Uncertainty Quantification of Environmental Performance Metrics for Risk Analysis in Hydrogeological Systems

Felipe de Barros

Sonny Astani Department of Civil and Environmental Engineering
University of Southern California
Los Angeles, CA, USA
Email: fbarros@usc.edu

Abstract

In this presentation, I provide a risk-driven perspective of the impact of hydrogeological heterogeneity in groundwater resources management with emphasis on the importance of uncertainty quantification in contaminated groundwater risk analysis. Many of the factors that constitute risk of exposure to contaminants in the subsurface environment are subject to uncertainty and requires knowledge from multiple fields ranging from hydrogeology to public health. Improved understanding of the impact from each of these factors in risk estimation can provide guidance for decision makers to better manage contaminated sites and allocate resources towards characterization efforts. Through the use of an integrated stochastic risk framework and several computational examples, I show the joint impact of hydrogeological properties and engineering factors on the uncertainty of key environmental performance metrics for health and environmental risk analysis.

Scale-Dependent Dispersion and its Uncertainty in Spatially Heterogeneous Porous Media

Felipe de Barros

Sonny Astani Department of Civil and Environmental Engineering
University of Southern California
Los Angeles, CA, USA
Email: fbarros@usc.edu

Abstract

Modeling solute transport behavior in large-scale heterogeneous porous formations require, in general, substantial computational burden. Additional challenges rise from the fact that the subsurface formation is usually characterized over a coarse measurement network that captures large-scale variability of the flow field. Due to computational and sampling constraints, solute transport models tend to adopt coarse numerical grid blocks. However, neglecting the subscale flow fluctuations that are wiped out by homogenization can lead to inaccurate representation of dispersive mass fluxes which have an impact on contaminant site management and risk analysis. In this talk, I will present a stochastic modeling framework to compute upscaled dispersion coefficients that incorporates the high frequency variability that is filtered out by homogenization with focus on the *uncertainty* associated with the dispersive flux under non-ergodic transport conditions. Analytical and semi-analytical expressions for the temporal evolution of the mean and variance of the block-scale dispersion tensor are derived. These quantities provide information regarding the mixing efficiency and the self-averaging properties of the transport process. Results show the importance of the initial scale of the solute body, the block-scale and local-scale dispersion in controlling the uncertainty of the solute cloud's dispersive behavior.