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Editorial: Water-related ecosystems in drylands: water dynamics, carbon storage and resilience to climate change and human actions

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Editorial on the Research Topic

[Water-related ecosystems in drylands: water dynamics, carbon storage and resilience to climate change and human actions](#)

Introduction

Water-related ecosystems (WRE) are vital for biodiversity and human life, providing essential services such as water purification, flood mitigation, and carbon storage. Despite being defined by water scarcity in drylands, these landscapes host a diverse array of aquatic and semi-aquatic features, including wetlands, rivers, ponds, marshes, oases, and groundwater-dependent. These ecosystems are under threat, especially by human activities and climate change, with over 50% of wetlands degraded in some regions (UNEP-United Nations Environment Programme, 2024). With modern observation tools, science shows various opportunities for optimizing water resource use that require innovation and investment to support agriculture, human consumption, and land health. Efforts to rehabilitate these regions often involve both passive measures, such as land conservation to allow natural regeneration, and active measures like tree planting to restore ecological balance (Yirdaw et al., 2017). However, further investigating the responses of water-related ecosystems to climate change, particularly the increase in the frequency, severity, and extent of extreme events, will enhance the adaptation strategies and facilitate decision-making processes at national or regional levels. There are literally no climate-smart solutions (e.g., climate services, soil water and conservation practices, rainwater harvesting, etc.) without a crucial role of managing water resources in drylands.

Selected from a rigorous process, the nine papers in this research topic provide an overall view of efforts being done toward the achievement of the SDG target 6.6. Collectively, the scientific insights demonstrate that dryland WRE are ecologically dynamic, highly sensitive to climate and human pressures, and measurable with increasingly accessible tools. More importantly, they offer practical pathways toward monitoring, restoration, and adaptive governance.

Overview of the published contributions

The first group of papers focuses on diagnosis. The Lake Guidimouni study in Niger (Karimou Barké et al.) combines a DPSIR-GIS framework with participatory mapping to reveal a striking transformation: nearly 80 ha of irrigated cropland were converted to invasive *Typha* grassland under hydrological stress, with clear response strategies proposed. The Ecuador study on the Chongón–El Azúcar water transfer system (Martínez-Angulo et al.) uses Sentinel-2 and Random Forest to document over 1,200 ha of tropical dry forest lost within a few hundred meters of the transfer canal, offering empirical support for ecological buffers and spectral early-warning thresholds.

A second group addresses resilience and biological indicators. The Panlaung River Basin study (Tun and Ho) in Myanmar introduces a multidimensional Ecosystem Resilience Index (structural, functional, compositional). It shows that functional resilience declined persistently after 2014, while structural recovery lagged years behind apparent vegetation green-up, a critical warning for post-disturbance assessments. The Peru study (Salcedo-Quiroz et al.) demonstrates that aquatic macroinvertebrates detect degradation where water chemistry alone shows no significant differences, providing a low-cost biomonitoring alternative for arid data-poor regions.

Carbon storage is the focus of two coastal contributions. The Senegal seagrass study (Diallo et al.) uses Sentinel-2, Landsat 9, and logistic regression to produce an operational probability map for seagrass beds, achieving 81% accuracy and providing a replicable West African framework for blue carbon assessment. The Saudi Arabia mangrove study (Dhawi et al.) tests five soil amendments and finds that peat moss plus microbial consortia, combined with tidal proximity, significantly improves *Avicennia marina* survival in hyper-saline sabkha, an evidence-based restoration protocol for arid coasts.

Two methodologically focused papers address measurement fidelity. The non-perennial stream study (Bao et al.) quantitatively compares UAV-SfM, machine-learning models, and smartphone LiDAR. UAV-SfM remains the most accurate (elevation error ~4 cm), while cheaper alternatives introduce substantially larger errors that propagate through hydraulic and biogeochemical calculations. The Jinchang City groundwater study (Shang et al.) uses an optimized random forest model to identify over-exploitation as the dominant driver of a 2.26-m water level decline over 6 years, with falling water tables concentrating solutes and degrading water quality—a feedback loop often ignored in water management.

Finally, the Central Asia study (Jiang et al.) scales up to continental analysis, finding that vegetation climate sensitivity has declined across 82% of vegetated areas over 40 years, driven by warming and CO₂. This unexpected decoupling of vegetation from climate variability complicates future projections but also raises the possibility that dryland ecosystems are entering unfamiliar regimes where historical relationships no longer hold.

Conclusion

The nine papers in this Research Topic, *Water-Related Ecosystems in Drylands: Water Dynamics, Carbon Storage and Resilience to Climate Change and Human Actions*, advances the field substantially. They demonstrate that researchers in dryland regions, from Niger to Myanmar, from Peru to Saudi Arabia, and to China, are not passive observers of WRE degradation. They are developing robust, transferable, and increasingly quantitative methods for diagnosing vulnerability, mapping change, and designing interventions. This Research Topic brings various evidences for options to improve water management, increase the biomass, and ensure sustainable management at the environmental, social, and economic transformation. The editorial team hopes that these nine contributions will serve as both a resource and an inspiration for the upcoming research on dryland WRE toward the achievement of the SDG target 6.6 by 2030.

Author contributions

AD: Conceptualization, Validation, Writing – original draft, Writing – review and editing. EP: Conceptualization, Validation, Writing – review and editing. MS: Conceptualization, Validation, Writing – review and editing. CM: Conceptualization, Validation, Writing – review and editing.

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