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Editorial: Biomass conversion and biomass-derived carbon-based materials for remediation of emerging pollutants in soil and water

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Editorial on the Research Topic
Biomass conversion and biomass-derived carbon-based materials for remediation of emerging pollutants in soil and water

Recently environmental pollution is increasing therefore effective strategies for soil and water remediation have become crucial for global sustainability. Emerging pollutants including pharmaceuticals, pesticides and industrial chemicals pose significant risks due to their persistence, bioaccumulation and toxicity. In response, this Research Topic of Frontiers in Materials explores the potential of "*biomass-derived carbon-based materials as innovative, sustainable solutions for removing contaminants from soil and water*". This Research Topic represents a culmination of current research on biomass conversion technologies, materials design and pollutant remediation, showcasing interdisciplinary efforts to address this pressing environmental challenge.

The conversion of biomass into carbon-based materials holds unique promise due to the abundance, renewability and versatility of biomass resources. Methods like pyrolysis, hydrothermal carbonization and chemical activation transform agricultural waste, forestry residues and other biomass sources into effective adsorbents with tunable properties. Recent advances in materials science have enabled the production of biomass-derived carbons with tailored porosities, high specific surface areas and functionalized surfaces, ideal for binding a wide range of organic and inorganic pollutants. These materials not only contribute to pollution mitigation but also promote waste valorization, creating added value from otherwise underutilized resources.

This Research Topic includes several contributions that expand on the various applications and efficiencies of these materials. Ali Bhatti et al., presents a promising, sustainable approach to wastewater treatment. By utilizing carbon materials derived from *C. colocynthis* an underutilized plant resource the research demonstrates effective photodegradation of methylene blue, a commonly used dye and pollutant in textile effluents. The work highlights the material's high surface area and light-responsive properties, emphasizing the potential of bio-derived carbon for advanced photocatalytic applications. This innovative approach not only offers an eco-friendly remediation strategy but also supports waste valorization, marking a step forward in green technologies for environmental restoration. Thirumalaivasan et al., contributed review paper which explores the powerful potential of microorganisms in managing environmental contaminants. By harnessing the natural degradative capabilities of fungi and bacteria, the research presents effective strategies for breaking down toxic compounds and biowaste, offering a sustainable alternative to conventional methods. The findings underscore how microbial bioremediation can reduce pollution levels, detoxify hazardous waste and transform waste into valuable by-products. This work advances the field of green remediation, emphasizing microbial solutions as eco-friendly and efficient approaches to tackling global waste challenges. Suresh et al., contributed review paper and highlights the vast potential of algae as a sustainable solution for water purification. By focusing on algae's unique adsorption capabilities and catalytic properties, the study presents an eco-friendly approach to removing organic pollutants from contaminated water sources. Algae's high surface area, adaptability, and natural ability to absorb and degrade toxins make it an effective tool for reducing environmental pollution. This work advances green remediation by exploring algae's role in water treatment, positioning it as a viable alternative to conventional methods and a contributor to ecological balance and health. Verma et al., contributed on the Production and characterization of biodiesel fuel from third-generation feedstock further highlights an innovative pathway toward sustainable energy. By focusing on third-generation feedstocks, such as algae and microbial sources, this work demonstrates a feasible alternative to fossil fuels and first-generation biofuels, which often compete with food resources. The research showcases the production process, fuel properties and emissions profile, underscoring biodiesel's potential for clean, renewable energy. This work marks a significant step forward in the biofuel sector, revealing environmentally friendly and economically viable alternatives that contribute to energy security and support the transition to low-carbon fuel sources.

The overarching aim of this Research Topic is to spotlight biomass-derived carbon materials as viable alternatives for environmental remediation, encouraging further research into optimized synthesis methods, material modifications and field-scale applications. This Research Topic underscores the need for sustainable innovation, bridging material science, environmental engineering and policy considerations to create real-world impact. We are confident that the insights shared here will inspire continued exploration into biomass-derived solutions, fostering interdisciplinary collaborations and advancements in sustainable remediation practices. We extend our gratitude to the authors, reviewers, and editorial board for their contributions, which have made this Research Topic possible. Together, these works serve as a demonstration to the potential of sustainable materials science in addressing the ecological challenges.

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