

Quantifying uncertainties in soil hydraulic parameters for dual-porosity models using a null-space Monte Carlo method - implications for groundwater recharge estimation.

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January 12, 2023

Abstract

Groundwater recharge can be significantly influenced by the macropores, especially in fine structured soils. However, models considering macropores require a number of additional parameters which are difficult to determine by conventional methods. Thus, inverse modeling is often applied to estimate soil hydraulic and solute transport properties of the unsaturated zone. In this study, an efficient method for recharge prediction and parameter uncertainty quantification by coupling a dual-porosity model (DPM) to the null-space Monte Carlo (NSMC) algorithm was developed, and the impact of uncertainty in the key model parameters on groundwater recharge were analyzed. Recharge estimates were further compared to the one by tritium peak method. Results showed that the estimated recharge was much smaller than the one estimated from the tritium peak method, indicating the possible overestimation of recharge by conventional tritium peak method with piston flow model. Our study further demonstrated that the conventional practice of deriving single set of parameters through inverse modeling could result in biased recharge prediction, and that for the complex subsurface flow and transport models such as the DPM, NSMC method can provide a practical solution for predictive uncertainty analysis.

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