SHORT NOTE

BED LOAD TRANSPORT FROM A REGENERATED FOREST CATCHMENT IN SARAWAK

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Abstract: This note presents preliminary results of a study on bed load transport from a 0.6 km^2 forested catchment in Sarawak, Malaysia, once affected by logging activities. The influence of rainfall and stream discharge on bedload production was investigated. The estimated 6 months total bedload of the study area was 0.54 tons or 0.18 t/ km^2/month.

Keywords: *Bed load, regenerated-forest, rainfall, streamflow*

Bed load is one of the major outputs of erosion processes resulting from human as well as natural activities. In natural forests, bed load materials are the result of intense chemical weathering and the breakdown of rock fragments to particles of sand-size or smaller (Douglas, 1968). Rivers are important geological agents for erosion, transportation and deposition of sediment (Vaithiyanathan, 1988). Large scale forest and land clearing operations especially in the seventies had accelerated erosion and sedimentation rate in Malaysia and led to dramatic increases in sediment loads of major rivers. For example Klang River and Pari River recorded sediment load exceeded 5000 t/km^2/yr (Leong, 1989). Until now, river sedimentation associated with agricultural and construction activities remain a major challenge in river management. While considerable number of studies have measured suspended sediment load (e.g. Douglas, 1968; Burgess, 1971) very few include the bedload portion. As such the scale of sedimentation problem might be underestimated.

Ongoing measurement of bedlod is carried out at Sg. Kebow catchment in Universiti Putra Malaysia, Bintulu Campus (03^o 12' 34.9" N and 113^o 05' 33.4" E). The catchment which is about 0.6 km^2 has undulating terrain with a maximum relief of 275 meter. The climate is of equatorial type, characterised by all year round warm and humid under the influence of two monsoon systems, the northeast monsoon (November-March) and the southwest monsoon (May-September). In general, these monsoons affecting rainfall largely determine the generation of

runoff and sediment transport. The geology of the study site is mainly the Nyalau formation of the Oligocene-Miocene period (Kho, 1968). The rock comprises a series of sandstone, shale, mudstone, limestone, lignite with some marlstone, siltstone, and calcareous sandstone.

Bedload was measured using Helley-Smith hand held sampling method. Rainfall depth were collected by tipping bucket rain gauge (Rain Wise) and the streamflow velocity were measured using Flo-Mate current meter.

During the 6 months observation period (October 2004-March 2005), continuous daily rainfall records and 30 river stage-discharge (H-Q) were obtained. Using the river stage-discharge records, a rating curve of the observation site was established as,

$$Q = 13.392\ H^{6.8381} \quad (1)$$

where Q is stream discharge (m^3/s) and H the water level (m).

The rating curve in Equation 1 was then used to estimate the river discharge during the bedload samplings. Fifty two bed load measurements were completed and a bedload-discharge relationship curve was established (Equation 2), by which total bedload can be estimated over a certain period using discharge record.

$$BL = 0.0005\ Q^{0.5895} \quad (2)$$

where BL is bedload (tons) and Q is river discharge (m^3/s).

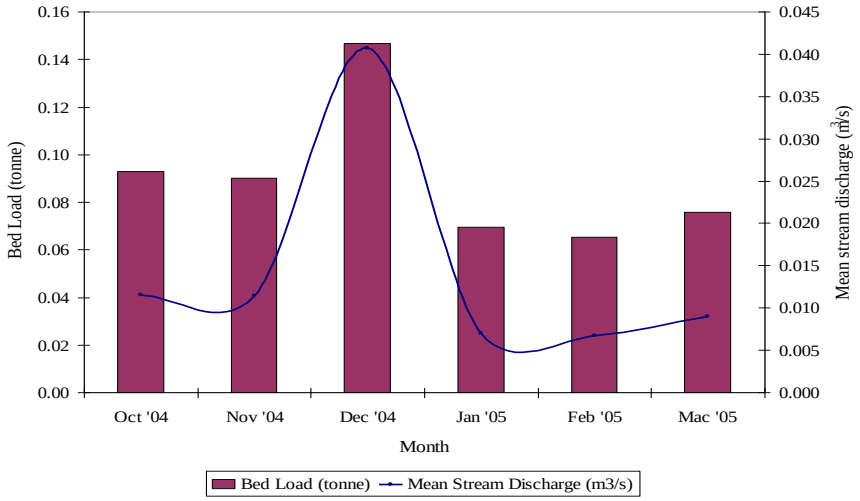

Figure 1: Estimated monthly bed load and mean stream discharge

Over six months, the estimated total bed load was 0.54 tons (Figure 1). The highest bed load was recorded in December 2005 which coincided with the inter-monsoon period. This preliminary result shows that high rainfall caused high runoff which inadvertently affects the production of bed load. Surface erosion characterized by intense weathering became the major source of sediment in tropical streams (Douglas, 1968). Storm size is also an important factor in transporting and depositing sediment in the stream channel. For instance, the higher load on December 27, 2004 was associated with a 2 hour storm of 101.2 mm. A week later, the total bed load decreased 15 folds compared to the previous measurement. This suggests that a large portion of the bed load is stored temporarily on the stream bed until the next storm evacuates the bed materials.

Table 1: Bed load studies in tropical catchments

Location	Catchment	Area (km^2)	Bedload ($t/km^2/yr$)	Vegetation	Source
Cameron Highland, Malaysia	Sg. Bertam	75.2	35.7	▪ 64% forest; 21% tea; 7% vegetables, steepland	Shallow (1956)
	Sg. Kial	21.4	70.1	▪ 70% forest; 11% tea; 19% vegetables, steepland	
	Sg. Telom	77.7	25.7	▪ 94% forest; 5% Tea; 1% vegetables, steepland	
Selangor, Malaysia	Sg.Batangsi	19.8	1263.8	▪ Steep rain forest (logging)	Lai (1990)
	Sg. Lawing	4.7	124.7	▪ Steep rain forest (unlogged)	
	Sg. Lui	68.1	22.0	▪ Rain forest (20% agricultural area)	
Cameron Highland,	Malaysia Sg. Telom	79.4	0.063	▪ Rain forest, tea plantation, agricultural	Baharuddin *et. al.* (1996)
	Sg. Bertam	21.2	0.184	▪ Rainforest, urban and residential area, agricultural area	
	Sg. Ikan	9.2	0.197	▪ Rain forest and agricultural	
Java, Indonesia	Mondo River	0.2	45	▪ Agathis forest plantation	Bruijnzeel (1983)
Sarawak, Malaysia	Sg. Kebow	0.6	1.8#	▪ Secondary/regenerated Forest	This study

Note: # projected to one year

Except for the measurement by Baharuddin *et al*., (1996), the presence estimate of bed load transport falls in the lower range of the reported values for forested catchments (Table 1). The low production is consistent with the forest condition which has reached a full recovery stage after affected by selective logging operation. This suggests the vital role of forest cover in maintaining low erosion rate and provides the most natural protection to streams. This study adds essential findings related to bed load transport characteristics for a fully regenerated forest. Such information is crucial as basis for assessing recovery rate of tropical forest

ecosystem affected disturbances.

Future study should include sampling during higher flows since on an annual basis, the bulk of sediment is usually transported by infrequent large storm events. It is also worthwhile to consider continuous monitoring of bed load to understand the mechanism and transportation processes.

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