CMWR - XVI

Sunday 18 June 2006 - Thursday 22 June 2006

Copenhagen, Denmark

Conference Scientific Programme

General

Organiser: Conference Committee</br>General conference submission: The conference committee will place papers submitted in this category into general conference sessions grouped by subject matter.

Ecohydrology: From Detailed Descriptions To General Synthesis?

Organiser: Amilcare Porporato, Duke University (amilcare@duke.edu)</br></br> The interactions among nutrient cycling, soil water balance, and plant dynamics are responsible for the dynamic equilibrium and the space-time patterns of terrestrial ecosystems. The mutual interaction between biotic and abiotic components of ecohydrological processes is complex. On the one hand, external hydro-climatic fluctuations propagate through the soil-plant system eliciting a hierarchy of responses at different scales. On the other hand, vegetation and soil biogeochemical cycles have important feedback on soil moisture dynamics and on the entire water cycle.</br></br> This special section solicits original research contributions broadly aimed at advancing our understanding of such complex interactions. Examples include the propagation of extreme hydrologic events on nonlinear dynamics of terrestrial ecosystems, the interrelationships between biogeochemical cycles and soil physical properties, the modeling and prediction of exchanges of carbon, nitrogen, and water within the soil-plant-atmosphere system, and the interactions among vegetation patterns, geomorphologic processes, and the hydrologic cycle. We especially encourage contributions that try to synthesize the complexity of detailed numerical and experimental analyses into a general description of the governing ecohydrological processes.

Geologic Sequestration of Carbon Dioxide

Organisers: Duane H. Smith (duane.smith@netl.doe.gov) and Jan M. Nordbotten (janmn@mi.uib.no)</br></br> Concerns about global warming and rising concentrations of greenhouse gases in the atmosphere have led to worldwide interest in the capture and sequestration of anthropogenic carbon dioxide. Many new technologies are being developed in response to these concerns. One of the most attractive options is geologic sequestration, in which carbon dioxide is injected into brine-saturated formations, unmineable coal seams, or depleted reservoirs of oil or gas. Because of concerns that injected carbon dioxide might leak back into the atmosphere, geologic sequestration has also stimulated new interests in the migration of underground fluids to the terrestrial surface.</br></br> Reservoir engineering simulations and other computations play a key role in predicting and evaluating the results of geologic sequestration field projects, in planning and interpreting laboratory experiments, and in designing multidisciplinary research programs. Accordingly, papers are solicited for this special session that address the latest ideas and progress in the development and use of computational methods for Geologic Sequestration of Carbon Dioxide. Relevant topics include computations from the basin or field scale, through the scale of laboratory measurements, down to the scales of flow through fractures and the fundamentals of flow through porous media. Studies of ongoing or planned field projects, multiphase flow, transport of chemical tracers, and chemically or biologically reactive transport are all appropriate, as are the modeling of interactive flow and geomechanical effects, and studies of the effects of sequestration on subsurface hydrology or the supply, quality, or disposal of surface waters.

Groundwater Optimal Management Session

Organiser: G. Karatzas, TU Crete (karatzas@mred.tuc.gr)</br></br> The main objectives of the present session are to include presentations that are related to the optimal management of groundwater quality and quantity and remediation. Beside the technical aspects emphasis should be given to the social and economical components of the problems. Related topics could be considered: Integrated methodologies of

management of surface waters and groundwater. Deterministic and stochastic approaches to groundwater quantity management problems. Deterministic and stochastic methodologies to solve groundwater quality management problems. Combination of numerical simulation and optimization techniques for the solution of groundwater management problems. Groundwater Remediation approaches such as pump-and-treat, air-stripping, bioremediation, phytoremediation, and reactive walls for the solution of groundwater quality problems. Uncertainty in the study of groundwater management problems The inverse problem for the determination of the contamination of groundwater management problems. Risk assessment and groundwater management. Field applications of new techniques related to optimal groundwater management.

Multi-Disciplinary Approaches To Reactive Transport Simulation In Aquifer Systems

Organiser: Steven F. Carle, Lawrence Livermore National Laboratory (carle1@llnl.gov)</br></br> Water managers have begun to realize the long-term links between water quality and quantity, surface water and groundwater interactions, and past and future human activities. There is increasing interest to improve application of reactive transport simulation to large-scale aquifer systems, which presents a multi-faceted theoretical and computation challenge.</br></br> The scientific problems are highly multi-disciplinary including conceptualization of hydraulic and biogeochemical heterogeneity; assessing the impact of the vadose zone; scaling of measurements, processes, theory, and computation; and improving efficiency and accuracy of theoretical and numerical algorithms.</br></br> Applications derive from a variety of reactive sources including non-point agricultural (e.g. pesticides, nitrate); point industrial (e.g. solvents, fuel, metals, and salts); use of treated sewage for recharge (e.g. viral, bacterial, and chemical residuals); radionuclide migration (e.g., waste disposal and underground nuclear tests); and natural (e.g. arsenic). This session emphasizes science and methods used to bridge multi-disciplinary challenges in creating realistic simulation of reactive transport processes at scales relevant to aquifer systems.

Pore-Scale Modelling: New Developments And Applications

Organiser: Mohammad Piri, Princeton University (mpiri@uwyo.edu) and Rink van Dijke, Heriot Watt University (rink@pet.hw.ac.uk)</br></br> By combining a description of the geometry of the pore space with the pertinent microscale physical and chemical processes, pore scale modelling is able to describe a wide range of phenomena in subsurface hydrology, including two- and three-phase flow, foam flow, non-Newtonian flow, dispersion, evaporation, precipitation, mass transfer, reactive transport and biological activity in porous media.</br></br> This session will be devoted to recent advances in this area: more accurate representations of the pore space through direct imaging, statistical reconstruction or process-based modelling; different methods to simulate flow and transport, including pore-network, lattice Boltzmann and particle tracking methods; derivation of threshold capillary pressures, hydraulic conductances and other intra-pore properties; comparison of pore-scale prediction with experiment for different porous media properties, such as relative permeability and dispersivity.

Multiscale methods for flow in porous media

Organiser: Knut-Andreas Lie</br></br> SINTEF ICT, Dept. of Applied Math.; P.O. Box 124, Blindern; NO-0314 OSLO, Norway email: Knut-Andreas.Lie@sintef.no</br></br> Natural porous formations are heterogeneous at all length scales and a large variety of length scales are used for modelling and measurement of various data types in the different subsurface disciplines. Currently, there is an increasing focus within reservoir description on integration of data and models from different disciplines to enhance the capabilities for analysis and interpretation. Increasing capabilities within time-laps seismic and computer modelling has enabled new options for data integration and accurate simulation. A current trend is

the so-called shared earth models that aim to provide correct and seamless integration of data, observations and interpretations from all specialists involved in the particular portion of the earth. If such models are to be used by all kind of subsurface specialists, they must provide model information on different length scales, for different purposes and with different spatial resolution, and most likely be accompanied with appropriate rescaling (up- and downscaling) techniques.</br></br> So far, rescaling techniques have mostly been devoted to upscaling of petrophysical and flow properties to accommodate flow simulations and has focused on the difference in scales between a geological model and a simulation model. Rescaling techniques are today needed for many other purposes, e.g., in connection with pore and core-scale modelling, data inversion, and seismic modelling, to name a few. Given the development outlined above, the whole concept of upscaling and downscaling therefore needs to be extended and, if possible, given a more sound mathematical foundation. For instance, there is currently no methodology that has been shown to perform well for the whole range of flow scenarios encountered in real reservoirs.</br></br> Multiscale methods may prove to be a good alternative to traditional upscaling methods. Multiscale methods reduce the computational complexity by incorporating fine-scale features into a set of coarse grid equations that are consistent with the local property of the differential operator.</br></br> This special session will address the use of multiscale methods to enhance our understanding of flow processes in heterogeneous porous media and show how the reduced computational complexity can offer new insight into the interplay of fine- and coarse-scale features. The talks will range from core-scale modelling to accelerated reservoir simulations and improved treatment of multiphysics phenomena in multiphase or multicomponent flow through porous media. The latter relates to the realisation that flow processes at different scales are governed by physical laws of a different character.

Modeling and managing coastal aquifers

Organiser: Aristotelis Mantoglou, Technical University Athens (mantog@central.ntua.gr)</br></br> To meet the freshwater demand of coastal and island regions, coastal aquifers are often intensively pumped causing saltwater intrusion. It is important to develop appropriate simulation models which combined with optimization methodologies can assist decisions regarding wise management of coastal aquifers.</br>The focus of this special session is on</br> Mathematical modeling of flow and seawater intrusion in coastal aquifers Sharp interface and variable density models and ranges of applicability Numerical solutions and computational aspects of coastal aquifer modeling System approximation with simpler models such as analytical solutions, neural networks, etc. Effects of spatial variability in coastal aquifers Inverse modeling and parameter estimation of coastal aquifers Coastal aquifer optimization combined with aquifer modeling Optimization methodologies based on linear and nonlinear programming, evolutionary algorithms, direct search methods, etc. Multi-objective optimization

Data assimilation in water resources modelling

Organiser: Henrik Madsen, DHI Denmark (hem@dhi.dk)</br></br> For sustainable water management it is essential to monitor, quantify and forecast the water resources by combined use of models and observations. Data assimilation allows to update model state variables and model parameters and to evaluate conceptual model descriptions when new data become available. The combination of modelling and observations can be used to monitor the hydrological system over time and, importantly, reduce the model prediction uncertainty. Data assimilation in water resources modelling has mainly been using in-situ measurements of hydrological variables, which are usually sparsely distributed in space. On the other hand, satellite remote sensing provides comprehensive spatial data, ideal for distributed modelling. New satellite platforms now provide data at previously unavailable spatial and temporal resolutions well suited for data assimilation in water resources modelling.</br></br> In this session contributions are invited that focus on applications and new theoretical developments of data assimilation in water resources modelling. This includes applications related to general process modelling studies as well as applications in operational, real-time forecast systems, considering both surface and groundwater modelling. Many of the theoretical and practical challenges of applying data assimilation in water resources modelling are related to the complex, non-linear nature and high-dimensionality of the numerical modelling systems. In addition, realistic

descriptions of model and measurement uncertainties are essential for the efficiency of the data assimilation procedure. Contributions are invited on new data assimilation algorithms that focus on these aspects.

Field measurements and simulations of land-atmosphere interaction

Organiser: Marc Parlange, Swiss Federal Institute of Technology Lausanne (Marc.Parlange@epfl.ch)</br></br> This broad session is open to presentations concerning the exchange of heat, mass and momentum at the land-atmosphere interface with particular focus on the development and application of instrumentation for field measurements, observations, new generation models and numerical simulations. Presentations concerning field measurments in support of the development of models for atmospheric turbulent flows (e.g. subgrid scale models for LES), new developments on flow over complex terrain (including plant canopies and urban environments), similarity theory of the atmospheric boundary layer, and flows under stable atmospheric stability are strongly encouraged. In addition technical developments in instrumentation and instrumentation physics that will allow the micrometeorology community to advance their science are most welcome.

Global Climate Change and Hydrologic Processes

Organiser: David Ahlfeld, University of Massachusetts Amherst (ahlfeld@ecs.umass.edu)</br></br> Global Climate Models (GCM) and Regional Climate Models (RCM) predict climate behavior under different forcing scenarios at decadal and century time scales with horizontal grid spacing at mid-latitude of 10's to 100's of km. Atmospheric and ocean modelers have traditionally played lead roles in the development of GCMs. In recent years, climate models have improved in their representation of physical processes, advanced with increased computational capabilities and proliferated as an increasing number of research groups develop models. These recent advances have brought anumber of research questions that have relevance to water resource modelers.</br></br> When GCM and RCM simulations of past climate are available, what are appropriate metrics for comparison between model results and hydrologic observations? How should hydrologic coupling between the atmosphere and land-surface be parameterized and associated scaling issues resolved? What role do deeper groundwater systems play in feedback to the atmosphere? It is apparent that human-induced climate change has begun and will continue, to some extent, regardless of mitigation measures that may be implemented.</br></br> At what spatial and temporal scale can current GCMs and RCMs provide predictions that are meaningful for assessing the impact of future climate change on regions? At what scales and with what level of certainty would predictions be needed for performing regional water resource planning? Papers are sought that address these and related questions.

Hydrogeophysical data fusion

Organiser: Andrew Binley, Lancaster University (a.binley@lancaster.ac.uk)</br></br>Geophysical methods have been widely used to support groundwater investigations for many years. Much of these established methods, however, offer only qualitative information about hydrogeological parameters and processes and during the 1990s a re-emergence of geophysics in hydrology occurred as attempts were made to provide more quantitative information about subsurface hydrology. The field hydrogeophysics emerged as a multi-disciplinary subject that focuses on the use of geophysical methods for characterising subsurface features, determining hydrogeological properties and monitoring processes relevant to soil and groundwater processes. Hydrogeophysical methods can allow, for example, large scale aquifer characterisation, previously unobtainable through conventional hydrogeological techniques. In addition, time-lapse deployment of appropriate methods can give useful insight into complex subsurface processes, aiding hydrological model development and the assessment of groundwater restoration strategies.</br></br> One of the key challenges in the field of hydrogeophysics is the fusion of geophysical data within a hydrological (conceptual or

numerical) model. Problems exist due to (1) the relationship between geophysical and hydrological properties is often poorly understood or (at best) subject to high uncertainty, (2) the resolution of properties within a geophysical image is often highly spatially variable and dependent on the property and geophysical modality, (3) the measurement support volume for a geophysical property is often significantly different from that of the hydrological variable under investigation, (4) the integration of multiple data sources within a formal framework that addresses data and model uncertainty is computationally demanding.</br></br> Despite these constraints, attempts have been made recently to formalise methodologies that will allow the fusion of multiple geophysical data sources and assist in constraining hydrological models of the subsurface. This session will address the challenges of such procedures, identify advances in theoretical and practical aspects of hydrogeophysical data fusion and document recent case studies where geophysical data have been integrated within a hydrogeological modelling framework.

Boltzmann Methods in Water Resources

Organiser: Mohamed Ghidaoui, Hong Kong University of Science and Technology (ghidaoui@ust.hk)</br></br> Boltzmann methods have recently attracted the interests of researchers in the water resources field. These methods are turning out to be both a conceptually satisfying and a numerically viable approach to modeling in the water resources field. Boltzmann methods can be broadly divided into Lattice Boltzmann (LB) and Boltzmann Battnager-Gross-Krook (BGK). The special session will be devoted to the merits of the LB and BGK approaches as well to comparison between the two methods.

Keynote speakers (reserved for keynotes only)

Reserved for keynote speakers