RIVER BANK EROSION RISK WITH REGARDS TO RAINFALL EROSIVITY

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ABSTRACT
A fast flowing river erodes its banks more seriously than the slow flowing one. With higher velocity and discharge, the river bank erosion risk potential increases and this affects its sediment carrying capacity too. Rainfall impact to a river will significantly force it to overflow to the bank. The rainfall erosivity and the flowing water have been the prime governing factors in causing erosion. The aim of this study is to evaluate the degree of rainfall erosiveness at Hulu Langat district of Langat River, Selangor, Malaysia and this valuable information would certainly enable the concerned government and private authorities to plan, design and construct the most suitable preventive measures in preventing the river bank erosion.

Keywords:
Rainfall, Erosivity, Energy, Soil Particles, Risk, "ROSE" index, River

INTRODUCTION

Rivers are natural watercourses, flowing over the surface in artificial channel formations, which drains discrete areas of mainland with a natural gradient. They are critical components of the hydrological cycle, acting as drainage channels for surface water and as water retention. River plays an important role in Malaysia's development process by providing the country with sufficient water supply to cover supply for domestic and agricultural as well as providing aquatic life form as food sources to humans. The rainfall potential in causing erosion is determined according to the rainfall erosivity which means the ability of rainfall to erode the soil. The characteristics of the erosive properties of rainfall are rainfall amount, duration, intensity, raindrops (size velocity and shape), kinetic energy and seasonal distribution of the rain. These are also the factors that have great influence on soil erosion (Roslan, et. al., 1996). The higher the rainfall erosivity, the greater the potential of rainfall induces erosion that can lead to river bank erosion (Wei et. al., 2009).

With the length of 120 km, the Langat River which is of concerned in this research is one of the major rivers draining a densely populated and developed area of Selangor. Figure 1 shows the map of Langat River where it passes by three districts in Selangor State namely Hulu Langat, Sepang and Kuala Langat district.

The problems are often initialled by heavy falls of rain in catchment with poor soil structure, causing the excess of run-off. Hence, it is important to carry out a study on rainfall erosivity that contributes to the river bank erosion. Therefore, by obtaining the quantum of the rainfall erosivity, the level of erosion risk potential along Langat River can be established.

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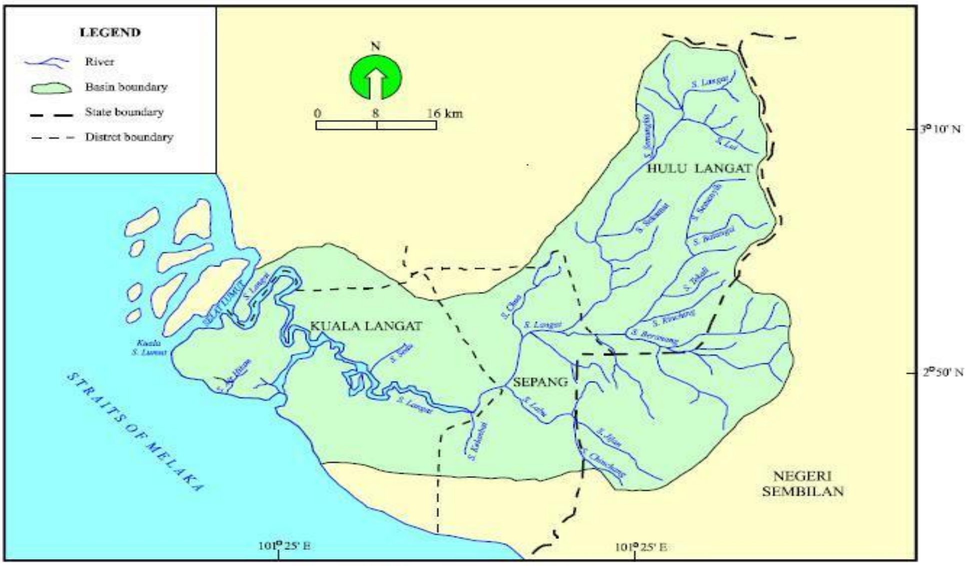

Figure 1: Map of Langat River (Source: DID)

In this research, five (5) rainfall stations have been analysed as shown in Table 1.

Table 1: Rainfall stations at Hulu Langat district of Langat River

No	Rainfall Station				
	Station No	Name	Latitude	Longitude	District
1	3218101	Pangsun	03° 12′ 34.7″	101° 52′ 33.1″	Hulu Langat
2	3017105	Sg. Raya	03° 04′ 04″	101° 46′ 19″	Hulu Langat
3	3017106	Sg. Serai	03° 05′ 58″	101° 47′ 51″	Hulu Langat
4	3017108	Sg. Balak	03° 00′ 59″	101° 45′ 49″	Hulu Langat
5	2816041	Dengkil	02° 51′ 20.8″	101° 40′ 53.1″	Hulu Langat

METHODOLOGY

The daily rainfall data of the studied area was obtained from the Department of Irrigation and Drainage Malaysia (DID), Ampang. Data analysis will be done by using the data that obtained from the Department of Irrigation and Drainage Malaysia (DID), Ampang. Once the data was analysed, it was classified according to the Degree of the Rainfall Amount (DORA) namely low, moderate, high, very high and critical category.

"ROSE" index is used to indicate the level of rainfall erosivity risk categories namely low, moderate, high, very high and critical. Figure 2 shows the procedure in determining the rainfall erosivity values.

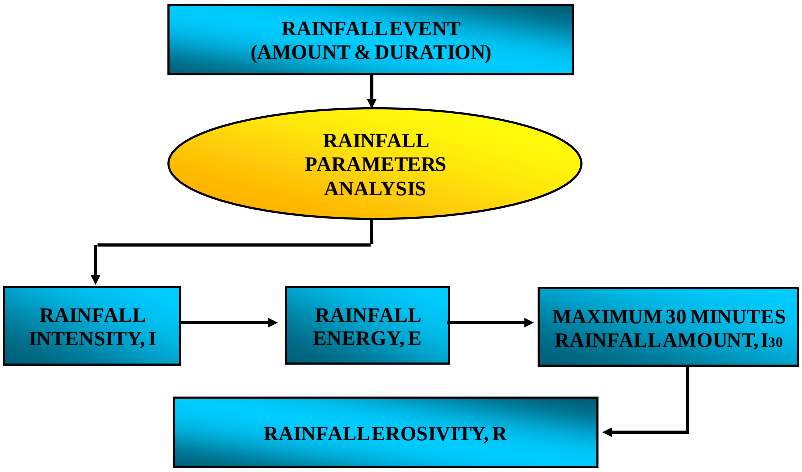

Figure 2: Steps of rainfall erosivity assessment

Equation 1 is used to calculate the rainfall intensity, I of a certain rainfall event:

$$I = \sum \frac{\text{Amount of rainfall}}{\text{Period of rainfall}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

By obtaining the rainfall intensity of a rainfall event, the particular rainfall kinetic energy, E can be calculated by using equation 2 below:

$$E = 210 + 89 \log_{10} I \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where, I = rainfall intensity (cm/h)

The rainfall erosivity value for certain rainfall event will need the maximum 30 minutes, I_{30} rainfall amount is to be taken into account. This 30 minutes rainfall amount is defined as the most critical amount of rain that falls within 30 minutes interval which generated the maximum rainfall intensities in a rainfall event.

By multiplying the product of rainfall kinetic energy and maximum 30 minutes rainfall amount of the rainfall event, the rainfall erosiveness can be finally determined from the equation 3 as follows:

$$R = E \times I_{30} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where, E = rainfall kinetic energy (tonne m/ha.cm), and

I_{30}= 30 minutes maximum rainfall amount (cm)

The final outcome of this analysis would be the rainfall erosivity value in tonne.m^2/ha.hr which represents the amount of soil loss caused by the rainfall effect on the surface of the soil. This method clearly shows the significant threshold of rainfall that can contribute to erosion induced landslide occurrence. The rainfall erosivity categories with respect to ‘ROSE’ Index (Roslan & Shafee, 2005) are as shown in Table 2.

Table 2: Rainfall erosivity category (‘ROSE’ Index)

‘ROSE’ Index (tonnes.m^2/ha.hr)	CATEGORY
< 500	Low
500 – 1000	Moderate
1000 – 1500	High
1500 – 2000	Very High
> 2000	Critical

RESULTS AND DISCUSSION

DAILY RAINFALL AMOUNT

Initially, daily rainfall risk frequency is an early indicator in which to obtain the rainfall erosivity. It is an early warning to show the soil erosion potential in that particular area within the coverage of 25 km radius. The analysis is based on the number of daily rainfall amount which is more than 20 mm/day (Roslan and Tew, 1997). Figure 3 shows the possibility of monthly rainfall erosivity risks for Hulu Langat district by considering all the rainfall stations for the year of 2008 to 2010.

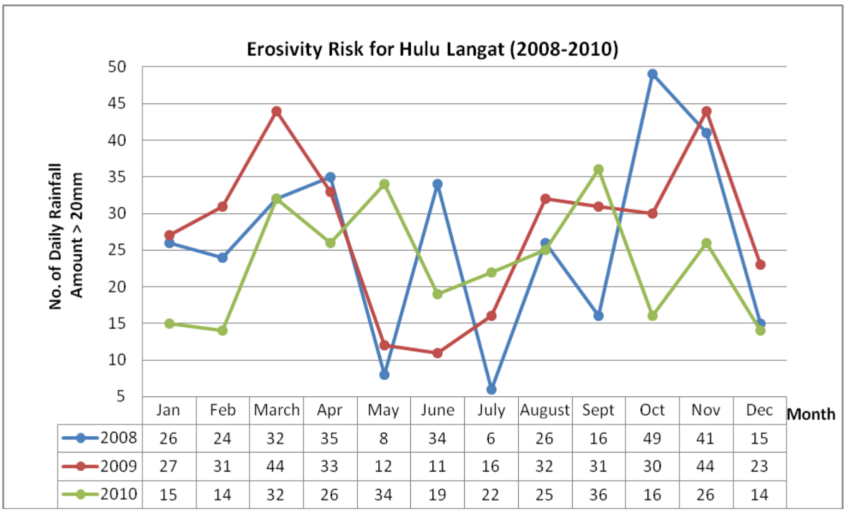

Figure 3: Monthly erosivity risk for Hulu Langat district

From Figure 3, it can be seen that the highest possibility of rainfall erosivity risk based on the daily rainfall amount were in the months of March, April and November whereby the lowest risk were in the months of June and July. These findings were consistent with the annual monsoons in Malaysia which is from southwest and northeast which started from April to October and from October to February respectively.

RAINFALL EROSIVITY ASSESSMENT

The assessments are based on every 10 minutes rainfall data which has been categorised to low, moderate, high, very high and critical. Table 3 shows the typical ranking of rainfall erosivity for Sg. Raya rainfall stations for Hulu Langat in the year 2008 to 2010.

Table 3: Ranking of Rainfall Erosivity for Sg. Raya rainfall station, Hulu Langat District

Ranking	Year	Month	Days	Rainfall Amount (cm)	D.O.R.A	Rainfall Erosivity (tonne m^2/ha.hr)	"ROSE" Index
1	2008	October	11-17	29.50	Critical	9519.94	Critical
2	2008	October	9-15	25.45	Critical	8451.91	Critical
3	2008	October	10-16	25.30	Critical	8145.35	Critical
4	2008	October	12-18	26.50	Critical	7891.17	Critical
5	2008	October	13-19	25.70	Critical	7844.87	Critical
6	2008	April	10-16	24.05	Critical	7537.40	Critical
7	2009	January	29-4	19.80	Critical	7351.98	Critical
8	2008	October	8-14	18.75	Very High	6885.16	Critical
9	2008	October	14-20	21.90	Critical	6794.20	Critical
10	2008	April	16-22	22.05	Critical	6747.50	Critical
11	2009	January	28-3	27.35	Critical	6472.83	Critical
12	2009	March	24-30	16.85	Very High	6433.20	Critical
13	2009	March	23-29	15.60	Very High	6183.68	Critical
14	2010	May	7-13	16.35	Very High	6169.10	Critical
15	2008	April	11-17	19.00	Very High	5965.91	Critical

Table 3 shows that the month of October experienced the highest number of daily of rainfall amount (D.O.R.A) as well as rainfall erosivity where the highest value of rainfall erosivity was 9519.94 tonne m^2/ha.hr. It also shows that the rainfall amount does not directly proportional with rainfall erosivity. The rainfall amount in May 2010 was lower than April 2008 but the rainfall erosivity value was higher in May 2010 compared to April 2008.

CONCLUSION

The erosiveness of rainfall reflects the degree of river bank erosion with regards to rainfall erosivity evaluation. It can be used as a tool in indicating the degree of river bank erosion along the river throughout the nation. Further to this, suitable rehabilitation programs and mitigation measures can be proposed to prevent serious conditions along Langat River bank in the near future particularly stream bank erosion. Thus, it would benefit the country in terms of cost reduction in river bank protection.

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