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Effective hydrogeological parameter estimation with a novel modified Tabu search algorithm

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The heterogeneity of the porous media has been considerably discussed in the recent decades (e.g. Gelhar, 1993). Many approaches had been developed for the estimation of the effective hydraulic conductivity for the hydrogeological system, such as perturbation approach (e.g. Gelhar, 1993; Dagan, 1989), renormalization group analysis (e.g. Hristopulos and Christakos, 1999), Bayesian approach (Yu and Christakos, 2005). Most of previous theoretical approaches were based upon the analysis of the local observations of hydraulic head and hydraulic conductivity in the small scale. In the reality, the pumping test is mostly widely used for the estimation of the effective hydraulic conductivity for a large scale groundwater system. The analytical solution of the anisotropic effective hydraulic conductivity from the pumping test was derived by Papadopoulos (Papadopulos, 1965; Vedat Batu, 1997). In addition, the type-curve method (Papadopulos, 1965) and straight-line method (Neuman et al., 1984) are applied to estimate the parameters of the analytical solution. However, the application of the type-curve method or straight-line method can easily induce the estimation uncertainty, because there was no systematic approach to obtain the optimal solution of the parameters of well functions.

In our work, we introduce the Tabu search integrated with adjoint-state method to support the parameter estimation for the effective hydraulic conductivity. Tabu search method is an heuristic algorithm for the optimal solution of the complex system (Glover,1993), which have recently applied in the parameter estimation in the groundwater system (Tan and Chen et al, 2006; Wu and Lin et al, 2006). On the other hand,

the adjoint state method has also been used in the variety of application of sensitivity analyses for groundwater modeling (Toweley and Wilson, 1985; Sun and Yeh, 1990). Finally, the simulation study will be conducted for the evaluation of the performance of our proposed approach to the effective hydraulic conductivity of the heterogeneous porous media. Our approach is innovative in both scientific and engineering aspects, which are two-fold:

1. Improving the current widely-used method to be more accurate and automatic.
2. Integrating Tabu search and adjoint state method to improve the computational efficiency of optimal solution search in the complex system.

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