High Impact Publication Selected for Special Recognition in 2020

Unit: Forest Resources and Conservation **PDF Download(s):** Publication

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Publication Impact: Groundwater supports crucial ecosystems around the world, including riparian zones, meadows, lakes, and wetlands, and represents ~40% of the world's freshwater resources. Besides serving domestic, industrial and agricultural needs, groundwater also underpins ecosystem goods and services essential for human welfare. However, groundwater's influence on ecosystem services have often been ignored or oversimplified in both global assessments and local planning studies. In particular, current knowledge on interactions, nonlinearities, and feedbacks between groundwater and a suite of services related to food, water, energy and biogeochemical processes in a changing climate remain limited. In fact, most large-scale initiatives (e.g., Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) for quantifying and predicting ecosystem services lack explicit considerations of groundwater influences, potentially leading to systematic bias. Addressing these knowledge gaps is crucial for achieving food and water security as outlined in the United Nations Sustainable Development Goals, advancing our predictive capacity of ecosystem service dynamics in a non-stationary future, and thus informing environmental policy and decisions. Focusing on an urbanizing agricultural watershed exemplary for many human-dominated landscapes globally, this study investigate groundwater's influences on eight ecosystem service indicators: recharge and overland flow; sediment, nitrogen, and phosphorus fluxes; crop and grass yield; and carbon storage. Our results demonstrate nonlinear and threshold effects of groundwater, with food production, water quality and quantity, and flood control most sensitive to groundwater. Climate also mediates groundwater effects, with especially strong responses under dry and wet climate conditions. Across landscapes, there is substantial spatial heterogeneity in groundwater influences, driven by water table depth and sensitivity to soil texture and land cover. Most ecosystem services respond nonlinearly to groundwater availability, and are most affected when water table depth is within a critical threshold of ~2.5-m. At local scales, groundwater effects for most services can reach up to 100%, highlighting that local ecosystem service management may need to realistically account for groundwater to target interventions for the desired return and to avoid interventions producing minimal service. This study illuminates the underappreciated role of groundwater in sustaining multiple ecosystem services, and highlights the pressing need to account for groundwater in the assessment, management and policy for ecosystem services. This research underscores the importance of groundwater resources in agriculture sustainability, and suggests that conserving groundwater is a key mechanism to enhance ecosystem service resilience to future climate extremes and increased climate variability. These findings are timely, given that groundwater depletion has been accelerating worldwide, posing a major sustainability challenge to our nature and society. The lessons learned will be applicable in similar watersheds around the world, and will be especially relevant for Florida landscape, given the high water table in many regions that are susceptible to future climate changes like climate extremes and sea level rises. This interdisciplinary research cuts cross sustainability issues related to agriculture and food security, climate change, hydrology, and ecosystem service, and is of relevance to research, policy, education, and management communities. It has also garnered attentions through avenues such as news reports, media, press release and social media.