Development of a water quality index based on a European classification scheme

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Abstract

This study comprised the development of a new index called the 'universal water quality index (UWQI)'. This index has advantages over pre-existing indices by reflecting the appropriateness of water for specific use, e.g. drinking water supply rather than general supply, and has been developed by studying the supranational standard, i.e. the European Community Standard. Three classification schemes for water quality are proposed for surface water quality assessment. Water quality determinants of the new index are cadmium, cyanide, mercury, selenium, arsenic, fluoride, nitrate-nitrogen, dissolved oxygen, biochemical oxygen demand, total phosphorus, pH and total coliform. The mathematical equations to transform the actual concentration values into quality indices have been formulated. The weighted sum method was proposed to obtain overall index scores based on individual index (sub-index) values. The application of the new index was demonstrated at a sampling station on Tahtali Reservoir in Turkey based on observed water quality data. Results revealed that the overall quality of the surface water falls under the 'excellent' class. On the other hand water quality was strongly affected by agricultural and domestic uses. This technique is believed to assist decision makers in reporting the state of the water quality, as well as investigating spatial and temporal changes. It is also useful to determine the level of acceptability for the individual parameter by referring to the concentration ranges defined in the proposed classification scheme.

Keywords: sub-index value, Tahtali Reservoir, water quality determinant, water quality index, water quality standard

Introduction

The quality of water is defined in terms of its physical, chemical and biological parameters, and ascertaining its quality is crucial before use for various intended purposes such as potable water, agricultural, recreational and industrial water uses, etc. (Sargaonkar and Deshpande, 2003). A major objective of water quality assessment is to determine whether or not the water quality meets previously defined objectives for designated uses, to describe water quality at regional, national or international scales, and also to investigate trends in time, etc.

Traditional approaches to assessing water quality are based on a comparison of experimentally determined parameter values with existing guidelines. In many cases, the use of this methodology allows proper identification of contamination sources and may be essential for checking legal compliance. However, it does not readily give an overall view of the spatial and temporal trends in the overall water quality in a watershed (Debels et al., 2005).

One of the difficult tasks facing environmental managers is how to transfer their interpretation of complex environmental data into information that is understandable and useful to technical and policy individuals as well as the general public. This is particularly important in reporting the state of the environment. Internationally, there have been a number of attempts to produce a method that meaningfully integrates the data sets and converts them into information (Nagels et al., 2001).

Since 1965, when Horton (1965) proposed the first water quality index (WQI), a great deal of consideration has been given to the development of 'water quality index' methods with the intent of providing a tool for simplifying the reporting of water quality data (Liou et al., 2004). WQI improves understanding of water quality issues by integrating complex data and generating a score that describes water quality status and evaluates water quality trends. These indices assess the appropriateness of the quality of the water for a variety of uses (Cude, 2001). They are considered more appropriate for disseminating information to general audiences.

The WQI concept is based on the comparison of the water quality parameter with respective regulatory standards (Khan et al., 2003). The development process of a water quality index can be generalised in four steps:

- Selecting the set of water quality variables of concern – **parameter selection**
- Transformation of the different units and dimensions of water quality variables to a common scale – **developing sub-indices**
- Weighting of the water quality variables based on their relative importance to overall water quality – **assignment of weights**
- Formulation of overall water quality index – **aggregation of sub-indices to produce an overall index** (Harrison et al., 2000).

Universal Water Quality Index (UWQI)

In this study a new index called the Universal Water Quality Index (UWQI) was developed to provide a simpler method for describing the quality of the surface water used for drinking water supply. UWQI has advantages over pre-existing indices by reflecting appropriateness of water for specific use - drinking water supply rather then general supply and has been developed by studying the supranational standard. Previous indices

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