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Preface

Towards holistic studies of the Earth's Critical Zone: hydropedology perspectives

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This special issue grew out of the *First International Conference on Hydropedology* held in July 2008 at The Pennsylvania State University in University Park, PA, USA and the symposium on "*The Earth's Critical Zone and Hydropedology*" held during the 33rd International Geological Congress in August 2008 in Oslo, Norway. This initiative was intended to stimulate integrated studies of hydropedology and its role in understanding the Earth's Critical Zone, which is defined as that part of the Earth from the vegetation top down to the aquifer bottom, with soil as its central juncture (NRC, 2001). The Critical Zone determines the availability of nearly every life-sustaining resource and provides the foundation for all human activities; hence, it is termed "critical". Emerging interests in the Critical Zone bring new momentum in revealing the secrets underfoot, embracing a focus on water as a unifying theme for addressing complex environmental systems, and taking a holistic approach towards integrating water with soil, rock, air, and biotic resources in the terrestrial near-surface environment. Soil is the fundamental control of the Critical Zone, as it is a living geomembrane through which water, solutes, energy, gases, solids, and living organisms dynamically interact with the atmosphere, biosphere, hydrosphere, and lithosphere to create a life-sustaining environment. Water is the agent that drives many of these interactions and the cycling of solutes and nutrients in the Critical Zone. The interaction of soil and water often dictates the interface between the biotic and abiotic factors in diverse ecosystems. Because of this critical role that soil and water play *together* in a wide array of environmental, ecological, geological, agricultural, and natural resource issues of societal importance, hydropedology has emerged in recent years as a viable interdisciplinary field of study that emphasizes *interactive* pedologic and hydrologic processes and their feedback mechanisms across space and time.

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After a rigorous peer-review process, 10 manuscripts have been accepted into this special issue. These papers cover a wide range of topics, which can be grouped into the following three categories:

1. *Fundamental concepts and future outlooks*: three papers fall in this category. The overview paper by Lin (2010) highlights the links between Critical Zone science and hydropedology and the opportunities for their synergistic advancements. Vepraskas et al. (2009) illustrate one of important future directions for hydropedology, namely quantifying the impacts of global change on land use. The paper by Li et al. (2009) demonstrates intimate relationships between belowground hydropedology and aboveground ecohydrology and their influence on soil moisture dynamics and hydrologic variability in desert shrubs.

2. *Applications of hydropedology principles*: three case studies from contrasting environments demonstrate the impacts of hydropedology on diverse ecosystems. Nordt and Driese (2009) provide a hydropedological assessment of a Vertisol climosequence across subhumid to humid climates in Texas Gulf Coast Prairie and quantify the formation of soil redoximorphic features as a function of rainfall level. Costantini et al. (2009) show that the diffusion of hydropedological models in precision viticulture in Central Italy could be boosted by considering salinity along with topography and soil hydrology. Barrett et al. (2009) examine the role of aquatic-

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terrestrial transition zones adjacent to streams and lakes in the Antarctic Dry Valleys as preferential zones for the transformation and transport of elements and solutes in an environment where geochemical weathering and biological activity in the soil is strictly limited by the dearth of liquid water.

3. *Soil architecture and hydrologic dynamics:* four papers in this category demonstrate the critical controls of soil architecture on hydrologic flow pathways and biophysical processes. de Jonge et al. (2009) present a road map that may serve as an inspiration for renewed and multidisciplinary focus on functional soil architecture and its constraints on biophysical processes. Through monitoring and analysis of major and trace elements, water isotopes, and dissolved organic carbon, Bestland et al. (2009) show the significance and lag-time of deep throughflow in a small, ephemeral catchment in South Australia that is a function of soil types. Zhu and Lin (2009) validate an effective means of detecting concentrated subsurface flow paths at various interfaces in soils over a large agricultural landscape in Pennsylvania using single-direction flow algorithm in GIS. Holländer et al. (2009) compare the conceptualization and parameterization of 10 different models in predicting discharge from the artificial Chicken Creek catchment in Germany using sparse soils data. The comparison indicates that the personal judgment of the modellers is a major source of the differences between model results and the most important parameters, which have to be estimated, are soil parameters and initial soil water content.

We are grateful to all the reviewers who donated their valuable time and professional insights to this initiative and helped to ensure the quality of all manuscripts submitted to this special issue. All these review comments and authors' responses, alongside with the original 15 manuscripts submitted, can be accessed online at http://www.hydrol-earth-syst-sci-discuss.net/special_issue37.html. We thank the Editors-in-Chief of *HESS*, especially Hubert Savenije, for his interest and support to publishing this special issue. Editorial assistance provided by Natascha Töpfer is also gratefully acknowledged.

We would like to note that, while this special issue has paid special attention to the role of water and its interaction with soil in the Critical Zone, a truly holistic study of the complex and dynamic Critical Zone requires expanded contributions from across scientific disciplines, including hydrology, soil science, geomorphology, geology, ecology, biogeochemistry, and many others. In addition, we believe that fostering a global alliance to monitor, map, and model the Critical Zone in a coordinated manner (see Lin, 2010) could help significantly to improve our capability to predict the behaviour and evolution of the Critical Zone in response to changing environments.

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