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Preface

"Water, climate, and vegetation: ecohydrology in a changing world"

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Ecohydrology has advanced rapidly in the past few decades. A search of the topic "ecohydrology" in the Web of Science showed an exponential growth of both publications and citations. The number of publications and citations increased from 7 and 6, respectively in 2000 to 65 and 1262 by 26 November 2012 (Fig. 1). Even with slightly different focus and definitions among scientists, ecohydrology is essentially a science dealing with the interactions between ecological and hydrological processes (e.g. Kundzewicz, 2002). Different from traditional hydrology, ecohydrology focuses more on the "eco-" component. Many recent ecohydrological studies have focused on the climate–soil–vegetation interactions in natural ecosystems (e.g. Rodriguez-Iturbe, 2000; D'Odorico et al., 2010; Miller et al., 2012). Changes in natural (e.g. droughts and floods) and anthropogenic (e.g. land use changes and population growth) drivers will undoubtedly affect hydrological cycles and water availability in all natural and managed ecosystems (Jackson et al., 2009). A better understanding of mechanism and consequence of changes in hydrological processes on ecosystems and societies will increase our ability to develop effective adaptation strategies to minimize the adverse effects of hydrological alternations (Vose et al., 2011). Ecohydrological science in both natural and human-dominated landscapes is therefore needed to help solve many of the immediate needs of modern environmental and resource issues, especially water and food shortages (Liu and Yang, 2010). We foresee that ecohydrologists will be increasingly called upon to address questions regarding vegetation and climate changes and their influence on water security at a range of spatial and temporal scales in the future.

This special issue is a product of three ecohydrology sessions at the 8th International Association of Landscape Ecology (IALE) World Congress in Beijing, 2011. The articles address recent advances in the understanding of the interactions among climate, water, biogeochemistry and land management practices, such as afforestation and ecological restoration. The spatial scales of these articles range from plot to regional scales. In particular, this special issue focuses on the following three aspects of recent advances in ecohydrological science:

1. New understanding of the consequences of anthropogenic activities (e.g. deforestation, water management) and climate change on water cycles, water quality and biogeochemical dynamics under various geographical and socioeconomical conditions. For example, Zhang et al. (2012) evaluated the effects of plantation expansion on streamflow regimes for 15 catchments in Australia, with sizes ranging from 0.6 to 1136 km^2. They showed that catchments with perennial streamflow showed relatively uniform reductions after plantation expansions, whereas catchments with ephemeral streamflow showed more dramatic reductions in low

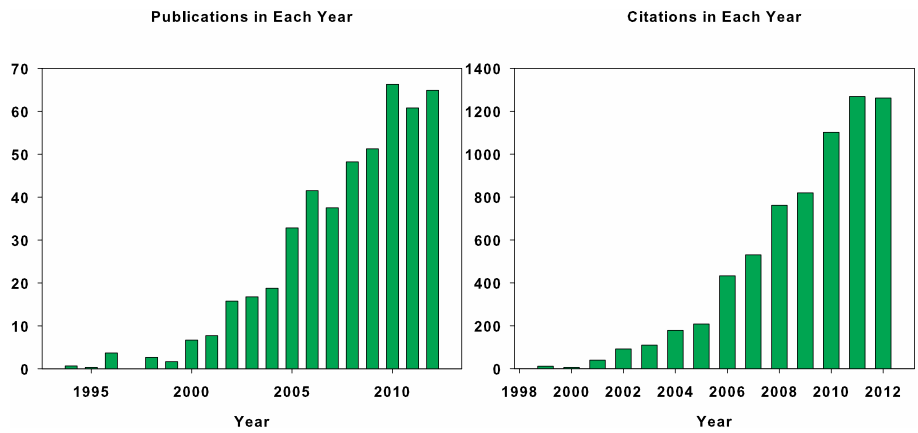

Fig. 1. The number of publications and citations based on the keyword "ecohydrology" from the Web of Science as of 26 November 2012.

flows. Wang et al. (2012) synthesized the critical issues in global drylands facing climate change such as population growth, agriculture and food security, desertification and bush encroachment, and discussed the development of research tools to address these critical issues. Meng et al. (2012) examined the impacts of the oasis interior heterogeneity on the oasis self-maintenance mechanism by using the mesoscale model and satellite observations. They concluded that the changes of oasis heterogeneity influenced the surface heat-flux partitioning. Z. L. Gao et al. (2012) analyzed the trends of streamflow, sediment load and their dynamic relations for the catchments in the middle reaches of the Yellow River during the past five decades. The authors identified three types of responses in streamflow, sediment load, and their dynamic relations for transition zone catchments, rocky mountain catchments and loess hilly-gully catchments. Using a monthly scale water balance model, Caldwell et al. (2012) evaluated the impacts of impervious cover, water withdrawals, and climate change on river flows in the conterminous US and showed integrated and spatially explicit modeling and management approaches are necessary to effectively manage water resources for aquatic life and human use under the influences of global change.

2. Advances in new tools in ecohydrological research, such as integrated simulation models, remote sensing, process-based models, isotopic methods, and eddy flux techniques. Zakharova et al. (2012) retrieved soil moisture and vegetation optical depth (VOD) by analyzing the results of Cooperative Airborne Radiometer for Ocean and Land Studies (CAROLS) air-borne L-band data. The high resolution data will be interesting for both hydrological and biogeochemical communities. G. Y. Gao et al. (2012) coupled the modified Soil Conservation Service curve number (SCS-CN) and Revised Universal Soil Loss Equation (RUSLE) models to simulate hydrological effects of restoring vegetation in the Loess Plateau of China. This study showed that antecedent moisture condition should be explicitly incorporated into the prediction of runoff production, and runoff should be included in predicting event based soil loss. Sutanto et al. (2012) evaluated multiple methods to partition evaporation into plant transpiration, soil evaporation and canopy interception using hydrometric measurements, modeling, and stable isotope analyses. Wang et al. (2012a) used the physically-based distributed hydrologic model, MIKESHE, to contrast a lumped calibration protocol that uses data measured at one single outlet to a multi-site calibration method which employed stream flow measurements at three separate stations within the large Chaohe River basin in northern China. They conclude that it is necessary to employ a multi-site calibration protocol to reduce prediction errors in order to account for the different hydrological processes of heterogeneous watersheds. Sun et al. (2012) examined the relationships between vegetation activities and ecosystem water balance (i.e. a growing season water deficit index) based on the Normalized Difference Vegetation Index (NDVI), and found that warming and water deficit exert counteracting controls on vegetation activity.

3. Case studies on the effects of environmental and anthropogenic perturbations on ecohydrological fluxes. For example, water footprint is an indicator of water consumption that includes both direct and indirect water use, and is defined as the total volume of freshwater used to produce the goods and services consumed by an individual or a community. Zeng et al. (2012) assessed the water footprint at a river basin level using a case study for the Heihe River Basin in northwest China. Zhang and Wei (2012) analyzed the cumulative effects of forest disturbance on streamflow in a large watershed in the central interior of British Columbia,

Canada. Their results showed that changes can occur in opposite directions in streamflow due to the complex interactions of forest disturbance and climatic variability. This study suggested an offsetting effect between the forest change and climate change, with the absolute influential strength of forest disturbance (increase in flow) overriding that from climate variability (decrease in flow). Yang et al. (2012) studied spatial variations of both shallow (0–2 m) and deep (2–8 m) soil moisture in the semi-arid loess hilly area, China. Soil moisture in deep soil layers was an important stable water resource for vegetation growth in this region and vegetation exerted a strong control on soil moisture dynamics. Their results suggested that vegetation growth conditions and slope gradients could be the key factors affecting the spatial variations in deep soil moisture. Zhao et al. (2012) applied a new soil loss evaluation index to the Yanhe watershed in China's Loess Plateau and compared it with the traditional RUSLE method to estimate soil erosion. Based on these analyses, they could locate the major soil erosion areas for land use planning purposes. Applications of the basic theories developed at a small watershed scale to a regional scale to evaluate the effect of land cover change on water resources remain challenging due to the complex interactions of vegetation and climatic variability. Feng et al. (2012) evaluated the effects of vegetation restoration on water yield across the Loess Plateau region in northern China. They found variable effects of restoration on local water resources across the region and emphasized the importance of considering the influences of spatial climate variability and long-term climate change on water yield. Zang et al. (2012) assessed spatial and temporal patterns of green (e.g. rainfall and water vapor) and blue water (e.g. lake and river water) flows in inland river basins in northwest China, providing crucial information for formulating reasonable water policies to improve water resource management in this region. Wang et al. (2012b) measured soil moisture dynamics and estimated evaporation of five land cover types in the Loess Plateau in northern China. This short study offered new insight into the complex interactions between water use, rainfall, soil water, and land use patterns in a complex terrain. Cui et al. (2012) summarized various studies on forest changes and hydrology at both forest stand and watershed scales in the upper reaches of Minjiang River, Yangtze River Basin. Their review suggests that historic forest logging or land cover changes have caused significant water yield increases due to the reduction of forest evaporation caused by removal of forest vegetation at both spatial scales. The study indicates that the hydrological effects of forest harvesting or land cover changes can be as important as those caused by climate change.

The majority of the papers in this volume were derived from studies in the drylands where water stress is the most obvious and the ecosystems are the most vulnerable to global changes. However, the articles reflect the rapid development in all aspects of ecohydrological sciences across several continents. More importantly, these studies raise awareness of the impacts of various climate change components on ecohydrological processes. It is our hope that readers will find new tools, findings, and insights for understanding ecological and hydrological processes that will help address emerging environmental issues in a changing world.

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