ESTIMATING HYDRAULIC CONDUCTIVITY GEOSTATISTICAL PARAMETERS USING AN ITERATIVE ENSEMBLE SMOOTHER SCHEME

Ryan Bailey, Colorado State University, 970-491-5387, rtbailey@engr.colostate.edu

1. Ryan Bailey, Colorado State University
2. Domenico Bau, Colorado State University

The ability of numerical models to accurately assess hydrologic processes in aquifer systems is often hindered due to a lack of knowledge regarding the magnitude and spatial distribution of parameters that govern these processes. Many inverse methods have been proposed in the literature to provide optimal estimates of the spatial distribution of parameter values such as hydraulic conductivity (K), given observation data from the true aquifer system. However, these methods are often employed with the assumption that the values of geostatistical parameters (mean, variance, and correlation length) governing the spatial distribution of the parameter are known a priori. This can often lead to inaccuracies when applying these methodologies to actual systems where geostatistical parameters are not known with certainty.

In this study, we demonstrate the use of an Ensemble Smoother, based on the Kalman Filter methodology, in an iterative scheme to identify the geostatistical parameters of K within an aquifer system through assimilation of water table (WT) elevation data and aquifer-stream exchange flow (ASF) data. Beginning with a set of geostatistical parameters that are known to be inaccurate, an ensemble of K fields is generated and the corresponding ensemble of groundwater flow simulations is run. Upon assimilating measurement data from the true aquifer system and conditioning the K fields, updated values of the geostatistical parameters are inferred from the updated K ensemble and used to produce the K ensemble for the subsequent iteration. This process proceeds until geostatistical parameter values are converged upon, with the assumption that these values define the spatial distribution of K in the true aquifer system.

The methodology is tested in one-dimensional (1D), two-dimensional (2D), and three-dimensional (3D) synthetic aquifer systems. For the 3D system, the catchment hydrology model CATHY, which couples the 3D variably saturated subsurface flow with the 1D diffusion wave overland and channel flow, is used in a V-catchment setting. For the 2D system, volumes of water leaving the aquifer along a constant-head (stream) boundary constitute the ASF data; for the 3D CATHY simulation, stream-flow rates, which depend upon the groundwater volumes discharged into the stream, are used to calculate the ASF data. Results indicate that the iterative scheme allows for the true geostatistical parameters to be identified, with less iteration steps required when both WT and ASF data are jointly assimilated.