

# BOOK REVIEW

## Applied Stochastic Hydrogeology



**YORAM RUBIN**

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Stochastic hydrogeology is an area of research that developed considerably over the last 20 years. A large body of knowledge has been accumulated, and many of the ideas, tools, and concepts in this area have reached the stage at which they are ready for use in applications. Stochastic hydrogeology has matured into a distinct branch or discipline within hydrogeology. Although several books have been published on this and related topics, *Applied Stochastic Hydrogeology* is a general reference book that allows newcomers to the field an easy introduction. Practitioners, researchers, professors, and graduate students in hydrogeology and engineering will find that this book is intuitive, valuable, and applicable.

Author Yoram Rubin, a professor at the University of California-Berkeley, has conducted research in this area for many years and is one of the leading experts in stochastic hydrogeology. The title of the book, *Applied Stochastic Hydrogeology*, appears to be carefully chosen. The book is focused on concepts and ideas that are not yet tested in applications, but are well understood and ready to be used in applications. The book informs practitioners about the discipline and helps them to understand and implement the various tools of stochastic hydrogeology. In other words, by grasping the concepts, practitioners will be better equipped to make better-informed decisions regarding applications. Furthermore,

potential "clients" of stochastic analyses, such as government/regulatory agencies, will be able to determine what to expect, what to demand, and how to relate to stochastic analyses they need.

The book's 13 chapters are focused on four separate but complementary areas: geostatistics, flow in heterogeneous media, transport in heterogeneous media, and inverse modeling. The book starts by introducing some basic concepts in stochastic hydrogeology, the fundamentals of hydrogeological site characterization, and the principals and practice of geostatistical estimation and simulation (chapters 1-3). It continues with extensive discussion on the stochastic analysis of the flow variables: the hydraulic head, the flux, and the velocity (chapter 4-6), and the fundamentals and modeling aspects of contaminant transport (chapters 7-10). Chapters 11 and 12 are devoted to the vadose zone. A unique chapter on model inference and forward and inverse modeling concludes the book.

Rubin has collected and presented the best work done by the stochastic hydrogeology community, and the book's coverage is not limited to the author's own work or that done by researchers in his small circle of colleagues. Unlike other books published in this area, this is not a scientific monograph, but rather an extensive compendium of works and ideas that were developed and presented over time by the community at large and withstood the test of time. This unique aspect of the book makes it the first of its kind in our discipline. The author also tries to cross the boundary between the theoreticians, who are mostly responsible for the theoretical work in the discipline, and those who pay more attention to geological detail. Rubin shares a lot of his insight into the geo-statistical models, his rich experience in numerical modeling in heterogeneous media, and his extensive theoretical analyses on scale-dependent dispersion.

The book's explanation of many concepts and problems that are difficult to understand and explain to a new comer to stochastic hydrogeology is very helpful. For example, the author provides some convincing arguments to a common criticism: a stochastic approach requires lots of data. This is "wrong," as stated in the book. Rubin explains, "First, if one accepts its logic, then one must conclude that when only few data are available, a deterministic approach is justified, which is obviously wrong. Second, ..., stochastic hydrogeology is flexible in its ability to analyze a wide range of information states, starting from total ignorance, when no data are available and uncertainty is at its largest, and ending with a deterministic state, where no uncertainty exists." This is just one example of many in-depth analyses presented in the book.

In presenting the material, the author is focused on intuitively explaining the concepts at the expense of mathematical rigor. The reader interested in a complete mathematical exposition of the ideas can search the references provided. The book has followed the guidelines that are useful for students, practitioners, and government/regulatory agencies. Many of the chapters in the book were tried and tested on his students over the years, and the students proofread these chapters many times, which significantly reduced typos. As a teacher, I think that in a semester-long course on stochastic hydrogeology, one may cover all or parts of six of the chapters in the book either sequentially or in various combinations.

In summary, *Applied Stochastic Hydrogeology* is unique and the most comprehensive reference book on this subject. It covers the fundamental and practical aspects of geostatistics and stochastic hydrogeology with many examples, case studies, and guidelines for applications. It presents a systematic approach for analyzing and modeling subsurface heterogeneity, for modeling flow and transport in aquifers and soils, and for decision-making under uncertainty.

—YOU-KUAN ZHANG, University of Iowa, Iowa City