ANALYSIS OF RAINFALL PATTERN BY USING NEW WEATHER STATION IN UNIVERSITI MALAYSIA PAHANG (UMP), CAMPUS GAMBANG

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ABSTRACT

The set-up of weather station is inevitable to collect the data in order to identify the rainfall pattern of certain area. The collected data also can be used for research and planning our daily activities. Although there is one weather station existed in Universiti Malaysia Pahang (UMP) Gambang, the location is no longer suitable to collect the weather data. The weather station in UMP Gambang is needed to relocate due to obstructions and developments in vicinity which may affect the accuracy of the data. The set-up of weather station is conducted at UMP Gambang. The ideal criteria and new location that fulfil the requirement to set up a weather station are at Kolej Kediaman 2 UMP Gambang. The ideal location and criteria is determined by refer to manual and standard guidelines. The data from Department of Irrigation and Drainage, Malaysian Meteorological Department and weather station of UMP Pekan is used for analysed rainfall pattern. The rainfall data collected from the weather station UMP Gambang were also analysed to identify the effect of rainfall pattern due to weather change. The relationship between relative humidity, temperature and wind speed towards the rainfall pattern is analysed. When there are increases of temperature, the relative humidity is relatively lower and affects the amount rainfall. Although the relative humidity of the surrounding is very high, it is not necessary having rainfall. Besides that, it is found that the yearly rainfall amount from 2009 to 2013 for surrounding area Gambang shows not consistent for 5 consecutive years. The minimum and maximum total yearly data is 14176.1 mm and 19904 mm at 2010 and 2009 respectively.

ABSTRAK

Penubuhan stesen kaji cuaca adalah penting untuk mengumpul data demi mengenal pasti corak hujan di sesuatu tempat. Data yang dikumpul juga boleh digunakan untuk tujuan penyelidikan dan perancangan aktiviti harian. Walaupun terdapat satu stesen kaji cuaca wujud di Universiti Malaysia Pahang (UMP) Gambang, lokasi tersebut tidak lagi sesuai untuk mengumpulkan data cuaca. Stesen kaji cuaca di UMP Gambang perlu ditempat semula disebabkan halangan dan perkembangan di sekeliling yang boleh menganggu ketepatan data. Penubuhan stesen kaji cuaca dijalankan di UMP Gambang. Lokasi baru yang dapat memenuhi kriteria untuk menubuhkan sebuah stesen kaji cuaca adalah di Kolej Kediaman 2 UMP Gambang. Lokasi dan kriteria sebuah stesen kaji cuaca dapat ditentukan dengan merujuk kepada garis panduan manual dan standard. Data daripada Jabatan Pengairan dan Saliran, Jabatan Meteorologi Malaysia dan stesen kaji cuaca UMP Pekan turut digunakan untuk menganalisis corak hujan. Data hujan yang dikumpul dari stesen kaji cuaca UMP Gambang turut dianalisis untuk mengenal pasti kesan corak hujan disebabkan perubahan cuaca. Hubungan antara kelembapan, suhu dan kelajuan angin kepada corak hujan dapat ditentukan selepas analisis. Apabila terdapat peningkatan suhu, kelembapan relatif adalah lebih rendah dan memberi kesan kepada jumlah hujan. Hujan tidak semestinya berlaku walaupun kelembapan relatif persekitaran adalah sangat tinggi. Di samping itu, didapati bahawa jumlah hujan tahunan antara 2009 sehinnga 2013 bagi kawasan sekitar Gambang menunjukkan tidak konsisten selama 5 tahun berturut-turut. Jumlah data hujan tahunan minimum dan maksimum masing- masing adalah 14176.1 mm dan 19904 mm pada 2010 dan 2009.

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LIST OF SYMBOLS

%	Percent
°	Degree
°C	Degree Celsius
cm	Centimetre
E	East
km	Kilometres
m	Meter
m/s	Meter per second
mm	Millimetres
N	North

LIST OF ABBREVIATIONS

CD	Compact Disc
DID	Department of Irrigation and Drainage
GPS	Global Positioning System
IPCC	International Panel on Climate Change
ISS	Integrated Sensor Suite
JKR	Jabatan Kerja Raya
JPS	Jabatan Pengairan dan Saliran
KK2	Kolej Kediaman 2
MMD	Malaysian Meteorological Department
UMP	Universiti Malaysia Pahang
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Weather and climate are the elements which interrelated with each other. The term that makes the difference between weather and climate are in terms of duration. Weather usually describes the particular event or condition for a short period of time such as hours or days whereas climate refers to the behavior of the atmosphere to a place over many years. On the other hand, weather includes current atmospheric conditions such as the temperature, precipitation, humidity and wind while climate describes the general weather conditions of a certain area over a long period of time. It shows that weather is a highly variable since it may change in a short time but climate is not.

Weather data are important in our daily 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. Besides, it is also important for others to plan the works. For example, in construction industry, the weather data is important for a project manager to plan their schedule so that the project can complete in time. The weather data collected for a long period can be used to predict the climate change in future trends. The weather data collected for the past decade can be used to analysis in order to identify the pattern of climate change.

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. Weather station is a device that can update the weather data in a more quickly and frequent way. It can collect the data in minutes or hourly based on the setting mode. The user can change the setting mode according to the purpose of the project respectively.

1.2 PROBLEM STATEMENT

There is one weather station existed in University Malaysia Pahang (UMP). However, the placement of the weather station has now been inappropriately since many developments and obstructions are taken around the weather station. The obstructions will affect the exactness of the data. In order to increase the accuracy of data, a new weather station is proposed and builds to determine the climate data. Since there is no other weather station around Gambang area, the weather station in UMP can be used to collect the climate data.

1.3 RESEARCH OBJECTIVES

The objectives of this study are as following:

i. To determine the ideal criteria to set up a weather station
ii. To set up the new location of weather station in UMP Gambang
iii. To determine the rainfall data of Gambang area by using weather station in UMP Gambang and rainfall pattern of Gambang area from Department of Irrigation and Drainage (DID)
iv. To determine how the change of weather data affect the rainfall pattern

1.4 SCOPES OF STUDY

The study will be conducted at UMP Gambang. A new weather station will be built on lands that are free from obstructions such as building and plants. The suitable location of the site proposes will be at the field at Kolej Kediaman 2 in UMP. The procedure for

the installation of weather station will follow the guideline and the manual provided. After the weather station is setup, the weather data such as humidity, wind speed, temperature and rainfall data will be recorded by the weather station. An observation of 21 days is carried out. Additional sources of data are obtained from Malaysian Meteorological Department and Department of Irrigation and Drainage to compare the rainfall pattern. Besides that, the selected data is taken from weather station Pekan to study the rainfall pattern at Pekan.

1.5 SIGNIFICANT OF STUDY

This study can help the future researchers to understand well the rainfall pattern of Gambang area. The rainfall, humidity and other data collected by weather station in UMP can be used as a reference for researcher since there is no other weather station in Gambang area. Besides, the data obtained from Department of Irrigation and Drainage (DID) and Meteorology Malaysia Department (MMD) from previous years can be used to observe the trends of change of rainfall pattern. In addition, students are exposed to a new experience to setting up of a weather station.

CHAPTER 2

LITERATURE REVIEW

The literature review is a general overview which related to the study. The literature review is done by reading and searching the related information from other sources such as journals, book, press release, handbook, local and international conferences paper which relevant with the study.

2.1 MALAYSIA CLIMATE

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 are usually range from 21 °C to 32 °C and the humidity is range in between 70 % to 90 %. Tangang et al. (2012) states that the temperature of Malaysia may rise 3-5 °C at the end of the 21st century.

2.2 RAINFALL

Water is the utmost important element and is vital in every living life. Water is important in all aspect such as transportation, irrigation in agriculture, domestic consumption and for other use purpose (Tam and Ibrahim, 2012). The availability of water in any area is come from rainfall or precipitation. The excessive or absence of rainfall event will cause flooding and drought respectively. The rainfall is an important consideration in design runoff conveyance and erosion control system. The rain gauge

can be used to measure the amount of rainfall since it has a quite high level of accuracy in measuring the amount of rainfall (Pettazzi & Salson, 2012).

In Malaysia, the rainfall is depends on two monsoon seasons which is southwest monsoon and northeast monsoon. Southwest monsoon seasons where originated from 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. Besides, there are two transition period of inter-monsoons period which usually starts 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 for occurrence of rainfall amount is varying during the whole year (Suhaila & Jemain, 2009).

Suhaila et al. (2010) found that the western region was affect significantly due to southwest monsoon season especially in the rainfall pattern of northwest region. During the southwest monsoon seasons, the northwest region is taken as the wettest region as the rainfall indices tested and obtained is more than other regions. In contrast, the northwest are the driest region during the northeast monsoon seasons (Ahmad et al., 2013). Minimum precipitation is recorded for northwest region during the northeast monsoon seasons. As the existence of Titiwangsa Range which shelters the inland region from receiving the heavy rain straightly, the northwest region is less affected by the northeast monsoon season. On the other hand, the exposed area during the northeast monsoon seasons will experience heavy rainfall. The lowland areas in eastern region will directly experience the northeast monsoonal flow.

As mentioned by Azumi et al. (2010), the northeast monsoon seasons brings more rainfall although rainfall occurs throughout the whole year. During the northeast monsoon season, the number of wet day and the total amount of rainfall observed from several stations shows positive trends for the rainfall intensity (Suhaila et al., 2010). Ahmad et al. (2013) also agreed that the annual rainfall variability for eastern is greater

than the western region. In the east coast region, the northeast and southwest monsoon season contribute 55 % and 31 % of the total annual rainfall respectively (Wong et al., 2009). It shows that the rainfall events in the eastern region are mostly effect by northwest monsoon. In contrast, there are no significant rainfall patterns between southern and northern region.

2.3 WEATHER CHANGE AND RAINFALL

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.

According to Johansson and Chen (2003) stated that the wind speed and rainfall is correlation with topography. Larissa and Christopher (2005) also stated that the relationship between wind speed and rainfall is depends on the geographical factor with rapidly increases in moister conditions. The wind speed and rainfall increase when there it faces to upward sides. In contrast, during the leeward sides, the wind speed significantly does not affect the rainfall amount. Besides that, when the wind speed is increasing during the storm, the rainfall loss rate is increasing too (Hsu & Guo, 2005). When the wind speed of the specific area is high, the rain gauge is affect by the wind speed and the rainfall amount that recorded by the rain gauge will be affected.

Humidity and relative humidity shows some difference although both show some similarities. Humidity is the measurement of the content of the water vapor in a particular sample of air. For relative humidity, it is the ratio of the actual amount of water vapor a sample to that amount that needed to saturate that particular sample. Relative humidity usually expressed in percentage. According to Valsson and Bharat (2011), the relative humidity depends on the amount of moisture available in that time and also the ambient temperature. Based on the experiment, when there is rise of temperature, the relative humidity will be decrease. The number of water vapor that present at saturation is less at

lower temperature, hence the existing amount of water vapor represent higher percentage of the saturation of the air.

2.4 EFFECT OF CLIMATE CHANGE

Climate change is issues that will arise during 21st century with comprise lots of environmental problems. Climate change may include the changes of temperature of air and ocean, melting of iceberg and rising of sea level. The definition of climate change for International Panel on Climate Change (IPCC, 2007):

> Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. (p. 30)

There are numerous effects for the climate change due to natural course and anthropogenic activities. The amount and the times for an extreme event to happen are expected to increase in future (Sunyer et al., 2012). The chance for a place to have heavy rainfall, storms and coastal flooding will increase when the occurrence of the extreme event increase. The trend increase in extreme events will cause loss of lives and brings economic impact to the country or the whole world.

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 depends on climatic condition, it is important to reduce the adverse effect from climate variable

towards the water resources. The agricultural activities and forestry are greatly depends on the water resources. Due to the effect of climate change, the availability for water resources will be scarcity and affect the ecosystem for terrestrial and also aquatic life. As the consequence of climate change, the water quality for surface and groundwater will be affected. The water supply for drinking purpose may be contaminates and increases the risk of having diseases such as cholera.

Besides, there are negative effects on the agricultural production. Due to heavy precipitation which increases the soil 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) agreed that the change in climate will have negative yield impacts on the production of crops. At low latitude region, the change in climate will decrease the yield of the crops. The climate change had brought adverse effect to the paddy farmers in Malaysia (Alam et al., 2013). The productivity of paddy was noticed declined due to the climate change. As the consequences, the decrease in the crop yield will increase the risk of shortage of food. Furthermore, there is increase in risk of the malnutrition for the poverty countries which always shortage of food and drinks.

2.5 WEATHER STATION EQUIPMENT FOR INTEGRATED SENSOR SUITE

Weather station is equipment which can observe, gather and record the meteorological data from the surrounding. Weather station may consist of several important sensors to measure the precipitation, wind direction, wind speed, humidity and temperature. There are several optimum conditions to locate the different types of sensors.

Temperature and humidity sensor is used to measure the surrounding temperature and humidity respectively. Combination of temperature and humidity are often presented into one instrument sensor in weather station. The sensor should avoid from sitting under direct sunlight with usually white plastic shields to shade the sensor (Brown & Bruce, 2010). Besides that, the sensor should also keep from the wall that will heat the temperature and eventually cause thermal radiation which can affect the reading of the

instrument (Setting up a Weather Station). If there is no other option, the combination sensor should install in shaded location which can prevent the exposure of direct sunlight and rainfall. The temperature and relative humidity for outside reading range from -40 °C to 65 °C and 0 % to 100 % respectively for weather station Vantage Vue ISS.

The rain collector is an instrument which similar to rain gauge is used to measure the amount of precipitation. To have an optimal performance, the rain sensor must mount on a level surface that free from vibration (Weather Station Set Up 101). The suggested height for the rain collector is at least two feet but not higher than six feet from surface level. The rain collector tipping spoon for Vantage Vue ISS captures precipitation and rotate on a pivot each time a known quantity of 0.2 mm water is collected. Rain collector debris screen, which is an additional component, is installed at the weather station to prevent the debris and dirt that can clog the rain collector. Besides, it can used to prevent other insects such as spider and wasps from housekeeping inside the collector.

The wind vane is used to point out the wind direction of the area. The wind wane is designed to rotate freely and point into the wind. The wind vane rotates 360 ° to display current and dominant wind direction on the compass rose of the console screen. The wind vane must be able to show correct direction when the anemometer is installed on the weather station. By default, if the arm of anemometer is pointing to true north, the wind vane is reports the correct orientation (Integrated Sensor Suite Installation Manual). The wind vane is in use immediately after installation.

The other component consists in the weather station is the anemometer. Anemometer has three cups attached to spokes which connect to a hub. The rate of cup rotation is proportional to wind speed. The ideal location of the wind speed sensor or known as anemometer is the place where the wind flows freely and not effected by nearby objects or building. Obstructions such as trees, houses and buildings around the anemometer may affect the wind speed. The mounting of pole is an important step since the arm of the anemometer must point to the true north for accurate wind direction

reading (Weather Station Set Up 101). The wind speed sensor should be place at a distance twice the height of the nearby obstructions.

2.6 IDEAL CRITERIA LOCATION TO SET UP A WEATHER STATION

The selection of the site is crucial in order to make sure the reliability and accuracy of the weather station. The ideal location of the weather station is the site should be at an open area and away from height obstructions such as trees and building in near vicinity (Weather Station Set Up 101). The minimum require distance from the obstruction to the station must have a least the height of the highest building. The building surrounding the weather station can significantly affect the reading of the sensors and the validity of the data will be affected.

Besides that, the location of the site should be flat area without steep slopes where there is low vegetation cover (Choosing a Suitable Location for an Automatic Weather Station). KNMI (2000) also state that the location of the site should be flat and away from shore and slope such as the area with gullies, valleys and peaks to ensure the accuracy measurement of the precipitation data.

The weather station should have minimum of 10 m x 10 m in size for ground based installations (Choosing a Suitable Location for an Automatic Weather Station). For site which lack of open spaces, it is recommended to have roof top installation or to site installation instead of ground installation. The standard height of the mast for installation of weather station is 2 m but the actual height of the mast can be altered based on the site condition such as the surrounding condition and obstruction around the weather station. It should place at least two times the distance away from the highest building obstruction.

The consideration for the security of the site such as prevention of human vandalism and wildlife must take into account. In order to prevent any damage from animals, livestock and human being, the installation of the fencing is highly recommended to protect the site. The site should have surround fencing to inhibit the

unauthorized access (KNMI, 2000). The maximum height for the fencing of the site is at most 2 m with non-opaque material. This height is recommended because it has the minimum affect to the measurement of the weather station.

CHAPTER 3

STUDY AREA

3.1 INTRODUCTION

Pahang is well-known as the largest state in Peninsular Malaysia with land area of 35960 square kilometers. About two-thirds of land area in Pahang is covered with tropical rainforest that become the home for endangered animals such as tapir, leopards and tigers. Besides, soft beach sand along South China Sea and the highlands that attract tourists is found in Pahang too. The capital city of Pahang is Kuantan, which located along east coast region whereas the royal town of Pahang is at Pekan. Over the course of a year, Pahang's tropical monsoon seasons usually range from 22 °C to maximum 33 °C whereas the relative humidity varies from 62 % (mild humidity) to 96 %(very humid). On the average, the driest month for is on February whereas December is the wettest month. The average monthly precipitation is around 438 mm.