Hydraulic Conductivity Estimation in Partially Saturated Soils

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Abstract

An iterative algorithm based on the adjoint method for the estimation of the saturated hydraulic conductivity k in a partially saturated soil Q is proposed. Groundwater flow in Q is assumed to be described by Richards equation.

The optimization problem minimizes the L^2-error between the pressure head values $p(k, x, t)$ calculated as the solution of a direct problem and the measured values of the pressure head at discrete points inside the domain Q.

The exact gradient of the cost functional is obtained by solving an appropriate adjoint problem, which is derived from the equations of the Gâteaux derivatives of the pressure head with respect to the parameter k.

A finite element procedure is used to obtain approximate solutions of the direct and adjoint problems and the Gâteaux derivatives. A discrete form of expression of the gradient of the cost functional at the continuous level is used inside a nonlinear conjugate gradient iteration to solve the optimization problem.

Numerical examples showing the implementation of the algorithm to estimate the saturated hydraulic conductivity $k(x)$ during hypothetical infiltration experiments in a heterogeneous soils are also presented.

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