Geophysical Research Abstracts
Vol. 14, EGU2012-2719, 2012
EGU General Assembly 2012

A new approach to calibrate steady groundwater flow models with time series of head observations

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We developed a new method to calibrate aquifer parameters of steady-state well field models using measured time series of head fluctuations. Our method is an alternative to standard pumping tests and is based on time series analysis using parametric impulse response functions. First, the pumping influence is isolated from the overall groundwater fluctuation observed at monitoring wells around the well field, and response functions are determined for each individual well. Time series parameters are optimized using a quasi-Newton algorithm. For one monitoring well, time series model parameters are also optimized by means of SCEM-UA, a Markov Chain Monte Carlo algorithm, as a control on the validity of the parameters obtained by the faster quasi-Newton method. Subsequently, the drawdown corresponding to an average yearly pumping rate is calculated from the response functions determined by time series analysis. The drawdown values estimated with acceptable confidence intervals are used as calibration targets of a steady groundwater flow model. A case study is presented of the drinking water supply well field of Waalwijk (Netherlands). In this case study, a uniform aquifer transmissivity is optimized together with the conductance of ditches in the vicinity of the well field. Groundwater recharge or boundary heads do not have to be entered, which eliminates two import sources of uncertainty. The method constitutes a cost-efficient alternative to pumping tests and allows the determination of pumping influences without changes in well field operation.