Short Course on

Fundamental and Advanced Topics in Hydrogeology and Hydrological Simulation

University of Cagliari, Italy, February 11–14, 2020

Lecturer
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Programme

Tuesday, February 11

Lecture 1. Introduction (basic definitions and physical properties, heterogeneity and anisotropy, REV and scale)
Lecture 2. Darcy's law (gradients, potential, hydraulic head)
Lecture 3. Principle of mass conservation (mixing model for lake pollution, dimensional analysis, behavior at steady state)
Lecture 4. Groundwater flow equation (hydrological water balance, continuity equation, specific storage)
Lecture 5. Solving the groundwater flow equation (flow nets, ICs and BCs, analytical solution, Tóth analysis)

- Modeling laboratory: 2D groundwater recharge and discharge (Tóth) model

Wednesday, February 12

Lecture 6. Groundwater well hydraulics (inverse modeling to determine aquifer parameters, Theis solution and extensions)
Lecture 7. Numerical modeling (why model?, finite difference and finite element methods, 2D flow example)
Lecture 8. Unsaturated zone (unconfined aquifers, capillarity, soil hydraulic properties, hysteresis)
Lecture 9. Richards' equation (derivation and applications, extension to soil swelling/shrinking and land subsidence)
Lecture 10. Low-dimensional and simplified flow models (Dupuit and Boussinesq approximations)

- Modeling laboratory: 1D soil infiltration (Richards' equation) model

Thursday, February 13

Lecture 11. Hydrogeochemistry (chemical properties of water, measuring concentrations, basic reactions, Fick's laws)
Lecture 12. Mass transfer and mass transport (advection, dispersion, dispersivity, sorption, decay)
Lecture 13. Advection–dispersion–reaction (ADR) equation (derivations of various transport models, non-LEA phenomena and the two-domain model, remarks on coupling and on particle transport, analogies with Fourier's equation, groundwater contamination and remediation)
Lecture 14. Seawater intrusion (variable density and viscosity phenomena, Ghyben-Herzberg analysis, disperse and sharp interface approaches, VarDenFT2D and CODESA-3D models, Henry's problem, a Tunisian case study)
Lecture 15. Hillslope-storage Boussinesq model (derivation, comparison with Richards' equation, dealing with leakage)

- Modeling laboratory: hillslope-storage Boussinesq (hsB) model and 1D analytical model for the ADR equation

Friday, February 14

Lecture 16. Coupled surface–subsurface modeling (general description, main features of the CATHY model)
Lecture 17. Geostatistics, data assimilation, and remote sensing (basic notions, scalar DA model, SAR for soil moisture RS)
Lecture 18. Model benchmarking (experiments at the Landscape Evolution Observatory, ISSHM intercomparison studies)
Lecture 19. Analytical solutions to 1D ADR equation (BCs for the transport equation, a simple example)
Lecture 20. ISSHMs and CATHY (survey of ISSHMs, successes and challenges, structure of CATHY)

- Modeling laboratory: Demonstration of the CATchment HYdrology (CATHY) model

Morning sessions are 9:00–13:00, afternoon sessions are 14:30–17:30.