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Coupled Bayesian hydrogeophysical inversion of the hydraulic properties of a model dike

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Coupled hydrogeophysical inversion aims to improve the use of geophysical data for hydrological model parameterization. Several numerical studies have illustrated the feasibility and advantages of a coupled approach, but there is still a lack of studies that apply this approach to actual data. In this study, we use spatial time domain reflectometry (TDR) and electrical resistance tomography (ERT) measurements to estimate the hydraulic properties of a model river dike. The measurements were obtained during a flood event in which the water level was raised to 1 m below the crest of the dike. In a first step, the hydraulic parameters of the dike were inversely estimated using in-situ spatial TDR measurements of soil water content with the HYDRUS model. The uncertainty of the obtained parameters was determined using a Bayesian approach and a MCMC sampling method. In a second step, the hydraulic parameters were estimated from ERT measurements by coupling a hydrological and a geophysical forward model. Again, the uncertainty of the optimized parameters was determined. The results show that ERT measurements provide useful information to constrain the hydraulic parameters of the dike, even in the absence of detailed knowledge of the petrophysical relationships. The hydraulic parameter estimates obtained from ERT were less well constrained than those obtained from spatial TDR, but the estimates from both data sources were consistent after considering parameter uncertainty.