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DETERMINATION OF HYDROLOGY CYCLE IN UNIVERSITI MALAYSIA PAHANG (UMP) GAMBANG AND PEKAN CAMPUS

IHSAN BIN MD YUSOFF

Report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor (Hons.) of Civil Engineering

Faculty of Civil Engineering & Earth Resources
UNIVERSITI MALAYSIA PAHANG

JANUARY 2017

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ABSTRACT

Climate change leads to changes in precipitation. This phenomenon has already begin to transform rainfall pattern in Malaysia. Rainfall data, temperature data, and evaporation data are collected and recorded monthly to display the relationship between rainfall, temperature, and evaporation to determine the pattern of hydrologic cycle. The relationship obtained, would also display the weather pattern at campus Universiti Malaysia Pahang (UMP) in Gambang and Pekan. Understanding the shift and predicting the changing trend in rainfall distribution is needed to manage floods. Changing trend in rainfall distribution also gives an effect on hydrological analysis especially related to historical rainfall record. Mann Kendall (MK) test and Sen's Slope estimator are employed to determine the rainfall trend of hydrologic cycle. The trend test would conclude if there is a rainfall trend or no rainfall trend at campus Universiti Malaysia Pahang (UMP) in Gambang and Pekan.

ABSTRAK

Perubahan iklim membawa kepada perubahan dalam hujan. Fenomena ini telah mula mengubah corak hujan di Malaysia. Data hujan, data suhu, dan data penyejatan dikumpul dan direkodkan setiap bulan untuk memaparkan hubungan antara hujan, suhu, dan penyejatan untuk menentukan corak kitaran hidrologi. Hubungan diperolehi, juga akan memaparkan corak cuaca di kampus Universiti Malaysia Pahang (UMP) di Gambang dan Pekan. Memahami peralihan dan meramalkan trend perubahan dalam taburan hujan diperlukan untuk menguruskan banjir. Menukar trend dalam taburan hujan juga memberi kesan ke atas analisis hidrologi terutamanya yang berkaitan dengan rekod hujan sejarah. Ujian Mann Kendall (MK) dan Slope Sen penganggar digunakan untuk menentukan trend hujan kitaran hidrologi. Ujian trend akan membuat kesimpulan jika terdapat satu trend hujan atau tiada trend hujan di kampus Universiti Malaysia Pahang (UMP) di Gambang dan Pekan.

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LIST OF SYMBOLS

˚C	Degrees Celcius
%	Percent
mm	Millimeter
lv	Latent Heat of Vaporization
mm/h	Millimeter per Hour
S	Test Statistic
Z	Standardized Statistic
H_o	Null Hypothesis
H_1	Alternative Hypothesis
H_s	Sensible Heat Flux
E_r	Rate of Radiation
R_n	Net Radiation Flux
T_a	Air temperature

LIST OF ABBREVIATIONS

UMP	Universiti Malaysia Pahang
MK	Mann Kendall
Eq.	Equation
USB	Universal Serial Bus
ET	Evapotranspiration
JPS	Jabatan Pengairan dan Saliran

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).

1.2 PROBLEM STATEMENT

The unpredictable weather pattern affects daily activities at Universiti Malaysia Pahang (UMP) Gambang and Pekan campus. Identify the hydrology cycle and weather pattern will help people to manage and plan their activities.

1.3 OBJECTIVE OF STUDY

i. To determine the pattern of hydrology cycle at UMP Gambang and Pekan campus.
ii. To determine the rainfall trend at UMP Gambang and Pekan campus.

1.4 SCOPE OF STUDY

This study focuses on determining the hydrology pattern. The hydrology data are obtained from the hydrology devices set up at Universiti Malaysia Pahang (UMP) Gambang and Pekan campus. The hydrology data is then organised and analysed to obtain the rainfall trend.

1.5 SIGNIFICANCE OF STUDY

The importance of determining the pattern of hydrology cycle is to see how the weather pattern is like at Universiti Malaysia Pahang (UMP) Gambang and Pekan campus.

CHAPTER 2

LITERATURE REVIEW

2.1 THE HYDROLOGY CYCLE

The hydrologic cycle is a conceptual model that describes the storage and movement of water between the biosphere, atmosphere, lithosphere, and the hydrosphere (see Figure 2.1). 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).

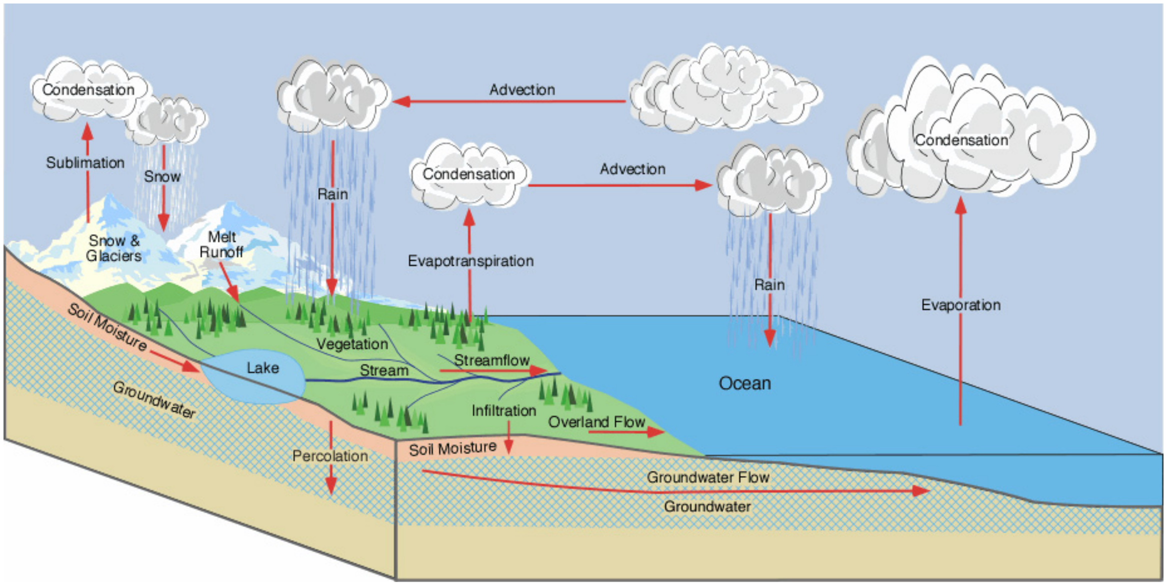

Figure 2.1: The Hydrology Cycle

2.2 PRECIPITATION

The term precipitation 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. Rainfall being predominant form 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).

2.2.1 Forms Of Precipitation

i. Rain

It is the principal form of precipitation. The term rainfall is used to describe precipitations in the form of water drops of sizes larger than 0.5 mm. The maximum size of a raindrop is about 6 mm. Any drop larger in size than this tends to break up into drops of smaller sizes during its fall from the clouds (Subramanya, 2013).

ii. Drizzle

A fine sprinkle of numerous water droplets of size less than 0.5 mm and intensity less than 1 mm/h is known as drizzle. In this, the drops are so small that they appear to float in the air (Subramanya, 2013).

iii. Hail

It is a showery precipitation in the form of irregular pellets or lumps of ice of size more than 8 mm. Hails occur in violent thunderstorms in which vertical currents are very strong (Subramanya, 2013).

iv. Sleet

It is frozen raindrops of transparent grains which form when rain falls through air at subfreezing temperature (Subramanya, 2013).

v. Glaze

When rain or drizzle comes in contact with cold ground at around 0˚C, the water drops freeze to form an ice coating called glaze or freezing rain (Subramanya, 2013).

2.2.2 Method Involved In Precipitation

Water balance equation is used to calculate the value of precipitation as shown in Eq. (2.1)

$$P = ET + R + \Delta S + \Delta G \tag{2.1}$$

Where P = Precipitation (mm)

ET = Evapotranspiration (mm)

R = Runoff/Streamflow (m3/s)

ΔS = change in storage

(for long term research therefore ΔS=0 if the duration is short)

ΔG = change in groundwater flow

(ΔG=0 if the assumptions are valid, example in large river basin)

<u>Trend Analysis: Mann Kendall Test and Sen's Slope Estimator.</u>

MK test is a statistical test widely used to assess the trend in hydrological time series. This test is a non-parametric test; therefore, data outliers do not affect the result. The test statistic of MK test, S, is computed as follows:

$$S = \sum_{k=1}^{n-1} \left(\sum_{j=k+1}^{n} \quad \mathrm{sign}(x_j - x_k) \right) \tag{2.2}$$

Where

$$\mathrm{sign}(x_j - x_k) = \begin{cases} 1, & X_J - X_K > 0 \\ 0, & X_J - X_K = 0 \\ -1, & X_J - X_K < 0 \end{cases}$$

where x_j and x_k are the sequential data values, n is the number of observations.

In the MK test, the positive test statistic, S indicates increasing trend, whereas the negative test statistic indicates decreasing trends.

The variance for the S statistic is defined by:

$$\text{Var (S)} = \frac{n(n-1)(2n+5)}{18} \tag{2.3}$$

The standardized Z statistic is calculated as follows:

$$z = \begin{cases} \frac{S-1}{Var\ (S)}\ ,\ S > 0 \\ 0\ ,\ S = 0 \\ \frac{S+1}{Var\ (S)}\ ,\ S < 0 \end{cases} \tag{2.4}$$

The test statistic Z is used to measure of significance of the trends. In fact, the null hypothesis, Ho of the MK test assume that there is no trend and tested against the alternative hypothesis H1 which assume that there is a trend (Onoz, 2003). If the calculated z statistic is larger than critical value at the chosen significance levels, then the null hypothesis is invalid implying the alternative hypothesis which is “there is trend" is accepted. The magnitude of trend was calculated using Sen’s slope approach. Sen's non-parametric method estimate the magnitude of trends in the time series data:

$$\text{Var (S)} = \frac{n(n-1)(2n+5)}{18} \tag{2.5}$$

2.3 EVAPORATION

Evaporation is the process by of water changing from its liquid phase to the vapour 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 reservoir design and operation. The supply of energy to provide 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 vaporization of liquid water to water vapour and is given as *lv* = 2.501×10^6. (Mays, 2011)

2.3.1 Method Or Equation Involved

Four methods are used to determine evaporation: the energy balance method, the aerodynamic method, and the combined aerodynamic and energy balance method. The energy balance method considers the heat energy balance of a hydrologic system, and the aerodynamic method considers the ability to transport away from an open surface. (Mays, 2011)

Energy Balance Method :

Assuming the sensible heat flux, H_s and the ground heat flux, G are both zero, then an evaporation rate, E_r which is the rate at which all incoming net radiation is absorbed by evaporation, can be calculated as

$$E_r = \frac{R_n}{l_v \text{ x } \rho_W} \tag{2.6}$$

Where Er = Rate of evaporation mm/day
Rn = Net radiation flux (Watts per m^2)
Lv = Latent heat of vaporization

Aerodynamic Method :

The aerodynamic method considers the ability to transport water vapour away from the water surface; that is, generated by the humidity gradient in the air near the surface and the wind speed across the surface. These processes can be analysed by coupling the equation for mass and momentum transport in the air. The final form of the evaporation equation for the aerodynamic method expresses the evaporation rate, E_a as a function of the difference of the vapor pressure at the surface, e_{as} which is the saturation vapor pressure at ambient air temperature (when the rate of evaporation and condensation are equal), and the vapor pressure at a height above the water surface, which is taken as the ambient vapor pressure in air e_a. (Mays, 2011)

$$E_a = B(e_{as} - e_a) \tag{2.7}$$

Where E_a = Evaporation rate, (mm/day)

B = vapor transfer coefficient (mm/day)

e_{as} = vapor pressure at the surface

e_a = vapor pressure in air

<u>Combined Method</u> :

When the energy supply is not limiting, the aerodynamic method can be used, and when the vapor transport is not limiting, the energy balance method can be used (Mays, 2011). However, both of these factors are not normally limiting, so a combination of these methods is usually required. The combined method equation is

$$E = \left(\frac{\Delta}{\Delta+\gamma}\right)E_r + \left(\frac{\gamma}{\Delta+\gamma}\right)E_a \tag{2.8}$$

Where Er = vapor transport term

Ea = aerodynamic term

$\boldsymbol{\gamma}$ = psychrometric constant (approximately 66.8/˚C)

Δ = is the gradient of the saturated vapor pressure curve

$$= \frac{4098e_{as}}{(237.3+T_a)^2} \tag{2.9}$$

T_a = air temperature

e_a = saturated vapor pressure

Priestly and Taylor :

Priestly and Taylor discovered that the aerodynamic term in equation (2.8) is approximately 30 percent of the energy term, so that equation (2.8) can be simplified to

$$E = 1.3\left(\frac{\Delta}{\Delta+\gamma}\right) E_r \qquad (2.9)$$

which is known as the Priestly-Taylor evaporation equation. (Mays, 2011)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 METHODOLOGY FLOW CHART

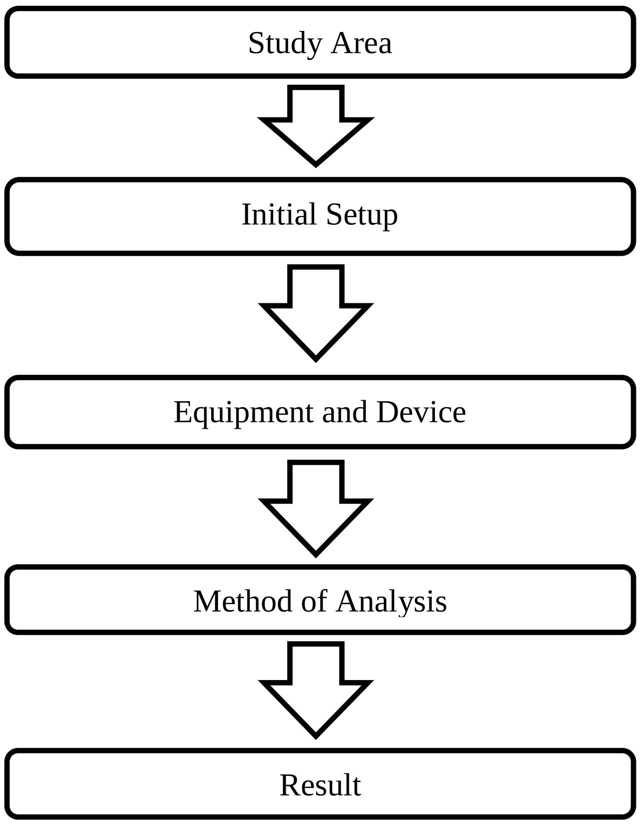

Figure 3.1: Methodology Flow Chart

Figure 3.1 is the methodology flow chart which is how the flow of study is carried out to obtain the expected result. It starts with the study area and end with the method of analysis.

3.2 STUDY AREA

Figure 3.2: Map of Malaysia

Figure 3.2 shows the map of Malaysia. Pahang is located on the center of the figure. Pahang is the third largest state in Malaysia, after Sarawak and Sabah, occupying the huge Pahang River river basin. It is bordered to the north by Kelantan, to the west by Perak, Selangor, Negeri Sembilan, to the south by Johor and to the east by Terengganu and the South China Sea.

Location of study is located at Universiti Malaysia Pahang (UMP), Gambang campus and Universiti Malaysia Pahang (UMP), Pekan campus. The coordinate for the location of UMP Gambang campus is 3.718491, 103.120784 and the coordinate for UMP Pekan campus is 3.546709, 103.435332. The two locations are located near to each other which is about 50 km away, and both locations are situated in Pahang. UMP Pekan is located in rural area and UMP Gambang is located in suburban area.

3.2.1 Location of Weather Station and Rain Gauge

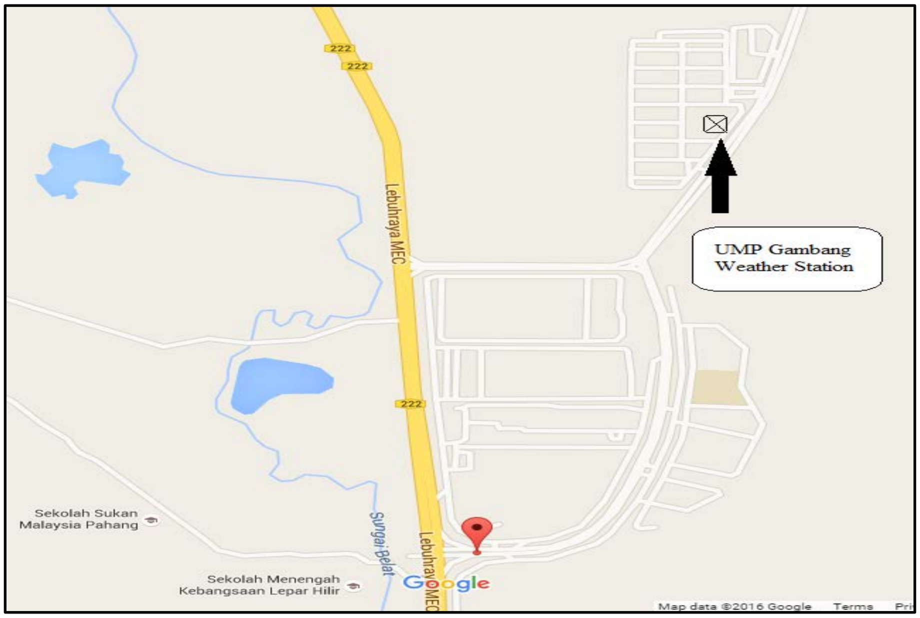

Figure 3.3: Location of Weather Station in UMP Gambang Campus

Figure 3.4: Weather Station in Kolej Kediaman 2 in UMP Gambang Campus

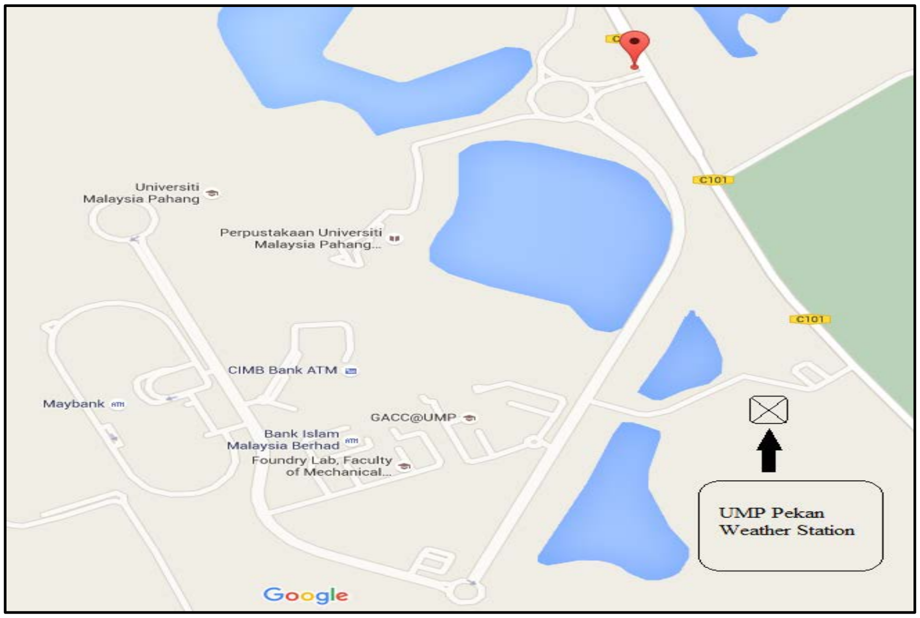

Figure 3.5: Location of Weather Station in UMP Pekan Campus

Figure 3.6: Weather Station in UMP Pekan Campus

3.2.2 Location of JPS Pahang Weather Station

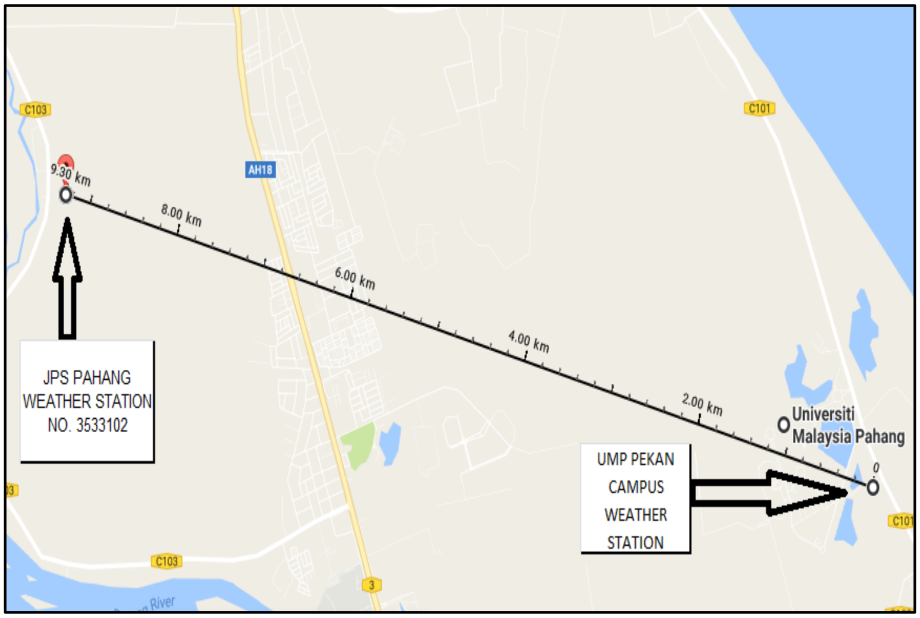

Figure 3.7: Location of JPS Pahang Hydrological Station

Figure 3.7 show the location of JPS Pahang hydrological station no. 3533102. The distance between this JPS weather station and UMP Pekan weather station is 9.3 km. This station is used because it is able to obtain the evaporation data.

3.3 INITIAL SETUP

Initial setup involves a process of gathering all the information that is related such as literature review, review of data and the provision of equipment used during the study period. Planning of field work is essential to ensure that the goal of research and work gets to be done properly. After obtaining the necessary information, raw data are required to be analysed to complete the research. Laboratory work is also important like the field work because the necessary data are needed for the next process. The use of good laboratory tools are essential to get accurate result.

3.4 EQUIPMENT AND DEVICE

Figure 3.8: HOBO Rain Gauge

Figure 3.8 is a HOBO Rain Gauge which is used in UMP Pekan campus. It records up to 160 inch of rainfall at rates up to 12.7 cm (5 inch) per hour. The Data Logging Rain Gauge system is battery powered and includes a HOBO Pendant Event data logger with a tipping-bucket rain gauge. Easily collect rainfall, time, and duration data, as well as temperature when used with an optional solar radiation shield (RS1 Solar Radiation Shield, or M-RSA).

Figure 3.9: Wireless Vantage Pro ISS with Fan-Aspirated Shield

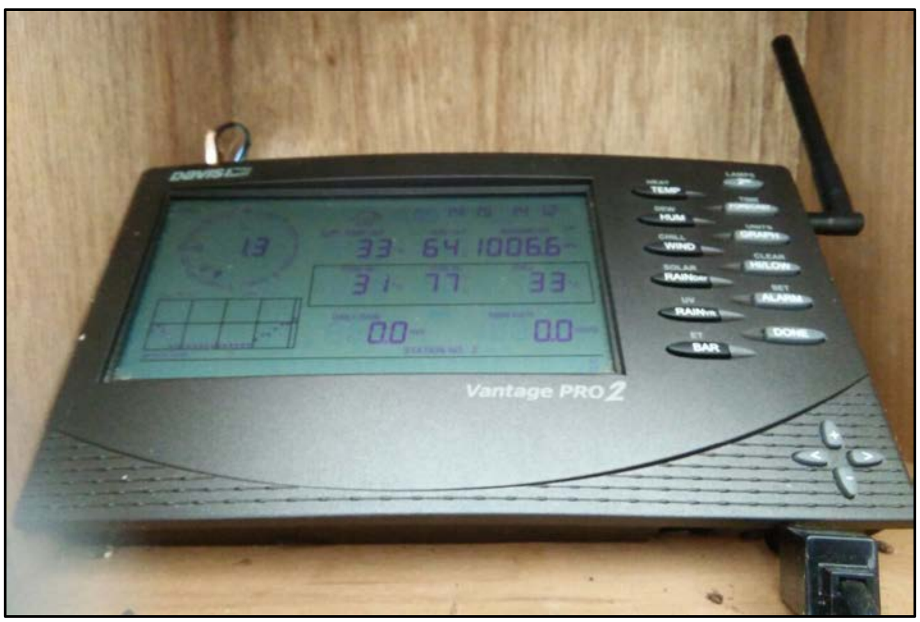

Figure 3.10: Vantage Pro2 Console

Figure 3.8 and figure 3.9 are weather monitoring equipment device. This is one of the world's foremost weather stations for both home and industrial use. It can either be a wireless and cabled system. Data can be transmitted wirelessly from the sensors to a detailed and easy to read console. The station measure barometric pressure, temperature, humidity, rainfall, wind speed and direction, solar radiation, evapotranspiration, ultraviolet radiation.

3.4.1 Measurement Descriptions

i. Apparent Temperatures

The Vantage Pro calculates three apparent temperature readings: Wind chill, Heat Index, and the Temperature/Humidity/Sun/Wind (THSW) Index. Apparent temperatures use additional weather data to calculate what a human body perceives the temperature to be in those conditions (Meijers, 2009).

ii. Rain

The Vantage Pro incorporates a tipping-bucket rain collector in the ISS that measures 0.01 for each tip of the bucket. The station logs rain data in inch units. Four separate variables track rain totals: rain storm, daily rain, monthly rain, and yearly rain. Rain rate calculations are based on the interval of time between each bucket tip, which is each 0.01 rainfall increment (Meijers, 2009).

iii. Solar Radiation

Current solar radiation is technically known as Global Solar Radiation, a measure of the intensity of the sun’s radiation reaching a horizontal surface. This irradiance includes both the direct component from the sun and the reflected component from the rest of the sky. The solar radiation reading gives a measure of the amount of solar radiation hitting the solar radiation sensor at any given time, expressed in Watts /sq. meter (W/m2) (Meijers, 2009).

iv. Evapotranspiration

Evapotranspiration (ET) is a measurement of the amount of water vapor returned to the air in a given area. It combines the amount of water vapor returned through evaporation (from wet vegetation surfaces and the stoma of leaves) with the amount of water vapor returned through transpiration (exhaling of moisture through plant skin) to arrive at a total. Effectively, ET is the opposite of rainfall, and it is expressed in the same units of measure (Inches, millimeters) (Meijers, 2009).

3.5 METHOD OF ANALYSIS

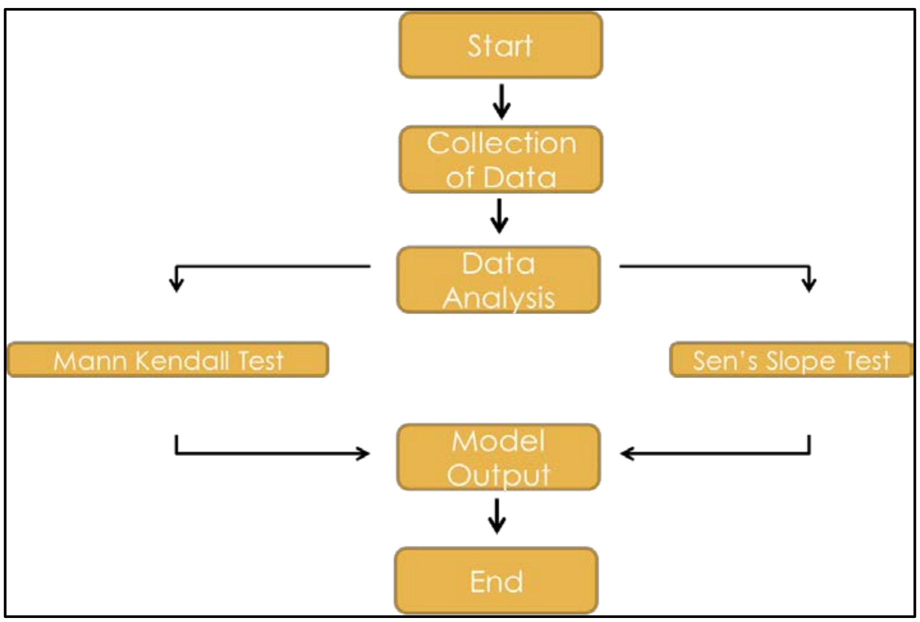

Figure 3.11: Rainfall Analysis Flowchart

Rainfall are first collected by the weather station. It is stored for a month or a few days depending on the memory size of the device. The extraction of rainfall data is done by using a USB connector device which connects to the laboratory laptop. The rainfall data is then stored in the laboratory computer and it is then are converted into MS excel format which will make it easier to be organised and analysed using mann kendall method and sen's slope to obtain the rainfall trend. From the trend test, the expected result would be to have a trend or no trend.

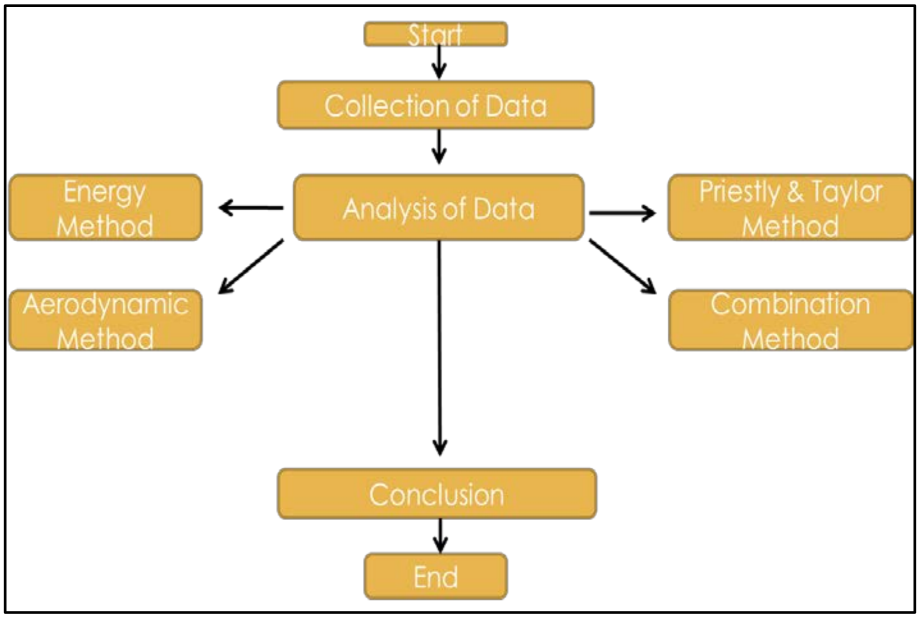

Figure 3.12: Evaporation Analysis Flowchart

The evaporation data for Universiti Malaysia Pahang (UMP) Gambang campus are collected from the weather station. Evaporation data for Universiti Malaysia Pahang (UMP) Pekan campus are obtained from the Jabatan Pengairan dan Saliran (JPS) of Kuantan. Evaporation data that is used is based on the nearest hydrological station to the weather station in UMP Pekan campus.

The evaporation data will then be organised in MS excel file format and will be analysed by one of the evaporation methods to determine the rate of evaporation. If there is evapotranspiration data given, then either use the given evapotranspiration data or obtain the new evaporation data by using one of the evaporation methods in the figure 3.12.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

Data that are collected and organised are analysed and presented in this topic. Data are obtained from the weather station, and from the Department of Irrigation and Drainage Pahang.

4.2 DATA RESULTS

Table 4.1 until Table 4.10 below are hydrological data that is obtained from the weather station in Kolej Kediaman 2 in UMP Gambang campus.

Table 4.1: Data for February 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	24.3	32.9	0	0.2	0.4	4.80
2	24.2	32.8	0	0.0	0.0	4.70
3	24.3	31.5	0	4.0	26.0	3.80
4	24.6	28.6	0	4.8	31.6	1.57
5	25.3	28.4	0	3.8	24.2	1.04
6	25.6	28.8	0	3.0	9.2	1.97
7	24.4	28.4	0	2.6	10.6	2.92
8	24.3	28.7	0	0.4	0.6	2.88
9	23.7	29.5	0	0.0	0.0	3.01
10	24.9	29.9	0	0.0	0.0	2.48
11	24.6	31.5	0	0.2	1.0	3.89
12	25.4	32.1	0	2.4	3.2	3.99
13	25.0	31.3	0	0.2	0.2	3.17
14	24.9	31.3	0	0.2	0.4	3.33
15	25.1	31.6	0	2.6	5.8	3.81
16	24.9	31.4	0	0.2	0.2	4.45
17	24.1	31.2	0	0.2	0.2	4.75
18	23.9	31.3	0	0.4	1.8	3.8
19	25.1	29.3	0	2.8	8.0	2.76
20	24.1	30.9	0	0.6	0.6	4.61
21	23.6	30.9	0	0.0	00	4.74
22	22.1	32.3	0	0.0	0.0	5.29
23	23.4	32.6	0	0.0	0.0	4.46
24	23.7	31.7	0	3.0	4.4	4.38
25	24.6	31.7	0	0.0	0.0	4.82
26	25.0	31.2	0	0.0	0.0	4.30
27	24.8	31.3	0	1.2	3.8	3.45
28	24.3	29.3	0	1.0	5.4	2.44
29	25.3	31.3	0	0.0	0.0	4.77

Table 4.1 shows a complete data for the month of February 2016. It is adequate to be analysed.

Table 4.2: Data for March 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	24.4	32.2	0	0.0	0.0	5.26
2	24.4	32.1	0	0.0	0.0	5.01
3	24.1	31.3	0	0.0	0.0	4.01
4	25.1	33.1	0	0.0	0.0	4.43
5	25.2	31.3	0	3.2	8.4	2.68
6	25.0	32.2	0	0.2	0.2	4.12
7	24.8	32.5	0	0.0	0.0	4.64
8	25.4	33.3	0	0.0	0.0	4.75
9	24.3	33.8	0	0.0	0.0	5.31
10	25.0	33.7	0	0.0	0.0	4.48
11	24.8	33.4	0	0.0	0.0	4.51
12	24.7	32.3	0	0.0	0.0	3.73
13	25.3	32.7	0	0.0	0.0	4.97
14	26.4	33.6	0	0.0	0.0	4.62
15	24.4	33.9	0	0.0	0.0	5.37
16	22.4	32.9	0	0.0	0.0	5.21
17	23.7	33.8	0	0.0	0.0	4.89
18	23.5	33.1	0	0.0	0.0	5.24
19	24.8	33.1	0	0.0	0.0	3.98
20	25.8	33.7	0	0.0	0.0	4.85
21	26.6	32.5	0	0.0	0.0	3.30
22	26.5	34.2	0	6.2	7.2	3.78
23	25.3	32.9	0	0.0	0.0	3.72
24	24.6	33.1	0	0.0	0.0	4.61
25	23.8	34.3	0	0.0	0.0	5.22
26	26.0	33.7	0	0.4	0.6	5.18
27	25.7	33.2	0	0.0	0.0	5.04
28	24.4	30.5	0	3.0	16.6	2.65
29	24.9	32.3	0	0.0	0.0	4.59
30	24.7	33.2	0	0.0	0.0	5.22
31	24.4	33.3	0	0.0	0.0	5.18

Table 4.2 shows a complete hydrological data for the month of March 2016.

Table 4.3: Data for April 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	24.7	33.8	0	0.0	0.0	5.29
2	25.2	33.3	0	0.0	0.0	4.92
3	24.4	32.7	0	0.2	0.4	3.92
4	25.8	33.8	0	0.0	0.0	4.98
5	25.6	32.8	0	0.0	0.0	3.71
6	24.9	34.4	0	0.0	0.0	5.43
7	23.4	35.0	0	0.0	0.0	4.51
8	24.1	33.8	0	0.0	0.0	4.88
9	24.6	34.1	0	0.0	0.0	4.34
10	33.8	25.4	0	0.0	0.0	4.22
11	26.7	36.2	0	0.6	0.6	4.30
12	26.7	34.9	0	2.2	6.0	3.69
13	25.8	34.5	0	0.6	1.2	4.45
14	25.6	35.8	0	3.4	5.0	4.58
15	26.0	32.3	0	0.2	0.4	1.79
16	25.8	35.3	0	0.0	0.0	4.38
17	25.9	34.4	0	6.8	9.6	4.12
18	25.6	33.9	0	0.0	0.0	3.42
19	26.0	35.2	0	0.0	0.0	5.43
20	25.8	35.2	0	1.6	1.8	5.38
21	25.8	34.2	0	0.0	0.0	5.29
22	26.0	33.8	0	0.0	0.0	4.10
23	25.9	33.8	0	1.2	1.8	3.39
24	25.8	33.7	0	0.8	1.6	3.28
25	25.3	35.9	0	0.4	0.4	3.75
26	25.0	34.8	0	0.0	0.0	3.65
27	26.0	34.4	0	0.0	0.0	3.51
28	26.4	34.6	0	0.8	2.8	3.91
29	26.7	34.4	0	0.0	0.0	3.63
30	25.7	35.4	0	0.2	0.6	4.50

Table 4.3 shows a complete hydrological data for the month of April 2016. This month is adequate to be analysed.

Table 4.4: Data for May 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	25.2	34.0	0	1.4	2.4	3.50
2	24.8	32.6	0	10.8	32.2	2.20
3	24.1	34.6	0	0.0	0.0	4.12
4	25.8	34.4	0	0.0	0.0	4.44
5	25.6	34.5	0	0.0	0.0	4.44
6	25.7	31.4	0	0.0	0.0	0.48
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15	-	-	-	-	-	-
16	-	-	-	-	-	-
17	-	-	-	-	-	-
18	-	-	-	-	-	-
19	-	-	-	-	-	-
20	-	-	-	-	-	-
21	-	-	-	-	-	-
22	-	-	-	-	-	-
23	-	-	-	-	-	-
24	-	-	-	-	-	-
25	-	-	-	-	-	-
26	-	-	-	-	-	-
27	-	-	-	-	-	-
28	-	-	-	-	-	-
29	-	-	-	-	-	-
30	-	-	-	-	-	-
31	-	-	-	-	-	-

Data for May 2016 is not complete. This is due to equipment error. Therefore data for may not be compared with other months to find the comparison.

Table 4.5: Data for June 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15	-	-	-	-	-	-
16	-	-	-	-	-	-
17	-	-	-	-	-	-
18	-	-	-	-	-	-
19	-	-	-	-	-	-
20	-	-	-	-	-	-
21	-	-	-	-	-	-
22	-	-	-	-	-	-
23	-	-	-	-	-	-
24	-	-	-	-	-	-
25	-	-	-	-	-	-
26	-	-	-	-	-	-
27	-	-	-	-	-	-
28	-	-	-	-	-	-
29	-	-	-	-	-	-
30	-	-	-	-	-	-

Data for June 2016 is also not complete due to equipment error. Month of June 2016 cannot be analysed and compared with other months

Table 4.6: Data for July 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	23.1	34.6	0	18.2	39.6	1.79
10	24.1	33.1	0	0.4	1.6	3.25
11	23.8	34.5	0	0.2	0.2	4.19
12	24.9	34.6	0	0.2	0.2	4.45
13	24.7	33.7	0	1.2	1.2	2.92
14	24.1	34.1	0	0.2	0.2	3.89
15	23.6	33.4	0	3.6	4.8	3.52
16	24.8	31.7	0	6.2	12.8	2.33
17	23.4	34.6	0	3.2	8.8	3.53
18	23.4	34.2	0	2.6	8.2	4.07
19	23.6	31.8	0	4.0	5.4	2.97
20	23.4	32.7	0	4.0	14.4	3.19
21	23.3	32.6	0	0.0	0.0	4.10
22	23.6	29.1	0	0.0	0.0	1.75
23	23.5	32.1	0	0.2	0.2	3.66
24	23.7	33.4	0	4.6	9.2	3.56
25	23.2	30.1	0	0.2	0.2	2.31
26	23.2	31.5	0	10.0	28.6	2.26
27	22.9	25.1	0	0.0	0.0	0.11
28	-	-	-	-	-	-
29	-	-	-	-	-	-
30	-	-	-	-	-	-
31	-	-	-	-	-	-

Data for July 2016 is also not complete due to equipment error. This month is not adequate to be analysed.

Table 4.7: Data for August 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15	-	-	-	-	-	-
16	-	-	-	-	-	-
17	-	-	-	-	-	-
18	-	-	-	-	-	-
19	-	-	-	-	-	-
20	-	-	-	-	-	-
21	-	-	-	-	-	-
22	26.6	28.9	0	0.0	0.0	0.03
23	23.9	34.6	0	4.8	11.6	4.05
24	24.3	31.6	0	0.2	0.2	2.62
25	24.7	33.8	0	2.2	4.0	3.69
26	24.2	32.7	0	0.2	0.4	2.77
27	24.6	30.5	0	0.0	0.0	1.95
28	24.2	32.2	0	5.6	27.4	2.31
29	23.7	33.4	0	2.6	5.8	3.63
30	23.6	27.9	0	4.6	21.6	1.20
31	23.3	33.8	0	0.0	0.0	4.75

Data for August 2016 is not complete due to equipment error. Therefore it is not suitable to be analysed.

Table 4.8: Data for September 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	24.7	33.6	0	5.0	8.0	3.54
2	23.3	32.7	0	0.0	0.0	3.29
3	23.3	34.5	0	0.0	0.0	4.86
4	23.8	33.1	0	5.2	6.0	3.37
5	24.0	34.3	0	0.2	0.2	4.34
6	23.3	33.6	0	11.0	25.0	3.32
7	23.5	30.8	0	0.0	0.0	2.68
8	23.2	31.6	0	15.4	37.4	2.68
9	23.1	33.2	0	0.2	0.2	4.51
10	23.4	33.1	0	0.0	0.0	4.47
11	24.3	33.9	0	0.2	0.6	3.74
12	23.6	31.8	0	7.4	14.4	3.31
13	23.7	34.2	0	0.0	0.0	4.38
14	24.1	32.9	0	5.8	7.8	3.63
15	24.2	34.8	0	1.6	5.0	4.06
16	24.1	33.2	0	0.0	0.0	3.40
17	24.4	32.2	0	0.2	0.8	2.99
18	22.7	33.4	0	8.6	27.6	2.12
19	22.3	33.2	0	0.2	0.6	4.02
20	24.2	32.8	0	0.0	0.0	3.59
21	23.7	29.4	0	14.0	40.2	1.27
22	23.4	28.9	0	0.2	1.2	1.82
23	23.3	33.3	0	0.4	1.2	4.44
24	23.4	33.6	0	0.2	0.4	4.06
25	22.4	30.5	0	5.0	25.6	2.62
26	23.1	33.4	0	0.0	0.0	4.10
27	22.3	34.3	0	3.2	17.8	4.57
28	23.0	32.9	0	0.6	1.0	4.19
29	24.1	32.1	0	0.2	0.2	3.20
30	32.7	32.9	0	1.0	1.2	3.42

Data for September 2016 is complete and adequate to be analysed.

Table 4.9: Data for October 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	22.5	33.2	0	11.6	22.0	3.86
2	25.0	33.8	0	0.0	0.0	4.40
3	25.2	32.2	0	0.0	0.0	3.15
4	24.5	34.2	0	2.6	6.2	3.03
5	23.7	32.8	0	0.0	0.0	3.58
6	23.0	31.3	0	0.6	1.2	2.79
7	22.5	31.1	0	0.2	0.2	2.92
8	24.4	32.7	0	0.0	0.0	3.68
9	24.4	32.3	0	0.6	2.4	2.19
10	23.7	34.1	0	0.4	0.8	4.18
11	23.8	34.4	0	0.2	0.4	4.56
12	23.2	34.3	0	15.2	43.6	4.20
13	23.5	33.1	0	1.2	2.8	4.16
14	23.7	32.7	0	8.6	15.8	3.55
15	23.8	32.8	0	0.0	0.0	3.64
16	24.4	31.1	0	16.2	55.4	2.21
17	24.4	30.3	0	0.2	0.2	1.89
18	25.4	31.2	0	0.0	0.0	1.97
19	24.3	30.7	0	2.0	10.2	1.71
20	24.3	33.8	0	0.6	1.2	3.67
21	25.3	32.8	0	0.2	0.4	3.28
22	24.4	28.2	0	3.4	9.2	1.16
23	23.8	32.6	0	0.4	1.8	3.37
24	23.6	33.8	0	0.4	4.2	3.97
25	23.7	32.2	0	10.6	19.2	2.87
26	23.0	32.8	0	1.6	6.8	3.09
27	23.6	29.1	0	0.8	13.4	1.29
28	23.1	32.7	0	0.2	0.2	3.91
29	23.7	31.3	0	11.6	34.2	2.67
30	23.2	31.7	0	9.8	17.0	2.92
31	23.2	32.8	0	9.4	27.2	4.35

Table 4.9 shows another complete hydrological data that is suitable to be analysed.

Table 4.10: Data for November 2016

Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)	Total Evapotranspiration (mm)
	Minimum	Maximum	Minimum	Maximum		
1	24.1	29.9	0	0.2	4.2	1.89
2	24.4	32.7	0	6.6	10.6	2.58
3	24.0	32.0	0	0.0	0.0	3.21
4	23.8	31.9	0	4.2	7.6	3.03
5	23.5	31.7	0	15.0	57.6	2.26
6	23.2	33.4	0	4.4	14.4	3.97
7	23.2	30.4	0	9.2	40.2	1.82
8	24.4	33.7	0	2.6	3.2	4.03
9	23.9	32.2	0	5.4	17.6	2.90
10	23.3	31.6	0	3.8	6.4	3.26
11	24.0	30.3	0	1.8	3.4	1.66
12	23.4	29.9	0	3.6	7.6	2.29
13	22.8	31.2	0	1.6	1.8	2.93
14	24.0	26.1	0	3.2	13.2	0.43
15	22.3	31.9	0	0.8	2.0	3.07
16	23.7	28.4	0	0.6	2.8	1.65
17	23.6	32.6	0	5.6	18.6	3.73
18	23.7	31.9	0	0.6	2.6	3.72
19	24.6	31.7	0	1.0	2.2	3.72
20	24.3	33.6	0	9.6	26.4	3.26
21	24.5	32.5	0	0.8	0.8	2.92
22	24.6	31.6	0	7.4	22.4	2.21
23	23.9	32.8	0	0.2	0.2	3.75
24	24.1	29.7	0	2.4	12.6	1.96
25	24.3	31.4	0	11.8	27.2	2.15
26	24.0	30.6	0	4.4	11.0	1.50
27	24.4	29.9	0	0.4	0.8	2.31
28	23.6	30.3	0	0.2	0.8	2.20
29	22.9	26.2	0	1.4	40.2	0.24
30	22.2	32.2	0	0.0	0.0	4.27

Table 4.10 shows data for November 2016. The data is complete and adequate to be analysed.

Table 4.11: Summary of Data for UMP Gambang Campus

Months	Total Rainfall (mm)	Total Evapotranspiration ET (mm)	Maximum Temperature (˚C)	Minimum Temperature (˚C)	Average Rainfall mm/day	Average ET mm/day
Mar-15	37.6	137.40	34.8	21.8	1.2	0.7
Apr-15	57.4	124.08	36	22.9	1.9	0.8
May-15	114	110.86	34.6	23.1	3.7	0.7
Jun-15	29	97.87	34.7	23	1.0	0.8
Jul-15	58.8	110.84	34.9	21.1	1.9	0.7
Aug-15	113.8	80.67	35.7	22.7	3.7	0.7
Sep-15	116	98.56	34.2	22.7	3.9	0.8
Oct-15	102.4	95.92	35.1	22.8	3.3	0.7
Nov-15	157.2	89.55	33.6	23	5.2	0.8
Dec-15	225.6	90.33	34.1	21.7	7.3	0.7
Jan-16	52.0	62.62	33.6	23.6	1.7	0.8
Feb-16	137.4	106.38	32.9	22.1	4.7	0.8
Mar-16	33.0	140.55	34.3	22.4	1.1	0.7
Apr-16	32.2	126.75	36.2	23.4	1.1	0.8
May-16	34.6	19.18	34.6	24.1	1.1	0.8
Jun-16	0	0.00	0	0	0.0	0.0
Jul-16	135.6	57.85	34.6	22.9	4.4	0.7
Aug-16	71	27.00	34.6	23.3	2.3	0.8
Sep-16	222.4	102.57	34.8	22.3	7.4	0.7
Oct-16	296.0	98.22	33.3	22.2	9.5	0.7
Nov-16	358.4	78.47	29.7	23.4	11.9	0.8

In table 4.11, the incomplete data are in the months of May 2016, June 2016, July 2016, and August 2016. Therefore these months are not adequate to be analysed. Hydrological data for March 2015 until January 2016 are obtained from thesis of previous student so that can have longer set of data for analysis .

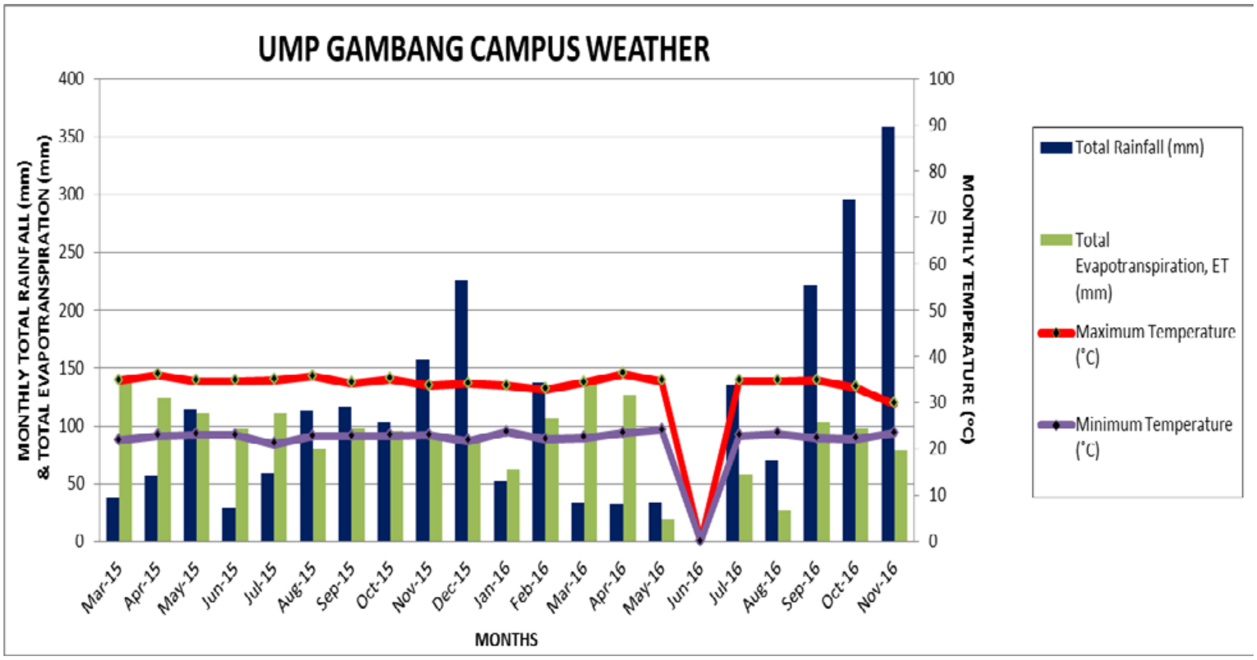

Figure 4.1: UMP Gambang Campus Weather

Based on figure 4.1, data shows from March 2015 to November 2016. The highest total rainfall is the month of November 2016 which is 358.4mm. The lowest total evapotranspiration is also in the month of November which is 78.47mm. The lowest maximum temperature is also in the same month which is 29.7˚C. November 2016 has the highest average rainfall compared to other months which is 11.9mm/day. This shows that rainfall can affect the temperature and evapotranspiration reading.

March 2015 shows that the total rainfall value is low but the total evapotranspiration is high. From there, the total rainfall value starts to rise gradually until it reach it's peak in the month of December 2015 but the total evapotranspiration decrease for that month. After that the total rainfall starts to decrease again in the next few months and increase gradually again until it reach the highest peak on November 2016. On the other hand, the total evapotranspiration shows increase pattern for the next few months after December 2015. It then decreases gradually to it's lowest value in the months of November 2016.

Table 4.12: Summary of Data for UMP Pekan Campus

Months	Total Rainfall (mm)	Average rainfall (mm/day)	Maximum Temperature (˚C)	Minimum Temperature (˚C)
Oct-15	19.5	0.6	39.1	20.1
Nov-15	176.9	5.9	39.5	23.1
Dec-15	0	0.0	0	0
Jan-16	95.8	3.1	38.9	22.6
Feb-16	75.7	2.6	38.8	23
Mar-16	41.3	1.3	37.4	22.6
Apr-16	27.5	0.9	40	23.2
May-16	211.8	6.8	41.1	23.4
Jun-16	58.2	1.9	40	22.7
Jul-16	83	2.7	39.5	22.3
Aug-16	109.7	3.5	40.2	22.5
Sep-16	91.5	3.1	39.4	21.1
Oct-16	299.9	9.7	41.3	21.9

Table 4.13 shows that the data for December 2015 is not complete. It is due to equipment error.

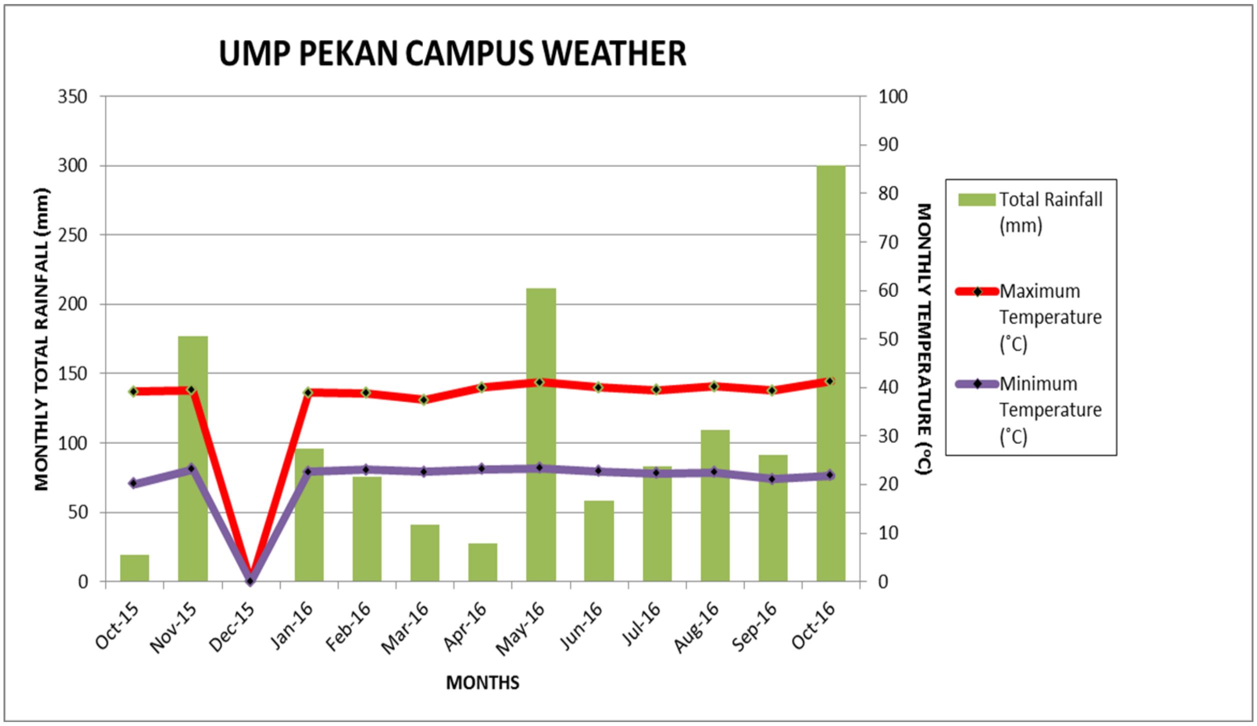

Figure 4.2: UMP Pekan Campus Weather

Figure 4.2 shows data from October 2015 to October 2016. The data for the month of October 2015 until January 2016 are taken from previous thesis of student so that the figure 4.2 would show one year set of data. The highest total rainfall is in October 2016 which is 299.9mm. The highest maximum temperature is also in the same month which is 41.3˚C. This shows that the weather pattern in UMP Pekan campus is very different from the weather pattern in UMP gambang campus. This is due to different in location of weather station.

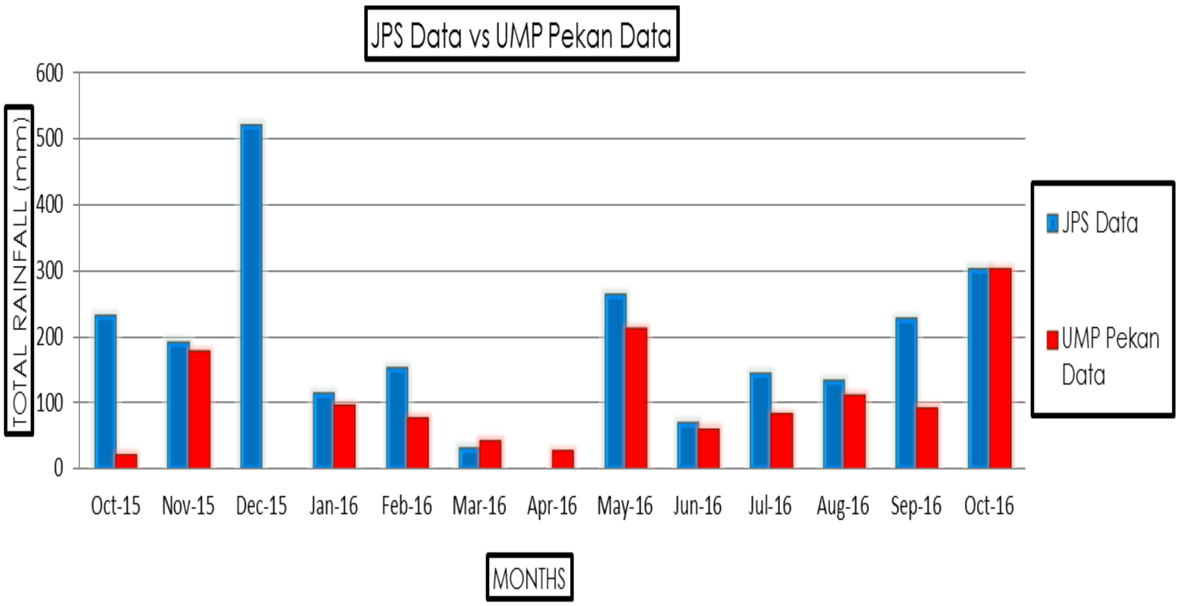

Figure 4.3: JPS Data vs UMP Pekan Data

Figure 4.3 shows data comparison between Jabatan Pengairan dan Saliran (JPS) Pahang data and UMP Pekan data from the month of October 2015 until October 2016. In the months of October 2016, both weather stations recorded that the value of total rainfall for both JPS and UMP Pekan is nearly the same which is 300 mm despite having 9.30 km distance apart from each other.

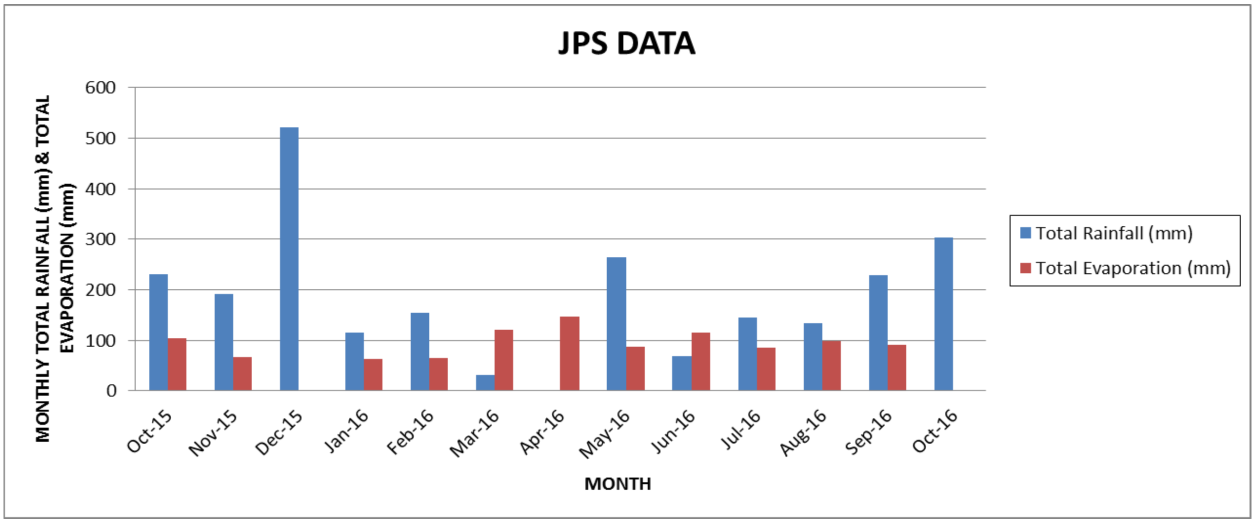

Figure 4.4: JPS Pahang Data for Rainfall and Evaporation

Figure 4.4 shows data for evaporation in UMP Pekan is taken from the JPS Pahang, and is compared with the total rainfall to find the relationship between the rainfall and evaporation. From figure 4.4, the data for all months are not complete for evaporation and thus is not readily to be analysed.

4.3 TREND TEST

Mann-Kendall trend test / Two-tailed test (Total Rainfall (mm)):

Kendall's tau	0.248
S	52.000
Var(S)	0.000
P-value (Two-tailed)	0.126
Alpha	0.05

THE P-VALUE IS COMPUTED USING AN EXACT METHOD.

TEST INTERPRETATION:

H0: THERE IS NO TREND IN THE SERIES

H1: THERE IS A TREND IN THE SERIES

AS THE COMPUTED P-VALUE IS GREATER THAN THE SIGNIFICANCE LEVEL ALPHA=0.05, ONE CANNOT REJECT THE NULL HYPOTHESIS H0.
THE RISK TO REJECT THE NULL HYPOTHESIS H0 WHILE IT IS TRUE IS 12.57%.

Sen's slope:	6.46
Confidence interval:	] 4.029,7.573 [

Figure 4.5: Trend test result for UMP Gambang campus

The mann kendall trend test is carried out by using Excel Addinsoft XL-STAT computer software. The trend test result in figure 4.5 indicate that there is no trend for UMP Gambang campus. The risk to reject this result is 12.57% which is small. The reason for no trend is because the rainfall data for UMP Gambang campus is not complete.

Mann-Kendall trend test / Two-tailed test (Total Rainfall (mm)):

Kendall's tau	0.359
S	28.000
Var(S)	0.000
P-value (Two-tailed)	0.100
Alpha	0.05

THE P-VALUE IS COMPUTED USING AN EXACT METHOD.

TEST INTERPRETATION:

H0: THERE IS NO TREND IN THE SERIES

H1: THERE IS A TREND IN THE SERIES

AS THE COMPUTED P-VALUE IS GREATER THAN THE SIGNIFICANCE LEVEL ALPHA=0.05, ONE CANNOT REJECT THE NULL HYPOTHESIS H0.
THE RISK TO REJECT THE NULL HYPOTHESIS H0 WHILE IT IS TRUE IS 10.00%.

Sen's slope: 8.693

Confidence interval:] 6.979,9.898 [

Figure 4.6: Trend test result for UMP Pekan campus

The trend test result in figure 4.6 indicate that there is no trend for UMP Pekan campus. The risk to reject this result is 12.57% which is small. The reason for no trend test is because the rainfall data for UMP Pekan is not complete.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Referring the objectives of the thesis, the objective no. 1 has been achieved. The relationship between the rainfall data, temperature data, evaporation data, and evapotranspiration data simplify the hydrologic weather pattern in Universiti Malaysia Pahang (UMP) Gambang and Pekan campus. In UMP Gambang campus, for certain month, the monthly total rainfall is low while the monthly total evapotranspiration is high, and vice versa. This shows that there is an inverse or negative relationship between rainfall and evapotranspiration.

In UMP Pekan Campus, the total rainfall is compared with the temperature and it seems that there is a linear relationship between rainfall and temperature because in a the total rainfall is highest when the maximum temperature is reached in a particular month. This shows a different weather pattern compared to the weather pattern in UMP Gambang campus. This is because the weather station for UMP Gambang is located in urban area while the weather station for UMP Pekan campus is located in rural area.

Objective no. 2 is not achieved. The mann kendall trend test indicate that there is no trend in terms of rainfall for UMP Gambang campus and UMP Pekan campus. This is because the rainfall data is incomplete. This is also could be due to having a short duration set of data.

5.2 RECOMMENDATIONS

The rainfall data for both location of UMP Gambang campus and UMP Pekan campus are not complete. This is due to the equipment error such as short battery life. One way to have a complete data is to monitor closely the weather station and extracting it's data frequently to prevent data loss.

The mann kendall test indicate that there is no trend in terms of rainfall for both UMP Gambang and Pekan campus. The mann kendall test requires a longer duration set of data or a complete set of data for it to have 'there is a trend' result.

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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

Data for April 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	23.6	32.6	0.2	0.2	0.2
2	23.9	31.5	0.2	3	6.2
3	23.2	33.9	0.2	0.2	0.2
4	24.8	33.9	0	0	0
5	24.6	33.4	0	0	0
6	24.3	35.2	0	0	0
7	26.2	33.3	0	0	0
8	25.8	34.4	0	0	0
9	25.9	32.2	0.4	0.6	1
10	24.8	31.6	0.2	2.8	9.2
11	24.3	33.1	0	0	0
12	24.5	33.2	0	0	0
13	24.4	33.9	0	0	0
14	24.2	32.6	0.2	0.6	1
15	24.8	32.5	0.2	0.2	0.4
16	24.6	32.2	0	0	0
17	25.2	34	0	0	0
18	24.2	34.9	0	0	0
19	25.4	34.9	0.2	1	2
20	24.6	36	0	0	0
21	24.1	34.4	0.4	0.6	2.4
22	23.5	34.8	0.2	0.2	0.2
23	25.8	32.8	0	0	0
24	24.4	33.3	0.2	0.2	0.2
25	24.2	31.3	0.2	9.4	23
26	24.3	33.1	0.2	0.2	0.4
27	24.7	32.6	0.2	0.4	2
28	22.9	33.4	0	0	0
29	24.7	33.1	0	0	0
30	24.1	33.4	0.2	4.6	9

Data for May 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	23.3	33.9	0	0	0
2	24.3	33.1	0.4	0.8	1.2
3	23.1	31.3	0	0	0
4	24.3	33.6	0	0	0
5	23.8	33.4	0.4	1.6	2.4
6	23.8	32.5	0.2	0.2	0.2
7	25.4	33.6	0	0	0
8	25.8	33.9	0	0	0
9	25.1	33.3	0.2	0.2	0.2
10	25	33.8	0	0	0
11	26.1	32.4	0	0	0
12	25.5	34.2	0.4	1	2.2
13	24.3	33.8	0.2	0.2	0.2
14	24.7	33.8	0.6	1	1.6
15	24.6	33.4	0.2	0.2	0.2
16	25.7	34.4	0	0	0
17	24.7	34.6	0.2	6.2	30.4
18	24	33.9	0.2	9.8	33.4
19	23.9	34.1	0	0	0
20	24.8	33.3	0	0	0
21	24.4	33.7	0.2	0.4	0.6
22	25	33.9	0	0	0
23	24	31.6	0	0	0
24	25.7	32.4	0	0	0
25	23.6	34.4	0.2	3.6	6.6
26	24.1	31.8	0.2	0.2	0.2
27	23.8	33.1	0.6	1.2	2.8
28	23.1	34	0.2	15.6	27.6
29	23.7	32.7	0.2	3.6	4.8
30	25.1	33.2	0	0	0

Data for June 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	24.1	32.7	0	0	0
2	24.8	33.5	0	0	0
3	23.4	33	0	0	0
4	24.3	33	0	0	0
5	24.5	34.7	0	0	0
6	24.1	33.8	0	0	0
7	24.5	33.8	0	0	0
8	24.8	34.6	0.2	0.2	0.2
9	23.8	33.8	0.2	2.6	5.4
10	-	-	-	-	-
11	-	-	-	-	-
12	-	-	-	-	-
13	-	-	-	-	-
14	23	31.8	0.2	0.2	0.2
15	24.3	31.2	0.2	0.6	2
16	24.1	30.8	0	0	0
17	24.2	30.6	0	0	0
18	24.1	33.7	0.2	7.2	10
19	23.9	33.4	0.2	0.2	0.2
20	24.8	33.1	0	0	0
21	25.6	33.6	0	0	0
22	25.3	33.4	0	0	0
23	25.4	34.6	0	0	0
24	24.6	34.1	0	0	0
25	24.8	34.6	0.2	6	11
26	25.3	33.8	0	0	0
27	26.3	34.1	0	0	0
28	25.9	34.6	0	0	0
29	24.4	34.7	0	0	0
30	25.5	34.1	0	0	0

Data for July 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	25.1	32.1	0	0	0
2	24.3	34.9	0.2	7.6	22.2
3	24.9	32.9	0.2	0.4	0.6
4	24.6	33.3	0.2	0.2	0.2
5	24.2	33.9	0	0	0
6	24.4	33.6	0	0	0
7	25.5	32.1	0.2	1.2	4
8	24	31.6	0.2	0.2	0.8
9	24	34.9	0	0	0
10	25.3	32.4	0	0	0
11	25.2	32.6	0	0	0
12	25.1	34.5	0	0	0
13	25.5	33.6	0	0	0
14	25.8	31.7	0	0	0
15	24.9	34.4	0	0	0
16	24.6	34.5	0	0	0
17	24.5	34.6	0.2	2	4.4
18	24.9	33.6	0.2	0.2	0.2
19	23.4	33	0.2	5	13.4
20	23.7	32.8	0.2	0.2	0.2
21	23.5	33.3	0.2	2.6	7
22	22.6	32.9	0.2	0.2	0.2
23	25	32.6	0.2	1.6	3
24	24.6	32.5	0	0	0
25	24.1	34.1	0	0	0
26	23.2	33.2	0	0	0
27	22.1	33.9	0	0	0
28	22.7	34.1	0	0	0
29	24.5	31.7	0	0	0
30	23.6	33.6	0	0	0
31	23.8	32.9	0.2	1	2.6

Data for August 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	23.6	30.9	0.2	0.4	1.8
2	22.8	34.4	0.2	0.4	0.6
3	23.4	31	0.2	4.4	24
4	23	31.6	0.2	0.2	0.2
5	-	-	-	-	-
6	-	-	-	-	-
7	-	-	-	-	-
8	-	-	-	-	-
9	-	-	-	-	-
10	25.6	31.3	0.2	0.2	0.2
11	24.4	33.2	0.2	5.2	20.8
12	23.3	32.3	0.2	2	3.8
13	24.3	34.2	0.2	0.2	0.2
14	25.3	34.1	0.2	0.2	0.2
15	25.7	32.4	0	0	0
16	25	30.9	0.2	0.6	1
17	23.8	33.9	0	0	0
18	24.7	34.2	0	0	0
19	25	34.2	0.2	0.8	1.6
20	24.9	33.6	0.4	0.4	0.8
21	24.7	35.4	0	0	0
22	24.2	35.7	0	0	0
23	25.2	32.6	0.2	9.2	15.8
24	22.7	31.1	0.2	8.4	42.6
25	24.4	31.4	0.2	0.2	0.2
26	24.6	30.1	0	0	0
27	-	-	-	-	-
28	-	-	-	-	-
29	-	-	-	-	-
30	-	-	-	-	-
31	-	-	-	-	-

Data for September 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	24.6	34.2	0	0	0
2	24.1	33.7	0	0	0
3	25.7	33	0	0	0
4	24.9	33.3	0.2	0.6	1.2
5	24.7	33.6	0	0	0
6	25.1	32.3	0	0	0
7	22.7	33.8	0.2	3.2	11.2
8	23.1	31.8	0.2	3.6	6.4
9	24	31.6	0	0	0
10	23.8	32.3	0.2	9.2	14
11	23.2	31.2	0	0	0
12	24.9	32.1	0	0	0
13	23	31.6	0.2	7.6	45.2
14	25.4	31.5	0	0	0
15	26	31.8	0	0	0
16	24.5	31.2	0.2	4.2	11
17	23.5	31.2	0.2	5.8	12.8
18	-	-	-	-	-
19	24.2	32.9	0.2	0.2	0.2
20	24.6	32.8	0	0	0
21	23.2	33.6	0	0	0
22	23.4	32.6	0.2	3	5.2
23	24.3	32.1	0	0	0
24	23.9	31.8	0	0	0
25	23.6	32.4	0	0	0
26	24.9	32.8	0	0	0
27	25.4	32.2	0	0	0
28	24.1	30.4	0.2	2.6	8.8
29	24.4	31.1	0	0	0
30	23.3	32.4	0	0	0

Data for November 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	23.9	32	0.2	5.8	14.2
2	23.2	31.8	0.2	0.2	0.6
3	23.9	31.8	0.2	0.6	1.4
4	24	31.1	0.2	0.2	0.4
5	24.3	33.6	0.2	0.4	3.4
6	23.9	32.6	0.2	0.4	1.4
7	23.3	32.5	0.2	3.2	8
8	23.8	31.6	0	0	0
9	23	31.6	0	0	0
10	24.6	32.8	0	0	0
11	23.6	32	0.2	1.2	3.8
12	23.4	33.4	0	0	0
13	24.6	31.7	0.2	0.4	0.6
14	23.7	32	0.2	0.4	0.6
15	23.8	31.7	0.2	0.8	1.8
16	24.4	30.3	0.2	0.8	5.8
17	24	28.9	0.2	0.4	2.6
18	24.2	31.5	0	0	0
19	24.3	33.4	0	0	0
20	24.3	30.8	0.2	5.6	17
21	23.5	30.9	2.2	2.2	2.2
22	23.1	32.3	0.2	5.2	20.2
23	23.6	32.9	0.2	0.6	10
24	23.8	32.3	1.6	9	21.2
25	23.7	32.6	0.2	1.2	4
26	24.6	30.2	0.2	3.2	15.2
27	24.1	26.9	0.2	0.6	6.2
28	23.9	29.9	0.2	0.2	1.4
29	23.6	31.3	0.2	3.2	14.8
30	24.9	31	0.2	0.2	0.4

Data for December 2015					
Day	Temperature (˚C)		Rainfall (mm)		Total Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
1	23.4	32.3	0.2	1.2	2
2	24.1	30.4	0.2	0.2	0.8
3	23.6	32.4	0	0	0
4	23.6	31.4	0.4	3.2	7
5	24.1	31.8	0.2	1.2	1.6
6	24.7	31.6	0.4	8.6	25.8
7	23.9	30.2	0.2	1.6	10.6
8	24.6	30.8	0.2	6.2	9.8
9	23	30.7	0.2	3.2	14.4
10	23.7	30.8	0.2	0.4	0.6
11	-	-	-	-	-
12	-	-	-	-	-
13	24.6	31.4	0.8	52.6	54
14	23.3	32.6	0	0	0
15	23.2	32.8	0	0	0
16	23.2	32.2	0	0	0
17	25	29.7	0.8	11.8	22.8
18	24.4	30.1	0.8	6.6	7.4
19	24.8	30.9	0	0	0
20	21.7	31.8	0	0	0
21	22.4	32.6	0	0	0
22	23.1	34	0	0	0
23	24.5	34.1	0	0	0
24	24.9	32.3	0	0	0
25	25.6	30.7	0.8	6	6.8
26	24.4	32.3	0	0	0
27	24.3	30	1.2	80.6	23.2
28	23.4	25.2	0.8	76.8	16.2
29	24.6	30.7	0.8	48	22.6
30	-	-	-	-	-
31	-	-	-	-	-

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

Data for November 2015			
Day	Temperature (˚C)		Total Rainfall (mm)
	Minimum	Maximum	
1	25.6	31.0	0.0
2	25.0	30.8	0.0
3	25.6	31.3	0.0
4	25.8	30.6	0.4
5	26.2	39.5	3.2
6	24.5	35.0	3.2
7	23.1	36.6	8.1
8	24.1	37.2	1.2
9	23.3	39.4	0.0
10	24.6	36.6	0.0
11	23.8	37.2	1.7
12	24.2	36.9	0.2
13	24.4	37.9	0.9
14	24.1	37.7	0.3
15	23.6	36.0	7.8
16	23.4	32.6	27.5
17	23.7	32.6	17.6
18	24.4	36.2	0.1
19	24.4	36.7	0.5
20	23.8	28.6	28.4
21	23.5	36.9	0.0
22	23.6	37.4	65.4
23	23.3	35.4	9.8
24	23.8	35.8	2.0
25	24.0	34.0	1.7
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
31	0.0	0.0	0.0

APPENDIX C – JPS DATA

~~ NIWA Tideda ~~~ JPS Ampang						28-Nov-16		15:18	
~~ PDAY ~~~ VER 1.9									
Source is F: \datatideda\MINILOG.mtd									
24 hour periods ending at 8 : 00 : 00am each day.									
Daily totals			Year 2015		site 3533102 RUMAH PAM PAHANG TUA at PEKAN, PAHANG				
Rain mm									
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
1	?	0.0	0.0	6.5	6.0	0.0	0.0	52.5	0.0	0.0
2	2.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
3	0.0	2.5	0.0	9.5	12.5	0.0	0.0	2.5	0.0	9.0
4	0.0	51.0	0.0	0.0	0.0	0.0	12.5	10.5	0.0	0.0
5	2.0	2.5	0.0	0.0	1.0	0.0	0.0	0.0	17.5	0.0
6	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
7	0.5	0.5	0.0	0.0	0.5	0.0	0.0	1.0	0.0	71.5
8	21.5	0.0	4.5	0.0	4.5	0.0	9.0	3.5	26.0	0.0
9	145.5	6.5	4.0	2.5	0.0	3.0	2.5	36.5	3.0	3.5
10	195.5	4.5	1.5	0.0	0.0	0.5	0.0	0.0	8.0	0.0
11	1.5	0.5	0.5	1.5	0.0	0.0	4.0	0.0	10.0	0.0
12	0.0	0.0	0.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	0.0
14	3.0	0.0	0.0	0.0	0.5	0.0	0.5	0.5	0.0	0.0
15	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	13.0	0.0	5.5	0.0	0.5	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	3.5	10.0	0.5	16.0	0.0
18	0.0	0.0	0.0	0.0	13.5	0.5	0.0	0.0	2.0	0.0
19	0.0	0.0	0.0	0.0	0.5	0.5	0.0	9.5	0.5	6.5
20	2.5	0.5	0.0	0.5	0.0	4.5	3.5	0.0	12.5	0.0
21	0.5	0.0	0.0	0.0	0.0	0.5	1.0	0.0	0.0	0.0
22	0.0	0.0	0.0	2.0	1.0	0.0	0.5	0.5	0.0	0.0
23	0.0	0.0	0.0	0.0	9.5	0.0	0.0	44.5	0.0	0.0
24	3.5	0.0	0.0	4.0	0.0	0.0	0.0	3.0	0.0	35.0
25	0.5	0.0	78.0	10.5	0.0	0.0	0.0	1.0	0.0	24.5
26	0.0	0.0	2.5	29.5	0.0	3.5	0.0	0.0	0.0	13.0
27	0.0	0.0	15.0	11.0	0.0	0.0	0.0	5.0	0.0	3.0
28	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	0.0
29	7.5	-	0.0	20.0	0.0	0.0	0.0	0.0	0.0	13.5
30	30.5	-	22.5	0.0	1.0	0.0	0.0	1.0	0.0	15.5
31	0.0	-	13.5	-	0.0	-	0.0	0.0	-	33.0
Minimum value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	417.0	73.0	142.0	111.0	52.5	22.0	44.0	175.5	113.5	231.5
Maximum value	195.5	51.0	78.0	29.5	13.5	5.5	12.5	52.5	26.0	71.5
NO. > 0.0	15	10	9	13	13	9	10	19	10	12

Daily totals		Year 2016		site 3533102 RUMAH PAM PAHANG TUA at PEKAN, PAHANG						
Rain mm										
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
1	?	0.5	0.0	0.0	0.0	2.0	10.5	30.5	0.0	6.5
2	3.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
3	10.0	12.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
4	0.5	20.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0
5	0.3	7.5	0.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0
6	0.2	10.0	4.0	0.0	27.5	0.0	0.0	2.0	1.0	61.5
7	0.0	5.5	0.0	0.0	0.5	0.0	0.0	0.5	0.5	2.0
8	0.0	11.5	0.5	0.0	2.5	0.0	2.0	10.5	0.0	0.5
9	0.0	0.5	0.0	0.0	0.5	19.5	0.0	0.0	56.0	0.0
10	0.0	0.5	0.0	0.0	0.0	16.0	0.0	0.0	0.0	?
11	0.0	6.0	0.0	0.0	0.0	0.0	14.0	5.0	0.0	5.0
12	0.0	0.5	0.0	0.5	0.0	9.5	0.0	0.5	6.0	0.5
13	0.0	3.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	15.0
14	0.0	2.0	0.0	0.0	0.0	0.0	36.5	0.0	1.5	12.0
15	15.5	0.0	0.0	0.0	0.0	5.0	31.0	0.0	31.0	0.5
16	0.0	12.0	0.0	0.0	4.5	0.5	2.5	0.0	10.0	1.0
17	3.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.5	0.0
18	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	12.0	0.0	0.0	7.0	4.0	0.0	6.5	5.0	6.0
20	0.0	14.0	0.0	0.0	0.0	0.0	32.0	34.0	0.5	2.0
21	0.0	0.0	0.0	0.0	44.0	0.0	2.0	7.5	4.0	37.0
22	38.5	0.0	0.0	0.0	2.0	2.5	0.0	4.0	4.0	3.5
23	14.5	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.5
24	0.5	0.0	0.0	0.0	0.0	0.0	7.0	18.5	13.0	21.5
25	3.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	42.0	0.0
26	5.0	0.0	0.0	0.0	44.5	0.0	0.0	3.5	0.0	63.0
27	0.0	0.5	0.0	0.0	0.0	0.0	0.0	1.5	48.5	8.5
28	0.5	1.5	0.0	0.0	36.5	0.0	0.0	0.0	3.0	20.5
29	0.5	25.0	26.0	1.5	0.0	0.0	0.0	0.0	0.0	2.5
30	0.0	-	0.0	0.0	48.5	0.0	0.0	0.0	0.0	18.5
31	0.0	-	0.0	-	38.0	-	6.0	8.0	-	14.5
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	95.5	154.0	30.5	2.5	264.5	69.5	144.5	133.0	228.5	303.5
Max	38.5	25.0	26.0	1.5	48.5	19.5	36.5	34.0	56.0	63.0
No>0.0	14.0	20.0	3.0	3.0	0.0	11.0	11.0	15.0	17.0	22.0

~~~ NIWA Tideda ~~~ JPS Ampang 28-Nov-16 15:13
~~~ PDAY ~~~ VER 1.9
Source is F:\datatideda\EVAPORAT.MTD
24 hour periods ending at 8 : 00 : 00am each day.

Daily totals Year 2015 site 3533302 Rumah Pam Pahang Tua at Pekan, Pahang

Day	October	November	December
1	?	?	?
2	5.0	4.0	?
3	7.0	3.5	?
4	4.0	3.0	?
5	4.0	?	?
6	3.0	?	?
7	?	3.0	?
8	?	3.5	?
9	5.5	4.0	?
10	4.0	5.5	?
11	5.0	3.0	?
12	4.0	3.0	?
13	4.0	5.0	?
14	5.0	5.0	?
15	4.0	?	?
16	3.0	?	?
17	4.0	?	?
18	4.0	4.0	?
19	4.0	5.0	?
20	4.0	3.0	?
21	4.0	3.0	?
22	4.0	?	?
23	4.0	?	?
24	?	3.5	?
25	?	4.5	?
26	?	?	?
27	3.0	?	?
28	4.0	?	?
29	4.5	?	?
30	7.5	2.0	?
31	?	-	?
Minimum value	3.0	2.0	?
Total	104.5	67.5	?
Maximum value	7.5	5.5	?
NO. > 0.0	24	18	0

Daily totals		Year 2016		site 3533302 Rumah Pam Pahang Tua at Pekan, Pahang						
Evaporat. Mm										
Day	January	February	March	April	May	June	July	August	September	October
1	?	?	?	?	4.0	?	?	?	4.0	?
2	5.0	4.0	4.0	4.0	4.5	6.0	?	?	4.0	?
3	4.0	?	4.0	5.0	5.0	5.0	4.0	4.5	5.0	?
4	3.0	?	5.0	4.0	4.5	4.0	4.0	4.0	4.0	?
5	4.0	3.0	5.0	4.0	5.0	4.0	5.0	3.0	4.0	?
6	4.0	5.0	5.0	4.0	?	5.0	4.0	5.0	3.0	?
7	4.0	4.5	4.0	5.0	?	5.0	2.0	4.5	5.0	?
8	4.0	?	4.5	4.0	4.5	5.0	5.0	3.5	4.0	?
9	4.0	?	5.0	5.0	3.5	?	4.0	3.0	?	?
10	4.0	6.0	4.0	5.0	4.0	?	4.0	3.0	?	?
11	4.0	5.0	5.0	4.0	4.5	?	?	4.0	4.0	?
12	5.5	5.0	5.0	5.0	5.0	5.0	?	3.5	5.0	?
13	?	3.0	4.0	5.5	4.0	3.5	4.0	4.0	3.0	?
14	?	?	5.0	5.0	5.0	4.0	?	4.0	4.5	?
15	?	?	4.0	6.0	3.0	5.0	?	3.0	?	?
16	?	?	4.0	5.0	4.5	5.5	?	5.0	?	?
17	4.0	?	4.0	5.0	4.0	4.0	4.0	3.0	3.5	?
18	4.0	4.5	5.0	7.0	4.0	3.0	5.0	4.0	4.0	?
19	4.0	5.0	4.0	5.0	3.0	5.0	4.0	4.5	4.0	?
20	3.0	?	4.0	5.0	4.0	4.0	?	?	4.5	?
21	3.0	?	4.0	6.0	?	5.0	?	?	5.0	?
22	?	4.0	5.0	5.0	?	4.5	4.0	5.0	3.0	?
23	?	3.0	4.0	7.0	3	3.0	5.0	4.0	4.0	?
24	?	4.0	3.0	5.0	4	4.0	3.0	?	5.0	?
25	?	5.0	7.5	5.0	4	5.5	2.0	?	?	?
26	?	4.0	5.5	5.0	?	5.0	3.5	4.5	?	?
27	?	?	4.0	5.0	?	4.0	4.0	5.5	?	?
28	?	?	?	5.0	?	4.0	4.0	4.0	?	?
29	?	?	?	5.0	?	4.0	3.0	4.0	5.0	?
30	?	-	?	5.5	?	4.0	4.0	3.0	4.0	?
31	?	-	4.0	-	?	-	4.0	3.0	-	?
Minimum value	3.0	3.0	3.0	4.0	3.0	3.0	2.0	?	?	?
Total	63.5	65.5	121.5	146.0	87.0	116.0	85.5	?	?	?
Maximum value	5.5	6.0	7.5	7.0	5.0	6.0	5.0	?	?	?
NO. > 0.0	16	15	27	29	21	26	22	0	0	0