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Editorial: Developments in managing emerging pollutants in natural waters: a focus on low- and middle-income regions

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Editorial on the Research Topic

[Developments in managing emerging pollutants in natural waters: a focus on low- and middle-income regions](#)

Globally, over 80% of wastewater is discharged without proper treatment. In middle-income countries, only 38% of municipal and industrial wastewater undergoes treatment, decreasing to 28% and 8% in lower middle-income and low-income countries, respectively ([European investment bank, 2022](#)). Numerous emerging pollutants (EPs) stem from human activities, often released without robust regulation. Examples of EPs encompass surfactants, flame retardants, pharmaceuticals, personal care products, gasoline additives, biocides, polar pesticides, microplastics, and their degradation byproducts. These pollutants can potentially travel long distances and have been identified in natural water bodies such as rivers, lakes, oceans, and even in tap water worldwide. Several EPs have been confirmed as endocrine disruptors. Moreover, certain substances like hormones and antibiotics pose a threat to aquatic fauna, leading to adverse environmental impacts, such as diminished biodiversity or alterations in ecosystem functions.

Compounding this issue, emerging pollutants (EPs) are not consistently integrated into international or national control programs, leading to a limited understanding of their fate, behavior, and ecotoxicological effects. In regions such as Latin America, the Caribbean, India, and Africa, this situation is exacerbated by the scarcity of adequate wastewater treatment facilities, the lack of regulation and control over industrial discharges, and the availability of low-cost and effective treatment technologies. This combination heightens the probability of EPs being present in sources used for domestic and agricultural purposes.

While this Research Topic research sought to assess the prevalence of emerging pollutants (EPs) in low-income countries, it has become evident that a significant dearth of information exists on this subject. This scarcity is primarily attributed to the unavailability of affordable instrumentation required for comprehensive EPs analysis.

Moreover, the limited research focus on EPs in developing nations exacerbates the situation. Compounded with the ongoing struggle to manage well-known harmful elements, it underscores the substantial gap in EPs control efforts. After all, effective control is unattainable without adequate measurement capabilities. This special issue delves into the contemporary issue of emerging pollutants (EPs) contamination in tap water, focusing on a Latin American country as a representative case of challenges faced in developing nations. Additionally, it explores innovative solutions for EPs treatment, including the utilization of bentonites and alternative low-cost methods, such as plant extracts replacing aluminum sulfate as a flocculant in water treatment processes.

Through different research on emerging contaminants, we can find studies on how to detect them, their occurrence, health and environmental risks, and methods for their remediation in different environmental matrices where surface water stands out. About analytical methods on how to detect them, the need for concentration techniques where solid-phase absorption is highlighted to subsequently detect them with liquid or gas chromatography, generally using a mass spectrometer. These advances have made it possible to qualify and quantify emerging contaminants around the world. Evidence shows that some of these, such as caffeine, are ubiquitous. Their presence has sparked interest in how their presence in the environment alters it. For example, endocrine disruptors can affect the hormonal function of the body, which is why they are related to cancer in humans and the feminization of fish. Antibiotics are related to bacterial resistance. Due to this concern, studies on how to eliminate these contaminants, especially from water, are frequent. However, one of the biggest challenges is that it be useful for several families of pollutants and at costs that allow its use especially in low-income countries.

This Research Topic is divided into two main areas: pollutants' status in low-income countries and alternatives for pollutant removal.

The first article examines the presence of emerging contaminants in drinking water from five Ecuadorian cities, highlighting the widespread occurrence of caffeine. Results underscore the need for regulatory frameworks to implement treatment technologies to safeguard public and environmental health against the risks posed by emerging contaminants (Jara-Negrete et al.).

The other article analyzes groundwater quality in semi-arid, industrial areas of Khyber Pakhtunkhwa, Pakistan. It reveals physicochemical parameters within permissible limits, except for iron (Fe). Significant correlations between parameters suggest contributions from industrial effluents and geogenic sources. The study emphasizes the importance of regular monitoring due to potential public health risks from contamination (Ishtiaq et al.).

In the alternative for pollutant removal, three articles are found:

The first investigates the potential of plant extracts, particularly *Moringa oleifera* and *Boscia senegalensis* seeds, as biocoagulants for raw water treatment. These extracts significantly reduce settling time and eliminate pathogenic microorganisms, presenting an alternative to aluminum sulfate. The study suggests their potential application, especially in resource-constrained settings (Konkobo et al.).

The second article examines UV-C disinfection's inactivation and reactivation dynamics in filamentous fungi using a single-pass

flow-through reactor. Notable inactivation efficiencies are achieved, with *Aspergillus niger* demonstrating higher resistance, but *Penicillium sp.* exhibiting greater photoreactivation capacity. The findings underscore the need for further research in fungal spores and continuous flow reactors (Duque-Sarango et al.).

Finally, the last study demonstrates that nitric acid treatment enhances the adsorption capacities of sodic and calcic bentonites for ciprofloxacin (CIP) removal from water. The treatment notably increases specific area and pore volume, leading to improved CIP adsorption. The study elucidates the adsorption mechanism through kinetic models and pH influence studies, highlighting the potential of acid treatment in enhancing clay adsorbent properties for efficient CIP removal (Jara-Cobos et al.).

Considering the scope outlined in the editorial "*Developments in Managing Emerging Pollutants in Natural Waters: A Focus on Low- and Middle-Income Regions*," several recommendations for future research can be proposed to further advance our understanding and management of emerging pollutants in these regions:

Discover new treatment methods; explore the effectiveness of approaches like oxidation processes (AOPs), nanotechnology solutions, and eco-friendly remediation techniques designed for the specific pollutants present in regions with lower and moderate-income levels.

Study changes over time and carry out long-term assessments to grasp the lasting effects on the environment and health caused by emerging pollutants and their remediation methods in natural water sources. Keep track of variations in levels, ecological reactions, and human exposure throughout time.

Enhance monitoring systems; improve surveillance systems to efficiently identify and monitor emerging contaminants in natural water sources. Use methods, remote technologies, and community involvement efforts to broaden monitoring coverage across different locations and periods.

Consider social and economic influences. Investigate the factors that contribute to the emergence of pollutants in regions with lower and moderate-income levels. Evaluate access equality to clean water resources, review community-driven pollution management strategies, and pinpoint obstacles hindering effective pollution cleanup.

Review policy impact to evaluate how well policy interventions, regulatory frameworks, and governance mechanisms are working towards reducing the effects of emerging pollutants. Identify areas where policies fall short and suggest evidence-based strategies for policy improvement and enforcement.

Promote teamwork in research; support partnerships among researchers, policymakers, industry players, and community members to tackle the issues related to new pollutants in rivers and lakes. Foster the sharing of expertise, skill development, and the adoption of technologies to boost the effectiveness and reach of research efforts.

The special issue on "*Developments in Managing Emerging Pollutants in Natural Waters: Putting an Emphasis on Low- and Middle-Income Regions*," the compilation of thoughtful articles elucidates the challenges and progress in the field of addressing new pollutants in water resources management, particularly in low- and middle-income areas. Hence, the existence of pharmaceutical by-products in urban drinking water does not seem to be a problem by now, as well as the process of plant extracts as bio coagulants and the investigation of ultraviolet irradiation for microbial inactivation offers meaningful approaches to mitigating emerging pollutants.

Furthermore, the exploration of the presence of dangerous substances in the groundwater and the purification by adsorption methods show the use of various methods and tactics to ensure that water is clean and does not threaten public health. Thus, all these studies reinforce the interdisciplinary nature of research on water quality and the need to go beyond common solutions and adapt ones with more innovative features to each challenge in low- and middle-income countries. Through developing collaboration between researchers, policymakers, and relevant parties, it will be possible to accomplish the provision of adequate management practices and availability of clean water to every community, today and in the future too.

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Conflict of interest

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