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Will the Global Plastics Treaty break the plastic wave? The beginning of a long discussion road

Fabiula Danielli Bastos de Sousa

Technology Development Center, Universidade Federal de Pelotas, Pelotas, RS, Brazil

Review

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Corresponding author:
Fabiula Danielli Bastos de Sousa;
Email: fabiuladesousa@gmail.com

Abstract

We are experiencing the effects of the triple planetary crisis—climate change, loss of nature, and pollution—aggravated by plastic pollution. Despite widespread global awareness of the adverse effects of plastic pollution, its ongoing increase remains persistent, with an annual increase in plastic consumption and incorrect disposal contributing to this serious problem. In 2022, 175 nations agreed to begin negotiations by the end of 2024 on a binding international agreement to control the life cycle of plastics, including preventing marine pollution. To ensure the efficacy of the Global Plastics Treaty for mitigating plastic pollution, the extensive participation of researchers is imperative. The literature focuses on efforts in line with ongoing negotiations. In this study, a systematic review of the Global Plastics Treaty was conducted. The analyzed literature mainly focuses on the adverse effects of plastic pollution, legislation, governance, and the economy. The resulting comprehensive overview of the subject can support ongoing negotiations and guide future research about the Global Plastics Treaty.

Impact statement

The United Nations Environment Assembly (UNEA) approved Resolution 5/14, entitled "End Plastic Pollution: Towards an International Legally Binding Instrument." An Intergovernmental Negotiating Committee (INC) was established to negotiate the Global Plastics Treaty, which is expected to enter into force by 2025. This treaty is aimed at reducing plastic pollution along the entire plastic life cycle. The work of the literature and INC in the negotiations is critical to developing a genuinely successful treaty that minimizes plastic pollution. This systematic review of the Global Plastics Treaty provides an overview of the literature's contributions to the negotiations. Among the crucial provisions and recommendations, the literature affirms the significance of limiting global plastic production as the most effective measure for mitigating plastic pollution.

Introduction

We are living in the "Plasticene" contemporary epoch (Haram et al., 2020; Alava et al., 2023), experiencing the effects of pollution and plastic production on the triple planetary crisis of pollution, loss of nature, and climate change (United Nations Environment Programme, 2022a). An effectively designed global legislative treaty to regulate plastics is necessary to mitigate the global crisis (Dauvergne, 2023b).

The United Nations Environment Assembly (UNEA) approved Resolution 5/14 entitled "End Plastic Pollution: Towards an International Legally Binding Instrument" in March 2022, which aims to address the issue of plastic pollution by implementing a worldwide and legally enforceable treaty on plastics (Bergmann et al., 2022; Walker, 2022), known as the Global Plastics Treaty. To conclude the treaty, by the end of 2024, an Intergovernmental Negotiating Committee (INC) was established, and the negotiations are ongoing (Tiller and Nyman, 2018).

To ensure the success of negotiations such as those of the Global Plastics Treaty and the long-term efficacy of their results, extensive involvement of researchers is essential (Wang et al., 2023), even if indirectly. The literature is essential for an in-depth understanding of plastic pollution and its implications (Carratta and Jaeckel, 2023) and is the solid basis for discussion and decision-making.

In this study, a systematic review of the Global Plastics Treaty was performed based on searches in the Scopus, Web of Science, and Google Scholar databases. As the main focus of the analyzed literature, the adverse effects of plastic pollution, legislation, governance, and the economy were briefly discussed. Based on this, a comprehensive overview of the available literature is presented in the following pages, which may support the negotiations and construction of an effective treaty, and guide future research on the Global Plastics Treaty.

Methodology

A systematic review follows a protocol, a methodical technique known as *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) (Shamseer et al., 2015). Practice guidelines were formulated by compiling data from previous and ongoing investigations. Appropriate keywords and inclusion criteria are determined when the methodology is followed; this helps prevent biases and omissions, and produces a more substantial review of the research issue (Neves et al., 2021). Thus, the results may guide future research and, in this case, the development of the Global Plastics Treaty.

Three literature databases were selected: Scopus, Web of Science, and Google Scholar. Both were accessed on December 6, 2023. The terms used in the searches were (global plastic* treaty), search within article title, abstract, and keywords.

Results from the data collection

In the diagram presented in Figure 1, gray shades represent the steps of the PRISMA protocol. In the identification step, 190 documents were found in the three databases. Some document types were excluded during the screening step, such as reviews, book chapters, notes, conference papers, and letters, resulting in 117 articles. Some articles were excluded in the eligibility step, such as those published in languages other than English and off-topic articles. Finally, 44 repeated articles were excluded, resulting in 59 articles. These articles were analyzed, and the results will be given from now on.

Literature about the Global Plastics Treaty is interdisciplinary. In the literature analyzed, authors focused on the adverse effects of plastic pollution in general (Jahan, 2021; Karasik et al., 2023; Prior and Seck, 2023; Smith et al., 2023), legislation and governance (Dauvergne, 2018; Tiller and Nyman, 2018; Khan, 2020; Kirk, 2020; Jahan, 2021; Telesetsky, 2021; Stöfen-O'brien, 2022; Tiller et al., 2022; Kurniaty et al., 2023; Prior and Seck, 2023; Ralston et al., 2023; Cowan et al., 2023a, 2023b; O'Meara, 2023a, 2023b), and the economy (Grabiel et al., 2022; Börger et al., 2023; Karasik et al., 2023; Tang, 2023; Tilsted et al., 2023). Some articles may be classified into various categories.

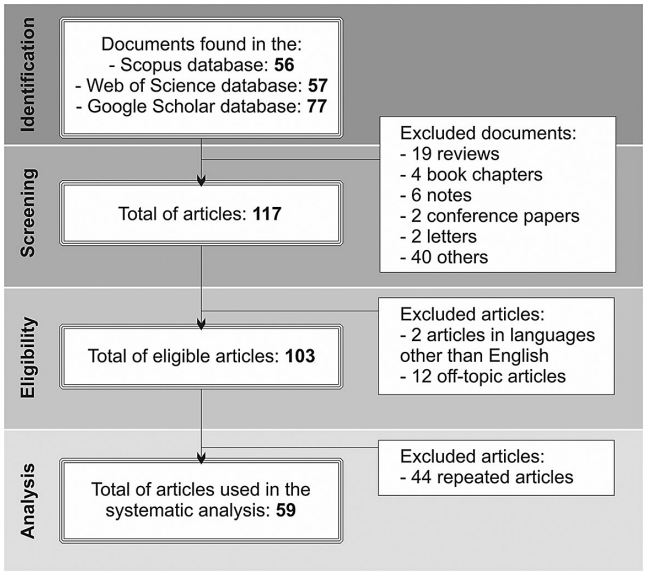

Figure 1. Steps of the systematic analysis of the Global Plastics Treaty.

As the primary objective of this study was to provide a comprehensive summary of the current literature's contribution to ongoing negotiations, the following issues will be examined from this point: plastic pollution (it is crucial to assess the magnitude of the problem), adverse effects of plastic pollution, the economy, and international legislation and governance.

It is important to note that the subsequent sections do not aim to provide an exhaustive review of all challenges; instead, they emphasize critical points raised in the literature so far.

Plastic pollution

Numerous social, economic, and environmental advantages can be attributed to plastic, including extending the lifespan of food to prevent food waste and safeguarding medicines; lightweight plastic packaging and plastics in cars, using less fuel to move people and goods (UNEP and Minderoo Foundation, 2022), among many others. Its life savior role became apparent during the COVID-19 pandemic (de Sousa, 2020; de Sousa, 2021b). Moreover, it is relevant to achieve the 2030 Agenda for Sustainable Development, which sets out the Sustainable Development Goals (de Sousa, 2021c, 2023c). However, the production, use and disposal of plastic are not sustainable and cause serious harm to the environment, human health, and economy, along with profound societal inequalities (Landrigan et al., 2023a).

The main reasons for exacerbating the negative impacts of plastic are a virtually exponential and continuous rise in worldwide plastic production, inadequate rates of collection and recycling, and the prolonged persistence of plastic waste in the environment (Landrigan et al., 2023a). Global plastic production reached 390.7 million tons in 2021 (Statista, 2023). Packaging accounts for approximately 40% of all plastic produced, becoming waste in a lifespan of about 6 months on average (Montenegro et al., 2020).

Only approximately 12% of the total plastics generated have undergone incineration, and 9% have been recycled (UNEP, 2021; OECD, 2022). Approximately 22% is improperly managed (OECD, 2022) and has either been disposed of in landfills or in the ecosystem. Annually, it is estimated that approximately 20 million metric tons of plastic residues are mismanaged (Bergmann et al., 2022).

Approximately 60–90% of marine debris is plastic, with more than 9 million metric tons entering the oceans in 2015. This amount is equivalent to 5–6 grocery bags of plastic for every foot of coastline (Jambeck et al., 2015). If no significant measures are taken, plastic waste reaching aquatic environments will increase almost three times, from approximately 11 million tons in 2016 to over 29 million tons in 2040 (UNEP, 2021). Literature indicates that China and India/South Asia are the sources of roughly half of the marine plastic pollution worldwide (Boucher and Friot, 2017), with five Asian countries—China, Vietnam, Thailand, the Philippines, and Indonesia—accounting for around 60% of this pollution (Ocean Conservancy and the McKinsey Center for Business and Environment, 2015). Plastic pollution has been much more noticeable since the COVID-19 outbreak, even though it is a life savior (de Sousa, 2020, 2021b).

Litter from consumer packaging and products, including shopping bags, straws, cling wrap, food containers, beverage bottles, and bottle caps, is the primary cause of this plastic pollution (Dauvergne, 2018). Nearly 50% of all plastic marine litter comprises single-use plastics (European Union, 2019). Abandoned and

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discarded fishing equipment also contributes to the accumulation of plastic waste (Dauvergne, 2018). Around 27% of the overall plastic marine litter consists of fishing-related things (European Union, 2019). Annually, smokers discard over 4.5 trillion cigarette butts, which accounts for approximately 75% of all cigarettes sold (Gould, 2015).

Understanding how plastic spreads and its consequences is essential to developing the strategies needed to deal with this worldwide threat, which is plastic pollution (Pinheiro et al., 2023). Thus, the adverse effects of plastic pollution will be addressed in the following section.

Adverse effects of plastic pollution

Plastic pollution can adversely affect human health and the biodiversity of both animals and plants (de Sousa, 2023b). The plastic itself (different plastic sizes) and the chemicals (or additives) present in plastic formulations can impact them. However, regarding size, the literature focuses mainly on the adverse impacts of microplastic (MP) pollution (de Sousa, 2023b). The literature emphasizes the importance of including MPs and additives in the ongoing negotiations of the Global Plastics Treaty (Dey et al., 2022; Wang and Praetorius, 2022; Maes et al., 2023; Wang et al., 2023; Landrigan et al., 2023b). Beyond this, plastic influences climate change through greenhouse gas (GHG) emissions (Andersen et al., 2021) in all the stages of its life (three main stages are comprised in the plastic life cycle: manufacture, use, and disposal (Landrigan et al., 2023a)).

Another significant point highlighted in the studies is the correlation between plastic pollution and human rights, as plastic pollution disproportionately affects the most vulnerable communities (Karasik et al., 2023; Landrigan et al., 2023a).

Concerning territory, particular emphasis is placed on the detrimental impacts of plastic pollution in the Arctic due to its unique and highly vulnerable ecosystem (Prior and Seck, 2023; Cowan et al., 2023a, 2023b).

All these items will be briefly discussed in the sequence.

Chemical additives

Chemical additives are incorporated in plastic formulations to enhance or alter their characteristics. Plastics contain many chemicals, including monomers, additives in general, processing agents, and non-intentionally added organic or inorganic compounds (Filella and Turner, 2023; Landrigan et al., 2023a). More than 13,000 chemicals are used in various plastic applications. Over 3,200 monomers, additives, processing aids, and unintentionally added substances could be dangerous because of their properties (Weber et al., 2023).

These compounds are the primary cause of plastics' well-documented adverse effects on human and planetary well-being (Landrigan et al., 2023a). Literature has provided ample evidence of additives' adverse effects on human health. A basic search in the Scopus database, using the terms (chemical additive* OR chemical* OR additive*) AND (plastic* OR polymer*) AND (human health), within the article title, abstract, and keywords, provided a total of 9,124 publications, ranging from 1956 to December 29, 2023 (Figure 2).

Humanity is exposed to the leakage or migration of dangerous additives from production (mainly workers) to plastic disposal, reuse, or recycling. They are released and transferred to the environment and organisms (Walker, 2022). In 2022, the president of UNEA 5 stated that chemicals connected to plastics were evidenced in his blood after having his blood drawn, including chemicals known to be harmful to humans (Tiller et al., 2022).

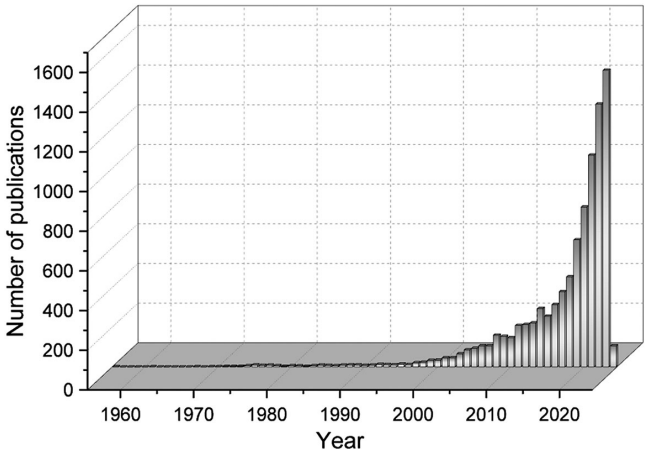

Figure 2. Number of publications per year about the effect of chemicals on human health.

Some hazardous additives are endocrine-disrupting chemicals (EDCs), such as bisphenols, brominated flame retardants, alkylphenol ethoxylates, perfluorinated compounds, phthalates, UV stabilizers and metals. EDCs may have harmful effects on the reproductive, metabolic, thyroid, immunological, and neurological systems (Flaws et al., 2020).

Furthermore, certain additives, such as pro-degrading agents, affect recycling by degrading the quality of the recycled materials. Using them, the chemical structure of fossil-based polymers is broken down more easily, producing molecules of lower molecular weight and inorganic particles that damage the environment and are not biodegradable. These additives can degrade the polymer matrix during the recycling process, thereby lowering the technical quality of the recycled materials (Hann et al., 2016; European Commission, 2018).

Efforts to mitigate the dangers of plastics must focus on the potentially hazardous chemicals associated with plastics (Landrigan et al., 2023a). Thus, the issue of additives must be closely aligned with the Global Plastics Treaty and the subject included in the negotiations. According to Wang and Praetorius (2022), "to successfully end plastic pollution, holistic action is required to address chemicals present in plastics, including (1) reducing the complexity of chemicals in plastics, (2) ensuring the transparency of chemicals in plastics and (3) aligning the right incentives for a systematic transition." In addition, further examination of chemical regulation and assessment of the necessity of additive use should also be considered (Maes et al., 2023): "Global leaders and policy mechanisms such as this are needed to support the development of National Action Plans (NAPs) on marine litter and plastic pollution, promoting universal bans of harmful substances, aligning chemicals of concern lists, agreeing to threshold limits for substances of concern in use, as well as aligning testing methods to evaluate the safety of substances and products." Alternative choices that reduce risks to individuals and the environment should be encouraged, such as eco-friendly additives (Zanchet et al., 2016, 2018a, 2018b). These additives can be derived from renewable sources or residues, optimizing their economic viability and making them sustainable additives.

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Due to hazardous additives, the use of recycled plastics in specific applications (such as toys and food packaging) should be avoided (Geueke et al., 2023). Consequently, specific formulations are less likely to be recycled, contributing to plastic pollution. Reviewing additive use is therefore necessary to ensure that recycling and the use of recycled plastics are not compromised. The indiscriminate use of additives may also impact the circular economy, which is crucial for mitigating plastic pollution. Therefore, a comprehensive treaty must address every interconnected issue associated with plastic, as it is an integral component of the problem, including chemical hazards (Dey et al., 2022).

Greenhouse gases

Throughout their entire life cycle, from extraction to end-of-life, plastics emit GHG (Ford et al., 2022). According to the authors (Ford et al., 2022), the impact of plastic on climate change (measured in carbon-dioxide-equivalent, CO_2e) can be classified into three distinct categories: (1) plastic production, transport, and use; (2) plastic disposal, mismanaged waste, and degradation; and (3) bio-based plastics.

The end-of-life of plastics contributes approximately 9% of the total GHG emitted over their lifetime (Zheng and Suh, 2019). This stage usually consists of three processes that produce different GHG emissions: incineration, landfill, and recycling (Ford et al., 2022). Although recycling is sustainable, it is expensive, energy-intensive, and can produce low-quality plastics. It is possible to reduce GHG emissions by 77% when using only renewable energy (Zheng and Suh, 2019). Most common plastics (such as polyethylene) emit methane and ethylene during degradation when exposed to ambient solar radiation, producing direct and indirect GHG indefinitely. Polyethylene is the most common emitter of both gases (Royer et al., 2018). Concerning bio-based plastics, when improperly disposed of in the marine environment, biodegradable plastics pollute like fossil fuel plastics. Under these conditions, the degradation rate of polylactic acid (PLA) is equivalent to that of high-density polyethylene (HDPE) (Chamas et al., 2020). Therefore, it is necessary to be aware of plastic use and disposal, reducing its use whenever possible (de Sousa, 2021a).

The process of plastic manufacturing requires a large amount of energy and has a substantial impact on climate change. Certain plastics use ozone-depleting substances (ODSs) and hydrofluorocarbons (HFC) as raw materials, most of which are potent GHG, contributing to climate change. It would be ideal to substitute these dangerous raw materials with more environmentally friendly alternatives (Andersen et al., 2021).

Plastic production generates GHG emissions of 1.96 gigatons CO_2e annually (Landrigan et al., 2023a). Plastic use is expected to nearly triple by 2060 (OECD, 2022). Consequently, GHG emissions from conventional plastics are expected to grow to 6.5 gigatons CO_2e by 2050 (Zheng and Suh, 2019). Growing output means expanding effects on the environment across numerous planetary boundaries (Galán-Martín et al., 2021).

Plastics are linked to 4.5% of GHG emissions worldwide during their life cycle (Cabernard et al., 2021). Plastic manufacturing is responsible for approximately 3.7% of global GHG emissions. If the existing patterns persist without intervention, this proportion will rise to 4.5% by 2060 (Landrigan et al., 2023a). While it is an important signal and supportive force for change, compensating for GHG emissions during the manufacturing phase is insufficient to change how fossil fuels are used (Bauer et al., 2020).

Microplastics

There is an urgent need for global action and solutions because an estimated 170 trillion plastic particles, mainly MPs, float in all of the world's oceans (Eriksen et al., 2023).

The primary contributors to MP contamination are the laundering of synthetic clothes (such as polyester and nylon) and wear of tires on roads. Approximately 55% of all textile fibers are made of polyester (more than twice that of cotton fiber), which is the largest source of MP contamination from clothing (TextileExchange, 2016). Another notable cause of pollution is small fragments of plastic generated by urban activities ("city dust"), such as the wear and tear of running shoes and artificial turf (Boucher and Friot, 2017).

Humans are exposed to MPs mainly through food, but also through dermal contact and inhalation. Research has confirmed that the ingestion of MPs by humans leads to many harmful consequences, primarily associated with diverse forms of inflammation (Prata et al., 2020; Xu et al., 2021; Yang et al., 2021; Zhao et al., 2021; Zheng et al., 2021; Huang et al., 2022, 2021; Junaid et al., 2022; Liu et al., 2022; Nikolic et al., 2022; Rawle et al., 2022; Tong et al., 2022; Weber et al., 2022; Yuan et al., 2022).

The Global Plastics Treaty must establish criteria for recyclability and classify MP as hazardous chemicals. It should promote evidence-based scientific decision-making and enforce obligatory regulations for reporting and sharing information (Dauvergne, 2023b).

Effects of plastic pollution in the Arctic

The literature is of specific concern regarding the effects of plastic pollution in the Arctic (Meyer et al., 2023; Prior and Seck, 2023; Cowan et al., 2023a).

Despite its remote location, the Arctic is still affected by several types of pollution caused by human activities, such as persistent organic pollutants (POPs), carbon black, mercury and plastics, which affect its fragile ecosystems (Meyer et al., 2023; Cowan et al., 2023a). For instance, some authors (Meyer et al., 2023) analyzed plastic debris from 14 remote Arctic beaches on the Spitsbergen archipelago and found plastic residues from all parts of the globe. Plastic pollution sources have local and global origins, moving northward through ocean currents, rivers, and winds.

These pollutants can substantially affect the Arctic ecosystems and their inhabitants. Therefore, pollution has been a critical focus of Arctic environmental governance since the 1990s (Prior and Seck, 2023). The Arctic Ocean has one of the most significant concentrations of surface microparticles worldwide (Barrows et al., 2018).

Ships operating in the Arctic experience more prolonged periods of operation and expand their range further north because of global warming, including a decrease in sea ice extent and shorter periods of sea ice covering (Meyer et al., 2023). Ships substantially contribute to the spread of plastic waste in the Earth's waters (Kurniaty et al., 2023).

According to Osmundsen (2023), the definition and characterization of port reception facilities (PRFs) in global agreements must be revised and more precise. It is an essential component of global legal and policy frameworks that focuses on preventing plastic waste discharge from ships to marine ecosystem. Additionally, the current direct fee procedure may not encourage ship operators to properly dispose of waste. The implementation of indirect cost regulations for waste disposal at ports, along with enhanced law

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enforcement, can encourage the adoption of appropriate waste management procedures (Kurniaty et al., 2023). All of these measures will help reduce plastic pollution in the Arctic (Osmundsen, 2023).

Human rights

Literature (O'Meara, 2023a) argues for including a human rights perspective in the draft Global Plastics Treaty, especially by emphasizing the right to health and a healthy environment.

Numerous developed nations continue to export their plastic waste to low-income countries, especially countries in the Global South, tiny island nations, and marginalized regions in the Global North (Landrigan et al., 2023b). Because of inadequate waste management in many of these areas, mainly the most vulnerable communities are exposed to plastic pollution and its consequences. The groups most severely impacted by the negative implications of plastics and plastic pollution are poor, disempowered, and marginalized populations, including workers, racial and ethnic minorities, "fenceline" communities, Indigenous groups, women, and children. These groups, which had minimal involvement in causing the current plastics crisis, need more political influence and resources to tackle this issue effectively (Landrigan et al., 2023a). In addition, the gender dimension must be considered as well. According to some authors (Prior and Seck, 2023), focusing a higher priority on the gender dimension of plastic pollution can provide valuable insights to guide policy decisions addressing plastic pollution worldwide.

The social and environmental justice (SEJ) principles must reverse these unfair burdens, ensuring that no particular group bears an excessive proportion of the negative consequences of plastics. In addition, those who profit economically from plastic should bear an equitable number of expenses currently not accounted for (Landrigan et al., 2023a). The economic advantages of plastic are rarely used to lessen or minimize the health risks it causes, which widens the gap between those who gain and those who suffer (Karasik et al., 2023).

Combating plastic pollution, axcelerating climate action, protecting ocean ecosystems, and protecting human rights would all be facilitated by incorporating human rights considerations through a precautionary and preventative approach, transferring responsibility to polluters, and expressing concern for intergenerational equal rights (O'Meara, 2023a).

Economy

The plastics, chemicals, and fossil fuel sectors are closely connected (Tilsted et al., 2023). The contribution of these groups amplifies the expenses associated with plastic pollution.

The minimum economic costs attributed to plastic pollution in the marine environment alone were estimated to range from US $3,300 to US$33,000 per year, encompassing expenses related to clean-up efforts and the decline in tourism. However, this estimation does not consider the valuation of impacts on human health or the deterioration of marine ecosystem services (Beaumont et al., 2019). Approximately US$100 billion is spent annually on the socioeconomic consequences of plastic waste worldwide (UNEP and Minderoo Foundation, 2022).

The adverse effects of plastic on human health lead to substantial economic costs. In 2015, global health-related expenses associated with plastic manufacturing were predicted to surpass US$250 billion. In the United States, the costs of disease and disability caused by plastic-related chemicals exceeded US$920 billion. Over 85,000 premature deaths each year, 1.5 million occurrences of cardiovascular disease, and US$675 billion in medical expenses are attributed to chemicals that leach out of plastic and plastic waste in the USA (Landrigan et al., 2023b).

New plastic business models should ideally address economic and social sustainability through methods that support capacity building, R&I, and the formation of new profitable companies and new jobs (Tang, 2023). As an example of accomplishment, Spanish tuna freezer companies use end-of-life fishing nets as a raw material to produce textile items (Andrés et al., 2022). In addition, companies should strive to adopt more sustainable practices in their operations.

To tackle the global plastic life cycle effectively, involving the industry in the negotiations is crucial. This will allow industry actors to be part of the process of creating commitments right from the beginning. The active participation of the plastic and chemical sectors should serve as a crucial foundation for the new instrument. However, it is essential to carefully consider the sector's involvement concerning the interests of other stakeholders, such as non-governmental organizations (Stöfen-O'brien, 2022). "Because domestic structures and actors play a critical role in the negotiators' decision to join or reject an agreement, relevant stakeholders must be involved in the negotiation process, including the private sector, non-profit organizations, and academia" (Tessnow-von Wysocki and Le Billon, 2019).

Package industries must adopt 'Design for Recycling Guidelines' to encourage multiple recycling cycles (Wang and Praetorius, 2022). As an example, the European PET Bottle Platform (EPBP) has recently created a set of design guidelines that focus on improving the recyclability of food-grade opaque white PET (polyethylene terephthalate) bottles (Recycling Magazine, 2023). Nevertheless, the current situation, in which virgin fossil feedstocks like naphtha and ethane are so inexpensive, makes it extremely difficult for alternatives like bio-based or recycled feedstocks and materials to compete with virgin fossil ones. While not all plastic is recyclable, the failure to recycle recyclable plastic results in substantial losses. Nevertheless, a viable economic case for alternatives is required (Bauer et al., 2020).

For industries, the most challenging topic will be the limitations of plastic production. The scientific community is very clear about this: a global cap on plastic production should be a core provision of the treaty (Simon et al., 2021; Bergmann et al., 2022; Walker, 2023; Landrigan et al., 2023a, 2023b). In addition, determining which categories of polymers fall within the instrument's scope will represent an additional complex topic. Considering the extensive range of plastics, which includes 4,000 distinct compounds used alone in plastic packaging and over 5,300 commercially accessible polymer formulations, determining the material reach of this instrument is crucial (Groh et al., 2019). Other difficult points will be: which plastic industry sectors will be involved? Will E-waste plastics be involved? Will the petrochemical sector be involved? And how about ships and ports?

With over 50 member nations, the High Ambition Coalition on Plastic Pollution has highlighted the need for legally-binding commitments. Meanwhile, those involved in the plastic and petrochemical industries, with different interests, persist in advocating postures that restrict the treaty's scope (Tilsted et al., 2023).

Fossil fuel-based plastics business interests and strong power hierarchies are at odds in the relationship between fossil fuels and plastics (Tilsted et al., 2023). The recent COP28 meeting in Dubai, the 28th UN Climate Change Conference (the official name for Climate

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Conferences of the Parties), made the economic effects of fossil fuels very clear. With respect to the imperative to phase out fossil fuels to constrain global warming within 1.5°C, the President Sultan Al Jaber of COP28 argued against the validity of such measures, positing a dearth of scientific support and cautioning against their implementation due to potential impediments to sustainable development, unless one intends to regress society to a primitive state reminiscent of "taking the world back into caves." The COP28 president also controls the state oil company of the United Arab Emirates (Carrington and Stockton, 2023). Nevertheless, the COP28 can be considered a triumph as it was the inaugural historical event to tackle the issue of fossil fuels and their effects on climate change. An open debate occurred, and a resolution was adopted. The COP28 was the inaugural effort in the history of COPs to limit the usage of fossil fuels.

Another economic issue is the equity and sharing of abatement costs in forming international environmental agreements (Börger et al., 2023). This issue refers to the expenses associated with achieving international environmental agreements' objectives, which are not always uniformly distributed among the participating nations. Additional considerations, such as politics, may influence the decision to contribute to cost-sharing.

International legislation and governance

Literature (Carratta and Jaeckel, 2023) indicates that it is crucial to coordinate several governmental levels: International law, regional legislation, and measures at the national and local levels. The authors cite numerous significant environmental laws. A concise discussion will be provided on the legislation that established the core of the literature for the Global Plastics Treaty, with a particular emphasis on international laws.

International legislation

According to Dauvergne (2023b), five particular principles of justice must guide the formulation and implementation of the Global Plastics Treaty:

(1) Distributive justice: Negotiators, policymakers, and implementors must prioritize distributive justice, considering the compelling evidence that plastic pollution is causing disproportionate harm to vulnerable populations, mainly in developing nations;
(2) Procedural justice: implementing the principles of procedural justice, guaranteeing the active and meaningful participation of Indigenous and marginalized populations;
(3) Justice across all governance levels and scales: at all levels of government, aim for environmental justice by rejecting policies, incentives, and market mechanisms that worsen social injustices or violate human rights;
(4) Corporate controls, transparency, and accountability: implementing stringent regulatory measures, such as trade and investment limitations, is necessary to improve corporate transparency and accountability regarding plastic pollution and environmental injustices;
(5) Justice-oriented financial and technical assistance: offering technical and financial support to shift disadvantaged communities towards an environmentally friendly global plastics economy. This approach aims to prevent additional financial burden on low-income countries while holding high polluting and economically capable countries responsible.

Additionally, the literature emphasizes the importance of considering existing agreements during INC meetings (Senathirajah et al., 2023), since adjusting current legal instruments is just as important as creating a new treaty specifically for plastic pollution (Börger et al., 2023). Several international instruments are mentioned, such as Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) (Tessnow-von Wysocki and Le Billon, 2019; Kirk, 2020; Andersen et al., 2021; Grabiel et al., 2022), Kyoto Protocol (Tessnow-von Wysocki and Le Billon, 2019; Tang, 2023), International Convention for the Prevention of Pollution from Ships, commonly referred to as MARPOL Annex V (Stöfen-O'brien, 2022; Kurniaty et al., 2023; Prior and Seck, 2023; Cowan et al., 2023b), Paris Agreement (Kirk, 2020; Tang, 2023; Cowan et al., 2023b), the United Nations Convention on the Law Of the Sea (UNCLOS) (Ortuño Crespo et al., 2020; Telesetsky, 2021; Kurniaty et al., 2023), Basel Convention (Khan, 2020; Carratta and Jaeckel, 2023; Prior and Seck, 2023), the treaty on the Protection of Biodiversity in areas Beyond National Jurisdiction (BBNJ) (Tiller and Nyman, 2018), Declaration on the Human Environment (the Stockholm Declaration) (Carratta and Jaeckel, 2023; Kurniaty et al., 2023; Prior and Seck, 2023), World Charter for Nature (Kurniaty et al., 2023), Washington Declaration on the Protection of the Marine Environment from Land-based activities (Kurniaty et al., 2023), Rio Declaration (Kurniaty et al., 2023), the United Nations Convention on the Law of the Sea (Kurniaty et al., 2023), Convention of the Protection of the Marine Environment of the Northeast Atlantic (Kurniaty et al., 2023), Protocol to the Convention on the Prevention of Marine Pollution by Dumping and other matter (Kurniaty et al., 2023), Honolulu Strategy (Kurniaty et al., 2023), Rotterdam Convention (Carratta and Jaeckel, 2023), and the United Nations Framework Convention on Climate Change (UNFCCC) (Tang, 2023).

In UNEA Resolution 5/14, some international conventions are also cited: the International Convention for the Prevention of Pollution from Ships of 1973, Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Rotterdam Convention on the Prior Informed Consent Procedure for specific Hazardous Chemicals and Pesticides in International Trade, Stockholm Convention on Persistent Organic Pollutants, United Nations Convention on the Law of the Sea, Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters of 1972, Strategic Approach to International Chemicals Management, United Nations Framework Convention on Climate Change, Convention on Biological Diversity (United Nations Environment Programme, 2022b), among others.

During the Global Plastics Treaty negotiations, it is crucial to consider current legislation. The various rights and wrongs of this legislation have been extensively discussed in the literature. Some examples are as follows.

According to Tang (2023), "learning from the shortcomings of the Kyoto Protocol and Paris Agreement, the international treaties for the plastic economy could push for more ambitious goals progressively and garner more active participation from the developing countries, which are also major plastic producers and consumers."

"Almost 40 years after the creation of the UNCLOS, we have a second opportunity as a global community to better address the conservation of living resources and the study, protection, and preservation of the marine environment beyond national boundaries" (Ortuño Crespo et al., 2020).

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"While amending UNCLOS might be considered politically impractical, even a rudimentary conversation on amending the treaty would provide much-needed political focus on critical ocean topics where there are present governance gaps" (Telesetsky, 2021).

Literature suggests that the problem of plastic pollution should be considered through the lens of disaster risk reduction. This is especially true when implementing the precautionary principle in many international legal instruments. The Paris Agreement guidelines could be used to lead the Global Plastics Treaty, driven by national action plans, the potential to offset, and mandatory reporting requirements (Senathirajah et al., 2023).

The literature also discusses the power and importance of activism in governing plastics (Dauvergne, 2023a). This involves implementing laws governing single-use plastics, funding waste infrastructure, expanding recycling initiatives, and developing policies to promote circular economies for plastics; media influencers alerting people about the adverse health and environmental effects of burning, disposing of, and littering plastics; community organizations campaigning for government legislation prohibiting the manufacturing, use, and import of "harmful" plastics; and a host of other initiatives (Dauvergne, 2023a). Each person's involvement is crucial in combating plastic pollution.

Some authors (Carratta and Jaeckel, 2023) analyzed the shortcomings of international environmental law at every stage of the plastic life cycle, indicated possible revisions, and also the crucial elements that the forthcoming plastic treaty should focus on. "The upcoming plastic treaty can offer a more comprehensive regulation of plastic pollution. It should promote sustainable production and consumption of plastic items, improve waste treatment systems, and encourage effective domestic plastic waste management. Furthermore, the treaty should address environmental protection strategies and the impact of MPs and other small plastic particles on a wider range of ecosystems" (Carratta and Jaeckel, 2023).

Some authors call for a reevaluation of the involvement of nonstate actors to facilitate more accessible access to meaningful participation in the design, negotiation, and subsequent implementation of the proposed Global Plastics Treaty and to create more opportunities for such participation (Akrofi et al., 2022). Furthermore, the plastic treaty under consideration might serve as the initial multilateral environmental accord to implement Principle 10 of the Rio Declaration. This principle delineates the following fundamental elements of environmental democracy: access to information, participation in decision-making processes concerning environmental matters, and access to justice on environmental issues.

Furthermore, INC must include representatives of these groups in the treaty negotiation and implementation processes to ensure that the agreement is fair and protects the health and human rights of vulnerable populations, including but not limited to children, pregnant women, waste pickers, individuals residing in fenceline communities adjacent to plastic industries, Indigenous populations and others (Landrigan et al., 2023b).

Some authors have questioned whether existing regulations, such as the Montreal Protocol or the Paris Agreement, can work as examples for the new Global Plastics Treaty (Kirk, 2020). Other authors, motivated by the Montreal Protocol, provided evidence for and advantages of a gradual approach to international regulation of virgin plastic production and consumption (Grabiel et al., 2022). Literature (Denta, 2022) proposed that regulatory measures alone are insufficient to address plastic pollution.

Agreements have been established to deal with marine litter, including the London Convention and Protocol and MARPOL Annex V (Xanthos and Walker, 2017). Despite their existence, establishing a new international treaty on plastics is considered necessary. Why is this so? Is the plastic "frightening enough" (Tiller and Nyman, 2018) to be inserted into other current regulations? Nevertheless, "do we have time to wait for the international community to come together to ratify a treaty text on this, with the required years of negotiations in between?" (Tiller and Nyman, 2018).

However, according to some experts, "there is no space for choosing between amending the existing legal instruments and adopting a new one. To regulate the full life cycle of plastics on a global scale, the two strategies should coexist and support each other" (Carratta and Jaeckel, 2023). According to some authors (Carratta and Jaeckel, 2023), the Global Plastics Treaty will be the first international environmental agreement to encompass all the stages of the plastics' life cycle. Other environmental accords emphasize particular phases of the plastics' life cycle, such as the Stockholm and Rotterdam Conventions (which indirectly address the production and manufacturing phases) and the Basel Convention, which primarily addresses the waste management stage.

To effectively regulate and reduce marine plastic pollution, legal regulations and policies under international water law and marine environmental law must align and coordinate with each other (Finska and Howden, 2018). The successful implementation of the Global Plastics Treaty necessitates coordinating and supplementing international efforts with national, regional, and local interventions (Landrigan et al., 2023a). This can be a strategy to mitigate pollution in international watercourses and oceans (Finska and Howden, 2018). Production controls are a prerequisite for achieving sustainable production and consumption of virgin plastic polymers (Grabiel et al., 2022). Novel and alternative solutions are also necessary (Denta, 2022).

Governance

A comprehensive definition of governance is the direction that public and private authorities give to actions. This includes state laws, business codes of conduct, international organizations, non-profit standards, and social conventions regarding what is right and wrong (Dauvergne, 2018). Concerning plastics, the wide range of pollution sources makes global governance challenging (Dauvergne, 2018).

Based on some authors (Bauer et al., 2020), plastic governance should have an accurate focus. Governance frameworks regarding plastics and plastic pollution have traditionally concentrated on the challenges of improving recycling (Nielsen et al., 2020) and waste management (Bauer et al., 2020; Nielsen et al., 2020). The governance panorama reflects industry efforts to oppose government regulation, transfer responsibility, and silence criticism. It also represents industry support for corporate self-regulation and consumer responsibility as basic governance concepts (Dauvergne, 2018). The absence of an integrated understanding of plastic pollution has fostered a fragmented decision-making process at all levels of governance (Carratta and Jaeckel, 2023). Bottom-up governance of industries has become less effective globally, partly because the industry may need to take advantage of the fragmentation of authority to avoid responsibility, limit the scope of reforms, and create loopholes (Dauvergne, 2018). "While recognizing the severity of plastic pollution, the industry does not point the finger at plastics *per se*, especially single-use plastic, but rephrases the narratives by steering attention to plastic waste" (Akrofi et al., 2022). Implementing a globally binding method could effectively

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address certain obstacles in the governance of marine plastics (Tessnow-von Wysocki and Le Billon, 2019).

Nevertheless, many crucial elements need to be considered, including the dependency on fossil fuels, the climate impact of plastics, the fundamental political and economic dynamics of the petrochemical sector, and the long-term trajectory of conventional plastics (Bauer et al., 2020). A robust global governance agreement to address all sources of plastic pollution still needs to be reached (Walker, 2022). The management of oceans needs to be improved to safeguard marine biodiversity at a worldwide level (Dauvergne, 2018). The plastic industry must take responsibility for the damage to society and the environment that has resulted from its selfish nature and profit policies.

Other important remarks

As stated in this manuscript, the literature focuses on contributing to the ongoing negotiations on the Global Plastics Treaty. The authors proposed the following recommendations to be included in the negotiations and final treaty (some of which had previously been discussed):

(a) MPs (Stöfen-O'brien, 2022; Ambrose and Walker, 2023; Eriksen et al., 2023; Landrigan et al., 2023a, 2023b);

(b) Chemicals incorporated in plastics (Dey et al., 2022; Grabiel et al., 2022; Stöfen-O'brien, 2022; Wang and Praetorius, 2022; Filella and Turner, 2023; Kurniaty et al., 2023; Maes et al., 2023; Tilsted et al., 2023; Wang et al., 2023; Landrigan et al., 2023a, 2023b);

(c) Decrease the chemical complexity of plastic products, establish health-protective criteria for plastics and plastic additives, mandate sustainable, non-toxic materials, ensure full disclosure of all components, and implement traceability of components. International collaboration will be crucial for the implementation and enforcement of these standards (Grabiel et al., 2022; Wang and Praetorius, 2022; Maes et al., 2023; Tilsted et al., 2023; Landrigan et al., 2023a, 2023b). Moreover, a broader definition of plastics as a substance composed of chemicals would be employed to govern the usage and disposal of plastic additives by law (Maes et al., 2023);

(d) Attribute the PBT criteria to plastics (*i.e.*, be classified as a persistent, bioaccumulative, and toxic (PBT) pollutant) under the precautionary principle (Alava et al., 2023);

(e) A clause that prohibits or significantly limits the production and use of superfluous, preventable, and troublesome plastic products, particularly single-use and synthetic microbeads (Andersen et al., 2021; Grabiel et al., 2022; Smith et al., 2023; Tilsted et al., 2023; Landrigan et al., 2023a);

(f) Taxation of virgin plastic pellets (Bauer et al., 2020);

(g) Quotas for recycled and biobased feedstocks in newly manufactured plastic goods (Bauer et al., 2020);

(h) Recognize and encourage mass-balance techniques in primary production that incorporate recycled and biobased feedstocks, with a growing minimum percentage of these inputs to promote progressive transformation (Bauer et al., 2020);

(i) Regulations about extended producer responsibility (EPR), which hold fossil carbon producers, plastic producers, and producers of plastic items responsible for the safety and proper disposal of all the materials they produce and sell, legally and financially (Khan, 2020; Carratta and Jaeckel, 2023; Farrelly and Chitaka, 2023; Landrigan et al., 2023a, 2023b);

(j) Ban the burning of plastic in any form (Landrigan et al., 2023b);

(l) Achieve zero emissions and decouple from dependence on fossil fuels by putting out industry and firm-level roadmaps (Bauer et al., 2020);

(m) Regulate the implementation of plastic clean-up technologies (Falk-Andersson et al., 2023);

(n) Integrate dynamic management in the high seas as area-based management tools (Ortuño Crespo et al., 2020);

(o) Build standardized monitoring systems (Aliani et al., 2023; Eriksen et al., 2023), and harmonized methods and datasets (Hurley et al., 2023) to track global trends and mitigate emissions of plastic pollution effectively;

(p) Address social and environmental justice solutions at every stage of the plastic life cycle and community knowledge gaps; promote equitable distribution and procedural fairness, including human rights (Jahan, 2021; Carratta and Jaeckel, 2023; Karasik et al., 2023; Prior and Seck, 2023; Landrigan et al., 2023a; O'Meara, 2023a; Dauvergne, 2023b).

In line with items (f–j), Simon *et al.* (Simon et al., 2021) proposed three fundamental objectives for establishing a global agreement on plastic pollution. The objectives include reducing the production and consumption of virgin plastic (Goal 1: Reduce), supporting a circular plastic economy that follows waste hierarchy principles (Goal 2: Reuse – Repair – Recycle), and eradicating plastic pollution in the environment (Goal 3: Remove). Also, in line with items (f–h), Tang (Tang, 2023) describes that participating countries can take several measures to decrease plastic pollution. Firstly, they can limit the production of conventional plastics by setting targets, similar to how carbon emissions are limited. Secondly, they can create market-based instruments that help achieve these production targets. Thirdly, they can progressively set more ambitious targets over time. Lastly, they can promote the development of environmentally friendly plastic alternatives, similar to the efforts to develop renewable energy to reduce carbon emissions.

As previously listed in item (o), with the establishment of international accords such as the Global Plastics Treaty, it is crucial to build standardized monitoring systems (Aliani et al., 2023; Eriksen et al., 2023), and harmonized methods and datasets (Hurley et al., 2023) to track global trends and mitigate emissions of plastic pollution effectively. For example, Ambrose and Walker (2023) identified the potential for Caribbean Small Island Developing States (SIDS) to establish a standard framework for monitoring MPs and mesoplastics. This data collection might support the ongoing discussions for the Global Plastics Treaty. Caribbean SIDS include Antigua and Barbuda, The Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname and Trinidad and Tobago. MPs and waste debris are transboundary at their shorelines due to their combined proximity to subtropical gyres. Their unique ecological, cultural, and economic characteristics, with a strong focus on tourism and marine-related businesses, have been adversely affected by plastic pollution.

Personally, given that the primary objective of the Global Plastics Treaty is to reduce plastic pollution, the treaty must include provisions to promote education. Depending on their awareness and knowledge, each individual may or may not contribute to plastic pollution (de Sousa, 2023a). As previously observed,

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recycling contributes to climate change by emitting GHG. Hence, the most effective approach is to reduce the use of plastics. Through education, conscientious consumers can refuse basic items such as plastic bags in their everyday routines, thus contributing to the mitigation of plastic pollution.

Moreover, the design of treaties significantly influences the success of environmental regulatory regimes. Robust design treaties encourage involvement, promote adherence, and discourage non-compliance among all parties (Tessnow-von Wysocki and Le Billon, 2019). Thus, the literature proposes seven treaty design aspects for improving the effectiveness of a future legally binding method to address marine plastic pollution (Tessnow-von Wysocki and Le Billon, 2019), as follows:

(a) The acceptance of a principle of common but distinct responsibilities;
(b) A comprehensive scope that encompasses both land and sea sources, as well as chemical additives and all stages of the plastic's life cycle;
(c) A connection between the issue and the international plastics trade;
(d) A financial mechanism to support the implementation of measures;
(e) Inherent flexibility to adapt to changes;
(f) Efficient monitoring, reporting, and review methods; and
(g) Enforcement through promoting compliance and preventing non-compliance.

"Since a change in social practices may be encouraged by effective lawmaking, a closer give-and-take between behavioral scientists and policymakers is desirable to shape broad and long-term strategies" (Carratta and Jaeckel, 2023). Additionally, it is crucial to comprehend how families use plastic products to facilitate the development of accurate legislation (Northen et al., 2023). For instance, specific directives, including the Single-Use Plastics Directive (European Union, 2019) and the Packaging and Packaging Waste Directive (European Commission, 1994), have impacted changing plastic consumption patterns. As evidenced by the successful examples of some African nations, it is imperative to enhance waste management systems, allocate resources for research, and mobilize regional funds for plastic management, emphasizing the local context and motivating behavioral change (Shomuyiwa et al., 2023). Consumers are essential in mitigating the adverse consequences caused by plastic-related issues. However, a lack of knowledge and/or awareness hinders it (de Sousa, 2023a). Whether and to what degree people fear the problem will determine how effective a legally binding treaty to control plastic pollution will be. Because it is unclear how plastic pollution may affect human health, the public will become aware of it (Tiller et al., 2022).

In conclusion, achieving a consensus regarding the Global Plastics Treaty will take work. It is only possible to satisfy some stakeholders as they all have unique interests. However, we must consider the future of the world that we bequeath to future generations. Stakeholders need to come together for the sake of humanity.

May there be no more dead whales with tons of plastic in their bellies, turtles with straws extracted from their nostrils, or dolphins that perish after getting entangled in fishing nets in the future. As told Inger Andersen, Executive Director of the UN Environment Programme, the global plastics treaty is "the most significant environmental multilateral deal since the Paris Accord…an insurance policy for this generation and future ones, so they may live with plastic and not be doomed by it" (Landrigan et al., 2023b). As a polymer researcher, I agree with his words and trust in the success of the Global Plastics Treaty. May the Global Plastics Treaty break the plastic wave (Figure 3).

Figure 3. Will the Global Plastics Treaty break the plastic wave?

Conclusions

Plastic pollution has reached unsustainable levels. In an effort to reduce plastic pollution, an INC has been established by UNEP to reach a resolution by the end of 2024. Subsequently, an ambitious treaty to reduce plastic pollution, known as the Global Plastics Treaty, is expected to be enforced in 2025.

A systematic review was performed on the Global Plastics Treaty. The analyzed literature mainly focuses on the adverse effects of plastic pollution, legislation, governance, and the economy. The literature supports restricting worldwide plastic production as the most effective strategy to address plastic pollution.

This comprehensive summary of the current literature can contribute to the ongoing negotiations and guide future research on the Global Plastics Treaty.

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