frontiers | Frontiers in Forests and Global Change

TYPE Editorial
PUBLISHED 10 March 2025
DOI 10.3389/ffgc.2025.1579133

OPEN ACCESS

EDITED AND REVIEWED BY
Frank Hagedorn,
Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Switzerland

*CORRESPONDENCE
Youjin Yan
✉ yyj_erosion@163.com
Quanhou Dai
✉ qhdairiver@163.com
Fengling Gan
✉ ganfengling@cqnu.edu.cn
Xi Zhang
✉ xizhang.soil@gmail.com

RECEIVED 18 February 2025
ACCEPTED 25 February 2025
PUBLISHED 10 March 2025

CITATION
Fan Y, Yan Y, Gan F, Dai Q and Zhang X (2025) Editorial: Understanding the relationship between extreme climate events and forest soil hydrology: implications for ecosystem functions.
Front. For. Glob. Change 8:1579133.
doi: 10.3389/ffgc.2025.1579133

Editorial: Understanding the relationship between extreme climate events and forest soil hydrology: implications for ecosystem functions

Yuchuan Fan[1], Youjin Yan[2]*, Fengling Gan[3]*, Quanhou Dai[4]* and Xi Zhang[5]*

[1]College of Jiyang, Zhejiang A&F University, Zhuji, China, [2]College of Forestry, Nanjing Forestry University, Nanjing, China, [3]Chongqing Key Laboratory of Surface Process and Ecological Restoration in the Three Gorges Reservoir Area, Chongqing Observation and Research Station of Earth Surface Ecological Process in the Three Gorges Reservoir Area, Karst Research Team, Chongqing Key Laboratory of Carbon Cycle and Carbon Regulation of Mountain Ecosystem, School of Geography and Tourism Science, Chongqing Normal University, Chongqing, China, [4]Institute for Forest Resources & Environment of Guizhou, Key Laboratory of Forest Cultivation in Plateau Mountain of Guizhou Province, College of Forestry, Guizhou University, Guiyang, China, [5]Biosystems Engineering and Soil Science Department, University of Tennessee, Knoxville, TN, United States

KEYWORDS

forest soil hydrology, extreme climate events, ecosystem functions, carbon cycling, sustainable forest management

Editorial on the Research Topic
Understanding the relationship between extreme climate events and forest soil hydrology: implications for ecosystem functions

1 Introduction

The accelerating pace of global warming and the associated rise in the frequency and intensity of extreme climate events have brought unprecedented challenges to ecosystems worldwide. Forest soils, a cornerstone for biodiversity preservation, carbon sequestration, and ecosystem stability, are particularly sensitive to these climatic changes. Rising temperatures, coupled with severe events such as prolonged droughts, intense rainfall, and wildfires, have disturbed forest soil hydrological processes, influencing solute transport, nutrient cycling, and carbon storage.

The increasing urgency to understand and address these issues has motivated this Research Topic: "*Understanding the Relationship between Extreme Climate Events and Forest Soil Hydrology: Implications for Ecosystem Functions*." This Research Topic seeks to unravel the complex interactions between forest soil hydrology and ecosystem functions under extreme climate conditions and to explore the role of sustainable management strategies, such as afforestation and ecological restoration, in mitigating these impacts. Contributions in this Research Topic represent an important step toward enhancing our understanding and management of forest ecosystems in a warming world.

1.1 Climate factors and forest soil nutrients

Du et al. conducted a meta-analysis exploring the spatial variation of soil nutrients in natural and planted forests under changing climatic conditions. The study emphasizes that climate factors, particularly mean annual temperature and precipitation, are dominant drivers of soil nutrient variability. The authors found that natural forests exhibit higher phosphorus availability and lower pH compared to planted forests, underscoring the importance of forest type in modulating nutrient responses to climate change. This research highlights the need for differentiated soil management strategies for natural and planted forests (Du et al.).

1.2 Carbon sink stability in terrestrial ecosystems

Zhou et al. investigated the dynamics and stability of carbon sinks in China's terrestrial ecosystems under future climate scenarios. Using advanced modeling approaches, the authors identified vapor pressure deficit and temperature variability as key factors influencing carbon sink stability. Their findings reveal that although carbon sink capacity may increase, its stability could be undermined in regions experiencing frequent extreme climate events. This study underscores the importance of adaptive carbon management policies (Zhou et al.).

1.3 Soil organic carbon stability in Karst areas

He et al. reviewed the stability of soil organic carbon (SOC) in Karst ecosystems, which are characterized by unique geological features and particularly high vulnerability to climate extremes. The review discusses how factors such as rocky desertification, shallow soils, vegetation restoration, and land use changes influence SOC stability. By elucidating these mechanisms, the study provides valuable guidance for the ecological rehabilitation and management of degraded Karst ecosystems (He et al.).

1.4 Carbon storage in *Larix gmelinii* forests

Zhao, Yue, et al. analyzed carbon storage dynamics in *Larix gmelinii* forests in Daxing'anling, China. The study revealed that carbon storage transitions from being soil-dominated in younger forests to tree biomass-dominated in older forests. These findings highlight the importance of forest age and structural characteristics

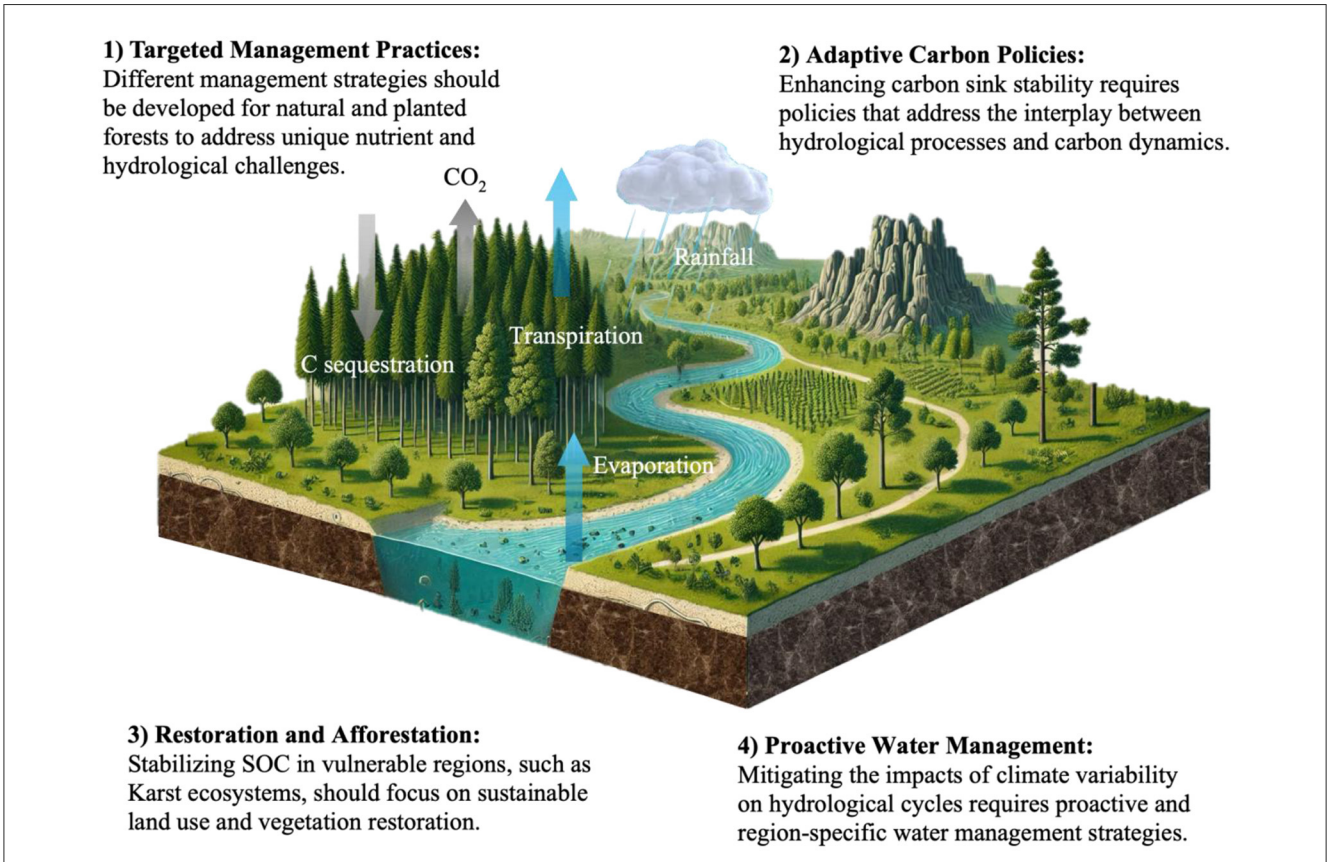

FIGURE 1
A conceptual figure of forest management implications from the collective articles.

in determining patterns of ecosystem carbon storage, offering insights into optimizing forest carbon sequestration strategies under varying climatic conditions (Zhao, Yue, et al.).

1.5 Hydrological processes in the Genhe River Basin

Zhao, Qin, et al. examined the hydrological processes of forest, grassland, and farmland ecosystems in the Genhe River Basin, a critical ecological region in northern China. Using the Soil and Water Assessment Tool (SWAT), the study demonstrated how land use changes and climate variability influence key hydrological processes, including runoff, evapotranspiration, and soil water content. The findings provide actionable insights for water resource management and ecological protection in regions experiencing rapid environmental changes (Zhao, Qin, et al.).

2 Implications for forest management

The studies presented in this Research Topic collectively emphasize the need for integrated forest management strategies to address the challenges posed by extreme climate events (Figure 1). Key recommendations include: (1) Targeted management practices: different management strategies should be developed for natural and planted forests to address unique nutrient and hydrological challenges. (2) Adaptive carbon policies: enhancing carbon sink stability requires policies that address the interplay between hydrological processes and carbon dynamics. (3) Restoration and afforestation: stabilizing SOC in vulnerable regions, such as Karst ecosystems, should focus on sustainable land use and vegetation restoration. (4) Proactive water management: mitigating the impacts of climate variability on hydrological cycles requires proactive and region-specific water management strategies.

3 Conclusion

This Research Topic sheds light on the intricate relationships between forest soil hydrology and ecosystem functions under extreme climate conditions. By addressing these complex interactions, the studies provide a robust foundation for developing resilient forest ecosystems capable of sustaining their critical functions in a changing climate. We hope this Research Topic inspires continued interdisciplinary research and collaboration among scientists, policymakers, and forest managers to safeguard forest ecosystems and their invaluable services.

Author contributions

YF: Writing – original draft, Writing – review & editing. YY: Writing – original draft, Writing – review & editing. FG: Writing – review & editing. QD: Writing – review & editing. XZ: Writing – review & editing.

Acknowledgments

We extend our gratitude to all the authors, reviewers, and editors who contributed to this Research Topic. Their dedication has been invaluable in advancing our understanding of forest soil hydrology under climate extremes.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note