*Cambridge Prisms: Plastics*

**www.cambridge.org/plc**

# Complexity in managing plastics

Rosalind Malcolm

Surrey Centre for International and Environmental Law, Surrey Law School, University of Surrey, Guildford, UK

## Letter to the Editor

**Cite this article:** Malcolm R (2025). Complexity in managing plastics. *Cambridge Prisms: Plastics*, **3**, e25, 1–3
https://doi.org/10.1017/plc.2025.10020

Received: 30 June 2025
Revised: 04 July 2025
Accepted: 07 July 2025

**Keywords:**
plastics; Global Plastics Treaty; chemical additives; international legally binding instrument; international negotiations; life cycles of plastics

**Corresponding author:**
Rosalind Malcolm;
Email: r.malcolm@surrey.ac.uk

### Abstract

This letter discusses the complex nature of plastics, why regulating plastics is a 'wicked problem', and the implications of a life cycle approach. The draft Global Plastics Treaty attempts to address two key problems: the cap on production and the problem of chemical additives in plastics. As a 'wicked' problem with many conflicting interests, dealing with plastics requires a holistic life cycle approach completely different from the Montreal Protocol. Strict and enforced limits on polymer production would reduce plastics pollution and also encourage a reduction in the range of additives, as limiting production would make mechanical or chemical recycling more viable. Used plastics need to be turned into a commodity rather than a waste, and reducing and standardising the number of different chemical formulations would help by reducing the number of chemicals to be regulated. To achieve these objectives, this letter argues for a regulatory approach based on a forensic analysis that applies extended environmental systems analysis to all the life cycle stages of the plastics value chain.

### Impact statement

There is clear evidence of the negative impacts of the chemical additives to plastics on society and the environment, and in cases where these impacts have not been evaluated, a precautionary approach should be taken (UNEP [2023], *United Nations Environment Programme and Secretariat of the Basel, Rotterdam and Stockholm Conventions.* Chemicals in Plastics: A Technical Report] and Wiesinger et al. [2021], *Environmental Science and Technology* 55, 9339–9351]). However, the failure to achieve a consensus at INC-5 leaves the possibility of thousands of potentially harmful chemicals used in plastics to be left poorly regulated and continue to escape into the environment. Legal frameworks around the plastics lifecycle need to be interrogated and clarified so that these chemicals are adequately regulated through a process of evaluation and registration and subjected to an extended environmental systems analysis, including their impacts on people and the environment. Including a careful forensic approach in the Global Plastics Treaty to the use of additives in plastics based on legally enforceable systems will be of huge value to the health of society and the environment.

## Introduction

In November 2024, the countries attending the fifth set of negotiations failed to reach an agreement on a Global Plastics Treaty. These negotiations started formally in March 2022, following a UNEA Resolution (UNEA-5.2) at the fifth session of the UN Environment Assembly agreeing on the need to develop an international legally binding instrument on plastic pollution, including in the marine environment.

The UNEA resolution (5/14) requested the Executive Director of the UN Environment Programme (UNEP) to convene an Intergovernmental Negotiating Committee (INC) to develop 'the instrument', to be based on a comprehensive approach addressing the full life cycle of plastic, including its production, design and disposal.

## The complexity of the life cycle

This logical approach based on life cycle thinking hides a complexity of different interests. The full life cycle of plastics includes all stages from the extraction of fossil fuels (which are still the feedstock for the great majority of bulk-use plastics) to disposal, including in the form of waste and emissions into the environment (UNEP INC 1, 2022; UNEP INC 1 INF, 2022). In the traditional linear approach to the use of materials, this can be characterised by the expression 'cradle to grave'. In a circular approach, where the materials are kept within the economy for reuse, remanufacture or recycling, then it might be described as 'cradle to cradle' (Malcolm and Mikheeva-Ashe, 2024). But

© The Author(s), 2025. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (http://creativecommons.org/licenses/by/4.0), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 16:20:29, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/plc.2025.10020

in either approach, a multitude of different economic interests are at play, leading to the complexity of the life cycle for plastics.

A key reason for this complexity lies in the fact that plastics are not a single substance: in addition to the basic polymers, plastics contain thousands of different constituents and chemical additives. All plastic products are made from the essential polymer mixed with a complex blend of materials known collectively as additives. Additives are essential to change structure, form and colour and make plastics into useful materials. Many different chemicals and additives are applied for different purposes during these stages. However, these added chemicals may themselves be problematic or even hazardous. For example, some chemicals added to make the 'plastic' material easier to form into a required shape, known as 'plasticisers', are endocrine disruptors with health impacts on fish and other aquatic organisms (UNEP, 2023; RCEP, 2003; Clift et al., 2019). However, only 25% of plastic additives have been characterised for their potential ecological concern (Maddela et al., 2023; Malcolm et al., 2025). According to the PlastChem Report (Wagner et al., 2024), there is evidence that more than 16,000 chemicals are potentially used or present in plastic materials and products, but 'a mere 6% of these chemicals are currently subject to international regulation'. This is surprising, given the level of scrutiny at the international level, including the European Union, of chemicals and would seem to be the result of inadequate regulatory attention to the plastics life cycle and its use of additives. This life cycle is not, in fact, that of a single material or a limited number of materials, but rather of a bundle of different materials with divergent – and often unknown – effects. On its own, the regulation of the chemicals used in plastics could have been the core and essential driver for a Global Plastics Treaty.

Not only are additives extensively used, but they also vary on a worldwide basis. Different world markets use different dyes, shapes and types of plastics, making waste collection even more challenging. Plastics in the South American market include a different range of containers to those marketed in Europe.[1] However, all these products fall under the generic heading of 'plastics'.

This complex life cycle hides numerous economic interests ranging from powerful corporate sectors to vulnerable informal systems of waste collection. The different interests represented include the fossil fuel sector; chemical manufacturing companies; manufacturers and producers of plastic products; regulated waste management sectors and informal waste pickers; recyclers and others. These are the varied stakeholders in the chain. There are also rightsholders to be considered such as the Indigenous communities (United Nations (General Assembly), 2007) who are largely excluded from the negotiating process (Liboiron, 2025). Ordinary citizens might also be included as rightsholders, given the impact of plastics on their health and well-being, bringing into play potential breaches of human rights to a clean environment.

## A wicked problem

Plastics are a prime example of the perfect storm – a classic 'wicked problem' (Rittel and Webber, 1973; Levin et al., 2012) requiring input from many different disciplines and perspectives where achieving a solution is not going to be a single step but manifold. For example, it has been argued that there should be a cap on the production of plastics and that the Global Plastics Treaty should be modelled in the style of the Montreal Protocol (United Nations, 1993) (Raubenheimer and McIlgorm, 2017; Kirk, 2020). The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production of around 100 substances responsible for ozone depletion. These substances, chlorofluorocarbons, constitute a single class of chemicals with a limited number of specific uses that can be replaced by chemicals having less impact on the ozone layer (although worse with respect to climate change). Plastic materials, by contrast, include a wide range of additives that give them specific properties, so they are much more diverse with a very wide range of uses (Wiesinger et al., 2021). That means there is a range of interests involved, and substitution by alternative materials is not as straightforward as it was in the case of the Montreal Protocol. Putting a cap on the production of plastics will not, on its own, achieve the necessary controls on those plastic additives, which are a primary cause of the problems around failure to recycle and occur at a life cycle stage following extraction and polymerisation (Clift et al., 2019).

## The contentious negotiations

There are two key areas of contention in the negotiations around these questions:

1. Should there be a cap on the production of plastics?
2. Should there be a limit (or ban) on including specific chemical and hazardous materials in plastic products?

In light of the discussion around the numerous chemicals that comprise plastics, it can be seen that these are two very distinct issues that need to be addressed separately.

A cap on production limiting the amount of plastics produced requires the life cycle stages – from extraction through to production – to be subjected to forensic examination. The extraction stage involves the complex nexus between plastics and climate change. The feedstock for most plastics is fossil fuels. This argument therefore triggers the concerns of countries that have interests in maintaining their fossil fuel industries, which they usually support with financial incentives. Inevitably, the enormity of such a change means that most of these countries do not support limits on production that will impact their own self-interests and wealth-producing activities. For similar reasons, countries with major chemical industries do not voluntarily support controls over chemicals in plastics – the second area of contention – even where these are hazardous.

The different interests causing the failure to reach a consensus in the negotiations include countries with sophisticated waste collection systems that tend to overlook the interests of informal waste collection systems in poorer countries. Even countries that depend on informal systems, with some exceptions such as Brazil, do not always integrate their interests into the negotiations at the Global Plastics Treaty. Social and environmental justice and human rights are not a feature of the discussions. The technological and economic interests around extraction, production and manufacture dominate, regardless of human interests and impacts.

## A forensic and brave approach

Complexity is not a reason not to achieve agreement. But what is required is a forensic approach to an analysis of the life cycle of

[1] On a recent visit to Cooper Viva Bem, a waste pickers' collective in Sao Paolo, Brazil, I was shown a range of plastic containers that I had never seen before. They included different colours, sizes and types of materials that had clearly been made for the South American market. They looked and felt different to those I am used to in Europe. None of them could be recycled.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 16:20:29, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/plc.2025.10020

plastics. This takes time and patience, but reaching a consensus is imperative to achieve the original goal that the Treaty should be legally binding. A soft voluntary unenforceable outcome, involving self-selecting National Action Plans, would achieve little. The plastics life cycle is global, and therefore legally enforceable, global solutions are needed.

Bans on obviously problematic products, such as microbeads and single-use plastic products, are highly achievable and already undertaken by a number of countries. But on their own, such legislative approaches are totally inadequate. A brave step needs to be taken to address the problems of the additives. Scientific analysis of the additives needs to be undertaken in a systematic and rigorous fashion on the model of REACH (2006) with registration following evaluation, including impacts on society and the environment – an extended environmental systems analysis (Clift et al., 2026). This process needs to be followed by bans on hazardous additives and limits on others as part of an ecodesign (ecological product) approach – a *codex rerum* ('a law of things') (Malcolm, 2019). These ecodesign approaches to plastic products need to be accompanied by transparency measures, including standardisation and labelling to enable reuse, recycling and remanufacturing of products. Such an approach would go part way to achieving a cap on production by banning or limiting the use of specified additives and would have the effect of limiting the production of some plastics. Such controls would also assist in turning plastics at the end of life into commodities for reuse and recycling (Lindner et al., 2025). One of the key reasons for the failure to recycle plastics is the inability of waste sorters and pickers to recognise the constituents of plastic products with the consequence that they are consigned to landfills or incineration. A system that ends the failure to retain plastics in the economy as stocks of materials available as feedstocks for new products will have its own effect in limiting production from virgin fossil fuels. This would be a real result to be attained by the Global Plastics Treaty and one that must be argued and fought for.

**Open peer review.** To view the open peer review materials for this article, please visit http://doi.org/10.1017/plc.2025.10020.

**Competing interest.** The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this letter to the editor.

**Ethical standards.** Ethical approval was not sought for this paper because the research analysis conducted here relies upon publicly available information on the Global Plastics Treaty. Ethics approval was not required for this letter to the editor.

## References

**Clift R, Baumann H, Murphy R and Stahel W** (2019) Managing plastics: Uses, losses and disposal. *Law, Environment & Development Journal* **15**(2), 93–107. https://doi.org/10.25501/SOAS.00033067.

**Clift R, Martin G, Mair S and Malcolm R** (2026) *Living Well on a Finite Planet*. Heidelberg, Germany: Springer Nature. (forthcoming)

**Kirk EA** (2020) The Montreal Protocol or the Paris agreement as a model for a plastics treaty? *AJIL Unbound* **114**, 212–216. https://doi.org/10.1017/aju.2020.39.

**Levin K, Cashore B, Bernstein S and Auld G** (2012) Overcoming the tragedy of super wicked problems: Constraining our future selves to ameliorate global climate change. *Policy Sciences* **45**, 123–152.

**Liboiron M** (2025) How to incorporate the UN declaration on the rights of Indigenous peoples (UNDRIP) in the global plastics treaty. *Cambridge Prisms: Plastics* **3**, e11. https://doi.org/10.1017/plc.2025.10003.

**Lindner A, Steenmans K, Scotford E and Malcolm R** (2025) Preventing the 'wasting' of waste: The expanding horizons of waste law. *Review of European, Comparative & International Environmental Law*, 1–5. https://doi.org/10.1111/reel.70011.

**Maddela NR, Kakarla D, Venkateswarlu K and Megharaj M** (2023) Additives of plastics: Entry into the environment and potential risks to human and ecological health. *Journal of Environmental Management* **348**, 119364. https://doi.org/10.1016/j.jenvman.2023.119364.

**Malcolm R** (2019) Life cycle thinking as a legal tool: A *codex rerum*, *Law Environment and Development Journal* **15**(2), 208. Available at http://www.lead-journal.org/content/19208.pdf.

**Malcolm R and Mikheeva-Ashe A** (2024) Plastics, products and life-cycle thinking in the European Union. In Kirk EA, Popattanachai N, Barnes RA and van der Marel ER. *Research Handbook on Plastics Regulation: Law, Policy and the Environment*. Cheltenham, UK: Edward Elgar, pp. 398–420.

**Malcolm R, Peacock M and Winton S** (2025) Plastics, life cycle approaches and the law. *Diálogos Socioambientais* **8**(21), 16–25. https://doi.org/10.36942/dialogossocioambientais.v8i21.1174.

**Raubenheimer K and McIlgorm A** (2017) Is the Montreal Protocol a model that can help solve the global marine plastic debris problem? *Marine Policy* **81**, 322–329. https://doi.org/10.1016/j.marpol.2017.04.014.

**RCEP** (2003) *Royal Commission on Environmental Pollution, Chemicals in Products: Safeguarding the Environment and Human Health, 24th Report, CM 5827*. London: TSO.

**REACH** (2006) Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (Text with EEA relevance)Text with EEA relevance.

**Rittel HWJ and Webber MM** (1973) Dilemmas in a general theory of planning. *Policy Sciences* **4**(2), 155–169.

**UNEP** (2023) *United Nations Environment Programme and Secretariat of the Basel, Rotterdam and Stockholm Conventions. Chemicals in Plastics: A Technical Report*. Geneva: UNEP

**UNEP INC 1** (2022) Priorities, needs, challenges and barriers relating to ending plastic pollution at the national level (UNEP/PP/INC.1/11).

**UNEP INC 1 INF** (2022) Addendum document on priorities, needs, challenges and barriers to end plastic pollution at national level (UNEP/PP/INC.1/11), UNEP/PP/INC.1/INF/8.

**United Nations (General Assembly)** 2007, Declaration on the Rights of Indigenous People.

**United Nations: Montreal Protocol on substances that deplete the ozone layer – adjustments and amendment** (1993) *International Legal Materials* **32**(3), 874–887. https://doi.org/10.1017/S0020782900016338.

**Wagner M, Monclús L, Arp HPH, Groh KJ, Løseth ME, Muncke J, Wang Z, Wolf R and Zimmermann L** (2024) State of the science on plastic chemicals: Identifying and addressing chemicals and polymers of concern. https://doi.org/10.5281/zenodo.10701706.

**Wiesinger H, Wang Z and Hellweg S** (2021) Deep dive into plastic monomers, additives, and processing aids. *Environmental Science & Technology* **55**(13), 9339–9351. https://doi.org/10.1021/acs.est.1c00976.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 16:20:29, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/plc.2025.10020