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Aquifer parameter estimation using meshfree RPCM with evolutionary algorithms

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A comparative assessment of simulation-optimization models to estimate transmissivity, an essential aquifer parameter is presented here. An inverse model is developed by coupling simulation-optimization (SO) model for parameter identification. The commonly used grid based methods like finite element method (FEM) and finite difference method (FDM) has the limitations of creating a grid or mesh. They are also reported to be computationally expensive. Hence, meshfree radial point collocation method (MFree-RPCM) is used as the forward model for modelling flow and transport phenomenon in groundwater. Two swarm intelligence based evolutionary algorithms are adopted for optimization here, which are cat swarm optimization (CSO) and particle swarm optimization (PSO). These are widely popular, but its application to groundwater and in particular parameter estimation is limited. An optimization model in a parameter identification inverse model aims to identify the aquifer parameter by minimizing deviation between the simulated and observed values of groundwater. The developed coupled SO models, RPCM-CSO and RPCM-PSO models are validated by determining the aquifer parameters of a hypothetical case study. Both models gave satisfactory results when applied to estimation of parameters even after incorporating noises in hydraulic head to represent real case scenarios. After successful validation, the developed models are applied to a field case study to determine the flow parameter using inverse modelling. Average percentage error in parameter estimation using RPCM-CSO model is 1.6% and for RPCM-PSO is 3.1%. In terms of accuracy the RPCM-CSO model is hence found to be superior to RPCM-PSO model. Premature convergence and stagnation point error in PSO is found tackled in seeking and tracking modes of CSO. The efficiency of RPCM-CSO model over RPCM-PSO is further examined by performing reliability analysis. The effectiveness of CSO over PSO is reflected in the comparative study.