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Editorial: The Future of Wastewater Pond and Algal Technologies for a Sustainable Planet (WPAT22)

Global climate change has led to an increase in the demand for safe water in many regions. To ensure water security and to protect community health and well-being, water and wastewater treatment plants must advance treatment technologies and adopt innovative management practices. In this regard, wastewater ponds or lagoons have seen increased use in treatment plants as an effective and economical method for removing organic and inorganic contaminants and pathogens from wastewater, especially in areas with ample land and favorable climates. Algae and cyanobacteria in wastewater ponds produce oxygen through photosynthesis, aiding aerobic bacteria in breaking down organic pollutants for effective treatment. Moreover, by growing these photosynthetic microorganisms in wastewater, there is immense potential to recover nutrients like nitrogen and phosphorus and produce added-value products such as chemical and agricultural feedstocks. The IWA WPAT22, an international conference held in Melbourne in July 2022, provided a forum for the international research community, water utilities and water professionals to present and discuss the latest developments in these areas.

This special issue includes selected contributions from across the globe presented at the IWA WPAT22. Two major themes stand out in this special issue: (1) recovery of microalgae and nutrients and (2) algae growth and metabolite monitoring and prediction.

With respect to the first, there was increased interest in algal cell and nutrient recovery using various biological treatment processes, including membrane bioreactors, activated sludge and other physico-chemical processes. For example, one study conducted a thorough bibliometric review of published literature on membrane photobioreactors used for wastewater treatment between 2000 and 2022. Other studies evaluated the relationships between metals, pathogens, microalgae and nutrients and their subsequent removal using different phytoplankton. Comparisons in the treatment performance between batch and continuous mixed high-rate algal ponds were also presented. Together these studies collectively highlight the evolving landscape of nature-based wastewater treatment technologies and underpin the potential for integrating advanced biological and physico-chemical processes to enhance treatment efficiency and sustainability in line with a circular bioeconomy approach.

The focus of studies on the second theme highlights the problem that while algae and cyanobacteria in wastewater ponds can be beneficial, unchecked bloom formation and toxic blooms can be harmful to the ecosystem. In this regard, one study focused on the prediction of *Microcystis aeruginosa* growth using a secondary decomposition integration model, while another explored the application of molecularly imprinted electrochemical sensors for microcystin detection. These studies have reiterated the need to develop early warning systems to identify and/or evaluate appropriate treatment approaches to establish when the water is safe to use.

Overall, the work presented in this special issue highlights the critical role of innovative technologies and management practices in advancing wastewater pond treatment systems to contribute to solving global challenges. Using microalgae in wastewater ponds offers a promising solution for enhancing water quality, safe wastewater reuse and the recovery of resources like nitrogen and phosphorus to reduce pressure on current linear production systems. The continued advancements and implementation of these technologies will be vital in ensuring water security and public health in the face of global climate change.

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