



Sediment Size Distribution at Three Rivers with Different Types of Land Use in Endau Catchment Area, Klung, Johor, Malaysia

*¹AWENG-EHRAK; ²ISMID-SAID; ³MAKETAB-MOHAMED; ⁴LIYANA, AA

¹Faculty of Earth Science, University Malaysia Kelantan (UMK)
(aweng@umk.edu.my)

²Faculty of Civil Engineering, University Technology Malaysia (UTM)
(ismid6410@gmail.com)

³Faculty of Chemical Engineering, University Technology Malaysia (UTM)
(maketab@fkkksa.utm.my)

⁴Centre for Language Studies and Generic Development
University Malaysia Kelantan Bachok Campus,
Locked Bag No 1, 16300 Bachok, Kelantan, MALAYSIA
(liyana.a@umk.edu.my)

ABSTRACT: Land use along the river will determine the substrate size and distributions. Substrate particle size will influence aquatic life because substrate is one of the main components forming aquatic habitat. This aquatic habitat is very important in determining river water quality as well as river health. Therefore, identifying the sediment size distribution based on land use is very crucial in river maintenance. The objective of this study is to determine the particle size variation between upper reach and lower reach of the sampling station as well as variation from different land use cover at different sub-catchment areas. The pebble counts was conducted at upper reach station and lower reach station by applying the Pebble Count Protocols developed by the West Virginia Department of Environmental Protection and Wolmen Pebble Count Procedure. The average median (D_{50}) for Dengar River ranged between 4.5 mm for upper portion and 2.4 mm for lower portion. Similar observations were found at the Mengkibol River, where particle size ranged between 3.0 mm for upper portion and 2.4 mm for lower portion. As for Madek River which represents land use area for logging activity, the results obtained were different in which the upper portion the particle size was smaller ($D_{50} = 4.5$ mm) than the lower portion ($D_{50} = 41.5$ mm). The finding of this study will be a basis for river catchment management study and can be used by river management authorities in the country for river management planning. © JASEM

<http://dx.doi.org/10.4314/jasem.v20i3.3>

Keyword: pebble count, sediment size, average median, fine gravel, very fine gravel, urban, oil palm, logging, land use,

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 stream flow, channel slope, sediment load, and particle size. If one of these characteristics changes in a stream, one or more of the other three must also change to accommodate and achieve equilibrium again. The change of streambed texture (particle size) is the first thing to change in response to a disturbance to restore equilibrium and it is the most sensitive measures of change (Leopold, 1992).

The suspended sediment flowing into the river normally come from the runoff which was altered by human land uses and land cover modifications (e.g.,

logging, agriculture, roads) and this will increase sediment supply to streams, potentially degrading aquatic habitat for benthic organisms and fish (Faustini and Kaufmann, 2007; Hart, 2006). Works by Iola Goncalves Boechat, *et al.* (2013) suggested that, river habitat and sediment quality mainly depended on environmental conditions in a river riparian, the higher the disturbance the higher the river sediment will be. It is known that excessive quantity of the suspended sediment has negative impact on the environment especially to the stream macro benthos (Cummins and Lauff, 1969) and fishes (Young, *et al.*, 1991). One of the basic parameters of suspended sediment is grain size which has an important role in water quality, contaminant adsorption, river bed stability and siltation of the river as well as reservoirs.

During large floods normally the particle size classes will depend on discharge or river flow. Sediment size distribution is also believed to be dependent on the disturbance type or, to be specific, land use type of the catchment.

Pebble counts have been used as a main component for stream evaluation efforts throughout the United States (Darren *et. al.*, 2005) and it is also becoming important in Malaysia. Thus, this study was carried out to compare the substrate sizes between upper reach and lower reach as well as to compare between three rivers with different type of land use. The three rivers are Dengar River representing palm oil plantation land use, Mengkibol River representing urban area and Madek River representing logging area. Rivers with a depth of about 200 meter were chosen for the sampling stations except for Madek River (100 meters) due to a site within 200 meters are in the pool area. The chosen river reach is actually the reach of the rivers that received more than 95 % of the impact from land uses. Among river reaches (sampling reaches), only one sampling reach has a sampling station close to the river crossing structure namely Madek River. Madek River has a physical structure which is logging bridge laid between two sampling stations. The distance between upper reach and lower reach is about 100 meters with the distance of 50 meters respectively from the logging bridge.

MATERIALS AND METHODS

Study Area: 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. Each river represents different types of land use. Dengar River for palm oil plantation Mengkibol River for urban area which is situated in Kluang Town and Madek River for logging activities.

Data Collection: 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 the West Virginia Department of Environmental Protection (2006) as well as Wolmen Pebble Count Procedure (Wolmen, 1954). The purpose is this process 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 the 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 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 were counted for the upper reach station and a total of 102 particles were counted for the lower reach station of Mengkibol River. A total of 108 particles were counted for the upper reach station and a total of 113 particles were counted for the lower reach station of Madek River. A sampling grid was established across the entire riffle, which consists of six (6) to nine (9) transects depending on the river width. The particles found at equidistant intervals across each transect was measured and determined. The measurement was begun 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 touches 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.

Data Analysis: The data from the site survey was then transformed and analysed using Microsoft Excel, where the total number of pebbles were obtained and then the percent in each size class calculated, and finally the cumulative percent 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.

RESULTS AND DISCUSSION

Figures 1(a) and (b), show particle size distribution between upper reach and lower reach of the sampling portion of Dengar River. The average median (D_{50}) for Dengar River which was represented by oil palm plantation land use, ranged between 4.5 mm (fine gravel) for upper portion and 2.4 mm (very fine gravel) for lower portion, where the particle size for the upper portion were bigger in size as compared to the lower portion. Mean diameter for particle at the upper portion station is 4.9 mm which can be placed under the fine gravel category. The mean diameter for lower reach station was 2.4 mm which on the other hand falls under very fine gravel category. The median size of the particle is in-line with D_{50} particle size.

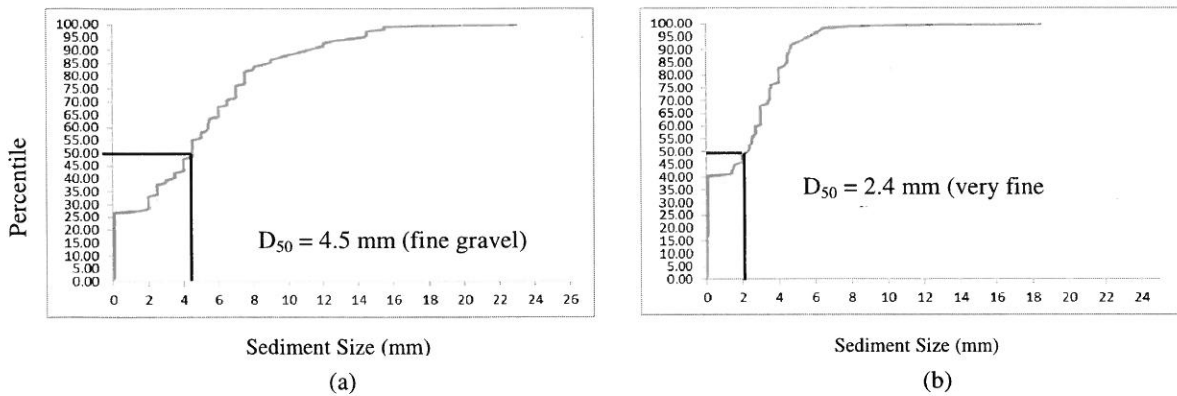


Fig 1: Sediment size distribution for (a) upper reach and (b) lower reach of Dengar River.

Figures 2(a) and (b), show a particle size distribution between upper reach and lower reach of the sampling portion of Madek River. The characteristic feature for Madek River represented as land use from logging showed differences in particle size where the upper was smaller than that from lower portion. The range for average median (D_{50}) was between 4.5 mm (fine

gravel) for upper portion and 41.5 mm (very coarse gravel) for lower portion. The mean diameter for particles at the upper reach station was 8.2 mm which falls under the medium gravel category, whereas that for lower reach station was 46.7 mm which comes under very coarse gravel category. The median size was comparable with D_{50} particle size

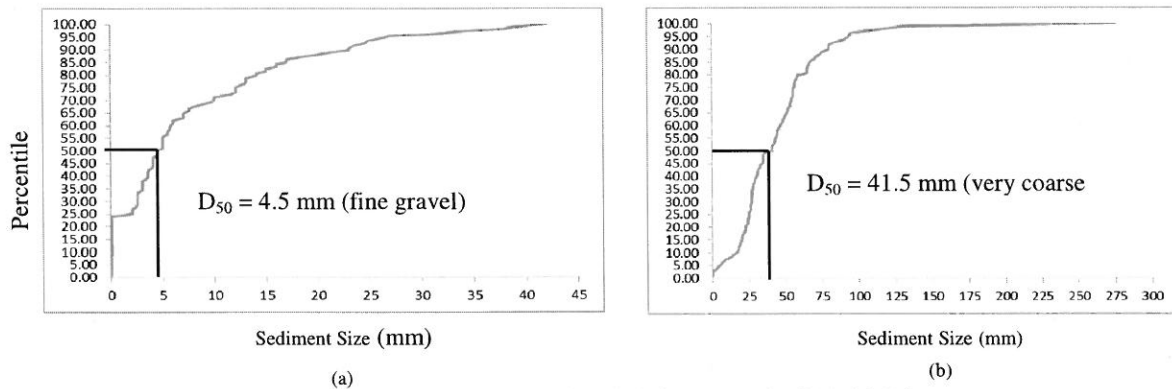


Fig 2: Sediment size distribution for (a) upper reach and (b) lower reach of Madek River.

Figures 3(a) and (b), shows a particle size distribution between upper reach and lower reach of the sampling portion of Mengkibol River. The features found at Mengkibol River, representing urban area land use, was similar with that of Dengar River, where the particle size for upper portion was bigger in size when compared to the lower portion. Particle size ranged between 3.0 mm (very fine gravel) for upper

portion and 2.4 mm (very fine gravel) for lower portion. Mean diameter for particle at the upper reach station was 2.9 mm which is categorized as very fine gravel, whereas the mean diameter for lower reach station was 2.8 mm which is categorized as very fine gravel. The median size obtained was comparable with D_{50} particle size.

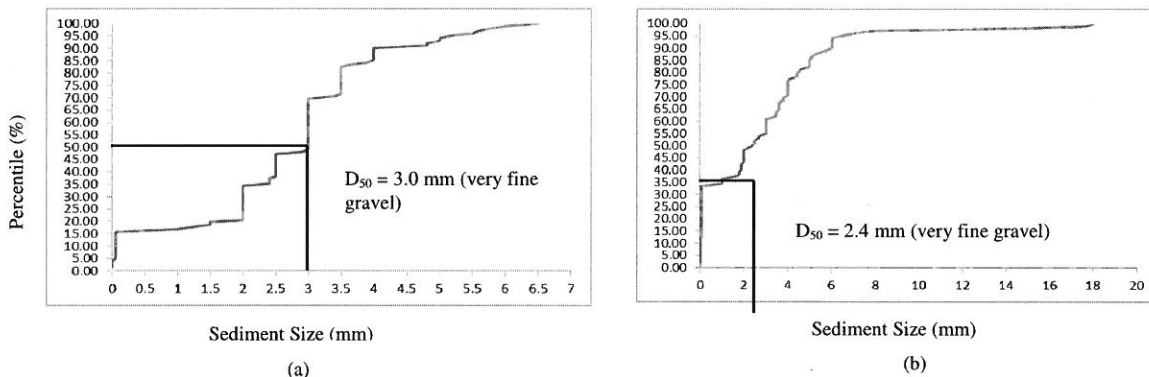


Fig 3: Sediment size distribution for (a) upper reach and (b) lower reach of Mengkibol River.

The results obtained for Madek River are in agreement with Medina's finding where the substrate sizes of various sites changed from generally fine-grained silts and clays to coarser sands and gravels (Medina, 2001). Medina's finding basically showed that upstream particle size has a smaller size as compared to downstream but the difference is very small. In this case, the difference between upstream and downstream particle sizes is very significant, and is believed to have been influenced by scouring caused by logging bridge.

However, there were differences in the characteristic features encountered for Mengkibol and Dengar River, where the sediment size distribution for these two rivers changed from coarser size at upper portion to smaller size at lower portion. This result indicates that, further survey is needed for the other rivers within the same catchment area so as to ascertain the actual characteristics prevailing there.

Conclusion: It can be suggested that, river which received impacts from logging activities has smaller particles size at the up-stream and bigger particles size as it flows down- stream. On the other hand, river which received impacts from the urban runoff and from palm oil plantation has coarser particles size at the upper reach and smaller particles size as it flows down-stream.

Acknowledgement: The authors like to express the deepest appreciation to Universiti Malaysia Kelantan (UMK) and Universiti Teknologi Malaysia (UTM), Skudai Johor for the laboratory facilities.

REFERENCES

- Cummins, KW; Lauff, GH (1969). The Influence of Substrate Particle Size on the Microdistribution of Macroinvertebrates. *Hydrobiologia*.34(2):145-181.
- Faustini, J; Kaufmann, PR (2007). Land use impacts

on stream bed substrate moderated by geology in the John Day Basin, Oregon. Paper presented at Association of America Geographers Annual meeting, San Francisco, CA, April 17 - 21, 2007.

Hart HM (2006). Effect of Land Use on Total Suspended Solids and Turbidity in the Little River Watershed, Blount County, Tennessee. *Master Thesis*, University of Tennessee.

Iola Goncalves Boechat; Aparecida Beatriz das Mercedes de Paiva; Sandra Hille; Bjorn Gucker (2013). Land-use effects on river habitat quality and sediment granulometry along a 4th-order tropical river. *Ambiente & Aqua*. 8(3); 54-64.

Leopold, L B (1992). Sediment Size that Determines Channel Morphology. *Dynamics of Gravel-bed Rivers*. John Wiley & Sons Ltd.

Medina, A L (2001). A Preliminary Analysis of Riparian Habitat Conditions of the Upper Verde River. Cliff Castle Lodge and Conference Center. 17 - 19 May. Camp Verde, Arizona.

Olsen DS; Roper BB; Kershner JL; Richard Henderson; Eric Archer (2005). Sources of Variability in Conducting Pebble Counts: Their Potential Influence on the Results of Stream Monitoring Programs. *Journal of the American Water Resources Association*. 1225-1236.

Wolmen, M G (1954) A Method of sampling coarse river-bed material. *Transactions of the American Geophysical Union*: 35(6):951-956

West Virginia Department of Environmental Protection (2006). *Pebble Count*. State of West Virginia, USA.

Young, MK; Hubert, WA; Wesche, TA (1991). Selection of Measures of Substrate Composition to Estimate Survival to Emergence of Salmonids and to Detect Changes in Stream Substrates. *North America Journal of Fishes Management*. 11: 339 - 346.