Rainfall Trend Analysis using Box Plot Method: Case Study UMP Campus Gambang and Pekan

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Abstract. Climate change leads to changes in precipitation. This phenomenon has already begun 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, shows weather pattern at campus Universiti Malaysia Pahang (UMP) in Gambang and Pekan. By monitoring of the weather conditions, it can help in controlling the activity in the UMP. Besides, weather data is very important in our life as the rainfall is an important consideration in design runoff conveyance and erosion control. Changing trend in rainfall distribution also gives an effect on hydrological analysis especially related to historical rainfall record. Box-plot method was used to determine the rainfall trend of hydrologic cycle. It is shown that the rainfall data that was collected that the rainfall event differs every year, as an example for 2016, a total of 1982.9 mm was collected and year after it decreased sharply to 994.7 mm in 2017 and for 2018 raised slightly to 1020.9 for UMP Pekan. Whereas for UMP Gambang, 1072.8 mm in 2016, and also decreased slightly to 972.5 mm in 2017 and in 2018 increased to 1309.8 mm. It shows that each year trend of rainfall for each UMP campuses had change.

1. Introduction

The normal features of the climate of Malaysia are uniform temperature, extensive rainfall and high humidity. 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 [2]. 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% [3]. The climate is affected by the northeast and southwest monsoons, tropical wind that alternative during the course of the year. The direction of the wind in this inter-monsoon season is variable and usually more than 10 knots [4]. Due to the seasonal rainfall in Malaysia, the probability of occurrence of rainfall amount is varied during the whole year [5]. The northeast monsoon blows from November to March and the southwest monsoon from May to September. The increase in temperature and rainfall will affect the water resources [6].

Daily human activity is influenced by weather conditions, monitoring of weather conditions can help in controlling the activity. The behavior of and pattern changes of the weather is not all the same in the UMP Gambang and UMP Pekan area and its nearest place. Differences in the magnitude of rainfall in various parts at a given time and variation of rainfall at a place in various seasons of the year are obvious and need no elebration [7]. It is important to monitor and study the pattern of weather at surrounding. Other than that, the weather consists of wind, humidity, temperature and precipitation. The pattern and trend of weather at Gambang and Pekan area can be identify by making analysis study.
of hydrological data from hydrological station. The primary goal of this project is to conduct experimental studies to identify the trend of rainfall event at UMP Gambang and Pekan campus. Studying the weather is a remote part of science. It will be able to study faraway places weather without ever having to go there. A weather station is a weather observation facility with tools and equipment to monitor atmospheric conditions to study the weather. It helps people measure wind, air pressure, rainfall, moisture and temperature. All data will be collected from the instruments used and compared with the weather data of the station in Kuantan. To search for patterns and trends, all weather data collected from the previous one week period will use and analyze it using graph, chart and averages. Data interpretation will be based on computational skills. The weather can be described from the graph or chart and how weather affects everyday life.

A rain gauge is an instrument that can be used in a given time period to measure the amount of rainfall received in the area. Rain gauge is a simple tool that can be installed and used. 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 [8]. The rain gauge can be used to measured the amount of rainfall since it has a high level of accuracy in measuring the amount of rainfall [9].

2. Study Area
The rain gauge was set up at the field at KolejKediaman 2 (KK2) in Universiti Malaysia Pahang (UMP) Campus Gambang (Figure 1). The field at KolejKediaman 2 (KK2), Universiti Malaysia Pahang (UMP) is chosen due to the stability and compromise to fulfil the ideal criteria to set up a rain gauge. The ideal location of the site should be free from obstacle, building and steep slopes which will be effect the data collection of the weather station. Figure 2 shows rain gauge in KK2, Campus Gambang.

There is also weather station that is set up at UMP Pekan located near to the kindergarten that is inside the UMP Pekan (Figure 3). This site is chosen due the criteria for the research which is to compare the rainfall event between UMP Pekan and UMP Gambang. Stationed here also is the rain gauge which located one meter apart from each other. Figure 4 shows location of weather station in Campus Pekan.
3. Methodology

The rainfall data from HOBO rain gauge is collected once a month from both rain gauge stations that situate in UMP Gambang and UMP Pekan campus, the data is collected by plugging in USB cable from the computer to the rain gauge in order to get the raw rainfall data. Figure 5 show the process of data collection from rain gauge at KK2, Campus Gambang.

At the same time with the planning and process to setting up and upgrading the weather station in Pekan, the weather station in Pekan is collected once a month. Figure 6 shows the data collected from weather station after transfer to PC and the data recorded from weather station. The Figure 7 shows the data recorded in the console from weather station.
3.1 Box plot method

There are a lot of methods that can be used in order to measure the rainfall event, the box-plot method can also be used to determine the event of rainfall. According to [10], box plot is the form of summary of a given dataset which includes, the median, the inter quartile range and the computation and the meaning each of the values are described below.

3.1.1 The median. Median is the middle data observation in a ranked of any dataset and as a measure for central tendency of the data and the same as the 50th percentile of a data.

3.1.2. The inter quartile range. The box represents the middle 50% of the ranked data and is drawn from the lower quartile value to the upper quartile value which is the 25th until 75th percentile.

3.1.3. The outer range. The whiskers represent an outer range and are drawn as a vertical lines extending outward from the ends of the box. This whisker represents the maximum and minimum of said data for the sample. Figure 8 shows what the box-plot will represent the data when it is plotted.

After collecting the data from both UMP Gambang and UMP Pekan campus, the suitable method proposed to analyse the data is box-plot method. The purpose of using this method is the ability to be able to check the trend and skewness of the rainfall trend for UMP Gambang and UMP Pekan.
The advantage of the box-plot method is that it is able to compare multiple datasets side-by-side, as idealized in Figure 9. Important characteristics of each dataset (central tendency, skewness, dispersion, and extremes) are very easy to interpret and visualize [8].

![Box plot example](image)

**Figure 9.** Example of datasets compared side-by-side [6]

From the box plot too, the trend or skewness can be determined by using the rainfall data, below in Figure 3.10 shows the idealized distribution example of rainfall data trend or skewness that can be determined by the shape of the box-plot that has been plotted by using dataset of rainfall data.

![Box plot example](image)

**Figure 10: Idealized box-plot data distribution [6]**

### 4. Results and Discussions

Based on the Table 1 and Table 2, it shows the raw rainfall data collected from Rain Gauge at KK2, UMP and also from UMP Pekan. The analysis data start from 2016 until March of 2019. The data which is from 2016 until early 2018 was carried out by past researches and is taken for further observation for this research. As for UMP Gambang, from 2016 to 2019, it shows that highest total rainfall collected is in 2018 with an average rainfall per month of 109.15 mm. And because 2019 is only taken until March, so there is not much data to be used and to compare with the other year in comparison. As for UMP Pekan, it is figured out that during year 2016 it collected the most rainfall data which is 1982.9 mm by the rain gauge. And as for the average rainfall per month for 2016 is 165.24 mm. It is shown that for UMP Gambang that rainfall data collected to be up and down as in 2016, it is 1072.8 mm, and the year after 2017, it decreased to 972.5 mm. It began to increase more the year after which is 1309.8 mm and as for 2019 which consists of only 3 months data, with 196.2 mm
so far. And as for UMP Pekan, 2016 is the highest with 1982.8 mm and decreases sharply the year after in 2017 with 994.7 mm and increases slightly with a collected of 1020.9 mm and for 2019 with 82.9 mm so far. This can be shown that data collected between the two places varies differently.

### Table 1. Data from rain gauge in UMP Gambang

| Year | Total Rainfall (mm) | Average Rainfall per month (mm) |
|------|---------------------|---------------------------------|
| 2016 | 1072.8              | 89.4                            |
| 2017 | 972.5               | 81.04                           |
| 2018 | 1309.8              | 109.15                          |
| 2019 | 196.2               | 65.4                            |

### Table 2. Data from rain gauge in UMP Pekan

| Year | Total Rainfall (mm) | Average Rainfall per month (mm) |
|------|---------------------|---------------------------------|
| 2016 | 1982.8              | 165.24                          |
| 2017 | 994.7               | 82.89                           |
| 2018 | 1020.9              | 85.08                           |
| 2019 | 82.9                | 27.63                           |

Chart 1 below shows that the rainfall data are from year 2016 to 2017 for UMP Gambang. The highest total rainfall occurs at the month of October 2016 which is 296.0 mm and can be seen on the end of the whisker of the box-plot for year 2016. As for year 2017, the highest rainfall data collected is also in October 2017 with 248.6. As for Chart 2, it continues for UMP Gambang but for year 2018 and 2019. For 2018, the highest is in December 2018 with 266.6 mm. As for year 2019, the highest is in January 2019 with 108.8 mm, but it is only for 3 months worth of data are only taken in 2019 so it will not amount to much.

Chart 3 shows that the rainfall data are from year 2016 to 2017 for UMP Pekan. The highest total rainfall occurs at the month of November 2016 which is 991.4 mm and can be seen on the end of the whisker of the box-plot for year 2016. As for year 2017, the highest rainfall data collected is also in November 2017 with 389.2 mm. As for Chart 4, it continues for UMP Pekan but for year 2018 and
2019. For 2018, the highest is in December 2018 with 346.7 mm. As for year 2019, the highest is in January 2019 with 69.3 mm, but it is only for 3 months worth of data are only taken in 2019 so it will not amount to much.

![Chart 3. UMP Pekan 2016 & 2017](image)

![Chart 4. UMP Pekan 2018 & 2019](image)

5. Conclusions
Weather at UMP Gambang campus shows that rainfall trend is varied throughout the year and would increase and decrease the following year. It can be concluded that near the end of each year which is around October to December, both UMP Gambang and UMP Pekan collected the highest rainfall data reading.

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