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Editorial: Remediation and health risks of heavy metal contaminated soils

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Editorial on the Research Topic
Remediation and health risks of heavy metal contaminated soils

Introduction

Soil contamination by heavy metals is a major problem for the environment and public health. Metals such as cadmium, lead and metalloids such as arsenic accumulate in the soil as a result of various activities, especially industrial activities and agricultural practices. Once in the soil, these metals can enter the food chain and pose toxic risks to human health. Mitigating these risks requires effective remediation strategies, including physical, chemical and biological methods. Key techniques include phytoremediation (use of plants to absorb pollutants), bioremediation (use of microorganisms to biotransform heavy metals into nontoxic forms) and immobilization (chemical modification of metals to reduce their mobility) (Liu et al., 2018; Rajendran et al., 2022). The success of these methods depends on the type of metal, the extent of contamination, soil properties and environmental factors. Both the remediation of contaminated soils and the associated health risks are crucial for protecting public health and promoting sustainable land use (Panqing et al., 2023).

This Research Topic includes 13 articles dealing with strategies and challenges related to soil contamination with heavy metals. Areas of focus include contamination in agriculture and food systems, risk assessment, innovative remediation techniques and advanced bioremediation methods. These articles examine the impact of agricultural and soil management practices on the uptake of metals by plants and explore the wider implications for public health. Innovative remediation techniques such as zero-valent iron at the nanoscale and bioremediation methods are highlighted, as well as risk assessments of environmental and health impacts. In addition, spatial analysis methods are discussed as tools to identify contamination patterns, with a focus on sustainable practices that mitigate health risks in agriculture. This Research Topic emphasizes the need for an integrated approach involving science, technology and policy to effectively manage the complexity of soil contamination.

Overview of contributions

The mechanisms that drive the migration and accumulation of heavy metals provide important insights into how these pollutants move through and persist in different environmental systems. Fan et al. investigate how chloride ions influence the movement and transformation of cadmium in soil-rice systems, revealing the interactions between agricultural chemicals and heavy metal behavior. Similarly, Farrow et al. investigate the uptake of arsenic and other trace elements in rice and show how soil composition, plant varieties and water management influence metal uptake.

In addition to investigating the mechanisms of heavy metal migration, several studies focus on assessing the risks that these metals pose to both ecosystems and human health. By using comprehensive risk assessment tools, these studies provide valuable insights into the extent of contamination and its potential impacts. Wang et al. conduct an ecological risk assessment of heavy metals in Bosten Lake sediments and identify the sources and severity of contamination. Mohanty et al. focus on the health risks associated with dietary exposure to heavy metals, especially in regions affected by chronic kidney disease. Tang et al. emphasize the importance of geographic and topographic factors in the assessment and remediation of soil contamination, especially in areas with varying terrain. Mohamed et al. use geospatial assessments and microbial strategies to manage contamination in arid regions.

Heavy metal contamination is not only a result of industrial and agricultural activities but can also arise from military operations. Sites used for military training and operations, such as firing ranges, often experience significant soil contamination due to the use of heavy metals in munitions. Addressing contamination in these areas requires specialized remediation strategies. Zhu et al. evaluate contamination in abandoned firing ranges, comparing the efficacy of various remediation techniques and their environmental impact.

Several studies in this Research Topic focus on novel remediation methods that improve both the efficiency and safety of removing heavy metals from contaminated soils. These advances offer promising solutions to mitigate the environmental and health risks posed by metal contamination. Pan et al. describe a synergistic approach using nanoscale zero-valent iron in combination with *Penicillium oxalicum* SL2 for chromium remediation. Kim and Park present the simultaneous removal of arsenic and lead using iron phosphate and analyze the complex interactions between remediation agents and contaminants. Biochar, a material known for its ability to stabilize heavy metals, plays an important role in several studies. Yang et al. develop biochar modified with iron and manganese to immobilize several heavy metals in soils. Naveed et al. investigate how the combination of biochar with polyacrylamide in wastewater irrigation can promote plant growth while reducing metal pollution. This approach not only reduces the environmental and health risks associated with the accumulation of metals in soils, but also increases agricultural productivity through the safe use of wastewater for irrigation.

To improve the effectiveness of remediation measures, integrated bioremediation strategies combining different biological techniques have been proposed. These approaches offer environmentally friendly solutions for dealing with metal-contaminated soils. Pérez-Vázquez et al. are investigating the combined use of bioaugmentation and phytoremediation in landfills, while Garbisu and Alkorta are researching improved phytoremediation methods aimed at reducing the spread of antibiotic resistance in soils contaminated with heavy metals.

Conclusion

Each paper in this Research Topic offers valuable insights into the detection, analysis, and remediation of heavy metal contamination in various environments. The studies emphasize the importance of innovative methods and strategies for addressing these persistent environmental and public health issues. The findings highlight the complex interactions between heavy metals and environmental factors, including agricultural chemicals, bioremediation agents, and topographic Research Topic. These interactions significantly affect the mobility, bioavailability, and ecological impact of heavy metals, underscoring the need for precise and effective remediation strategies. Ongoing research is essential to developing innovative, effective, and sustainable solutions for heavy metal-contaminated sites, with the ultimate goal of protecting both human health and the environment.

Author contributions

WY: Writing–review and editing. QL: Writing–review and editing. MG: Writing–original draft, Writing–review and editing.

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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.

Publisher's note

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