Treatability Assessment of Raw Surface Water Quality of Selected Philippine Vulnerable Sites: Application of Multivariate Statistics and Composite Raw Water Treatability Index (RWTI)

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ABSTRACT

In the Philippines, several regions have been identified as water-stressed as freshwater ecosystems continue to face deterioration, in quantity and quality, which is further exacerbated by seasonal variabilities, climate change, and anthropogenic influences. Due to the intricate nature of interactions within waterbodies dictated by water chemistry, there is difficulty in quantifying the impacts of point- and non-point sources of pollution. Moreover, determining the appropriate level of prioritization for water quality parameters and micropollutants to be included in decision-making processes continues to be a challenge, particularly when considering long-term spatiotemporal changes in boundary conditions within the water environment. In conjunction, these lead to further strains, and costly enhancements in existing raw water treatment systems as pollutant prioritization may overlook parameters that are highly important in the step-process for those systems.

To address this issue, the study aimed to develop a composite Raw Water Treatability Index (RWTI) as a preliminary tool for the detailed assessment of surface water sources based on their treatability prior to being processed in various treatment systems in a site-specific context. The specific objectives of the index were to critically evaluate and capture the limitations of current raw water sources against existing treatment systems through a multi-stakeholder perspective and to produce a communication tool for water resource planners and stakeholders.

The study employed a multifaceted approach, which was adapted to the local context at each study site. Multivariate analysis techniques, such as principal component analysis and clustering, were used to assess the spatiotemporal characteristics of the study sites. A multi-criteria decision analysis (MCDA) framework, specifically the Analytical Hierarchy Process (AHP), was then applied to incorporate expert knowledge and value judgments on the prioritization of water quality parameters. A key aspect of the RWTI development was the incorporation of a special parameter, identified as the most valuable factor or factors impacting treatment efficiency at each study site. The RWTI calculation applied a dynamic penalty factor to account for the influence of this special parameter, reflecting its critical importance in the local context.

The results demonstrate the utility of the RWTI in identifying critical water quality parameters, understanding spatial and temporal patterns, and prioritizing water bodies for further detailed analysis or rehabilitation. This research provides water managers with a robust decision-making tool to ensure the long-term sustainability of water resources and the viability of treatment systems.

Keywords: analytical hierarchical process (AHP), clustering, dynamic penalty factoring, multi-criteria decision analysis, principal component analysis