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Editorial: Innovative treatment technologies for sustainable water and wastewater management

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Editorial on the Research Topic
Innovative treatment technologies for sustainable water and wastewater management

1. Introduction

Water, the fundamental life force sustaining all living organisms, faces a critical deterioration in quality due to the relentless expansion of population, industrialization, urbanization, and agricultural practices. This threat is worsened by geological shifts and environmental alterations. Consequently, water pollution looms as a major threat to our landscape, impacting not only living organisms but also vital aspects like domestic use, recreation, fishing industries, transportation, and various commercial sectors (Ali, 2012). By 2030, an estimated 3.9 billion individuals are predicted to face both water scarcity and dire water quality issues, according to the World Water Council. These challenges further worsen the situation, leaving an estimated 1.1 billion people without access to clean drinking water and 2.6 billion lacking proper sanitation facilities, according to the World Health Organization. Addressing these complex problems will necessitate advancements in water and wastewater treatment technologies, as explored by Pendergast and Hoek (2011).

Driven by the urgent need for sustainable water and wastewater management, this Research Topic ("*Innovative treatment technologies for sustainable water and wastewater management*") aims to delve into pressing issues and promote impactful strategies and policies. Encompassing both treatment methods and recycling initiatives, this Research Topic (RT) will deepen our knowledge of various approaches to purifying water sources and contributing to a more sustainable future.

2. An overview of the Research Topic

We have received several review and research papers for this specific Research Topic. Each submission has undergone a rigorous peer-review process, leading to the selection of four original research and review papers focused on the detection and removal of organic and inorganic contaminants from water sources. The following themes are addressed in the studies presented in this Research Topic:

Organic contaminants in water, such as pesticides and polyvinylpyrrolidone, pose significant health and environmental risks. Their presence can lead to contamination of drinking water sources, harming aquatic life and ecosystems. Effective management and treatment are crucial to safeguarding human health and the environment from the detrimental effects of these pollutants. In efforts to combat groundwater pollution, research has focused on degrading the pesticide metabolite 2,6-dichlorobenzamide (BAM) through biological methods. Previous studies about the biological techniques showed potential but faced challenges with degradation process. Based on the Ellegaard-Jensen et al., enhancement of degradation was achieved through novel inoculation methods, reduced flow rates, and increased nutrient concentrations. Modified membrane treatment facilitated the concentration of nutrients and BAM, supporting the survival of degraders and enabling lower flow rates. This approach resulted in 100% BAM removal over 40 days. Molecular analysis confirmed the dominance of the degrader strain *Aminobacter* sp. MSH1. The Al-Marri et al. investigated the polyvinyl pyrrolidone (PVP) removal from water using electrocoagulation (Al electrodes). Results highlighted the roles of chemical and electrochemical processes in hydroxo-aluminum species generation. Electrocoagulation achieved up to 95% total organic carbon (TOC) removal, confirming PVP elimination through $Al(OH)_3$ adsorption.

Metal pollution, such as lead (Pb) and arsenic (As), poses a significant threat to ecosystems due to its toxic, non-biodegradable, and persistent nature. Heavy metals easily accumulate in soil, water, and sediment, leading to substantial environmental hazards (Prasad Ahirvar et al., 2023). Mohamed et al. developed a cost-effective, sustainable adsorbent for the efficient removal of Pb(II) from water. Various ternary composite adsorbents, incorporating chitosan, kaolinite, and biomass additives, were synthesized and characterized. The adsorption properties of lead nitrate were evaluated in both batch and dynamic conditions, with the optimal composition (chitosan: 50%, kaolinite: 10%, oat hulls: 40%) demonstrating maximum Pb(II) removal. Dynamic adsorption in a fixed bed column confirmed these findings. Mojiri et al. investigated the mechanisms of arsenic accumulation in water bodies. Arsenic concentrations in drinking water can exceed 1,320 μg/L (Nicaragua), groundwater surpassing 5,000 μg/L (Thailand), and wastewater reaching up to 134,000 μg/L (Brazil landfill leachate). Fish bioaccumulation ranges from 0.4 to 362 μg/g (Brazil's Paraná River Delta and Northern Adriatic Sea, respectively). Recent research predominantly focuses on arsenic removal through adsorption methods, particularly employing nanoparticle and graphene-based adsorbents known for their high efficiency in water purification.

The Research Topic "*Innovative treatment technologies for sustainable water and wastewater management*" tackles critical water quality challenges by presenting novel solutions for purification. It addresses both organic and inorganic contaminants, offering promising advancements for efficient water management. These innovations pave the way for a sustainable future, safeguarding water resources and contributing to a healthy environment for generations to come. However, further research is crucial to refine and develop comprehensive water treatment methods, ensuring continued progress in overcoming global water pollution issues.

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