MODELING WATER FLOW AND CONTAMINANT TRANSPORT IN SOILS AND GROUNDWATER USING THE HYDRUS COMPUTER SOFTWARE PACKAGES

Instructor

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OVERVIEW

Soil and groundwater pollution is an ever-increasing, worldwide problem. Tens of billions of dollars are spent each year in the United States and elsewhere to remediate groundwater pollution, and to limit or prevent future contamination of the subsurface. Most subsurface pollution problems stem from activities involving the unsaturated (vadose) zone between the soil surface and the groundwater table. The unsaturated zone hence provides the best opportunities to limit or prevent groundwater pollution. Once contaminants enter groundwater, pollution is essentially irreversible, or can be remediated only with extreme costs.

Numerical modeling is becoming an increasingly important tool for analyzing complex problems involving water flow and contaminant transport in the unsaturated zone. This course is designed to familiarize participants with the principles and mathematical analysis of variably-saturated flow and transport processes, and the application of state-of-the-art numerical codes to site-specific subsurface flow and transport problems.

COURSE DESCRIPTION

The course begins with a detailed conceptual and mathematical description of water flow and solute transport processes in the vadose zone, followed by an brief overview of the use of finite element techniques for solving the governing flow and transport equations. Special attention is given to the highly nonlinear nature of the governing flow equation. Alternative methods for describing and modeling the hydraulic functions of unsaturated porous media are also described.

"Hands-on" computer sessions provide participants an opportunity to become familiar with the Windows-based HYDRUS computer software packages, including several additional modules, such as ROSETTA, HP1, UNSATCHEM, and/or the Wetlands module. Emphasis is on the preparation of input data for a variety of applications, including flow and transport in a multilayered vadose zone, flow and transport from a subsurface point source, flow and transport to a tile drain, and two-dimensional leachate migration from a landfill through the unsaturated zone into groundwater. Calibration is discussed and demonstrated with several examples for both water flow and solute transport (using HYDRUS).
**COURSE SOFTWARE**

The course introduces a new generation of Windows-based numerical models for simulating water, heat and/or contaminant transport in variably-saturated porous media. These include the HYDRUS-1D and HYDRUS (2D/3D) codes for one- and two-dimensional simulations, respectively, and the Rosetta code for estimating the soil hydraulic properties (and their uncertainty) from soil texture and related data. HYDRUS-1D and HYDRUS (2D/3D) are supported by interactive graphics-based interfaces for data-preprocessing, generation of unstructured as well as structured finite element grid systems, and graphic presentation of the simulation results. Except for HYDRUS (2D/3D), all software packages are in the public domain.

**COURSE HANDOUTS**

Course handouts include lecture notes prepared by the instructor. Documentation of the RETC, STANMOD, HYDRUS-1D and HYDRUS 2D/3D models can be downloaded from the HYDRUS website.
**COURSE INSTRUCTOR**

*Dr. Jirka Simunek* is a Professor of Hydrology with the Department of Environmental Sciences of the University of California Riverside. He received an M.S. in Civil Engineering from the Czech Technical University, Prague, Czech Republic, and a Ph.D. in Water Management from the Czech Academy of Sciences, Prague. His expertise is in numerical modeling of subsurface water flow and solute transport processes, equilibrium and nonequilibrium chemical transport, multicomponent major ion chemistry, field-scale spatial variability, and inverse procedures for estimating the hydraulic properties of unsaturated porous media. He has authored and coauthored over 190 peer-reviewed journal publications, over 20 book chapters, and two books. His numeric models, HYDRUS-1D, HYDRUS-2D, and HYDRUS (2D/3D), are used by virtually all scientists, students, and practitioners modeling water flow, chemical movement, and heat transport through variably saturated soils. Dr. Šimůnek is a recipient of the Soil Science Society of America’s Don and Betty Kirkham Soil Physics Award, SSSA Fellow, and the past chair of the Soil Physics (S1) of SSSA. He is an associate editor of Vadose Zone Hydrology, Journal of Hydrological Sciences, and a past AE of Water Resources Research.

**COURSE CO-DEVELOPER**

*Martinus T. van Genuchten* is a soil physicist with the U.S. Salinity Laboratory, USDA, ARS, Riverside, CA. He received a B.S. and M.S. in irrigation and drainage from the Agricultural University of Wageningen, The Netherlands, and a Ph.D. in soil physics from New Mexico State University. He has published widely on variably-saturated flow and contaminant transport processes in the subsurface, analytical and numerical modeling, nonequilibrium transport, preferential flow, characterization and measurement of the unsaturated hydraulic functions, and root-water uptake. Dr. van Genuchten is a recipient of the Soil Science Society of America’s Don and Betty Kirkham Soil Physics Award, and fellow of the Soil Science Society of America, American Society of Agronomy, American Geophysical Union and American Association for the Advancement of Sciences.