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Rachid Ababou · Juliette Chastanet ·  
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Michel Quintard



**Uncertainty Analyses in  
Environmental Sciences  
and Hydrogeology**  
Methods and Applications  
to Subsurface  
Contamination

 Springer

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# Uncertainty Analyses in Environmental Sciences and Hydrogeology

Methods and Applications to Subsurface  
Contamination

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# Chapter 1

## Introduction, Objectives



The different alternatives for managing a contaminated site are based on a cost/benefit balance that requires predictive modeling to assess mass depletion and duration of contamination source in the subsurface. For instance, the ESPER<sup>1</sup> project (*Evaluation and Sensitivity of models for Predicting the depletion and Remediation of organic contamination sources in subsurface*) was aimed at developing a methodology and a software tool for facilitating the incorporation of uncertainty and sensitivity analyses into such subsurface contamination models.

Let us first clarify from the outset the term “uncertainty propagation.”

Mathematical methods of uncertainty analyses can be viewed as “uncertainty propagation” methods, in the sense that they can “propagate” (or “carry”) the uncertainty from the input parameters to the outputs of the model. The model may be analytical: a simple example is the first order decay model  $C(t) = C_0 \exp(-\lambda t)$ . Or it can be a more complex quasi-analytical model containing special functions and simple integrals. Or else, it can be a fully discretized space–time numerical model such as the MODFLOW- SURFACT<sup>TM</sup> code. It can also be, possibly, a polynomial “meta-model” (“surrogate model”) derived from the initial model. The metamodel is essentially an input/output response function, derived from the original model, and which can be used to simplify the uncertainty propagation process (as will be explained later).

This book reviews and illustrates various approaches and methods for uncertainty analysis, and presents various models (from simple to complex) to illustrate these uncertainty analyses, including some model-specific results, and also, site-specific results, from the ESPER project in particular.

This book is organized as follows. After the present introduction, the next chapter (Chap. 2) covers different methods for carrying out uncertainty analysis, starting with an overview of different approaches and concepts. Chapter 3 develops a comprehen-

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