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Addressing microplastics in drinking water in the global plastics treaty – Gaps, challenges and opportunities

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Abstract

The escalating presence of microplastics (<5 mm) in drinking water presents urgent environmental and health challenges, yet the United Nations Environment Programme's (UNEP) Global Plastics Treaty draft texts, including UNEP/PP/INC.5/4 and the Chair's Text, lack robust provisions to address this issue. This Letter to the Editor analyzes deficiencies in the treaty's approach, identifying critical gaps in standardized terminology, globally consistent monitoring methodologies, comprehensive source control and enforceable international regulations. Leveraging insights from California's innovative microplastics monitoring framework, which employs spectroscopy-based detection and provisional health thresholds, we highlight scalable solutions for global policy. Key obstacles include technological disparities, economic reliance on plastic production, limited toxicological data and geopolitical barriers to unified action. We propose targeted strategies for the Intergovernmental Negotiating Committee (INC-5.2), including adopting precise microplastics definitions, establishing universal detection protocols, regulating both primary and secondary microplastic sources and supporting research and capacity-building in low-resource regions. These measures aim to enhance the treaty's ability to mitigate microplastic pollution in drinking water, fostering science-driven global cooperation to protect ecosystems and public health.

Impact statement

Microplastics pose a significant threat to environmental and human health, yet they remain inadequately addressed in the draft texts and Chair's Texts of the United Nations Environment Programme (UNEP) Global Plastics Treaty. This Letter to the Editor highlights key gaps in the Global Plastics Treaty's approach to addressing microplastics in drinking water, drawing on recent literature and regulatory developments, such as California's pioneering microplastics monitoring in drinking water. We identify challenges, including the lack of standardized definitions, monitoring methodologies and global regulatory frameworks, and propose actionable recommendations to strengthen the Global Plastics Treaty's effectiveness in tackling microplastic pollution in drinking water. These include integrating specific microplastics provisions, harmonizing global monitoring standards and leveraging lessons from regional regulations.

Letter to the editor

Plastic pollution, particularly microplastics (plastic particles <5 mm), has emerged as a critical global environmental challenge, impacting marine, terrestrial, freshwater and atmospheric ecosystems, as well as human health (Thompson et al., 2024; Ammendolia et al., 2025). The United Nations Environment Assembly (UNEA) Resolution 5/14 mandates a legally binding Global Plastics Treaty to address the full life cycle of plastics, including microplastics, by the end of 2024 (UNEA, 2022). Despite progress in negotiations through the Intergovernmental Negotiating Committee (INC), microplastics remain a significant gap in the draft treaty texts, as highlighted in recent analyses (Thompson et al., 2024; Farrelly et al., 2025). This Letter to the Editor examines these gaps, drawing on the Compilation of Draft Text UNEP/PP/INC.5/4 and the Chair's Text, alongside California's pioneering microplastics regulations in drinking water, to propose solutions for an effective treaty (Coffin et al., 2022; Coffin, 2023; UNEP, 2024a; UNEP, 2024b).

To inform these solutions, it is essential to first examine where the current treaty texts fall short in addressing microplastics in drinking water. A closer review of the Compilation of Draft

Text (UNEP/PP/INC.5/4) and Chair's Text INC-5.2 reveals several structural and substantive omissions that undermine their capacity to manage microplastic pollution, specifically in drinking water, effectively (UNEP, 2024a; UNEP, 2024b). These gaps span **definitions, monitoring protocols, source attribution and regulatory enforcement**.

One of the most fundamental issues **is the lack of clear and consistent definitions**. Terms such as "microplastics," "intentionally added microplastics" and "problematic plastics" are not clearly delineated in either the Chair's Text or the Compilation Text (UNEP, 2024a; UNEP, 2024b). This ambiguity hampers the development of enforceable regulations, obstructs data standardization and weakens compliance mechanisms. As Farrelly et al. (2025) highlight, definitions are not merely semantic; they form the legal and technical foundation for action. Without shared terminology, international coordination becomes fragmented and ineffective.

Building on this concern is the treaty's failure to establish **harmonized monitoring standards** for microplastics. Although monitoring is acknowledged as vital to the treaty's implementation, there are no globally accepted methodologies outlined in the draft texts. This is a significant limitation given the diverse types and pathways of microplastic pollution. Vince et al. (2024) and Zhao et al. (2024) both note that inconsistencies in sampling and analytical techniques across regions – particularly in drinking and freshwater monitoring – make it nearly impossible to compare data or track long-term trends. In the absence of a standardized global framework, efforts to detect and regulate microplastics – particularly in sensitive systems like drinking water – remain localized and ineffective (Bakir et al., 2024; Xiong, 2025).

Closely linked to the monitoring gap is the treaty's **limited attention to the full range of microplastic sources**. The existing drafts emphasize interventions like improvements in waste management systems, which are primarily downstream measures focused on post-consumer plastic handling. While bans on single-use plastics, as top-down approaches, represent upstream interventions aimed at reducing plastic production and use at the source, the drafts inadequately address other primary microplastics (e.g., microbeads in cosmetics, fibers from synthetic textiles, tire wear particles). As emphasized by Diana et al. (2024), the treaty must explicitly include secondary microplastics (i.e., generated by degradation of larger plastics) to fulfill its stated mandate. Thompson et al. (2024) and Lea (2023) point out, this narrow focus ignores some of the most prevalent and difficult-to-control contributors to microplastic pollution. A more holistic approach is required to address both primary and secondary microplastic sources effectively.

Moreover, the treaty suffers from an **insufficient global regulatory framework** to effectively manage the transboundary nature of microplastics. While the texts acknowledge existing instruments like the Basel Convention, they fall short of providing specific measures or legal instruments to monitor and control microplastics' movement across borders or their release into shared environments. The Chair's Text also reflects a tension between respecting national sovereignty and fostering global cooperation – a tension that often results in nonbinding language or "no text" options that dilute enforceability. This regulatory gap could lead to inconsistent implementation across countries and hinder the treaty's overall impact.

Taken together, these gaps reflect a broader pattern: while the Global Plastics Treaty aspires to address plastic pollution in drinking water comprehensively, its current form fails to operationalize that ambition. Closing these gaps will require not only technical refinement but also political will and alignment among stakeholders. Despite these shortcomings, regional frameworks are beginning to fill the void by developing more rigorous approaches to microplastics governance. One such example is California's regulatory model, which offers valuable insights into how microplastics in drinking water can be monitored, managed and integrated into broader environmental health strategies. California's approach to regulating microplastics in drinking water provides a robust, science-informed model that could significantly enhance the Global Plastics Treaty. Its legal and technical framework, developed under the State Water Resources Control Board, demonstrates how regional leadership can advance microplastics governance, even in the absence of global consensus (Coffin et al., 2022; Coffin, 2023).

A major contribution of California's policy is its **adoption of standardized analytical methods** for microplastics detection. Since 2021, the state has implemented the world's first drinking water testing requirements for microplastics, using spectroscopy-based methods such as Fourier-transform infrared (FTIR) and Raman spectroscopy to detect particles down to 1 μm in size (Wong and Weisberg, 2024). This methodical precision allows for consistent and replicable data across utilities and timeframes, a standard sorely lacking in the current draft treaty texts. These practices address key technical gaps identified by Vince et al. (2024) and Lea (2023), who emphasize that reliable data depend on uniform protocols and analytical reliability.

In addition to methodological rigor, California has begun setting **health-based thresholds** to guide risk assessment, another area where the treaty remains silent. While these thresholds are provisional and not yet enforceable as maximum contaminant levels (MCLs), they create a risk-informed baseline for future regulatory development. The State Water Board's draft thresholds, developed in consultation with toxicologists and epidemiologists, reflect a precautionary approach that aligns well with the treaty's stated principles – yet they remain unmatched in the global arena.

California's legislative landscape also underscores the importance of **continuous research funding.** Assembly Bill 1365 (2023) mandates further studies into the toxicological and ecological impacts of microplastics, including their interaction with chemical additives and other contaminants. This is vital given persistent uncertainties around microplastics' health effects, especially their potential as vectors for heavy metals and persistent organic pollutants, as highlighted by laboratory studies by Lea (2023). Embedding research mandates within policy ensures responsiveness to evolving scientific knowledge – a model that global negotiators could emulate.

Finally, California's regulations offer a governance **template for public transparency and institutional accountability**. Water utilities are required to report results publicly, and the monitoring program includes third-party data validation. This transparent, multi-stakeholder process not only enhances public trust but also encourages early adoption of mitigation strategies. In contrast, the draft treaty lacks clarity on data disclosure obligations, an omission that could limit public engagement and compliance motivation on the international stage.

California's pioneering framework demonstrates that subnational initiatives can drive innovation and set de facto global standards. By drawing lessons from California's experience – particularly in analytical standardization, health-based thresholds, research funding and transparency – the Global Plastics Treaty can more effectively incorporate microplastics into its scope and build a resilient foundation for long-term environmental and public health protection. Yet scaling such efforts globally presents

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significant hurdles. Addressing microplastics at the international level requires confronting a range of systemic challenges that go beyond policy design – challenges rooted in **technical disparities, economic structures, scientific uncertainty and geopolitical complexity.**

A major **technical barrier** is the lack of accessible monitoring technology in many low-resource regions. The detection and quantification of microplastics – especially those smaller than 5 µm – require advanced instrumentation such as Raman or FTIR spectroscopy and specialized filtration and imaging tools. These technologies are expensive and require trained personnel, making them unattainable for many developing countries and Small Island Developing States (SIDS). As Farrelly et al. (2025) highlight, the disparity in technical capacity between high- and low-income nations poses a serious obstacle to globally harmonized monitoring and compliance efforts.

Compounding the technical issues are **economic dependencies** that make reducing microplastics production politically sensitive. Many countries, particularly those with large petrochemical and textile industries, are heavily reliant on the economic value generated by plastic manufacturing and exports. These dependencies can slow down efforts to restrict primary microplastic sources such as synthetic fibers, tire wear particles and industrial abrasives. As UNEP (2024a) notes, this is especially problematic given the treaty's goal of addressing the full life cycle of plastics, including upstream production.

Another significant hurdle is the **knowledge gap regarding microplastics' health and ecological impacts**. While microplastics are known to be ubiquitous in drinking water and food systems, their toxicological pathways remain poorly understood. For example, findings by Lea (2023) suggest that aged microplastics more readily adsorb heavy metals, increasing the risk of bioaccumulation and toxicity in aquatic environments and possibly in humans. However, comprehensive epidemiological studies remain scarce. Thompson et al. (2024) also stress that additive chemicals such as phthalates and flame retardants associated with microplastics have potential endocrine-disrupting effects but remain largely unregulated due to a lack of data.

Lastly, efforts to coordinate global action are often hindered by **geopolitical fragmentation and uneven regulatory ambition**. As Vince et al. (2024) observe, negotiations under the INC reveal major disparities in national positions regarding the scope, definitions and enforcement mechanisms of the treaty. These disagreements are compounded by principles of national sovereignty in the Chair's Text, which allow countries significant discretion in implementation, potentially undermining the treaty's uniformity. Without stronger mechanisms for coordination, funding and capacity-building, these structural gaps could prevent the treaty from achieving global coherence.

Despite these barriers, there remains a window of opportunity to strengthen the treaty's provisions through targeted, evidence-based actions. Several practical strategies – grounded in science, policy experience and international equity – can help close the current gaps and enhance the treaty's ability to address microplastic pollution in drinking water effectively. To address these gaps and challenges, we propose the following for INC-5.2 negotiations:

- Define Microplastics Explicitly: Adopt a clear, science-based definition of microplastics to guide policy and enforcement, building on existing frameworks (Thompson et al., 2024).
- Develop Global Monitoring Standards: Establish standardized protocols for microplastics detection, drawing on California's spectroscopy-based methods (California State Water Resources Control Board, 2024) and informed by global freshwater monitoring challenges identified by Zhao et al. (2024).
- Target Primary and Secondary Sources: Include provisions to regulate primary microplastics (e.g., bans on microbeads in cosmetics) and incentivize technologies to prevent plastic degradation (Thompson et al., 2024) and avoid secondary pollution pathways, particularly from poorly regulated recycling streams (Singh and Walker, 2024).
- Leverage Regional Models: Integrate lessons from California's regulations, such as mandatory monitoring and health-based thresholds, into the treaty framework (Waterworld, 2023).
- Support Research and Capacity Building: Allocate funding for microplastics research and technical assistance for SIDS and developing nations (Farrelly et al., 2025).

By implementing these recommendations, the treaty can move beyond its current limitations and chart a more effective course for addressing microplastics in drinking water. These particles represent a critical yet underexplored dimension of the plastic pollution crisis. The Global Plastics Treaty offers a rare opportunity to tackle this issue through science-based standards, robust international cooperation and informed policy design. Drawing from pioneering regional frameworks like California's, negotiators can construct a treaty that not only bridges key gaps but also advances global efforts to safeguard environmental and human health. Urgent action at INC-5.2 is essential to realizing this potential.

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