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Editorial

Remediation Strategies for Soil and Water

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With the rapid development of industry worldwide, soil and water pollution has increased in recent decades [1,2]. Pollutants such as heavy metals, polycyclic aromatic hydrocarbons, antibiotics, and microplastics in soil and water cause severe environmental problems [3–6], posing serious risks to human health and the ecological system. Approximately 4 billion people, representing about half of the world's population, suffer from severe physical water scarcity for at least part of the year [7]. Hence, several techniques have been developed for the remediation of contaminated soil and water, including adsorption, membrane separation, advanced oxidation, ion exchange, electrochemical treatment, microbial degradation, and phytoremediation [8–15]. Considering the ongoing issue of pollution and emerging pollutants, remediation strategies for soil and water should be further optimized to focus on developing functional materials, improving remediation efficiency, and enhancing integrated remediation processes. This Special Issue entitled "Remediation Strategies for Soil and Water" features six research articles and three review papers, each addressing critical aspects of remediation processes for soil and water. The contributions are briefly described below.

Liu et al. [16] demonstrated the application of the volume-of-fluid (VOF) technique in the prediction of leakage and diffusion of underwater oil spill, providing potential remediation strategies. They determined the impacts of various parameters on leakage and diffusion characteristics by adjusting ocean current velocity, spilled oil velocity, and the density and viscosity of crude oil. Notably, a user-defined function was proposed and used for computational fluid dynamics modeling, and they obtained a critical formula to determine the lateral migration distance of spilled oil under various conditions. Their results can provide a theoretical basis for developing an emergency treatment scheme for offshore oil spills and improve the remediation efficiency of oil-contaminated water.

Yang et al. [17] focused on the effective removal of ammonium from water using ball-milled biochar modified with NaOH. They aimed to explore the feasibility of using modified biochars to achieve the enhanced remediation of ammonium-polluted water. The results indicate that the ball-milling treatment and NaOH modification greatly improved the ammonium sorption capacity of biochar, and the modified biochars showed enhanced sorption performance in a wide pH range (3–7). The surface complexation with functional groups and cation exchange were considered the main sorption mechanisms. The authors concluded that biochar modified via NaOH/ball-milling can be employed as a cost-effective sorbent for the remediation of ammonium-polluted water.

Meng et al. [18] proposed a promising scheme for the sustainable remediation of nitrate-contaminated groundwater through permeable reactive barrier (PRB) remediation systems. They fabricated nano zero-valent iron (nZVI) particles encapsulated within an acrylonitrile–butadiene–styrene (ABS) matrix, which efficiently solved the problem of aggregation and reactivity decrease through regulating the distribution of nZVI particles

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and controlling the interaction between nZVI particles and the polluted water. The results demonstrate that encapsulation suppressed the aggregation of nZVI, achieving sustainable denitrification performance during wastewater remediation.

Luo et al.'s research [19] delves into the impacts of fertilization on nitrogen and phosphorus pollution in agricultural water bodies. They built a crop–soil runoff water system to determine the variation in crop growth and the pollutant contents in water bodies under different fertilization rates. The authors emphasized that crop growth intercepted the migration of nitrogen and phosphorus, which was further affected by different growth stages. Considering the combined effects of fertilization on soil fertility, crop yield, and environmental risk, they proposed an optimized fertilization rate for an eggplant planting system, achieving the best interception effect on nitrogen and phosphorus in the water system.

Wang et al. [20] provide an overview of a hot topic, reducing greenhouse gas (GHG) emissions from farmland soil, especially focusing on the microbial-mediated process. They systematically illuminated the main generation pathways of GHGs (i.e., CO_2, CH_4, and N_2O) in soil and analyzed the impacts of various environmental factors, including soil temperature, organic matter, moisture, and pH, on soil GHG emissions. Additionally, they determined the microbial mechanisms involved in the soil GHG emission process under various soil remediation modes (e.g., the biochar addition, organic fertilizer addition, straw return, and microalgal biofertilizer application modes). They demonstrated the critical role of microalgae biofertilizer in reducing GHG emissions in farmland soil, providing a theoretical basis for achieving carbon neutrality in agriculture production.

Wang et al. [21] systematically reviewed hydrothermal treatment for food waste to address its potential environmental risk. The authors presented an in-depth analysis of the effects of the mechanisms of hydrothermal conditions (e.g., hydrothermal temperature, time, feedstock properties, and catalysts) on the generation of various products, focusing on the potential application of the value-added products derived from the hydrothermal treatment of food waste. Hydrochar, bio-oil, and gaseous products derived from this process showed good potential in environmental remediation, soil improvement, energy production, and new material synthesis. Finally, the authors proposed the potential challenges and development directions for the hydrothermal treatment of food waste.

Liu et al. [22] conducted a study on landfill gas–water joint regulation technology. Low oxygen utilization rates resulted in high energy consumption and operating costs, further restraining the application of in situ aeration technology to stabilize municipal solid waste. The authors aimed to improve oxygen utilization efficiency through observing the dynamic respiratory index and the removal of pollutants. Hence, they constructed three continuous reactors and proposed targeted aeration and re-circulation schemes for various landfill ages. The results imply that a well-designed reactor (aerobic, semi-aerobic, and anaerobic systems) can effectively degrade the organic components of municipal solid waste with various landfill ages, and gas–water joint technology is beneficial to activating microorganisms.

Cao et al. [23] provide a comprehensive overview of oxygenated and nitrated polycyclic aromatic hydrocarbons (PAHs) in soil, including the sources, quantification, incidence, toxicity, and transport of these PAHs in soil. Considering the high toxicity and distinct environmental effects of oxygenated and nitrated PAHs, their behaviors were systematically summarized. The authors discussed the toxicity, human health risk, and transformation of oxygenated and nitrated PAHs in soil, providing a valuable basis for the efficient remediation of PAH-contaminated soil.

The study by Ortiz-Soto et al. [24] focused on the electrokinetic remediation of heavy-metal-contaminated mining area soil. The electrokinetic remediation (EKR) technique was employed to assess the migration of heavy metal contaminant from fresh mine tailings.

Hence, a pilot EKR cell was designed to study the recovery potential of cobalt, nickel, and copper species, and the impacts of electric field intensity, pH, and their interaction on heavy metal recovery performance were determined. The authors found the optimized electric field and pretreatment solution concentration for the enhanced migration of typical heavy metals, promoting the recovery of various species and the remediation of mining area soil.

This Special Issue aims to elucidate the recent advancements and emerging challenges in the remediation of soil and water. We hope that these valuable contributions from outstanding scientists will inspire readers to gain new ideas for future research and promote the development of environmental remediation.

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