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Benthic Macroinvertebrate as an Alternative Tool for Biological Monitoring in Assessing River Water Quality

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Abstract. Water quality monitoring based on invertebrate aquatic life is capable of giving a short and easy approach to assess water quality status. In order to determine the quality of water, the method selected in monitoring is very important. Assessment is carried out through collection and identification of the indicator which comprises of invertebrate especially aquatic insect. This study focus on pollution level in Melana River, Skudai, Johor. The methods applied in this study including physical and chemical analysis and biological monitoring. The water quality parameters involved are dissolve oxygen (DO), pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen (AN) and total suspended solid (TSS), meanwhile the Water Quality Index (WQI) for each station were calculated. From the result, Melana River is classified into Class IV or polluted whereas the Biological Water Quality Index (BWQI) indicate Melana River as slightly polluted with the score in between 3.8 to 4.0, showing both of these river are rather-dirty. This method can be applied to any river to identify their pollution river.

Keywords: Melana River, Benthic Macroinvertebrate, Water Quality Index, Biological Water Quality Index

1. Introduction

In recent years, numerous publications have critically reviewed the use of benthic macroinvertebrates as bioindicator as well as the appropriateness and shortcoming of certain indices. Biological monitoring, the systematic use of biological responses to evaluate environmental changes (Rosenberg and Resh 1993), has proven to be a valuable water resource management tool in rivers (Hynes 2007; Bonada et al. 2006), and particularly for the management of rivers in developing countries (Resh 2007; Mason 1996). There are several possible assemblages of organisms available for use in bioassessment. However, benthic macroinvertebrates, periphyton, and fish are the biological indicators suggested for use by the U.S. EPA in lotic environments (Barbour et al. 1999). Benthic macroinvertebrates are the most commonly used assemblage (De Pauw et al. 1992; Hellawell 1986; Rosenberg and Resh 1993).

Benthic macroinvertebrates are a diverse assemblage, consist of species exhibiting a range of pollution tolerance levels, and are abundant in most streams (Plafkin et al. 1989, Barbour et al. 1999). Furthermore, they often live the majority of their lives in direct contact with both the water and sediments and their life cycles may span multiple seasons, thereby showing cumulative changes. They also serve as an important link in the food chain (Plafkin et al. 1989), maintaining the rest of the aquatic community and managing algal systems. Benthic macroinvertebrates are easy and affordable to collect, making them extremely attractive for biological monitoring.

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Use of indices to evaluate pollution effects on aquatic community were practiced by scientists since early 20th century ago. Basic indices comprises of diversity index, comparison index and biotic index. Biotic index differ compared to others because it more specific to type of pollution and geographic area which involved. Biotic index system have been developed which give numerical scores to specific indicator organisms at a particular taxonomic level (Armitage et al., 1983).

2. Methodology

2.1. Study Area

This study is located at Melana River catchment (Fig. 1). This river started from Gunung Pulai until Skudai River reach at Taman Perling district of Johor Bahru. Melana River is one of network in Skudai River basin. This watershed is located in Mutiara Rini area, Skudai in Johor Bahru district. The area of Melana watershed is about 22.92 km^2 with many changes occurred in this area because of vast development. Many housing area and light industry being constructed in this watershed such as Taman Teratai, Taman Universiti, Taman Mutiara Rini, Taman Sri Pulai, and Taman Pulai Perdana to cater the increasing of population.

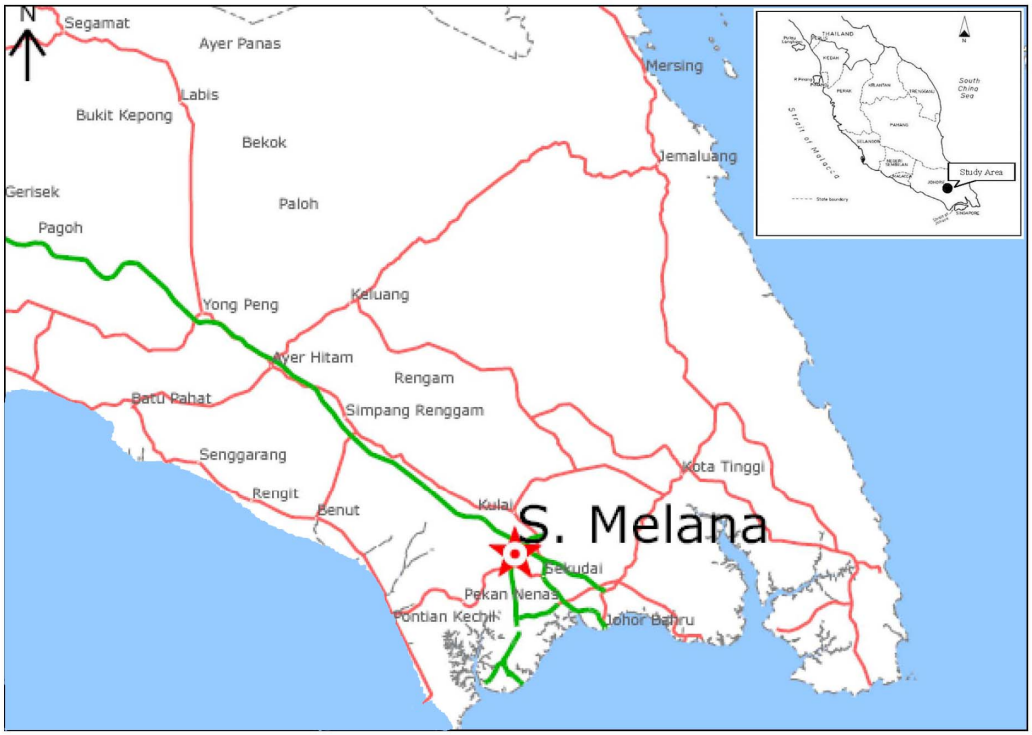

Fig. 1: Macroinvertebrate study area at Melana River, Skudai

2.2. Sampling and Identification

A rectangular dip net with 500µ mesh size was used to collect the the benthic macroinvertebrates. Samples were taken in duplicates at each station. The samples collected were put into polyethelene bottles and preserved with 70% alcohol for further analysis in laboratory using light microscopy. In the laboratory, benthic macroinvertebrates were sorted, enumerated and identified to the lowest possible taxon. Benthic macroinvertebrate were analysed and calculated according to Biological Water Quality Index, BWQI (DID 1996), as shown below:

$$BWQI = \Sigma S / \Sigma J$$

where: BWQI = Biologcal Water Quality Index, S = Total score, J = Number of animal type

Water quality paramaters (temperature, conductivity, depth, width, DO and pH) were measured in-situ. Dissolved oxygen and pH were determined using YSI meter (Multi sensor) model 610D while others (BOD, COD, TSS and AN) were analysed in laboratory. These parameters were then calculated to obtain the water quality index based on equation below:

WQI = 0.22*SIDO + 0.19*SIBOD + 0.16*SICOD + 0.15* SIAN +0.16*SISS + 0.12*SipH

Where: WQI = Water Quality Index, DO = Dissolved oxygen, BOD = Biochemical oxygen demand, COD = Chemical oxygen demand, AN = Ammoniacal-N, SS = Suspended solids, pH = acidic value

3. Result and Discussion

3.1. Existing Water Quality of Melana River

The Water Quality Index is a good indicator of any deterioration or improvement of a water body. Generally, most of the parameters indicated low water quality corresponding to the downstream of the river. This is due to the circumstances of the sampling area congested by residential and industrial area, sewerage treatment plant and other land use activities. With regards to the Malaysian Water Quality Index (WQI), Melana River is classified into Class IV with range between 47 - 52 which is only suitable for irrigation purposes (Table 1).

Table 1: The water quality of Melana River, Skudai, Johor

Station No.	SIDO	SIBOD	SICOD	SIAN	SISS	SIpH	WQI	Status
St-1	51	32	40	8	92	99	52	IV (P)
St-2	45	15	48	0	94	100	47	IV (P)
St-3	57	21	27	0	86	100	47	IV (P)

3.2. Composition and Distribution of Benthic Macroinvertebrate

A total of 77 individual representing 7 families from 3 orders were successfully sampled from three sampling point at the middle section of Melana River (Table 2). Among all, molluscs (Fig. 2a) and dragonfly nymph (Fig. 2b) were the most diverse group found in each sampling station. High number of organisms were sampled in station 2 (34) followed by station 3 (25) and station 1 (18). Abundance of non-biting midge larvae (Fig. 2c) were also observed in each station. According to Galdean et al. (2000) their abundance usually associated with the amount of detritus, as can be seen whereby silt and clay were the major component of sediment in that area.

The Biological Water Quality Index (BWQI) values in Melana River were in between 3.8 - 4.25, indicating that the water quality of that river were slightly polluted. However, based on Family Biotic Index (FBI), the score for station 1 and 3 were 7.44 and 8.0 showed that sampling area were heavily polluted whereas station 2 score was 6.97 (polluted). The changes of the ecosystem especially in the downstream of Melana River might be associated with man-induced activities such as sedimentation, sewage/ nutrients runoff and agricultural pesticides.

Table 2: Classification of water quality in Melana River, Skudai, Johor based on biological indices

Station No.	BWQI	Status	FBI	Status
St-1	3.8	Rather dirty - average	7.44	Heavily polluted
St-2	4.25	Rather dirty - average	6.97	Polluted
St-3	4.25	Rather dirty - average	8.0	Heavily polluted

Fig. 2a: Molluscs sampled in Melana River, Skudai, Johor

Fig. 2b: Dragonfly nymph sampled in Melana River, Skudai, Johor

Fig. 2c: Non-biting midge larvae sampled in Melana River, Skudai, Johor

4. Conclusion

As a whole, the result from chemical and biological analysis conducted shows that water quality of Melana River was degraded with similar result. Pollution factors will also influence the abundance of invertebrates. Organic pollutants such as fertilizers from agricultural activities, residential areas and factories resulted in increased populations of resistant organisms to contamination. On the other hand, collection for certain macrobenthic species present particularly in polluted and non-polluted parts of a river indicated that they could be employed as suitable bioindicators for river pollution studies.

5. Acknowledgement

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