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Effect of Logging Activities on Water Quality and Benthic macroinvertebrate Assemblages of Madek River Basin, Kluang, Johor, Malaysia

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ABSTRACT: The study was conducted to determine the effect of logging activities on water quality and benthic macroinvertebrate assemblages for the Madek River basin. The study area was situated in Kluang, Johor, Malaysia. Two sampling stations 500 meters apart are upstream and the other, downstream located at Madek River which flows through a logging area in Kluang Forest Reserve were identified. The sampling was conducted four (4) times from November 2008 to August 2009. Surber Net measuring 500 micron mesh size combined with a rectangular quadrat of 30 cm x 30 cm (0.09 m^2) was used to sample the macroinvertebrates. The organisms were identified up to genus level except for Chironomidae which was only identified up to Sub-family level. For water quality, six in-situ parameters based on the *standard procedure of U. S. Environmental Protection Agency* were measured at each station. The parameters such as temperature, conductivity, dissolved oxygen (DO), pH, turbidity and salinity were measured using a multi parameter probe Model YSI 6920 with 650 MDS Display/Logger as well as a single parameter probe. All the physico-chemical water quality parameters were well below Class I as provided for under Interim National Water Quality Standards for Malaysia (INWQS), except turbidity which fell under Class II of the INWQS. There were only two (2) sensitive taxa namely Ephemeroptera and Trichoptera found in this station. Ephemeroptera that was found in the logging area was from genus Potamanthus, Pseudiron, Ephemerella and Rhithrogena, while Trichoptera was from genus Hydropsyche and Macrostemum. @JASEM

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Logging activities in the study area were carried out legally and in an appropriate manner, and adhered to international standards and good logging practices. However, there may still be possible impacts on the ecology such as, siltation to the receiving river body, habitat disturbances and changes in river morphology. The changes of ecology was believed to be a major cause that determined the aquatic organisms assemblages in the water and the aquatic organisms that normally use to indicate water conditions is benthic macroinvertebrates.

Benthic macroinvertebrates, or more simply "benthos", are animals without backbones that are larger than ½ millimeter in size. These animals live on rocks, logs, sediment, debris and aquatic plants during some period in their life. The benthos include crustaceans such as crayfish, molluscs such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs. Benthic macroinvertebrates are good indicators of watershed health because they live in the water for all or most of their life, are easy to collect, differ in their tolerance to amount and types of pollution/habitat alteration, can be identified in laboratory, often live for more than one year; have limited mobility, and are integrators of environmental condition (Lenat and Barbour, 1994; Richards and Host, 1994; Sivaramakrishnan, 2000; Davis, *et. al*., 2003; Thompson, 2005; Dinakaran and Anbalagan, 2007). The distribution highly depends on physical nature of the substratum, nutritive content, level of stability, oxygen content and level of hydrogen sulphide (Anbuchezian, 2009). The small changes in the environment will have considerable response on the benthic community and it avails to measure the degree of pollution (Coull, 1973; Fernando, 1981). The study was conducted to determine the effect of logging activities on water quality and benthic macroinvertebrate assemblages for the Madek River basin.

MATERIALS AND METHODS

The study area is situated in Kluang, Johor, Malaysia. The sampling station is located in the Madek River which flows through a logging area located in Kluang Forest Reserve (Fig 1).

Sampling was conducted four (4) times from November 2008 to August 2009. A 500 meter reach representative of the characteristics of the stream was selected for each sampling site or sampling reach. One sampling reach comprises of two sampling stations where one station is located at the upper reach, while the other station is situated at the lower reach. Surber Net measuring 500 micron mesh size combined with a rectangular quadrat of 30 cm x 30 cm (0.09 m^2) was used to sample macroinvertebrates.

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Each station comprised three sampling points one situated on the right bank, one in the middle of the river and the third is located on the left bank. All the three samples from each sampling station were bulked as one sample. There were two bulked samples for each sampling reach which at the upper and lower reach.

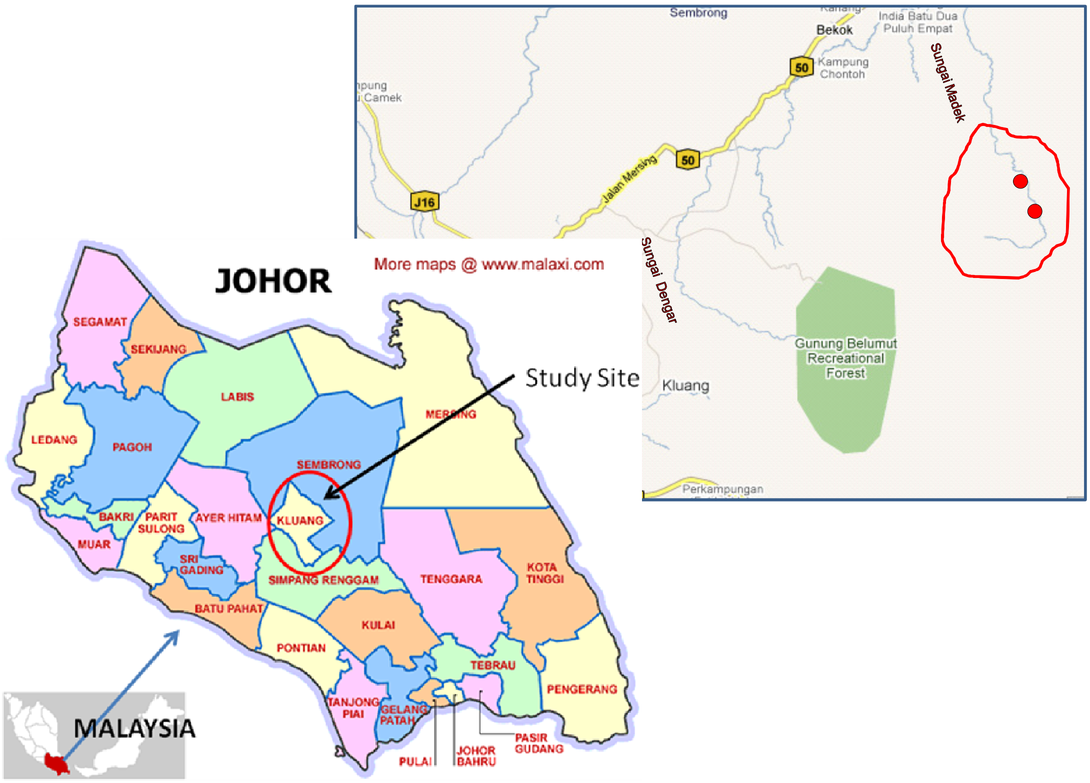

Figure 1 : Study area and sampling

The benthic macro invertebrate samples were preserved in 80% ethanol before laboratory identification were made. In the laboratory, the sample was then rinsed with tap water to remove the preservative and then sorted out into major taxa. The sorted organisms were stored in 10 ml glass bottle containing 70% ethanol for preservation and for subsequent identification. The sorted organisms were identified up to genus level except Chironomidae where they were only identified up to sub-family level (Edmondson, 1959; Cook, *et. al.*, 1971; McCafferty, 1981; Merritt and Cummins, 1984; Needham and Needham, 1962; Thorp and Covich, 1991; Henderson, 1989; Wiederholm, 1983; Robert, 1953). Six in-situ parameters were measured as dictated in the standard procedure of U. S. Environmental Protection Agency (US EPA, 2007) for water quality. In-situ water quality sampling was taken only at the upper reach station due to the distance between upper and lower station was too close (500 meter). The parameters such as temperature, conductivity, dissolved oxygen (DO), pH, turbidity and salinity were measured using multi parameter probe Model YSI 6920 with 650 MDS Display/Logger as well as a single parameter probe. On the other hand, habitat characteristics assessment was assessed through field survey with the use of a field survey form, the format was adopted from Barbour, (1999). The main components that was available in the given field study form was riparian vegetation, in-stream features, large woody debris, canopy cover and aquatic vegetation but only canopy cover and riparian compositions were considered for the purpose of this study. Sampling reach for river physical characteristics at all the sampling sites were approximately 500 meters in length and 10 meters wide (5 meters width at each bank) except for the reference station which was only 200 meters in length.

RESULTS AND DISCUSSION

The surface water dissolved oxygen content ranged from 7.25 mg/l to 8.36 mg/l with the maximum value of 8.36 was recorded during monsoon season (November), while, the minimum value of 7.25 was recorded during dry season (March). The highest dissolved oxygen values recorded during monsoon season was believed to be due to the fast water flow, while the lowest reading recorded during the dry season was believed to be due to stagnant and low flowing water. Meanwhile, pH was ranged from 5.48 to 7.49. The maximum value was recorded in

August while the minimum value in March. The lowest pH value in March (dry season) was believed to be due to the river received low runoff. Runoff will not only cause soil erosion but also increased acidity to the receiving water body because soil particles normally bring along nutrients that can cause water acidity. With regard to the surface temperature, this varied between 24.5 °C to 27.0 °C. The maximum temperature was observed during pre-monsoon period (August) and the minimum temperature was noted during drought season (March). This was unusual because, generally, temperature of the water will rise during dry season (March) due to low flow conditions and strong sunshine but Madek River have shown otherwise. As for conductivity, the values ranged from 24.3 uS/cm to 28.7 uS/cm. The maximum conductivity was recorded during pre-monsoon period (August) and the minimum value during drought season (March). Although salinity was not detected at all the sampling events but the concentration of water turbidity was high which ranging from 4.5 NTU to 26.2 NTU with the maximum value recorded in March and the minimum in August. Generally, turbidity of the river was dependent on the raining event, where during the monsoon period water become more turbid compared to dry season because of the runoff and soil erosion but surprisingly Madek River have shown otherwise.

There were only two (2) sensitive taxa namely Ephemeroptera and Trichoptera found in this area. Ephemeroptera found in the logging area was from the genus Potamanthus, Pseudiron, Ephemerella and Rhithrogena, while for Trichoptera the genus obtained was Hydropsyche and Macrostemum. Coleoptera from the genus Stenelmis and Gyrinus were also found in this area. In addition, the taxa Odonata from the genus Arigomphus and Dromogomphus and Hemiptera from the family Gerridae and Mesoveliidae were also found. The taxa Diptera from the genus Tipula and sub-family Chironominae and Tanypodinae were also recorded besides Decapoda from the genus Macrobrachium and M. Pillimanus (**Table 1**).

Logging activities regardless of whether carried out traditionally or by "Selective Management System" will definitely alter the river riparian compositions and canopy cover but activities which followed "Selective Management System" produce less impact compared to traditional logging.

Cutting of trees resulting in reduce canopy cover will lead to increase in river water temperature which at the same time will promote undergrowth that can act as control for soil erosion and siltation.

Table 1: Benthic Macro-invertebrate Composition for Madek River

Land Uses	Taxonomy		
	Order	Family	Genus
Logging	Ephemeroptera	Potamanthidae	Potamanthus
	Ephemeroptera	Baetidae	Pseudiron
	Ephemeroptera	Ephemerellidae	Ephemerella
	Ephemeroptera	Heptageniidae	Rhithrogena
	Trichoptera	Hydropsychidae	Hydropsyche
	Trichoptera	Hydropsychidae	Macrostemum
	Coleoptera	Elmidae	Stenelmis
	Coleoptera	Gyrinidae	Gyrinus
	Diptera	Chironomidae	Chironominae (sub-family)
	Diptera	Chironomidae	Tanypodinae (sub-family)
	Diptera	Tipulidae	Tipula
	Hemiptera	Gerridae	Gerris
	Hemiptera	Mesoveliidae	-
	Odonata	Gomphidae	Arigomphus
	Odonata	Gomphidae	Dromogomphus
	Decapoda	Palaemonidae	Macrobrachium
	Decapoda	Atiyiedae	M. Pilimanus

This was proven by high water quality measurements (physico-chemical) obtained at both sampling stations where all the parameters were under Class I, Interim National Water Quality Standards for Malaysia (INWQS) except for turbidity which fell under Class II, INWQS but still considered as a good water quality. Even though, logging activities was followed strictly the "Selective Management System" imposed by the Forestry Department but the impact on benthic macroinvertebrate assemblages can still be occurred, where it was found that Plecoptera was absent at both stations, while, complete Ephemeroptera, Plecoptera and Trichoptera (EPT) was found at undisturbed stations.

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