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Editorial

Sources, Risks, and Remediation Technologies of Pollutants in Aquatic Environments

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1. Introduction

Water, the lifeblood of our planet, is encountering unprecedented challenges stemming from a diverse array of pollution sources, including industrial wastewater, agricultural runoff, and urban domestic sewage [1,2]. Water pollution poses significant threats to aquatic ecosystems, water quality, and ultimately the health of our planet and its inhabitants [3]. With urbanization and industrialization rapidly developing, conventional and new pollutants pose additional potential risks to the environment and human health [4,5]. Substantial information is required to stay informed on pollutant sources and their potential risks in aquatic environments, as well as to develop innovative technologies for pollution control and remediation, to establish sustainable solutions for maintaining the health of ecology and humans [6-8].

2. Overview of This Special Issue

The Special Issue entitled "*Water Environment Pollution and Control, Volume II*" contains 12 contributions, including nine original articles on diverse topics within the scope, two reviews, and one communication. These articles focus on both organic (organophosphate esters, phenolic compounds, polycyclic aromatic hydrocarbons, fulvic acid, rhodamine B dye, etc.) and inorganic pollutants (mercury, strontium, salinity, etc.). They also discuss contaminants of emerging concern in groundwater, irrigation water, wastewater, drinking water, and seawater, as well as those environmental compartments closely related to the aquatic environment. Innovative technologies have also been proposed to treat the polluted water resources, such as alkaline prehydrolysis, sonochemical catalysis, and photocatalysis. Further, the potential functional applications of seagrass, a promising resource with significant potential for industrial applications and environmental remediation, are explored.

Cao et al. provide valuable insights into the spatiotemporal variations, source determination, and potential ecological risks of organophosphate esters (OPEs) in water and sediment samples collected from 19 coastal tourist resorts in the Shandong Peninsula, China (contribution 1). OPEs are common flame retardants and plasticizers in various consumer products. This study contributes to the knowledge on the environmental fate and impacts of OPEs by highlighting the widespread presence of OPEs in coastal tourist resorts.

Gu et al. investigated alkaline prehydrolysis as a means to enhance phenolic compound absorption in oil wastewater (contribution 2). Phenolic compounds are notoriously toxic and difficult to degrade, but the research showed that hydrolysis in alkaline conditions (pH 12) for 12 h rendered them more susceptible to destruction. Prehydrolysis plays a crucial role in reducing chemical oxygen demand (COD). This research provides

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valuable insight into the effective treatment of phenolic compounds in oil wastewater and their environmental implications.

Hu et al. investigated the impact of soil salinity distribution, groundwater depth, and irrigation management on agricultural sustainability with a case study in the Hetao Irrigation District in China (contribution 3). They found that groundwater depth and irrigation practices significantly affected soil salinity. Salinized farmland adversely affects crop yield and water resource utilization. The dynamic relationship between soil and groundwater necessitates further research on the temporal variability of soil salinity, in order to implement effective measures for enhancing resource utilization efficiency and agricultural production.

The study by Malov focused on strontium pollution in drinking groundwater and the associated health risks in North-West Russia (contribution 4). Key findings indicate that groundwater with strontium concentrations exceeding the maximum permissible limits exhibited an increased correlation between strontium concentrations, total dissolved solids, and the saturation indices of celestite and gypsum. The research highlights the formation of strontium pollution in drinking groundwater, its potential health implications, and the need for continued monitoring and management to safeguard public health.

Mulenga et al. provide a comprehensive review of mercury (Hg) pollution in aquatic environments resulting from artisanal and small-scale gold mining in Sub-Saharan Africa (contribution 5). The article highlights that this gold mining, which is prevalent in many regions of Sub-Saharan Africa, often uses mercury to extract gold from ore. This process results in significant mercury pollution, which enters aquatic environments through runoff, leaching, and direct discharge. The impacts of mercury pollution on aquatic ecosystems and potential interventions to address it are also explored.

Feng et al.'s systematic review comprehensively explores the global research trends on contaminants of emerging concern (CECs) over the past decade (contribution 6). The authors provide an in-depth analysis of CECs, which covers their occurrence in water, soil, and air. They also delve into the various sources of these contaminants, including industrial discharges, agricultural runoff, and urban waste. This comprehensive coverage enhances understanding of CECs' scope and scale. The risks that CECs pose to ecosystems and human health are particularly concerning. The study highlights the potential for CECs to bioaccumulate in organisms, affecting food chains and ultimately human health. The implications for water quality are also discussed, emphasizing the need for effective monitoring and management strategies to ensure safe drinking water supplies.

Tian et al. studied the remediation of saline–alkali farmland by drainage with subsurface pipes in typical arid and semi-arid agricultural areas, i.e., the Hetao Irrigation District in China (contribution 7). Water and salt migration in amended heavy saline soil was investigated with field experiments on growing sunflowers. The DRAINMOD model and drainmod equation were used to calculate the water and salt migration with the support of field studies. The results can help in developing strategies for desalination and salt control in arid and semi-arid soil with the optimal layout of subsurface pipes. This method is highly significant in effectively managing soil and water resources and improving agricultural production efficiency in these relatively infertile areas. With continuous technological advancements and in-depth research, more innovative solutions are anticipated to emerge, bringing greater breakthroughs to soil and water resource management, as well as the sustainable development of agricultural production.

Tsenter et al. investigated the synergistic inactivation of bacteria during water disinfection by ultrasound coupled with sonocatalysts, including persulfate, nano- and microzinc oxide (contribution 8). In terms of environmental remediation, sonochemical reactors have demonstrated strong potential in advanced oxidation processes, especially in the remediation of microbial hazards in water and wastewater treatment. Research has indicated that combining ultrasound and different catalysts can significantly improve the degradation efficiency of organic pollutants, providing new effective means for

environmental remediation. Meanwhile, nanotechnology has also driven breakthroughs in environmental remediation, such as the synergistic effect of nanocrystals and ultrasound.

Wu et al. investigated the concentration, composition, source, and ecological and health risks of polycyclic aromatic hydrocarbons (PAHs) in the soil surrounding oil wells in the Yellow River Delta, China (contribution 9). Their comprehensive analyses revealed the pollution status and sources of PAHs in the region. Although the current risks of PAHs to the ecology and human health are low, potential threats still exist in the long run. Future work is proposed to strengthen environmental monitoring and assessment for pollution treatment and remediation.

Xiao et al. examined the dynamics of sedimentary fulvic acid (FA) fractions from an urban river affected by anthropogenic activities (contribution 10). Utilizing advanced spectroscopic techniques, including excitation–emission matrix (EEM) fluorescence spectroscopy with parallel factor (PARAFAC) analysis and two-dimensional correlation spectroscopy (2D-COS), the researchers tracked changes in the composition, spatial distribution, sources, and transformation mechanism of FA fractions from different reaches of the Baitapu River in Shenyang, north-east China. Sediment samples were collected along gradients with varying human activities, including rural, town, and urban sections. The findings help explain how anthropogenic activities alter the composition and behavior of organic matter in aquatic sediments, which is crucial for water quality management and environmental protection.

Photocatalysis has shown significant potential in environmental pollution control and energy conversion in recent years. Zhang et al. compared the degradation effects of rhodamine B (RhB) dye by graphite carbon nitride (g-C_3N_4) synthesized with different precursors under natural sunlight and LED lights, and found that natural light achieves better degradation results due to its diverse spectral components (contribution 11). Meanwhile, g-C_3N_4 synthesized with urea as a precursor has better photocatalytic performance in degrading RhB dye. These research findings not only broaden the application scope of photocatalysis but also strongly support addressing energy crises and environmental pollution issues. In the future, photocatalysis technology is poised to become an important pathway for solving energy shortages and environmental pollution problems, contributing to the sustainable development of human society.

In recent years, seaweed has attracted widespread attention for its commercial potential and biological activity. Lee et al. suggested that seaweed has broad applications as biofuels, functional food ingredients, and sources of biologically active polysaccharides (contribution 12). Specifically, *Sargassum* from Mexico has demonstrated tremendous potential in the food, agricultural, and environmental protection industries, due to its nutritional value, eco-friendly characteristics, and growth-stimulating effects. They also improved the extraction methods of organic components from *Sargassum* for safe application in commercial products.

3. Conclusions

Collectively, these papers showcase cutting-edge research spanning multiple disciplines on water environment pollution and control. Our intention with this Special Issue is to spark further interest in this crucial area of research, as it is desperately needed. While admiring this impressive compilation of work, we still need to remember that water environmental protection is a cornerstone in our efforts to tackle the global environmental crisis. We must collaborate in many battles ahead to achieve sustainable development within our global community.

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List of Contributions

1. Cao, X.; Wang, B.; Liu, X.; Cheng, J.; Wang, S. Study of the Spatiotemporal Variations, Source Determination, and Potential Ecological Risk of Organophosphate Esters in Typical Coastal Tourist Resorts in China. *Water* **2023**, *15*, 3976.
2. Gu, C.; Yan, K.; Bo, L.; Zhou, X.; He, Y.; Feng, J.; Qin, J. Alkaline Prehydrolysis Prolongs Resin Life and Enhances the Adsorption of Phenolic Compounds. *Water* **2023**, *15*, 2566.
3. Hu, Z.; Miao, Q.; Shi, H.; Feng, W.; Hou, C.; Yu, C.; Mu, Y. Spatial Variations and Distribution Patterns of Soil Salinity at the Canal Scale in the Hetao Irrigation District. *Water* **2023**, *15*, 3342.
4. Malov, A.I. Features of the Formation of Strontium Pollution of Drinking Groundwater and Associated Health Risks in the North-West of Russia. *Water* **2023**, *15*, 3846.
5. Mulenga, M.; Ouma, K.O.; Monde, C.; Syampungani, S. Aquatic Mercury Pollution from Artisanal and Small-Scale Gold Mining in Sub-Saharan Africa: Status, Impacts, and Interventions. *Water* **2024**, *16*, 756.
6. Feng, W.; Deng, Y.; Yang, F.; Miao, Q.; Ngien, S.K. Systematic Review of Contaminants of Emerging Concern (CECs): Distribution, Risks, and Implications for Water Quality and Health. *Water* **2023**, *15*, 3922.
7. Tian, F.; Miao, Q.; Shi, H.; Li, R.; Dou, X.; Duan, J.; Liu, J.; Feng, W. Study on Water and Salt Transport under Different Subsurface Pipe Arrangement Conditions in Severe Saline–Alkali Land in Hetao Irrigation District with DRAINMOD Model. *Water* **2023**, *15*, 3001.
8. Tsenter, I.; Kobunova, E.; Matafonova, G.; Batoev, V. Synergistic Piezo-Catalytic Inactivation of Bacteria by Dual-Frequency Ultrasound (120 + 1700 kHz) Using Persulfate and ZnO Nano- and Microparticles. *Water* **2023**, *15*, 2937.
9. Wu, Y.; Zhao, Y.; Qi, Y.; Li, J.; Hou, Y.; Hao, H.; Xiao, N.; Zhi, Q. Characteristics, Source and Risk Assessment of Soil Polycyclic Aromatic Hydrocarbons around Oil Wells in the Yellow River Delta, China. *Water* **2023**, *15*, 3324.
10. Xiao, Y.; Yu, H.; Song, Y. Influences of Anthropogenic Pollution on the Dynamics of Sedimentary Fulvic Acid Fractions as Revealed via Spectroscopic Techniques Combined with Two-Dimensional Correlation Spectroscopy. *Water* **2023**, *15*, 2256.
11. Zhang, M.; Xing, M.; Dong, B.; Zhang, H.; Sun, X.; Li, Q.; Lu, X.; Mo, J.; Zhu, H. Thermal Polymerisation Synthesis of g-C3N4 for Photocatalytic Degradation of Rhodamine B Dye under Natural Sunlight. *Water* **2023**, *15*, 2903.
12. Lee, M.C.; Yeh, H.Y.; Chang, C.M.; Liou, Y.F.; Nan, F.H.; Wungen-Sani, J. Tracking and Utilizing Sargassum, an Abundant Resource from the Caribbean Sea. *Water* **2023**, *15*, 2694.

References

1. Kuang, X.; Liu, J.; Scanlon, B.R.; Jiao, J.J.; Jasechko, S.; Lancia, M.; Biskaborn, B.K.; Wada, Y.; Li, H.; Zeng, Z.; et al. The Changing Nature of Groundwater in the Global Water Cycle. *Science* **2024**, *383*, 3976.
2. Gu, B.; Zhang, X.; Lam, S.K.; Yu, Y.; Van Grinsven, H.J.; Zhang, S.; Wang, X.; Bodirsky, B.L.; Wang, S.; Duan, J.; et al. Cost-effective Mitigation of Nitrogen Pollution from Global Croplands. *Nature* **2023**, *613*, 77–84.
3. Zhang, H., Cao, X., Huo, S. et al. Changes in China's river water quality since 1980: management implications from sustainable development. *npj Clean Water* 2023, 6, 45.
4. Ateia, M.; Wei, H.; Andreescu, S. Sensors for Emerging Water Contaminants: Overcoming Roadblocks to Innovation. *Environ. Sci. Technol*. **2024**, *58*, 6, 2636–2651.
5. Li, P.; Liu, J. Micro(nano)plastics in the Human Body: Sources, Occurrences, Fates, and Health Risks. *Environ. Sci. Technol.* **2024**, *58*, 7, 3065–3078.
6. Sultana, F.; McAllister, T.; Katyaini, S.; Blackstock, M.D. How to Achieve Safe Water Access for All: Work with Local Communities. *Nature* **2024**, *627*, 732–734.
7. He, J., Ma, W., Han, L. et al. Unraveling the role of natural and pyrogenic dissolved organic matter in photodegradation of biodegradable microplastics in freshwater. *Carbon Res 2023*, 2, 18.
8. Wu, A., Yang, C., Zhao, X. et al. Heteroaggregation and sedimentation of natural goethite and artificial Fe3O4 nanoparticles with polystyrene nanoplastics in water. *Carbon Res* 2024, 3, 38.