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Research Article

Assessment of a Physicochemical Indexing Method for Evaluation of Tropical River Water Quality

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This paper attempts to evaluate the Malaysian water quality indexing method that has been criticized for its ineffectiveness. The indexing method is referred to as the Water Quality Index of the Department of Environment, Malaysia (DOE-WQI). This index was assessed against two other indices (River Ganga Index and Minimal Water Quality Index (WQI_{min})) and a modified DOE-WQI was also proposed. DOE-WQI and WQI_{min} are physicochemical indices, whereas the River Ganga Index and modified DOE-WQI are indices with the inclusion of a microbiological parameter. The assessment was conducted based on the water quality of tropical rivers in Malaysia, with specific reference to Sarawak River and its tributaries. Water quality in terms of pH, dissolved oxygen, conductivity, turbidity, total suspended solids, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, and fecal coliform count (FCC) was measured from 18 stations in December 2015, January 2016, and March 2016. Generally, the river was characterized with high FCC with the four indices significantly correlated. The results demonstrated the shortcomings of the existing DOE-WQI; the physicochemical index assigned water quality to a better class than its actual conditions without taking into consideration the FCC.

1. Introduction

Water quality monitoring is an area of utmost concern for many developing countries due to the rapid growth in population and urbanization. In Malaysia, many river catchments are at risk as a result of increasing land use. As reported by the Department of Environment (2010) [1], the percentage of clean river basins has consistently reduced with increasing numbers of rivers categorized as moderately polluted/polluted. The water quality of Malaysian rivers is primarily monitored based on the water quality index (WQI) developed by the Department of Environment using six physicochemical parameters, namely, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (NH_3-N), total suspended solids (TSS), and pH. This approach, like other water quality indices, transforms the water quality data into a single numerical value to depict the overall water quality with a score between 0 and 100 [2, 3]. It has been widely used to facilitate the decision-making process and management of regulatory programs relating to water quality assessment in Malaysia.

Numerous water quality indexing methods were developed for different uses and water sources; the first water quality index was introduced in 1965 [4]. They differ primarily in the determinants used, the mathematical derivation strategies, and the classification criteria [2]. This has been comprehensively reviewed by Gitau et al. [5]; for example, the water quality index of the U.S. National Sanitation Foundation (NSF) uses nine variables, that is, DO, fecal coliform count (FCC), pH, biochemical oxygen demand (BOD), temperature (Temp), total phosphate (TP), nitrate (NO_3^-), turbidity (Turb), and total solids (TS). For each parameter, a score, Q_n, is determined from a rating curve and multiplied by the weightage assigned, W_n, yielding the weighted subindices. The sum of the weighted subindices describes the water quality status where a score of 90–100 denotes excellent water quality whereas a score of 70–90 indicates water in good condition [$\sum_{n=1}^{N} Q_n W_n$ (n is the determinant involved)]. A lower score of 50–70, 25–50, and 0–25 refers to medium,