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RAINFALL ANALYSIS TO DETERMINE THE POTENTIAL OF RAINWATER HARVESTING SITE IN KUANTAN, PAHANG

Nadiatul Adilah Ahmad Abdul Ghani[1], Noor Asiah Mohamad[2], Teo Wei Hui[1]
[1]Faculty of Civil Engineering and Earth Resources, University Malaysia Pahang, Pahang, Malaysia
[2]Faculty of Engineering Technology, University Malaysia Pahang, Pahang, Malaysia
E-Mail: nadiatul@ump.edu.my

ABSTRACT

Malaysia as a country, which received a very high rainfall throughout the year, is moving towards adopting rainwater harvesting system (RWHS) as a means to mitigate water shortage and flood problem. In 2012, RWHS is made compulsory for every development of new housing and building at several states in Malaysia, both for water supply and flood control. Furthermore, since flood is becoming more prevalent nowadays in Malaysia especially in Kuantan, Pahang, lacks of space for the construction of flood mitigation facilities has prompted authorities to look for other solutions for flood control. This study intends to determine the potential of rainwater harvesting site in Kuantan, Pahang. Daily rainfall data from five selected hydrology stations in Kuantan catchment are used to analyse the water availability in order to identify the potential of rainwater harvesting site in Kuantan. Based on average monthly rainfall data, the highest amount of rainfall received by all stations is on December meanwhile the least number of rainfalls received by all stations is on February except for station Sg. Lembing P.C.C.L Mill which received the lowest number of rainfall on July.

Keywords: hydrology station, rainwater-harvesting, rainfall, intensity.

1. INTRODUCTION

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 [1]. 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. Malaysia as a country which received a very high rainfall throughout the year is moving towards adopting rainwater harvesting system to mitigate water shortage and flood problem. Rainwater harvesting lately has gained recognition as a sustainable means of domestic water supply globally [2]. The Malaysian Government has recognized that rainwater harvesting contribute toward National Water Conservation Policy. It has made a commitment to revise the Guidelines for Installing a Rainwater Collection and Utilization System in the Ninth Malaysian Plan within a period of 2006 – 2010 [2].

In 2012, RWHS is made compulsory for every development of new housing and building at several states in Malaysia both for water supply and flood control. Furthermore, since flood is becoming more prevalent nowadays in Malaysia especially in Kuantan, Pahang, lacks of space for the construction of flood mitigation facilities has prompted authorities to look for other solutions for flood control. National Hydraulic Research Institute of Malaysia [3] found that in the future, many sub regions of Peninsular Malaysia will experience higher maximum and lower minimum rainfall, thus more extreme hydrological conditions may be expected. It is expected that there is an increase in annual rainfall over Pahang subregions of Central Region of Peninsular Malaysia with the change of climate in the future [3].

Higher maximum rainfall may lead to extreme flood event whereas lower minimum rainfall may result in extreme drought event. Integration of rainwater harvesting in water resources management can be a good solution to this extreme weather events problems. Harvested rainwater during heavy rainfall can be stored and used during drought period. Properly designed rainwater harvesting system can also be used to temporarily detent water during heavy pours to mitigate flash flood problem especially in Kuantan City.

1.1. Rainfall

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 [4]. Suhaila et al. [5] found that the western region was affected 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 [6]. As mentioned by Azumi et al. [7], 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 [5].

Ahmad et al. [6] 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 [8]. 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.

1.2. Kuantan catchment

Pahang is 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. Kuantan is the capital city of Pahang, which is located within the Kuantan river basin.

The city is prone to flood during North East monsoon from November to February. Over the course of a year, Kuantan'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 is on February whereas the wettest month is on December. The average monthly precipitation is around 438 mm. Kuantan River flows from Hutan Simpan Reman Cereh to Kuantan City before discharges into South China Sea.

Four main tributaries discharge into downstream of Kuantan River namely Soi River, Belat River, Pandan River and Pinang River. Meanwhile, Lembing River is an important tributary upstream of Kuantan River. There are four river discharges into Lembing River namely Kebuh River, Kenau River, Nilok River and Rengik River. Local Municipal Council estimated that population of Kuantan is expected to grow to about 488,409 by the year 2015 with 2.68% annual population growth rate. The population living in urban area has increased to 60% of the population due to the new urban areas and extension of existing administrative boundaries.

1.3. Hyrological station

Rainfall data from five active hydrological stations as shown in Table-1 is used to analyse the rainfall pattern for this study. The data was obtained from Department of Irrigation and Drainage (DID) Pahang. Three selected active hydrological stations are located downstream of Kuantan River, close to Kuantan City as shown in Figure-1. Meanwhile, the other two hydrological stations are located at Lembing River and upstream of Belat River respectively.

Table-1. The selected hydrological station in Kuantan River Basin.

Station no.	Station name	Latitude	Longitude
3731018	JKR Gambang	03 42 20	103 07 00
3732020	Paya Besar Kuantan	03 46 20	103 16 50
3732021	Kg. Sg. Soi	03 43 50	103 18 00
3833002	Pejabat JPS Negeri Pahang	03 48 30	103 19 45
3930012	Sg. Lembing P.C.C.L Mill	03 55 00	103 02 10

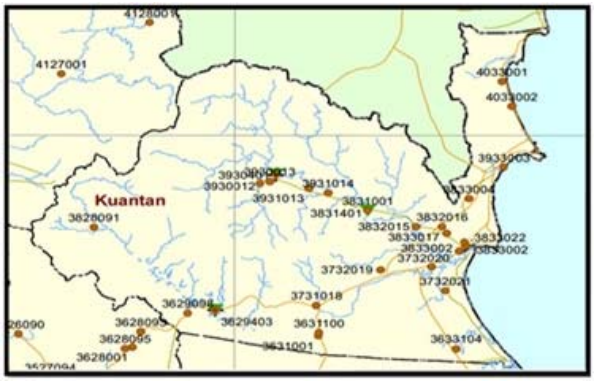

Figure-1. Location of hydrological station in Kuantan River Basin.

2. ANALYSIS AND RESULTS

The daily rainfall data for five hydrological stations was obtained from the Department of Irrigation and Drainage from year 2009 to 2013. The data obtained is summarised in total monthly rainfall data as shown in Figure-2a to Figure-2e. In year 2009, all of the stations having the most number of rainfalls on December with the highest rainfall of 982 mm recorded at station Paya Besar, Kuantan.

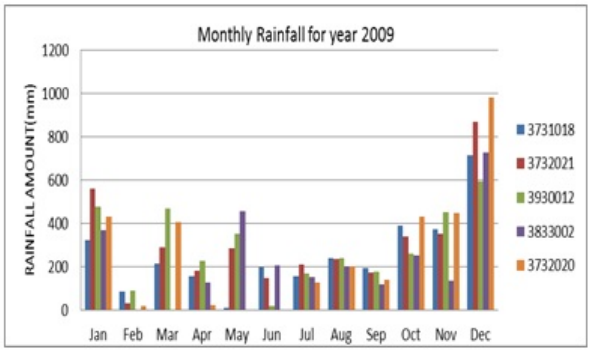

Figure-2(a). Graph of total rainfall amount versus month for 2009.

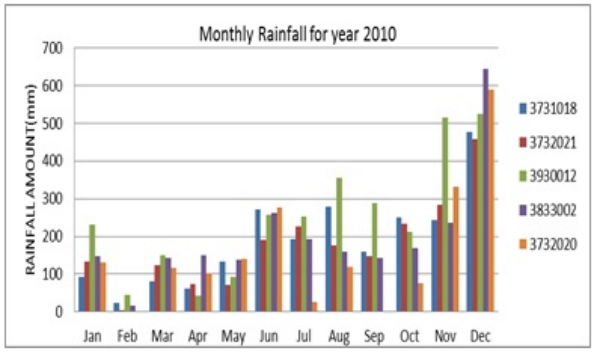

Figure-2(b). Graph of total rainfall amount versus month for 2010.

The same pattern is observed in year 2010 in which all of the stations having the most number of rainfalls on December with the highest rainfall of 643 mm recorded at station Pejabat JPS Negeri Pahang. Meanwhile, all stations recorded least number of rainfalls on February except for station Sg. Lembing P.C.C.L Mill which recorded least number of rainfalls on April. Notice that there are missing data for station Paya Besar Kuantan on September that year.

It is observed at all stations that heavy rainfall pattern from December 2010 continue until January 2011. All stations recorded total amount of rainfall of more than 300mm on January in year 2011. However, the wettest month of the year is on December, similar to the previous years. Notice that there are no rainfall data available at station Pejabat JPS Negeri Pahang and station Paya Besar Kuantan on December that year.

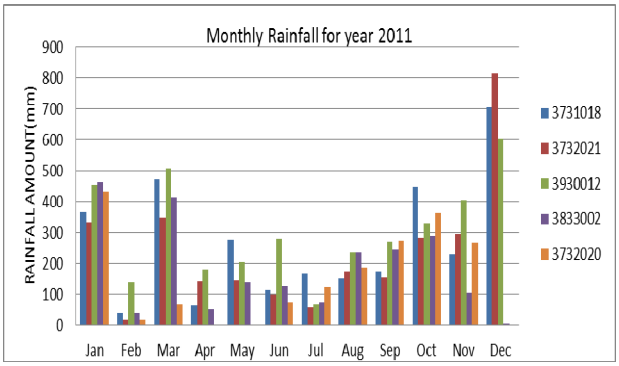

Figure-2(c). Graph of total rainfall amount versus month for 2011.

In year 2012, two stations recorded highest number of rainfall of more than 1000 mm. Station Kg. Sg. Soi and station Pejabat JPS Negeri Pahang received 1039 mm and 1100 mm rainfall respectively on December that year. The other three stations also recorded highest number of rainfall on December in which station Paya Besar, Kuantan received 917 mm rainfall that year. All stations had complete daily rainfall data in year 2012. Thus, it can be seen that the driest month is observed on February except for station Sg. Lembing P.C.C.L Mill and station JKR Gambang that recorded lowest amount of rainfall on August and September, respectively.

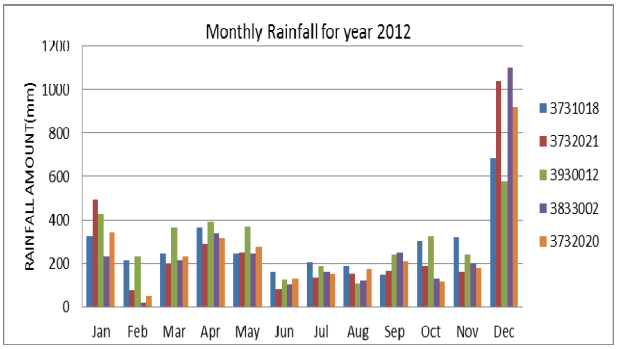

Figure-2(d). Graph of total rainfall amount versus month for 2012.

In year 2013, only Stations JKR Gambang and station Kg. Sg. Soi had rainfall data on October to December. Thus, no comparison can be made between the stations. However, slightly different pattern is observed on February year 2013. All stations recorded higher amount of rainfall on February as compared to the previous years where February seems to be the driest month. All stations received an amount of rainfall in the range of 355mm to 490 mm on February and on average, March is observed as the driest month for that year.

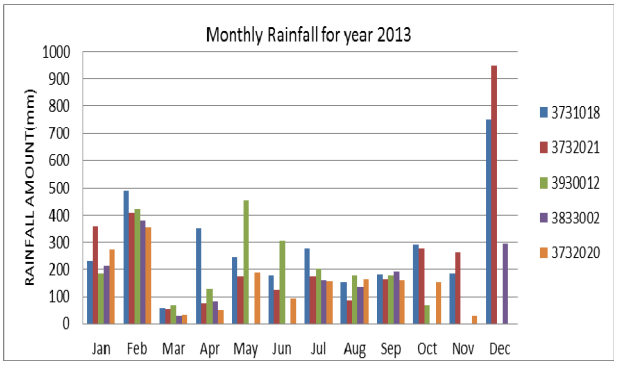

Figure-2(e). Graph of total rainfall amount versus month for 2013.

Figure-3 shows average monthly rainfall for five stations based on five years data from year 2009 to 2013. It is noted that all stations received the highest number of rainfall on December with the highest monthly average rainfall of 829 mm recorded at station Paya Besar Kuantan. Meanwhile, the lowest number of rainfall is recorded on February except for station Sg. Lembing P.C.C.L Mill which received the lowest number of rainfall on July. Average monthly rainfall analysis from year 2009 to year 2013 exclude missing data at some station as discussed earlier. Thus, it can be seen that an amount of rainfall recorded every month at all stations is almost the same pattern.

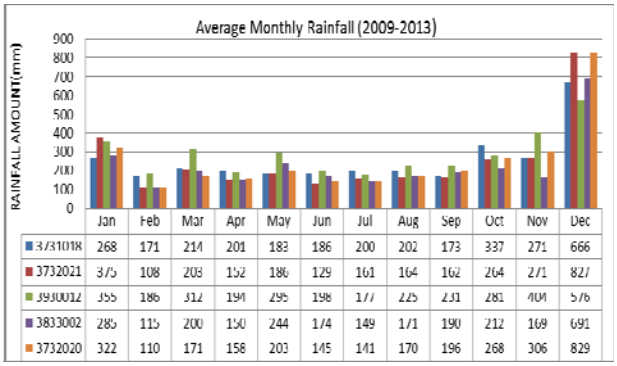

Figure-3. Graph of monthly average rainfall amount versus month.

Figure-4 shows the annual rainfall from year 2009 to year 2013 observed at all selected stations. It can be seen that within five years of observation, all stations have recorded annual rainfall of more than 3000mm. Station Kg. Sg. Soi received the highest number of annual rainfall in year 2009 which is 3682mm.

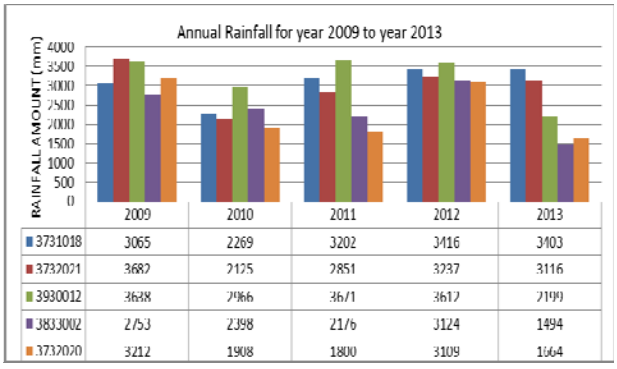

Figure-4. Graph of annual rainfall amount versus month.

3. CONCLUSIONS

Among the five years of observation of rainfall data obtained from DID, it can be concluded that most of the driest month is on February and the wettest month is on December. The maximum annual rainfall data is 3682 mm recorded in year 2009 at station Kg. Sg. Soi. The station is located on the downstream of Kuantan catchment within the sub-catchment of Soi River. Overall, the results shows that Kuantan river basin received high number rainfall and it will be a potential and suitable site for rainwater harvesting system to mitigate water shortage and flood problem during extreme weather event.

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