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Impact of heterogeneity on the analysis of pumping test in leaky aquifers

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In field applications, drawdown data from hydraulic tests are typically used to infer representative hydraulic parameters of the perturbed aquifer volume. Most existing pumping test analysis procedures assume that the aquifer system in the vicinity of pumping well is homogeneous, or at most consists of few deterministically predefined homogeneous units. This paper examines numerically the impact of the heterogeneity of leaky aquifer systems on the analysis of pumping test data. The leaky aquifer system considered consists of two aquifers connected hydraulically through an aquitard. The log-transmissivity of the pumped aquifer and the vertical conductance of the aquitard are modeled as two independent multivariate random spatial functions with stationary first and second moments. The non-pumped aquifer is assumed to remain unperturbed. A Monte Carlo approach is used to simulate the transient drawdown for a suite of observation points covering different distances from the pumping well. The simulated drawdown data are analyzed using the inflection-point method developed by Hantush (1956), the curve fitting approach based on the leaky aquifer type-curves developed by Walton (1962), and the double inflection (DIP) method developed recently by Trinchero et al. (2008), with each method providing single estimates of the flow parameters. The resulting estimates indicate that each method places emphasis on different parts of the time-drawdown data, leading to potential differences among the estimated parameters, and relative to the actual values used in model simulation.

Results also reveal that the heterogeneities of the aquifer or the aquitard have distinct impacts on the pumping test analysis procedures, and that the estimated flow parameters are dependent on the distance to the pumping well. Through the synthesis of the parameter estimates from the different analysis procedures, it is shown that some information on the heterogeneity of the leaky aquifer system may be inferred. The implications of these results on the interpretation of pumping tests conducted in heterogeneous aquifer systems are discussed.