Evaluation of the environmental quality associated with near-surface groundwater characteristics in coal-mining areas based on rough set and uncertainty measure theory

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ABSTRACT

It is important to assess detrimental environmental effects, including those associated with groundwater, in arid and semi-arid areas of western China where coal mines are located. Here, we analyze geological and hydrogeological data for these coal-mining areas to better understand the environmental quality and conditions, and groundwater characteristics. Using rough set and uncertainty measure theory, we establish a model for evaluating the environmental conditions and effects associated with variations in near-surface groundwater characteristics (chemistry, circulation, and distribution) in coal-mining areas. Rough set theory is used to analyze the data of various evaluation indexes used for measuring environmental conditions and groundwater characteristics as well as to optimize the number of indexes by removing redundant/unimportant indexes and to assign the relative weightings of the remaining indexes. By using uncertainty measure theory to construct the uncertainty function and to calculate the uncertainty evaluation vector, the level of environmental quality is determined according to the criterion of confidence recognition. To test the application and effectiveness of the model, it is used to evaluate the environmental quality and conditions associated with near-surface groundwater characteristics in five coal-mining areas in western China. The evaluation results are compared with the results obtained using the fuzzy comprehensive evaluation method and uncertainty measure theory without a reduction in the number of indexes in the evaluation. The results show that the model is appropriate for environmental studies, has a high level of applicability, and establishes a good reference for future evaluations of environmental and groundwater changes associated with coal-mining or other environmental disturbance.

Keywords: Rough set; Uncertainty measure; Groundwater; Near-surface environmental conditions