The Impact of Pilot Points Configuration on Flow Model Calibration Results

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Abstract

When calibrating models of flow in pours media, two approaches are commonly used. These are namely the zonation and the pilot-points method. The zonation approach divides the model domain into various zones with one value of a calibrated parameter at each. This, it has an abrupt spatial change between zones. The pilot-points method uses the spatial statistics of the calibrated parameter to produce a smooth distribution. While pilot points method is more realistic than the zonation approach, however, the number and placement of the pilot-points can be challenging. The objective of this study is to examine the impact of pilot-points number and locations on the calibrated parameters, and to assess the predictive uncertainty of a highly parameterized aquifer. Various arrangement of pilot numbers and locations points locations were examined. The northern aquifer of Qatar was used as a case study, using a 3D finite difference-based MODFLOW model. The model was calibrated using Parameter Estimation and Uncertainty Analysis (PEST) package using historical data of groundwater levels. The Root Mean Square Error (RMSE) for all the runs (corresponding to different configurations of pilot-points) was maintained under a certain threshold. A statistical analysis was done to examine and assess the impact of pilot points location on the hydraulic conductivity, to evaluate how far these parameters are impacted by the pilot-point locations. Finally, a stochastic approach was used to assess the predicted uncertainty of the calibrated parameter using Null-Space Monte Carlo (NSMC). The NSMC helps overcome the non-uniqueness issue of the inverse problem by calibration-constrained random sampling. Results showed there is a great impact of pilot points number, distribution and configuration on the calibrated parameters, in particular, in the high permeable regions. Uncertainty analysis using stochastic NSMC shows high uncertainty in karst and highly fractured zone of the study area. The findings of this study might help design data collection locations to reduce uncertainty and have a better model calibration. In addition, it can significantly reduce the run-time of model calibration.