Application of Two-stage Fuzzy Set Theory to River Quality Evaluation in Taiwan

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Abstract

An indicator model for evaluating trends in river quality using a two-stage fuzzy set theory to condense efficiently monitoring data is proposed. This candidate data reduction method uses fuzzy set theory in two analysis stages and constructs two different kinds of membership degree functions to produce an aggregate indicator of water quality. First, membership functions of the standard River pollution index (RPI) indicators, DO, BOD(5), SS, and NH(3)-N are constructed as piecewise linear distributions on the interval [0,1], with the critical variables normalized in four degrees of membership (0, 0.33, 0.67 and 1). The extension of the convergence of the fuzzy c-means (FCM) methodology is then used to construct a second membership set from the same normalized variables as used in the RPI estimations. Weighted sums of the similarity degrees derived from the extensions of FCM are used to construct an alternate overall index, the River quality index (RQI). The RQI provides for more logical analysis of disparate surveillance data than the RPI, resulting in a more systematic, less ambiguous approach to data integration and interpretation. In addition, this proposed alternative provides a more sensitive indication of changes in quality than the RPI. Finally, a case study of the Keeling River is presented to illustrate the application and advantages of the RQI.