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The entangled fates of plastics and climate change

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Abstract

Plastics and climate change are inseparable issues, both materially and geopolitically. Plastics are derived almost entirely from fossil fuels and have an enormous greenhouse gas footprint. Aligning with the Paris Agreement requires rapid, dramatic decreases in plastic production, contravening the industry's plans to continue expanding production. The oil, gas and petrochemical industry wields substantial power in both the climate and plastics treaty negotiations and has used that power to stymie progress in both. Rather than repeat the failures of the climate negotiations, plastics negotiators should seek to create a "plastics club" for ambitious action.

Impact statement

The multilateral system of environmental governance is in trouble. Multiple failures at the UNFCCC and the Convention on Biological Diversity have raised the question of whether the current system can deliver on its commitments. Against this backdrop, the unanimous support for UNEA Resolution 5/14, "End Plastic Pollution: Towards an International Legally Binding Instrument" was welcomed as evidence of the reinvigoration of the multilateral system. But with INC 5.2 approaching, negotiating member states have largely split into two distant camps: the majority want to fulfill the negotiating mandate with an ambitious treaty while a small group is blocking any meaningful action. This political dichotomy resembles that of the UNFCCC and with good reason: the geopolitical differences reflect the material connections between plastics and climate change. Plastics treaty negotiators have the opportunity to learn from the failures of the UNFCCC and follow the path not taken: namely, creating a "plastics club" of countries dedicated to ambitious action. Persisting along the current path and expecting different results will further undermine the multilateral system but a plastics club approach can deliver a useful, if not universal, treaty.

Letter

Lawyers love precedents. So when negotiations opened towards an international, legally binding instrument to end plastic pollution (the global plastics treaty or GPT), both the negotiation processes and the draft text borrowed heavily from existing multilateral environmental agreements (MEAs). In particular, the Montreal Protocol to the Vienna Convention on Ozone Depleting Substances – frequently lauded as the most successful MEA ever – served as an inspiration (Simon et al., 2021). On the other hand, the United Nations Framework on Climate Change (UNFCCC) has become the prime example of all that is wrong with international diplomacy (Bhushan, 2019). Its annual meetings, hosted by a series of petrostates, are a bloated festival of dealmaking and greenwashing while the treaty's agreed red lines – no dangerous anthropogenic interference in the climate system; ensure adaptation of those adversely affected; stabilize mean surface temperatures at 1.5°C above preindustrial; provide financial compensation for loss and damage – have become a litany of shattered promises (Maslin et al., 2023).

Negotiators, champions and facilitators have thus tried to steer the GPT negotiations in the path of previous United Nations Environment Programme (UNEP) conventions, such as the Montreal Protocol and Stockholm Convention. But the challenges that have crippled the UNFCCC are not so easily sidestepped. Indeed, plastic arguably has more in common with climate change than with other environmental issues. The lesson to be learned from the UNFCCC's failure might be that limited progress in directly confronting those challenges is more productive than wishing them away.

The first similarity between plastics and climate change is that plastics are literally fossil fuels. They are overwhelmingly manufactured from petroleum, fossil gas and coal, which serve as both feedstock and energy sources (Posen et al., 2017; Cabernard et al., 2021). Despite their durability,

most plastics enjoy short useful lifetimes, after which a large proportion are burned, either for energy or simply as a form of crude waste management. Plastics have thus been described as fossil fuels that spend a short period of time in solid form. As a result, plastics have an enormous carbon footprint – the production of plastic releases 2.24 Gt CO_2e per year, more than twice as much as the aviation sector (Karali et al., 2024). Combustion at the end of life – in the open, in cement kilns, or trash incinerators – adds another ~0.1 Gt CO_2e per year (Zheng and Suh, 2019; Cabernard et al., 2021). Once released into the environment, plastic particles can further affect the climate through interference with the marine biological carbon pump, altering soil carbon storage rates, driving increased cloud nucleation, and changing planetary albedo, among other mechanisms (Zhu et al., 2025). However, the science of these aspects is nascent, and further studies are required to understand the magnitude and even direction of these impacts.

The prospects for decarbonizing plastic are poor. Cracking, refining and polymerization require large quantities of industrial high heat and are difficult to electrify (Bataille et al., 2018; Davis et al., 2018). Fossil feedstocks could be replaced with bio-based feedstocks such as soybean or corn oil, but doing so at scale would drive dramatic increases in deforestation, food insecurity and biodiversity loss which would likely cancel out any climate benefits (Helm et al., 2025). Modern agriculture is also an intense emitter of greenhouse gases (GHGs), particularly through its dependence on synthetic fertilizers (Ritchie et al., 2020). The petrochemical industry has proposed retrofitting plants with carbon capture and storage systems but these technologies have suffered a long series of technical and financial failures and have yet to be successfully commercialized, let alone at the scale required to decarbonize a petrochemical refinery (Wang et al., 2021; Hekmatmehr et al., 2024). The only sure strategy to reduce plastic's enormous footprint is to make less of it – a lot less. Yet rather than plan for a rapid drawdown in production, the industry is investing billions of dollars in new and expanded production capacity, to maintain its historic growth rate of around 4% per year (Bauer et al., 2023).

The plastics industry defends its product by pointing to myriad ways in which cheap, lightweight plastic reduces emissions, from packaging to automobiles (*e.g.*, Herberz et al., 2020). These arguments are frequently supported by flawed lifecycle analyses that compare plastic to alternatives on terms favorable to plastic (Farrelly et al., 2020). For example, shipping plastic soft drink bottles one way (and then to a landfill) generates less emissions than shipping heavy glass bottles roundtrip over the same distance. But in places where glass bottles are still in use, bottling plants are typically close to customers: most cities used to have their own bottlers, resulting in short distribution chains without trucking water – soft drinks' primary ingredient – long distances (Saltzman et al., 1999). This example points towards a more general solution: rather than replace plastic with another material while maintaining the current, globe-spanning supply chains that have been built around plastic, the solution is often to find another delivery system to meet customers' needs. Such systems abound: reuse and refill businesses, replacing single-use plastics with rental of durable equipment, zero waste shops, reusable packaging, and even cloth nappy (diaper) services to replace the mountains of plastic nappies. However, they struggle to scale up against the artificially low price of highly subsidized plastic.

In any case, climate arguments that favor the lesser of two evils ignore the hard math of the carbon budget. As human interference in the climate system pushes Earth out of the Holocene, the carbon budget refers to the total anthropogenic emissions of CO_2 associated with a stable target temperature and a desired certainty. For a 67% chance of keeping global heating to 1.5°C, humanity can emit no more than 400 Gt of CO_2 since the end of 2019 (Pathak et al., 2023). For a 50% chance, this rises to 500 Gt CO_2. A critical, but poorly understood aspect of the carbon budget is that it is *cumulative*, not annual. It describes total anthropogenic emissions over time. Like a gift card, once spent, it is gone, never to be replenished.

The implications for emissions-heavy industries like plastic are severe. With the carbon budget rapidly running out, industries with no viable path to carbon neutrality must quickly scale down to *de minimis* levels. Tangri et al. (2024) calculated that plastic production should shrink by 12%–17% annually and indefinitely to avoid breaching its share of the 1.5 C carbon budget. In fact, shrinking production and decarbonization are synergistic approaches. There is not enough sustainable biomass available to support bio-based plastic production at current scales, but a very small plastic industry could potentially work with waste biomass from a variety of sources, avoiding fossil feedstock altogether (Zheng and Suh, 2019; Helm et al., 2025). The adoption of renewable energy could slightly slow the pace of needed production cuts. Even under the most generous assumptions, however, it is impossible to escape the conclusion that a plastics industry consistent with climate stability can only be a small fraction of the size of the current industry.

The rapid scale-down of plastics production is not an acceptable scenario for the oil and gas industry, which is relying on growing plastic production to justify pumping ever greater quantities of fossil fuels despite stagnant demand for transportation fuel (Tilsted et al., 2023). The integrated oil, gas and petrochemicals industry is well-represented in the GPT negotiations by a handful of petrostates that have manifested intransigence on the central issue of reducing plastic production – a position cited as a core requirement by over 100 member states.[1] Lacking substantive arguments, these countries have resorted to procedural delays and stall tactics, reopening closed questions, frittering away precious negotiating time, and, above all, insisting on the right to veto agreements forged by the majority of negotiating states (Løvold, 2024). These tactics perfectly reflect 30 years of stalling action within the UNFCCC, and for the same reason. In both cases, effective treaties would require dramatically shrinking the lucrative and powerful fossil fuel industry.

To rescue the GPT from the UNFCCC's fate, plastics treaty negotiators must reckon with the fact that a handful of countries are not negotiating in good faith. Rather, their actions are calibrated to prevent progress. Under the GPT's current, ill-defined rules of procedure, these few countries effectively wield a veto over every element of the potential treaty. This is another commonality with the UNFCCC, which after 33 years, still does not have agreed-upon rules of procedure (Depledge, 2024). They have advertised their intention to use this leverage to ensure that no form of production control survives into the final text. This would include not only production caps but also restrictions on hazardous polymers, additives and other chemicals; and problematic plastic products. Production controls, in other words, are the very heart of the solution, and a treaty without them would amount to little more than window-dressing.

[1]Conference Room Papers submitted during INC 5.1 by Panama on behalf of 88 countries, the Pacific Small Island Developing States on behalf of 14 countries, and 44 countries of the Africa Group called for the treaty to "reduce the production of primary plastic polymers to sustainable levels." Removing overlaps, 106 countries supported this language.

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It is now clear that a treaty that brings plastic production in line with the Paris Agreement cannot be expected to emerge from the procedural straitjacket of UNEP. An ambitious treaty – including legally binding production cuts in line with the available science – will require a different process, insulated from the petrochemical industry and its proxy states (Olsen et al., 2025). Fortunately, a critical mass of countries – more than 100 – are prepared to negotiate and sign exactly such a treaty. All they lack is a venue and opportunity in which to do so, free from the interference and sabotage of the petrostates.

This raises the question of how effective a treaty can be if major plastics producers do not participate. Once again, the history of the UNFCCC is instructive. As the failures of the Kyoto Protocol and now the Paris Agreement have become manifest, both negotiators and academics have investigated the possibility of "climate clubs" – groups of nations with similar levels of ambition that would form trade blocs and use their economic leverage to demand action from less-ambitious countries (Hovi et al., 2016; Tagliapietra and Wolff, 2021). Game theory analysis indicates that this approach is far more likely to deliver ambitious outcomes than universal, consensus-based negotiations (Nordhaus, 2015). The club approach is even more likely to be successful with plastics. Plastic production is highly concentrated in a handful of countries, which are dependent upon export markets to maintain their industry. Large "plastic clubs" – for example, the 100+ countries demanding cuts in plastic production – would wield considerable market power by restricting imports from plastic exporters.

A few years ago, it was not uncommon to hear that plastic pollution was a distraction from a far more serious environmental challenge: climate change. Now, there is greater recognition that the two are deeply enmeshed: materially, economically and geopolitically. Plastics treaty negotiators should learn the hard-won lessons of the UNFCCC's failures and strike a new path: a "coalition of the willing" can create an effective plastics club that will drive down both plastic pollution and GHG emissions. In doing so, they will not only meet their mandate to end plastic pollution but also breathe new life into efforts to arrest climate change.

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