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# Editorial: Soil carbon stability in forests in response to global change scenarios

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Editorial on the Research Topic
Soil carbon stability in forests in response to global change scenarios

Forests cover about 30% of the Earth's terrestrial surface and are the largest carbon (C) reservoir in terrestrial ecosystems, storing ∼662 Pg C based on Global Forest Resources Assessment 2020. Over 45% of this C is stored in soils. Even minor fluctuations in soil C can lead to substantial changes in atmospheric $CO_2$ concentrations in the long run. Thus, soil C stability is not only crucial to the forests' ability to sequester C but also for our efforts in mitigating climate change. It is imperative to scrutinize the interaction between forest soil C stability and various global change factors to accurately assess the C sequestration potential in forests.

An expanding body of research has introduced diverse perspectives, concepts, and hypotheses concerning soil C stabilization. However, our quantitative understanding of these processes remains unclear, as soils act as a "black box," and the response of soil C stability to global change scenarios (e.g., N deposition, land-use change, and climate change) remain ambiguous. Under increasing global change pressure, it is crucial to investigate the direction and magnitude of changes in forest soil C. Many questions persist regarding the mechanisms that drive soil C stabilization in response to these global change factors, including the relationships between labile and recalcitrant C fractions and the interplay between biotic and abiotic processes in C stabilization or mineralization under these scenarios.

Given the above considerations, this Research Topic has been curated to offer a comprehensive synthesis of the current concepts and knowledge concerning the effects of various global change scenarios on forest soil C stabilization. It specifically aims to elucidate the magnitude of key processes and the underlying mechanisms (physical, chemical, and/or biotic) that drive soil C stabilization. Among the six articles constituting this Research Topic, one delves into the effects of nitrogen (N) deposition, three examine land-use change (forest restoration), one addresses the combined impacts of climate change and land-use change, and another explores the microbial mechanisms underpinning soil organic C stability.

In a 3-year experimental study, Chen et al. investigated the impact of N deposition on C and N characteristics within soil aggregates in a subtropical plantation. They found that N addition suppresses soil organic C mineralization but accelerates N mineralization, particularly in microaggregates. This study highlights the significance of aggregates as fundamental units of soil structure in determining soil organic C stability and C sequestration potential under N deposition. Further, Roach et al. focused on the concomitant effects of climate change and land-use change (forest harvesting) on different sizes of downed woody debris by investigating nine forest sites along a 900-km climate gradient in Canada. They found that coarse woody debris (CWD) in humid climates had significantly higher C stocks, volume, and diversity than in arid climates. Harvesting practices generally reduced total CWD volume, particularly the large, more decomposed pieces, except at the most arid sites. The study emphasizes the imperative need for strategic management in arid forests to prevent the depletion of CWD during harvesting, especially clear-cutting, given that future inputs may be delayed by several decades.

Meng et al. studied dissolved organic C dynamics and its driving factors along soil profiles (0–1 m) in various forest types on the loess plateau. They found that dissolved organic C content peaks in mixed forest and declines with increasing soil depth across all forest types, potentially driven by differences in litter production and root exudate levels. These results suggest that mixed forests are more effective in enhancing soil organic C accumulation than monoculture forests in the region under study. Yu et al. also concerned the effects of restoration on the dynamics of soil organic C fractions and priming effect in a secondary shrubland with a 45-day incubation experiment. They found that the restoration measurement promotes the priming effect by increasing fungal diversity and stimulating particulate organic C mineralization. This study suggests that well-considered management practices are necessary for minimizing C emission during vegetation restoration. Meanwhile, Song et al. explored the potential of ecosystem C sequestration following mangrove restoration in Qinzhou Bay, China. They found that both vegetation and root C stocks increase with forest age, and that mangrove soil C stocks are higher in the cofferdam area compared to the non-cofferdam area. Moreover, Nagano et al. analyzed soil $^{13}C$ and $^{15}N$ in water-extractable organic matter in a temperate broadleaf forest transformed from grassland succession about 150 years ago. They found that the enrichment of stable isotopes under varying substrate availability can serve as a robust indicator of microbial utilization of soil C and N, which is pivotal for understanding the mechanisms of soil organic matter stabilization in the studied scenario.

The six articles in this Research Topic contributed to our understanding of forest C cycling under global changes. However, many questions regarding soil C stability in forests under global change scenarios remain to be addressed. In the future, it is essential to consider the following aspects. Firstly, there is an urgent need for long-term *in-situ* experiments incorporating multiple global change scenarios to gain a deeper understanding of the mechanisms of soil C stability in forests, an area that has been extensively explored in other ecosystems such as grasslands and agroecosystems. Secondly, even with the application of numerous methods and techniques to study the mechanisms of soil C formation and stabilization, accurately quantifying the contributions of biotic and abiotic processes to soil C stabilization in forests under various global change scenarios remains a tremendous challenge.

## Author contributions

ZF: Writing – original draft. GL: Writing – review & editing. XZ: Writing – review & editing. DZ: Writing – review & editing. RZ: Writing – original draft.

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## 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.

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