WATER QUALITY EVALUATION AND TREND ANALYSIS IN SELECTED WATERSHEDS OF THE ATLANTIC REGION OF CANADA

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Abstract. Water quality indices (WQIs) have been developed to assess the suitability of water for a variety of uses. These indices reflect the status of water quality in lakes, streams, rivers, and reservoirs. The concept of WQIs is based on a comparison of the concentration of contaminants with the respective environmental standards. The number, frequency, and magnitude by which the environmental standards for specific variables are not met in a given time period are reflected in WQIs. Further, the water quality trend analysis predicts the behavior of the water quality parameters and overall water quality in the time domain. In this paper, the concept of WQI was applied to three selected watersheds of Atlantic region: the Mersey River, the Point Wolfe River, and the Dunk River sites. To have robust study, two different water quality indices are used: Canadian Water Quality Index (CWQI), and British Columbia Water Quality Index (BWQI). The complete study was conducted in two steps. The first step was to organize and process the data into a format compatible with WQI analysis. After processing the input data, the WQI was calculated. The second step outlined in the paper discusses detailed trend analysis using linear and quadratic models for all the three sites. As per the 25 years trend analysis, overall water quality for agriculture use observed an improving trend at all the three sites studied. Water quality for raw water used for drinking (prior to treatment) and aquatic uses has shown improving trend at Point Wolfe River. It is further observed that pH, SO4, and NO3 concentrations are improving at Dunk River, Mersey River, and Point Wolfe River sites. To ascertain the reliability and significance of the trend analysis, a detailed error analysis and parametric significance tests were also conducted. It was observed that for most of the sites and water uses quadratic trend models were a better fit than the linear models.

Keywords: CCME, EMAN sites, guidelines and standards, trend analysis, water quality index

1. Introduction

High profile events such as contamination of public water supplies in the towns of Walkerton, Ontario and North Battleford, Saskatchewan and numerous boil water orders in other municipalities in Canada, have been stern reminders that we can’t take a healthy environment for granted. Outcomes from these tragedies include the realization that there is no established national water quality monitoring program in Canada; current monitoring is temporally and spatially fragmented; monitoring of key issues and stressors is lacking; and there is inadequate use of data and information generated by monitoring activities. As a result, water quality managers...
are unable to provide a comprehensive, national picture of the status and trends of water quality in Canada.

Water is one of the most important natural resources to sustain life. Ascertaining its quality is very crucial before use for water drinking, agricultural, aquatic life, recreational, or industrial purposes. However, all available water bodies are not suitable for all different uses. Water quality indices (WQIs) have been developed to assess the suitability of water for a variety of uses. These indices reflect the status of water quality in lakes, streams, rivers, and reservoirs. The concept of WQIs is based on the comparison of the water quality parameter with respective regulatory standards. The number of variables with exceedances (failed test), frequency of exceedances, and magnitude of exceedances of regulatory standards for specific parameters (variables) are reflected in WQIs.

Considering the simplicity and scientific basis of WQI, it is expected that these indices will provide meaningful summaries of overall water quality and possibly trends. While appreciating the importance and usability of WQIs, it is important to understand the limitations of WQIs. The WQIs are not intended to replace a detailed analysis of environmental monitoring and modelling, nor should they be the sole tool for the management of water bodies. However, WQIs can be used to provide a broad overview of environmental performance that can be conveyed to the public in an easy to understand format. The many advantages of these indices include their ability to represent measurements of a variety of variables in a single number; the ability to combine various measurements with a variety of measurement units in a single metric; and the facilitation of communication of the results. On the other hand, there are limitations in the use of WQIs: the loss of information by combining several variables to a single index value; the sensitivity of the results to the formulation of the index; the loss of information on interactions between variables; and the lack of portability of the index to different ecosystems (Zandbergen and Hall, 1998).

In Canada, there were different types of performance measures to assess water quality prior to the development of the Canadian Water Quality Index (CWQI). In 1997, to provide a homogenous system, the Water Quality Guidelines Task Group of the Canadian Council of Ministers of the Environment (CCME) formed the Water Quality Index Technical Subcommittee to standardize protocols for CWQI calculations and use (applications). The objective of this subcommittee was to assess different approaches and to develop a unified water quality index that could be used in Canada for water quality assessment.

In this paper, the authors briefly describe different approaches of water quality assessment that were in practice and the approaches proposed by CCME. In a later section of the paper, the water quality of three watersheds is discussed using the unified CCME’s proposed water quality index.