

Chapter 7

Discussion and Conclusions



In this book, we have presented several concepts and methods for propagating uncertainty through models, especially environmental geoscience models and hydrogeological models. One of the examples involves a probabilistic model of corrosion pit growth on nuclear waste canister, but most other examples involve solute concentration migration or decay: 0-dimensional first order decay kinetics, 1D concentration transport, and fully 3D concentration transport models (analytical and computational) in the presence of a trapped NAPL “source”. The novel 3D quasi-analytical model of advective–dispersive contaminant migration from a decaying rectangular patch of NAPL source may be of interest not only for uncertainty analyses, as we do here, but also for benchmark tests in contaminant hydrogeology. The final sub-section dealing with the 3D numerical modeling of a real polluted site with the MODFLOW-SURFACT code illustrates how uncertainty analysis methods can be employed in practice, with what objectives, what output criteria, and what kinds of results.

A broad range of uncertainty propagation methods is covered in the theoretical sections, and then illustrated with the example models. Conceptually, the methods investigated here are based on probabilistic concepts, on fuzzy variable concepts, or both in the case of the “possibilistic” approach. Technically, our discussion covers several aspects: sampling plans such as LHS and other plans (“Design of Experiments”); different ways of implementing Monte Carlo simulations (directly on the model itself, or indirectly via a “metamodel” or “surrogate model”); various ways of propagating uncertainty analytically (exactly or approximately through Taylor expansions); and other issues of interest like multivariate probabilities to deal with joint sets of uncertain parameters, and sensitivity analyses performed via uncertainty propagation.