



## **Estimating Parameters of Aquifer Heterogeneity Using Pumping Tests - a Paradigm for Field Applications**

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The vast majority of natural aquifers are characterized by heterogeneity which can be statistically represented by parameters such as geometric mean, correlation lengths and variance of hydraulic conductivity. Head measurements of pumping tests are commonly used to estimate the hydraulic properties of porous media. Zech et al. 2012, WRR introduced the effective well flow method allowing a direct parameter estimation from steady state pumping test drawdowns.

However, in contrast to simulated pumping tests, the number and spatial distribution of piezometers is limited for on-site pumping tests. We analyze the capability of the effective well flow method to provide accurate and confident parameter estimates of a heterogeneous aquifer under limited availability of head measurements.

We use simulated pumping tests to systematically reduce sampling size while also determining the accuracy and uncertainty of estimates at each level of data availability. The same analytical solution is then applied to estimate the statistical parameters of a fluvial heterogeneous aquifer at the test site Horkheimer Insel, Germany. We thereby close the gap between theoretical and practical application of an analytical solution describing three-dimensional steady state well flow.

Our findings indicate how accuracy and uncertainty of estimated parameters, like mean conductivities and correlation lengths correlate to number and spatial distribution of head measurements. The results provide valuable implications regarding the conceptual design of ground water pumping tests and the predictive power of established pumping test sites.