frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 26 September 2024
DOI 10.3389/fenvs.2024.1498172

OPEN ACCESS

EDITED AND REVIEWED BY
Yuncong Li,
University of Florida, United States

*CORRESPONDENCE
Rubén Forján,
castropadron@hotmail.com

RECEIVED 18 September 2024
ACCEPTED 23 September 2024
PUBLISHED 26 September 2024

CITATION
Santos ES, Afif E and Forján R (2024) Editorial: By-product amendments for the remediation of metal and metalloid contaminated soils.
Front. Environ. Sci. 12:1498172.
doi: 10.3389/fenvs.2024.1498172

Editorial: By-product amendments for the remediation of metal and metalloid contaminated soils

Erika S. Santos[1], Elias Afif[2] and Rubén Forján[3]*

[1]Universidade de Lisboa, Instituto Superior de Agronomia, Linking Landscape, Environment, Agriculture and Food Research Centre, Lisbon, Portugal, [2]Agroforestry Engineering Area, Department of Organisms and Systems Biology, Polytechnic School of Mieres, University of Oviedo, Mieres, Asturias, Spain, [3]INDUROT and Environmental Biogeochemistry and Raw Materials Group, University of Oviedo, Mieres, Spain

KEYWORDS

compost, biochar, technosols, inorganic amendments, phytoremediation, by-products, nature based solutions (NbS), metal(loid)s

Editorial on the Research Topic
By-product amendments for the remediation of metal- and metalloid-contaminated soils

The contamination of soils with metals and metalloids is a significant global issue, with detrimental effects on both ecosystem functionality and human health. Heavy metals such as cadmium, lead, arsenic, and zinc are not only persistent in soils but also highly toxic, often becoming bioavailable and entering the food chain. This poses serious risks, including soil fertility loss, reduced agricultural productivity, and increased potential for human exposure to toxic elements through food crops. Traditional remediation techniques, such as soil excavation and chemical treatments, often involve high costs and environmental disturbances, highlighting the need for more sustainable, cost-effective, and eco-friendly alternatives.

In recent years, a growing body of research has focused on nature-based solutions (NBS) and circular economy principles to address soil contamination. The use of organic and inorganic by-products, such as biochar, compost, and industrial residues, for soil amendment has gained considerable attention due to their dual role in pollutant immobilization and soil restoration. These amendments not only reduce the bioavailability of harmful metals but also improve soil structure, increase organic matter, and enhance nutrient cycling. By leveraging materials that would otherwise be waste, these approaches align with the European Union's zero-waste strategy and contribute to broader sustainability goals. Furthermore, emerging technologies, such as biochar modification and combined amendment strategies, are being actively explored to optimize the effectiveness of these materials in various soil types and contamination scenarios.

This Research Topic brings together cutting-edge research that explores the use of by-product amendments for the remediation of soils contaminated with metals and metalloids. The collected articles highlight innovative methods for reducing metal bioavailability, improving soil health, and integrating sustainable practices into land management. The studies presented aim to advance the current understanding of how organic and inorganic amendments can be applied to mitigate the risks associated with contaminated soils, offering practical insights for researchers, practitioners, and policymakers.

One of the most popular amendments at present is biochar. One of the articles in this Research Topic is about a mini review focused in a meta-analysis, that investigates the effectiveness of modified biochar in immobilizing cadmium in contaminated soils (Liu et al.). The study systematically evaluates data from 58 papers and demonstrates that modified biochar, compared to unmodified biochar, significantly reduces cadmium availability in the soil by 65.01% and lowers cadmium content in plants by 70.72%. These results highlight the potential of modified biochar as a cost-effective and highly efficient solution for cadmium remediation, offering valuable insights into biochar modification techniques and optimal application rates.

An original research article delves into the spatial distribution and source apportionment of heavy metals in soils affected by non-ferrous metal slag in Southwest China (Jia et al.). Through detailed sampling and analysis of 87 topsoil samples, the study finds that metals such as lead, arsenic, copper, and zinc exceed natural background levels, with arsenic being the most significant contaminant, at 11.11 times the background level. The article identifies industrial and agricultural activities as major contributors to the presence of these metals in the soil. This research emphasizes the need for targeted remediation strategies in areas affected by metal smelting and industrial waste.

In a study exploring the potential of iron slag-based amendments, researchers investigate how by-products from industrial slag can be repurposed to stabilize metals and reduce their bioavailability in contaminated soils (Galgo et al.). Iron slag, due to its high sorption capacity, shows promise in immobilizing heavy metals, particularly lead and cadmium, by altering soil properties such as pH and cation exchange capacity. The study provides crucial data on the effectiveness of iron slag in different soil types and environmental conditions.

Another review study is focused on the use of organic amendments, specifically biochar, for the remediation of metal-polluted soils (Rizwan et al.). It compares the performance of biochar derived from different feedstocks, finding that lignocellulosic biochar is particularly effective in reducing cadmium mobility. This research underscores the importance of feedstock selection and highlights biochar's role in reducing metal availability and improving soil health.

The study from Manzoor et al. investigates the effectiveness of various organic amendments in immobilizing toxic heavy metals (lead, cadmium, nickel, and arsenic) in soils contaminated by wastewater through maize cultivation. Farmyard manure (FYM) applied at 5.0 tons per hectare (T3) significantly improved soil characteristics, including pH, electrical conductivity, and organic matter content. This treatment also reduced heavy metal concentrations in the soil and enhanced the growth of maize plants, increasing biomass yield and nutrient content (nitrogen, phosphorus, potassium). The findings demonstrate that FYM is a promising amendment for mitigating heavy metal toxicity in contaminated soils and improving soil health.

Finally, a comprehensive review on drilling waste as an amendment for oil-contaminated soils evaluates how by-products from the petroleum industry can be used in soil remediation (Saffarian et al.). This study focuses on the use of drilling muds and other residual materials to enhance soil properties and reduce the bioavailability of hazardous contaminants such as polycyclic aromatic hydrocarbons and heavy metals. By integrating waste management with soil remediation, the study illustrates a circular economy approach that aligns with the EU's zero-waste goals.

Through the contributions presented in this issue, we aim to provide a detailed and forward-thinking perspective on the use of by-product amendments in soil remediation. Each article brings new insights into the synergistic effects of organic and inorganic amendments, paving the way for innovative solutions to address the global challenge of contaminated soils.

Author contributions

ES: Conceptualization, Writing–original draft, Writing–review and editing. EA: Writing–original draft, Writing–review and editing. RF: Conceptualization, Supervision, Writing–original draft, Writing–review and editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We would like to thank all authors, reviewers, and editors who have contributed to this Research Topic.

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

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.