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Impact of Flow Connectivity on the Interpretation of Pumping Test Data

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Pumping tests are often used for the estimation of subsurface flow parameters. Research has indicated that traditional geostatistical techniques expressed in terms of two-point correlations (i.e., the covariance of flow parameters at two points is only a function of separation distance) may not be adequate to fully represent complex patterns of flow and transport in heterogeneous subsurface systems. To address this issue, the concept of flow connectivity has been introduced to describe how different regions of the aquifer relate to each other. In this study, the impact of point-to-point flow connectivity on radially convergent flow tests towards a well is investigated numerically. A Monte Carlo approach is adopted whereby a large number of heterogeneous aquifer systems with different levels of connectivity (Gaussian, connected high-transmissivity fields, and connected low-transmissivity fields) are synthetically generated and then used to simulate pumping tests. Various test interpretation methods are then used to estimate apparent flow parameters from the time-drawdown curves, and examine how the estimated parameters relate to the underlying heterogeneous aquifer systems. Results indicate that the estimated transmissivity using only drawdown data corresponding to early times is dominated by the point transmissivity distribution in the vicinity of the well. The estimated transmissivity value gradually approaches the geometric mean of the full transmissivity field as a longer time-drawdown dataset is included in the interpretation. On the other hand, the storage coefficient estimated from late drawdown data is strongly sensitive to aquifer point-to-point flow connectivity and the relative locations of the observation and pumping wells. The relations between the estimated storage coefficient and different aquifer connectivity functions are also examined.