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Use of Water Quality Index in Water Quality Assessment: A Case Study in the Metro Manila

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ABSTRACT

Over the last 20-30 years, most of the water bodies in Metro Manila have become increasingly threatened. The deteriorating quality of the river systems is directly linked to the inadequacy of the existing sewage systems in the Metro Manila area and untreated wastewater discharged from domestic, agricultural, commercial and industrial sources. This paper examines the water quality of the Pasig River system in Metro Manila using the Canadian Council of Ministers of the Environment water quality index (CCME WQI) for aquatic ecosystem and recreation purposes. Four water quality parameters were used to determine the CCME WQI at fourteen different sampling stations. Analysis of the data revealed that the water quality is poor. With regard to the use of river water in the study area, this study is expected to present valuable information to policy makers, administrators, water managers and local people.

Keywords: Metro Manila; water quality index; aquatic ecosystem; recreation

INTRODUCTION

Rapid urbanization of the Metro Manila area coupled with slow infrastructural development has exerted tremendous pressure on water resources and the urban environment. Water bodies in the Philippines, both inland surface waters and coastal and marine waters are classified according to their current most beneficial use or, in special cases, according to their intended or future beneficial use (DENR, 1990). Water classifications have been described according to the degree of protection required, with AA and SA classifications for inland surface waters and coastal and marine waters, respectively, corresponding to the most stringent levels of water quality. Five river systems traverse Metro Manila: the Marikina River, San Juan River, Parañaque River, Pasig River and Navotas-Malabon-Tullahan-Tenejeros River. Both the Marikina and San Juan rivers are major tributaries of the Pasig River. Except for the upper reaches of the Marikina River, which are classified as Class A, all five river systems were classified as Class C water bodies.
A water quality index (WQI) is the most effective way to communicate and categorize the quality of water in order to assess its suitability for various uses. However, no efforts have been made to develop a WQI for the water bodies in Metro Manila. Several WQIs have been formulated to promptly and efficiently evaluate the overall water quality within a particular area. The WQI of the Canadian Council of Ministers of the Environment (CCME WQI) (CCME, 2001) is an index used in many countries in addition to Canada (Lumb et al., 2011).

The CCME WQI model is a simple yet robust way of reporting water quality issues (UNEP, 2007; CCME, 2001), and provides a simplified way of interpreting water quality parameters so that they are easily understood by policy makers and the general public. In this study, the CCME WQI calculation method was applied to evaluate the pollution status of the Pasig River system of Metro Manila by determining the indices for aquatic ecosystem and recreation.

MATERIAL AND METHODS

This study was conducted along the Pasig River system of Metro Manila and is based on a dataset of four water quality parameters: pH, dissolved oxygen (DO), bio-chemical oxygen demand (BOD), and total coliform (TC). The data was collected by the Department of Environment and Natural Resources (DENR), and has been made available on a quarterly basis from the first quarter of 2011 to the second quarter of 2014. Water quality sampling locations in

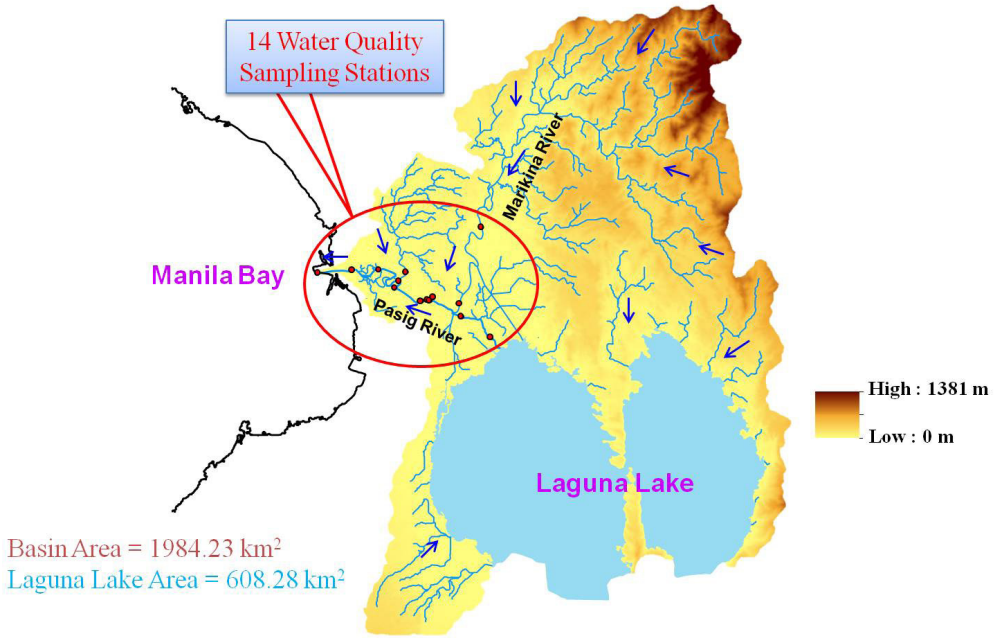

Figure 1 *Water quality sampling locations in the Pasig River System.*

Table 1 *Water quality objectives used in the model for aquatic ecosystem and recreation uses.*

Parameter	Aquatic Ecosystem	Recreation
pH	6.5-8.5	6.5-8.5
DO (mg/l)	5	5
BOD (mg/l)	7	5
TC (MPN/100 ml)	5000	1000

Source: DENR (1990).

Table 2 *Water quality objectives used in the model for aquatic ecosystem and recreational uses.*

Rank	WQI value	Description
Excellent	95-100	Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.
Very Good	89-94	Water quality is protected with a slight present of threat or impairment; conditions close to natural or pristine levels.
Good	80-88	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
Fair	65-79	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Marginal	45-64	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
Poor	0-44	Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

Source: CCME (2001).

the Pasig River System are shown in Figure 1. The standard value for the parameters was taken from DENR (1990) (Table 1).

In this study, the CCME WQI calculation method was used to compute WQI. The CCME WQI is based on a combination of three essential measures of variance (scope, frequency and amplitude). The combination of these measures of variance produces a single value (between 0 and 100), which classifies water quality into six respective categories: excellent, very good, good, fair, marginal and poor (Table 2). The CCME WQI computation technique has been described in detail by Abbasi and Abbasi (2012).

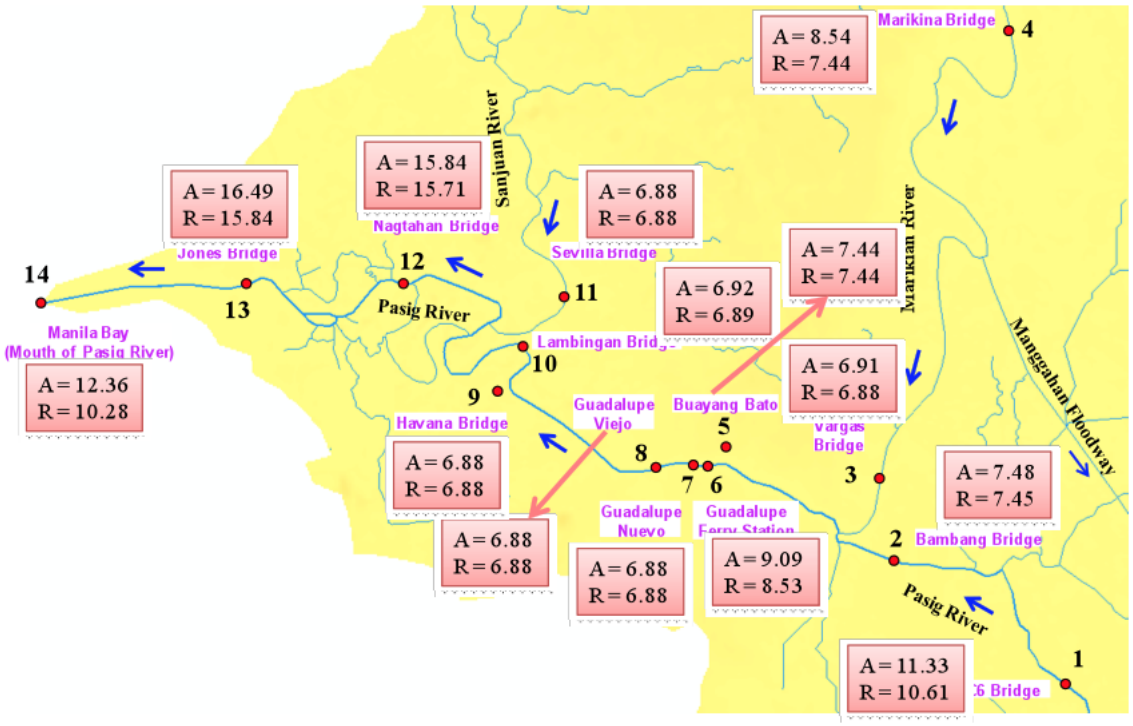

Figure 2 *CCME WQI values at different sampling stations (A and R represent aquatic ecosystem and recreation, respectively).*

RESULTS AND CONCLUSION

The CCME WQI has been developed to reflect the following four major water quality parameters: pH, DO, BOD, and TC at different fourteen sampling stations along the Pasig River system. Table 1 shows the water quality objectives used in the CCME WQI computation approach. Across all four parameters, the pH samples very rarely failed to meet water quality objectives. On the other hand, DO and BOD samples very rarely met the water quality objectives. All the TC samples failed to meet the water quality objectives. The computed WQI values for all sampling stations for aquatic ecosystem and recreational uses found by this study are presented in Figure 2.

The WQI values show that the water quality at all sampling stations is poor for both the aquatic ecosystem and recreational uses. For the aquatic ecosystem, the minimum and maximum WQI values were 6.88 and 16.49, respectively. Similarly for recreational use, the minimum and maximum WQI values were 6.88 and 15.71, respectively. Inadequate existing sewage systems and untreated wastewater discharged from domestic, agricultural, commercial and industrial sources are the main factors leading to contamination of the Pasig River system.

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REFERENCES

Abbasi, T. and Abbasi, S. A. (2012), Water quality indices. Elsevier, Amsterdam, The Netherlands, 384pp.

CCME (Canadian Council of Ministers of the Environment) (2001), Canadian water quality index 1.0 technical report and user's manual. Canadian Environmental Quality Guidelines Water Quality Index Technical Subcommittee, Gatineau, QC, Canada.

DENR (1990), Revised water usage and classification Water Quality Criteria. Department of Environment and Natural Resources, Administrative Order No.34, Series of 1990.

Lumb, A., Sharma, T. C., Bibeault and J. F. (2011), A Review of genesis and evolution of water quality index (WQI) and some future directions. Water Quality, Exposure and Health, 3(1), 11-24.

UNEP (2007), Global Drinking Water Quality Index Development and Sensitivity analysis report. United Nations Environment Programme Global Environment Monitoring System (GEMS)/Water Programme.