Preface

Coupled ecological–hydrological processes

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ABSTRACT

The papers in this issue represent a selection of the presentations made at the session entitled “Climate-soil and vegetation interactions in ecological–hydrological processes” of the European Geophysical Union General Assembly. The special issue “Coupled Ecological–Hydrological Processes” focuses on different aspects of Ecohydrology that can be summarized in the following topics: soil moisture dynamics, soil–plant interactions, vegetation modelling and effects of climate change on natural ecosystems. Copyright © 2010 John Wiley & Sons, Ltd.

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THE NATURE AND SCOPE OF THE SPECIAL ISSUE

The interrelationship between ecological and geophysical determinants of water balance is at the forefront of a number of outstanding issues. The water cycle is governed by complex and dynamic interactions and feedbacks between climate, soil and vegetation. These interactions regulate, across a wide range of scales, the patterns of vegetation and the exchange of mass, energy and momentum across the biosphere–atmosphere interface. The mechanisms by which the spatial and temporal patterns of hydrological fluxes arise from the physical linkages between soil, climate and vegetation are of central importance to surface hydrology. Similarly, the interactive manner by which spatial and temporal patterns of resource availability are manifested within various ecological systems observed in nature is a critical field open to the development of new theories in ecohydrology.

In recent years, ecohydrology has emerged as an interdisciplinary science that seeks to establish a bridge between ecology and hydrology. In establishing this bridge, the discipline seeks to link different aspects of the environmental sciences, dealing with surface hydrology, soil hydrology, hydraulics, hydrogeology, geophysics and ecology (e.g. Rodriguez-Iturbe, 2000; Eagleson 2002; Nuttle 2002; Rodriguez-Iturbe and Porporato, 2005). Given this wide range of linkages, it is understandable that researchers have suggested different and apparently contrasting definitions for this emerging discipline according to their personal vision. Despite some differences in vision, it is, nevertheless, crucial to underline that in order to advance as a discipline, ecohydrology must operate in interdisciplinary mode (Hannah et al., 2004).

This fast-growing science is expected to explain important problems related to natural processes and provide engineering solutions with reduced environmental impact. Moreover, understanding the basic processes of ecohydrology will lead hopefully to the development of tools for a more sustainable use of water resources and management of natural ecosystems.

This special issue stems from the need to stimulate and collect the most recent results in this field with a specific focus on bringing together modelling applications and experimental experiences. The papers have emerged from a recent session entitled “Climate-soil and vegetation interactions in ecological–hydrological processes” of the European Geophysical Union (EGU) General Assembly 2008. This has been a very successful event for the EGU, attracting a significant number of authors who represent probably a selection of some of the most active researchers in this field.

The special issue “Coupled Ecological–Hydrological Processes” focuses on different aspects of this discipline that can be summarized in the following topics: soil
moisture dynamics, soil–plant interaction, vegetation modelling and effects of climate change on ecosystems.

The first group of papers deals with field experiments aimed at the characterization of the hydrological water fluxes. In particular, Barnard et al. (2010) describe the outcomes of a steady-state irrigation experiment to quantify the relationships among soil moisture, transpiration and hillslope subsurface flow. The second experimental campaign is conducted in a semi-arid pine forest in Israel and describes the main components of the hydrological budget: precipitation, soil water content, evapotranspiration, tree transpiration, soil evaporation and intercepted precipitation (Raz Yaseef et al., 2010).

Modelling soil moisture and vegetation water stress is described in the following papers. Manfreda et al. (2010) investigate the effects of limited infiltration capacity of the soil on soil moisture dynamics and vegetation water stress. It is shown, in particular, that vegetation water stress is sensitive to infiltration process and this stress may increase in less permeable soil. Pumo et al. (2010) investigate the effects of potential climatic changes on the vegetation water stress of a Mediterranean ecosystem using a numerical ecohydrological model. Borgogno et al. (2010) use a dichotomic Markov process to describe the temporal evolution of vegetation water stress in different climatic and pedological conditions. From these analyses, they find, for example, that resistant species are favoured in relatively humid environments, while resilient shallow-rooted plants have an advantage in drier conditions.

The third group of papers deals with coupled physically based ecohydrological models. Bertoldi et al. (2010) analyse, using the ecohydrological model GEOtop, the role of the key parameter land surface temperature (LST) in a mountainous region. Results show that, for the humid climate considered in this study, the main factors controlling the spatial distribution of LST are the incoming solar radiation and land cover variability, with distinct thermal behaviour of grasslands and forests in north- and south-facing slopes. Cervarolo et al. (2010) introduce an ecohydrological model coupled with a three-dimensional description of the unsaturated zone for a more detailed description of the interactions between vegetation dynamics, subsurface flow processes and water and energy budgets. The model is used in order to understand the benefit of a three-dimensional schematization to enhance the comprehension of the reciprocal influences of soil moisture, water and CO$_2$ fluxes and vegetation dynamics. Finally, Tietjen et al. (2010) use an ecohydrological model of soil moisture and vegetation cover to investigate the response of different plant types under the effects of global climate change. Results show that two main factors control the response of plants towards a change in water availability and a change in water allocation to a specific plant type. Model results indicate that reduced competitiveness of grasses can lead to a higher risk of shrub encroachment in these systems.

REFERENCES


