frontiers | Frontiers in Water

TYPE Editorial
PUBLISHED 24 March 2025
DOI 10.3389/frwa.2025.1584752

OPEN ACCESS

EDITED AND REVIEWED BY
Tissa H. Illangasekare,
Colorado School of Mines, United States

*CORRESPONDENCE
Geonildo Rodrigo Disner
✉ disner.rodrigo@gmail.com

RECEIVED 27 February 2025
ACCEPTED 10 March 2025
PUBLISHED 24 March 2025

CITATION
Disner GR and Tareq SM (2025) Editorial: Emerging water contaminants in developing countries: detection, monitoring, and impact of xenobiotics. *Front. Water* 7:1584752. doi: 10.3389/frwa.2025.1584752

Editorial: Emerging water contaminants in developing countries: detection, monitoring, and impact of xenobiotics

Geonildo Rodrigo Disner[1]* and Shafi Mohammad Tareq[2]

[1]Immunoregulation Unit, Laboratory of Applied Toxinology (CeTICS/FAPESP), Butantan Institute, São Paulo, Brazil, [2]Hydrobiogeochemistry and Pollution Control Laboratory, Department of Environmental Sciences, Jahangirnagar University, Savar, Bangladesh

KEYWORDS

emerging contaminants (EC), contaminants of emerging concern (CECs), developing countries, monitoring, xenobiotics

Editorial on the Research Topic
Emerging water contaminants in developing countries: detection, monitoring, and impact of xenobiotics

Water is indispensable for life, fundamentally sustaining ecosystems, regulating climate, and supporting basic human activities. Global water usage is projected to rise by 55% from 2000 to 2050, mainly driven by increased domestic and agro-industrial consumption (Osei-Owusu et al., 2023). As the demand for freshwater continues to grow, concerns about its quality are increasingly becoming central to addressing water scarcity (Saxena and Bhattacharya, 2024). Therefore, water quality control has become of primary importance for all countries, especially those under development. Notably, in these developing countries, freshwater sources are threatened due to climate change, population growth, and urbanization (Semasinghe et al., 2023).

Around half of the population globally experiences water shortage for at least part of the year. Water deficits were linked to a 10% increase in global migration between 1970–2000. The demand for freshwater is expected to outstrip its supply by 40% by the end of this decade. This crisis is worsening; without action, by 2050, water-related problems will shave about 8% off global GDP, with developing countries facing a 15% loss (Global Commission on the Economics of Water, 2025). Such a crisis may be attributed to the fact that the world's water systems are under unprecedented stress, with the main problem not being the availability of water but rather its quality and conservation.

In lower-income countries, poor water quality is due to low levels of wastewater treatment, which differ from higher-income countries, whereas runoff from agriculture poses the most serious problem (UN World Water Development Report, 2025). Water pollution presents serious risks to ecological and human health. Inorganic and organic pollutants, along with microbial agents, are increasingly seen as harmful to ecosystems and organisms (Shemer et al., 2023). Therefore, it is necessary to allocate resources to mitigate water pollution.

In that context, even the threats have changed. Nowadays, at the center of the debate are the emerging contaminants (ECs) such as pharmaceuticals (antibiotics, analgesics, anti-inflammatories, hormones), personal care products (hygiene and cosmetics), plasticizers,

surfactants, fire retardants (PBDEs), nanomaterials, fuel additives and pesticides, which have received special attention in recent years due to their hazardous effects (Daughton, 2007; UNEP, 2019; Rosenfeld and Feng, 2011). Emerging contaminants, best known as contaminants of emerging concern (CECs), encompass a large group of chemicals and pollutants not removed or eliminated by traditional water treatment processes (Puri et al., 2023). They are classified as emerging not necessarily because they are new but rather because there is growing concern that their presence is being detected in quantities and places not previously recorded (UNEP, 2019). Research on CEC has also been highlighted around the world in recent years. Hundreds of compounds detected in water, soil, or air are of anthropogenic origin, present in different effluents, or even, although less commonly, of natural origin. These pollutants have diverse chemical structures, whose behavior in the aquatic environment is diverse, and can, in addition to causing toxic effects, bioaccumulate in various organisms, including humans.

Emerging contaminants may also have low acute toxicity but cause significant reproductive effects at extremely low exposure levels. Furthermore, the effects of exposure in aquatic organisms during early life stages may only be observed in adulthood. This is because many of these pollutants act as endocrine disruptors, i.e., they alter the normal functions of hormones (as agonists or antagonists), resulting in various health effects. Due to their high use, emerging contaminants are increasingly detected at low levels in surface waters, and many studies reinforce the understanding that these compounds have a severe impact on aquatic life. Some of these substances are found in the environment at very low concentrations ranging from $ng.mL^{-1}$ to $\mu g.mL^{-1}$.

Many of these CECs are not part of water monitoring programs, and there is no specific legislation for their control. This highlights a critical need for studies that can shed light on the behavior of these compounds and their interaction with experimental and natural organisms. Research should aim to understand the risks associated with exposure to these compounds, with the ultimate goal of contributing to developing specific legislation. This regulation could potentially reduce their environmental impacts, either by prohibiting their production, reducing their presence, or even optimizing their removal in treatment plants (Montagner et al., 2017).

Regrettably, developing countries, such as Brazil and Bangladesh, bear the brunt of pollution resulting from emerging contaminants. These countries, with their burgeoning economies and populations, are more susceptible to the environmental impacts of industrial production. They often house the manufacturing plants of many companies, and the environmental externalities of this production are a significant challenge for these thriving economies. For this reason, pollution prevention at source, the precautionary principle, and remediation of contaminated habitats have become key elements of successful policies to prevent, control, and reduce the entry of hazardous substances, excess nutrients, and other pollutants into aquatic ecosystems.

Therefore, detection and monitoring programs are imperative for stopping the increase in the environmental collapse boosted by chemical pollution. Looking toward reaching the Global Goals for Sustainable Development, notably "clean water and sanitation" and "life below water" and promoting "One Health," which integrates and optimizes the health of people, animals, and the environment, this Research Topic aimed to gather scientific contributions covering the study of the ecotoxicological effects and toxic mechanisms of emerging contaminants, as well as to provide meaningful contributions and insights on the impact of novel contaminants present in aquatic sources.

The compiled works in this Research Topic concentrate on different aspects of emerging water contaminants. The study by Kulathunga et al. focuses on evaluating the levels of potentially toxic heavy metals in groundwater and locally grown rice in Sri Lanka, where there is a high prevalence of chronic kidney disease of unknown etiology (CKDu). Throughout the study, the authors performed a comprehensive health risk assessment to elucidate the relationship between heavy metals exposure and CKDu, which is relevant to developing countries, as it highlights the potential health risks of toxic heavy metals in essential food and water sources. Another study by Ishaque et al. underscores the broader implications of water contamination on national security and sustainability. It also highlights the difficulties developing countries face in implementing effective water management policies, aligning with the global challenges of providing clean water amid pollution, resource overuse, and inadequate infrastructure. Brahma et al. investigated the quality of commercially supplied jar water in Bangladesh, focusing on physicochemical, trace element, and microbial parameters to assess potential human health risks. Their findings on arsenic contamination and microbial pathogens in commercial drinking water reflect the broader challenge of ensuring safe water access in areas with limited regulatory enforcement and emphasize the need for effective quality control and governmental oversight, illustrating how poor water safety standards in developing nations contribute to public health risks, including chronic diseases and waterborne infections. Peixoto et al. assessed the toxicity of Diuron, a widely used herbicide in Brazilian agriculture, particularly in sugarcane farming, and its metabolites—3,4-dichloroaniline (DCA) and 3-(3,4-dichlorophenyl)-1-methylurea (DCPMU)—on zebrafish, a relevant model for ecotoxicology and human health risk assessment. Given the persistence, environmental impact, and high use of Diuron, this study uses a multiparametric approach to assess their effects on zebrafish at early developmental stages and in adult specimens, which is particularly relevant where extensive pesticide use contributes massively to environmental and water pollution.

In conclusion, this Research Topic contributed to advancing our understanding of the major concerns related to environmental contamination and water quality, particularly in developing countries. The contributions highlight the impact of pollutants, underscoring the multifaceted nature of environmental risks and revealing how contaminants affect ecosystems, human health, and societal stability. The findings support a One Health perspective and stress the need for rigorous monitoring, policy development, and sustainable management strategies to mitigate the adverse

effects of contaminants on water resources, informing global and regional efforts to protect public health and achieve sustainable development goals.

Author contributions

GD: Writing – original draft, Writing – review & editing. ST: Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. GD is supported by the São Paulo Research Foundation - FAPESP (#2019/27677-7).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Daughton, C. G. (2007). "Pharmaceuticals in the environment: sources and their management," in *Analysis, fate and removal of pharmaceuticals in the water cycle,* eds. D. Barcelo, and M. Petrovic (Amsterdam: Elsevier Science), 1–58. doi: 10.1016/S0166-526X(07)50001-2

Global Commission on the Economics of Water (2025). Available online at: https://watercommission.org/ (accessed February 21, 2025).

Montagner, C. C., Vidala, C., and Acayababa, R. D. (2017). Contaminantes emergentes em matrizes aquáticas do Brasil: cenário atual e aspectos analíticos, ecotoxicológicos e regulatórios. *Quim. Nova* 40, 1094–1110. doi: 10.21577/0100-4042.20170091

Osei-Owusu, J., Heve, W. K., Duker, R. Q., Aidoo, O. F., Larbi, L., Edusei, G., et al. (2023). Assessments of microbial and heavy metal contaminations in water supply systems at the University of Environment and Sustainable Development in Ghana. *Sustain. Chem. Environ.* 2:100015. doi: 10.1016/j.scenv.2023.100015

Puri, M., Gandhi, K., and Kumar, M. S. (2023). Emerging environmental contaminants: a global perspective on policies and regulations. *J. Environ. Manage.* 332:117344. doi: 10.1016/j.jenvman.2023.117344

Rosenfeld, P. E., and Feng, L. G. H. (2011). "Emerging contaminants," in *Risks of Hazardous Wastes,* eds. P. E. Rosenfeld, and L. G. H. Feng (Boston: William Andrew Publishing), 215–222. doi: 10.1016/B978-1-4377-7842-7.00016-7

Saxena, M., and Bhattacharya, A. (2024). "Separation of microbial and organic pollutants from water using low-pressure tailor-made membranes," in *Advances in Drinking Water Purification* (Elsevier), 327–352. doi: 10.1016/B978-0-323-91733-9.00014-3

Semasinghe, C., Jatrana, S., and King, T. J. (2023). Exploring the associations between the perception of water scarcity and support for alternative potable water sources. *PLoS ONE* 18:e0283245. doi: 10.1371/journal.pone.0283245

Shemer, H., Wald, S., and Semiat, R. (2023). Challenges and solutions for global water scarcity. *Membranes* 13:612. doi: 10.3390/membranes13060612

UN World Water Development Report (2025). Available online at: https://www.unesco.org/reports/wwdr/en (accessed February 21, 2025).

UNEP (2019). *Evidence Rising: The Emerging Pollutants Poisoning Our Environment*. Nairobi: UNEP. Available online at: https://www.unep.org/news-and-stories/story/evidence-rising-emerging-pollutants-poisoning-our-environment (accessed November 4, 2024).