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Optimal data acquisition strategy for sampling of future hydraulic head: Uncertainty minimization in model predictions

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In this study, a sampling network design method was developed to define the optimal number and location of head monitoring observations (sampling strategy) that can reduce uncertainty in model predictions of contaminant transport. The design uses a large number of head monitoring locations ranked based on their relative influence in reducing the uncertainty associated with the estimation of input parameters that are critical to model predictions. The 3D variable-density flow and solute transport model (SEAWAT) was used to assess the impact of parameter uncertainty in predicting salinity migration in a heterogeneous aquifer located along the Eastern Mediterranean. The results defined a set of possible locations to monitor hydraulic head in an effort to estimate with a low level of uncertainty an individual sensitive parameter critical to model predictions . The precision of sampling locations was evaluated through calibrating the model using datasets randomly selected from the suggested hydraulic heads monitoring locations. A high random noise was also added to the (unimportant) non- sensitive parameters omitted from the parameter estimation process to emulate realistic field conditions where non-calibration initial parameters are not properly defined (lack of or poor geological characterization). The use of the suggested monitoring networks succeeded in preserving a low predictive uncertainty level (<5% and <20% during the wet and dry seasons, respectively) after a twenty-year simulation compared to other networks, when the same number of head observations was not selected from the suggested locations. This stresses that while an optimal number of head observations can reduce the total parameter uncertainty during the model calibration, the effectiveness of a monitoring network to acquire a low predictive uncertainty level is contingent on locating the head observation wells properly.