Improvement of Gray Water Footprint Calculation Method Based on Comprehensive Evaluation

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Abstract

The Gray Water Footprint (GWF) analysis method, defined as the volume of fresh water required to assimilate the load of pollutants discharged into water based on natural background concentrations and existing ambient water quality standards, has been widely used in regional water quality management. In traditional calculation method, GWF value is obtained by dividing the load of critical pollutant by the difference between the ambient water quality standard for that pollutant and its natural background concentration in the receiving water body. In other words, GWF refers to the volume of freshwater that is always only required to assimilate the load of the largest concentration of pollutants based on existing ambient water quality standards. However, many studies have raised questions about this traditional single factor evaluation method, since it lacks the consideration to the combined effects of multiple pollutants, which will lead a higher GWF result in confidence-limit rate. In this study, a new GWF calculation framework oriented the solutions of multi-pollutants is proposed based on a 2-phases calibration model. In the first phases, we consider the dilution and autopurification process of multi-pollutants in natural waters. In the second phases, several comprehensive evaluation methods, such as the fuzzy synthetic evaluation (FSE), principal component analysis (PCA) and fuzzy inference system (FIS), are applied to determine the "ecological threshold" of GWF. The application conditions and uncertainties of the three multi-factors appraisal methods have also been discussed. Our research gives the methodological support for the precise calculation of GWF.

Keywords: *Gray water footprint, singe index method, comprehensive evaluation, fuzzy inference system, principal component analysis, fuzzy inference system.*