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Coupling groundwater simulation and optimization models, using MODFLOW and Harmony Search Algorithm

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ABSTRACT

In this paper, a groundwater management model for which the solution is obtained through a coupled application of simulation and optimization models is analyzed. The most widely used numerical groundwater flow model, MODFLOW, which is a three-dimensional (3-D) model using the finite differences method for solving the governing groundwater flow equations, is used as the flow-simulation model. This model is then connected to the Harmony Search Algorithm, one of the most emerging and successful metaheuristic optimization techniques, which simulates the quest for perfect harmony in music. In this paper, this technique is applied to a classic, theoretical example found in the manual of MODFLOW for comparison purposes, by examining the optimization of its aquifer system in terms of minimizing the pumping cost. For this application, a specially designed computer software programme was developed in MATLAB environment. This software, apart from coupling the simulation and optimization models, provides 2-D and 3-D graphical representations of the results allowing users to have a visual image of the piezometric surface in the whole aquifer system area. More specifically, in the specific management problem, the positions and the total required water demand for the pumping wells from the three aquifers system are pre-defined, while the optimal distribution of the pumping rates is determined through the proposed methodology. The results show that coupling flow-simulation and optimization models could be a very useful procedure when solving complex groundwater management problems.

Keywords: Groundwater resources management; Groundwater flow-simulation models; MODFLOW; Harmony Search Algorithm; Optimization

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