# MONITORING AND ANALYZING DATA FROM WEATHER STATION IN UNIVERSITI MALAYSIA PAHANG (PEKAN AND GAMBANG CAMPUS)

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# MONITORING AND ANALYZING DATA FROM WEATHER STATION IN UNIVERSITI MALAYSIA PAHANG (PEKAN AND GAMBANG CAMPUS)

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Thesis submitted in fulfillment of the requirements
for the award of the
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## ABSTRAK

Data cuaca penting dalam kehidupan seharian kerana perubahan iklim menyebabkan perubahan dalam hujan. Stesen cuaca adalah salah satu peranti untuk mengumpul data cuaca. Data cuaca seperti hujan, kelembapan, suhu, dan kelajuan angin dikumpulkan dengan menggunakan peranti ini. Data seperti hujan dan suhu digunakan sebagai langkah berjaga-jaga untuk menentang malapetaka atau bencana alam seperti banjir dan kemarau. Data cuaca yang dikumpul untuk tempoh yang lama digunakan untuk meramalkan perubahan iklim dalam trend masa hadapan. Selain itu, pola hujan di Universiti Malaysia Pahang (UMP) ditentukan dengan menganalisis data hujan dan suhu di stesen UMP Pekan dan Gambang. Semua data dianalisis untuk memeriksa data bulanan minimum untuk setiap tahun bermula dari tahun 2015 hingga 2017. Untuk mengetahui trend data hujan di UMP (Gambang dan Pekan), data maksimum hujan yang diterima pada bulan tersebut juga dianalisis. Analisis ini juga bermula dari tahun 2015 hingga 2017. Corak hujan di kawasan UMP ditentukan daripada analisis data.

## ABSTRACT

Weather data are important in our daily life as climate change leads to changes in precipitation. Weather station is one of the devices to collect the weather data. The weather data such as precipitation, humidity, temperature, and wind speed are collected by using this device. The data such as rainfall and temperature are used to serve as a precautionary measure to against natural calamity or disaster such as flood and drought. The weather data collected for a long period are used to predict the climate change in future trends. Besides, the rainfall pattern in University Malaysia Pahang (UMP) is determined by analyzing the data of rainfall and temperature in UMP Pekan and Gambang station. All the data are analyzed to check the minimum monthly data for every year starting from 2015 until 2017. In order to check the trend of rainfall data at UMP (Gambang and Pekan), maximum data of rainfall received for that month also are analyzed. The analysis also start from year 2015 until 2017. The rainfall pattern in UMP area are determined from the data analysis.

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# LIST OF ABBREVIATIONS

| | |
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| UMP | University Malaysia Pahang |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

Water is the source of all life on earth. Water exists on earth as a solid, liquid or gas. The circulation and conservation of earth's water is called the "hydrologic cycle". The hydrologic cycle regulates and reflects natural variability in climate at the regional and global scales. Large-scale human activities that involve changes in land cover, such as tropical deforestation, are likely to modify climate through changes in the water cycle. Adler et al (2000) stated that precipitation information is essential for understanding the hydrologic balance on a global scale and for understanding the complex interactions among the components within the hydrologic cycle.

Weather is the condition of the atmosphere at a particular place over a short period of time, whereas climate refers to the weather pattern of a place over a long period, long enough to yield meaningful averages (Strahler, 1960).

Besides, weather data is very important in our life. The data collected such as rainfall and temperature can be used to serve as a precautionary measure to against natural calamity or disaster such as flood and drought. Weather station is one of the devices to collect the weather data. The weather data such as precipitation, humidity, temperature, and wind speed can be collected by using this device. The usage of weather station is increasing popularity among the nation. It also is being acceptable to everyone as it can predict the weather in our future and give benefits to the society. It is very important in our life as the rainfall is an important consideration in design runoff conveyance and erosion control (Pettazi and Salson, 2012).

## 1.2 Problem Statement

There is a weather station existed in UMP Gambang and there is no weather station at UMP Pekan. However, since there are many developments and constructions occur at UMP Pekan as it is the main campus, the weather station in UMP Gambang will be moved to UMP Pekan. As construction activity is influenced by weather conditions, monitoring of weather conditions can help in controlling the activity in the UMP. The weather change is not same as the UMP area and the nearest place. On top of that, weather station that has been set up at KK2 UMP Gambang in 2014 will be moved to UMP Pekan. The data from the weather station in UMP can be used to predict the weather and for the database development for UMP.

## 1.3 Objective of Study

I. To set up the weather station in UMP Pekan

II. To collect and monitor hydrological data at a weather station in UMP Gambang

III. To analyse the rainfall data at UMP Pekan and UMP Gambang

## 1.4 Scope of Study

The study will be conducted at UMP Pekan and UMP Gambang. A new weather station will be set up in UMP Pekan. The suitable location of the site proposes will be on the land that's free from obstructions such as building and trees. The procedure of the installation of weather stations will follow the guidelines and manual provided. After the weather station is set up at Pekan, the weather data, such as humidity, wind speed, temperature and rainfall data will be recorded by the weather station. On top of that, this study focuses on compiling and analysing the hydrological record of data from 2015 at Pekan and Gambang. The hydrology data are obtained from the weather station setup at University Malaysia Pahang (UMP) Gambang and Pekan campus.

## 1.5 Significance of Study

This study can help many future construction companies and future researchers in planning their schedule to complete their project on the time and avoid delays in construction process. All the result collected in this study will be compiled and a weather database for UMP can be recorded.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Malaysia Climate

The normal features of the climate of Malaysia are uniform temperature, extensive rainfall and high humidity. Besides, winds are commonly light and it is extremely rare to have a full day with a completely clear sky even during the periods of severe drought. On the other hand, it is also rare to have a stretch of a few days with completely no sunshine except during the northeast monsoon seasons as Malaysia is located at South East part of Asia where Peninsular Malaysia and East Malaysia is separated by the South China Sea. There are thirteen states and three federal territories in the country. Malaysia is observed to have a tropical climate, means the average temperature of the country, usually ranges from 21 °C to 32 °C and the humidity is range in between 70% to 90% (Tangang et al, 2012). The climate is affected by the northeast and a southwest monsoon, tropical winds that alternative during the course of the year. The northeast monsoon blows from November to March and the southwest monsoon from May to September.

Climate change is expected to cause adverse health consequences. A direct impact could be how it will affect water resources around the world. Water also will impact on other resource and social issues such as health, food supply, transportation and ecosystem community. Climate change is already having a negative effect on ecosystems, economies and communities. Increasing average temperatures do not simply mean mild winters because some regions will experience more extreme heat while others may cool slightly. Flooding, drought and intense summer heat could result. Climate change also threatens the health of our children and grandchildren through increased disease and a shortage of fresh water.

The weather change includes the change of weather parameter such as change of temperature, change of wind speed and change of relative humidity. The change of the weather parameters may affect the amount of rainfall during the specific time. The climate change is issues that arise during the 21st century with comprise a lot of environmental problems (IPCC, 2007). The impact of climate change affects several sectors in Malaysia mainly agriculture, forestry, public health, energy sector and water and also coastal resources. Agriculture is one of the sectors greatly affected by extreme climate change. Physical damage, loss of crop harvest, drop in productivity, vigor and other related to crop potentials are examples of direct and indirect effect of the extreme climate change. There are numerous impact for the climate change due to natural course and anthropogenic activities. The amount and the times for extreme event to happen are increasing in future (Sunyer et al, 2012). In addition, the increase in temperature and rainfall will affect the water resources (Wang et al., 2013). Since the availability of water resources are mostly depending on climatic condition, it is important to reduce the adverse effect of climate variability towards the water resources. The agricultural activities and forestry depend on the water resources. Due to the effect of climate change, the availability of water resources will be scarce and affect the ecosystem for industrial and also aquatic life. As the consequence of climate change, the water quality of surface and groundwater will be affected. The water supply for drinking purpose may be contaminated and increases the risk of having diseases.

Besides, there are negative effects on the agricultural production. Due to heavy precipitation which increases the moisture, the production of crops will decrease because of excessive soil moisture content. In contrast, the area which suffers from drought will increase too (Bates et al 2008).

## 2.2 Rainfall

Rainfall is the amount of rain that falls in a place during a particular period. In Malaysia, the rainfall depends on two monsoon seasons, which is southwest monsoon and northeast monsoon. Southwest monsoon seasons where originated from the deserts of Australia usually started from May to August whereas the northeast monsoon seasons, which originated from China and north Pacific commence between November and February. The magnitude of precipitation varies with time and space (Subramanya, 2013). Besides, there are two transition period of inter-monsoon period, which usually start from March to April and from September to October which brings heavy rainfall. The direction of the wind in this inter-monsoon season is variable and usually more than 10 knots (Ho & Yusof, 2012). Due to the seasonal rainfall in Malaysia, the probability of occurrence of rainfall amount is varied during the whole year (Suhaila & Jemain, 2009).

The seasonal variation of rainfall in Peninsular Malaysia is can divided into three main types. The first is over the east coast districts, November, December and January are the months with maximum rainfall, while June and July are the driest month in most districts. The second is over the rest of the Peninsular with the exception of the southwest coastal area, the monthly rainfall pattern shows two periods of maximum rainfall separated by two periods of minimum rainfall. The primary maximum generally occurs in October - November while the secondary maximum generally occurs in April-May the north-western region, the primary minimum occurs in January-February with the secondary minimum in June-July while elsewhere the primary minimum occurs in June-July with the secondary minimum in February. The third is the rainfall pattern over the southwest coastal area is much affected by early morning from May to August with the result that the double maximum and minimum pattern is no longer discernible. October and November are month with maximum rainfall and February the month with minimum rainfall. The March-April-May maximum and June-July minimum are absent or indistinct.

The rainfall is an important consideration in design runoff conveyance and erosion control system. The rain gauge can be measure the amount of rainfall since it has a quite high level of accuracy in measuring the amount of rainfall (Pettazi & Salson, 2012).

## 2.3 Humidity

Humidity is the amount of water vapor present in the air. Water vapor is the gaseous state of water and is invisible to the human eye. The air content is made up of numerous gases, including water vapor. Each atmospheric gas has its own vapor pressure, a measure of the number of molecules present at a given temperature. The vapor pressure of water, thus measures the amount of water vapor in the air. The saturation vapor pressure is the vapor pressure when liquid water begins to condense. Relative humidity is determined by using the actual vapor pressure divided by the saturation vapor pressure.

Meteorologists also use dew point temperature as a measure of the amount of water vapor in the atmosphere. This is the temperature at which the atmosphere becomes saturated and dew starts to form. It is also defined as the temperature at which the vapor pressure equals the saturation vapor pressure. Thus, as the temperature approaches and equals the dew point temperature, the vapor pressure and the saturation vapor pressure become the same. When this occurs, dew starts to form.

The hydrologic cycle begins with the evaporation of water from the surface of the ocean. As the moist air is lifted, it cools and water vapor condenses to form clouds. Moisture is transported around the globe until it returns to the surface as precipitation. Once the water reaches the ground, one of two processes may occur; 1) some of the water may evaporate back into the atmosphere or 2) the water may penetrate the surface and become groundwater. Groundwater either seeps its way to into the oceans, rivers, and streams, or is released back into the atmosphere through transpiration. The balance of water that remains on the earth's surface is runoff, which empties into lakes, rivers and streams and is carried back to the oceans, where the cycle begins again.

## 2.4 The Hydrology Cycle

The hydrologic cycle involves of water moving from the surface and more importantly the oceans to the atmosphere, across the land, and everywhere in between. It begins with the evaporation of water from the surface of the ocean. As the moist air is lifted, it cools and water vapor condenses to form clouds. Moisture is moved around the globe until it returns to the surface as precipitation. Once the water reaches the ground, some of the water may evaporate back into the atmosphere or the water may penetrate the surface and become groundwater. The balance of water that remains on the earth's surface is runoff, which empties into lakes, rivers and streams and is carried back to the oceans, where the cycle begins again. The hydrologic cycle is a conceptual model that describes the storage and movement of water between the biospheres, atmosphere, lithosphere, and the hydrosphere. Water on our planet can be stored in any one of the following major reservoirs: atmosphere, oceans, lakes, rivers, soils, glaciers, snowfields, and groundwater. Water moves from one reservoir to another by way of processes like evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, melting, and groundwater flow. The oceans supply most of the evaporated water found in the atmosphere. Of this evaporated water, only 91% of it is returned to the ocean basins by way of precipitation. The remaining 9% is transported to areas over landmasses where climatological factors induce the formation of precipitation. The resulting imbalance between rates of evaporation and precipitation over land and ocean is corrected by runoff and groundwater flow to the oceans (Hubbart, 2010).

## 2.5 Precipitation

The term precipitation is the product of the condensation of atmospheric water vapors that falls to the ground under gravity. It denotes all forms of water that reach the earth from the atmosphere. The usual forms are rainfall, snowfall, hail, frost and dew. Of all these, only the first two contribute significant amounts of water. The rainfall being predominant forms of precipitation causing stream flow, especially the flood flow in a river. The magnitude of precipitation varies with time and space. Differences in the magnitude of rainfall in various parts of a country at a given time and variations of rainfall at a place in various seasons of the year are obvious and need no elaboration. It is this variation that is responsible for many hydrological problems, such as floods and droughts (Subramanya, 2013).

## 2.6 Evaporation

Evaporation is a type of vaporization of a liquid that occurs from the surface of a liquid into a gaseous phase that is not saturated with the evaporating substance. It is the process by of water changing from its liquid phase to the vapor phase. This process may occur from water bodies, from saturated soils, or from unsaturated surfaces. The computation of evaporation in hydrologic analysis and design is important in water supply design, particularly the reservoir design and operation. The supply of energy to provide the latent heat of vaporization and the ability to transport water vapor away from the evaporative surface are the two major factors that influence evaporation. Latent heat is the heat that is given up or absorbed when a phase (solid, liquid, or gaseous state) changes. Latent heat of vaporization ($lv$) refers to the heat given up during the vaporization of liquid water to water vapor and is given as $lv = 2.501x10^6$. (Mays, 2011).

In order for evaporation to occur, the heat energy is required. The energy is used to break the bonds that hold water molecules together, which is why water easily evaporates at the boiling point (212° F, 100° C). But evaporates much more slowly at the freezing point. When the rate of evaporation exceeds the rate of condensation, the net evaporation will occurs. When these two process rates are equal, a state of saturation exists at which point the relative humidity of the air is 100 percent. Besides, the process of condensation which is the opposite of evaporation occurs when saturated air is cooled below the dew point (the temperature to which air must be cooled at a constant pressure for it to become fully saturated with water), such as on the outside of a glass of ice water.

The primary mechanism of evaporation is from the oceans supporting the surface-to-atmosphere portion of the water cycle. After all, the large surface area of the oceans provides the opportunity for large-scale evaporation to occur. On a global scale, the amount of water evaporating is about the same as the amount of water delivered to the Earth as precipitation. Evaporation is more prevalent over the oceans than precipitation, while over the land, precipitation routinely exceeds evaporation.

## 2.7 Rain Gauge

A rain gauge is an instrument that can be used to measure the amount of rainfall in the area receives in a given time period. Rain gauge is a simple instrument that can be installed and use. The reading amount of rainfall is in inches or millimeters. Rain gauges are the most worldwide used devices for in-situ point measurements of precipitation intensity and duration, especially for the Tipping-Bucket rain gauge since it can not only accurately measure rainfall intensity from low-to-intermediate level, but also recording remotely with reliability and suitability (Song, 2016).

Besides, rain gauges must be placed in an expose area where there are no obstacles, such as buildings or trees, to block the rain. This is also to prevent the water collected on the roofs of buildings or the leaves of trees from dripping into the rain gauge after a rain, resulting in inaccurate readings.

There are three types of recording rain gauge. The first is weighing bucket type rain gauge, which is most common self-recording rain gauge. It consists of a receiver bucket supported by a spring or lever balance or some other weighing mechanism. The movement of bucket due to its increasing weight is transmitted to a pen which traces record or some marking on a clock driven chart. It gives a plot of the accumulated rainfall values against the elapsed time and the mass curve is formed. Figure 2.1 shows weighing bucket type rain gauge.

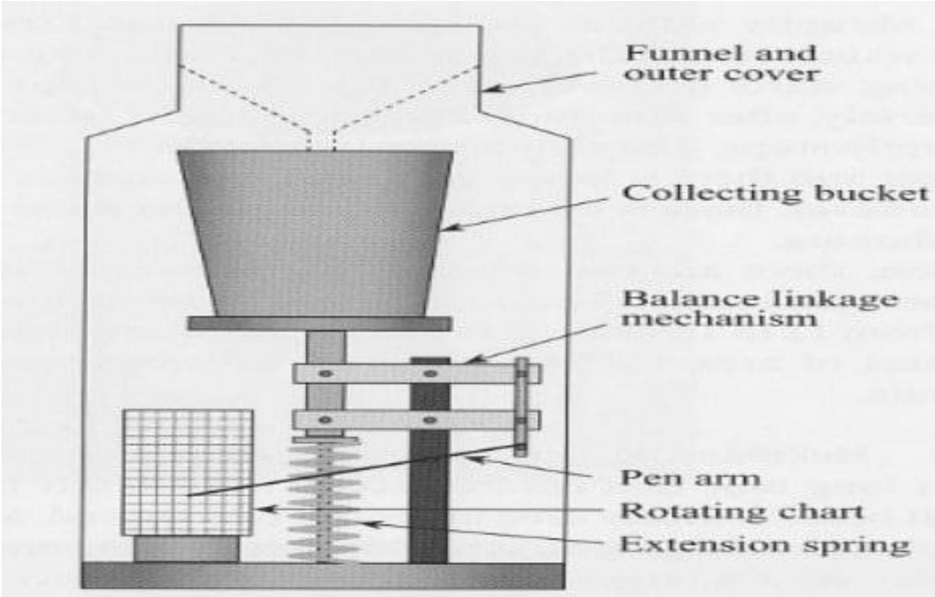


Figure 2.1 Weighing Bucket Type Rain Gauge (source: The Constructor,2017)

The second is tipping bucket type rain gauge. It is 30cm sized circular rain gauge adopted for use by US weather bureau. It has 30cm diameter sharp edged receiver and at the end of the receiver is provided a funnel. When one bucket receives 0.25mm of rainfall, it tips discharging its rainfall into the container, bringing the other bucket under the funnel. The tipping of bucket completes an electric circuit causing the movement of pen to mark on clock driven receiving drum which carries a recorded sheet. Figure 2.2 shows tipping bucket type rain gauge.

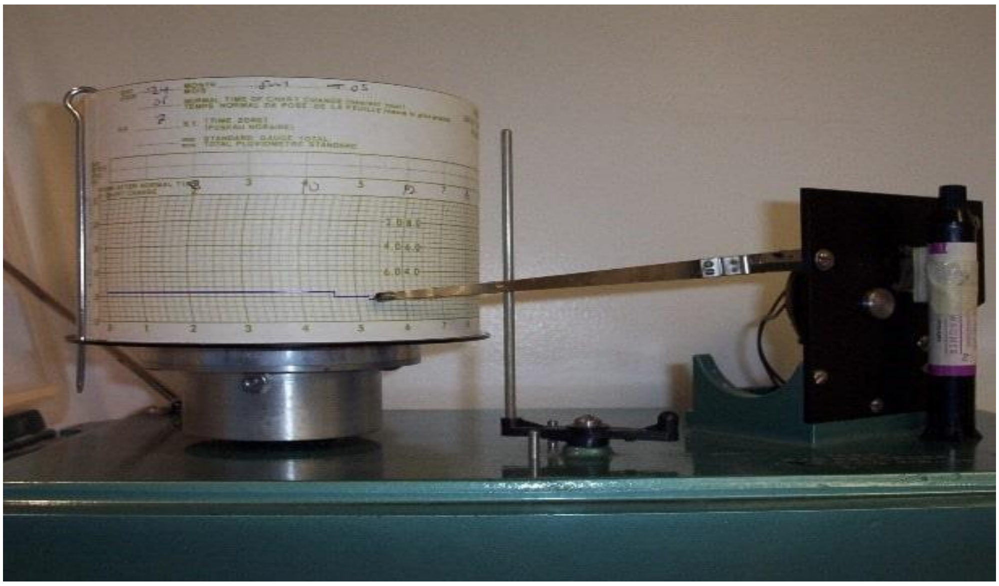

Figure 2.2 Tipping Bucket Type Rain Gauge (source: The Constructor,2017)

The third is natural syphon type rain gauge. The mechanism of this type is similar to weighing bucket rain gauge. Its movement being recorded by a pen moving on a recording drum actuated by a clock work. The rain gauge is adopted as the standard recording rain gauge in India and the curve drawn using this data is known as mass curve of rain fall. Figure 2.3 shows natural syphon type rain gauge.

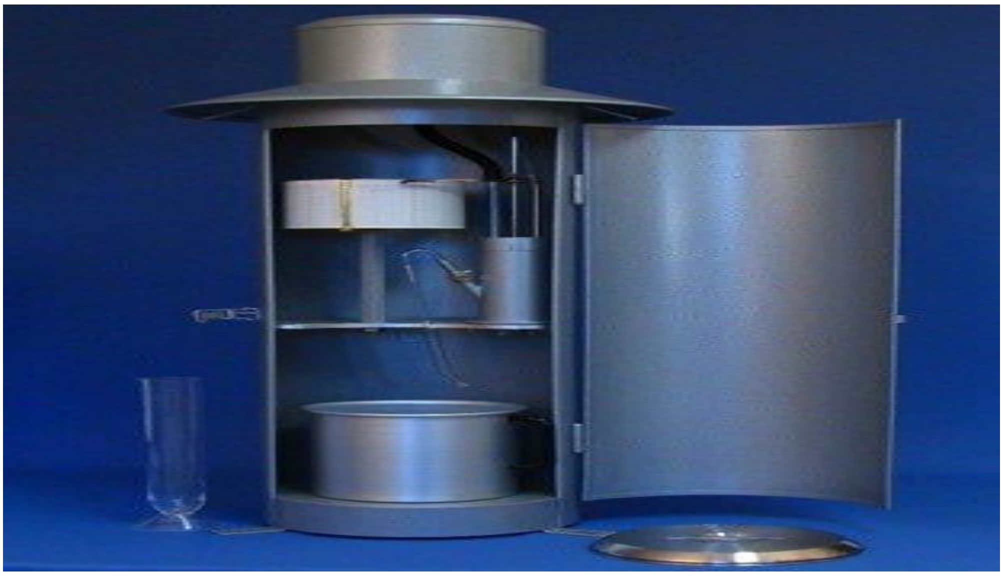

Figure 2.3 Natural Syphon Type Rain Gauge (source: The Constructor,2017)

# CHAPTER 3

# METHODOLOGY

## 3.1 Methodology Flow Chart

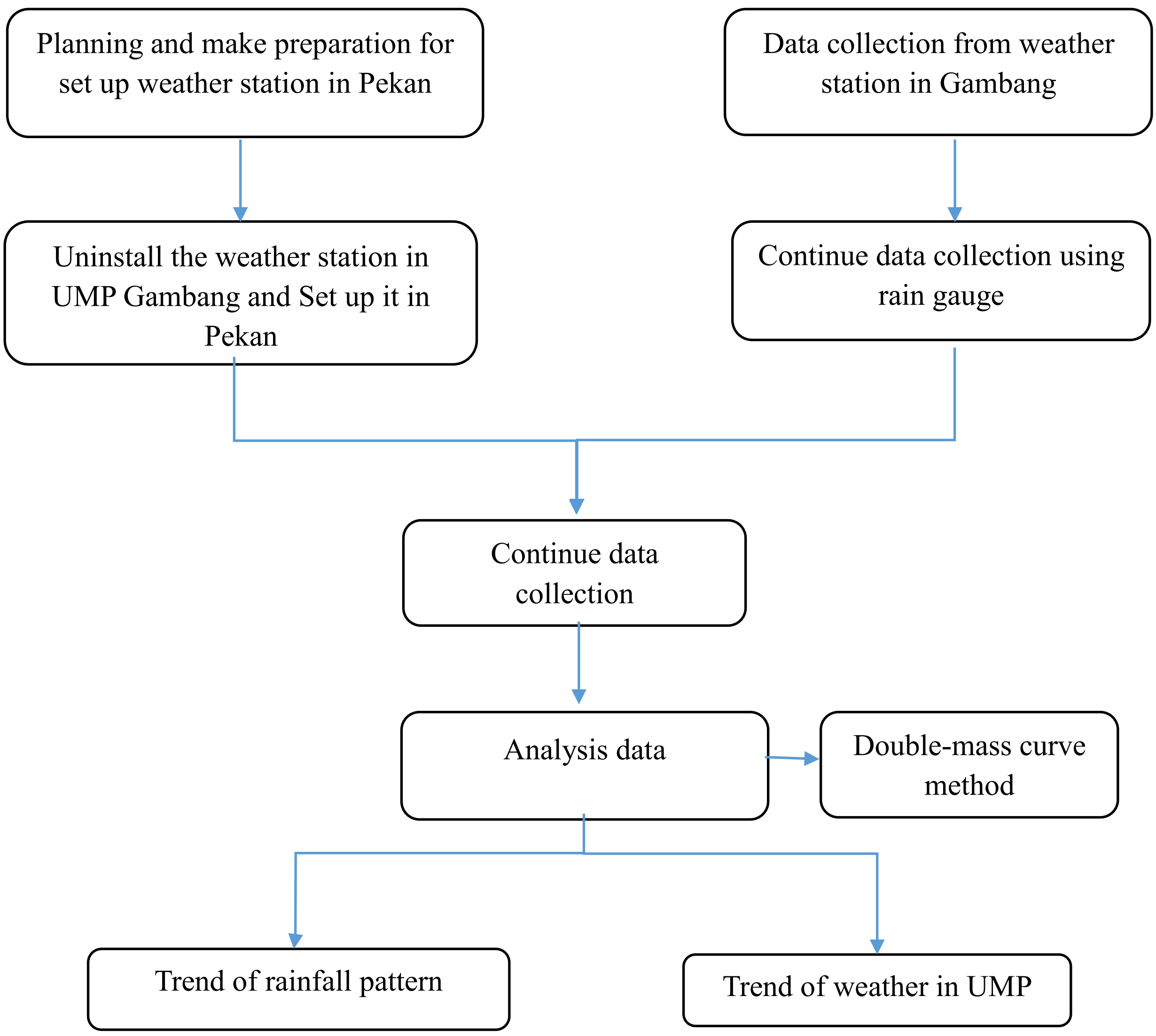


Figure 3.1 Methodology Flow Chart

Figure 3.1 is the methodology flow chart which is how the flow of study is carried out to obtain the expected result. There are a few methods for data collection in Pekan and Gambang campus. The knowledge of literature review which is reviewing the journals, articles, handbooks and internet is interrelated to this chapter. There are two parts for the data collection, which is the data collection from the weather station that set up in University Malaysia Pahang (UMP) campus Pekan and Gambang campus.

## 3.2 Planning and Make Preparation for Set Up Weather Station in Pekan

The project to move the weather station to UMP Pekan was planned during the meeting with the supervisor and supplier. The important elements such objectives, procedure of installation weather station, significant of study and selection of area for site location were discussed in the meeting. The selected area was decided based on the ideal criterion which is free from obstruction such as building and trees. To perform at its best for the weather station, the guidelines to select the optimum mounting locations for the ISS and anemometer is used. A few factors need to take into consideration in order to choose the suitable location. For example, be sure to take into consideration ease of access for maintenance, wireless transmission range when sitting the station and the sensor cable length. The guidelines for the location are mentioned below:

### 3.2.1 The general ISS sitting guidelines includes

The ISS need to be placed away from the sources of heat such as air conditioner, heaters and exhaust vents. Besides, the ISS need to be placed at least 30m (100’) away from any concrete roadway that can readily absorb and radiates the heat in the sun. In addition, the installation of ISS near the fences and sides building that receive a lot of sun during the day need to be avoided as well. Normally, the radiation shield of ISS is placed 1.5m above the ground in the middle of flat ground or the natural landscape area that drains well when it drains. Next, the ISS cannot be installed in the area that have directly sprayed by a sprinkler system as it will adversely affect the readings. The ISS also cannot be placed under the tree or near the building that creates ‘rain shadows’. Lastly, it must be placed in a location with good sun exposure throughout the day.

### 3.2.2 Anemometer Sitting Guidelines

The anemometer should be place 2.1m from the surrounding obstruction such as trees and building that prevent the wind flow. For the best result if the ISS and the anemometer are placed together on a pole, the mount anemometer should be at least 0.3m above the top of the rain collector cone. According to the meteorological standard and aviation application, the anemometer should be place 10m above the ground.

### 3.2.3 Anemometer Cable Length Considerations

All the Vantage Pro2 stations include a 12m cable will be use between the anemometer and ISS. This can be extended using extension cables up to 165m. If possible, keep the anemometer cable coiled during the ISS and anemometer assembly so that it can easily show when the installation is complete.

From considering the above guidelines, the suitable place for the ISS and anemometer is at the field near the Faculty of Electrical and Electronic Engineering at UMP Pekan. The place chosen is more likely based on the guidelines provided which is shadow free from the trees and building obstruction, far away from the fences and roadside and it is can easily access to the site for the maintenance.


Figure 3.1 Map of University Malaysia Pahang Campus Pekan

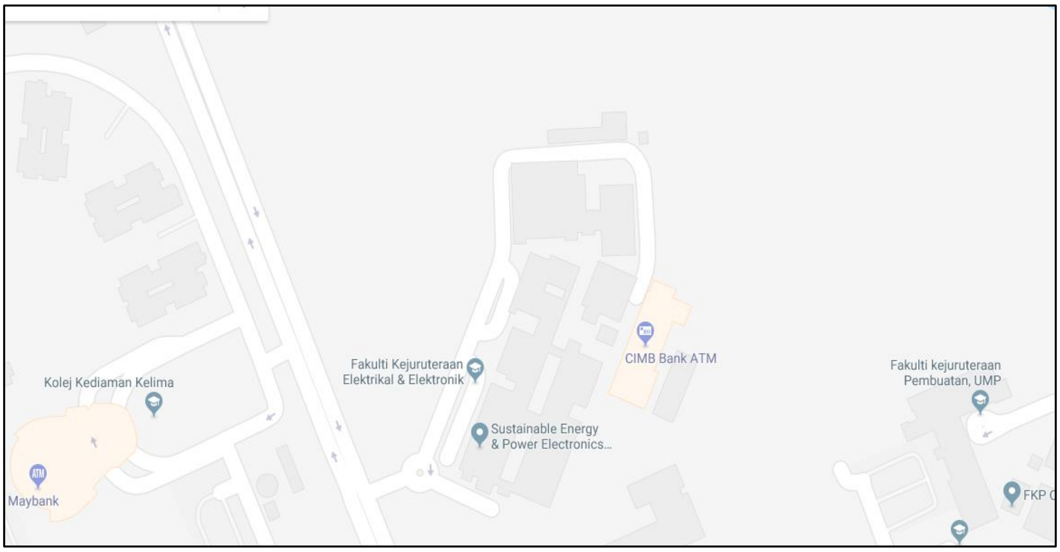


Figure 3.2 Location of Faculty of Electrical and Electronic Engineering

Figure 3.1 shows the map of UMP Campus Pekan and Figure 3.2 shows the location of weather station near the Faculty of Electrical and Electronic Engineering. This location is used because it has the ideal criteria based on the guidelines such as free from obstruction.

## 3.3 Data Collection from Weather Station in Gambang

At the same time with the planning to set up weather station in Pekan, the weather station at field Kolej Kediaman 2 University Malaysia Pahang (UMP) campus Gambang is collected once a week. Figure 3.4 and 3.5 shows the data collected from weather station after transfer to PC and the data recorded from weather station. Figure 3.3 shows the data collected from weather station after transfer to PC. The Figure 3.4 shows the data recorded in the console from weather station.

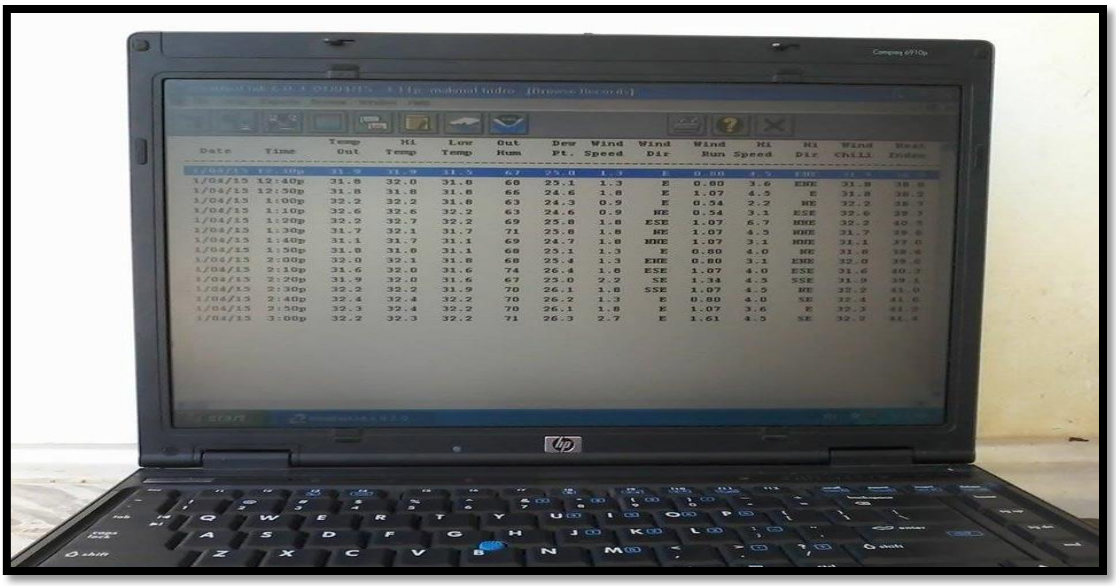

Figure 3.3 The data collected from weather station after transfer to PC.

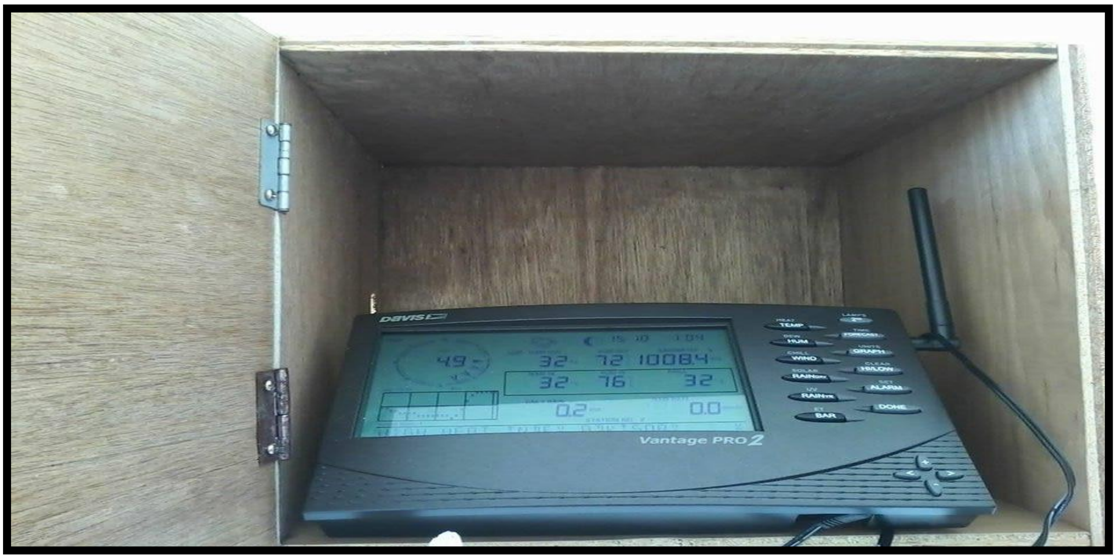


Figure 3.4 The Data recorded from weather station.

### 3.4 Uninstall the Weather Station at Ump Gambang

The procedure to set up the hardware of the weather station was shown in manual and guideline provided by the manufacturer. The hardware for the weather station included Vantage Pro Vue console and Integrated Sensor Suite (ISS). The Integrated Sensor Suite (ISS) is to collect outside weather data and sends the data to a Vantage Pro2 console. The standard version of ISS includes a rain collector, temperature sensors, humidity sensor and anemometer. To minimize the impact of solar radiation on sensor readings, the temperature and humidity sensors are mounted in a passive radiation shield. The anemometer is a device used for measuring the speed of wind, and is also a common weather station instrument. The ISS 'brains' is located at Sensor Interface Module (SIM) and acts as a radio transmitter. To uninstall the weather station, the steps below are followed:

#### 3.4.1 Disconnect the solar panel connection

The solar panel on the box cover is connected to the SIM by a wire. To disconnect the solar power connection, the tab is lift away from the box while sliding the cover up. Next, the box cover can be easily removed from the box when the alignment indicator on the cover on the cover is lined up with the alignment indicator on the box. The cover is lifted off the box and when removing the cover, be extra careful not to stress the solar panel cable. After that, locate the brown connector for the solar power wire. The connector is pull outward off the brown solar power tab. Then, the solar panel is no longer connected to the SIM (Meijers, 2009).

#### 3.4.2 Disconnect the Anemometer Cable from the SIM

The foam between the cables is taken out. The function of the foam is to ensure no holes or gaps large enough for weather or insects. In addition, the foam is sensitive to water, so it can help to protect the cable greatly by absorbing the water in the SIM. After that, take out the anemometer cable from the cable access port from beneath the SIM box. Make sure that the anemometer cable is taken out from the connector labelled WIND (Meijers, 2009).

### 3.4.3 Remove the Rain Collector

The bucket of the rain collector must be released in order to remove the rain collector. The rain collector cone is removed from the ISS base by rotating the cone counter-clockwise. The cone of the ISS base is lift off when the cone's latches line up with the opening in the base. To secure the tipping bucket, carefully tie with rubber band to hold the tipping bucket in place during shipping to another place. On the console screen, look for the Daily Rain to ensure the tipping bucket is not moving (Meijers, 2009).

### 3.4.4 Set Up the Weather Station at UMP Pekan

#### 3.4.4.1 Set up the Rain Collector

The first step is setting up the rain collector. The bucket of the rain collector must be released in order to remove the rain collector. The rain collector cone will have removed from the ISS base by rotating the cone counter-clockwise. The cone of the ISS base is lift off when the cone's latches line up with the opening in the base. The rubber bands that holds the tipping bucket is cut and remove. On the console screen, look for the Daily Rain and reconnect the cable to see if the console is receiving rain readings. While watching to Daily Rain display, the bucket is tip until it drops to opposite site. Then see at the display weather it registers a rain reading or not. Each tip indicates 0.01" or 0.2mm of rain and to register at the console, it may take a minute. The number on the console display may not change if the bucket is tipped to quickly.

#### 3.4.4.2 Connect the Anemometer Cable to the SIM

The anemometer cable is insert end into the cable access port from beneath the SIM box. The cable is slide through the cable access port with the connector lever down. The end of the anemometer cable is insert firmly into the connector labelled WIND. On the bottom of the cable access port, make sure that the cables lie flat neatly. The foam is insert between the cables and at the top of the cable access port. A connection between the ISS and the Vantage Pro2 console must be made once the sensor connections have been checked and the anemometer cable has been inserted.

#### 3.4.4.3 Connect the Solar Panel Connection

To connect the solar power connection, the tab is lift away from the box while sliding the cover up. Look on the side of the SIM box. The box cover can be easily removed from the box when the alignment indicator on the cover on the cover is lined up with the alignment indicator on the box. The cover is lifted off the box. When removing the cover, be extra careful not to stress the solar panel cable. When the SIM cover is removed, the SIM and sensor connector are visible. Locate the brown connector for the solar power wire. The connector is insert to the brown solar power tab. Then, the solar panel is connected to the SIM.

#### 3.4.4.4 Applying the Power

The 100' (30 m) console cable will provides power to the ISS. It is used to send data from the ISS to the console. With extension cables, the length of the console cable can be extended up to 1000' (305 m). To apply the power, the console is located within 30m with the system. The foam insert of cable access is pull out. The console connector cable is insert into the port from beneath the SIM box. Firmly insert one end of the 4-conductor cable into the modular connector located apart from the sensor connectors next to the battery insert on the sim. This connector is labelled COMM. The other end of the console cable is inserting on the back of the console labelled “ISS”. The foam is insert firmly between the cables and at the top of the cable access port to ensure the cable is safe from insects or water. The console cable is plugging into the console power of ISS to establish communication between the ISS and the console. The ISS is ready to collecting weather data and start sending the data to the console immediately.

### 3.4.5 Set Up Interval

The hardware implementation included the setup of Vantage Pro Vue console. The Vantage Pro Vue console automatically enters setup mode when first powered. In the setup mode, button <DONE> was used to move to the next screen whereas <BAR> displayed the previous screen. The <2ND> and <UNIT> was used to change the unit of measure when applicable. To exit the setup mode, button <DONE> was press and hold until the current weather screen display.

#### I. Screen 1: Time and Date

Button (<) and (>) was used to move between segments.

Button (+) and (-) was used to change the value of the flashing segments.

Button <2ND> and <UNITS> was used to change from 12-hour to 24-hour clock.

Button <DONE> was pressed to move to the next screen.

#### II. Screen 2: Time Zone

Button (+) and (-) was used to cycle through time zones.

Button <2ND> then (+) and (-) was used to set UTC offset.

Button <DONE> was pressed to move to the next screen.

#### III. Screen 3: Daylight Saving Setting

Button (+) and (-) was used to choose MANUAL or AUTO. MANUAL was selected for this setting.

Button <DONE> was pressed to move to the next screen.

#### IV. Screen 4: Daylight Saving Status

If the daylight setting=AUTO, it will display current status.

The daylight manual setting=MAN, button (+) and (-) was used to turn DST on or off.

Button <DONE> was pressed to move to the next screen.

## V. Screen 5: Receiving Form

The console displayed the transmitter IDs that console currently received. It takes several minutes to display all IDs. The default transmitter ID setting is “1” (ISS) ON.

Button <DONE> was pressed to move to the next screen.

## VI. Screen 6: Active Transmitters

Button (<) and (>) was used to select the ID, (+) and (-) to set to ON which to receive from that station or OFF. Button GRAPH was used to change the station type between ISS, VP2 or WIND. Station type ISS was chosen.

Button <DONE> was pressed to move to the next screen.

## VII. Screen 7: Retransmit

Button (+) and (-) was used to set the retransmit function ON or OFF. The retransmit function was set ON.

Button <DONE> was pressed to move to the next screen.

## VIII. Screen 8: Latitude and Longitude

Button (<) and (>) was used to move between segments.

Button (+) and (-) was used to change the value of the flashing segments.

Button <2ND> and <UNITS> was used to toggle between NORTH and SOUTH for latitude or EAST and WEST for longitude.

Button <DONE> was pressed to move to the next screen.

## IX. Screen 9: Elevation

Button (<) and (>) was used to move between segments.

Button (+) and (-) was used to change the value of the flashing segments.

Button <2ND> and <UNITS> was used to toggle between FEET and METERS.

Button <DONE> was pressed to move to the next screen.

## X. Screen 10: Barometric Reduction

Button (+) and (-) was used to change the barometric setting types between NOAA, ALT SETTING and NONE. The default setting was NOAA.

Button <DONE> was pressed to move to the next screen.

## XI. Screen 11: Wind Cup

Button (+) and (-) was used to change wind cup option: SMALL, LARGE and OTHER. The setting is change only when using a Vantage Pro2 ISS or an anemometer transmitter kit.

Button <DONE> was pressed to move to the next screen.

## XII. Screen 12: Rain Collector

The factory setting used was default for calibration.

Button <DONE> was pressed to move to the next screen.

## XIII. Screen 13: Rain Season Begins

Button (+) and (-) was used to change the month.

Button <DONE> was pressed to move to the next screen.

## XIV. Screen 14: Cooling/ Heating Degree Day Base

Button (<) and (>) was used to move between segments.

Button (+) and (-) was used to change the value of the flashing segments.

Button <2ND> and <CLEAR> was used to clear the setting. The default setting was 'DASHED'.

Button <DONE> was pressed to move to the next screen.

## XV. Screen 15: Commentary

Button (+) and (-) was used to toggle between OFF and ON setting. The setting was set to OFF.

Button <DONE> was pressed to move to the next screen.

## XVI. Scree 16: Key Beep

Button (+) and (-) was used to toggle between OFF and ON setting.

Button <DONE> was pressed to move to the next screen.

## XVII. Screen 17: Baud Rate

Button (+) and (-) was used to set the available baud rate values. The default setting was 19200.

Button <DONE> was pressed and holds to exit the setup mode. The current weather screen was shown on console.

### 3.5 Continue Data Collection Using Rain Gauge

After the weather station in Kolej Kediaman 2 University Malaysia Pahang (UMP) campus Gambang is uninstall, the collection of data will continue from the Rain Gauge at field Kolej Kediaman 2. The figure below shows the rain gauge at field Kolej Kediaman 2 after the weather station is moved to UMP Pekan. Figure 3.5 shows the rain gauge at field Kolej Kediaman 2.

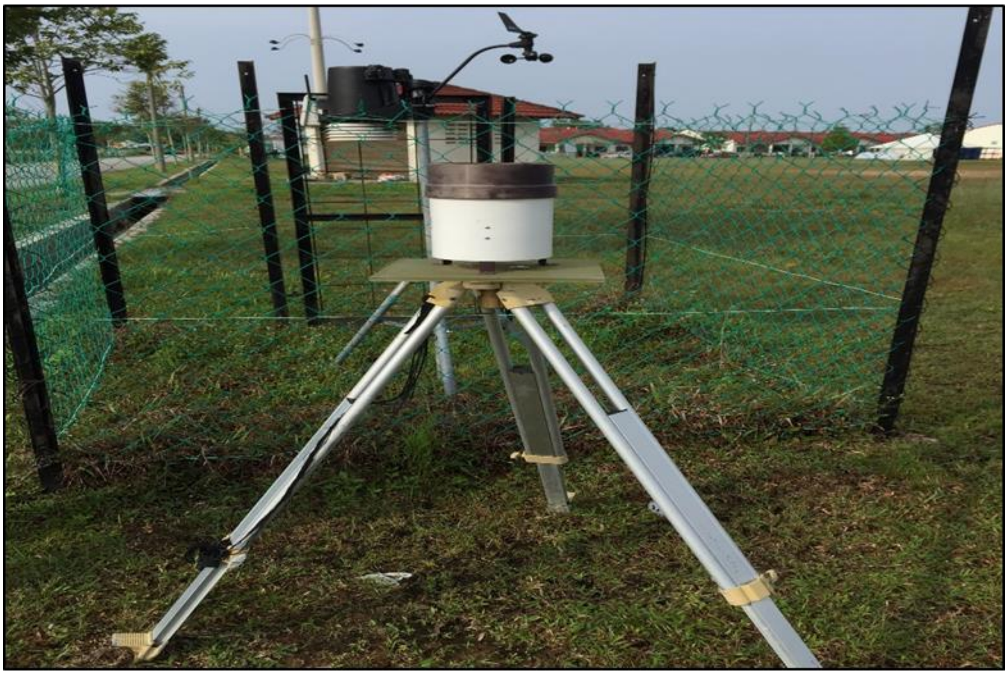

Figure 3.5 The Rain Gauge at field Kolej Kediaman 2

## 3.6 Set Up Weather Station in Ump Pekan

The figure 3.6 below shows the weather station that has been set up in Ump Pekan. After the weather station has been set up, it cannot be run as the console of the weather station cannot be installed. The console cannot be installed due to some technical problems at the site. However, the collection of hydrological data at Ump Pekan is focused on the rainfall and temperature using the rain gauge. Figure 3.7 shows the rain gauge that already been set up at UMP Pekan by previous student to collect the rainfall data. This equipment has been set up since year 2012 until now.


Figure 3.6 The Weather Station that has been set up in UMP Pekan

Figure 3.7 The Rain Gauge at Ump Pekan

## 3.7 Analyze the Data

After collecting the data from both UMP Pekan and Gambang Campus, the suitable method proposed to analyse the data is using double mass curve. The purpose of using the method is to check the consistency of data and to solve missing data of rainfall. The Double-mass curve (DMC) is the suitable tool or technique for checking inconsistency of a record (Subramanya, Engineering hydrology, 2009).

The first step of double mass curve is the annual catch of the stations is added for each year. The summation of the annual catch of every station is cumulated. Next, the cumulative for station X is calculated. After that, the graph of cumulative rainfall for X station against cumulative rainfall of stations is plotted. The graph will have two straight lines which the line is separated at the break point. The slope of each straight line is determined which is S1 and S2. The modified station X is calculated by using [(S2 / S1)* rainfall data each year of X station]. The summation of modified X station is calculated. For the next step, plot the graph cumulative modified X station against cumulative rainfall of the stations.

After analysing the data using double mass curve, the expected outcome will be the trend of weather and trend of rainfall pattern in University Malaysia Pahang for Pekan and Gambang campus. From this analysis, the conclusion and recommendation will be done.

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

Data that are collected and organized are analysed and presented on this topic. Data are obtained from the weather station and rain gauge at UMP Gambang and Pekan Campus.

## 4.2 Data Results

Rainfall and weather data (temperature and rainfall) was analyse for UMP Pekan and Gambang station. All the data was been analysed to check the minimum monthly data for every year starting from 2015 until 2017. In order to check the trend of rainfall data at UMP (Gambang and Pekan), maximum data of rainfall received for that month also has been analysed. The analyses also start from year 2015 until 2017.

### 4.2.1 Ump Gambang

i. Minimum Monthly 2015

Table 4.1 Minimum Monthly 2015

| Month | Rainfall (mm) | Temperature ( ˚C ) |
|---|---|---|
| Mac | 0.4 | 21.8 |
| Apr | 0.2 | 22.9 |
| May | 0.2 | 23.1 |
| Jun | 0.2 | 23 |
| July | 0.2 | 22.1 |
| Aug | 0.2 | 22.7 |
| Sep | 0.2 | 22.7 |
| Oct | 0.2 | 22.1 |
| Nov | 0.4 | 23 |
| Dec | 0.6 | 21.7 |

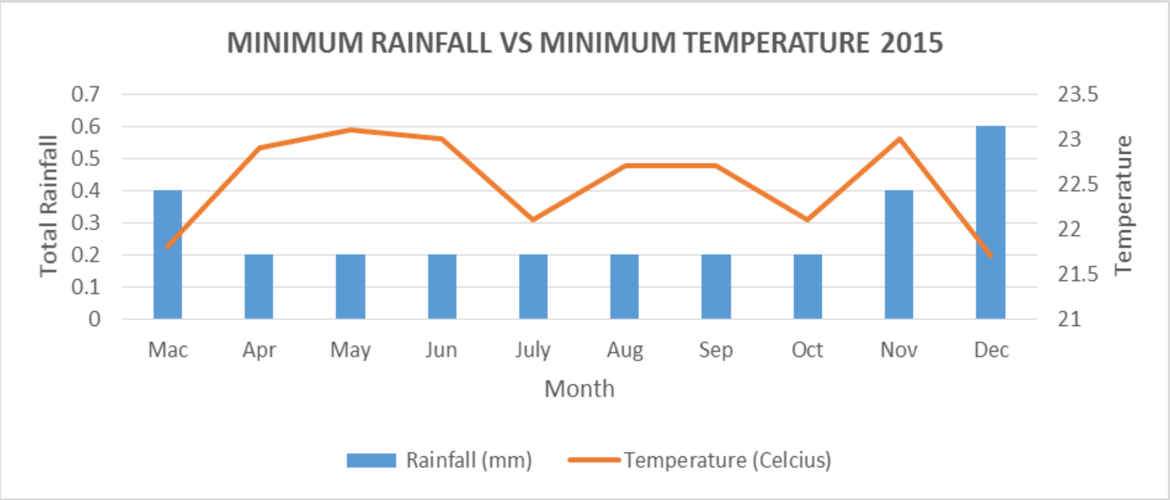


Figure 4.1 Graph of Minimum Rainfall vs. Minimum Temperature 2015

Based on Figure 4.1, data shows from March 2015 to December 2015. The lowest minimum rainfall is the month of April, May, June, July, August, September and October which are 0.2 mm. From the graph of minimum rainfall against minimum temperature, the minimum temperature of the month is higher when the minimum rainfall is 0.2 mm. The minimum rainfall for December 2015 is 0.6 as it is in monsoon season and the temperature recorded is 21.7 ˚C. All the result has been show in Table 4.1.

ii. Minimum Monthly Rainfall 2016

Table 4.2 Minimum Monthly Rainfall 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 0.2 | 23.6 |
| Feb | 0.2 | 22.1 |
| Mac | 0.2 | 22.4 |
| Apr | 0.4 | 23.5 |
| May | 0.2 | 24.1 |
| July | 0.2 | 23 |
| Aug | 0.4 | 23.3 |
| Sep | 0.2 | 22.3 |
| Oct | 0.2 | 22.5 |
| Nov | 0.8 | 22.2 |

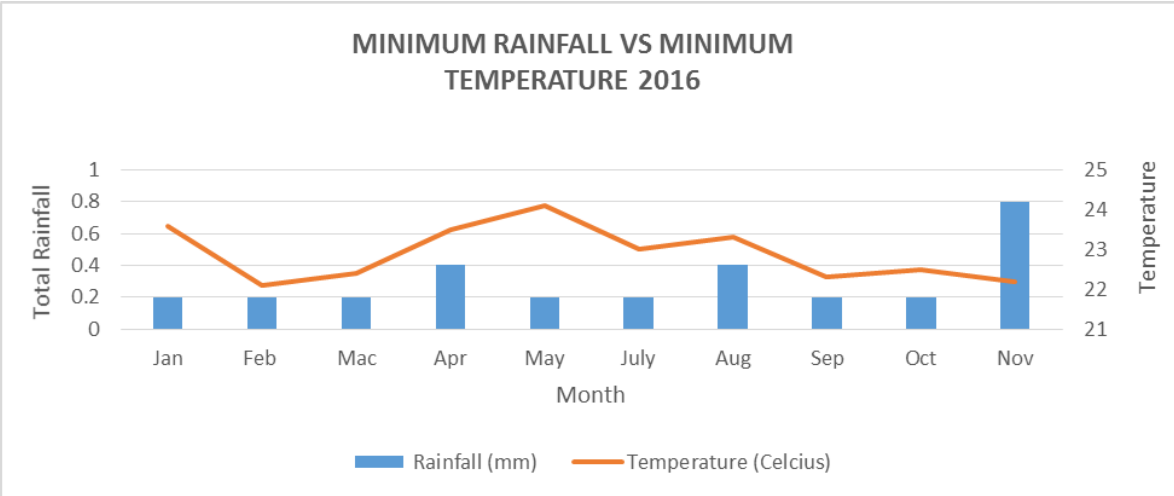


Figure 4.2 Graph of Minimum Rainfall vs. Minimum Temperature 2016

Based on Figure 4.2, data show from January 2016 to November 2016. The highest minimum rainfall is the month of December 2016 which is 0.8mm. The lowest temperature is also in the month of November which is 22.2 ˚C. May 2016 has the lowest minimum rainfall with high temperature compared to other months which is 24.1 ˚C. This shows that rainfall can affect the temperature reading. The detail information about this has been written in Table 4.2.

iii. Minimum Monthly Rainfall 2017

Table 4.3 Minimum Monthly Rainfall 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Feb | 0.2 | 22 |
| Mac | 0.2 | 22.7 |
| Apr | 0.2 | 23.2 |
| Aug | 0.2 | 23.8 |
| Sep | 0.2 | 23.1 |
| Oct | 0.2 | 22 |
| Nov | 0.2 | 22.8 |
| Dec | 0.2 | 22.7 |

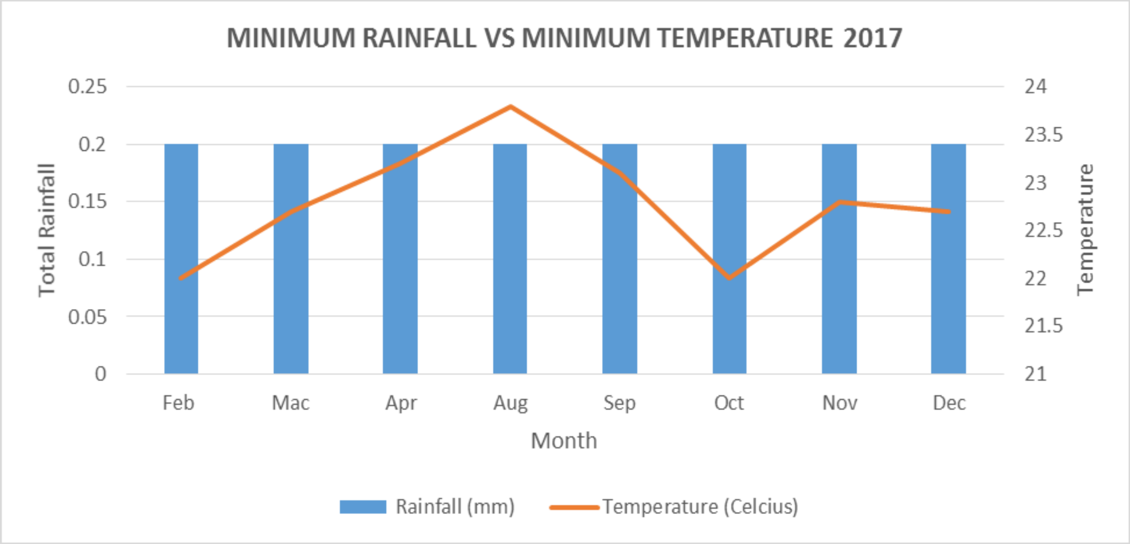


Figure 4.3 Graph of Minimum Rainfall vs. Minimum Temperature 2017

Based on the graph in figure 4.3, the minimum rainfall from January 2017 until December 2017 is remaining stable at 0.2mm. The minimum temperature is increased from February until August. The highest minimum temperature is in the month of August which is 23.8 ˚C. After it reaches a peak in August, the temperature gradually declines in October which is 22˚C and slightly goes up until 22.7 ˚C in December 2017. Overall, the temperature from October to January is generally lower as it is during the monsoon season. The detail information about this has been written in Table 4.3.

iv. Maximum Monthly 2015

Table 4.4 Maximum Monthly Rainfall 2015

| Month | Rainfall (mm) | Temperature ( ˚C ) |
|---|---|---|
| Mac | 22.4 | 34.8 |
| Apr | 23 | 36 |
| May | 33.4 | 34.6 |
| Jun | 11 | 34.7 |
| July | 22.2 | 34.9 |
| Aug | 42.6 | 35.7 |
| Sep | 45.2 | 34.2 |
| Nov | 21.2 | 33.6 |
| Dec | 54 | 34.1 |

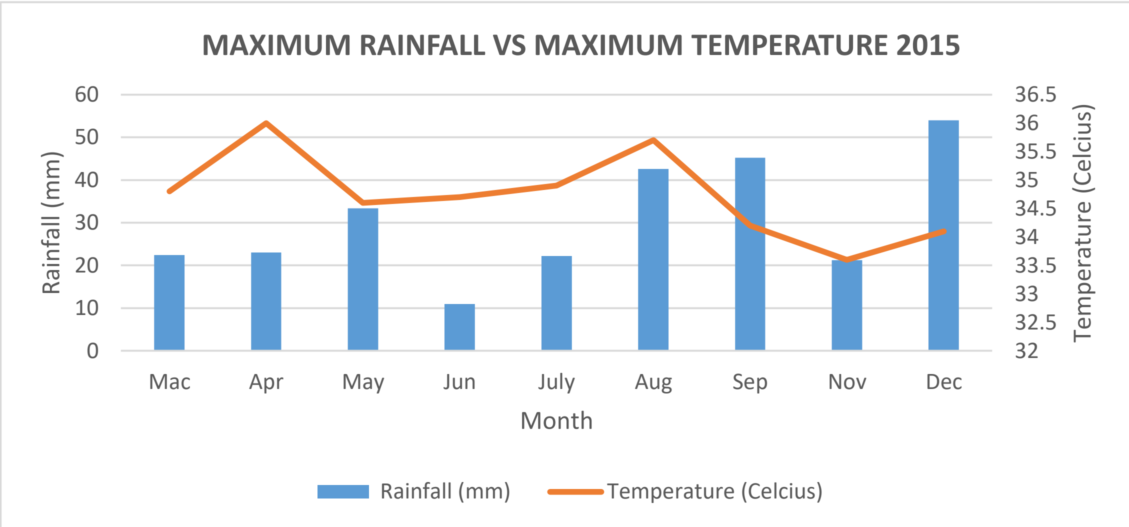


Figure 4.4 Graph of Maximum Rainfall vs. Maximum Temperature 2015

Based on the Figure 4.4, the trend of graph of maximum rainfall against maximum temperature data from Mac 2015 until December 2015 is fluctuating. The rainfall is slightly increased from Mac until May and slightly drops to 11mm in June. In July, the rainfall reading has gradually increased until December. It is a rise from 11mm to 54mm. When the rainfall increase, the temperature reading is also will decrease as the rainfall give impact to the temperature. It can be seen clearly that the highest maximum rainfall is in the month of December which is 54mm. Besides, the lowest maximum temperature is in December which is 34.1 ˚C. All the result has been show in Table 4.4.

v. Maximum Monthly 2016

Table 4.5 Maximum Monthly Rainfall 2016

| Month | Rainfall (mm) | Temperature ( ˚C) |
|---|---|---|
| Jan | 14.6 | 33.6 |
| Feb | 31.6 | 32.8 |
| Mac | 16.6 | 34.1 |
| Apr | 3.6 | 36.1 |
| May | 32.2 | 34.6 |
| July | 39.6 | 34.6 |
| Aug | 27.4 | 34.6 |
| Sep | 40.2 | 34.8 |
| Oct | 55.4 | 34.4 |
| Nov | 57.6 | 33.7 |

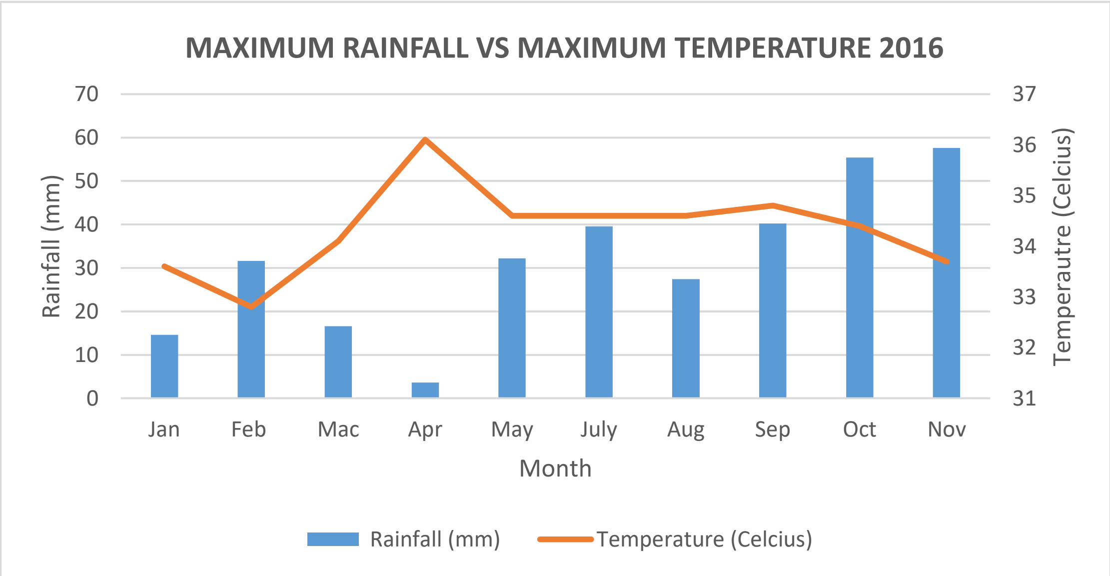


Figure 4.5 Graph of Maximum Rainfall vs. Minimum Temperature 2016

From Figure 4.5, it shows the reading of maximum rainfall against maximum temperature from January 2016 until November 2016. In the month of February, it starts to decline from 31.6mm to 3.6mm in April. After reaching the lowest point in April, it steeply increases up to 39.6mm in July. In August, there is a little decline which is about 2.2mm. After that, it gradually increases until November which is 57.6mm. Besides, the reading of temperature is changing with the rainfall reading. In the month of April, the maximum rainfall is the lowest yet the temperature reading is the highest which is 36.1 ˚C compared to the other months. The temperature is higher, as it has less rainfall that gradually decreases the humidity of the air. The detail information about this has been written in Table 4.5.

vi. Maximum Monthly 2017

Table 4.6 Maximum Monthly Rainfall 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 0 | 33.7 |
| Feb | 44.8 | 32.8 |
| Mac | 40.4 | 34.3 |
| Apr | 22.4 | 33.6 |
| Aug | 16.2 | 32.8 |
| Sep | 28 | 33.8 |
| Oct | 52 | 33.6 |
| Nov | 51.4 | 33.3 |
| Dec | 60.6 | 32.5 |

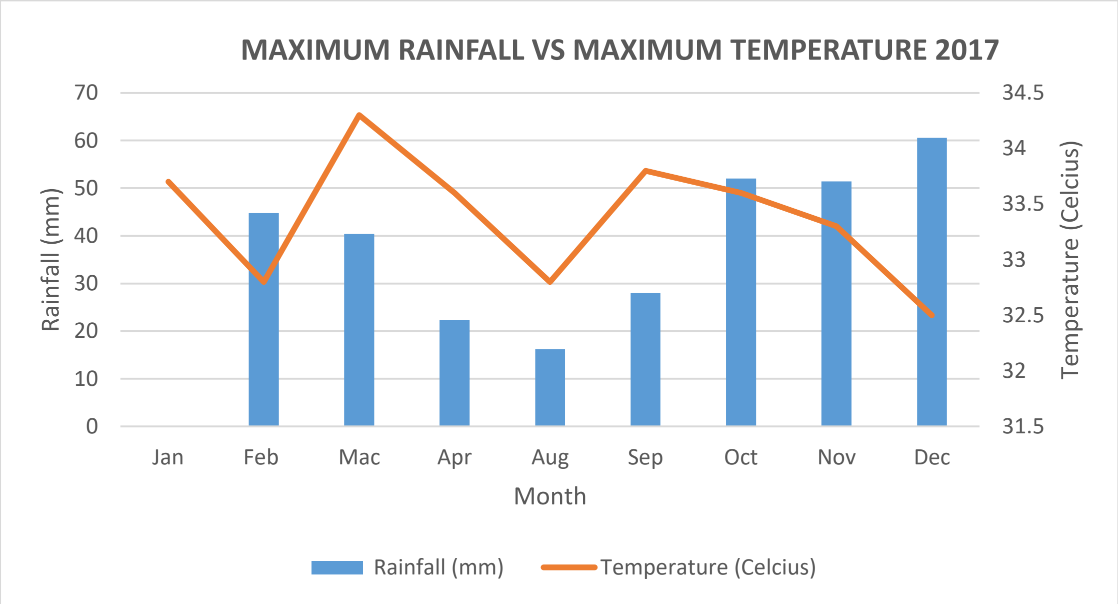


Figure 4.6 Graph of Maximum Rainfall vs. Minimum Temperature 2017

February 2017 shows the total rainfall value is higher, but the temperature reading is also higher. During the month of February, the reading of maximum rainfall starts to decline until August which is 16.2mm. From there, the total rainfall value starts to rise gradually until it reaches its peak in the month of December 2017 but the temperature reading decrease for that month. The highest maximum rainfall reading is in December which is 60.6mm and the temperature reading is 32.5˚C. The temperature is slightly drops with the increase of rainfall reading. The detail information about this has been written in Table 4.6.

vii. Average Monthly 2015

Table 4.7 Average Monthly 2015

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Mac | 1.1 | 28.5 |
| Apr | 1.9 | 28.6 |
| May | 3.8 | 28.9 |
| Jun | 1.1 | 29 |
| July | 1.9 | 28.8 |
| Aug | 5.4 | 28.6 |
| Sep | 4 | 28.3 |
| Nov | 5.2 | 27.7 |
| Dec | 8.4 | 27.7 |

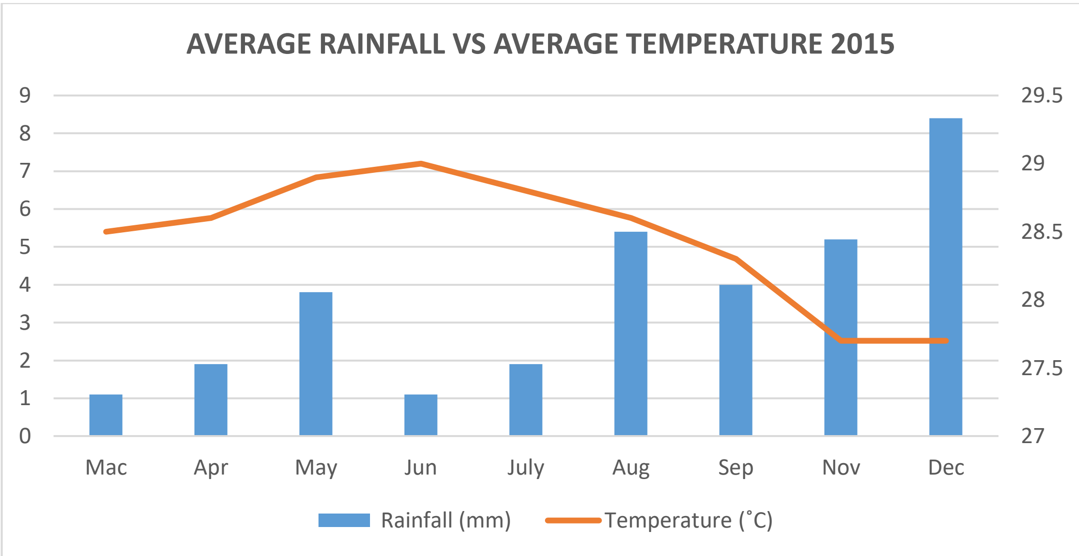


Figure 4.7 Average Monthly Rainfall vs. Average Temperature 2015

Based on Figure 4.7, data show from Mac 2015 to December 2015. The highest average rainfall is the month of December which is 8.4mm. The lowest temperature is also in the month of December which is 27.7 ˚C. June 2015 has the lowest minimum rainfall with high temperature compared to other months which is 29 ˚C. This shows that rainfall can affect the temperature reading. All the result has been show in Table 4.7.

viii. Average Monthly 2016

Table 4.9 Average Monthly 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 3.1 | 28.1 |
| Feb | 9.2 | 27.6 |
| Mac | 1.1 | 28.8 |
| Apr | 1.1 | 30 |
| May | 5.8 | 29.4 |
| July | 7.1 | 28.2 |
| Aug | 7.9 | 28.1 |
| Sep | 7.4 | 28.3 |
| Oct | 9.5 | 28.2 |
| Nov | 12 | 27.5 |

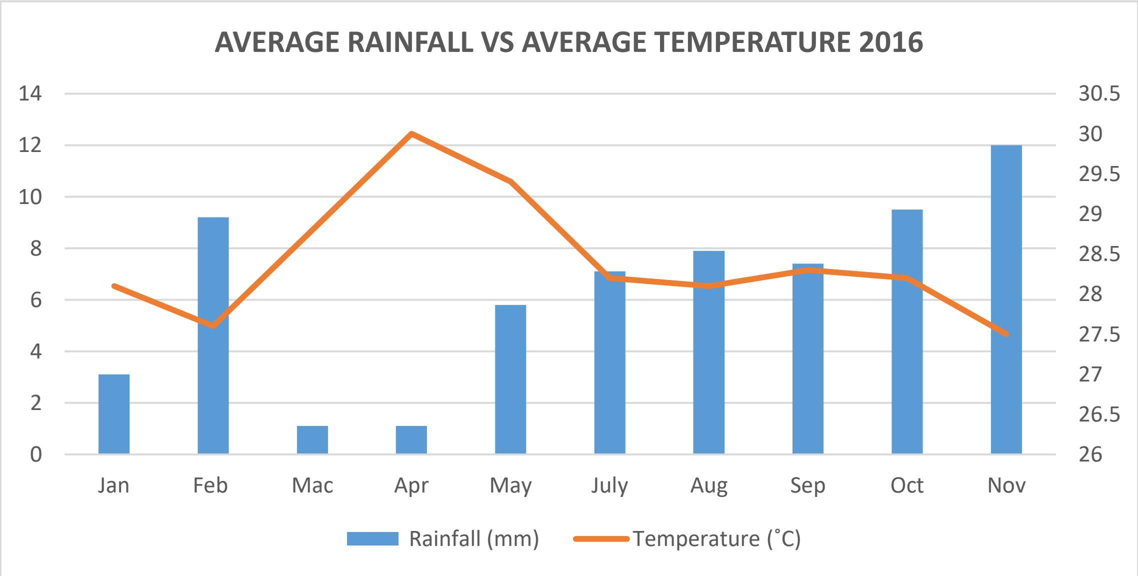


Figure 4.8 Average Monthly Rainfall vs. Average Temperature 2016

November 2016 shows that the average rainfall value is higher with the temperature reading are 27. 5˚C. During the month of January, the reading of average rainfall starts to decline until April which is 1.1mm. From there, the average rainfall value starts to rise gradually until it reaches its peak in the month of November 2016 but the temperature reading decrease for that month. All the result has been show in Figure 4.8 and Table 4.8.

ix. Average Monthly 2017

Table 4.9 Average Monthly 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 0 | 27.5 |
| Feb | 6.7 | 27.3 |
| Mac | 5.8 | 27.8 |
| Apr | 4.1 | 28.1 |
| Aug | 6.2 | 27.6 |
| Sep | 3.4 | 28.4 |
| Oct | 10.5 | 28 |
| Nov | 9.1 | 27.8 |
| Dec | 9.3 | 27 |

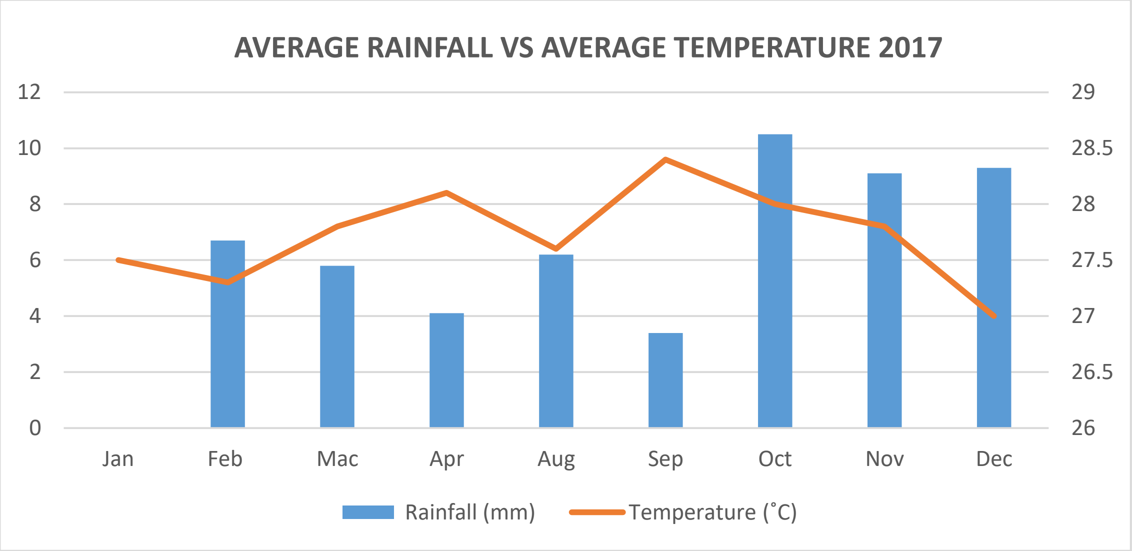


Figure 4.9 Average Monthly Rainfall vs. Average Temperature 2017

Based on Figure 4.9, the bar chart shows the data from January 2017 to December 2017. The highest average rainfall is in October which is 10.5mm with the temperature of 28˚C. The lowest temperature is in the month of December which is 27˚C with the average rainfall 9.3mm. All the result has been show in Figure 4.9 and Table 4.9.

x. Annual Rainfall 2015

Table 4.10 Annual Rainfall 2015

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Mac | 37.6 | 28.5 |
| Apr | 57.4 | 28.6 |
| May | 114 | 28.9 |
| Jun | 29 | 29 |
| July | 58.8 | 28.8 |
| Aug | 113.8 | 28.6 |
| Sep | 116 | 28.3 |
| Nov | 157.2 | 27.7 |
| Dec | 225.6 | 27.7 |

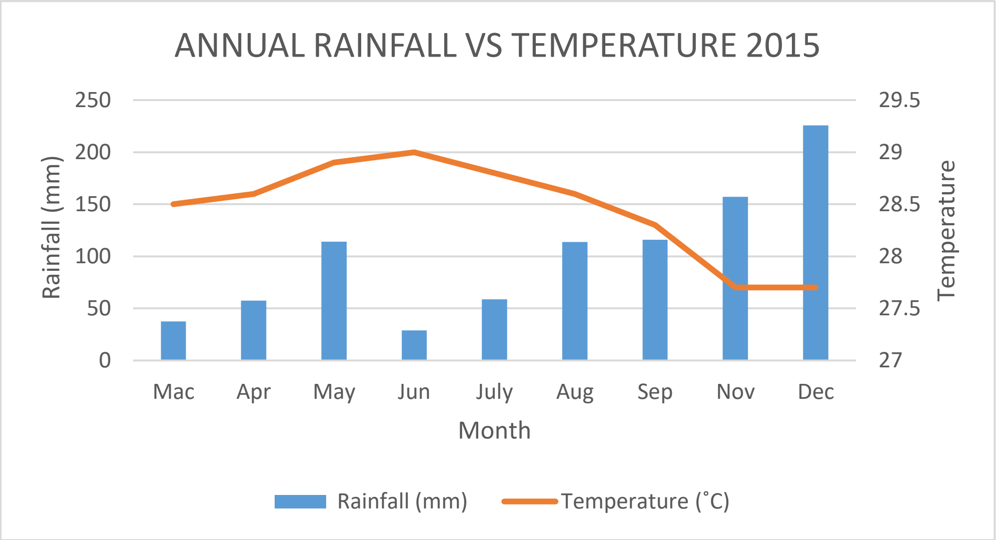


Figure 4.10 Annual Rainfall vs. Temperature 2015

Based on Figure 4.10, data show from Mac 2015 to December 2015. The highest annual rainfall is the month of December which is 225.6mm. The lowest temperature is also in the month of December which is 27.7˚C. June 2015 has the lowest minimum rainfall with high temperature compared to other months which is 29˚C. This shows that rainfall can affect the temperature reading. All the result has been show in Table 4.10.

xi. Annual Rainfall 2016

Table 4.11 Annual Rainfall 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 52 | 28.1 |
| Feb | 137.4 | 27.6 |
| Mac | 33 | 28.8 |
| Apr | 32.2 | 30 |
| May | 34.6 | 29.4 |
| July | 135.6 | 28.2 |
| Aug | 71 | 28.1 |
| Sep | 222.4 | 28.3 |
| Oct | 296 | 28.2 |
| Nov | 358.4 | 27.5 |

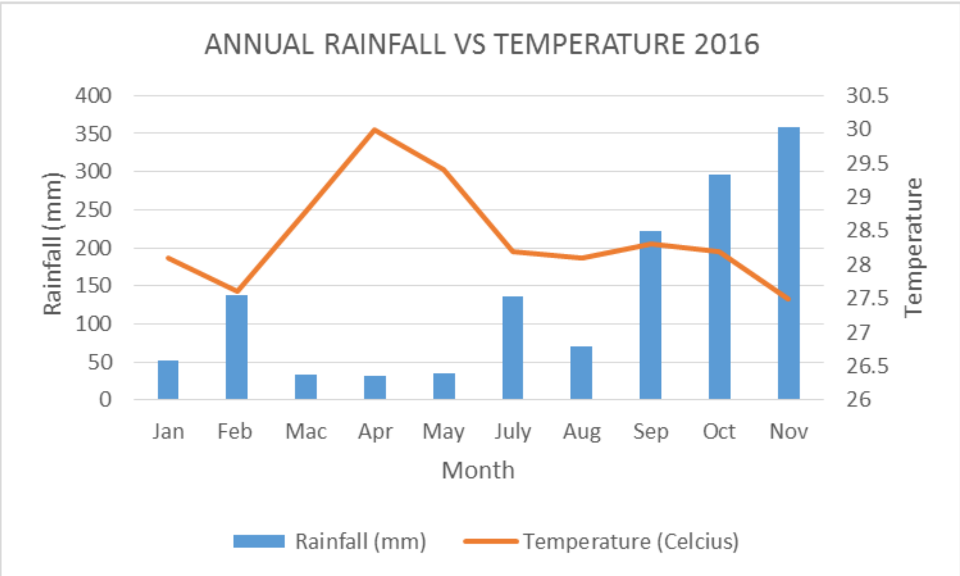


Figure 4.11 Annual Rainfall vs. Temperature 2016

Based on the graph in Figure 4.11, the annual rainfall in December shows the highest which is 358.4mm with the lowest temperature, 27.5˚C. The minimum temperature is increased from July until April. The highest minimum temperature is in the month of April which is 30˚C. Overall, the temperature from September to November is generally lower as it is during the monsoon season. All the result has been show in Table 4.11.

xii. Annual Rainfall 2017

Table 4.12 Annual Rainfall 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 0 | 27.5 |
| Feb | 154.6 | 27.3 |
| Mac | 168.2 | 27.8 |
| Apr | 56.4 | 28.1 |
| Aug | 67.6 | 27.6 |
| Sep | 67.6 | 28.4 |
| Oct | 305.2 | 28 |
| Nov | 246.4 | 27.8 |
| Dec | 203.8 | 27 |

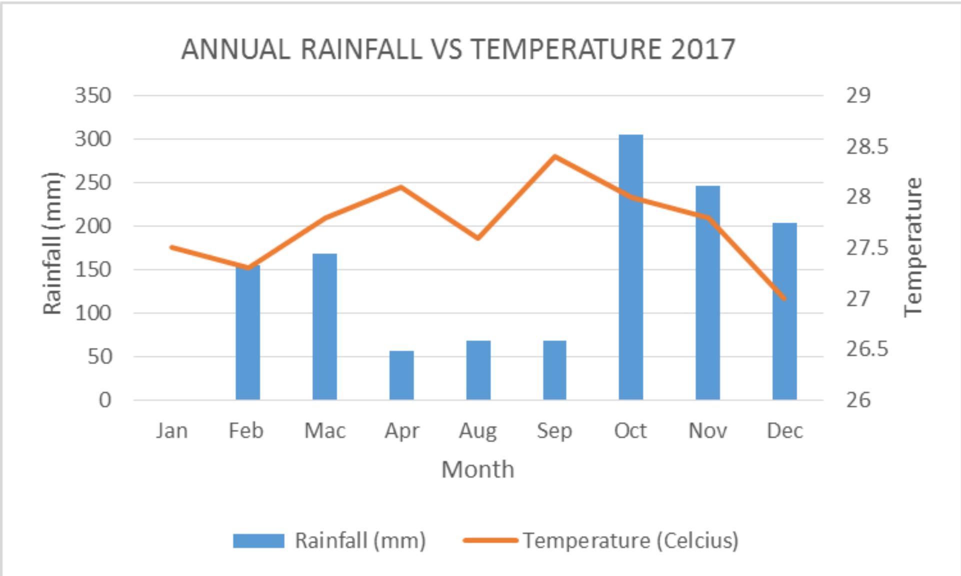


Figure 4.12 Annual Rainfall vs. Temperature 2017

October 2017 shows that the total rainfall value is the highest which is 305.2mm with the temperature reading is 28˚C. From there, the total rainfall value starts to decrease until February. During the month of Mac, the reading of annual rainfall starts to decline until September which is 67.6mm. The temperature is slightly drops with the increase of rainfall reading. All the result has been show in Figure 4.12 and Table 4.12.

### 4.2.2 Ump Pekan

i. Minimum Monthly 2016

Table 4.13 Minimum Monthly 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 0.3 | 23.2 |
| Feb | 0.1 | 22.3 |
| Mac | 0.1 | 25.7 |
| Apr | 0.3 | 23.2 |
| May | 0.1 | 23.3 |
| June | 0.1 | 22.8 |
| July | 0.1 | 23 |
| Aug | 0.1 | 22.5 |
| Sep | 0.1 | 21.1 |
| Oct | 0.1 | 22.2 |
| Nov | 0.1 | 22 |
| Dec | 0.1 | 22 |

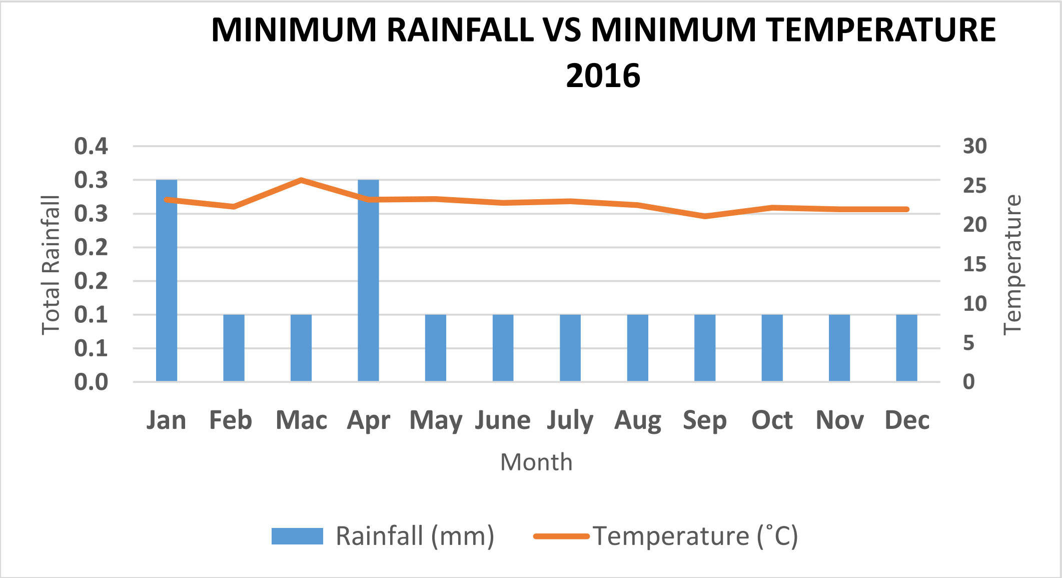


Figure 4.13 Graph of Minimum Rainfall vs. Minimum Temperature 2016

Based on Figure 4.13, data show from January 2016 to December 2016. The highest minimum rainfall is in the months of January and April 2016 which is 0.3mm. The lowest temperature is 21˚C. In months of February, Mac, May, June, July, August, September, October, November and December 2016 has the lowest minimum rainfall which is 0.1mm. All the result has been show in Table 4.13.

ii. Minimum Monthly 2017

Table 4.14 Minimum Monthly 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 0.1 | 22 |
| Feb | 0.1 | 22.5 |
| Mac | 0.1 | 22.5 |
| Apr | 0.1 | 22.7 |
| May | 0.1 | 23.4 |
| June | 0.1 | 22.2 |
| Aug | 0.1 | 22 |
| Sep | 0.1 | 22.1 |
| Oct | 0.3 | 22.9 |
| Nov | 0.3 | 22.9 |
| Dec | 0.6 | 22.7 |

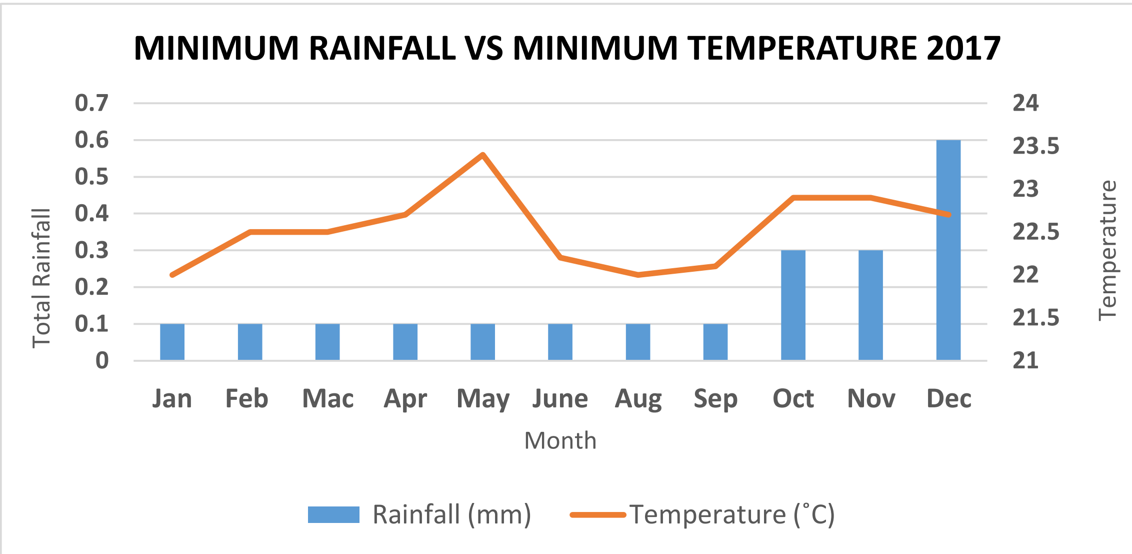


Figure 4.14 Graph of Minimum Rainfall vs. Minimum Temperature 2017

Based on the graph in Figure 4.14, the minimum rainfall from January 2017 until September 2017 is remaining stable at 0.1mm. The highest minimum rainfall is in the month of December which is 0.6mm. The minimum temperature is increased from February until May. The highest minimum rainfall is in the month of May which is 23.3˚C. After it reach a peak in May, the temperature gradually declines until August which is 22.2˚C and slightly goes up until 23.2˚C in October 2017. All the result has been show in Table 4.14.

iii. Minimum Monthly 2018

Table 4.15 Minimum Monthly 2018

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Feb | 0.2 | 19.3 |
| Mac | 0.1 | 23 |
| Apr | 0.1 | 23 |

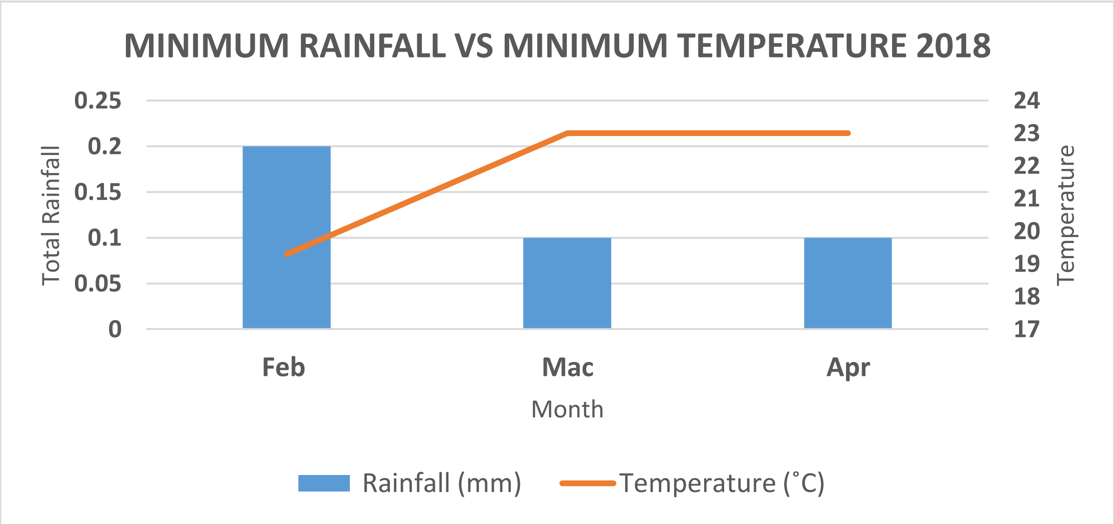


Figure 4.15 Graph of Minimum Rainfall vs Minimum Temperature 2018

Based on Figure 4.15, data show from February 2018 until April 2018. For the year 2018, rainfall data for January and May are excluded as it has missing data due to lack of battery of rain gauge. The highest minimum rainfall is the month of January 2018 which is 0.2mm. The lowest temperature is also in the month of January which is19.3˚C. Mac and April have the lowest minimum rainfall with high temperature compared to other months which is 23˚C. All the result has been show in Table 4.15.

iv. Maximum Monthly 2016

Table 4.16 Maximum Monthly 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 14.7 | 29.5 |
| Feb | 4.9 | 28.8 |
| Mac | 6.0 | 28.6 |
| Apr | 5.5 | 30.8 |
| May | 12.9 | 29 |
| June | 7.7 | 28.9 |
| July | 5.4 | 29.8 |
| Aug | 8.6 | 29 |
| Sep | 4.5 | 28.5 |
| Oct | 12.4 | 27.5 |
| Nov | 12.2 | 27.7 |
| Dec | 10.5 | 27.4 |

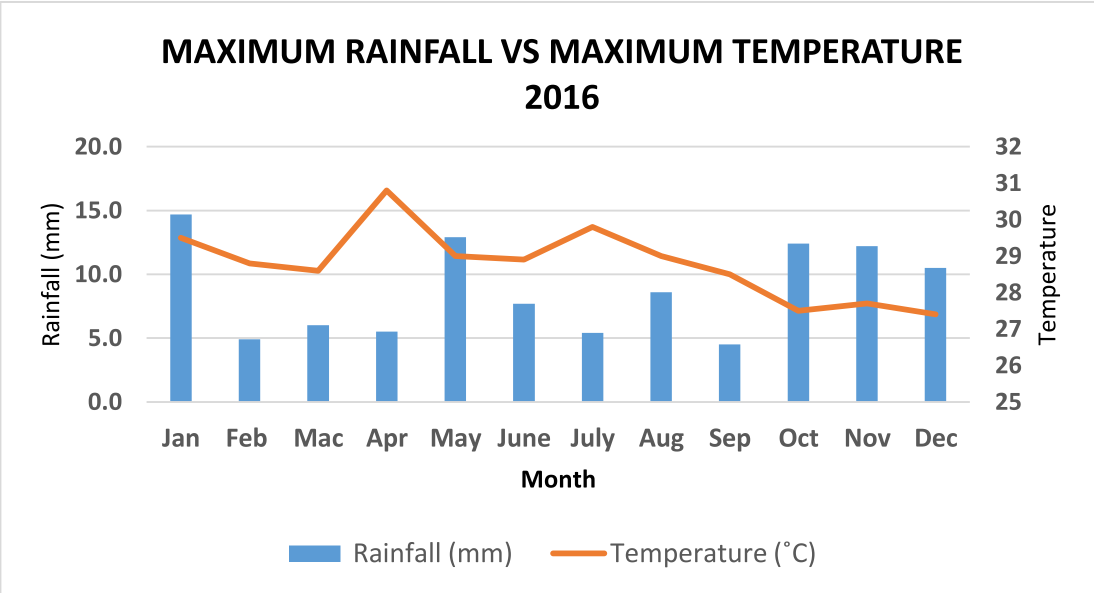


Figure 4.16 Graph of Maximum Rainfall vs. Minimum Temperature 2016

From Figure 4.16, it shows the reading of maximum rainfall against maximum temperature from January 2016 until December 2016. In the month of January, the maximum rainfall is the highest which is 14.7mm compared to the other months. The lowest maximum rainfall 4.9mm which is in September. All the result has been show in Table 4.16.

v. Maximum Monthly 2017

Table 4.17 Maximum Monthly 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 29.5 | 27.4 |
| Feb | 8.8 | 28 |
| Mac | 23.8 | 29.1 |
| Apr | 4.7 | 29.2 |
| May | 10.4 | 29.2 |
| June | 9 | 29.2 |
| Aug | 9.1 | 28.4 |
| Sep | 9.5 | 28.4 |
| Oct | 9.9 | 28.5 |
| Nov | 13.1 | 27.7 |
| Dec | 16.8 | 27.6 |

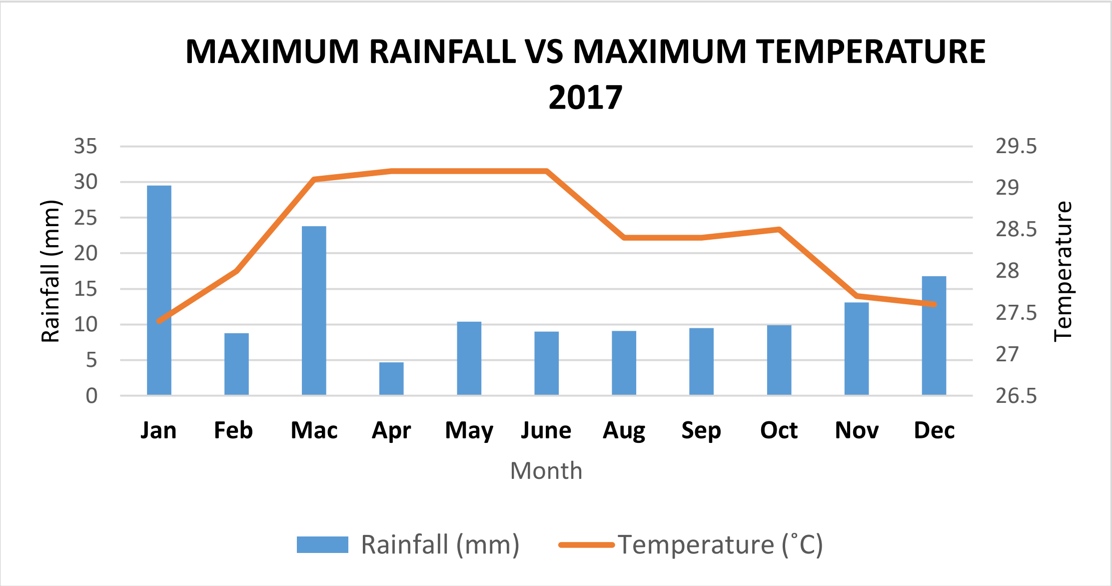


Figure 4.17 Graph of Maximum Rainfall vs. Minimum Temperature 2017

January 2017 shows that the total rainfall value is the highest which is 29.5mm with the lowest temperature 27.4˚C. In Mac, the reading of maximum rainfall starts to decline until August which is 0.9mm. From there, the total rainfall value starts to rise gradually until it reaches its peak in the month of January 2017. The lowest maximum rainfall reading is in April which is 4.7mm and the temperature reading is 29.2˚C. The temperature is slightly drops with the increase of rainfall reading. All the result has been show in Figure 4.17 and Table 4.17.

vi. Maximum Monthly 2018

Table 4.18 Maximum Monthly 2018

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Feb | 4.4 | 28.3 |
| Mac | 11.4 | 29.4 |
| Apr | 0.4 | 29.2 |

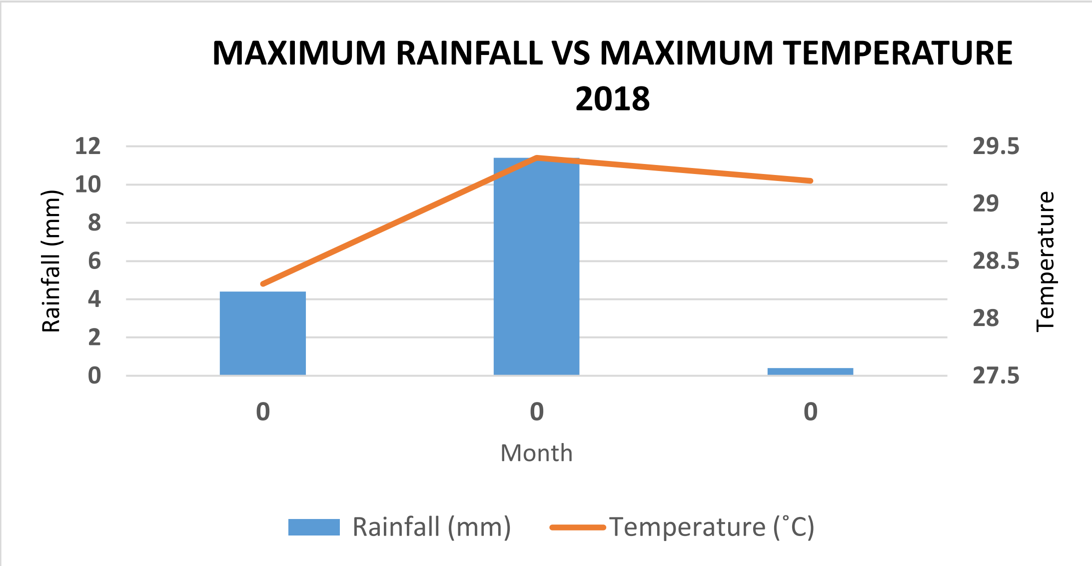


Figure 4.18 Graph of Maximum Rainfall vs. Maximum Temperature 2018

Based on Figure 4.18, data show from February 2018 until April 2018. The highest maximum rainfall is the month of February 2018 which is 11.4mm with the highest temperature of 29.4˚C. Mac has the lowest maximum rainfall which is 0.4mm. All the result has been show in Table 4.18. For the year 2018, rainfall data for January and May are excluded as it has missing data due to lack of battery of rain gauge.

vii. Average monthly 2016

Table 4.19 Average Monthly 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 14.7 | 29.5 |
| Feb | 4.9 | 28.8 |
| Mac | 6.0 | 28.6 |
| Apr | 5.5 | 30.8 |
| May | 12.9 | 29 |
| June | 7.7 | 28.9 |
| July | 5.4 | 29.8 |
| Aug | 8.6 | 29 |
| Sep | 4.5 | 28.5 |
| Oct | 12.4 | 27.5 |
| Nov | 12.2 | 27.7 |
| Dec | 10.5 | 27.4 |

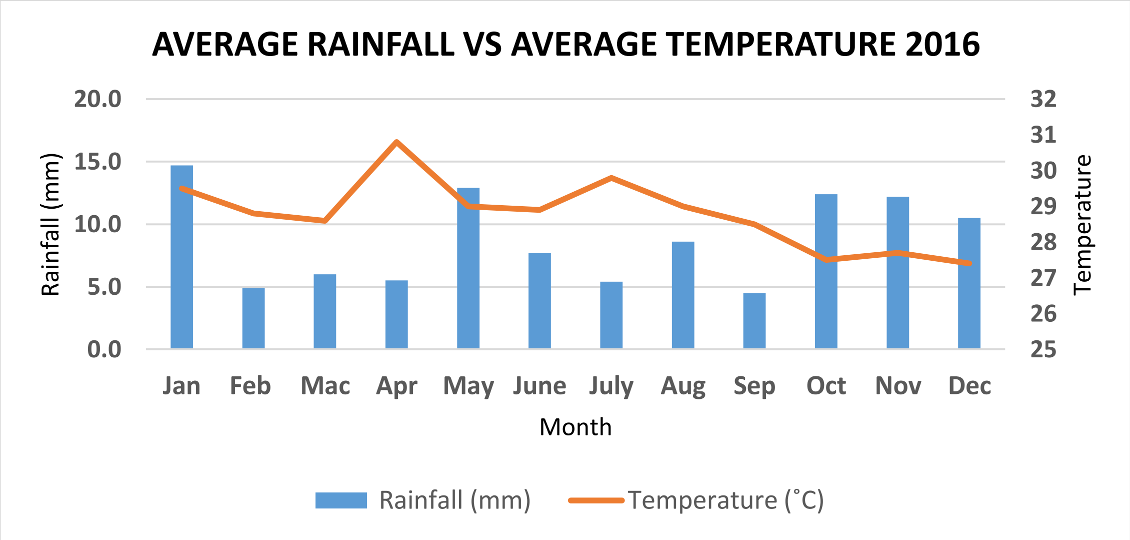


Figure 4.19 Graph of Average Rainfall vs Average Temperature 2016

January 2016 shows that the average rainfall value is higher with the temperature reading are 29. 5˚C. During the month of January, the reading of average rainfall starts to decline until April which is 5.5mm. The lowest average rainfall is in September which is 4.5mm with temperature reading 28.5˚C. All the result has been show in Table 4.19 and Figure 4.19.

viii. Average monthly 2017

Table 4.20 Average Monthly 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 29.5 | 27.4 |
| Feb | 8.8 | 28 |
| Mac | 23.8 | 29.1 |
| Apr | 4.7 | 29.2 |
| May | 10.4 | 29.2 |
| June | 9 | 29.2 |
| Aug | 9.1 | 28.4 |
| Sep | 9.5 | 28.4 |
| Oct | 9.9 | 28.5 |
| Nov | 13.1 | 27.7 |
| Dec | 16.8 | 27.6 |

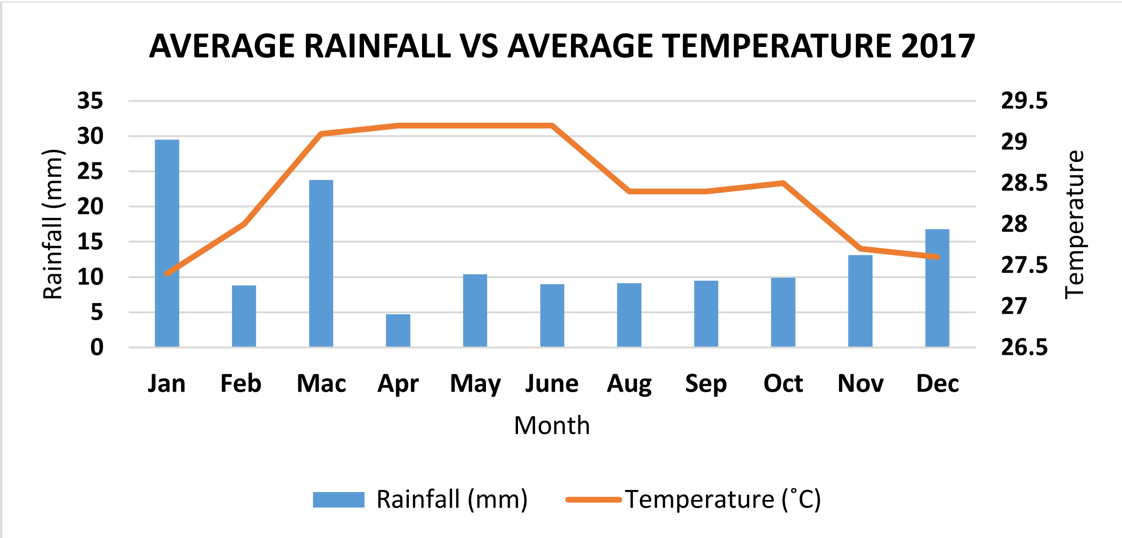


Figure 4.20 Graph of Average Rainfall vs. Average Temperature 2017

Based on the Figure 4.20, the graph shows the average rainfall against average temperature from January 2017 until December 2017. The highest average rainfall is in January which is 29.5mm. The lowest average rainfall is in April which is 4.7mm with the temperature of 29.2˚C. When the rainfall increase, the temperature reading is also will decrease as the rainfall give impact to the temperature. All the result has been show in Table 4.20.

ix. Average monthly 2018

Table 4.21 Average Monthly 2018

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Feb | 4.4 | 28.3 |
| Mac | 11.4 | 29.4 |
| Apr | 0.4 | 29.2 |

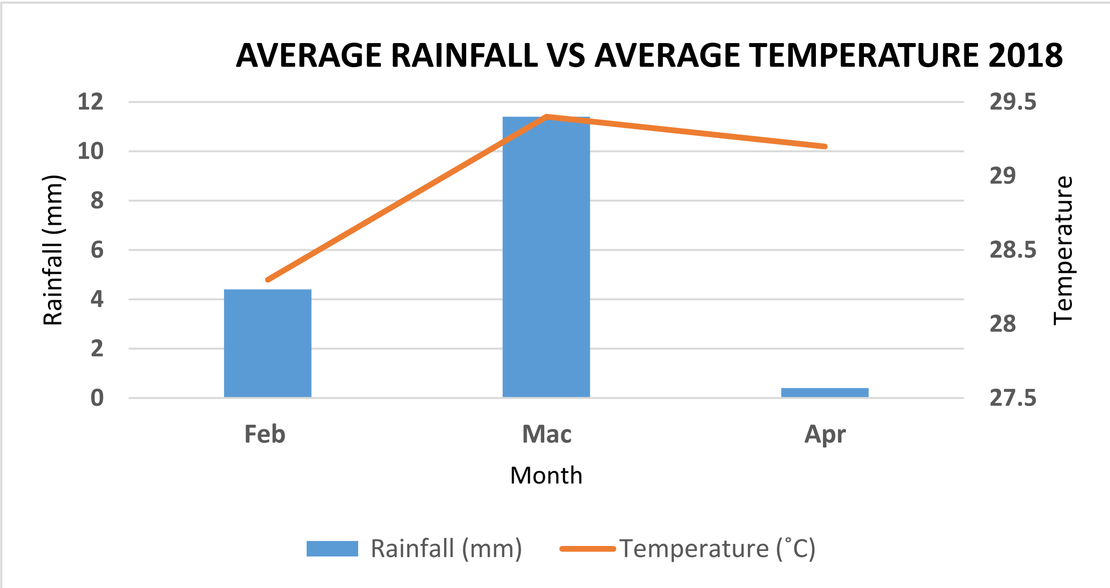


Figure 4.21 Graph of Average Rainfall vs. Average Temperature 2018

From Figure 4.21, the highest average rainfall in 2018 is in Mac which is 11.4mm with temperature 29.4˚C. The lowest average rainfall is in April which is 0.4mm and the average temperature is 29.2˚C. The average temperature in February is 28.43˚C with the average rainfall of 4.4mm. All the result has been show in Table 4.21.

x. Monthly Rainfall 2016

Table 4.22 Average Monthly 2016

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 93.9 | 29.5 |
| Feb | 75.7 | 28.8 |
| Mac | 41.7 | 28.6 |
| Apr | 27.6 | 30.8 |
| May | 204.3 | 29 |
| June | 57.7 | 28.9 |
| July | 82.5 | 29.8 |
| Aug | 118.6 | 29 |
| Sep | 91.5 | 28.5 |
| Oct | 303.7 | 27.5 |
| Nov | 225.1 | 27.7 |
| Dec | 240.2 | 27.4 |

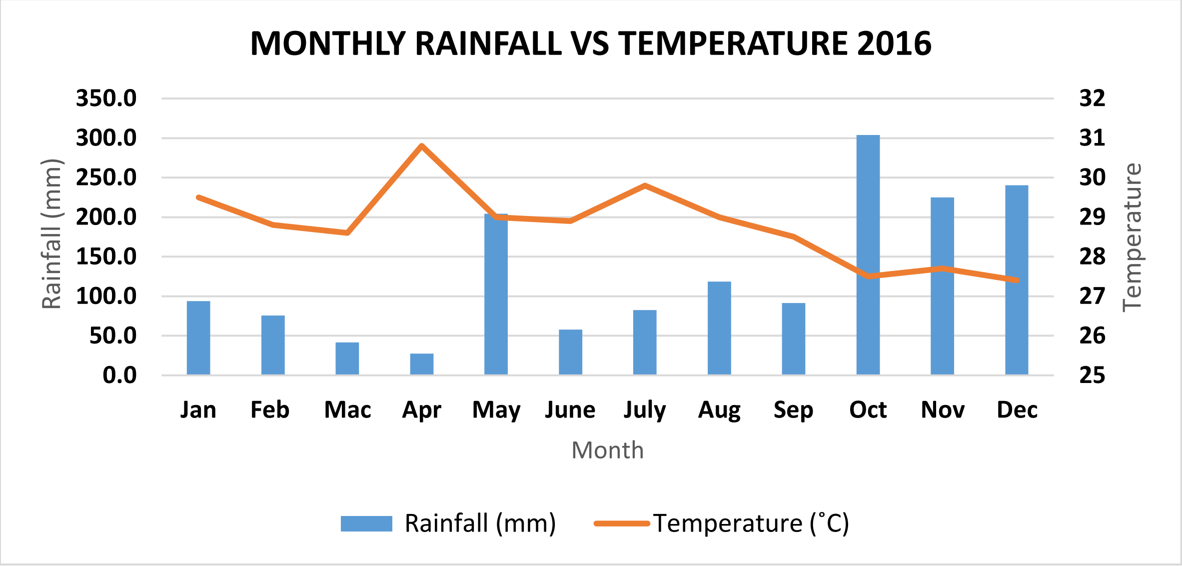


Figure 4.22 Graph of Monthly Rainfall vs. Temperature 2016

Based on the graph in Figure 4.22, the total monthly rainfall in October shows the highest which is 303.7mm with the lowest temperature, 27.5˚C. The highest minimum temperature is in the month of April which is 30.8˚C. Overall, the temperature from September to December is generally lower as it is during the monsoon season. All the result has been show in Table 4.22.

xi. Monthly Rainfall 2017

Table 4.23 Total Monthly 2017

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Jan | 539.3 | 27.4 |
| Feb | 115.4 | 28 |
| Mac | 160.1 | 29.1 |
| Apr | 68 | 29.2 |
| May | 173 | 29.2 |
| June | 104.5 | 29.2 |
| Aug | 62.8 | 28.4 |
| Sep | 133.8 | 28.4 |
| Oct | 189.1 | 28.5 |
| Nov | 322.1 | 27.7 |
| Dec | 117.1 | 27.6 |

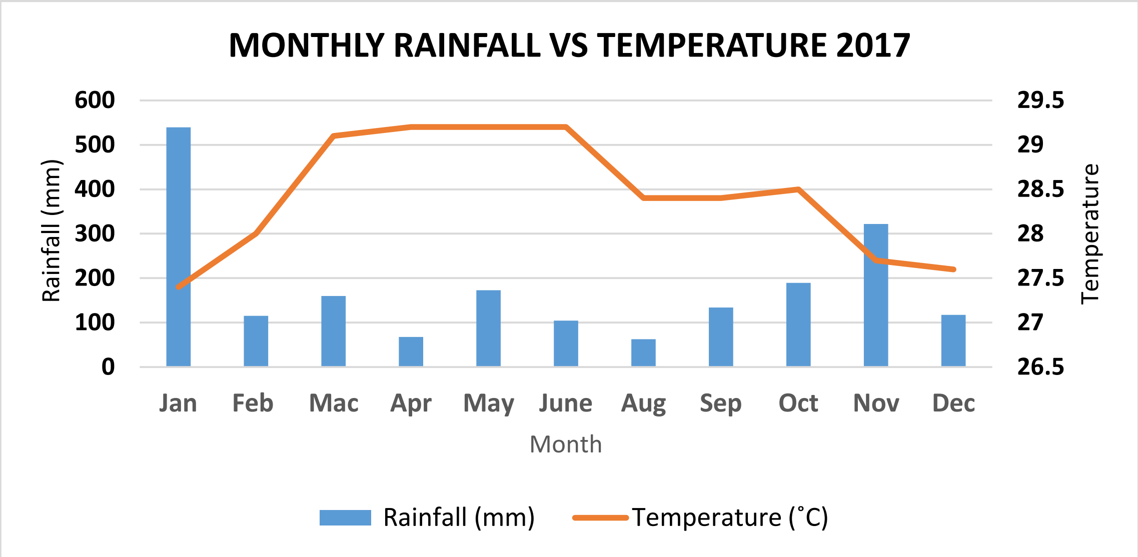


Figure 4.23 Graph of Monthly Rainfall vs. Temperature 2017

January 2017 shows that the total rainfall value is the highest which is 539.3mm with the lowest temperature reading is 27.4˚C. The lowest total monthly rainfall is in August which is 62.8mm. All the result has been show in Table 4.23 and Figure 4.23.

xii. Monthly Rainfall 2018

Table 4.24 Total Monthly 2018

| Month | Rainfall (mm) | Temperature (˚C) |
|---|---|---|
| Feb | 21.9 | 28.3 |
| Mac | 64.3 | 29.4 |
| Apr | 0.8 | 29.2 |

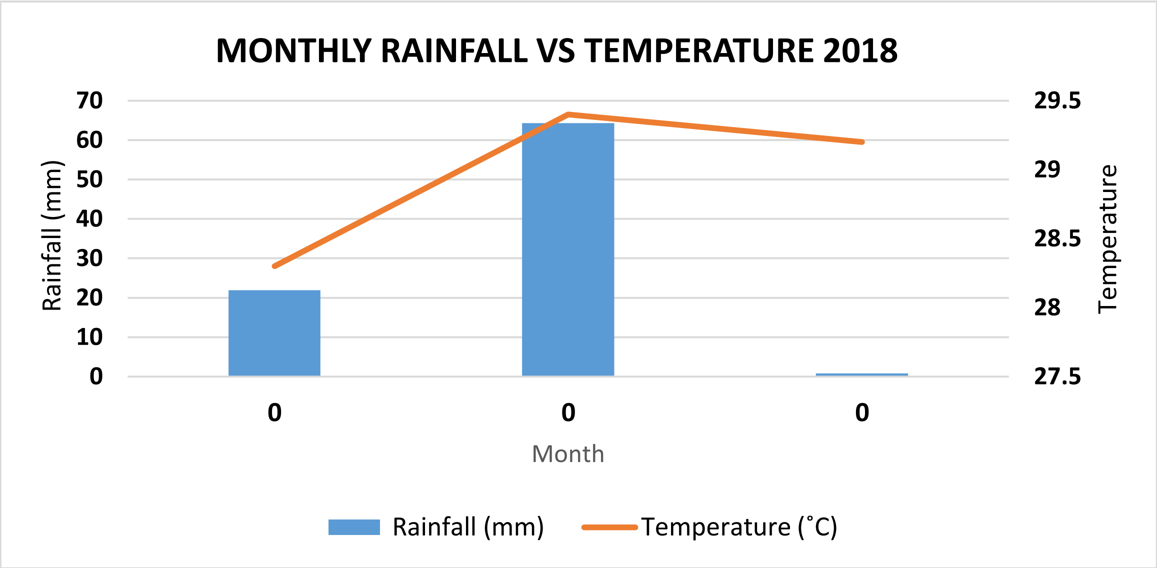


Figure 4.24 Graph of Monthly Rainfall vs. Temperature 2018

From Figure 4.24, the total monthly rainfall in 2018 is plotted against the temperature. From the bar chart, the highest monthly rainfall is in Mac which is 64.3mm with the temperature of 29.4˚C. The lowest monthly rainfall is in April which is 0.8mm with 29.2˚C. All the information details has been show in Table 4.24.

### 4.2.3 Double Mass Curve

In order to check the consistency of the data, double mass curve method is carried out using the data obtain from the weather station at Kolej Kediaman 2, UMP Gambang campus.

i. Double-Mass Curve 2015

Table 4.25 Data for Double Mass 2015

| YEAR | Annual Catch | | | | | TOTAL MONTHLY 2016 & 2017 | CUMULATIVE MONTHLY CATCH | | Equations | REAL MONTHLY DATA |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | | 2016 & 2017 | 2015 | | |
| JANUARY | 0 | 0 | 52 | 0 | | 52 | 52 | 0 | 18.27 | 18.27 |
| FEBRUARY | 0 | 0 | 137.4 | 154.6 | | 292 | 344 | 0 | 120.85 | 102.58 |
| MARCH | 11.2 | 37.6 | 33 | 168.2 | | 201.2 | 545.2 | 37.6 | 191.53 | 70.68 |
| APRIL | 0 | 57.4 | 32.2 | 56.4 | | 88.6 | 633.8 | 95 | 222.65 | 31.13 |
| MAY | 0 | 114 | 34.6 | 0 | | 34.6 | 668.4 | 209 | 234.81 | 12.15 |
| JUNE | 0 | 29 | 0 | 0 | | 0 | 668.4 | 238 | 234.81 | 0.00 |
| JULY | 0 | 58.8 | 135.6 | 0 | | 135.6 | 804 | 296.8 | 282.45 | 47.64 |
| AUGUST | 0 | 113.8 | 71 | 67.6 | | 138.6 | 942.6 | 410.6 | 331.14 | 48.69 |
| SEPTEMBER | 0 | 116 | 222.4 | 67.6 | | 290 | 1232.6 | 526.6 | 433.01 | 101.88 |
| OCTOBER | 0 | 102.4 | 296 | 305.2 | | 601.2 | 1833.8 | 629 | 644.21 | 211.20 |
| NOVEMBER | 0 | 157.2 | 358.4 | 246.4 | | 604.8 | 2438.6 | 786.2 | 856.68 | 212.47 |
| DECEMBER | 0 | 225.6 | 0 | 203.8 | | 203.8 | 2642.4 | 1011.8 | 928.28 | 71.59 |

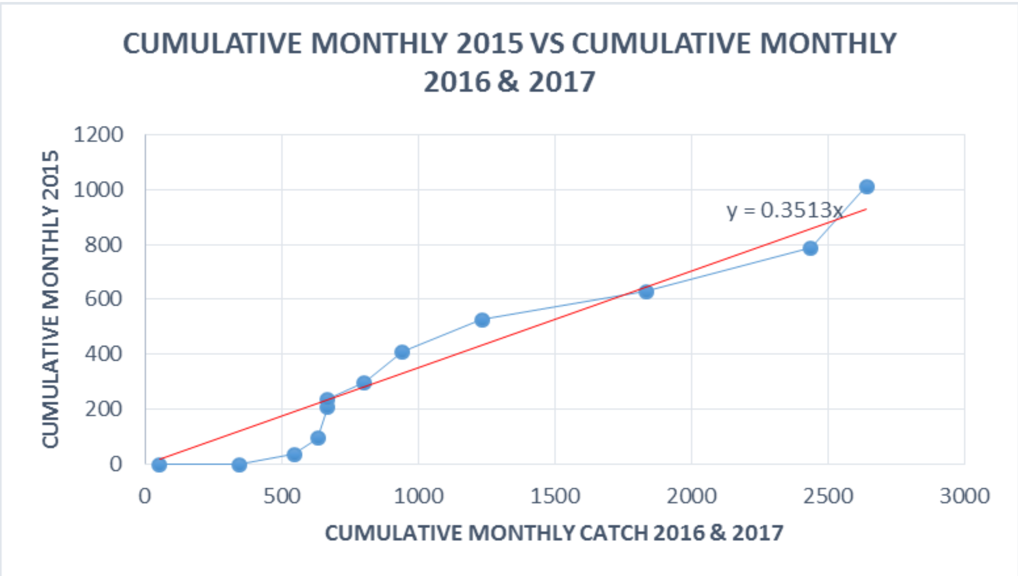


Figure 4.25 Double Mass Curve 2015

In Figure 4.25, the checking for the consistency of rainfall data in 2015 is explained by the double mass curve above. After the annual rainfall for 2015, 2016 and 2017 are tabulated and cumulated as in Table 4.8, the cumulative for each month is then plotted against the cumulative monthly catch in 2016 and 2017. In the months of 2015, the double mass curve shows significant breaks in slope. The breaks in slope mean that the data is not constant at any accumulation. In other word, the data obtained from the rain gauge is not consistent. The reason of the inconsistency of the data is because the rain gauge has been moved to a different location around UMP Gambang. Besides, the records from the rain gage at the new location might indicate an increase or decrease in average rainfall even though no real change had taken place. The Table 4.25 shows the data for double mass for year 2015.

ii. Double-Mass Curve 2016

Table 4.26 Data for Double Mass 2016

| YEAR | Annual Catch | | | | | TOTAL MONTHLY 2015 & 2017 | CUMULATIVE MONTHLY CATCH | | Equations | REAL MONTHLY DATA |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | | 2015 & 2017 | 2016 | | |
| JANUARY | 0 | 0 | 52 | 0 | | 0 | 0 | 52 | 0.00 | 0.00 |
| FEBRUARY | 0 | 0 | 137.4 | 154.6 | | 154.6 | 154.6 | 189.4 | 100.57 | 100.57 |
| MARCH | 11.2 | 37.6 | 33 | 168.2 | | 205.8 | 360.4 | 222.4 | 234.44 | 133.87 |
| APRIL | 0 | 57.4 | 32.2 | 56.4 | | 113.8 | 474.2 | 254.6 | 308.47 | 74.03 |
| MAY | 0 | 114 | 34.6 | 0 | | 114 | 588.2 | 289.2 | 382.62 | 74.16 |
| JUNE | 0 | 29 | 0 | 0 | | 29 | 617.2 | 289.2 | 401.49 | 18.86 |
| JULY | 0 | 58.8 | 135.6 | 0 | | 58.8 | 676 | 424.8 | 439.74 | 38.25 |
| AUGUST | 0 | 113.8 | 71 | 67.6 | | 181.4 | 857.4 | 495.8 | 557.74 | 118.00 |
| SEPTEMBE | 0 | 116 | 222.4 | 67.6 | | 183.6 | 1041 | 718.2 | 677.17 | 119.43 |
| OCTOBER | 0 | 102.4 | 296 | 305.2 | | 407.6 | 1448.6 | 1014.2 | 942.31 | 265.14 |
| NOVEMBE | 0 | 157.2 | 358.4 | 246.4 | | 403.6 | 1852.2 | 1372.6 | 1204.86 | 262.54 |
| DECEMBEI | 0 | 225.6 | 0 | 203.8 | | 429.4 | 2281.6 | 1372.6 | 1484.18 | 279.32 |

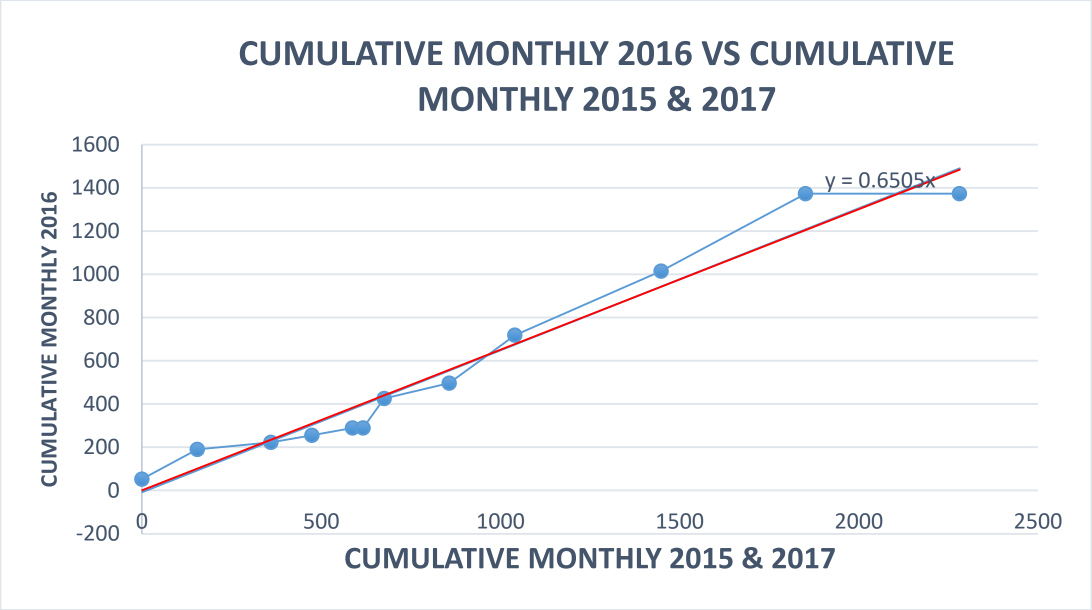


Figure 4.26 Double Mass Curve 2016

In Figure 4.26, the cumulative monthly in 2016 is plotted against the total cumulative monthly for 2015 and 2017. The double mass curve in Figure 4.26 indicates that there is a slight break in the slope. The breaks in slope show the data obtained is inconsistent due to the changes in slope. These changes may be due to changes in the method of data collection or to physical changes that affect the relation. It should be assumed that all inconsistencies shown by a double mass curve represent inconsistencies due to change in methods of collecting the data. It is because, there are a few students who collect the data from rain gauge for each year and the changes may affect the data. The Table 4.26 shows the data for double mass for year 2016.

iii. Double-Mass Curve 2017

Table 4.27 Data for Double Mass 2017

| YEAR | Annual Catch | | | | | TOTAL MONTHLY 2015 & 2016 | CUMULATIVE MONTHLY CATCH | | Equations | REAL MONTHLY DATA |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | | 2015 & 2016 | 2017 | | |
| JANUARY | 0 | 0 | 52 | 0 | | 52 | 52 | 0 | 26.88 | 26.88 |
| FEBRUARY | 0 | 0 | 137.4 | 154.6 | | 137.4 | 189.4 | 154.6 | 97.92 | 71.04 |
| MARCH | 11.2 | 37.6 | 33 | 168.2 | | 70.6 | 260 | 322.8 | 134.42 | 36.50 |
| APRIL | 0 | 57.4 | 32.2 | 56.4 | | 89.6 | 349.6 | 379.2 | 180.74 | 46.32 |
| MAY | 0 | 114 | 34.6 | 0 | | 148.6 | 498.2 | 379.2 | 257.57 | 76.83 |
| JUNE | 0 | 29 | 0 | 0 | | 29 | 527.2 | 379.2 | 272.56 | 14.99 |
| JULY | 0 | 58.8 | 135.6 | 0 | | 194.4 | 721.6 | 379.2 | 373.07 | 100.50 |
| AUGUST | 0 | 113.8 | 71 | 67.6 | | 184.8 | 906.4 | 446.8 | 468.61 | 95.54 |
| SEPTEMBER | 0 | 116 | 222.4 | 67.6 | | 338.4 | 1244.8 | 514.4 | 643.56 | 174.95 |
| OCTOBER | 0 | 102.4 | 296 | 305.2 | | 398.4 | 1643.2 | 819.6 | 849.53 | 205.97 |
| NOVEMBER | 0 | 157.2 | 358.4 | 246.4 | | 515.6 | 2158.8 | 1066 | 1116.10 | 266.57 |
| DECEMBER | 0 | 225.6 | 0 | 203.8 | | 225.6 | 2384.4 | 1269.8 | 1232.73 | 116.64 |

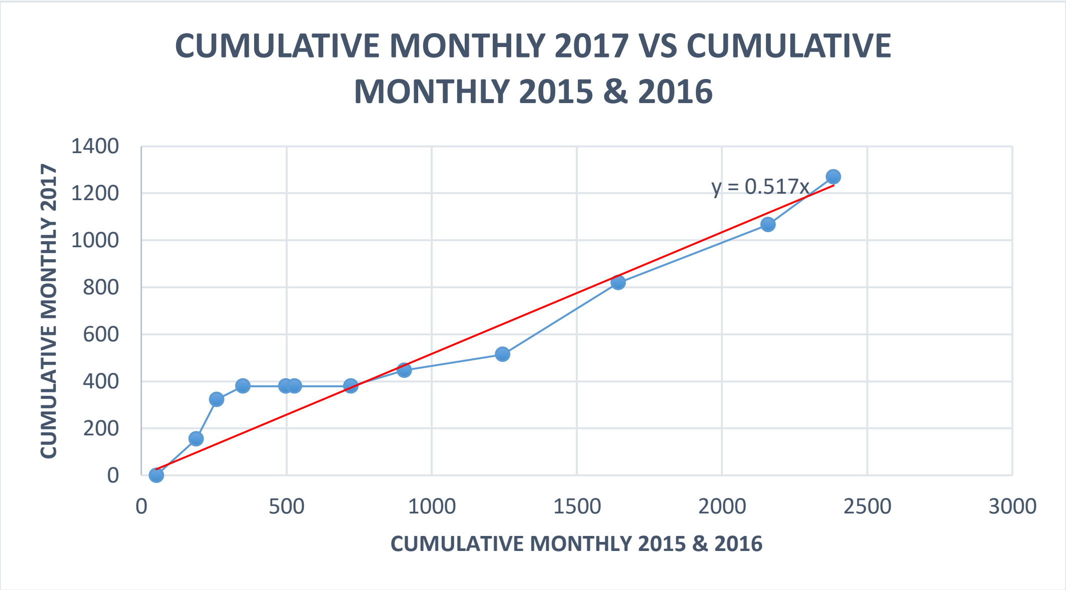


Figure 4.27 Double Mass Curve 2017

In Figure 4.27, the cumulative monthly of 2017 and the total cumulative monthly from 2015 and 2016 is plotted. From the double mass curve produced, it can be seen that there is a break in slope in the first few months in 2017. The break in slope indicates that the data is not consistent. The data is inconsistent as the data obtained have a few missing data. The Table 4.27 shows the data for double mass for year 2017.

## 4.3 Summary

From analysis of rainfall against temperature for 2015, 2016 and 2017 in UMP Gambang, it can be seen that the highest rainfall is 358.4mm in the month of November in 2016. In UMP Pekan, January 2017 shows that the total rainfall value is the highest which is 539.3mm with the lowest temperature reading is 27.4˚C. The rainfall pattern in UMP starts to decrease in a few months in the dry season and increase gradually again until it reach the highest peak in monsoon season.

The data obtained from the rain gauge is not consistent. The reason of the inconsistency of the data is because the rain gauge has been moved to a different location around UMP Gambang. Besides, the records from the rain gage at the new location might indicate an increase or decrease in average rainfall even though no real change had taken place. Next, the inconsistencies might be due to change in methods of collecting the data. It is because, there are a few students who collect the data from rain gauge for each year and the changes may affect the data. For data analysis in UMP Pekan for year 2018, the data in January and May are excluded as it have missing data due to lack of battery of rain gauge.

# CHAPTER 5

# CONCLUSION

## 5.1 Introduction

This chapter summary the study based on the result of the data analysis. Some recommendation is included in this chapter so that the better performance of the study of weather data and rain gauge data can be made for next researcher. According to literature reviews from chapter two, the main objective of study and scope of study are achieved.

## 5.2 Conclusion

The finding of the study is presented in this section. The main objectives of the research have been successfully achieved. The first objective of the study is achieved by monitored and collected the hydrological data at weather station UMP Gambang once a week. For Ump Pekan, the data collected is focused on the rainfall and temperature using the rain gauge as the weather station cannot be run. It is because the console of weather station cannot be installed at the site as it need to have suitable place and electrical supply in order to install them.

Besides that, the second objective of the study is achieved by analysed the rainfall data at UMP (Pekan and Gambang) starting from 2015 (Gambang) and 2016 (Pekan) by using rainfall and temperature data as important factors in climate change. From data analysis in UMP Pekan, the maximum rainfall for 3 years is 539.3mm with temperature of 27.4°C in January 2017. Next, the minimum temperature is 19.3°C with the rainfall 0.2mm in February 2018. In 3 years analysis, the maximum rainfall is in January for every year in UMP Pekan. For the data analysis in UMP Gambang, the maximum rainfall for 3 years is 358.4mm with 27.5°C in November 2016 while the minimum temperature is 21.8°C with the rainfall 0.4mm in Mac 2015. In 3 years analysis, in November and December show the maximum rainfall for every year in UMP Gambang. It can be conclude that from month October to January the trend rainfall show in chart increased with maximum rainfall while start from February to April it show the trend rainfall decreased with minimum rainfall during that period.

## 5.3 Recommendation

A few recommendations are suggested to improve and help the further researcher in this field. The recommendation is based on the experience after conducting all the works. Below are some of recommendations for next researcher to have a better performance of this study.

a) The next student should continue to collect more rainfall data in UMP Gambang and Pekan so that weather database for UMP can be recorded.

b) The duration for the collection data for weather station and rain gauge at Ump Gambang and Pekan should be prolonging to see clearly how the rainfall pattern in UMP area.

c) Select the best nearest hydrological station with weather station at UMP Gambang to get the best result comparison of the data.

d) Regular checking on the rain gauge and weather station to avoid missing data.

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# APPENDICES

## APPENDIX A – UMP GAMBANG CAMPUS DATA

| Data for March 2015 | | | | | |
|---|---|---|---|---|---|
| Day | Temperature (˚C) | | Rainfall (mm) | | Total Rainfall (mm) |
| | Minimum | Maximum | Minimum | Maximum | |
| 1 | 24.4 | 32.4 | 0 | 0 | 0 |
| 2 | 23.7 | 32.6 | 0 | 0 | 0 |
| 3 | 24.7 | 33.4 | 0 | 0 | 0 |
| 4 | - | - | - | - | - |
| 5 | 22.2 | 32.4 | 0 | 0 | 0 |
| 6 | 22.4 | 33.6 | 0 | 0 | 0 |
| 7 | 22.5 | 33.2 | 0 | 0 | 0 |
| 8 | 24.4 | 32.9 | 0 | 0 | 0 |
| 9 | 25.3 | 32.7 | 0 | 0 | 0 |
| 10 | 23.3 | 32.7 | 0.2 | 0.2 | 0.4 |
| 11 | 24.6 | 33.2 | 0 | 0 | 0 |
| 12 | 23.4 | 33.1 | 0 | 0 | 0 |
| 13 | 21.8 | 31.2 | 0 | 0 | 0 |
| 14 | 21.9 | 33.4 | 0 | 0 | 0 |
| 15 | 24.3 | 33.5 | 0 | 0 | 0 |
| 16 | 23.4 | 33.1 | 0 | 0 | 0 |
| 17 | 24 | 34.5 | 0 | 0 | 0 |
| 18 | 24.7 | 32.8 | 0 | 0 | 0 |
| 19 | 25.3 | 34.8 | 0 | 0 | 0 |
| 20 | 24.1 | 34.5 | 0 | 0 | 0 |
| 21 | 24 | 33.3 | 0 | 0 | 0 |
| 22 | 25.8 | 32.2 | 0.2 | 0.2 | 0.6 |
| 23 | 25.1 | 32.3 | 0 | 0 | 0 |
| 24 | 24.6 | 30.7 | 0 | 0 | 0 |
| 25 | 25.2 | 30.9 | 0.2 | 0.8 | 3.6 |
| 26 | 25.6 | 31.9 | 0.2 | 0.2 | 0.6 |
| 27 | 25 | 33.1 | 0 | 0 | 0 |
| 28 | 26.2 | 32.8 | 0 | 0 | 0 |
| 29 | 25.6 | 32.4 | 0.2 | 2.2 | 3.6 |
| 30 | 24.6 | 30.6 | 0.2 | 1.8 | 2.8 |
| 31 | 24.3 | 30.7 | 0.2 | 4.2 | 22.4 |

## APPENDIX B – UMP PEKAN CAMPUS DATA

| Data for October 2015 | | | |
|---|---|---|---|
| Day | Temperature (˚C) | | Total Rainfall (mm) |
| | Minimum | Maximum | |
| 1 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 0.0 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 |
| 13 | 0.0 | 0.0 | 0.0 |
| 14 | 0.0 | 0.0 | 0.0 |
| 15 | 0.0 | 0.0 | 0.0 |
| 16 | 0.0 | 0.0 | 0.0 |
| 17 | 0.0 | 0.0 | 0.0 |
| 18 | 0.0 | 0.0 | 0.0 |
| 19 | 0.0 | 0.0 | 0.0 |
| 20 | 0.0 | 0.0 | 0.0 |
| 21 | 27.5 | 32.2 | 0.6 |
| 22 | 26.0 | 31.3 | 0.0 |
| 23 | 26.4 | 32.3 | 0.0 |
| 24 | 27.1 | 30.4 | 0.0 |
| 25 | 25.9 | 32.4 | 0.0 |
| 26 | 26.4 | 31.9 | 0.0 |
| 27 | 20.5 | 39.1 | 15.8 |
| 28 | 26.4 | 31.3 | 0.2 |
| 29 | 25.4 | 32.8 | 1.2 |
| 30 | 25.4 | 27.7 | 2.1 |
| 31 | 24.8 | 29.4 | 0.0 |