https://doi.org/10.1038/s41893-023-01236-z

On the plastics crisis

Plastics are ubiquitous, but problematic from a whole life cycle perspective. *Nature Sustainability* asked four experts to present their views about the ongoing plastics crisis.

Offering lightweight, excellent durability and useful mechanical properties, plastics have found indispensable roles in most aspects of modern life, including packaging, building construction, transportation vehicles, textiles, machinery, medical tools and electronics. As a result, plastics production has enjoyed a boom since the 1970s, and it now amounts to 400 million tonnes per year. However, such massive production of plastic materials has turned into a heavy environmental burden threatening our sustainable development aspirations. Owing to poor end-of-life management, 7 billion tonnes of plastic waste have been generated globally, of which we are recycling less than 10%. Plastic debris are now ubiquitous in the natural environment, from land to ocean, severely threatening the heath of ecosystems[1]. In addition to waste accumulation, the production of plastics in the first place is problematic. Currently, it relies heavily on non-renewable fossil fuels and has a huge carbon footprint responsible for 4.5% of global greenhouse gas emissions[2]. As Sylvia Lorek tells our readers in a World View in this issue, the environmental footprint of plastics is however just the tip of the iceberg, it reflects much deeper and wider sustainable development challenges.

Public awareness of the likely impacts of plastic waste is growing and policymakers around the world are reacting. In March 2022, the resumed fifth session of the United Nations Environment Assembly adopted a resolution entitled "End plastic pollution: towards an international legally binding instrument", which convened an Intergovernmental Negotiating Committee aiming to reach a global agreement about addressing the plastic pollution crisis by the end of 2024. The resolution sets plastic pollution as a top global threat in need of a holistic solution. This means tackling the problem along the full life cycle of plastics, including production and end-of-life management, and engaging all societal actors, such as citizens, policymakers, the private sector and academia.

Although it is out of the question that reducing demand and usage of plastics is an essential part of the strategy to tackle the plastics crisis, realistically we won't be able to abandon plastics for the foreseeable future as there is a lack of reliable alternatives. Designing and making plastic materials more sustainable can reduce their environmental impacts. From the perspective of materials design, sustainability refers to the degradability, recyclability and biocompatibility of plastics, as well as the use of more sustainable raw materials. However, as argued by Eugene Chen in a World View in this issue, designing plastic materials with sustainability in mind means considering the temporal dimension: resource use at a faster rate than resource regeneration along the whole supply chain of plastics is unsustainable. Besides, to ensure that more sustainable plastics replace rapidly conventional ones in the market, we need to ensure that more environmentally friendly alternatives perform as well as conventional ones.

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Although research on designing better materials is progressing, we still rely on conventional plastics now and will continue to do so for years. Therefore, improving the circularity of plastics is fundamental in the transition to a future with more sustainable materials. This means developing ways to maximize the reuse of the highly organized carbon structures present in end-of-life plastics through recycling and upcycling. Closing the loops will limit use of fossil fuels in materials and chemicals manufacturing and in doing so it will reduce the environmental problems associated with end-of-life plastics. Chemists and engineers are developing diverse plastic transformation techniques to this end, as shown in an Article in this issue[3]. Research shows that it is possible to produce either new, but similar, plastics or other value-added chemicals from raw materials recovered from end-of-life plastics. But recycling and upcycling strategies are not sustainable processes: many available techniques are energy intensive. In addition, transforming real-life end-of-life plastic mixtures remains challenging. In a World View in this issue, Ding Ma discusses how to address these challenges to advance the commercialization of end-of-life plastics recycling techniques.

Technological solutions alone won't solve the plastics crisis. Technologies need to be adopted, and to support adoption, governments need to intervene, as explained by Patrick Schröder in a World View in this issue. It is encouraging to see policy progress. For example, the Extended Producer Responsibility policy approach offers the benefit of sharing burdens and responsibilities between the public and private sectors and allows internalizing unaccounted environmental costs associated with plastics waste. Policies can accelerate the development of innovative technological solutions promoting the overall sustainability of plastics. Government policies can also stimulate changes in consumption behaviour and societal practices around plastics more broadly; they can enable behavioural changes from 'single-use and throw away' consumption patterns to more responsible 'reduce and reuse' patterns. As the plastics crisis affects individuals and countries across the world, international governmental cooperation and the establishment of a global framework are essential to move forward.

Plastic pollution is a growing threat to the health of people and the planet. Nevertheless, governments, citizens and industry leaders should not forget that tackling pollution is part of a much broader, systemic societal transformation needed to set the world on a truly sustainable development path.

Published online: 19 October 2023

References

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