frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 09 December 2025
DOI 10.3389/fenvs.2025.1743208

OPEN ACCESS

EDITED AND REVIEWED BY
Lalisa A. Duguma,
Global Evergreening Alliance, Australia

*CORRESPONDENCE
Tianjiao Feng,
fengtianjiaobest@sina.cn

RECEIVED 10 November 2025
REVISED 24 November 2025
ACCEPTED 27 November 2025
PUBLISHED 09 December 2025

CITATION
Feng T, Hu P and Zhu H (2025) Editorial: Ecosystem services and sustainable restoration interlinking soil, geological, and vegetation interactions for sustainable development. *Front. Environ. Sci.* 13:1743208. doi: 10.3389/fenvs.2025.1743208

Editorial: Ecosystem services and sustainable restoration interlinking soil, geological, and vegetation interactions for sustainable development

Tianjiao Feng[1,2]*, Pengcheng Hu[3] and Huoxing Zhu[4]

[1]Key Laboratory of Mine Ecological Effects and Systematic Restoration, Ministry of Natural Resources, Beijing, China, [2]School of Soil and Water Conservation, Beijing Forestry University, Beijing, China, [3]Department of Agriculture and Food, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Canberra, ACT, Australia, [4]Guangdong Provincial Key Laboratory of Applied Botany, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, China

KEYWORDS

environmental science, ecosystem services (ES), soil hydrology, geological attribute, sustainable development goals-SDGs

Editorial on the Research Topic
Ecosystem services and sustainable restoration interlinking soil, geological, and vegetation interactions for sustainable development

1 Introduction

The restoration of ecosystems is increasingly critical in the context of global environmental and ecological challenges. As the world faces the growing impacts of climate change and land degradation, restoring ecosystems to enhance their services—such as water regulation, carbon sequestration, and biodiversity—is paramount. This Research Topic explores the interrelations between geological attributes, soil properties, and vegetation in ecosystem restoration, focusing on how these interactions influence ecosystem services and contribute to sustainable development goals (SDGs). Specifically, SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 15 (Life on Land) are particularly relevant as they align with the goals of enhancing water management, mitigating climate change, and restoring terrestrial ecosystems. Through examining empirical research and integrating findings from diverse geomorphological conditions, the articles in this Research Topic offer novel insights into enhancing ecosystem resilience and advancing ecosystem-based solutions for water and land management.

Ecosystem restoration offers a pathway to address multiple environmental issues simultaneously, particularly in regions affected by overexploitation, desertification, and deforestation. By understanding how soil, geology, and vegetation interact, researchers can design more effective restoration strategies that improve ecosystem functions and contribute to climate adaptation and the achievement of SDGs. The studies included in

this Research Topic emphasize the need for interdisciplinary approaches that combine ecological, hydrological, and geological knowledge. They provide critical insights into how restoration practices can enhance ecosystem services, improve land and water management, and ultimately support the achievement of sustainable development goals in the face of global environmental stressors.

2 Soil-plant interactions in ecosystem restoration

Soil-plant interactions are fundamental to ecosystem restoration, as they influence nutrient cycling, water retention, and plant growth. Soil properties such as texture, organic matter content, and moisture availability directly impact vegetation health, which in turn affects ecosystem functions. Feng et al. analyzed how long-term vegetation restoration in the Loess Plateau influenced soil hydrological functions and highlighted the role of soil moisture in sustaining restored vegetation. Similarly, Shao et al. found that different restoration methods in arid regions significantly enhanced soil water retention, which improved vegetation growth and ecosystem stability. These studies underscore the importance of soil-plant interactions in ecosystem restoration and their broader implications for land and water management.

3 Technological advances in ecosystem monitoring

Advances in monitoring technology have revolutionized our ability to assess and manage ecosystems. Remote sensing, GIS, and hydrological modeling tools enable more precise tracking of vegetation dynamics, soil moisture, and overall ecosystem health. Yue et al. used advanced spatial analysis to measure the impact of photovoltaic panels on soil properties in desert ecosystems, providing critical data for ecological restoration efforts. Cheng et al. also utilized remote sensing technology to study the influence of vegetation characteristics and soil properties on ecosystem dynamics in tropical forests. These innovations not only improve our understanding of ecosystem processes but also enhance the effectiveness of restoration strategies.

4 Biogeochemical processes and carbon sequestration

Biogeochemical processes are essential for understanding how ecosystems recover and enhance their ability to sequester carbon. This is particularly important in the context of climate change, as restored ecosystems can contribute to mitigating carbon emissions. Zhang et al. found that soil carbon and nitrogen changes due to soil particle redistribution in photovoltaic arrays influenced soil fertility and carbon sequestration potential. In a similar study, Zhang et al. investigated the role of vegetation restoration in improving soil organic carbon storage in degraded landscapes. These studies highlight the significant role of biogeochemical processes in carbon cycling and their potential for enhancing ecosystem services related to climate change mitigation.

5 Ecosystem services and water management

Effective water management is a critical aspect of ecosystem restoration, particularly in regions affected by droughts and water scarcity. Restoration practices that enhance water regulation, such as reforestation and wetland restoration, can help restore the hydrological cycle and mitigate the impacts of climate change. Ma et al. demonstrated that moderate grazing promotes plant diversity and increases grassland water retention in the Qinghai-Tibet Plateau, which is crucial for sustainable water management. Similarly, Ma et al. assessed the role of vegetation restoration in improving water yield in China's arid regions. Collectively, these studies underscore the importance of integrating ecosystem-based water management strategies in restoration efforts.

6 Conclusion

The research presented in this special issue collection highlights the critical connections between soil, geology, and vegetation in the restoration of ecosystems and the enhancement of their services. From improving water retention and carbon sequestration to advancing ecosystem monitoring and management strategies, these research findings offer valuable insights into how ecological restoration can contribute to sustainable development goals. Restoration is a complex and multifaceted process, and a one-size-fits-all approach is unlikely to be effective. Ecosystem restoration requires a holistic approach that incorporates local geological, soil, and vegetation conditions, as well as socio-economic factors, to ensure long-term success. These studies reinforce the need for interdisciplinary strategies to tackle the diverse challenges of ecosystem restoration and to achieve lasting improvements in ecosystem services.

Author contributions

TF: Writing – original draft, Writing – review and editing. PH: Writing – review and editing. HZ: Writing – review and editing.

Funding

The authors declare that financial support was received for the research and/or publication of this article. This study was funded by the open Fund of Key Laboratory of Mine Ecological Effects and Systematic Restoration, Ministry of Natural Resources (No. MEER-2025-08), the National Natural Science Foundation of China (No. 42371114), the Fundamental Research Funds for the Central Universities (QNTD202508).

Conflict of interest

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

Generative AI statement

The authors declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note