Regulating chemicals globally is key to successful plastics treaty

Susanne Brander, Coastal Oregon Marine Experiment Station, College of Agricultural Sciences, Oregon State University, Corvallis, OR, U.S.A. (https://orcid.org/0000-0002-2305-5659)

Andrea Bonisoli-Alquati, Department of Biological Sciences, California State Polytechnic University – Pomona, Pomona, CA, USA (https://orcid.org/0000-0002-9255-7556)

Xavier Cousin, MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, INRAE, 34250, Palavas, France (https://orcid.org/0000-0002-8520-3610)

Trisia Farrelly, Transdisciplinary Science Group, Cawthron Institute, Nelson, NZ; and School of People, Environment and Planning, Massey University, Palmerston North NZ (https://orcid.org/0000-0002-0333-3893)

Ricarda Fieber, Department of Management, Technology and Economics, ETH Zurich, Zurich, Switzerland (https://orcid.org/0009-0000-9001-0314)

Jane Muncke, Food Packaging Forum Foundation, Zurich, Switzerland (http://orcid.org/0000-0002-6942-0594)

Hervé Raps, Medical Biology Department, Centre Scientifique de Monaco, Monaco, Principality of Monaco (https://orcid.org/0000-0002-5532-2715)

Martin Wagner, Department of Biology, Norwegian University of Science and Technology, Norway (https://orcid.org/0000-0002-4402-3234)

Figure 1. A treaty lacking in, or with weak consideration of, chemicals of concern would lead to increases in chronic diseases. The gap in regulation would also lead to increased waste and healthcare expenses, and regulatory costs associated with the ongoing removal and replacement of hazardous plastic chemicals in use with potentially regrettable substitutions. A treaty that considers of plastic chemicals across the full life cycle of plastisc will improve overall human and environmental health, material circularity. It will also limit plastic chemicals essential uses, and facilitate a just transition to a safer and more sustainable global economy. Icons sourced from Biorender and The Noun Project, 2024.

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Impact Statement: In advance of INC 5.2, we highlight the urgency and importance of fully incorporating plastics-associated chemicals of concern in the final treaty text. Their widespread hazards to human (Symeonides et al., 2024) and environmental health (e.g. Giroux et al., 2024) are long-established: they present a threat to several United Nations Sustainable Development Goals (Brander et al., 2024) and they have already exceeded planetary boundaries (Persson et al., 2022).

Abstract:

The unchecked rise in global plastic production has resulted in widespread pollution and exposure to hazardous chemicals. Over 16,000 chemicals are used across the plastics life cycle, with thousands meeting criteria for persistence, bioaccumulation, mobility, and toxicity. Many remain unregulated under existing multilateral environmental agreements. In response, the United Nations Environment Assembly (UNEA) has mandated the development of an international legally binding instrument to end plastic pollution. Current treaty negotiations have begun addressing a short list of chemicals, yet significant gaps remain. These include insufficient regulatory mechanisms, lack of chemical transparency, and reliance on ineffective recycling strategies that reintroduce toxic substances into consumer products. The presence of harmful chemicals in plastics contributes to major public health burdens and is an environmental threat, with high annual costs that reduce the potential for economic development through safer recycling. Vulnerable populations, including children, reproductive-aged individuals, and frontline communities, face heightened risks. To address this, we recommend three critical actions for the treaty: (1) globally regulating chemicals of concern based on hazard; (2) mandating transparency of plastic chemical composition; and (3) designing plastics using safe-by-design principles and essential-use criteria. Group-based regulation, which would consider categories of related chemicals, should replace individual chemical approaches to prevent regrettable substitutions. Binding, global obligations, rather than fragmented or voluntary measures, are vital for sustainability, chemical safety, circularity, and accountability across the plastics life cycle. A strong treaty is a critical opportunity to achieve a safer, more sustainable future for human and environmental health.

Keywords: plastic chemicals, chemicals of concern, hazards, UNEP, chronic disease

Introduction

The Scientists' Coalition for an Effective Plastics Treaty (the Scientists' Coalition) has reached scientific consensus that the unbounded increase in plastic production and subsequent pollution presents distinct hazards to human and environmental health as well as unevenly distributed and disproportionate impacts to marginalized countries and communities, particularly those in lower and middle-income countries (Brander et al. 2024, Farrelly et al. 2025). According to a recent report, upwards of 16,000 chemicals can be used in plastics across the full life cycle, with over 4,200 meeting persistence, bioaccumulation, mobility, and toxicity (PBMT) criteria based on government and other authoritative assessments (Wagner et al., 2024), and over 3,600 unregulated in existing multilateral environmental agreements (e.g., Basel, Stockholm Conventions). These chemicals of concern span across a range of classes and uses, including starting substances (e.g., monomers), additives (e.g., plasticizers, colorants, flame retardants),

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and processing aids (e.g., lubricants), in addition to non-intentionally added substances (NIAS). NIAS include reaction byproducts, degradation products, and impurities. In response to this massive health and environmental challenge, the UNEA put forth resolution 5/14 “End plastic pollution: Toward an international legally binding instrument” in March 2022 requesting that the United Nations Environment Programme (UNEP) bring countries together across the globe to negotiate and establish an international legally binding instrument to end plastic pollution.

As we prepare for the second part of the fifth session of the Intergovernmental Negotiating Committee (INC-5.2) to develop a global plastics treaty, member states are considering the latest draft of the treaty (‘the Chair’s text’). Article 3 of the Chair's text suggests that chemicals should be regulated. The Scientists’ Coalition considers the regulation of plastic chemicals crucial to the success of the treaty. Here, we offer recommendations for the Chair’s text that will protect people and the environment from the hazardous chemicals present in plastics all along the full life cycle.

While negotiations have progressed, and the Chair’s text now specifically refers to few plastic chemicals with well-established toxicity, such as bisphenols and phthalates, further headway has been slowed by pushback from the lower-ambition countries involved in treaty negotiations. The lack of current global regulatory oversight has been exacerbated by insufficient global legally binding measures requiring supply chain actors to disclose key information about plastic chemicals. This regulatory gap has been justified by claims of proprietary formulations and trade secrecy, preventing the public from knowing which harmful chemicals are present in plastics, and scientists from assessing the full impacts of plastics. Importantly, this data disclosure is essential to supply chain actors seeking safe and sustainable plastics. For example, a lack of data transparency and the push by some countries to focus primarily on waste management has resulted in unknown chemical mixtures in recyclates, and the continued release of macro-, micro- and nano-sized plastic particles and particulates. For example, one recent study found that 6–13% of plastics processed in recycling may be released to water or air as microplastics (Brown et al., 2023). Complex and poorly characterized chemical mixtures in recycled plastics are reintroduced into consumer products including food packaging and children's toys (Carmona et al., 2023; Liu et al., 2024).

Hazards, health, and environmental concerns

Considering the large number (over 4,200) of hazardous chemicals in plastics, many toxicity mechanisms or targeted functions are at play (Wagner et al., 2024; Wiesinger et al., 2025;). Almost 1,500 plastic chemicals are Carcinogenic, Mutagenic, or Toxic to Reproduction. Some plastic chemicals are endocrine disrupting chemicals while others (over 1,700 chemicals) may adversely affect specific organs or systems after repeated exposures. In addition, over 2,700 chemicals of concern are known to be toxic to aquatic organisms and over 450 chemicals are persistent, bioaccumulative, and/or mobile. This highlights that many plastic chemicals are not only of concern for human health; they can also present serious and lasting negative consequences for ecosystems.

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The financial consequences of ecosystem disruption by plastic chemicals are not easily assessed, while costs to society associated with adverse human health outcomes of plastic chemical use (Trasande et al., 2024) and other economic costs of plastic pollution (Beaumont et al., 2019) can be estimated. Plastic chemicals are linked to cancers, infertility, neurodevelopmental disorders, and cardiovascular and metabolic diseases like obesity and type 2 diabetes (Symeonides et al., 2024). Recent converging estimates of both direct (medical) or indirect (productivity loss) costs for some plastic chemicals (bisphenol A [BPA], selected per- and polyfluoroalkyl substances [PFAS], phthalates and polybrominated diphenyl ethers [PBDEs], among other chemicals) ranged from 250 to 675 billion USD yearly for the USA (Landrigan et al., 2023; Trasande et al., 2024;). These examples demonstrate that regulating chemicals of concern in the treaty would deliver substantial health and economic benefits. For instance, a regulation of BPA in *all* plastics could prevent up to 61,800–66,400 children annually (82-88% of cases) from developing childhood obesity in the US and EU and save associated health costs of 3.6–3.9 billion USD. In contrast, a phase-out of BPA in the specific products currently considered in the treaty text, such as toys, would only prevent 11–27% of childhood obesity cases (Scientists' Coalition for an Effective Plastics Treaty, 2025).

The example of BPA highlights the issue of regrettable substitution: BPA was replaced by structurally similar chemicals, e.g., Bisphenol S (BPS) with equal or even more severe effects on health than BPA (Wu et al., 2025). Therefore, it is crucial that chemical management that is protective of health and the environment avoids regrettable substitutions. The most effective way of ensuring this is by regulating chemicals as groups. For example, instating phase-outs on all bisphenols and exemptions for specific members of chemical groups only if reliable data can show the *absence of* hazard properties for a specific compound. Such exempted compounds are used in controlled environments and are not present in end-applications, and / or are essential and alternatives are not yet available.

Apart from their direct effects on human health, plastic chemicals can also have indirect effects on health as evidenced by effects on animal health (through contamination of the food chain, for example) and ecosystem health (through reduced or impaired ecosystem services). Apart from [or in addition to] their direct effects on human health, plastic chemicals can also have indirect effects on health through their effects on animal health (through contamination of the food chain, for example) and ecosystem health (through reduced or impaired ecosystem services). The chemical 6PPD or N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine is commonly used in tire rubber as an anti-degradant. 6PPD exemplifies the need to consider health through the prism of "One Health", which recognizes that the health of humans, animals, plants and the environment are interconnected and interdependent. After substantial analytical work, Tian et al. (2021) identified 6PPD, or more specifically its quinone derivative, as the plastic chemical responsible for the mass death of coho salmon and toxicity to other salmonid species (Mayer et al., 2024; Greer et al., 2023). The Washington State Department of Ecology has identified several populations affected by 6PPD, including Indigenous peoples, and populations with higher fish consumption, such as subsistence fishers from low income or communities of color, and people working in or living near tire manufacturing facilities, or exposed to artificial turf. The Department of Toxic Substances Control (DTSC) from California has estimated that loss of coho salmon has significantly impacted their Native American Tribal Nations. Beyond cultural loss, DTSC has

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paralleled the decline of the salmon fishery and the increase in disorders or disease in the Karuk Tribe in the Klamath Basin inducing a yearly health cost about 1.9 million USD (Bass, 2024; Morales, 2024).

It has been shown that early life stages (embryos *in utero* and children), as well as people of reproductive age, are particularly sensitive to several plastic chemicals. This highlights the need to protect these subpopulations, as developmental exposures can lead to diseases and disorders later in life. In addition, frontline and fence line communities (including waste workers and Indigenous Peoples) constitute other vulnerable populations, who are particularly chronically exposed to hazardous plastic chemicals. In addition, the use and presence of hazardous chemicals in plastic products poses a significant challenge to achieving a toxic-free and sustainable circular economy. Such chemicals undermine circular strategies such as safer and more sustainable reuse, repair, repurpose, remanufacture, and recycling. For instance, legacy substances which were widely used in plastic products, such as hexabromocyclododecane (HBCD), hinder safer and more sustainable reuse of plastic products in their entirety (Wagner & Schlummer, 2020).

Further, chemicals raise a variety of safety concerns for mechanical recycling as the most commonly applied recycling technology. Mechanical recycling can delay the phase-out of legacy substances and increase risk to human exposure when they are reintroduced into new products such as food packaging and artificial turf (Wiesinger et al. 2024, Mayer et al. 2024). Brominated flame retardants in electrical and electronic products can be recycled and introduced into consumer goods, like toys and kitchen utensils (Hahladakis et al., 2018). Harmful plastic chemical emissions released during processing pose occupational health risks, especially in informal or poorly regulated settings (Cook et al., 2023). Moreover, mechanical recycling can result in the formation of complex and often poorly characterized chemical mixtures. These mixtures in recycled plastics may reintroduce hazardous chemicals into consumer products, including food packaging and children's toys, raising safety concerns (Carmona et al., 2023). Testing recyclates for a wide range of substances to ensure their safety is technically challenging, particularly for NIAS, and due to extensive time and analytical requirements, this can also be financially burdensome. In summary, hazardous plastic chemicals pose a broad range of safety and sustainability challenges and hinder a transition to plastics circularity and if they are not regulated at design phase, toxic leakage and emissions become increasingly challenging and costly to mitigate as supply chains become increasingly complex (Houssini et al., 2025).

Way Forward

Considering the above, we strongly recommend that the plastics treaty addresses chemicals of concern if it is to deliver on the goal of the UNEA resolution 5/14 to "protect human health and the environment". Addressing chemicals of concern is also a prerequisite to achieve the treaty objective to make plastics safer, more sustainable, and more circular. There are three major pathways to improve the chemical safety of plastics.

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First, the use of known chemicals of concern in plastics will be best regulated based on their hazards (Wagner et al., 2024). Phase-outs of known chemicals of concern globally have been implemented in the past, and continuing this process will have substantial benefits for public and environmental health and result in significant cost savings (Cropper et al., 2025). It will also provide regulatory clarity and a level playing field for plastic manufacturers (Scientists' Coalition for an Effective Plastics Treaty, 2024). Importantly, these benefits and the success of the instrument will be significantly greater if phase outs are global and comprehensive rather than national and limited in scope.

Second, the widespread lack of transparency, traceability, and trackability on plastic chemicals hinders not only the implementation of effective policies, such as trade restrictions, but also a just transition towards safer and more sustainable plastics. Hence, the treaty should consider plastic chemicals data as public interest information and require plastic producers to publicly disclose the chemical composition of plastics. This is an area that has not seen much progress so far and would support the universal human right to access to information, enabling consumers to make informed decisions and supply-side actors to proactively improve the safety and sustainability of their products, meaning that sustainable chemistry would be used in the design of products and processes, with the aim to minimize waste and the generation of hazardous substances.

Third, redesigning plastic materials and products to improve their safety and to facilitate chemical simplification will be key to avoid shifting to similarly harmful chemicals, enabling a transition to a truly safer and more sustainable plastics economy. An efficient mechanism to list new chemicals for global regulation can address this issue but alone, it will be insufficient to end the "whack-a-mole" of new plastic chemicals (in which one hazardous chemical is merely replaced with another). Accordingly, incentivizing a safe-and-sustainable-by-design approach to new plastic materials and products that contain fewer and safer chemicals will require comprehensively assessing those chemicals, with premarket testing and post-market regular monitoring and reporting requirements.

Conclusion

Incorporating strategic and robust global controls on hazardous chemicals in the plastic treaty is essential to protect human and environmental health, reduce societal costs, and ensure safer and more sustainable plastic chemicals and products. Chemicals of concern are currently intrinsic to plastics and largely unregulated. Aligning chemical regulation globally would enable coordinated phase-outs of harmful substances, reduce the burden of fragmented national policies, and incentivize reduction in chemicals all of which supports the broader transition to a safer and more sustainable circular economy. Binding global obligations, rather than voluntary measures, will ensure chemical transparency across the plastics lifecycle. Covering all plastic chemicals and using grouping approaches will prevent loopholes and regrettable substitutions. Sustainable chemistry innovation and simplification based on safety, sustainability, transparency, and essential use criteria will collectively ensure companies are accountable for safer and more sustainable plastic chemicals in our products. This treaty is a pivotal opportunity

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to shift toward a safer and more sustainable future global chemical footprint.

Author contributions

As corresponding author, S.B. has the authority to act on behalf of all co-authors. S.B. conceptualized the Letter and produced the first draft of the Letter. All authors are co-leads or core members of a Scientists' Coalition for an Effective Plastics Treaty working group. All authors substantially contributed to the work by adding content in their field of expertise. All authors contributed to the final drafting, cohesion, and integration of the Letter in its entirety and approved its final version for publication. Therefore, all authors are accountable for all aspects of the work.

Conflicts of interest statements

Martin Wagner is an unremunerated member of the Scientific Advisory Board of the Food Packaging Forum foundation. Trisia Farrelly is a Senior Editor of *Cambridge Prisms: Plastics*. Susanne Brander serves on the Green Ribbon Science Panel (advisory board) for the Safer Consumer Products program at the California Department of Toxic Substances Control.

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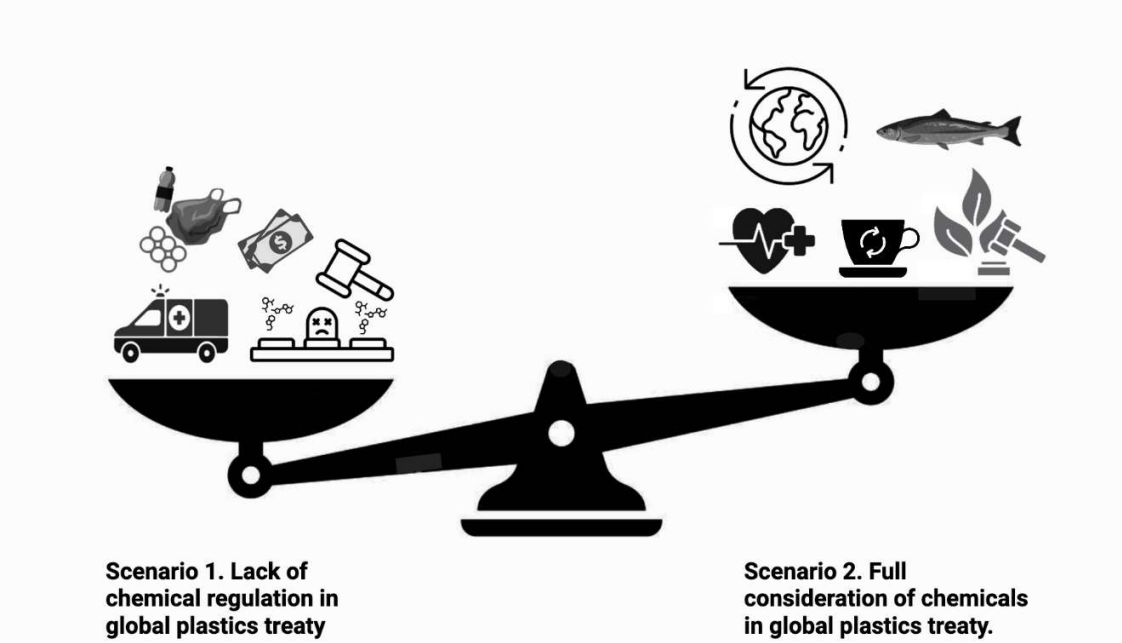
Figure 1



Scenario 1. Lack of chemical regulation in global plastics treaty

Scenario 2. Full consideration of chemicals in global plastics treaty.

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