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An Analysis of the Relation Between Values of D_{50} and Discharge for Several Rivers in Endau River Catchment Area, Johor, Malaysia.

[1]Aweng-Eh Rak, [2]Ismid-Said and [3]Maketab-Mohamed

[1]Faculty of Agro Industry and Natural Resources, Universiti Malaysia Kelantan (UMK)
[2]Faculty of Civil Engineering, Universiti Teknologi Malaysia (UTM)
[3]Faculty of Chemical Engineering, Universiti Teknologi Malaysia (UTM)

Abstract: This paper examines the relationship between the values of median grain size (D_{50}) and average discharge for several rivers in Endau River catchment area, Johor, Malaysia. Madek, Dengar and Mengkibol rivers were surveyed at these stage and the result shows that there is a weak relation between median grain size (D_{50}) and average discharge. The flow rate for Dengar river upper station was 0.87 m^3/s and the D_{50} were 4.5 mm, where the flow rate for the lower station for Dengar river was 0.23 m^3/s and the D_{50} were 2.4 mm. The result obtained from Mengkibol river were different where the flow rate for upper and lower stations was very high when compared to Dengar river which is 2.91 m^3/s and 3.11 m^3/s respectively but the values of D_{50} was similar which was 3.0 mm for upper station and 2.4 mm for lower station. Result obtained for Madek river was huge different, where the flow rate for upper station was 1.23 m^3/s and the D_{50} were 4.5 mm, whereas the flow rate for the lower station was similar which is 1.26 m^3/s but the D_{50} value was 41.5 mm.

Key word: Pebble count, D_{50}, river gauging, average discharge

INTRODUCTION

Stream channels and floodplains are constantly adjusting to the amount of water and sediment supplied by the watershed. Four physical characteristics of a stream are in a dynamic state of equilibrium called Lane's Balance. These characteristics are streamflow, channel slope, sediment load, and particle size. If one of these characteristics change in a stream, one or more of the other three must also change to accommodate and achieve equilibrium again (Leopold, 1992).

A number of investigators have studied and analyzed the relation between river bed grain size and streamflow (Hejduk *et al.,* 2006; Xu, 1990). Some of them studied the grain size distribution caused by rainfall and flooding (Hejduk *et al.,* 2006; Madej, 1997) which was the consequences to determine the grain size and steam flow.

Based on their analysis, there was not a strong relation between value of D_{50} and average discharge of the river downstream ((Hejduk *et al.,* 2006).

The objective of the study is to analyses the relation between values of D_{50} and average discharge of several rivers in Johor. We managed to survey and analyzed three rivers in Endau River catchment area namely Dengar, Mengkibol and Madek River. The three rivers are representing difference types of land used. Dengar river (up-stream) representing un-disturb or pristine area, Dengar river(down stream) representing palm oil plantation land use, Mengkibol river representing urban area and Madek river representing logging area.

MATERIALS AND METHODS

The study area is situated in Endau River catchment area, Johor, Malaysia with three tributaries or sub-catchments namely Dengar river, Mengkibol River and Madek river (Figure 1). Each river represents different types of land use. Dengar river for palm oil plantation, Mengkibol river for urban area which is Kluang Town and Madek river for logging activities.

Corresponding Author: Aweng-Eh Rak, Faculty of Agro Industry and Natural Resources, Universiti Malaysia Kelantan (UMK)

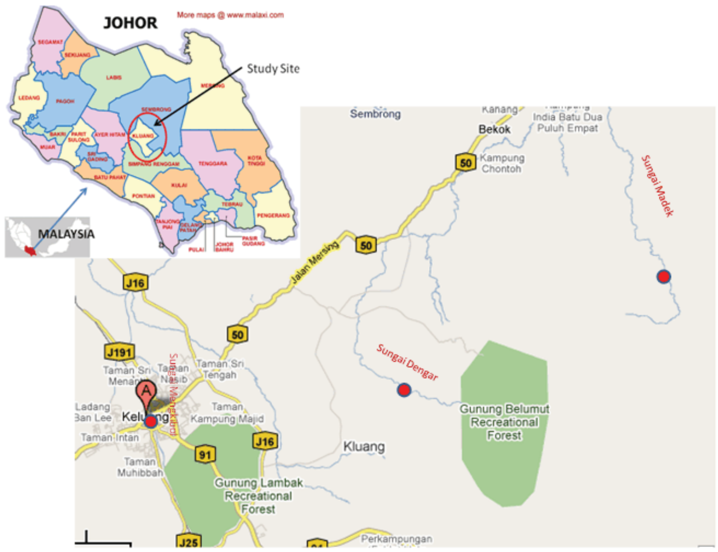

Fig. 1: Sampling Stations at Sungai Mengkibol, Madek and Dengar

The pebble count was conducted at upper reach station and lower reach station for the sampling portion by applying the Pebble Count Protocols developed by B. U. G. S. Consulting for the Southern Ute Indian Tribe Environmental Programs Division Water Quality (B.U.G.S. Consulting, 2003) as well as Wolmen Pebble Count Procedure (1954). The purpose is to evaluate the streambed composition. The composition of the streambed can explain a lot about the characteristics of the stream. It can illustrate the effects of flooding, sedimentation, and other physical impacts to a stream.

The pebble count method was conducted on a riffle to evaluate the streambed composition. The process for the pebble count is to classify the size of at least 100 particles within a riffle. A sampling grid was established across the entire riffle, which consisted between six (6) to nine (9) transects depending on the river width. The particles found at equidistant intervals across each transect was measured/ determined. The measurements were begin at the point of bank full. Straight rigid tool, the ruler and calliper were used to measure the particles size. The particle where the toe touched the particle was picked up. The diameter of the pebble was measured to determine the particle size class. The metric calliper was used to measure the intermediate axis or the middle value and not the shortest or longest value of the particle in millimetres.

The data from the site survey was then transformed and analysed, where the total number of pebbles was obtained and then the percentage in each size class was calculated, and finally the cumulative percentage for each size class was determined.

The cumulative percent was calculated by adding all the percentage size class by moving down the matrix. The value was plotted to calculate percentage for size class, D_{50} and mean diameter.

River gauging to determine the river discharge was performed at the same time and same station. Current meter or flow meter measurements (model BFM001) by wading was used for the survey. A measuring tape or tag line was stretched across the river perpendicular to the flow; the spacing within the mark is 1 meter. The position of successive verticals used for depth and velocity area located by horizontal measurements from a reference marker (initial point) on the bank, which was marked by a rod. The gauging started at the water edge of the near bank, where depth and velocity may or may not be zero. At each chosen vertical the depth was measured and the value used to compute the setting or settings of the current meter depending on the method to be used (usually 0.6 or 0.2 and 0.8 depth). For those survey the value used to compute the setting of the current meter is 0.6 depth. The position of the operator is important to ensure that the operator's body does not effect the flow pattern at or approaching the current meter. The best position is to stand slightly downstream of the meter. The rod is kept vertical throughout the measurement with the meter parallel to the direction of flow. After the meter was in position the rotor was allowed to adjust to the stream velocity before the count of rotor revolution was started. A revolution count was then taken at each selected point for a minimum of 60 seconds. The velocity at the point can then be taken as the average of all the separate readings (Herrschy, 1995).

RESULTS AND DISCUSSION

A total of 109 particles was counted for the upper reach station and a total of 114 particles was counted for the lower reach station of Dengar River. A total of 116 particles was counted for the upper reach station and a total of 102 particles was counted for the lower reach station of Mengkibol River. A total of 108 particles was counted for the upper reach station and a total of 113 particles was counted for the lower reach station of Madek River.

Table 1, show, data comparison between the values of median grain size (D_{50}) and average discharge of Dengar, Mengkibol and Madek River in Johor. The flow rate for Dengar river upper station was 0.87 m^3/s and the D_{50} was 4.5 mm, where the flow rate for the lower station for Dengar river was 0.23 m^3/s and the D_{50} were 2.4 mm. The result obtained from Mengkibol river were different where the flow rate for upper and lower stations was very high when compared to Dengar river which is 2.91 m^3/s and 3.11 m^3/s respectively but the values of D_{50} was similar which was 3.0 mm for upper station and 2.4 mm for lower station. Result obtained for Madek river was huge different, where the flow rate for upper station was 1.23 m^3/s and the D_{50} was 4.5 mm, whereas the flow rate for the lower station was similar which is 1.26 m^3/s but the D_{50} value was 41.5 mm.

Result from Table 1 was transformed into graft as shown in Figure 2. It shows the relation between values of D_{50} in mm and average discharge in m^3/s for Dengar, Mengkibol and Madek River in Johor in the scatter graft form. The results obtained almost confirmed that of Hejduk's finding. Where in his analysis it showed a weak relation between values of D_{50} and average discharge at certain level. Hejduk's found that the analyzed result showed a slight increase in D_{50} with discharge. However, this stopped near a value of about 0.1 m^3/s. When discharge was larger, there was siginificant scatter in the values of D_{50}. The Hejduk's finding basically showed that there was a weak relation between the values of D_{50} and discharge at the lower river discharge (0.1 m^3/s and below) but as the discharge exceeded 0.1 m^3/s there was no relation. Hedjuk's concluded that there was no strong relation between D_{50} and discharge(Hejduk *et al.,* 2006).

The minimum discharge for this survey was 0.23 m^3/s, where the values were exceeded 0.1 m^3/s, that was why an analysis did not show any relation at the lower discharge. But it was confirmed that of Hejduk's finding at the higher discharge where there was a significant scatter in the values of D_{50}. However, this result indicates that further survey and analysis is needed for the other rivers within the same catchment area so as to ascertain the actual relationship between values of D_{50} and discharge.

Table 1: Data Comparison Between Particles Size and Flow Rate of Dengar, Mengkibol and Madek River in Johor

No.	River	Sampling Frequency	Flow Rate (m3/s)	D_{50} (mm)
1	Mengkibol	1	2.91	3.0 (very fine gravel)
			3.11	2.4 (very fine gravel)
		2	1.34	3.0 (very fine gravel)
			1.34	2.0 (very fine gravel)
		3	0.91	3.0 (very fine gravel)
			0.91	2.0 (very fine gravel)
		4	0.67	3.75 (very fine gravel)
			0.67	2.0 (very fine gravel)
2	Madek	1	1.23	4.5 (fine gravel)
			1.26	41.5 (very coarse gravel)
		2	2.93	3.0 (very fine gravel)
			2.93	46.25 (very coarse gravel)
		3	1.38	3.5 (very fine gravel)
			1.38	40.0 (very coarse gravel)
		4	0.43	3.5 (very fine gravel)
			0.43	41.5 (very coarse gravel)
3	Dengar	1	0.87	4.5 (fine gravel)
			0.23	2.4 (very fine gravel)
		2	0.68	3.0 (very fine gravel)
			0.16	3.5 (very fine gravel)
		3	0.39	2.0 (very fine gravel)
		4	0.18	1.5 (sand)
4	Ulu Dengar	1		
		2		
		3	0.34	60.0 (very coarse gravel)
		4	0.21	58.0 (very coarse gravel)

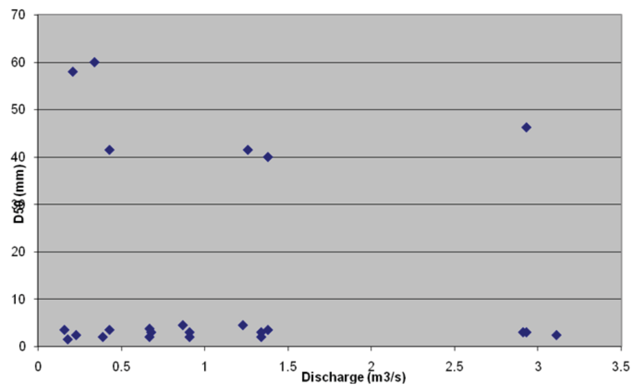

Fig. 2: Relation Between Values of D_{50} in mm and Average Discharge in m^3/s for Dengar, Mengkibol and Madek River in Johor

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