Modelling of Water Flow and Solute (Salinity) Transport in Porous Media Using the HYDRUS-1D Software Package

Instructors
Prof. Dr. Jirka Šimůnek
University of California Riverside
Riverside, CA, USA

Dr. David Rassam and Dr. Dirk Mallants
CSIRO Land and Water

Organiser
CSIRO Land and Water, Waite Campus, Adelaide, SA

Sponsors
CSIRO Science Excellence Research Office & Goyder Institute

February 28 – March 2 2017
Modelling of Water Flow and Solute (Salinity) Transport in Porous Media Using the HYDRUS Software Package

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 a 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 modelling 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, and UNSATCHEM. Emphasis is on the preparation of input data for a variety of applications, including flow and transport in a vadose zone. Special attention will be given to apply the major chemistry module UNSATCHEM to soil salinization and sodification issues.

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 code for one-dimensional simulations and the Rosetta code for estimating the soil hydraulic properties (and their uncertainty) from soil texture and related data. HYDRUS-1D is supported by interactive graphics-based interfaces for data-preprocessing, generation of finite element grid systems, and graphic presentation of the simulation results. The HYDRUS-1D software package is in the public domain.

COURSE HANDOUTS

Course handouts include lecture notes prepared by the instructor.
COURSE INSTRUCTORS

**Dr. Jirka Šimůnek** 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 co-authored over 250 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. Simunek is a recipient of the Soil Science Society of America’s Don and Betty Kirkham Soil Physics Award, and Fellow of American Geophysical Union (AGU), Soil Science Society of America (SSSA), American Society of Agronomy (ASA), American Association for Advancement of Sciences (AAAS). He is a co-editor of Vadose Zone Hydrology, associate editor of Journal of Hydrology, and a former AE of Journal of Hydrological Sciences and Water Resources Research. In 2016 he received the CSIRO Sir Frederick McMaster Fellowship.

**Dr. Dirk Mallants** is a Senior Principal Research Scientist with CSIRO Land and Water and based at the Waite Campus, Adelaide (South Australia). He has a background in soil and groundwater hydrology with more than 25 years of experience in characterising and modelling water flow and contaminant transport in complex environments – typically variably-saturated soils, aquifers and low-permeable porous media including deep clay formations and fractured concretes. He contributed to establishing one of the most extensive datasets on hydraulic conductivity of aquitards. Integrating experimental observations and numerical modelling has always been at the centre of his research. His work includes parameterisation of pore-scale and field-scale spatial variability in flow and transport properties, modelling processes of water flow and contaminant transport across a range of spatial scales, and the evaluation by means of process-based models of management options for water-related environmental pollution problems. He previously had oversight on the development of the coupled reactive transport simulator HP1 (HYDRUS-PHREEQC). The ability to incorporate coupled physical, chemical,
geological and biological processes in the simulation of chemical migration and natural attenuation means a significant step forward in risk assessment and testing of mitigating measures as part of pollution prevention.

Dr. David Rassam is a Senior Research Scientist with CSIRO Land and Water based in Dutton Park, Brisbane. He received a PhD in Environmental Geotechnics from the University of Queensland, Brisbane, Australia. His main expertise is in modelling surface-groundwater interactions. He has authored 30 journal papers and book articles. He is the lead author of the book: ‘Modelling Variably Saturated Flow with HYDRUS-2D’; he authored 10 other journal and conference papers on the applications of HYDRUS-2D software to model various flow and transport problems
Modeling of Water Flow and Solute (Salinity) Transport in Porous Media Using the HYDRUS Software Package

COURSE DETAILED OUTLINE

Venue: CSIRO Waite Laboratories, Waite Road, Entry/Gate 4, Building C1 (Soil & Water Environments Centre)

Day 1 (February 28: 8:30 am – 5:00 pm):

Lecture 1: Vadose zone flow and transport modelling: An overview.
Lecture 2: The HYDRUS-1D software for simulating one-dimensional variably-saturated water flow and solute transport.
Computer session 1: HYDRUS-1D: Infiltration of water into a one-dimensional soil profile.
Lecture 3: On the characterization and measurement of the hydraulic properties of unsaturated porous media.
Lecture 4: Application of the finite element method to variably-saturated water flow and solute transport.
Computer session 2: HYDRUS-1D: Water flow and solute transport in a layered soil profile.

Day 2 (March 1: 8:30 am – 5:00 pm):

Computer session 3: Modelling Salinity Using the Standard Module of HYDRUS-1D.
Computer session 4: Modelling Salinity Using the UnsatChem Module of HYDRUS-1D.

Day 3 (March 2: 8:30 am – 5:00 pm):

Computer session 5: Applications of the UnsatChem Module based on site-specific data (SA).
Registration and contact

via email to Dirk.Mallants@CSIRO.au

Registration fee

$500

This price includes course documentation and coffee breaks.

Computer exercises will be done on your own personal laptops. Please inform us if you are not able to bring your own laptop.

Course Secretary
All mail should be addressed to:
Dirk Mallants
CSIRO Land & Water
Gate 4, Waite Road, Waite Campus, Urrbrae SA 5064
Tel: +61 8 8303 8595 | Fax: +61 8 8303 8555 | Mobile: 0467 818 207