Groundwater Sensitivity Analysis under Model and Scenario Uncertainty: Not to Look for Keys under the Lamppost

Ming Ye (mye@fsu.edu), Professor
Department of Earth, Ocean, and Atmospheric Science
Florida State University

A police officer sees a drunken man intently searching the ground near a lamppost and asks him the goal of his quest. The inebriate replies that he is looking for his car keys. The officer helps for a few minutes without success then he asks whether the man is certain that he dropped the keys near the lamppost. "No," is the reply, "I do not know where I lost the keys." "Why look here?" asks the surprised and irritated officer. "The light is much better here," the intoxicated man responds with aplomb.

The environmental system consists of various physical, chemical, and biological processes, and environmental models are always built to simulate these processes and their interactions. For model building and improvement, it is necessary to identify important processes and parameters so that limited resources can be used to better characterize the processes and parameters. While global sensitivity analysis has been widely used to identify important processes and parameters, the identification is always based on a single model that represents the system processes and under a single scenario that represents future scenarios of the system. However, environmental systems are open and complex, and it happens often that there are multiple conceptualizations of the system and that the system is under various possible scenarios. Ignoring the model and scenario uncertainty may lead to incorrect identification in that the identified important processes and parameters may not be important in the real world. The model and scenarios uncertainty leads to a number of research questions. For example, are the parameters important to one model also important to other models? Are the parameters important under one modeling scenario also important under other modeling scenarios? This presentation addresses this problem by developing a new method of global sensitivity analysis for process and parameter identification. The new method integrate the concept of Sobol sensitivity analysis into the framework of model and scenario averaging. The method is demonstrated using examples of groundwater flow and nitrogen transport modeling. The method is mathematically general, and can be applied to a wide range of environmental problems.