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Editorial

Frontiers in Freshwater Ecology, Conservation and Water Treatment Technologies

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1. Introduction

Freshwater ecosystems are biodiversity 'hotspots' and offer a wide range of vital services to humanity, particularly water and food supplies, aesthetic, spiritual, and scientific stimuli, and water purification. Nevertheless, they are one of the most threatened types of ecosystems, facing complex challenges [1–3]. Indeed, freshwater habitats and existing water resources are rapidly being pushed to their limits due to urban population growth, the rising demand for food and consumer goods, and pressures caused by pollution and climate change [4,5]. The existing nexus of human well-being and freshwater ecosystem health [6] implies that sustainable water use encompasses the simultaneous conservation and restoration of freshwater aquatic habitats and the protection of water quality and quantity by human societies. The optimization of water use in urban and agricultural areas and industrial processes by (1) reducing water consumption through the adoption of efficient devices and (2) implementing water treatment technologies and water reuse will allow for a reduction in the pressure on freshwater ecosystems.

2. Contributions

In light of the above, under the umbrella of "Frontiers in Freshwater Ecology, Conservation and Water Treatment Technologies", this Special Issue was designed to collect research on the following topics: (1) freshwater ecosystem conservation, rehabilitation, and management; (2) freshwater ecosystem services; (3) freshwater biodiversity; (4) the effects of climate change on freshwater ecosystems; (5) water quality monitoring; (6) water circular economy and urban water management; (7) water efficiency promotion; and (8) nature-based and other water treatment technologies. Eight diverse papers focusing on the proposed topics were accepted. These contributions are summarized in the forthcoming paragraphs, following a coherent narrative. Contributions [7,8] focused on freshwater ecosystem monitoring. The contribution [9] proposed measures to improve water efficiency in a public building, contributions [10–12] investigated methods to improve wastewater treatment methodologies, contribution [13] evaluated how treated effluent impacted the health of the recipient river, contribution [14] evaluated the economic sustainability of wastewater treatment plants. Bird et al. [7] monitored different species of freshwater mussels. Despite being ecologically valuable to freshwater ecosystems, mussels are highly endangered due to the numerous threats that face freshwater ecosystems. Coastal plain streams are not an exception: erosion, sedimentation, gravel mining, paper mill spills, and high discharge events related to storm occurrence appeared to be the main

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anthropogenic stressors adversely affecting mussel assemblages. The protection and regeneration of forested land would likely promote freshwater mussel abundance and richness in these ecosystems.

A snapshot screening was carried out by Canle and Antão-Geraldes [8] on an urban river located in the Portuguese upper part of the River Douro basin to assess the presence and environmental risk of several contaminants of emerging concern (CECs), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Despite the relatively low concentration of most of the detected contaminants, considering the screened compounds altogether, the overall environmental risk cannot be considered negligible. Additionally, the obtained results were compared with a large number of dispersed studies on these contaminants, which were carried out previously in other European countries and gathered in this paper. Moreover, a four-color alert system is included to provide information about the level of risk associated with the amount of each CEC, PAH, and PCB. This information is relevant for river managers and decision makers.

Silva et al. [9] aimed to determine the water demand of a municipal swimming pool complex in order to propose water use efficiency measures. Concomitantly, the possibility of recycling and reusing the water from filter backwashing for irrigation was evaluated. The pools consumed 25.6% of the water, the filter backwashing 24.5%, and the showers 34.7%. Despite the current impossibility of reducing water consumption in pools and exploiting filter backwashing, it is feasible to promote more efficient water use by adopting simple water-saving initiatives for showers, taps, and flushing cisterns. Moreover, the backwashed water, after installing a relatively simple system for its treatment, such as a settler or a settling tank, can be fully reused for irrigation. This research could be valuable for other municipalities aiming to implement water use efficiency measures in their infrastructure.

A case study of a grower of beansprouts and other varieties of sprouted seeds that uses six million liters of water weekly is presented by Garcia-Garcia and Jagtap [10]. Approximately 60% of the spent irrigation water is recycled using 50 µm and 20 µm drum filtration. In addition, chlorine dioxide is used as a disinfectant as part of the recycling process. Nevertheless, the existing treatment system was ineffective. Therefore, the authors proposed installing a membrane filtration system with ultraviolet technology to increase the finest level of filtration from the existing 20 µm to 0.45 µm absolute level and sterilize any remaining bacteria. This not only improved the water quality but also allowed for the removal of chemicals from the recycling system, delivering financial and technical improvements.

Sátiro et al. [11] investigated the best inoculation strategies for a microalgae and bacteria consortium in the treatment of paper pulp industry effluents, intending to remove organic matter and nutrients, and evaluated the consortium formation, sedimentability, and biomass composition. Therefore, the study can aid future work in deciding on the initial concentration of microalgae and bacterial inoculums. The results showed that the symbiotic process between microalgae and bacteria was present in the treatment of the paper pulp wastewater, allowing for a good efficiency in the removal of organic matter and nutrients while increasing biomass harvesting and producing sedimentable photogranules. Meanwhile, for the first time, de Oliveira et al. [12] proposed the use of filling wastes from metallurgy to manufacture electrodes for electrocoagulation in order to remove heavy metals and total coliforms from sanitary landfill leachate. These electrodes could remove 51% to 95% of the heavy metals and 100% of the thermotolerant coliforms.

Zero-emission technology for palm oil mill effluent has led to a breakthrough in the palm oil industry, thus contributing to the goal of sustainable development. However, data concerning the ways in which this technology has affected the bacterial community in the recipient aquatic systems that have previously been polluted with palm oil mill effluent are very limited. Thus, the research conducted by Mohamad-Zainal et al. [13] assessed the recoverability of the bacterial community in the recipient water of a constructed river subjected to zero-emission technology for palm oil mill effluent final discharge. The obtained results demonstrated the efficacy of this technology not only in reducing

the polluting properties but also in the rebound of bacterial biodiversity in the affected water system.

The discharging of untreated or mistreated wastewater causes contributes significantly to environmental degradation. Therefore, water reuse is paramount to the National Strategic Plan for the Water Supply and Wastewater Sanitation Sector in Portugal and Spain. Since centralized treatment systems have proved inefficient, tackling environmental issues requires a regional approach, according to Santo et al. [14]. Therefore, these authors analyzed the financial sustainability of 222 Wastewater Treatment Plants (WWTPs) in the Iberian Peninsula representing NUTS II (Nomenclature of territorial units for statistical purposes) regions in 2016–2019 to identify the region with the best performance and financial stability and provide regional policy implications. Using the SABI database, this research encompassed a numerical and narrative analysis of key financial ratios. This framework of analysis can help policymakers to design industrial and regional policies with a view to the early identification of those firms and regions that are more sustainable in financial and economic terms.

3. Conclusions

This set of papers illustrate the multiplicity of approaches whose ultimate goal is the conservation of freshwater ecosystems, their inherent biodiversity, and the preservation of water quality and quantity. Monitoring these ecosystems is crucial for the detection of their degradation, decision making regarding the management measures that should be implemented to mitigate the causes of degradation, and the evaluation of their effectiveness. Promoting water efficiency in buildings, as well as agricultural and industrial activities, is the best way to mitigate the anthropogenic impacts inherent to water use in these ecosystems, as well as climate change. This can be achieved by reducing consumption through the use of more efficient devices and the reuse of water. To enable water reuse and avoid the degradation of water quality, it is necessary to develop cheap, energy-efficient, and decentralized technologies for efficient wastewater treatment. This Special Issue presents innovative technologies that could, in the future, make water reuse for various purposes a reality and reduce the contamination of aquatic ecosystems to almost zero.

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