Chapter 12
Commonly Used Methods to Calculate Water Quality Indices

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ABSTRACT

Water supplied to communities should be of acceptable level in terms of quality. Water quality can be assessed by the use of the water quality index (WQI). The use of indices is crucial in this era where water quality issues have raised health as well as legal concerns, both at local, national, and international levels. Water samples have to be collected, tested, and values for water quality index determined. It was initially proposed by Horton in 1965. There are several ways to calculate WQI, and this chapter gives formulae for different methods. Water quality indices differ from country to country. Some indices use three, six parameters, or even more than six parameters. Earlier methods to calculate the water quality indices did not capture microbial parameters, hence the reason for various methods. A recent method of calculating a WQI is based on fuzzy logic. Therefore, this chapter looks at the methods from all continents.

INTRODUCTION

This chapter aims to explain the commonly used water quality index calculation methods for ease of reference by students and lecturers. The majority of water quality indices formulae are used for assessing the health of a river or a stream. The use of these indices started in mid of the 20th century and specifically in 1965. Over the past half a century modifications have been done for adoption in different countries as well as for different water bodies. The most recent of them is the fuzzy logic calculation procedure. This chapter gives the water quality parameters definitions and their recommended guidelines for use in calculating the indices. The chapter, therefore, gives methods from Malaysia, the United States of America, India, and Europe that can be applied by other countries.

DOI: 10.4018/978-1-7998-7356-3.ch012

BACKGROUND

Water from surface sources, underground aquifers or atmosphere forming part of the hydrosphere constitutes the main water supply for agricultural, drinking, environmental and industrial use. Keeping the health of these water sources at acceptable levels for the optimum function to support life (Hasan et al. 2015) is critical to the health of living things including human beings. Moreover, knowledge of raw water quality is essential to define the adequate process to treat natural water for human consumption, as well as to assess water treatment plant performance (de Oliveira, et al., 2019). As a consequence, water samples have to be collected, tested and values of various biological, chemical and physical characteristics of water to be measured for the determination of the Water Quality Index. The concept of indexing water with a numerical value to express its quality, based on physical, chemical and biological measurements, was developed in 1965 by National Sanitation Foundation (NSF) in the United States (Lumb et al., 2011) after being proposed by Horton in the same year. Water Quality Indices (WQI) can, and have been used to identify threats to water quality along a stream and contribute to better water resources management (Misaghi et al., 2017). Indeed, WQI is a very useful, efficient, and simple tool for assessing the suitability of water at a certain location and time (Lumb et al., 2011). Use of the indices ensures that water supplied meets the needs of concerned citizens and policy makers thus helping in managing both surface and groundwater quality for different uses (Akoteyon et al. 2011). It uses a mathematical equation to give the health of a waterbody numerically (Yongera & Puttaiah, 2008).

In many papers, book chapters and journal articles, there are several ways to calculate WQI and this chapter gives the formulae for different ways of calculating them. Indices differ from country to country. Some indices use three parameters, some have more than three parameters. One method for six parameters is given based on New Water Quality Index from Malaysia.

In Water Quality Index proposed by the National Sanitation Foundation, the selection of parameters is based on Delphi method and these models were formulated in additive and multiplicative forms. The term Delphi has its origin in the Oracle of Delphi, and this method is based on the belief that group judgements are mature, well-considered and more valid than individual judgements and hence the need for one parameter to stand in for all the other water quality parameters. Delphi is an ancient Greek city where all the men used to consult one woman for major decisions and hence its analogy to Water Quality Index. Another method comes from Europe (Spain) for calculation of the Water Quality Index. There is also Oregon Water Quality Index (OWQI). Another one is the Canadian Water Quality Index also known as the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI). This model, CCME WQI, was adopted by the United Nations Environmental Programme (UNEP) as a model for Global Drinking Water Quality Index (GDWQI).

Water quality parameters normally used to calculate water quality index are dissolved oxygen (DO), pH, turbidity, temperature, faecal coliforms, biochemical oxygen demand (BOD), chlorides, colour, total dissolved solids, nitrates, total phosphorus (Lumb et al. 2011). It is evident that earlier methods to calculate the water quality indices did not mention something like microbial parameters. The biological health of a water body is of great concern owing to its relationship with health risks of contaminated water to people's health. The use of physico-chemical parameters thus was initially a limitation of the Water Quality Index. Another limitation is the handling of emerging pollutants in the world that needs to be captured by future indices.

Statistical techniques such as fuzzy logic have been used of late to deal with uncertainties in the water quality parameters. Fuzzy logic can reflect human thinking, therefore deals with non-linear information