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Editorial: Soil health, functions, and ecosystem services: insights into soil parameters and methods of integration

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Editorial on the Research Topic
Soil health, functions, and ecosystem services: insights into soil parameters and methods of integration

Introduction

Soil health is the capacity of the soil to continue delivering functions and ecosystem services, determining directly or indirectly the life and livelihood of human beings as well as the survival and sustenance of plants and animals. Soil functions on its turn depend on the quality of soil's physical, chemical, and biological properties, which are influenced by both natural processes and anthropogenic activities (Li et al., 2023). Hence, improving our understanding of the response of soil properties to various management practices and environmental stressors is a prerequisite to maintain or even enhance soil functions (e.g., regulating water quality and availability, sustaining plant and animal life, filtering and buffering environmental pollutants, elemental cycling, and providing physical stability) and therefore also overall soil health and related ecosystem service performance such as climate regulation, flood and erosion protection, food and water security (Pereira et al., 2018). As such there exists an important positive feedback mechanism because many of these ecosystem services are vital for the long-term functioning and maintenance of healthy soils (Figure 1). The main focus of this Research Topic was to bring expertise in this particular field of research togheter in order to present a range of management interventions allowing the improvement of soil health and providing policymakers with options to combat major global threats such as the current food security, climate change and environmental pollution crises. For example, the delivery of some key United Nations Sustainable Development Goals (SDGs), such as Zero Hunger (SDG 2), Clean Water and Sanitation (SDG 6), Climate Action (SDG 13), and Life on Land (SDG 15), depend on soil health and functions governed by soil quality (Lal et al., 2021).

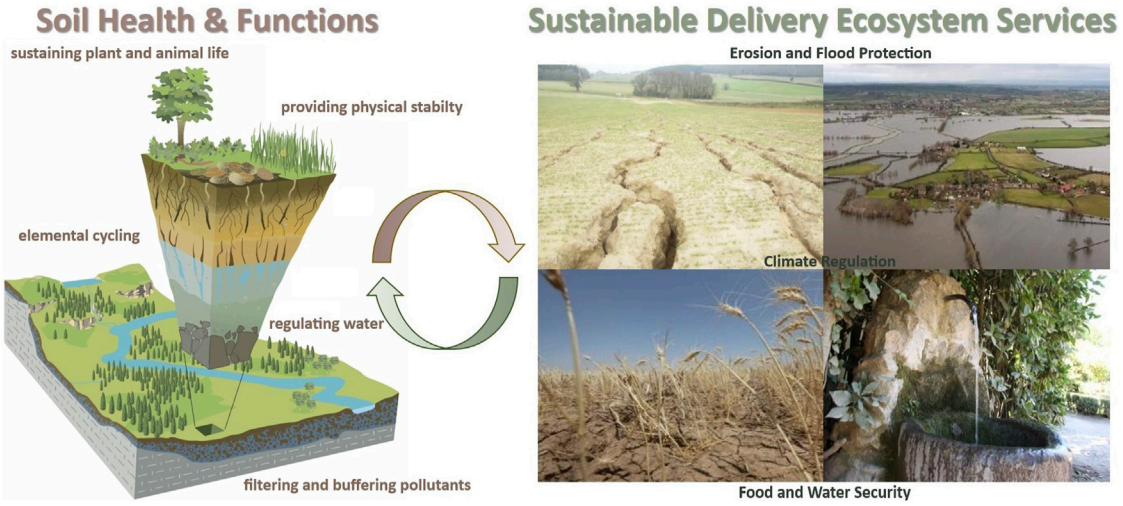

FIGURE 1
Schematic illustration of the feedback mechanism between i) soil heath and associated functions (e.g., sustaining plant and animal life, providing physical stability, elemental cycling, regulating water and filtering and buffering pollutants) and ii) the sustainable delivery of ecosystem services (e.g., climate regulation, erosion and flood protection, food and water security) (figure adapted from Charover et al., 2007).

Summary of the papers published in the Research Topic

This Research Topic contains six articles, all addressing an emerging research question within the vast topic of soil health. Although across these articles, a fairly wide range of soil functions and ecosystem services have been considered, in 5 out of 6 articles, the main focus is on climate regulation in an agricultural context through organic carbon sequestration in cropland soils (i.e., Xie et al.; Arunrat et al.; Wang et al.; Liang et al.; Ranjan et al.). Furthermore, all contributions' study areas are located in Asia of which four in China (Zhao et al.; Liang et al.; Wang et al.), one in India (Ranjan et al.) and one in Thailand (Arunrat et al.). This particular focus is remarkable as the Research Topic welcomed scientific contributions across the entire world considering an extensive range of soil parameters, functions and/or services, allowing soil health assessment from a chemical, physical and biological point of view. As such, this Research Topic suggests that 1) the ability of the soil to store carbon is probably one of its most important functions, which is directly linked to many vital ecological processes and 2) that this Research Topic is receiving a lot of interest from soil scientists, and in particular among Asian researchers, due to the soil reservoir's great potential to act as a sink of CO_2. Since the green revolution, intensive agricultural management practices (e.g., ploughing and applying mineral fertilizers) have resulted in a considerable decrease in soil organic carbon (SOC). Consequently, there is currently an enormous potential to sequester carbon in cropland ecosystems by restoring the initial SOC levels after replacing the intensive agro-practices with more sustainable alternatives, forming the main research focus in four out of six articles. More precisely, Ranjan et al., Wang et al., and Liang et al. are showcasing the great long-term SOC sequestration potential by integrating organic manure amendments within, or by even entirely replacing, traditional mineral fertilizer treatments, considering respectively a rice-wheat cropping system in Northern India as well as typical Chinese dryland and paddy soils. In addition, Xie et al. and Wang et al. identified crop residue incorporation in soils, such as straw return, as another efficient SOC sequestration agro-management option across China. Finally, Arunrat et al. studied the temporal response of SOC on fire land management practices as farmers in Northern Thailand applied them. The latter article considers, besides carbon, soil's nitrogen and nutrient contents and associated soil erodibility implications, allowing a more complete assessment of soil health within a post-fire recovery context. However, Zhao et al. present a more comprehensive evaluation of various soil health management methods by assessing the trade-offs and synergies between multiple soil functions at the sub-national scale (i.e. 151 fields across three climatic zones in China). In this study, an innovative methodological approach, combing the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model with Bayesian belief networks, allowed an in-depth analysis concerning the impact of climatic conditions and land management on soil multi-functionality and how this may change over time. Hence, this kind of studies are crucial in order to conduct a sustainable cropland management strategy plan with the objective to enhance soil's total ecosystem service delivery capacity across large geographical areas. However, the five other studies in this Research Topic, considering only one or a very few agro-management practices and their impact on a limited set of soil functions, are likewise very important, because these novel detailed insights provide us with the key knowledge required to build and continuously improve models (such as Invest) which on its turn is needed to assess soil multi-functionality and ecosystem service dynamics across larger scales.

Author contributions

JM: Writing–original draft, Writing–review and editing. GC: Writing–original draft, Writing–review and editing. WN: Writing–original draft, Writing–review and editing.

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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