Principal Components Based Fuzzy Rule Model for Management of Groundwater Systems

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Modeling of subsurface flow and contaminant transport processes and its dynamics is basic necessity for dealing with groundwater management problems. In recent years, researchers actively coupled the aquifer simulation model with techniques of optimization to address important groundwater management problems. The coupled simulation-optimization approach is appealing as it accounts for the complex behavior of the groundwater system and identifies the best management strategy considering the management objectives and constraints. However, groundwater flow and transport is sensitive to uncertain flow and transport parameters as well as uncertain source characterization. These uncertainties directly affect the source concentration in the optimization model. To overcome this problem, methodology based on fuzzy set approach is utilized for providing a solution to the optimal groundwater management system by identifying the unknown pollution sources. Fuzzy set theory provides an efficient mechanism for carrying out approximate reasoning processes when available information are uncertain, incomplete, imprecise, or vague.

Present work present the principal component analysis based fuzzy rule methodology to identify the unknown pollution sources in groundwater. Developed methodology is demonstrated through an example problem to identify the source fluxes responsible for groundwater pollution. The groundwater flow and transport simulation model, MOC (Method of characteristics)[1] is being utilized to simulate the pollution scenario in groundwater system. The simulated concentration from different observation wells are decomposed into principal components. Principal components of concentration values are then utilized to develop the fuzzy model. Fuzzy model, in fact, perform an inverse mapping to find the pollution source characteristics (location, magnitude and disposal periods) from observed pollution concentration in a specified number of observation wells. Initial results, performed with one potential source and one observation well, give

normalized error around 30 percent. Performance evaluation results show potential application of developed methodology.

Keywords: flow and transport simulation; principal components; fuzzy rule base; groundwater management; inverse problem.

References

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