Identifying the hydraulic transmissivity of an aquifer with noisy hydraulic head data: a comparison study using three direct inversion methods

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Abstract

The parameters required to set up an hydrological model are often obtained by solving an inverse problem, using indirect or direct solution methods. Indirect methods are widely used, in particular when the state variable (here the hydraulic head h) is known at sparse locations only. Despite their flexibility, when the number of parameters rises, their computational requirements can become a challenging issue, together with problems related to non-uniqueness and instability. On the other side, direct methods have other limitations, including a more exhaustive knowledge of the state variables, but are less demanding in terms of computational resources.

In this work three direct inversion methods are compared: the Comparison Model Method (CMM), the Double Constraint Method (DCM) and the Differential System Method (DSM). The three methods are compared on a two-dimensional synthetic aquifer, whose geometry, boundary conditions and h measurements are realistic and extracted from a data set collected for the aquifer of Weiach, north of Switzerland. Sequential-Gaussian simulation (SGS) was used to generate a transmissivity field (T) for the aquifer, which was then used to obtain the h data required by the three methods. A noise of increasing magnitude was added to h to verify the stability of the methods with respect to noisy input data.

For a small noise on the input h, the results obtained with the three methods are comparable. However, for more noisy data, the DCM is more robust, whereas the DSM is very sensitive to the position of the starting point for integration and to the T value assigned there.

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