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Comparative Assessment of Moyog River Watershed and Malaysia Water Quality Index

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Water is vital to the existence of all living organisms, but this invaluable resource is badly threatened by fast-growing human population and urbanization when increasing number of rivers are polluted due to the uncontrolled human activities. Here, we report the assessment of Water quality of Moyog river through the Malaysia Water Quality Index (NWQI) versus Canadian Water Quality Index (CWQI) as well as Biological Monitoring Work Party (BMWP) index. Sampling stations were set at Kg. Kibunut (KB), Kg. Notoruss (NT) and Kg. Babagon (BB) located in middle stream, as well as Kg. Kibabaig (KG) located in the lower stream of the Moyog river. NWQI shows that all the selected sites except KG fall under First Class category indicating an excellent water quality of the river. However, under CWQI, water quality for both MY, NT and BB falls into Second Class and Third Class, respectively, signifying a deterioration of water quality, and inconsistency of NWQI and CWQI in the water quality assessment. Besides, through BMWP index approach, a total of 538 individuals belonging to 8 orders, 17 families and 18 genera identified during the whole sampling event. The BMWP index is in good agreement with CWQI and this implies that a more stringent and holistic NWQI should be proposed for better assessment of river water quality in Malaysia.

Keywords: Water Quality Index, Moyog River, Biological Monitoring Work Party index.

I. INTRODUCTION

Water quality index (WQI) is a mathematical formula to determine the level of cleanliness of freshwater. It combines the water quality parameters into a single number for further classification of the water quality status. Good WQI is the one that is sensitive and flexible towards any changes of the environment (Naubi *et al.*, 2015). In Malaysia, the Department of Environment has applied WQI since 1978 (DOE, 2009). Six parameters namely pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (NH_3-N) and total suspended solids (TSS) are used to calculate the water quality index. Equation 1 shows the WQI formula used to calculate the WQI value. These measurements further determine the classification of the river based on the Interim National Water Quality Standard (INWQS), Malaysia (DOE, 2009). WQI for Malaysia, however, is only relevant towards physicochemical parameters and the index is not detailed (Varadhrajan, 2009; Al-Mamun & Idris, 2009).

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WQI = 0.22 (SIDO) + 0.19 (SIBOD) + 0.16 (SICOD) + 0.15 (SIAN) +0.16 (SISS) + 0.12 (SIpH) (1)

where,

SIDO = Sub-index of DO in percentage saturation

SIAN = Sub-index of NH_3-N

SIBOD = Sub-index of BOD

SISS = Sub-index of TSS

SICOD = Sub-index of COD

SIpH = Sub-index of pH

The Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) or also referred to as Canadian Water Quality Index (CWQI), has come out with the most stringent formulation to grade the quality of water (Lumb *et al.*, 2011). It is a flexible mathematical formulation which requires at least four variables with a frequency of sampling at a minimum for four times. CWQI combines three variables such as scope (F1), frequency (F2) and amplitude (F3) to produce a number that represents the water quality. CWQI is calculated based on formula shown in Equation 2. The index value is further used to determine the water quality ranking (CCME, 2001).

$$CWQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}\right) \quad (2)$$

Aquatic insects have been widely used to access water quality (Yoshimura, 2012). Through the list of macro-invertebrates species and as its great respond to a variety of perturbations, present in a wide array of aquatic habitats is able to make a significant indicators for monitoring river quality (Whiles *et al.*, 2000). The Biological Monitoring Work Party (BMWP) index is calculated by adding the individual tolerance values of all indicator organisms present (family level). The effectiveness of this index is that the score not only reflects water quality but also indicate the presence of pollution in the nature (Armitage, 1989; Friedrich *et al.*,1999). In this paper, the water quality of Moyog river watershed was identified. Assessment of the water quality were through the Malaysia Water Quality Index (NWQI) versus Canadian Water Quality Index (CWQI) as well as Biological Monitoring Work Party (BMWP) index. The results proved that the existing NWQI, however, is less stringent and inconsistent compared to both CWQI and BMWP index. Hence, it is time to propose a universal NWQI for future assessment of water quality in Malaysia

II. EXPERIMENTAL DETAILS

A. Sampling Location

This research has focused on the Moyog River watershed, which were located at Kampung Kibunut (KB), Kampung Notoruss (NT), Kampung Babagon (BB) and Kampung Kibabaig (KG) as in Figure 1. There were total of five sampling stations selected for study. Table 1 describes the GPS coordination for the sampling location.

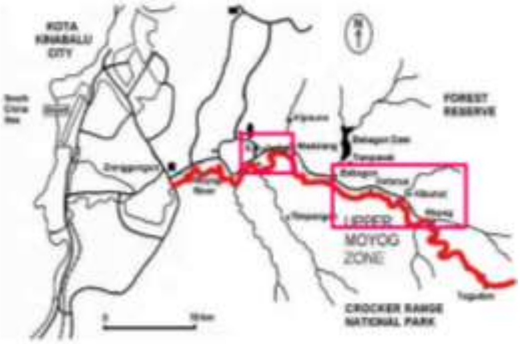

Figure 1. Moyog river watershed, Penampang, Sabah.

Table 1. GPS coordination for sampling location along the Moyog River Watershed, Penampang.

Location Points	GPS Coordination		Sampling code
	Latitude (°)	Longitude (°)	
Kibunut River at Kampung Kibunut	5.8962	116.2215	KB
Moyog River at Kampung Kibunut	5.8955	116.2211	MY
Moyog River at Kampung Notoruss	5.8997	116.1955	NT
Moyog River at Kampung Babagon	5.9031	116.1833	BB
Kibabaig River at Kampung Kibabaig	5.9150	116.1156	KG

B. Water Quality

The sampling, preservation and analysis of water follow the standard guidelines recommended by the American Public Health Association (APHA), United States Environmental Protection Agency (USEPA). Water samples were collected once a month starting from January to May 2017. Physico–chemical parameters such as pH and dissolved oxygen (DO) were recorded in situ by using YSI (Digital Professional Series) multiparameter. Biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS) and ammoniacal nitrogen (NH3-N) were analyzed ex-situ. Salicylate Method was used to measure NH3-N (HACH DR6000). TSS was determined using APHA 2540D method. USEPA reactor digestion method (HACH DR6000) was used to identify the COD of the samples. The 5-days BOD test was following the APHA 5210B method. The measured results therefore were used in order to calculate the NWQI and CWQI.

C. Aquatic Insect Collection

The aquatic insects were collected at three different locations: KB, NT and BB. Aquatic insects were sampled along approximately 100 m reach by using a surber net (mesh size 12 µm, 900 cm^2 area) and following the kick net sampling technique (Merrit *et al.*, 2008). Three replications were used covering riffles, runs and pool area. Specimens were sorted out from the sediment, leaf litters or substrates inside the net and placed in universal bottles containing 90% ethanol and later preserved in 70% ethanol. Identification was done using genus level taxonomic key (Whiles *et al.*, 2000; Merrit *et al.*, 2008). Specimens later were deposited at BORNEENSIS in Institute for Tropical Biology and Conservation (ITBC), Universiti Malaysia Sabah (UMS) for specimen collection.

III. RESULTS AND DISCUSSIONS

Table 2 summarizes the water quality of Moyog river watershed based on NWQI, CWQI and BMWP index within five consecutive months (January – May 2017) (Lim, 2017; Muh, 2017). All of the selected sites fall under First Class category according to the NWQI except KG. This indicates an excellent water quality of the river. In comparison to the NWQI, CWQI signifying a deterioration of water quality for MY and NT as both falls into Second Class respectively, while BB into Third Class. Hence, this results proved the inconsistency of NWQI and CWQI in the water quality assessment. Biological assessment through BMWP index approach has identified a total of 538 individuals. The BMWP index shows that both results of NT and BB is in good agreement with CWQI.

Table 2. NWQI vs. CWQI vs. BMWP Index (for Jan – May 2017)

Malaysia WQI				**Canadian WQI**			**BMWP Index**		
Class	Value	Grade	Site	Value	Grade	Site	Value	Grade	Site
I	> 92.7	Very Good	KB, MY NT, BB	95–100	Excellent	KB	> 150	Excellent	
II	76.5–92.7	Good		80–95	Good	MY, NT	100–150	Very Good	
III	51.9–76.5	Average	KG	65–79	Fair	BB, KG	50–99	Good	NT
IV	31.0–51.9	Polluted		45–64	Marginal		25–49	Fair	BB, KB
V	< 31.0	Very Polluted		0–44	Poor		< 25	Poor	

IV. CONCLUSION

The water quality of Moyog River remains unpolluted based on NWQI, CWQI and BMWP index. However, NWQI is too loose and less stringent. This model ranked water quality of Moyog river watershed as excellent in almost all cases, including MY, NT and BB which are among the stressed water bodies as they pass through recreational, and illegal clearing and hill cutting activities. Besides, BMWP index is one of the biological assessments which is weather dependent and does not reflect the overall physicochemical characteristic of the river water. Thus, results in the inconsistent grading between NWQI, CWQI and BMWQ index. A more stringent and holistic NWQI should be proposed for better assessment of river water quality in Malaysia to ensure relationship and degree of relation of each parameter so that the related parameters shall be avoided in the determination of water quality through the Water Quality Index.

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