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Water Quality Index: A Robust Tool for Comprehensive Aquatic Water Quality Assessment

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Abstract

Water, a precious natural resource, fundamental to human survival and socio-economic development. Accurate assessment of water quality is crucial for effective public policy and water improvement programs. In this context, the Water Quality Index (WQI) has emerged as a robust and effective tool for simplifying complex water quality data into a single, interpretable value. Results demonstrate that WQI effectively reflects the cumulative impact of natural processes and anthropogenic activities on water quality. Since its introduction in the 1960s, the Water Quality Index has gained widespread acceptance because of its simplified structure and user-friendly application. Typically, WQI models follow four sequential steps: (1) selection of relevant water quality parameters, (2) development of sub-indices for individual parameters, (3) parameter weighting values calculation and (4) integration of the sub-indices to derive the overall water quality index.

Key words: Water quality, Sub-indices, Accurate assessment, public policy, simplified structure

Introduction

'Water gives life a voice and nature a future'

Water is a vital resource that is critical for the sustenance of life, fostering economic development, and ensuring stability to aquatic and terrestrial ecosystems. Its quality and availability are intrinsically linked to human health, agricultural productivity, and industrial viability. Nevertheless, increasing anthropogenic activities, including urbanization, industrial discharge, and intensive agriculture, exert substantial pressure on both surface and groundwater bodies. Surface water and groundwater are the primary sources of drinking water worldwide (Paun et al., 2016). However, the limited availability of surface water in many regions has increased dependence on groundwater resources to meet domestic and other water needs (Bharti and Katyal, 2011).

Due to diverse and intensive uses, surface water bodies have been increasingly exposed to exploitation and degradation. Consistent monitoring of water quality in water resources is essential to evaluate its suitability for ecosystem health, hygiene, industrial, agricultural, and

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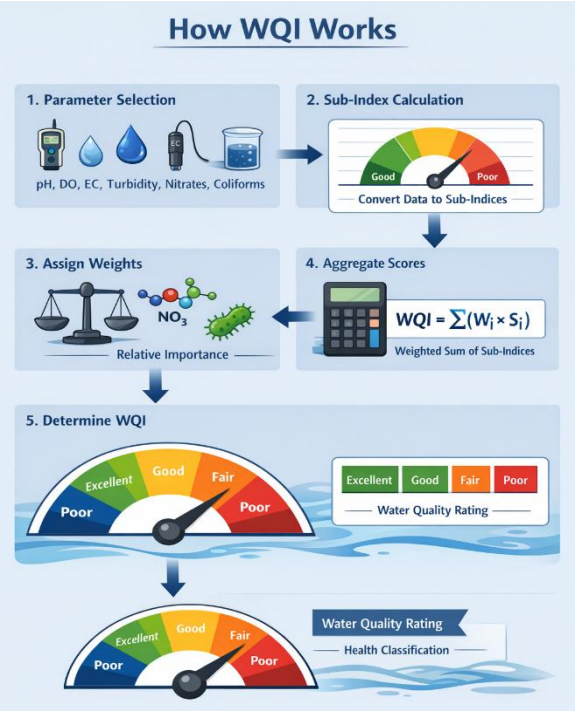
domestic purposes. Assessing water quality can be a complex task due to the intricate parameters involved, which can lead to various concerns regarding the overall quality of the water (Bharti and Katyal, 2011). Assessing the quality of water in natural environments presents numerous challenges, such as issues with accessibility (Batugedara and Samaik, 2022), technological deficiencies (Kirschke et al., 2020), and financial constraints (Berthet et al., 2021). Moreover, obtaining a sufficient number of samples is crucial for accurately interpreting water quality (Mcmillan et al., 2012). In addition, Méndez-Barroso et al. (2020) noted that continuous monitoring is necessary to capture the temporal variations in water quality.

What is water quality index?

Water Quality Index (WQI) represents a numerical value derived from the aggregation of multiple water quality parameters, offering a simplified expression of the overall water status (Aljanabi et al., 2021). The idea of the Water Quality Index (WQI) originated in the 1960s, with significant contributions from researchers like Horton in 1965 (Kachroud et al., 2019). Initial efforts were focused on creating methods to combine various water quality parameters into a single, representative numerical value. Over the years, the techniques for calculating the WQI have significantly advanced, reflecting progress in water science and computational methods. While a universally standardized composite index is still being developed, many countries have adopted and modified WQI methodologies to fit their unique environmental conditions and regulatory needs (Tyagi et al., 2013). This widespread adoption highlights the recognized importance of WQI as an effective tool for environmental evaluation and communication.



A multitude of water quality indices, such as the National Sanitation Foundation Water Quality

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Index (NSFWQI), Weight Arithmetic Water Quality Index (WAWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), and Oregon Water Quality Index (OWQI), among others, have been developed by various national and international bodies. These indices are utilized to assess the water quality in specific regions. Additionally, these indices often rely on a diverse range of water quality parameters, which are compared against the standards of the respective region.

Table 1. Water Quality Status using different WQI methods (Marselina et al., 2022)

NSF WQI		**CCME WQI**		**OWQI**	
Index	Quality Status	Index	Quality Status	Index	Quality Status
0-25	Very Bad	0-44	Bad	0-59	Very Bad
26-50	Bad	45-59	Marginal	60-79	Bad
51-70	Fair	60-79	Fair	80-84	Fair
71-90	Good	80-94	Good	85-89	Good
91-100	Very Good	95-100	Very Good	90-100	Very Good

Advantages

Simplicity for communication: WQI condenses many measurements into a single interpretable score facilitating stakeholder dialogue and reporting

Flexibility: indices can be adapted to local priorities by changing parameter sets, weights, or aggregation rules

Limitations

Loss of detail: when multiple parameters are reduced to one number, potentially hiding specific problems.

Regional and Practical Implementation Gaps: Beyond methodological issues, practical limitations emerge in real-world applications, particularly in data availability and enforcement.

Conclusion

The Water Quality Index maintains its status as an indispensable and pragmatic tool for evaluating and conveying the ecological health of aquatic environments. As global water resources continue to experience escalating pressures, the continuous improvement and judicious deployment of WQI, in concert with other robust complementary assessment tools, remain imperative. The water quality index is crucial for evaluating the condition of a water source over time and under various influencing factors. The timing of sample collection greatly

affects the water quality parameters and, consequently, the index value. Despite this, creating a universally accepted general water quality index is extremely challenging. Nevertheless, researchers can develop water quality indices tailored to specific regions and sources.

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