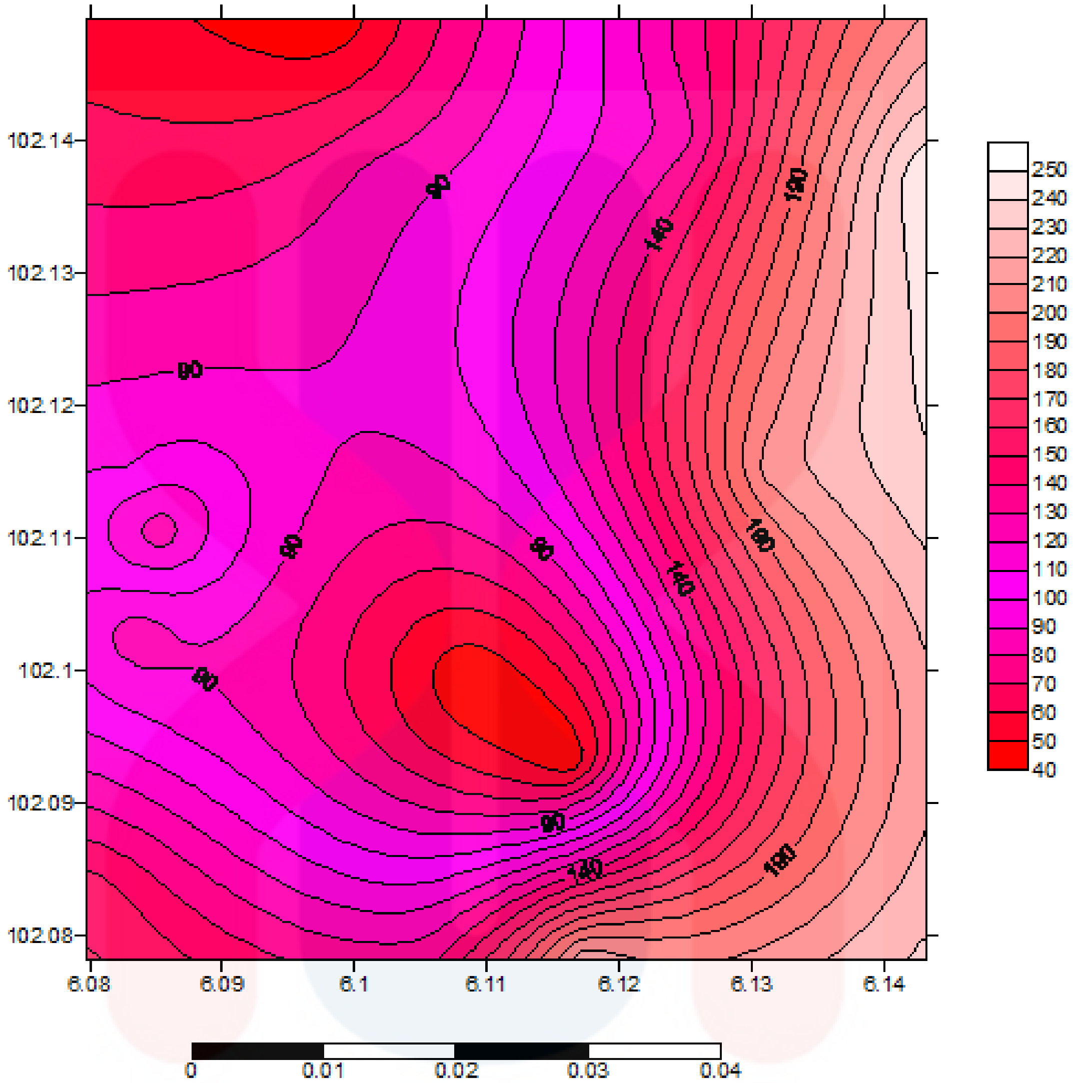


Figure 5.3: Distribution map of TDS

Electrical Conductivity (EC)

. The electric conductivity where the ability of water pass through the electric flow. There are several factors the ability of water to conduct electricity may depends on concentration and types of dissolved material presents. According to John et. Al., (1990) water containing dissolved inorganic salt and the resulting ions are relatively good conductors when dissolved organic compound that do not separate very little to conductivity.

Based on the 15 sample that carried out in Figure 5.4 sample 4 recorded higher value of electric conductivity is 411µs/cm. while the lowest electric conductivity in sample in sample 13 is 71 µs/cm. The value of electric conductivity for all samples dominated 500 µs/cm indicates low conductivity. The ranges of electric conductivity are 411 µs/cm and 71 µs/cm.

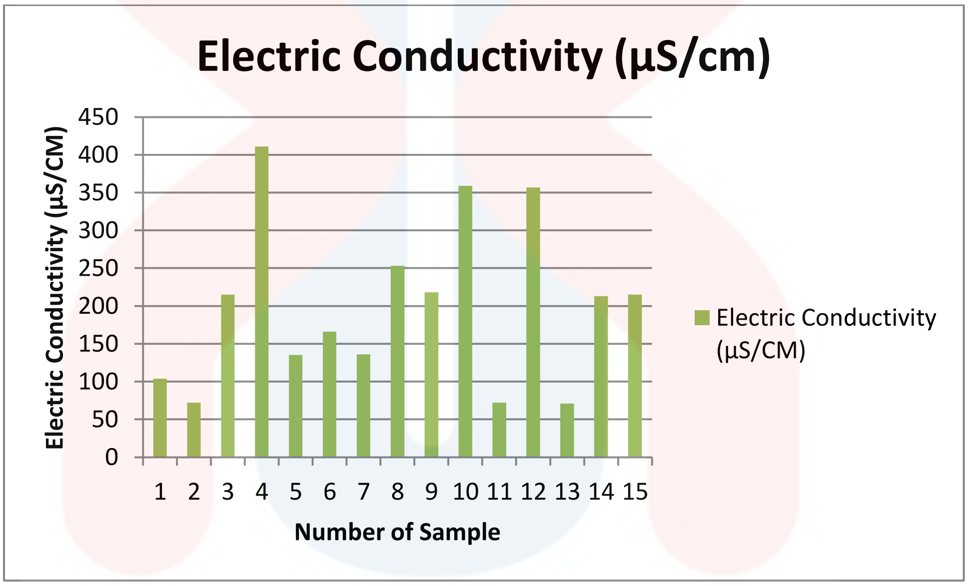


Figure 5.4: The value of Electric Conductivity µs/cm

Table 5.6: The Classification of Electric Conductivity (Suzannah, 2007) and classification of groundwater based on drinking purpose.

Class	EC (µs/cm at 25º)	Sample
Low Conductivity	<500	All sample
Medium Conductivity, Class 1	500-1000	0
Medium Conductivity, Class 2	1000 – 3000	0
Medium Conductivity, Class 3	>3000	0

pH (Hydrogen Ion Concentration)

The pH value indicates the acidity of samples water. The pH is measurement of potential activity of hydrogen ions (H^+) in the sample. The reading of pH value in the samples can be measure of the acidity and alkalinity by measurements of run scale from 0 to 14 where the neutral reading is 7.0. The sample solution have value pH below 7.0 are considered as acids and sample solution above 7.0 to 14.0 are considered bases.

The potential of Hydrogen (pH) have varies value to all sample. Sample 8 have higher reading of pH is 6.64 compare to other sample while sample 12 recorded 4.33 reading. This can be concluded sample 8 nearest to neutral while sample 12 is acidic. The ranges for sample water mostly nearest to neutral which is 5.38 until 6.64. The acidic of sample 12 due to well is located nearest mangrove and swamps. The reaction of water with soil in shallow aquifer will decrease the pH. There are several factors that affected the pH of body of water are which water moves through bedrock and soil composition, both in its beds and as groundwater. Some rocks for example limestone can to an extent and neutralize the acid while others rocks likes granite have virtually no effect on pH. Another factors affect the pH is the amount of plant growth and organic material within the water body (Timothy M.Kresse, 2012). Hence, carbon dioxide will released when the material decomposed and carbon dioxide will combines with water to form carbonics acids (Elmahdy & Mohamed, 2012).

Based on the purpose to drinking from W.H.O and M.H.O, well 9,14 and 15 are acceptable to drink while others well are rejected.

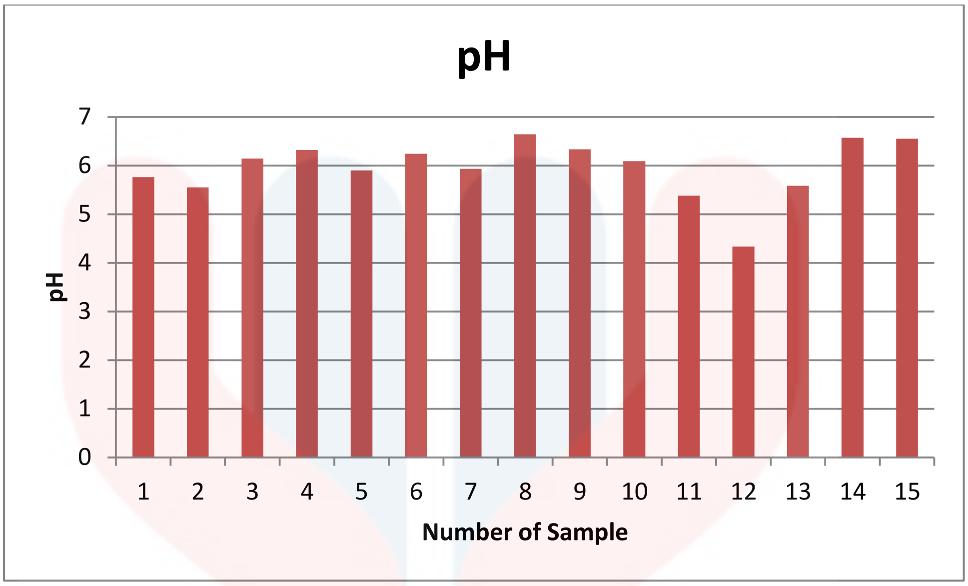


Figure 5.5: The value of pH

Table 5.7: The criteria classification based on rank of pH in groundwater by W.H.O and M.O.H that for drinking purpose (Vantakesh & Rajasekar, 2005).

Parameter	Rank	Criteria	Remarks	Sample
pH	1	6.50-8.50	Acceptable by WHO and MOH standards	9,14,15
	2	8.51-9.20	Acceptable by WHO and MOH standards	-
	3	< = 6.49	To be rejected	1,2,3,4,5,6,7.8.10,11,12,13
	4	>= 9.21	To be rejected	-

Turbidity

Water consists of many different particles in varying of size and always has suspended solids. Turbidity is the cloudiness and haziness of a fluid can been seen by naked eyes caused by suspended solids. High turbidity will show the water is cloudy while low turbidity will be seen water crystal clear and very few suspended solid that are closely related by it the amount and type of suspended solids. Turbidity can be measured for purpose of water quality in units NTU because measurement of turbidity cannot in milligram per liter (mg/L) but in nephelometric turbidity units (NTU).

The highest value of turbidity in NTU units is 18 NTU in sample 3. It is shown sample 3 have more cloudiness compare to other samples which caused by suspended solids in the sample due the well nearest to agriculture which paddy field. The lowest value turbidity is 0.55 NTU in sample 7. This shown the clearness water sample compare to other sample.

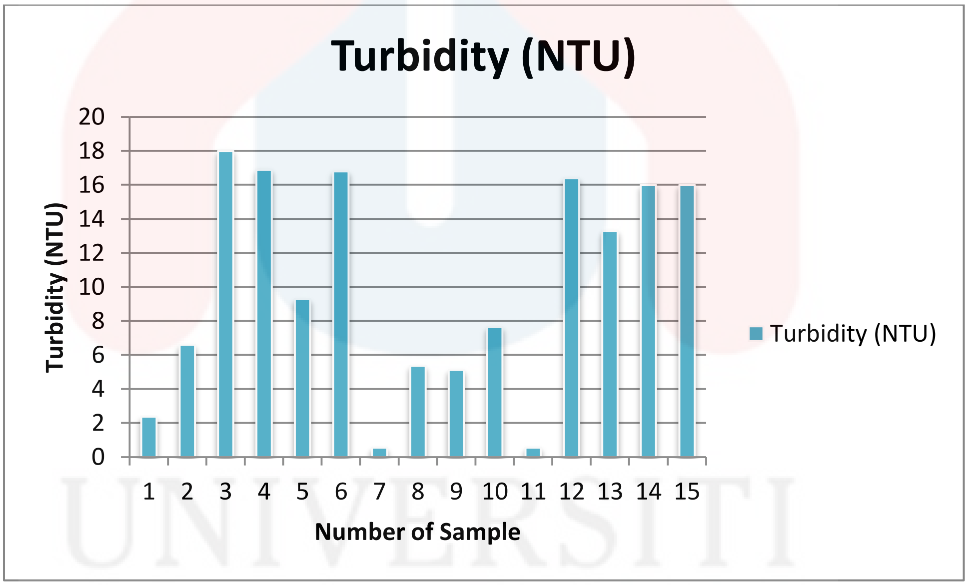


Figure 5.6: The value of turbidity

Temperature

Temperature is defined as degree or intensity of heat present whereas in substance or objects. Temperature can be measured in warmth or coldness of an objects or substances with reference in some standard value. The detection of heat radiation or particle velocity or kinetic energy or by the bulk behavior of a thermometric material in Celcius scales (Claire,2009).

The highest temperature is 31.14 in sample 2 while the lowest temperature is 27.55 in sample 5. The ranges of temperature were collected between 27.55 until 31.14.

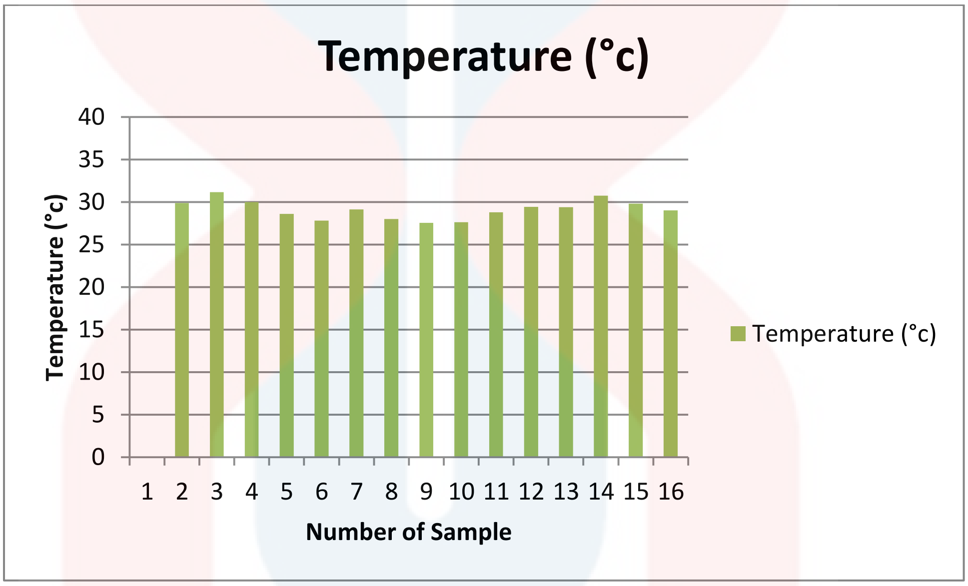


Figure 5.7: The value of Temperature (C°)

5.3 Chemical Properties of Groundwater

Chemical analysis of groundwater are based on analyses major ions divide by two which Anion and Cation. In anion analysis are Bicarbonate, Chloride and Sulfate while cation analysis Sodium, Potassium, Magnesium, Calcium, Ferum that present in the groundwater area using Atomic Absorption Spectrometer (AAS) in laboratory.

Major contribution of groundwater composition is geological formation which can determined and identify the geological history of the rocks that interacted with groundwater and determine discharged and recharged activity of the groundwater system (Timothy M.Kresse, 2012).

Table 5.8: The **c**hemical properties of groundwater in mg/L.

Sample	Anion (mg/L)			Cation (mg/L)				
	HCO_3^-	Cl^-	SO_4^{2-}	Na^+	K^+	Mg^{+2}	Ca^{+2}	$Fe+^2$
1	417.5	32.66	10	0.968	0.034	0.364	0.133	0.444
2	337.5	36.21	7.42	0.401	0.229	0.069	0.142	0.172
3	260	36.21	8.23	0.437	0.092	0.08	0.718	0.419
4	277.5	66.74	8.23	0.906	0.248	0.013	0.216	0.364
5	212.5	41.89	5.7	0.44	2.011	0.17	0.359	0.094
6	207.5	44.02	1.6	0.128	0.163	0.041	0.182	0.284
7	230	37.63	1.2	0.937	0.09	0.045	0.2	0.231
8	332.5	44.73	14.8	0.593	0.186	0.02	0.151	0.219
9	187.5	36.92	2.4	0.755	0.123	0.015	0.069	0.331
10	125	97.27	7.4	0.507	0.043	0.028	0.124	0.158
11	175	33.37	18.29	1.749	0.105	0.032	0.143	0.354
12	167.5	38.34	6.6	0.178	0.021	0.319	0.012	0.701
13	155	37.63	20.6	2.515	0.044	0.009	0.2	0.207
14	367.25	24.85	13.16	0.602	0.074	0.014	0.215	0.267
15	185	43.31	14	0.565	0.033	0.168	0.208	0.191

5.3.1 Major Anion

The major anion that are present in the study area includes bicarbonates (HCO3), chloride (Cl), sulphate (SO4).

Bicarbonates (HCO_3^-)

The water relies on pH that shows bicarbonate concentration usually less than 500 mg/L in groundwater for all surface and groundwater bodies found as standard alkaline. The factors that added bicarbonate in water content causes weathering of rock. Bicarbonate are easily soluble in water especially magnesium and calcium. Current study shows the value of bicarbonate ranges from 125-417.5 mg/L. The highest concentration of carbonates can be described the location is near either fossil, plants remains and animal as exoskeleton organism which shell contributes calcium carbonates $CaCO_3$ (Rajmohan *et al*., 2000).

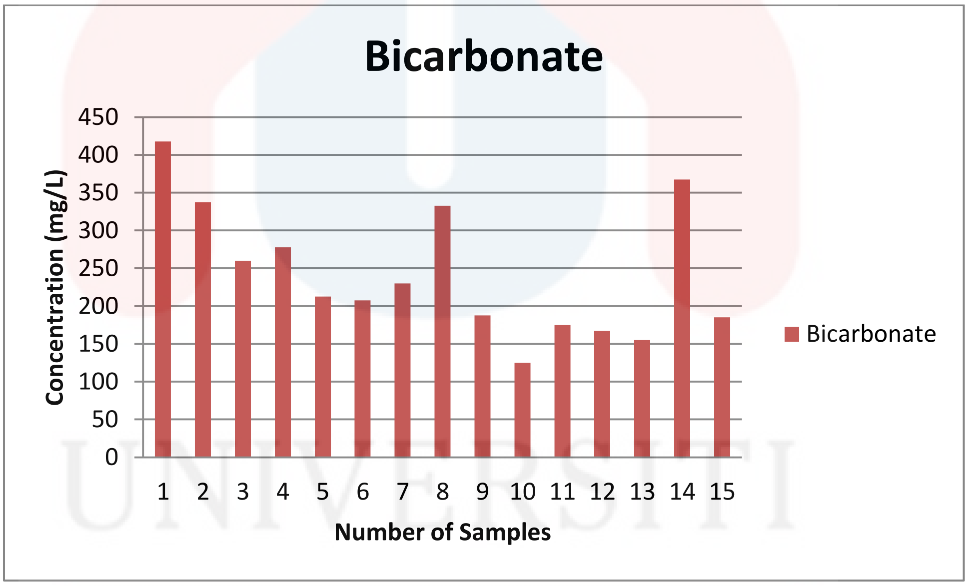


Figure 5.8: Concentration of Bicarbonates

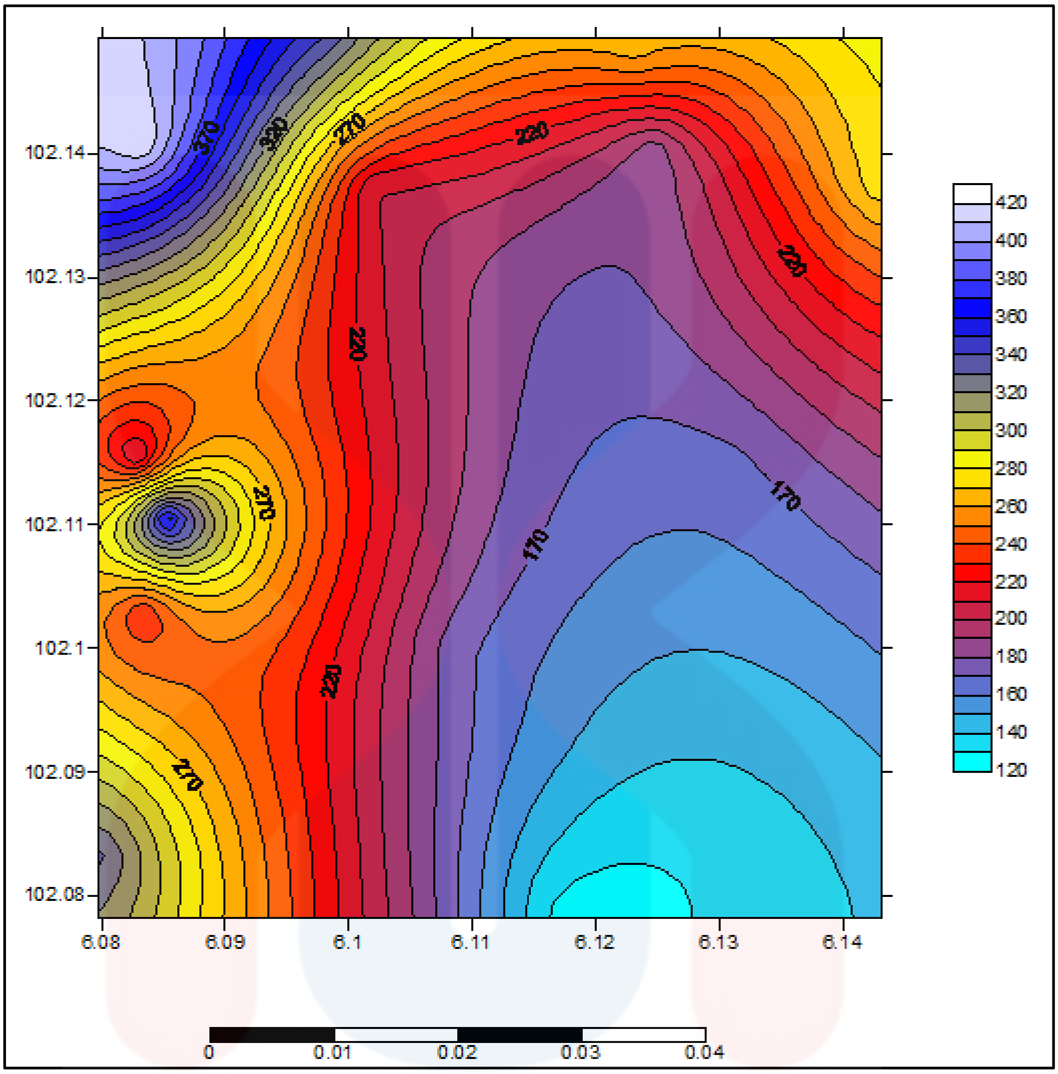


Figure 5.9: The map distribution of Bicarbonate.

Chloride (Cl^-)

A chloride is consisting of dissolution of salt of hydrochloric acid. Groundwater has higher concentration value of chloride compare to surface water bodies. The higher concentration content in water will effects harms growing plants. Chlorides naturally occur from resulted agriculture activities, industrial and chloride rich rocks.

The all samples have lower concentration of chlorides 24.85 mg/L in sample 14 and the highest concentration of Cl^- is 97.27 mg/L in sample 10. The concentration ions of Cl^- that permissible limit by W.H.O and M.O.H should not exceed 250 mg/L. All the samples record value of chloride below 250 mg/L.

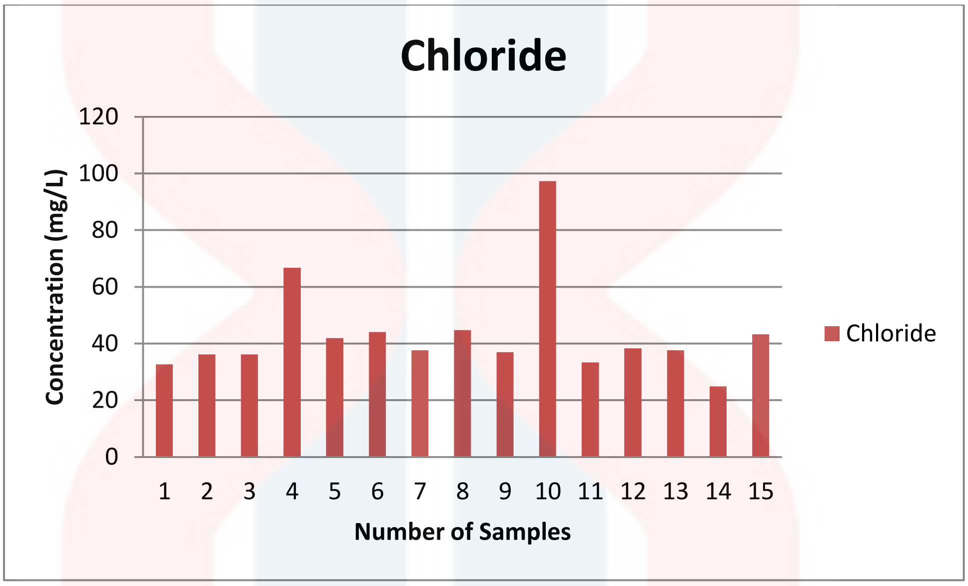


Figure 5.10: Concentration of Chloride.

Table 5.9: The table ranking of Chloride.

Ion	Rank	Criteria	Remarks	
Chloride Cl^-	1	<=250	Acceptable by WHO and MOH standards	All samples
	2	251 – 600	Partly acceptable by WHO standards	
	3	601-1000	To be rejected	
	4	>1000	To be rejected	

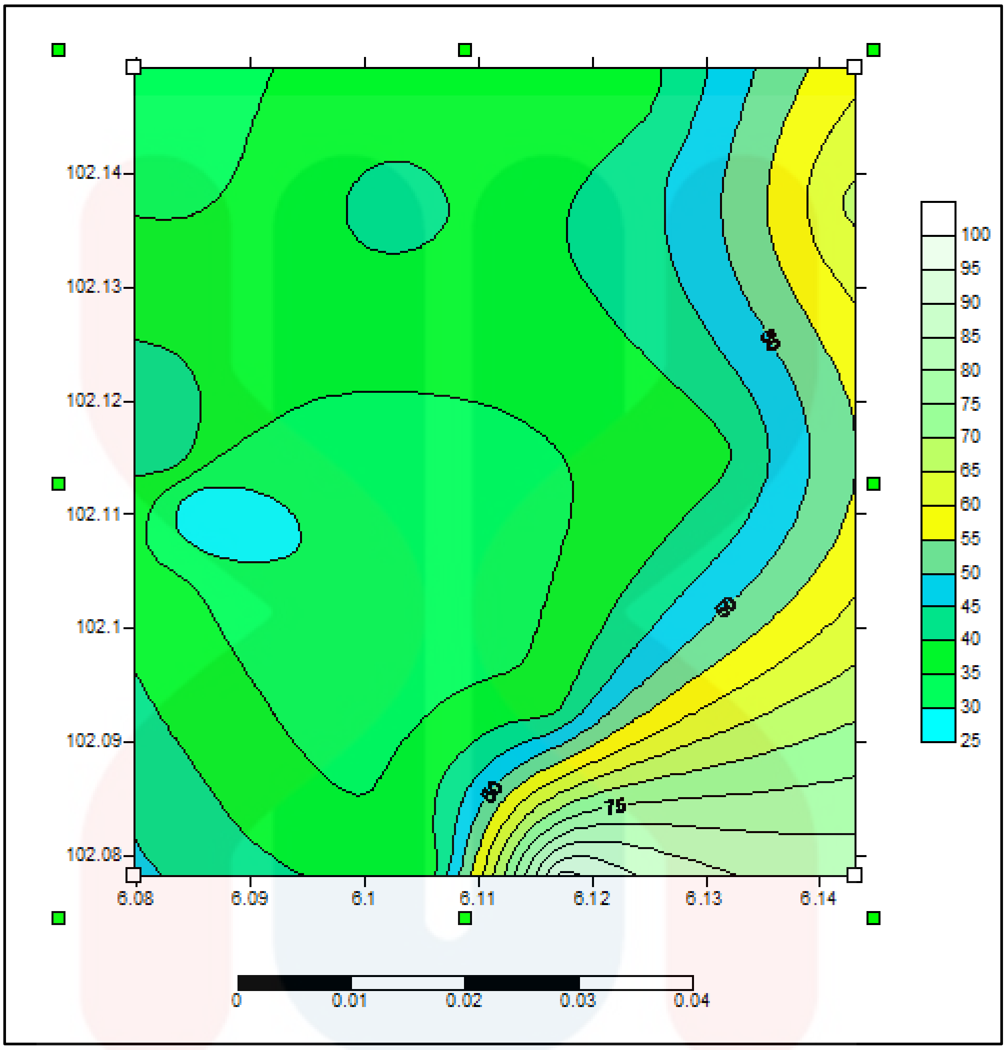


Figure 5.11: The map distribution of Chloride.

Sulphate (SO_4^-)

Sulphate almost found in all water bodies and derived from the dissolution of salts of sulphuric acids. The oxidation of pyrites and mine drainage will increase the concentration of sulfate. Based on the result of Sulphate sample 13 have higher sulphate 20.6 is mg/L while sample 7 recorded lowest sulfate are 1.2 mg/L. The highest value sulphate in sample 1 due to well near agriculture land. The production of fertilizers, chemicals, dyes, glass, paper, soaps, textiles and insecticides from sulfate products (World Health Organization, 2004).The increasing of sulfate concentration may due to agricultures activities that contributes excessive amount of fertilizers.

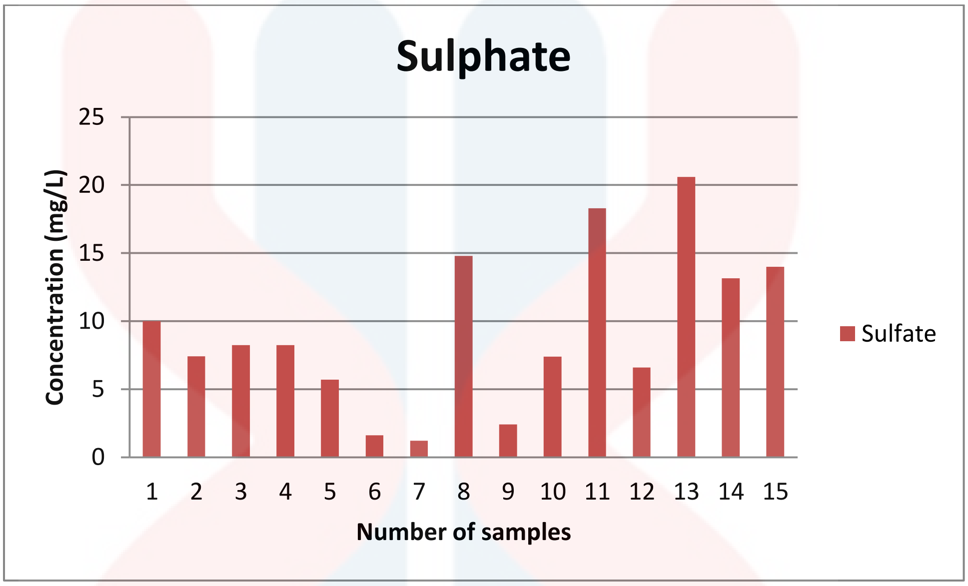


Figure 5.12: Concentration of Sulphate (SO_4^{2-})

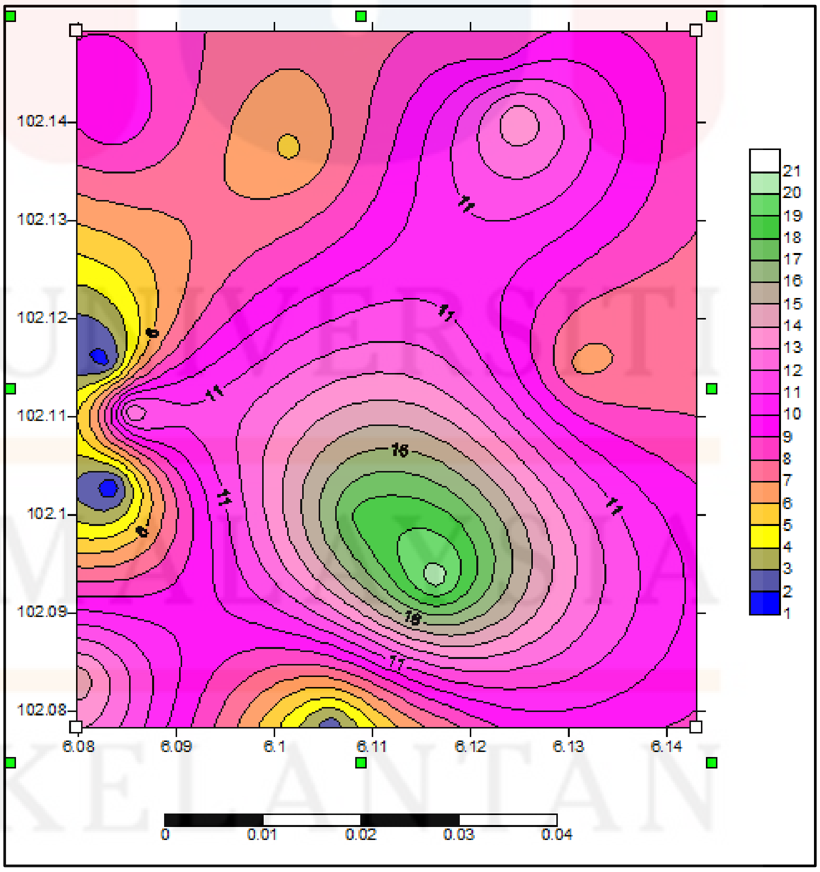


Figure 5.13: The map distribution of Sulphate

5.3.2 Major Cation

The major cation are present in the study area includes sodium (Na^{+}), Potassium (K^{+}), Magnesium (Mg^{2+}), Calcium (Ca^{2+}),Sodium (Na^{+}) and Ferum (Fe^{2+}).

Magnesium

Magnesium is the element in number eight most abundant in the earth crust and natural constituent on water. It is needed for living organism and also found in mineral like dolomite. Figure 5.14 represent the reading of sample 1 until sample 15. The calibration standard is used to determine concentrations of Magnesium ($Mg^{2+)}$ in the sample are 0.4 mg/L, 0.8 mg/L, 12.0 mg/L and 16 mg/L. Distilled water is used to control the standard which is 0.00 mg/L. From the result Atomic Absorption Spectrometer (AAS) sample 1 have the highest reading which is 0.364 mg/L compare to sample 13 have lower reading is 0.009 mg/L. The limit of Magnesium ion in surface water is 4 mg/L (Eaton et al., 2005).

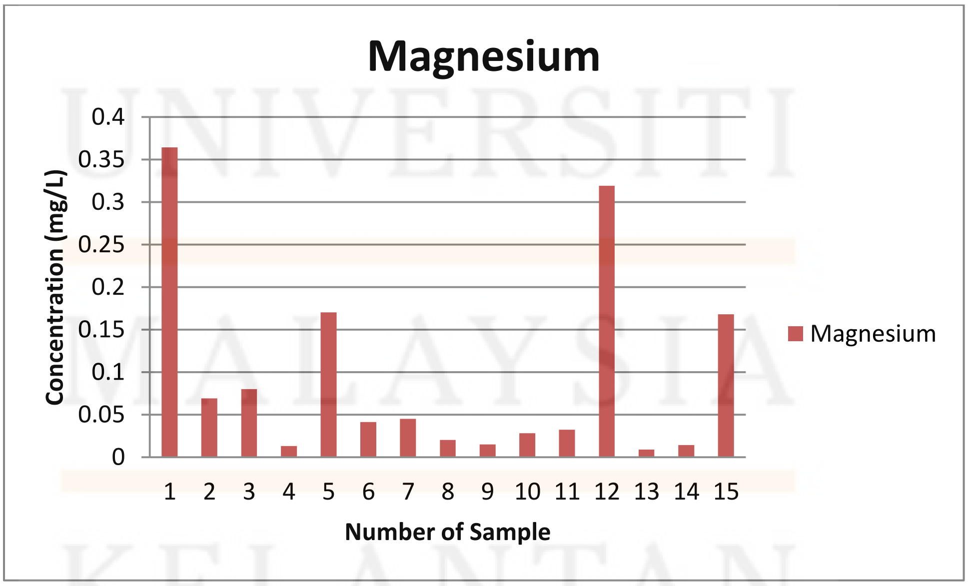


Figure 5.14: Concentration of Magnesium

Potassium

Potassium is highly reactive with water. Potassium is functioning for living organism and found in human and animal tissue then plant cell. Figure shows the reading Potassium value the samples 1 until sample 15. The calibration standard is used to determine the concentrations of Potassium are 0.4 mg/L, 0.8 mg/L, 12.0 mg/L and 16 mg/L. To controlled the standard, distilled water is used where value 0.00 mg/L. Sample 5 have higher reading which contain high Potassium compare others is 2.04 mg/L while sample 12 have value 0.021 mg/L which lower of potassium value.

The higher concentration of Potassium may due to agricultural activities in nearest well. Potassium is main contributes as fertilizers in crops and plantation. The potassium ions are used as fertilizer and held by clays in soil composition (Willis,2001).

Based on W.H.O and M.O.H standard stated for drinking purpose is 30 mg/L. All the sample are permissible for drinking purpose.

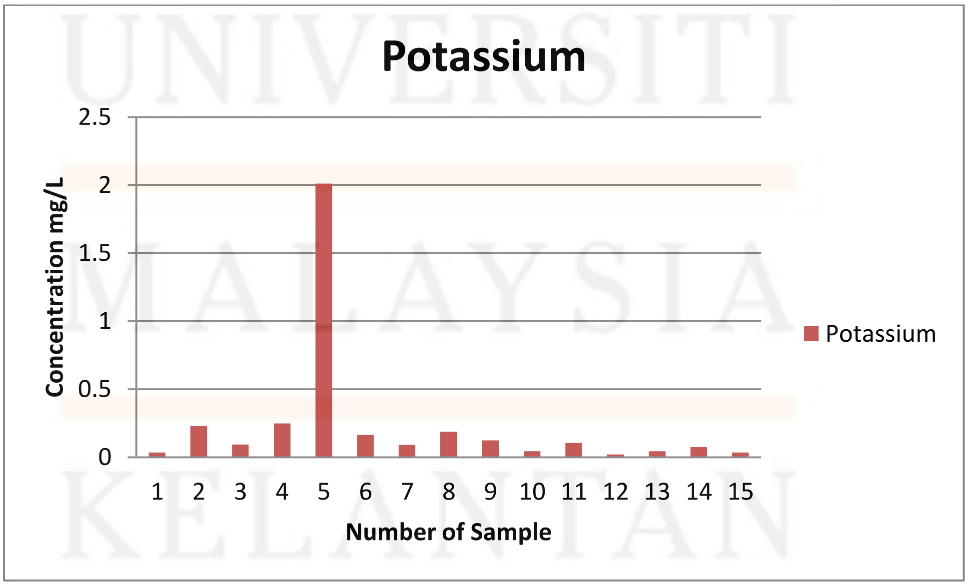


Figure 5.15: The concentration of Potassium

Calcium

Calcium is the fifth most abundant in earth crust and important for human health. Human body stored 95% of calcium in bones and teeth. The higher value in human body also can give negative impacts such as bones fractures and rickets.

Figure 5.16 represents the value reading of Calcium from sample 1 until sample 15. Based on the graph shown, the sample show the highest value in sample 3 is 0.718 mg/L while the lowest value give sample 12 is 0.012 mg/L. The standard concentrations used are 0.4 mg/L, 0.8 mg/L, 12 mg/L and 16 mg/L. The distilled water is use as control is 0.00 mg/L. The highest rainfall contributes dilution rate of calcium concentration. According M.O.H and W.H.O standard for calcium is 200 mg/L All the sample are significance with the purpose for drinking.

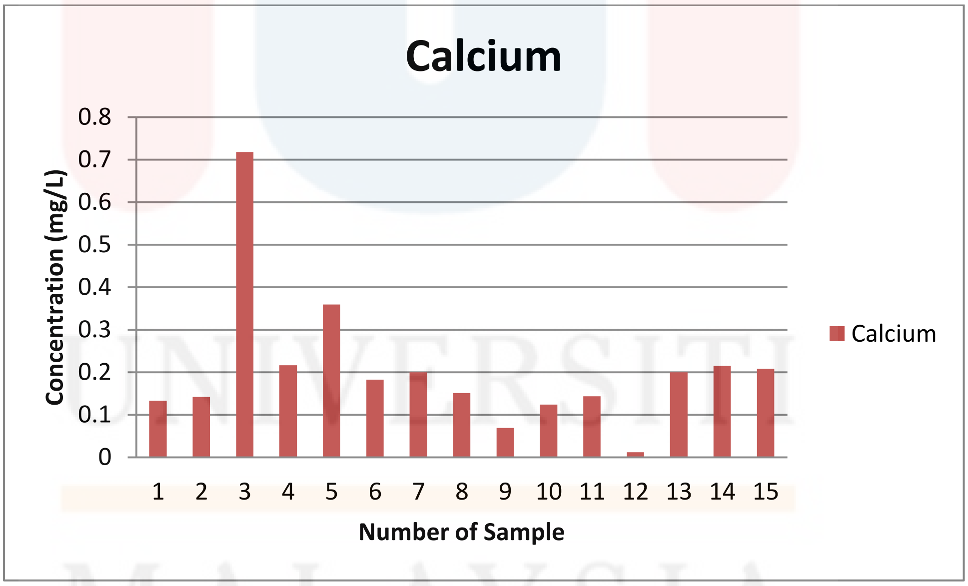


Figure 5.16: Concentration of Calcium

Sodium

Sodium mostly occurs naturally in groundwater with less quantity in water and has highly soluble chemical elements. The sufficient sodium in human body will prevent many fatal diseases like kidney damage.

Figure 5.17 shows Sodium reading in water sample in different area. The standard concentrations used are 0.4 mg/L, 0.8 mg/L, 12 mg/L and 16 mg/L. Distilled water is used as control the concentration is 0.00 mg/L. Sample 13 recorded highest contain of Sodium is 2.515 mg/L while sample 6 has low contain of calcium is 0.128 mg/L.

The standards of W.H.O and M.O.H for drinking purpose are 200 mg/L. Based on the study area ,all the sample are permissible for drinking purpose.

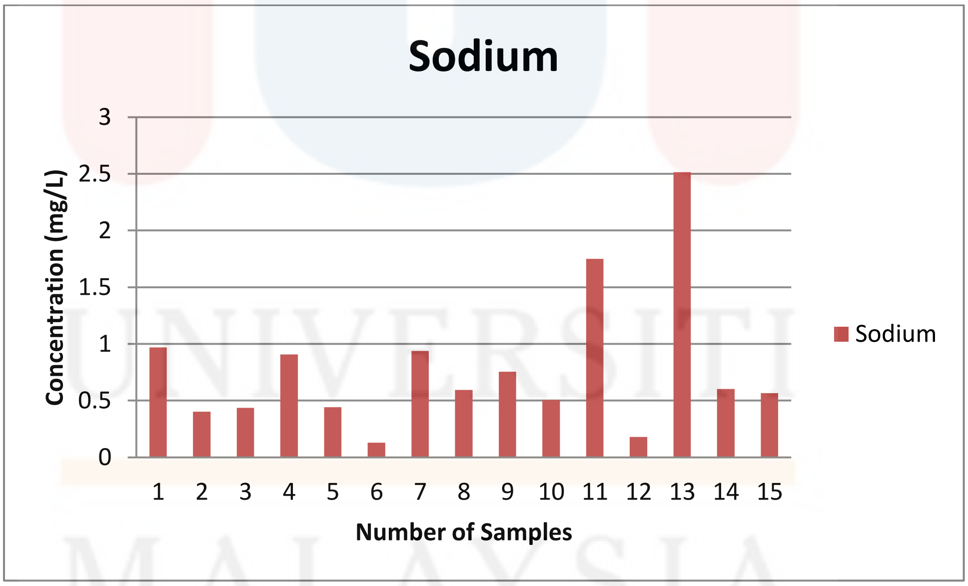


Figure 5.17: Concentration of Sodium

Ferum

Figure 5.18 show the reading of Ferum was recorded. The standard concentration for Ferum is 0.2 mg/L, 0.8 mg/L, 12 mg/L and 16 mg/L. Distilled water is used as controlled for the standard is 0.00 mg/L. From the Atomic Absorption Spectrometer (AAS) the highest reading is 0.701 in sample 12 compare to sample 5 give the lower reading is 0.094 mg/L. The standard M.O.H and W.H.O below 500 mg/L based on guideline for drinking purpose. All the sample recorded below the permissible limit.

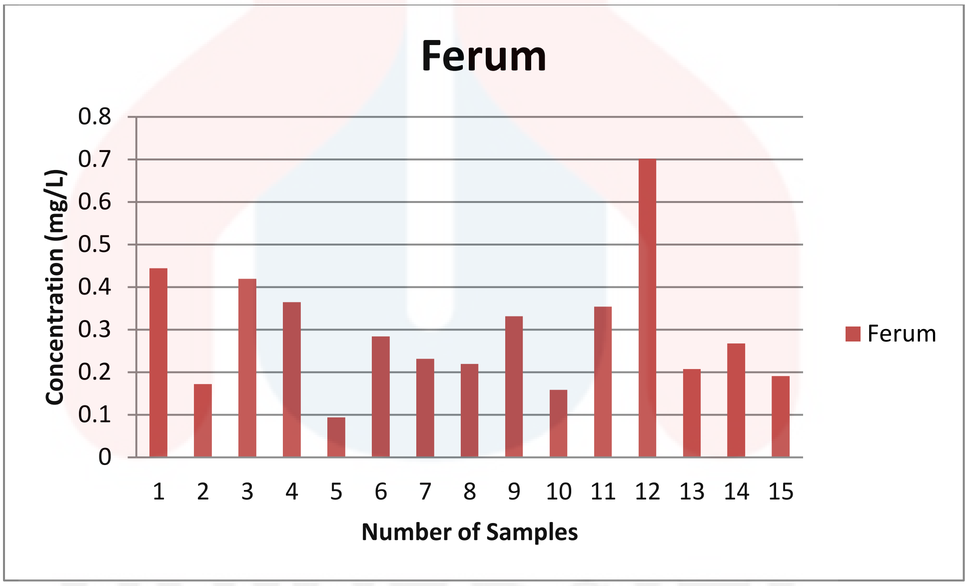


Figure 5.18: Concentration of Ferum

5.4 Chemical Composition of Groundwater/ Factor Affecting Groundwater Composition

Groundwater have many chemicals which occur both naturally and man-made. Groundwater chemicals are present some in large quantities and others in trace concentration. Some small groundwater chemical sizes are chemically dissolved in water while large particles are suspended. The biological and chemical groundwater is used for most purpose in a nation whole. The groundwater quality is important especially for shallow aquifer groundwater due to changing of a result by human activities.

The shallow aquifer compare to groundwater have high potential to pollution due to soil and rock through groundwater will flows screen out most of bacteria. However, bacteria have their way to penetrate the groundwater and it might be in higher concentration. Even though the water are freedom from bacterial pollution does not meant it's suitable to drinking and others purpose. It possible has unseen mineral that dissolved in the water and organic constituent that present in groundwater with higher concentration. Some of dissolved mineral might be high toxic even have beneficial.

Water naturally occurring as a solvent and dissolves mineral from the rock within comes from contact. Groundwater taste may influence by dissolved mineral and gas that gives tangy taste if not it will taste flat. The common substance constituents in water chemistry are potassium, calcium, magnesium, sodium, sulphate, chloride and bicarbonate. In the research study that determine the physical and chemical groundwater to know the chemistry of groundwater.

Dissolved mineral content and major ions constitute in water are important for drinking purpose. The value of dissolved mineral will influence to classify of water whereas it will be saline or not. The dissolved mineral with higher value about thousand mg/L and above will indicate not considerable for drinking. But sometimes have area that necessary this water because of less-mineralized water is not available.

Many factors that can affected to humans, animals or plant where if dissolved minerals or major ions contribute higher concentration in water that comes from some well and springs. Based on the result of physical and chemical groundwater parameters,

The major ions need to analyze to know the water quality of groundwater. According to Hounslow (1995) the origin solutes can reveal the major ions chemistry of groundwater and relate to composition among ionic species with process that generated an observed water composition. There are negative effects if the value of major ions constitute in water over the limit. Besides that, it also can be hazardous and harmful to animal or plants in higher concentration. For instance, higher value of sodium will affected people who have heart disease. Other than that, higher calcium and magnesium concentration can consider is hardness.

The pH value also gives effect to groundwater composition. If the pH with lower than 7 indicate as acidic while higher than 7 pH will consider as alkali. The result of neutral will show vale of pH is 7. The acidic of groundwater might be the places contain excessive iron. This is revealed the groundwater have pollution.

The development of technology, industry and people nowadays increase the uses of water. Indirectly it will give pressure to land and water resources. The resulted of the development revealed chemically waste contain enter directly in the soil which infiltrate in aquifer and give pollution to groundwater. The faulty septic tank operation and landfill leachates also give pollution to our groundwater.

5.5 Classification of Groundwater

The groundwater classification needs to classify using Piper Trilinear Diagram. Piper diagram constitutes the percentage of major ions elements. Three constitutes will represent 100% concentration each element. Major anion can be added of carbonate and bicarbonate group together. The percentage of each constituents representing by the points of the sample would be plotted on the line between the apexes of the group sample. There are diamond shape in the middle between two triangles to represents major anions and cations. In diamond-shaped field will projected cation and anion points parallel to the side of labeled magnesium and sulphate and the intersection of two lines is plotted as a point on the diamond-shaped field.

Table 5.10: Conversion Factors for Chemical Equivalence. (Todd, 1976)

Chemical Constituents	Conversion Factors
Bicarbonate HCO_3^-	0.01639
Chloride, Cl^-	0.02821
Sulfate, SO_4^{2-}	0.02082
Sodium, Na^+	0.04350
Potassium, K^+	0.02557
Calcium, Ca^{2+}	0.04990
Magnesium, Mg^{2+}	0.08226

Table 5.11: The value of anion Concentration after multiplied by respective conversion factors in miliequivalent per litre (meq/L)

Sample	HCO_3^-	Cl^-	SO_4^{2-}
1	6.842825	0.921339	0.2082
2	5.531625	1.021484	0.154484
3	4.2614	1.021484	0.171349
4	4.548225	1.882735	0.171349
5	3.482875	1.181717	0.118674
6	3.400925	1.241804	0.033312
7	3.7697	1.061542	0.024984
8	5.449675	1.261833	0.308136
9	3.073125	1.041513	0.049968
10	2.04875	2.743987	0.154068
11	2.86825	0.941368	0.380798
12	2.745325	1.081571	0.137412
13	2.54045	1.061542	0.428892
14	6.0192275	0.701019	0.273991
15	3.03215	1.221775	0.29148

Table 5.12: The value of cation Concentration after multiplied by respective conversion factors in miliequivalent per litre (meq/L)

Sample	Na	K	Na+K	Ca	Mg
1	0.042108	0.000869	0.042977	0.0066367	0.029943
2	0.0174435	0.005856	0.0233	0.0070858	0.005676
3	0.0190095	0.002352	0.021362	0.0358282	0.006581
4	0.039411	0.006341	0.045752	0.0107784	0.001069
5	0.01914	0.051421	0.070561	0.0179141	0.013984
6	0.005568	0.004168	0.009736	0.0090818	0.003373
7	0.0407595	0.002301	0.043061	0.00998	0.003702
]8	0.0257955	0.004756	0.030552	0.0075349	0.001645
9	0.0328425	0.003145	0.035988	0.0034431	0.001234
10	0.0220545	0.0011	0.023155	0.0061876	0.002303
11	0.0760815	0.002685	0.078767	0.0071357	0.002632
12	0.007743	0.000537	0.00828	0.0005988	0.026241
13	0.1094025	0.001125	0.110528	0.00998	0.00074
14	0.026187	0.001892	0.028079	0.0107285	0.001152
15	0.0245775	0.000844	0.025422	0.0103792	0.01382

Table 5.13: The cation and Anion Concentration in Percentages Value %.

Sample	HCO_3^- %	Cl^- %	SO_4^{2-} %	Total %	Na+K %	Ca %	Mg %	Total %
1	85.83	11.56	2.61	100	54.02	8.34	37.64	100
2	82.47	15.23	2.30	100	64.61	19.65	15.74	100
3	78.13	18.73	3.14	100	33.50	56.18	10.32	100
4	68.89	28.52	2.59	100	79.43	18.71	1.86	100
5	72.81	24.71	2.48	100	68.87	17.48	13.65	100
6	72.73	26.56	0.71	100	43.87	40.93	15.2	100
7	77.63	21.86	0.51	100	75.89	17.59	6.52	100
8	77.63	17.98	4.39	100	76.9	18.95	4.15	100
9	73.79	25.01	1.2	100	88.5	8.47	3.03	100
10	41.42	55.47	3.11	100	73.17	19.55	7.28	100
11	68.45	22.46	9.09	100	88.97	8.06	2.97	100
12	69.25	27.28	3.47	100	23.58	1.7	74.72	100
13	63.02	26.34	10.64	100	91.16	8.23	0.61	100
14	86.06	10.02	3.92	100	70.27	26.85	2.88	100
15	66.71	26.88	6.41	100	51.24	20.91	27.85	100

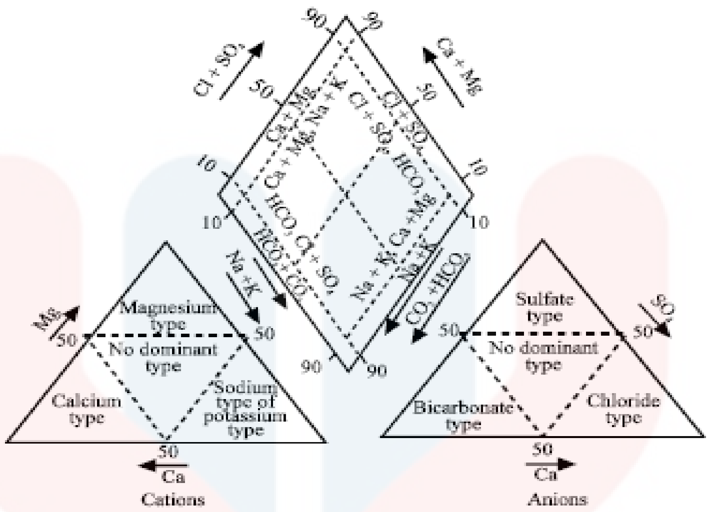


Figure 5.19: The water type classification using the Piper trilinear diagram.Water types are designated according to the domain in which they occur on the diagram segments (Back, 1961; Hanshaw, 1965).

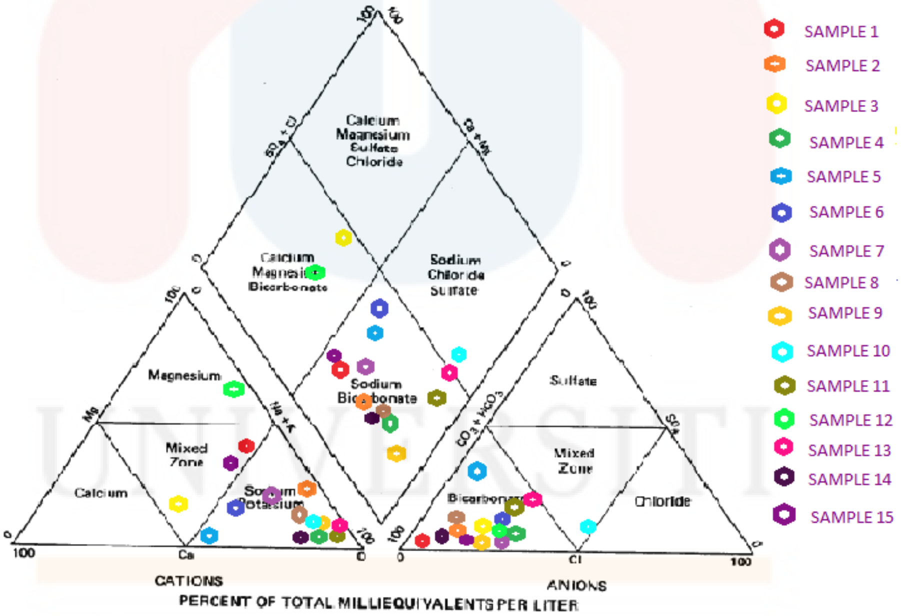


Figure 5.20: The classification types of groundwater facies in Kubang Gadong, Pasir Mas.

The geochemical evolution and groundwater distribution of the study area is shown in Piper Diagram by plotting the concentration of major anion and major cation in Piper Diagram. The combination of major anion value and major cation value that lies on a common baseline. The Piper Trilinear Diagram can be concluding the origin of water represented by analysis from plotting position of analysis in Piper diagram. There are four basic conclusion can be derived from multiples analyses plotting in Piper diagram. There are water type, precipitation or solutiuon, mixing and ion exchanges. The water types can be classified into four basic based on their placement near the four corners of the diamonds. Water that have plotting at the top of the diamond will classified as high in (Ca^{+2} + Mg^{+2} and Cl^{-} + SO_4^{2-}) that have permanent hardness in this area. Water that plotted in lower corner of diamond is primarily composed of alkali carbonates which (Na^{+} + K^{+} and HCO_3^{-} + CO_3^{-}). In area that water plot near left corner of the diamond will show rich in (Ca^{2+} + Mg^{2+} and HCO_3^{-}) This result shown this area have water temporary of hardness. Lastly, water lying at the right side of the diamond may be considered as saline (Na^{+} + K^{+} and Cl^{-} + SO_4^{2-}). Based on the result shown in figure, Water that plotted in lower corner of diamond is primarily composed of alkali carbonates which (Na^{+} + K^{+} and HCO_3^{-} + CO_3^{-}). In this study area, the classification of water dominantly in alkali carbonates. This can be proven by the highest value of bicarbonates.

CHAPTER 6

CONCLUSION AND SUGGESTION

6.1 Conclusion

In order the objectives that stated in research study earlier in chapter 1, it can be general geology and hydro chemical analysis of groundwater. There were done this research which were updating alluvium map with scale 1:25 000 in Kubang Gadong area, to determine the physical and chemical characteristic of groundwater and to classify the types of groundwater.

Based on the objective in chapter 1 the alluvium map 1:25 000 of the study area was produced. The map was produced in area about 64 km^2 about alluvium mapping. Next, to determine the psychochemical parameter og groundwater successfully determined using AAS, titration, gravimetric and In-situ parameter which related with drinking and domestic purposes. The classification of groundwater facies in sodium potassium bicarbonate.

In alluvium mapping five location were determined the soil alluvium using auger. The five location was carried out about 100 cm and was found gravel, sand, silt and clay.

In chapter hydrochemistry analysis insitu parameter, major cation and anion were determined. The reading of TDS between 42 mg/L to 250 mg/L which classify all samples as fresh water. The pH value indicates only sample 9, 14 and 15 have under permissible limit of W.H.O and M.H.O while others are rejected according to Vantakesh and Rajeshkar, 2005. The reading electric conductivity, temperature and turbidity are in good condition. For major anion cation and anion shows the good reading for all well.

6.2 Suggestion

In order to controlled the contamination, the study area was used huge of fertilizers for paddy field. The fertilizers need to less used in the study area.

On the other hand, the well need to regularly monitoring before using the water to prevent any contamination occur. The drilling more depth of well will can decrease the contamination of water.

Lastly, people society need to replaced older water tanks like galvanized tanks which use for drinking purpose because its have higher density polypropylene containers or fiber glass.

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APPENDIX A

Carried out water from well.

One of water flow from groundwater in Department in Irrigation and Drainage.

APPENDIX B

Measure the reading of water using Multipara meter.

The instruments in In-Situ parameter.

APPENDIX C

Atomic Absorption Spectrometer analysis.

Reading the water concentration result in computer.

APPENDIX D

The sample of water in different concentration.

Water analysis

APPENDIX E

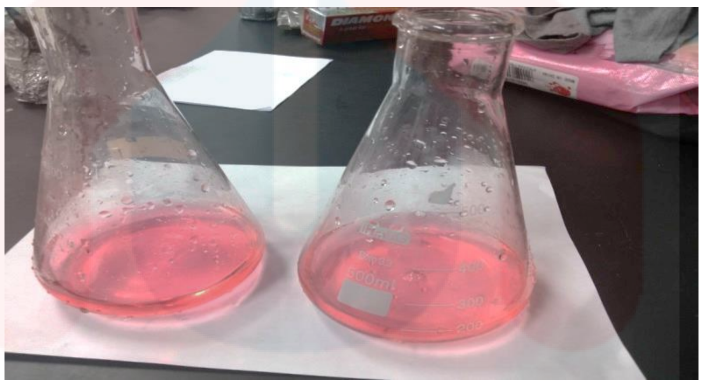
Soil sampling using auger.

Determination alluvium soil

Sieving Analysis

APPENDIX F

Reagent for laboratory analysis.



Titration in lab analysis.

Conduct titration of water sample

APPENDIX G

The alluvium soil in mapping.