Ecological Processes

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Preface for the article collection "Ecohydrological Processes and Ecosystem Services"

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Water is essential to life on Earth. Ecohydrology, the study of interactions between ecological and hydrological processes, is fundamental to our understanding and quantification of services provided by ecosystems. Our knowledge of ecohydrology is incomplete due to the complex nature of ecosystems, which are constantly changing under multiple stresses from air pollution to climate change, from deforestation to urbanization, and from soil erosion to soil pollution. Ecosystem services, the goods and services that ecosystems provide for human well-being, are increasingly adopted as a framework worldwide for ecological restoration and conservation, watershed management, and sustainable development policy making. Therefore, linking ecohydrological processes (e.g., evapotranspiration, streamflow, groundwater recharge) to ecosystem services (e.g., carbon sequestration, water quality improvement, biodiversity conservation, heat island mitigation) is critical to the advancement of ecological science and ecosystem restoration at multiple scales, from a single species to the entire globe. This special issue includes ten articles that aim at addressing questions in the following research areas:

- Ecohydrological recovery processes in degraded territorial or aquatic ecosystems coupling processes and balances of water, carbon, and energy fluxes in natural or managed ecosystems
- Ecohydrological projections of ecosystem responses to climate change, land use change, and other human disturbances (e.g., wildland fires, urbanization)
- Advances in understanding the links between ecohydrological processes and ecosystem services under different environmental and socioeconomical settings.

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The first review paper by (Sun et al. 2017) provides a synthesis of current literature on water-related ecosystem service studies and illustrates the importance of understanding the ecohydrological processes for accurately quantifying ecosystem services under different environmental and socioeconomic settings and scales. The study identifies research gaps suggesting that future ecohydrological studies need to better account for the scaling effects of natural and anthropogenic stressors and future studies should focus on the bidirectional interactions between hydrological functions and services and human actions. A second review paper by Coble et al. (2017) examines the published literature on drought vulnerability including drought tolerance and sensitivity of Northeastern US forests under a changing climate. The authors conclude that it is important that trees have multiple unique traits to prevent hydraulic failure and depleted carbon reserves that may lead to mortality. The third review paper by Owuor et al. (2016) examines the effects of land use and land cover (LULC) on groundwater recharge and surface runoff for 27 studies in semi-arid tropical and tropical environments. The authors report that limited experimental studies show that bare land rehabilitation reduces groundwater recharge and surface runoff. The authors identify an urgent need to increase ecohydrological studies in the study regions where the pressure of growing human population and climate change on water resources is increasing.

Understanding the ecohydrological effects of vegetation management on surface and groundwater resources is important to evaluate ecosystem services of these management practices. Gribovszki et al. (2017) quantify groundwater use by different tree covers and discuss its consequences on soil surface slat accumulation in the great Hungarian plain. The authors conclude that hybrid poplar was slightly less favorable than native oak in terms of salt accumulation concerns. However, they caution that greater groundwater uptake by trees over longer timescales could cause more significant salt accumulation under severe drought conditions due to climate change. Eucalyptus expansion in central Ethiopia represents a major land use/land cover change causing controversy regarding its potential ecological effects. In response, Jaleta et al. (2017) conducted a study to evaluate effects of three land uses/land covers including cultivated land, grassland, and *Eucalyptus* woodlot on surface runoff in the Meja River watershed, central Ethiopia. The authors conclude that expansion of Eucalyptus on grassland may not have significant impact on surface runoff, but if it is planted on previously farmland surface runoff may be reduced. In addition to non-market ecosystem services such as biodiversity, support for ecosystems, habitat for plant and animal life and social services, streams provide important market ecosystem services such as storm drainage. Zhu et al. (2018) investigated the impacts of hydrological modification in an urban stream and demonstrated that a new bridge built to reduce flood risk also decreased macroinvertebrate biodiversity and water quality of the stream. At a watershed scale, hillslopes provide a critical role in controlling soil erosion control and regulating storm flow. Hallema et al. (2016) apply the geomorphologic unit hydrograph (GIUH)-based model to hypothetical hillslopes to show that the spatial organization of the channel network is critical in quantifying the flow characteristics and that topographic attributes are key to accurately represent hydrologic connectivity. Ecohydrological processes are projected to change dramatically under a changing climate and air pollution. Using a biogeochemical and ecohydrological simulation model (MART2), Kros et al. (2016) quantify the potential effects of the soil pH and nitrate (NO_3), and groundwater hydrology, on the vegetation dynamics of the Netherlands in response to changes in atmospheric nitrogen (N) and sulfur (S) deposition and groundwater level over the period 1990–2030. The study suggests that reductions in N and S deposition and an increase in groundwater level between 1990 and 2030 caused minor changes in soil pH, but a significant increase in plant diversity.

Drought frequency and intensity is expected to increase under a changing climate. Thus, drought has been increasingly recognized as a major disturbance threat to ecosystems. It becomes important to understand both short-term and long-term accumulative drought impacts. However, meaningfully characterizing droughts for resource management remains elusive in many cases. Flint et al. (2018) examine the recent drought and recovery in the state of California using two different drought indices (one for natural water supply and one for landscape water stress) developed from water balance modeling. They conclude that warm droughts recover much more slowly than short very dry droughts. Ahmed et al. (2017) examine the interconnections between the long-term rainfall variation and the rangeland Water Requirement and Satisfaction Index (WRSI) in Ethiopia. The researchers conclude that annual rainfall anomaly is a major control on WRSI and the future rainfall variability is expected to increase in the next 100 years. The authors recommend establishment and implementation of early warning systems to reduce the likely impacts on rangeland productivity.

In summary, water is central to the framework of ecosystem service for practical applications in solving environmental issues in the twenty-first century. This special issue presents basic principles and case studies around the world that show the importance of understanding ecohydrological processes and better assessing ecosystem services. We hope these papers may stimulate further discussion on mechanically understanding how ecological processes interact with ecosystem functions and services so better models may be developed to serve land managers and society.

Authors' contributions
All authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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