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ACCUMULATED SUSPENDED SEDIMENT YIELD DUE TO COMMERCIAL TIMBER HARVESTING AT UPPER HILLS DIPTEROCARP FOREST, MALAYSIA

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Abstract: A study was conducted at Upper Hill Dipterocarp forest in Malaysia to assess the impact of commercial timber harvesting on suspended sediment (SS) accumulation in the stream. Suspended sediment assessment was conducted based on current harvesting practice (Selective Management System) and improved harvesting protocol. The assessment was made before, during and after timber harvesting. It was found that total SS accumulation in catchment under selective management system higher compared to new protocol during harvesting processes. The accumulation of sediment decreased about two to seven fold on the following year after harvesting processes completed at both catchments.

Keywords: Suspended sediment, timber harvesting, upper hills, dipterocarp forest

1. Introduction

Selective Management System (SMS) was introduced in Peninsular Malaysia since 1978. According to Apanah and Weinland (1990), the SMS consists of trees harvesting above a certain cutting limit, and leaving behind adequate residuals which are expected to form the next cut in about 25 to 30 *y*. In addition, Thang (1987) mentioned that all commercial species above 45 cm dbh for non-dipterocarps and 50 cm for dipterocarps are felled while the residual stocking to be left behind. However, few drawback of the current system found due to high removal in patches that resulted in creation of large gaps. Thus, change in species composition due to domination of pioneer which impacted the biodiversity composition in the affected area. The ITTO/FRIM through conservation of biodiversity project (CBiod) proposes new improvement of the current harvesting system to tackle those gaps. The major features of improve harvesting protocol includes of 100 percent assessment of trees above 30 cm dbh during pre-f compared to SMS that of 10 %, creation of tree maps and GIS database, marked all trees above cutting limits, and selected trees to be felled should be between 20 to 30 meters apart depending on size (UNDP-GEF MAL/04/G31ITTO PD165/02 Rev.3 (F) in http://www.site.cbiod.org). The major difference between the current and new harvesting protocol was the spatial distribution of the felled trees. In the new harvesting protocol, harvesting of trees limited in number due to the spatial distance between the trees. It was anticipated that the harvesting practices produce less sediment load and better water quality concentration

Several studies (Peh, 1981 and Baharuddin, 1988) had been conducted to quantify the effects of logging on hydrological parameters but less has been done at the upper hill dipterocarp forest. One study conducted by Lai et. al (1995) was concentrated on the sediment yield in a steep tropical catchments (elevation from 1035 to 1210 m) at Sungai Lawing basin, Selangor. The area was undergone commercial logging based on the typical harvesting applied elsewhere, with crawler tractors employed to construct roads and skid trails and felling was on the selective basis under the Selective Management System (SMS). He found that the concentration of suspended sediment increased 73.2% (19, 920 mg/l) during logging compared to only 28.3 % before logging. Baharuddin (1988) through his study at Berembun hill dipterocarp forest (elevation 170 to 302 m.a.s.l) found that the mean annual suspended sediment yield increased significantly after logging particularly a year after completion of logging. It was increased between 70% under close supervision to 97 % under current practice. Besides harvesting regime, the coverage area of selected catchment also gives variations on the sediment concentration. For example, Lai (1993) reported that the highest increment at Batangsi river (1980 ha) and Sungai Chongkak (1270 ha) was 5133 % and 4474%. This indicated that the sediment concentration increased proportionally with the coverage area of the selected catchment. In steep areas where the climates are wet, unpaved road commonly associated with logging operation can cause 10 to 300 fold increase in landslide erosion rate in forested catchments (Dolidon et al. 2009). Perhaps this situation also support high sediment load in the stream. In fact there are various factors that contribute to sediment concentration. Aminuddin *et al* (2010) point out that the shape of the channel also contributed in sediment variations.

Much fewer studies have been attempted to clarify the effect of deforestation in Malaysian upper hill forest. Therefore, this paper reports some finding on observations at Temenggor Forest Reserve, emphasize on quantification of sediment concentration at the upper hill forest with regards to timber harvesting.

2. Materials and Method

2.1. Description of Study plots

This study was conducted at Compartment 44, of the Perak Integrated Timber Complex (PITC) Concession area located in Temenggor Forest Reserve within the Hulu Perak District, Grik, Perak. This area was harvested using available harvesting protocol (Selective management system) with some modification. The major difference between the current and new harvesting protocol is the spatial distribution of the felled trees. This area is approximately 600 m to just over 800 m above sea level. It also has a typical monsoon climate characterized by uniformly high temperature and high humidity. It is not surprising therefore when Temenggor FR received rain exceeded 3000mm per year at times. It is received less rainfall during July and February. Average daily hours of sunshine are usually around 10 to 11 hours with potential evapotranspiration of about 1300 mm (http://www/site. cbiod.org). This paper compare the accumulated sediment in three catchments namely HP1 (SMS), HP2 (New Protocol) and HP9 (Control). HP1 is a catchment under the SMS and HP2 under the new protocol while HP9 was designated as a control catchment. The catchments varies in areas; HP1 (31.5 ha), HP2 (39.

2.2. Sediment Assessment

The multi-stage sediment sampler equipped with 6 bottles at the interval of 10 cm each was installed at each catchment to collect storm flow samples. Samples from this device were analyzed in the laboratory using oven dry method. Glass Microfibre Filter (GFC), suction pump, weighing device, measuring cylinder and oven were used during laboratory analysis. Samples were oven-dried at 500 degree for 1 hour before it was re-weighing. Suspended sediment data was collected since June 2009 until December 2011.

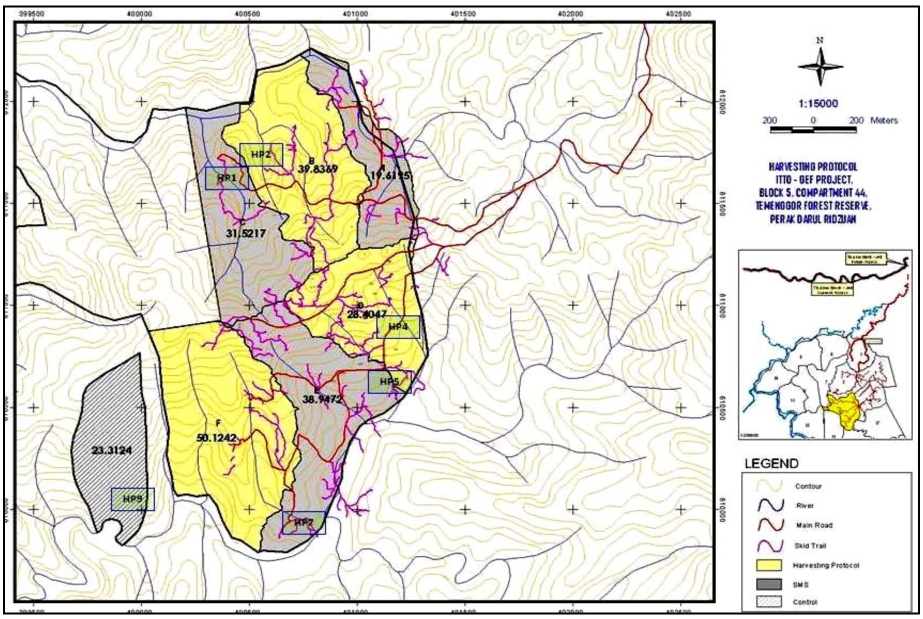

Figure 1. The location of the study area at Block 5, Compartment 44, Temenggor F.R, Perak

3. Result and Discussion

3.1. Sediment Concentration at Different Harvesting Regime

Assessment on accumulative sediment in the river at two different harvesting regimes shown that river fall under the new harvesting protocol has less accumulative sediment compared with current harvesting protocol even though the coverage area was bigger than catchment in current harvesting protocol. Total amount of sediment accumulated in river under the current harvesting protocol was 5, 228,008.50 mg/l which was 87, 797.50 mg/l more compared to new protocol (5,249,895.75 mg/l) during timber harvesting processes. Maximum sediment accumulation was 1, 861, 246.50 mg/l (SMS), 1,530,744.75 mg/l (New protocol) and 499, 962.00 (control). However, the total sediment accumulation decreased gradually after timber harvesting to 1, 942, 661.50 mg/l, 861, 190.25 mg/l and 62, 646.75 mg/l for SMS, new protocol and control respectively (table 1).

Table 1. Summary of the sediment concentration at HP1 (SMS), HP2 (new protocol) and HP9 (control) during and after timber harvesting

	Before timber harvesting			During timber harvesting			After timber harvesting		
	HP1 (SMS)	HP2 (NP)	HP9 (control)	HP1 (SMS)	HP2 (NP)	HP9 (control)	HP1 (SMS)	HP2 (NP)	HP9 (control)
Total (mg/l)	9.6×10^4	2.7×10^5	5.4×10^4	5.4×10^6	5.2×10^6	9.3×10^5	1.9×10^6	8.6×10^5	6.2×10^4
Max (mg/l)	2.3×10^4	1.1×10^5	1.6×10^4	1.8×10^6	1.5×10^6	4.9×10^5	1.2×10^6	2.3×10^5	2.8×10^4
Min (mg/l)	6.0	1.8×10^1	1.1×10^3	2.5×10^5	5.9×10^5	1.1×10^3	1.8×10^3	4.7×10^4	3.8×10^3
Range (mg/l)	2.3×10^4	1.1×10^5	1.4×10^4	1.6×10^6	9.3×10^5	4.9×10^5	1.2×10^6	1.8×10^5	2.5×10^4

3.2. Accumulative Sediment Concentration According to Water Level

Sediment movement is sensitive to rainfall intensity and the water level fluctuation in the river. More water accelerates more surface, streambed and bank erosion which increased sediment concentration. The dynamics of the water level has influence the sediment accumulation behavior in the catchment. In addition, the erosion and sedimentation are dynamic processes which were resulted from the interaction between the flowing water and sediment bed (Aminuddin *et al* (2010). Figure 3 shown sediment accumulation of three catchments under different harvesting regime according to surface water level during timber harvesting processes. Most of the sediment accumulation concentrated at lower stage (19cm) and become lessens at the higher stage (59 cm). Catchment under SMS shown highest sediment concentration compared to that of new protocol and control. The trend was gradually decreased towards higher water level. The highest accumulated concentrations of sediment are 1, 861,246.50 mg/l in catchment under SMS and 1,530,744.75 mg/l in catchment under new protocol while 499,962 mg/l for control at lowest stage (19cm). It decreased to 259, 757 mg/l (SMS), 594, 075 mg/l (NP) and 1, 101 mg/l (Control) at the upper level.

Total sediment accumulation decreased about two to seven fold a year after timber harvesting completed at both catchment that fall under SMS and new protocol. However, sediment accumulation at catchment under SMS remains high at the lower stage (19 cm) after harvesting completed. It reduced about 57,000 mg/l since the harvesting period. Large reduction in sediment accumulation was at catchment under the new protocol which range between 1, 307, 212 mg/l at 19 cm of water level to 428, 622 mg/l at the highest water level (59 cm). The detail of sediment reduction is shown in table 2.

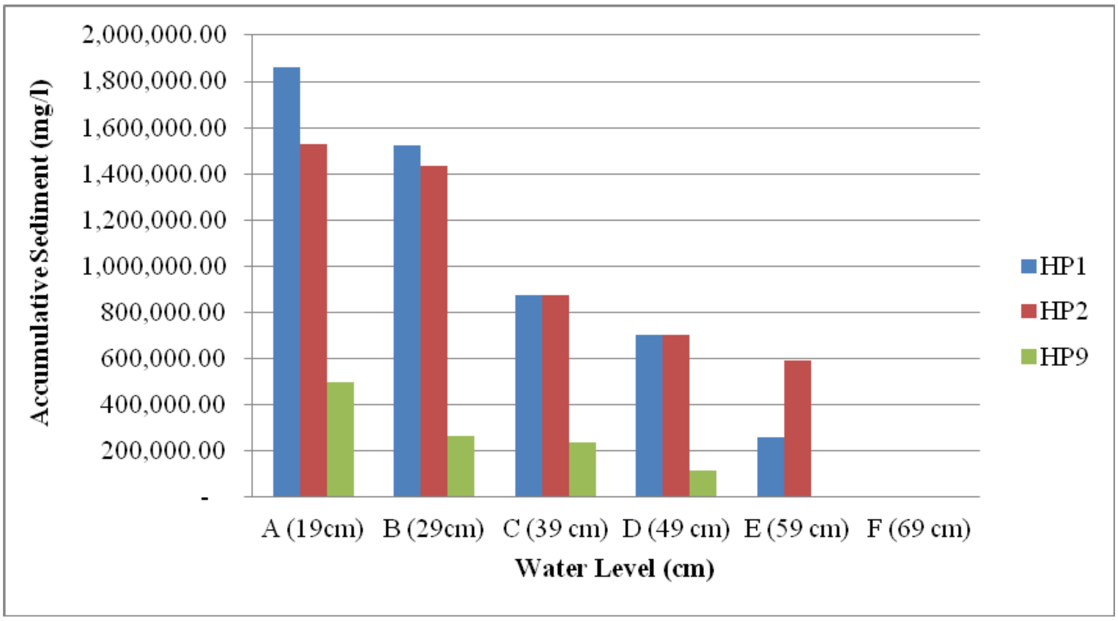

Figure 3. Sediment accumulation at station HP1 (SMS), HP2 (NP) and HP9 (Control) during timber harvesting

Table 2. Total sediment reduction in catchment under SMS, NP and Control after harvesting

	Water Level (cm)				
Stations	19	29	39	49	59
HP1 (SMS)	570,758.25	1,242,139.75	585,499.25	629,067.25	257,882.50
HP2 (NP)	1,307,212.75	1,241,774.75	645,528.00	655,883.00	428,622.25
HP9 (CONTROL)	471,053.00	251,939.50	223,522.00	113,283.25	

Note: SMS: Selective Management System; NP: New Protocol

4. Conclusion

Through this observation, there was a remarkable difference between the effects of current harvesting practice and new harvesting protocol application in this area. Though, the difference in sediment concentration might also associated with other environmental factors, plot condition and machinery usage during harvesting process but, the improved harvesting technique help in reducing hydrological degradation. More studies need to be conducted to determine the degree of improvement resulted from this technique.

5. Acknowledegement

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6. References

[1] Aminuddin Ab. Ghani, Rabie Ali, Nor Azazi Zakaria, Zorkeflee Abu Hasan, Chun Kiat Chang & Mohd Sanusi S. Ahamad (2010): A temporal change study of the Muda River system over 22 years, International Journal of River Basin Management, 8:1, 25-37.

[2] Baharuddin, K. (1988). Effect of logging on sediment yield in a hill dipterocarp forest in Peninsular Malaysia. Journal of Tropical Forest Science 1(1): 56-66

[3] Dolidon, N., Hofer, T., Jansky, L. & Sidle, R. (2009). Watershed and forest management

[4] for landslide risk reduction. *In Landslides – disaster risk reduction,* pp. 633-649. Berlin,Springer-Verlag.

[5] F.S. Lai, M.J. Lee & S. Mohd Rizal (1995). Changes in sediment discharge resulting from commercial logging in the Sungai Lawing Basin, Selangor, Malaysia. In: Proceedings of a Boulder Symposium: Effects of Scale on Interpretation and Management of sediment and water quality. IAHS Publ. No. 226 (55-62).

[6] Lai, F.S. (1993). Sediment yield from logged, steep upland catchments in Peninsular Malaysia. In: Proceeding of the Yokohama Symposium, Hydrology of Warm Humid Regiond, IAHS Publ. No. 216: 219-229

[7] Peh, C. H. (1981). The suspended and dissolved sediment load of three small forested drainage basins in Peninsular Malaysia. The Malaysian Forester 44(4): 438-452