Università degli Studi di Cagliari
Dottorato di Ricerca in Ingegneria del Territorio

Short Course on

Fundamental and Advanced Topics in Hydrogeology and Hydrological Simulation

Cagliari (Italy) – October 24-26, 2007

Lecturer

Prof. Claudio Paniconi, INRS-ETE, University of Quebec, Quebec City, Canada.
claudio.paniconi@ete.inrs.ca

Description

Course Description

The hydrological cycle is controlled by the continuous interactions between the atmosphere (rainfall and evaporation), the land surface (overland and channel flow), and the subsurface (unsaturated zone and aquifer). The ability to reliably monitor and model these interlinked processes is critical to the sustainable management of our freshwater resources (including our response to future stresses arising from population, land use, and climate changes). The challenges in doing so can be attributed to several factors, not least of which the sheer complexity of these interactions, the spatio-temporal heterogeneity that characterizes natural systems, the difficulty in measuring key parameters and state variables, and the knowledge gaps and uncertainties in the models we use to study and simulate hydrological dynamics. These challenges are being addressed by continual advances in several domains, including: computer technology (in support of observation networks, data analysis, and process simulation); hydrological observation (on the ground, airborne, and from space); numerical algorithms (to deal more effectively and efficiently with scale, nonlinearity, and other complexities); and evolving methodologies for model calibration, parameter estimation, and data assimilation (so that simulation models and observation data can be integrated in a physically consistent manner).

This intensive 3-day course will review fundamental and practical aspects of hydrological theory and modeling. The primary focus will be on the subsurface (groundwater and soil water), and special attention will be devoted to advanced topics such as:

- Modeling coupled phenomena (e.g., water flow and contaminant transport; atmosphere–surface–subsurface interactions);
- Matching models and complexity (e.g., 1D models for infiltration; quasi-2D models for hillslopes; 2D models for recharge–discharge analysis; analytical solutions for groundwater well response to pumping and for simple reactive transport);
- Soil moisture remote sensing with active microwave SAR, or synthetic aperture radar (this will include a field campaign to measure surface soil moisture and roughness on the ground, in coincidence with an acquisition of an Envisat ASAR satellite image);

- Data assimilation in a 3D coupled numerical model (simple and sophisticated algorithms will be introduced and compared).

The course will be structured as 3 morning lectures (8:30–12:30), followed by afternoon sessions devoted to hands-on simulation code demonstrations and exercises (2 afternoons, using models of varying complexity) and to a remote sensing field campaign (1 afternoon, with the collaboration of the Cagliari-based agricultural research center CRAS). The afternoon sessions will begin at 15:30 and will run for 3–4 hours.

Short Course on

Fundamental and Advanced Topics in Hydrogeology and Hydrological Simulation

Cagliari (Italy) – October 24-26, 2007

The morning lectures will cover, in addition to the advanced topics mentioned above, the following theoretical and applied elements of hydrology, hydrogeology, and numerical modeling: basic definitions, concepts, and parameters in porous media flow and transport; Darcy's law, conservation of mass, and Richards' equation; Dupuit, Boussinesq, and other approximations; advection, dispersion, and mass transfer; first-order, equilibrium, and kinetic reactions; finite difference and finite element discretization.

There is no registration or tuition fee for the course. Participation is limited to 12 students, with eligible applicants admitted on a first-come first-served basis.

Call for Applications

Please fill in the Application Form and send it by e-mail to Giuseppe Mascaro (gmascaro@unica.it), enclosing also your CV.
Deadline for applications is October 1, 2007.

Due to logistic problem, Participation is limited to 12 students, with eligible applicants admitted on a first-come first-served basis.
The school is founded by the University of Cagliari and is free of charge.

More information will be available on the web: www.unica.it/rdeidda/indexEvents.htm

Università degli Studi di Cagliari
Dottorato di Ricerca in Ingegneria del Territorio

Short Course on

Fundamental and Advanced Topics in Hydrogeology and Hydrological Simulation

Cagliari (Italy) – October 24-26, 2007

Tentative Program

Wednesday, October 24

Morning session, 8:30–12:30
- Introduction to hydrogeology (subsurface water balance, basic definitions, physical characteristics of water and porous media)
- Darcy's law; hydraulic pressure, potential, and head
- Conservation of mass principles, equation governing groundwater flow
- Hydraulic characterization of aquifers from pumping tests
- Unsaturated zone physics, Richards' equation
- Soil moisture (its importance as a hydrological state variable, its detection and mapping from spaceborne SAR sensors)

Afternoon session, 15:30–19:00
- Field campaign at CRAS agricultural research center (near Ussana) for surface soil moisture and roughness measurements

Thursday, October 25

Morning session, 8:30–12:30
- Low-dimensional and simplified models of subsurface flow
- Introduction to hydrogeochemistry (chemical properties of water, basic reactions, Fick's laws of diffusion)
- Mass transfer and mass transport in groundwater
- Advection–dispersion–reaction (ADR) equation
- Representation of decay (first-order rate law) and adsorption (equilibrium and kinetic approximations)
- Analytical solution to a 1D ADR equation

Afternoon session, 15:30–19:00
- Demonstration and exercises with three low-dimensional models (1D soil infiltration, 2D groundwater recharge and discharge, 1D reactive transport)

Friday, October 26

Morning session, 8:30–12:30
- Basic principles of finite difference and finite element modeling
- The hillslope-storage Boussinesq model for subsurface flow in sloping unconfined aquifers
- Coupling groundwater flow and contaminant transport for variable density phenomena
- Seawater intrusion in coastal aquifers
- Coupling surface and subsurface flow for an integrated overland–channel–soil–aquifer model
- Data assimilation for integration of observation data and simulation models

Afternoon session, 15:30–19:00
- Demonstration and exercises with a quasi-2D hillslope Boussinesq model and with a 3D coupled surface–subsurface flow model