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Full paper

Influence of Water Quality Index (WQI) on Biotic Indices of Benthic Macroinvertebrate at Highland Rivers in Kelantan and Pahang

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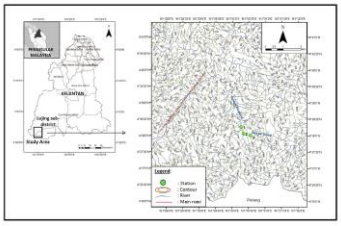
Graphical abstract



Abstract

A physicochemical survey of water quality and benthic macroinvertebrates at two rivers namely Sungai Dekong and Dawai in Lojing Highland was conducted on 23 and 24, January 2014. Three stations were selected for physicochemical water quality, one station at Sungai Dekong and two other stations at Sungai Dawai. On the other hand, benthic macroinvertebrates were collected at nine stations, i.e. three stations at Sungai Dekong and the other six stations at Sungai Dawai. Result shows that, Station 1 (Sungai Dekong) recorded Very Poor Biological Monitoring Working Party, BMWP (2.0–12.0), Poor Average Species per Taxon, ASPT (2.0–4.0), Poor Citizen Monitoring Biotic Index, CMBI (2.0–2.3), Fairly Poor Family Biotic Index, FBI (5.3–6.0) and Poor Ephemeroptera, Plecoptera and Trichoptera or EPT Index (0.0). However, the Water Quality Index WQI (70.01) falls into Class III which can be categorized as Slightly Polluted River. On the other hand, Station 2 (Sungai Dawai downstream) recorded better Biotic and Ecological Index but lower Water Quality Index as compared to Station 1. It recorded Moderate BMWP (26.0–84.0), Very Good ASPT (5.3–6.5), Good CMBI (2.7–3.2), Excellent FBI (3.4–4.3) and Moderate EPT Index (2.0–5.0). However, the WQI (54.99) falls into Class III, and can be categorized as Polluted River. Finally, Station 3 (the most upstream station at Sungai Dawai) recorded almost similar Biotic and Ecological Index with Station 2 but in terms of WQI revealed a significant difference. Station 3 recorded Poor BMWP (34.0–46.0), Very Good ASPT (6.5–6.8), Good CMBI (2.9–3.1), Excellent FBI (3.1–3.9) and Moderate EPT Index (3.0–4.0). However, it's WQI (84.48) falls into Class II which could be categorized as Cleaned River. As a conclusion, physicochemical river water quality was not the only contributing factor to the Biotic Index at the highland rivers as per other factors such as river substrates, river discharge, aquatic plants, river riparian and river canopy.

Keywords: Water quality index; biotic index; highland river; EPT index

1.0 INTRODUCTION

Benthic macroinvertebrates, or more simply "benthos", are animals without backbones that are larger than ½ millimeter. These animals live on rocks, logs, sediment, debris and aquatic plants during some periods in their life. 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 [1-6]. Its distribution highly depends on physical nature of the substratum, nutritive content, degree of stability, oxygen content and level of hydrogen sulphide [7]. The small changes in the environment will have considerable response on the benthic community and it avails to measure the degree of pollution [8-9]. The Biotic Indices as well as the presence and numbers of different types of benthic macroinvertebrates provide accurate information about the health of a stream and watershed. In addition, the distribution and composition of benthic macroinvertebrates were also strongly related to the habitat characteristic and water quality [10, 11]. As there is no assessment on the influence of Water Quality Index (WQI) on Biotic Index of Benthic Macroinvertebrate in Highland River, especially in Lojing which was never done before, the present study has been undertaken to identify the Biotic Indices of benthic macroinvertebrate in relation to WQI.

2.0 METHODOLOGY

The study area was situated in Lojing Highland (610-1500 meter), Gua Musang, Kelantan. The sampling station for water quality was located in the Sungai Dawai and Sungai Dekong which are located in between of 1000 to 1050 meters above the mean sea level (Figure 1). Station 1 is the most downstream station which is located at the Sungai Dekong main river, and station 2 was located at the tributary of Sungai Dekong which is the confluence between Sungai Dekong and Sungai Dawai. On the other hand, station 3 was located about 200 meters upstream of station 2. Benthic macroinvertebrates were collected at nine stations: three stations located at Station 1(to measure the water quality of Sungai Dekong), three points at Station 2, (to measure the water quality of Sungai Dawai) and another three points at Station 3, (to measure the water quality of upstream Sungai Dawai).

The sampling procedure was conducted from 23 and 24 January 2014 at three identified sampling stations for water quality and nine stations for benthic macroinvertebrates at Sungai Dekong and Sungai Dawai, Lojing Highland, Gua Musang, Kelantan. Surber Net with 500 micron mesh size combined with a rectangular quadrate with the size of 30 cm x 30 cm (0.09 m^2) was used to sample the macroinvertebrates. Each station comprises of three sampling points for macroinvertebrate sampling, one at the right bank, one at the middle and the other one at the left bank. All three samples in each sampling station was composite as one sample. Benthic macro invertebrate sample was preserved in 80% ethanol before sending to laboratory for identification. In the laboratory, the genus levels of the samples were identified [12-13]. For water quality, at each station, five in-situ parameters were measured by following the standard procedure of USEPA [14]. The parameters were temperature, dissolved oxygen (DO), pH, turbidity and salinity which can be measured by using a multi parameters probe Model YSI 6920 with 650 MDS Display/Logger as well as single parameter probe. Meanwhile, Total Suspended Solid (TSS), Ammoniacal Nitrogen (AN), Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD) were analysed in the laboratory using spectrophotometer model DR2800.

Individual water quality was converted into Water Quality Index (WQI) and interpreted into river classification based on "Water Quality Index Classification" and "Water Quality Classification Based on Water Quality Index" established by the Department of Environment, Malaysia [15]. At the same time, Biotic Indices namely Average Species per Taxon (ASPT), Biological Monitoring Working Party (BMWP), Family Biotic Index (FBI), Ephemeroptera, Plecoptera and Trichoptera (EPT) Index [16] and Citizen Monitoring Biotic Index (CMBI) [17] were also calculated.

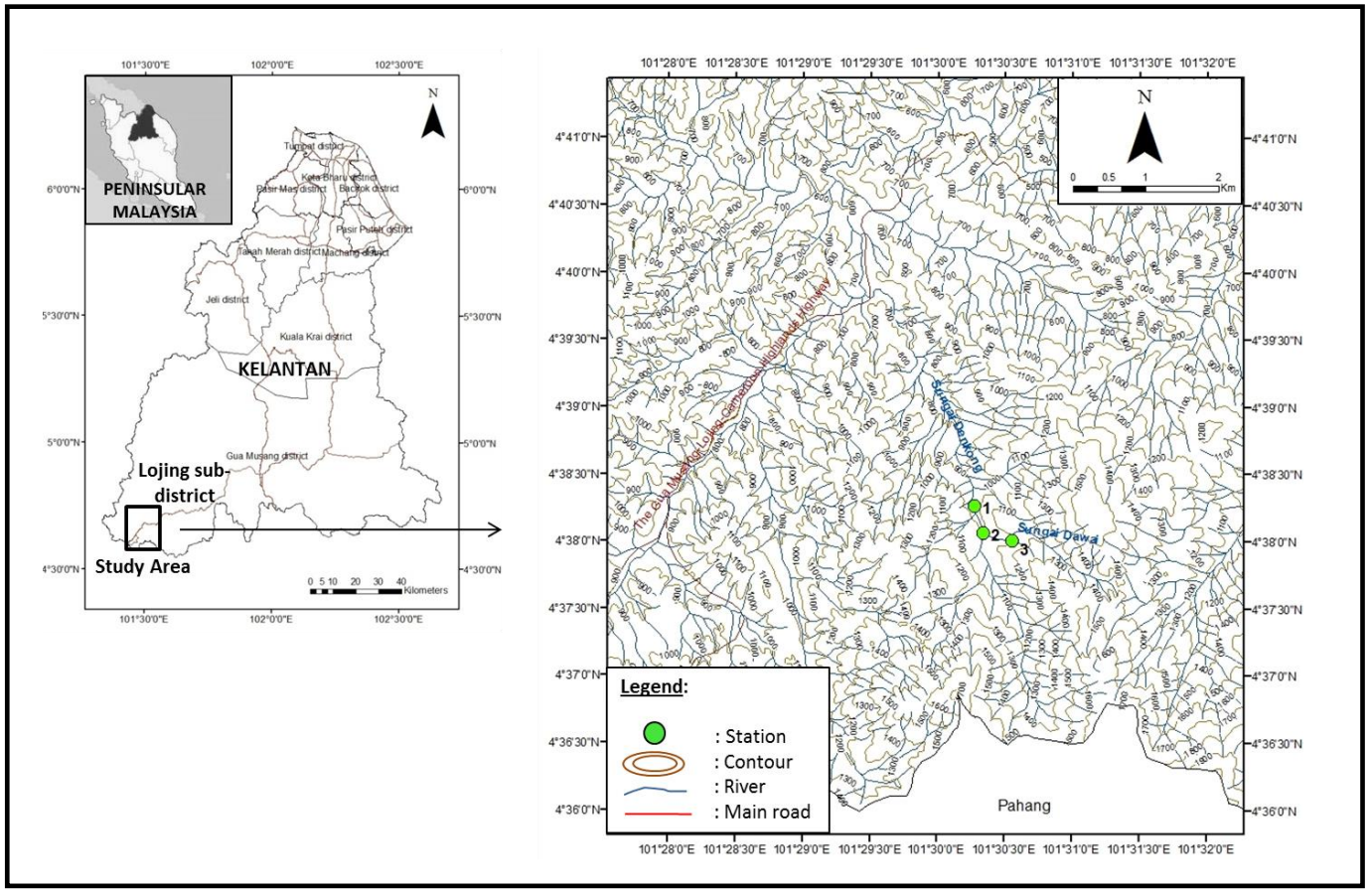


Figure 1 Study area and sampling stations

3.0 RESULTS AND DISCUSSION

The results of BMWP from three stations recorded different findings (refer Table 1). The BMWP of Sungai Dawai (upstream) was between 34.0 and 39.0 which can be categorized as Poor. Meanwhile, the BMWP for Sungai Dawai (middle stream) was recorded between 26.0 and 84.0 which can be categorized as Moderate. However, the BMWP for Sungai Dekong

(downstream) was recorded between 2.0 and 12.0 which can be categorized as Very Poor.

On the other hand, results for ASPT were recorded between 6.5 and 6.8 (Very Good) for Sungai Dawai (upstream), 5.3-6.5 (Very Good) for Sungai Dawai (middle stream) and 2.0-4.0 (Poor) for Sungai Dekong.

In terms of CMBI, Sungai Dawai (upstream) recorded between 2.9 and 3.1 which can be categorized as Good, Sungai Dawai (middle stream) recorded between 3.4 and 4.3 which falls into Good category, meanwhile, for Sungai Dekong (downstream) CMBI was between 2.0 and 2.3 which could be categorized as Poor.

The result of FBI for Sungai Dawai (upstream) was between 3.1 and 3.9 which was categorized as Excellent, meanwhile, FBI for Sungai Dawai (middle stream) was recorded between 3.4 and 4.3 which was also categorized as Excellent. However, FBI for Sungai Dekong (downstream) was recorded between 5.3 and 6.0 which can be categorized as Fairly Poor.

In terms of EPT index, Sungai Dawai (upstream) recorded between 3.0 and 4.0 which falls into Moderate category, Sungai Dawai (middle stream) recorded between 2.0 and 5.0 which also falls into Moderate category, meanwhile, for Sungai Dekong (downstream) EPT Index was recorded as 0.0 which was categorized as Poor.

Overall categories for Biotic Index in Sungai Dawai (upstream) and Sungai Dawai (middle stream) were considered as Good, however in Sungai Dekong (downstream) was Poor.

In terms of WQI, Sungai Dawai (upstream) recorded 84.48 which can be classified as Cleaned River, however, Sungai Dawai (middle stream) recorded 54.99 which was categorized as Polluted River and Sungai Dekong (downstream) recorded 70.01 which was categorized as Slightly Polluted River. However, when WQI was compared with overall Biotic Index, it showed some inconsistencies in the results. For example, Sungai Dawai (middle stream) station recorded Good Biotic Index but yet the WQI was very low (54.99-Polluted River). If WQI was the only factor that contributed to the Biotic Index, it should fall into Poor category because this station recorded the lowest WQI. Similarly, with respect to the findings of the station at Sungai Dekong (downstream), if the WQI is the only factor that influenced Biotic Index, it should fall into Moderate category instead of Poor.

Table 1 Biotic index of benthic macroinvertebrates

		Sungai Dekong (Down Stream)			Sungai Dawai (Middle Stream)			Sungai Dawai (Up Stream)		
Index	Score/ Category	1	2	3	4	5	6	7	8	9
BMWP	Score	2.0	12.0	7.0	26.0	84.0	49.0	39.0	46.0	34.0
	Category	Very Poor	Poor	Very Poor	Poor	Good	Moderate	Poor	Moderate	Poor
ASPT	Score	2.0	4.0	2.3	6.5	5.3	6.1	6.5	6.6	6.8
	Category	Poor	Poor	Poor	Very Good	Good	Very Good	Very Good	Very Good	Very Good
CMBI	Score	2.0	2.3	2.0	3.1	2.7	3.2	3.0	3.1	2.9
	Category	Poor	Fair	Poor	Good	Good	Good	Good	Good	Good
FBI	Score	6.0	5.3	6.0	4.3	3.7	3.4	3.1	3.9	3.2
	Category	Fairly Poor	Fair	Fairly Poor	Very Good	Excellent	Excellent	Excellent	Very Good	Excellent
EPT Index	Score	0.0	0.0	0.0	2.0	5.0	4.0	3.0	4.0	3.0
	Category	Poor	Poor	Poor	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
EPT%	Score	0%	0%	0%	23%	21%	48%	71%	75%	50%
	Category	Poor	Poor	Poor	Poor	Poor	Moderate	Good	Good	Good
Overall	Category	Poor	Poor	Poor	Moderate	Good	Good	Good	Good	Good
WQI			70.01			54.99			84.48	
River Classes			III (Slightly Polluted)			III (Polluted)			II (Cleaned)	

■4.0 CONCLUSION

As a conclusion, the researchers believe that physicochemical river water quality was not the only factor that contributed to the Biotic Index at the highland rivers. River substrate, river discharge, aquatic plants, river riparian and river canopy were also believed to be some of the possible factors. It can be concluded that Sungai Dawai is healthier than Sungai Dekong but certain portion of Sungai Dawai is more polluted as compared to Sungai Dekong.

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