IAHS2017-219
IAHS Scientific Assembly 2017

Application of a Game Theory-Cloud Model in regional water quality evaluation

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Abstract: Regional water quality assessment entails essentially a multi-criteria decision-making process accounting for quantitative and qualitative uncertainties and their transformation. Considering uncertainties of nonlinear relation, fuzziness and randomness between evaluation indices and water quality grade are always difficult points in the evaluation process, a game theory-cloud model assessment approach is proposed. The cognitive cloud model, derived from information science, can realize the transformation between qualitative concept and quantitative data, based on probability and statistics and fuzzy set theory. To correct the one-sidedness of the single weighting method, a combination weight integrating entropy weight and criteria importance through inter criteria correlation is adopted based on game theory. The game theory-cloud model is tested by evaluating the water quality status of river in the Qingyuan city, comparing with the fuzzy comprehensive evaluation and set pair analysis respectively. The analysis of the weight uncertainty shows that the weight has an influence on membership of index, however, there is no effect for the final evaluation level of water quality. When combining weights, this study considered the advantages of entropy weight and Critic Weight adequately. The combining weight can prevent the phenomenon that anomalies of individual index data lead to the anomalies of a single weight as the phenomenon can make the final evaluation results unreasonable. The analysis of parametric uncertainties shows that the greater value of He is, the greater fuzzy degree of model will be. The value range of He has a great influence on the final evaluation results. The results calculated by the evaluation method of cloud model are consistent with the results of fuzzy evaluation method and set pair analysis method. The difference ratio with fuzzy evaluation method is only 0.47%. With further analysis of different samples, it can be found that the cloud model is more consistent with actual conditions when dealing with the critical value, which proves that the cloud model is more practical. The proposed approach yields information concerning membership for each water quality status which leads to the final status. The approach is found to be representative of other alternative methods and accurate.