Efficient uncertainty quantification methods in groundwater contaminant risk assessment

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Groundwater contaminant risk assessment requires uncertainty quantification (UQ). However, UQ in groundwater modeling is challenging because of model complexity and massive computational requirement. To reduce the computational cost, a surrogate model is usually constructed to approximate and replace the expensive groundwater model in the UQ. For a complex model with a large number of model parameters and model outputs, constructing and evaluating the surrogate model itself is computationally intensive due to the “curse of dimensionality” and the difficulties in data load and storage capacity. This study uses Bayesian compressive sensing technique to reduce the model dimensionality, thus building an accurate surrogate in a reasonable amount of time. In addition, this study uses singular value decomposition method to learn and retain the most information of the model outputs, thus dramatically reducing the computational time in surrogate evaluation. We apply the methods to a groundwater transport model that simulates the uranium (U(VI)) concentration at a uranium mill site in Naturita, CO, USA. The results indicate that using a reasonable time, an accurate surrogate model is constructed and can be fast evaluated in UQ for the U(VI) contaminant risk assessment.

