

Soil Water Dynamics. ARTHUR W. WARRICK. Oxford University Press, New York, NY 10016. 2003. Hardcover. 416 pp. \$85.00. ISBN 0-19-512605-X.

As implied by the title, Dr. Warrick's book focuses on the transport of water in soils, rather than also addressing the many broader topics of soil and environmental physics. This allows him to devote an uncharacteristic level of detail to his chosen subject relative to other texts. The book has seven chapters: the soil system, soil water flow, saturated flow, one-dimensional adsorption, one-dimensional infiltration and vertical flow, multidimensional water flow in variably saturated soils, and solute and contaminant transport. Each chapter encompasses multiple subtopics. The first chapter sets the stage by addressing the three-phase soil system, soil water potential and the soil water retention relationship, representative sampling volumes, spatial variability, and a few related issues. The topic of spatial variability, for which Dr. Warrick is an acknowledged authority, is covered in 12 pages, providing a useful overview and references to more comprehensive information sources. Soil water retention is treated using both the traditional bundle-of-capillaries context and the more recent angular pore space model, with the latter, less familiar topic covered in some detail. Ensuing chapters address subjects including the Darcy and Richards equations and their applications, functional forms for hydraulic properties (including conventional and angular pore spaces approaches), coupled flow processes, subsurface drainage, three-dimensional sources and sinks, the Boltzmann transform, infiltration equations, preferential flow, analytical and numerical solutions for multidimensional water flow, solute transport models including convective-dispersive, transfer function, and stream tubes, mobile-immobile systems, reactive and adsorbed chemicals, and nonideal transport.

A substantial number of models and calculation methods are provided, with many worked examples, the more than 100 of which should be of significant value to students as well as to those using the text as reference. Detailed quantification of processes is emphasized. The writing style is clear and easy to follow, as are the mathematical derivations. Some topics are treated at a more advanced level than others, but I consider this as inevitable. A nice mix of analytical and numerical approaches is used throughout. There are a few omissions. The book generally does not address measurement methods or instruments, a fundamental treatment of evaporation processes is missing, and the discussion of plant water extraction is limited to incorporation of a few sink functions, in common with a majority of texts that focus on soil and water. The author acknowledges in the preface that additional topics including preferential flow, stochastic processes, and percolation theory are treated in little detail or are not mentioned. Still, I found the breadth of coverage to be laudable for this medium-sized textbook.

An intriguing and diverse "Additional Topics" section is provided at the end of each chapter. These encompass many

brief but engaging and informative topics, including, for example, scaling and fractal scaling, pedotransfer functions, modeling hysteresis, characteristics of differential equations, Dupuit-Forchheimer theory, Fourier series, infiltration with air resistance, capillary diversions and barriers, and Burgers' equation. Sufficient information is provided to serve as basic introduction to these topics, and for use as springboards to more in-depth investigation or application. I found these as analogous to setting aside my novel of the moment in favor of enjoying a few related short stories.

The number and range of analytical solutions to variably saturated flow and solute transport provided here is unique. Discussion of numerical solutions including several examples using common two- and three-dimensional flow problems is augmented by Dr. Warrick's AUSTERE finite differences water flow model, representing incrementally more difficult or complicated flow problems (e.g., uniform or layered systems; 1-, 2-, or 3-D), and these discussions are contextualized by example applications. The Fortran code is provided in text version in the book, and is available for download via link from the author's web site (<http://ag.arizona.edu/swes/projects/soilwaterdynamics/Index.htm>; accessed 26 July 2004, verified 4 Oct. 2004). The well-known HYDRUS numerical models are also introduced and some capabilities briefly described.

Questions at the end of each chapter (179 in all) emphasize quantitative procedures and appear to be suitable for graduate and perhaps advanced undergraduate courses where students are comfortable with calculus and differential equations. A solutions manual would be a convenient addition. An accompanying CD was noted in the Preface, but its inclusion was apparently altered before publication. No worries, though: an errata sheet in pdf format, as well as data files and multiple (18, when I investigated) Fortran and MathCad programs from the book are available for download (<http://ag.arizona.edu/swes/projects/soilwaterdynamics/Index.htm>).

I consider *Soil Water Dynamics* to occupy a unique station among its contemporaries. Many topics necessarily overlap with those in soil physics texts such as Hillel's *Environmental Soil Physics* (D. Hillel. 1998. Academic Press, New York), the newly-updated *Soil Physics* (W.A. Jury and R. Horton. 2004. Wiley, New York) and others, but the focus of Warrick's book is less general and hence is able to provide greater detail. Many professionals and advanced students in soil physics, engineering, and hydrology will welcome Dr. Warrick's new book as a reference, and introduction in some cases, to advanced quantitative methods in flow and transport. It should have longstanding utility to those with interests in research, applications, and/or modeling related to soil water dynamics. His former students may have been previously exposed to much of the content, but will likely appreciate the clean textbook format and the accrued benefits of contributions or reviews by many colleagues.

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