

BLUE ECONOMY

VECTOR FOR
THE DEVELOPMENT
OF BRAZIL

Organizers

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MARINE POLLUTION AS EVERYONE'S RESPONSIBILITY

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1. Introduction

Marine pollution presents itself as a large-scale transboundary phenomenon,¹ present throughout the ocean, regardless of the type of pollutant or the location where it originated.

There is increasing scientific evidence demonstrating serious impacts of pollution on the marine environment. Ocean chemistry has been altered due to human activities both in coastal waters and in the open sea. This phenomenon has been going on for decades, causing the destruction of coastal habitats and concomitantly overfishing, causing devastating impacts on biodiversity and marine habitats (WEIS, 2015, p.4).

The progressive increase in marine pollution, along with its consequences, progressively perceived by society, have driven International Law to develop rules and regulations in order to mitigate it.² Actions in this direction are increasingly urgent and essential, especially since almost every activity performed in the terrestrial environment generates, to some extent,

waste that will contribute to growing levels of ocean pollution, even activities that, at first, aimed to mitigate pollution, such as the introduction of invasive species, such as Sargassum, in certain regions of the ocean, (RODRÍGUEZ-MARTÍNEZ, 2019, p.202).

This is reflected not only in the quality of life of marine animals, but directly interferes with human life, either because the waste in the sea reaches the food chains, being later ingested by humans organisms, or because it affects coastal landscapes, directly influencing a decrease in tourism in a given area and, consequently, affecting the economy, by reducing the provision of ecosystem services. The imperative issue observed, therefore, is that marine pollution can affect society in practically all its spheres, from the social, to the economic, passing through the environmental.

Thus, it can be seen that marine pollution constitutes a phenomenon to be treated not only by International Law and by international actors in the abstract but enters

the sphere of responsibilities in a broad way, being, in fact, a responsibility of all: from the individual to the collective.

In this sense, there are several international legal norms that provide for the responsibility of States when they cause pollution in the ocean: it is understood that the duty of each country is to refrain from the occurrence of this type of damage, especially in order to guarantee that the activities under its jurisdiction and control are carried out with due diligence not to cause pollution to other States and their environment. In Brazilian domestic law, in turn, the National Plan to Combat Marine Litter was developed, which is specifically aimed at mitigating marine pollution, considering, for its actions, the specificities of each region and location (BRASIL, 2019).

It should be noted that in the Brazilian case, standards of this nature are becoming increasingly important, mainly due to the repeated occurrence of oil spills on the country's coasts. The substances spilled on the Brazilian coast are varied, the main ones being identified: diesel, marine fuel, oily residue; lubricant; and/or oil. Such spills may have a known origin, such as those from vessels, or they may be orphan spots of unknown origin, which makes it difficult to identify the volume of spilled oil. These, even in small volumes, occur with an expressive frequency. This is the profile of most spills that have occurred in the last ten years in the country: small, but frequent (SILVA, 2019). Yet, in early September 2019, dense crude oil began washing up to the beaches of Brazil's tropical coast. This oil spill was the most extensive and serious environmental disaster ever recorded in the history of Bra-

zil, in the South Atlantic basin and in tropical coastal regions around the world (SOARES *et al.*, 2020).

The fact that marine pollution is a topic addressed in so many spheres of law demonstrates the magnitude of the phenomenon, as well as justifies the concern and urgency of the problem, which can manifest itself in different ways. The international community remains committed to eliminating important legal gaps, such as the issue of marine plastic pollution and the specific approach to microplastics, such as the recent negotiations that culminated in the UN Resolution "End Plastic Pollution" (UNITED NATIONS, 2021/2022).

This work, therefore, presents reflections that range from the concept of marine pollution and its main origins, to the understanding of collective responsibility that is characteristic of the phenomenon, which is translated into the provisions of various legal mechanisms, whether international or national. The subsistence of legal gaps, however, proves to be an important obstacle to the effective approach and mitigation of the problem, as which, on the other hand, has already been duly recognized and has been emphatically debated. Although there are several types of marine pollution, the main focus of the research is on marine pollution from plastics to *Sargassum sp.*, demonstrating how different human activities can severely impact the ocean. It is a theoretical, bibliographical, descriptive, exploratory and qualitative research of national and international bibliography, with priority to recently published scientific articles, in addition to legislation and international documents relevant to the object under analysis, especially reports, resolutions and international conventions.

2. Marine pollution as a transboundary phenomenon: concept and approaches

Efforts to provide the scientific basis for pollution control have been increasing, and the law, although permeated by inadequacies in the scientific understanding of marine pollution, has progressed at national and international levels for some decades now (TOMCZAK, 1984, p. 311-322). This is largely due to the fact that one of the ecosystems in which the impact of humanity has been felt most severely is the marine environment. For long periods, humanity acted as if the ocean, so vast and so full of life, could tolerate any level of pollution thrown into it (POTTERS, 2013), but this is not the reality.

In 1972, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter was created; known as the London Convention, it has been in force since 1975. This convention aims to promote the effective control of all sources of marine pollution and to adopt possible measures to avoid sea pollution from the release of waste and other materials (TURRA, 2020, p. 41). The Convention operates on lists of "waste or other matter" classified by their hazardous nature and makes appropriate regulations by reference to the lists. The terms pollution, harmful and dangerous matter, however, are also invoked, but not defined (TOMCZAK, 1984, p. 315).

The Montego Bay Convention (UNCLOS), ten years later, presented a definition of pollution³ of the marine environment, conceptualizing it as the type of pollution resulting from the introduction,

by individuals, directly or indirectly, of substances or energy into the marine environment, whose results can turn out in deleterious effects, such as danger to living beings and marine life, human health and compromising the quality of seawater use.⁴

Reinforcing the transboundary nature of marine pollution, more broadly, the phenomenon "transboundary pollution" was the object of international arbitration in the emblematic Trail Smelter case⁵ of 1941, considered as the dispute that established the foundations of International Environmental Law with regard to transboundary pollution (HALL, 2007, p. 696). In the arbitration award, the court, when deciding on an episode of air pollution, mentioned a case related to water pollution, in which the city of New York was subpoenaed, at the request of the State of New Jersey, to desist from the practice of dumping sewage into the sea, which was harmful to the applicant's coastal waters in the vicinity of their resorts (UNITED NATIONS; Trail Smelter case. *Op. Cit.* p.1964).

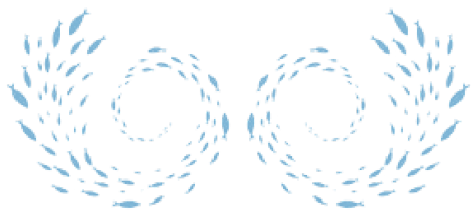
Considering the nuances of the case and the precedents addressed by the court, it was decided that no State has the right to use or permit the use of its territory in a way that causes harm arising from toxic gases in the territory of another State or in the properties of the persons contained therein. The Arbitral Tribunal reached this conclusion regarding air pollution, but it is equally applicable to water and sea pollution and is, since then, widely considered as part of general international law (MENDIS, 2006, p. 11).

The arbitration of the Trail Smelter case, in addition to being a pioneer, having originated an international judicial decision that specifically dealt with a modality of transboundary pollution, had its precedent reaffirmed in several international declarations, and its arbitration decision was incorporated into the Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration, 1972) (HALL, *Op. Cit.*, p. 699).

In turn, while the term “contamination” is used to describe the fact that a certain chemical compound is present in a certain habitat and/or in the organisms that live in it, in a concentration higher than the normal or the background value (and this due to unnatural causes), the definition of “pollution” can be understood as any form of contamination, in an ecosystem, with a harmful impact on the organisms that inhabit it, altering the growth rate and reproduction of plant or animal species, or interfering with human amenities, comfort, health or property values. In a broader sense, the terms contamination and pollution also include any physical modification that alters the flow of energy or radiation in an environment (such as a heat source or sink, or a radioactive element), or even the presence of an invasive species. (POTTERS, *Op. Cit.*, p.16).

It is worth mentioning that marine pollution, due to intrinsic characteristics of the ocean, such as the fluidity of waters and the occurrence of sea currents that contribute to the displacement of substances and materials through marine spaces (ZANELLA, 2013) is largely a cross-border phenomenon. Pollution that originates in an ocean location can, when crossing the border by water or air, cause damage to the environment of another State,⁶ being one of the oldest and most persistent problems in the sphere of Environmental Law, (HALL, 2007, p. 681) regardless of whether it is a point source of pollution or a diffuse source of pollution.⁷

Given the complexity and magnitude of this phenomenon, UNCLOS establishes specific principles and rules on marine pollution, so that States have a general obligation of due diligence, under article 194 of the Convention,⁸ to ensure that activities under their jurisdiction and control are conducted in such a way as not to cause pollution damage to other States and their environment. UNCLOS also contains provisions that establish direct obligations on States to prevent, reduce and control pollution of the marine environment by specific activities subject to their jurisdiction and control (BECKMAN, 2014, p. 24-25).



3. Main causes of marine pollution: from plastic to *Sargassum sp.*

A wide range of threats such as increased acidification, coral bleaching, toxins and chemical pollution, nutrient overload, and fisheries depletion, including many others, are undermining the ocean's ability to sustain its ecological functions. Debris or residues inserted into the ocean are part of this phenomenon (JAYASIRI, 2018, p. 136).

From messages in bottles to exotic tropical seeds that make their way to shores, the scattering of floating debris in the sea has long fascinated people (RYAN, 2015, p.2). The origin of marine pollution, where the solid waste that enters the oceans comes from, is a topic addressed since the first records of this type of pollution. Most human activities, whether on land or in the seas, produce some kind of waste and, to some extent, part of it ends up reaching this ecosystem. Terrestrial activities are indicated as those mainly responsible for the introduction of solid residues in the ocean, because it is speculated that 80% of the residues detected in the marine environment come from terrestrial sources (TURRA, *Op. Cit.*, p.9).

Terrestrial sources of pollution of the seas are related to the whole range of daily activities carried out on land, which includes the waste generated in residential homes, businesses, buildings, hospitals, and industries. About 10 million tons of plastic waste enter the ocean annually from land sources. The plastics that enter the sea are concentrated in five major ocean gyres: in the north and south

of the Pacific, in the north and south of the Atlantic and in the Indian Ocean. The North Pacific gyre, popularly known as the Great Pacific Garbage Deposit, is the most known one (HENRICH BÖLL FOUNDATION, 2020, p. 32).

Debris or residues that enter the seas can be any persistent, manufactured or processed solid material that is discarded, released, or abandoned in the marine and coastal environment. These materials are composed primarily of floating plastics and may include cigarette butts or filters, disposable baby diapers, beverage bottles and cans, tires, disposable syringes, plastic bags, bottle caps, and fishing lines and tackle (JAYASIRI, *Op. Cit.*, p.137-138).

It should also be noted that after the outbreak of the Covid-19 pandemic, social distancing and the use of face masks became socially encouraged care, which proved to be essential in an attempt to overcome such an adverse scenario. However, the adverse effect that such measures have had on the environment since then is undeniable. Plastic pollution, especially in marine ecosystems, has been exacerbated by the sanitary measures adopted as well as by the lack of adequate disposal of plastic waste. It is undeniable that plastics have revolutionized society and have been essential as a material used in various ways and at an affordable price, with the health crisis triggered by Covid-19 increasing its consumption worldwide, especially disposables after a single use. It happens that plastic waste is not inert in the environment, on the

contrary, although at first they are used for the protection of individuals and have relevance for this, they are extremely harmful when improperly disposed. The pandemic, therefore, represents a huge increase factor for the already existing overload of plastic waste in the environment (LEITÃO; MONT'ALVERNE, 2021).

The properties that have made plastics so useful to society are the same properties that make improperly handled plastic waste a significant environmental threat. Their durability means they persist in the environment for many years, and their low density demonstrates that they are easily dispersed by water and wind, sometimes traveling thousands of kilometers from their areas of origin. As a result, plastic waste is an omnipresent pollutant even in the most remote areas of the planet (RYAN, *Op. Cit.*, p.2).

From this waste, the widespread use of single-use plastic bottles, utensils, shopping bags and take-out food containers or packaging has resulted in a serious marine pollution problem across the planet. Widespread use of plastics, improper waste management practices, stormwater runoff, and inadequate treatment of wastewater and general waste cause and exacerbate marine plastic pollution, generating marine habitat degradation, threatening wildlife, hampering coastal economic activities and threatening human health (NY/NJ BAYKEEPER. NY-NJ, 2016, p. 4.).

Plastics are the last stage of the vast petrochemical industry, with more than half of this waste ending up in consumer products, mainly in the form of disposable packaging. It is known that only a few

dozen food and consumer goods companies are the sources of almost all the plastic waste dumped in the ocean. The industry lobby promotes public policies that, on the one hand, are focused on recycling and consumer behavior, but that, on the other hand, ignore the need to reduce plastic production.⁹

Industrial activities, therefore, are great potential generators of plastic waste, such as the production of plastic bags, single-use disposable plastic items and microspheres, which are made up of synthetic plastic particles that are intentionally added to consumer and industrial products. Plastic bags are the number one consumer item on the planet. Most plastic packaging is disposable, especially in trade applications carried out directly between the producer, seller or service provider and the final consumer, most of which are discarded in the same year in which they are produced. In 2015, plastic packaging waste accounted for 47% of plastic waste generated globally, with half originating from the Asian continent (UNITED NATIONS ENVIRONMENT PROGRAMME, 2018, p. 6.).

The ecological integrity and biodiversity of marine ecosystems have been highly threatened due to the controlled or uncontrolled release of high concentrations of pollutants generated by human activities. In an attempt to solve or remedy the problem, different technologies have been developed for the recovery and degradation of pollutants from the marine environment, such as filter processing and other electrochemical methods. However, these technologies have limitations such

as high cost and low efficiency in the total removal of contaminants. For these reasons, biosorption is seen as a low-cost, simple, and safe alternative for pollutant recovery. This technique refers to the ability of non-living biomass of some organisms to bind and capture substances of a different nature from aqueous solutions, allowing for their passive removal from the environment. The algae *Sargassum sp.*, therefore, has been used for this purpose, due to its efficiency to capture pollutants directed to the coastal ecosystem (SALDARRIAGA-HERNANDEZ; et. al., 2020, p. 1-3).

The use of *Sargassum sp.*, however, presents itself as a pressing problem all over the world, because despite its usefulness, its unusual proliferation near tropical coasts and the subsequent formation of seas of *Sargassum sp.* is associated with mass mortality of coastal fauna (RODRÍGUEZ-MARTÍNEZ; et. al., 2019, p. 202).

In general, the effects of pollutants on marine ecosystems and living resources are negative. The main consequences are the reduction of fish biodiversity; loss of nesting habitats; the degradation of coastal habitats and biodiversity; disruption of fish life cycles in aquaculture; the mass death of fish from contaminated water and changes in water chemistry, which are just a few examples of the environmental pressure exerted by pollutants on marine ecosystems. The introduction of invasive species for this purpose, however, although considered economically viable and sustainable, like the use of *Sargassum sp.*, has shown a reverse effect.

In addition to the health problems associated with the use of *Sargassum sp.*,¹⁰ tourism, which is the main economic activity in many coastal locations, such as the Caribbean,¹¹ is also negatively impacted because the alarming amount of *Sargassum sp.* on the beaches does not allow access to the sea, colors the clear water in dark brown, generates an unpleasant sight and gives off an unpleasant odor (SALDARRIAGA-HERNANDEZ; et. al. *Op. Cit.*, p. 3-4).

It is also worth mentioning that specifically in Brazil, there has been a recurrence of another type of marine pollution, caused by oil spills on the country's coasts. More specifically, in 2019, a major oil spill disaster was detected on the Brazilian coast, which proved to be severely damaging, having affected a significant number of coastal and marine protected areas, in addition to Brazilian tropical ecosystems. This disaster highlighted the social, environmental, and economic challenges arising from marine pollution (SOARES, *Op. Cit.*, p.2) which becomes even more noticeable when a new appearance of oil slicks on the coast was found in the year 2022, mainly on the beaches of the east coast of Ceará (UNIVERSIDADE FEDERAL DO CEARÁ, 2022).

The causes of marine pollution, therefore, originate from several sources, all to some extent harmful, whether for the marine environment, for living beings – humans and others – or even for the economy at local, regional, and global levels. It is unequivocal, hence, that the responsibility for marine pollution spreads among the most diverse actors in society: it is everyone's responsibility.

4. The economic bias of marine pollution: a shared responsibility for all

The ocean is governed by legal structures at the international, national, state, and local levels and, similarly, regulations on marine pollution are enacted. Several multilateral and bilateral treaties are in force, in addition to other agreements for fisheries management, maritime transport, protection of biodiversity and pollution (WEIS, *Op. Cit.*, p.16).

The interactions of society, the economy and the environment exert an important influence on marine ecosystems through their dynamics and their broader biogeochemical cycle. This is because ecosystem services are dependent on each other and exhibit complex interactions that generate trade-offs in the delivery of one ecosystem service versus the delivery of others. For the ocean economy, this is relevant because these interactions indirectly determine the viability of ocean-based industries (OECD, 2016).

According to the Organization for Economic Co-operation and Development (OECD), the ocean can be considered as the new economic frontier. These maritime spaces have great potential for growth, employment, and innovation. Therefore, it is already considered an environment of crucial importance to face many of the challenges that the world has faced and will face in the coming decades, especially post-Covid-19, such as: food security, climate change, energy production, supply of natural resources, in addition to the progress of medicine (OECD, 2017).

Human activities, however, have the potential to intervene indirectly in the functioning of marine ecosystems, thus under-

mining the economic viability of the economy of the sea. In addition to the damage to the environment and human health, the negative impacts resulting from the release of plastic waste into the ocean, for example, are reflected in the world economy. It is estimated that about 4.8 to 12.7 million metric tons of plastic were released into the ocean from terrestrial sources in 2010 alone, and forecasts regarding the flow of plastics into the marine environment point to its increase over the years (BEAUMONT, 2019).

Plastic waste, specifically, has the potential to work together with other stressors, such as climate change and the overexploitation of marine resources, in ways that cause much greater damage than if they occurred in isolation. Habitat changes in key coastal ecosystems caused by the direct impacts of marine litter and plastics affect local food production and damage coastal structures, leading to far-reaching and unpredictable consequences, including loss of resilience to extreme events and climate change in coastal communities (UNEP, 2021).

The productivity, viability, profitability and safety of the fisheries and aquaculture industry are highly vulnerable to the impact of plastic deposited in the ocean, especially when coupled with broader factors including climate change and overfishing. The high dependence on seafood for nutrition leaves the well-being of a significant proportion of the world's population extremely susceptible to any changes in the quantity, quality, and safety of this food source (BEAUMONT, *Op. Cit.*).

Traditional maritime industries will be increasingly influenced by climate change, as changes in temperature, ocean acidity and sea level rise affect the movements of fish stocks, opening up new trade routes and affecting port structures, thus creating new destinations and tourist attractions, while others are destroyed. It is noteworthy that the destruction of the Aral Sea, for example, caused economic collapse and mass migration from the surrounding coastal area, which provides an extreme view of how the collapse of an ecosystem can affect the local economy (SWISS RE INSTITUTE, 2022).

Conjectures about the reduction of terrestrial ecosystem services due to anthropogenic disturbances point to a decline of 11% to 28% of them (BEAUMONT, *Op. Cit.*). Understanding the concept of ecosystem services is, thus, essential for it to be possible to assimilate the magnitude of the economic problem that involves marine plastic pollution, consequently, affecting all sectors of society. Ecosystem services, or environmental services, can be defined as flows from natural capital stocks that combine with human services capital to provide well-being to populations. Such services can be classified into four categories: cultural services (aesthetic and recreational elements); regulation (whether climate, floods, pests, and water purification); support (nutrient cycling and soil formation); and provision (supply of food, fresh water, fiber, and fuel) (NUSDEO, 2016).

Over half of the global GDP – that is, 55%, equivalent to US\$41.7 trillion – depends on high-functioning biodiversity and

ecosystem services. Of the world's countries, however, 20% are at risk of their ecosystems collapsing due to the decline in biodiversity and related beneficial services. This strong economic dependence on natural resources highlights the fundamental character of sustainable development and conservation for the long-term sustainability of world economies (SWISS RE INSTITUTE, *Op. Cit.*).

In terms of loss valuation, it is possible to estimate that a decline of just 1% to 5% in the provision of marine ecosystem services is equivalent to an annual loss of 500 to 2,500 billion dollars in the value of benefits derived from these services. Given that this figure only includes the impacts of marine natural capital, the total economic cost is likely to be much higher (BEAUMONT, *Op. Cit.*). By comparison, the global plastics market in 2020 was estimated to be around \$580 billion, which is less than the monetary value of marine natural capital losses per year. (UNEP, *Op. Cit.*).

This calculation of the economic costs per ton of plastic in the ocean¹² is fundamental for future global negotiations in order to transform the way plastics are designed, produced, used, reused and reprocessed, bearing in mind that the ocean economy is essential for the future of human prosperity, and which is an essential source of food, energy, minerals, health and leisure on which hundreds of millions of people depend on (OECD, 2017).

Marine pollution, therefore, as an event whose consequences are perceived in a joint and non-segmented way, mainly due to its transboundary nature, enters the

sphere of responsibility as a practice from which everyone must refrain from carrying out, whether individuals, companies or States. In this sense, the Declaration of the United Nations Conference on the Human Environment and the Rio Declaration on Environment and Development affirmed in their principles the responsibility of States¹³ to ensure that activities carried out under their jurisdiction do not cause damage to the environment of other localities or areas beyond the limits of their national jurisdiction.¹⁴

Responsibility as a principle emerges from the perception that there is a great vulnerability of nature subjected to the technical intervention of humanity, a vulnerability that was not suspected before becoming recognizable in the damage caused by human conduct. Nature as human responsibility, therefore, is undoubtedly a topic on which ethical theory is dedicated to reflecting (JONAS, 1995). The obligation of responsibility – whether of States or individuals, that is, of society as a whole – also extends to responsibility for the future, and this responsibility can only exist if the beings that can in fact take responsibility continue to exist. This requires ensuring the continuity of human existence in the world (JONAS, 2017).

In this context, the protection of marine ecosystems and, in particular, the fight against marine pollution, must be promoted by the whole society, at all its levels, being crucial for the achievement of the Sustainable Development Goals (SDGs) and, specifically, to promote ocean health and planet resilience. Conserving the ocean must reflect the possibility of guaranteeing inter-generational solidarity, that is, agents must have a transforming look at natural resources, not only envisioning them as an investment opportunity, but as valuable resources to be perpetuated and transmitted to the descendants in the future (WEISS, 1992).

The unsustainable use of the seas and their resources threatens the very foundation on which the planet's well-being and prosperity depend on. Embodying the full potential of the sea economy therefore requires responsible and sustainable approaches to its economic development. In taking action to reduce marine pollution, society as a whole invests in both the current and future provision of marine ecosystem services and the human benefits they provide. The principle of responsibility, therefore, in line with sustainable development, is essential for the maintenance of adequate conditions for the biosphere and the future survival of humanity (JONAS, 1976).



5. Legal responses to face marine pollution: from the international to the national sphere

In view of the magnitude of the phenomenon hereupon analyzed, as well as its serious consequences, the international community is making efforts to provide legal responses to the fight against marine pollution. At the international level, there are different categories of binding instruments relevant to addressing marine pollution. The principles and rules that govern States regarding transboundary pollution of the seas, as seen, are established in the UNCLOS, more specifically in its article 194.¹⁵

A notable feature of this device is its abdication of any damage as a triggering element of the established obligations. The main focus of its legal regime is not on liability or obligation for damage to the environment, but on comprehensive regulation to prevent, reduce and control marine pollution (PRÖLSS, 2017).

The general principle of this provision, regarding the State's liability for damage caused by pollution outside its territory, must be considered as customary law since the Nuclear Test Cases.¹⁶ The main objective, contained in article 194, is that States do not cause damage by pollution, but if pollution occurs, the intention is that it does not spread beyond the areas of jurisdiction of a particular State. This obligation of conduct, according to the 2015 Advisory Opinion of the Sub-Regional Fisheries Commission of the International Court of the Law of the Sea (ITLOS), of 2015, requires due diligence in the sense that a State not only adopts appropriate rules and measures, but, likewise, some level of

vigilance in its application and in the exercise of administrative control (*Idem*, 2017).

Such an understanding was adopted by the Arbitration Court in the South China Sea Arbitration, whose judgment is dated July 12, 2016. The decision reiterates an obligation of due diligence that States must ensure that activities within their jurisdiction and control respect the environment of other States or areas beyond national control. The States have a positive duty to prevent or mitigate significant damage to the environment when engaging in large-scale construction activities, as opposed to a negative duty to refrain from degrading the environment. The sentence was also progressive in the sense of confirming that Part XII of UNCLOS can evolve through interpretation and the duty of cooperation (KOJIMA, *Op. Cit.*).

Other norms interact with the UNCLOS when it comes to pollution of the marine environment, presenting specific provisions regarding pollution from different sources, with instruments oriented or related to pollution, such as the London Convention;¹⁷ mechanisms focused on biodiversity or species, such as the CBD¹⁸; and agreements on chemicals and waste, such as the Basel, Rotterdam and Stockholm Conventions (UNEP, 2017), and specifically regarding marine pollution from oil spills, the International Convention Relating to Intervention on the High Seas in cases of oil pollution casualties.¹⁹

More emphatically, the Basel Convention on the Control of Transboundary

Movements of Hazardous Wastes and their Disposal, specifically, aware of the risk of harm to human health and the environment caused by hazardous wastes and other wastes and their transboundary movement (BASEL CONVENTION, 2020), can be understood as an important binding mechanism allied to the mitigation of the effects of transboundary pollution. Specifically, regarding plastic waste, which has been recognized as a serious global environmental problem, the Conference of the Parties to the Basel Convention, in 2019, adopted important decisions to address the issue. These measures strengthened the Basel Convention as the only legally binding global instrument to specifically address plastic waste (*Idem*, 2020).

In the Report of the Conference of the Parties to the Convention on the work of its fourteenth meeting, many representatives, including several who spoke on behalf of groups of countries, took the floor to highlight the extent of the plastic waste problem and the importance of taking steps to manage them. The fourteenth meeting of the Conference of the Parties to the Basel Convention (COP-14, 29 April to 10 May 2019) adopted, in its decision BC-14/12,²⁰ amendments to Annexes II, VIII and IX of the Convention with the objective of increasing the control of transboundary movements of plastic waste, clarifying the scope of the Convention regarding this waste.

More recently, in March 2022, Heads of State, Environment Ministers and other representatives of 175 States endorsed a landmark resolution at the United Nations Environment Assembly (UNEA-5) to “End

Plastic Pollution” and adopt a legally binding international agreement by 2024. The resolution addresses the entire life cycle of plastics, including their production, development and disposal.

Resolution UNEP/EA.5/L.23/Rev.1, entitled “Ending plastic pollution: Towards a legally binding international instrument”, addresses several aspects of marine plastic pollution and, among them, recognizes that: a) microplastics are part of the problem; b) plastic pollution, in marine and other environments, can be of a transboundary nature and needs to be tackled, along with its impacts, through a full life cycle approach to these materials; c) there is an urgent need to strengthen global coordination, cooperation and governance to take immediate action for the long-term elimination of plastic pollution in marine and other environments; and d) greater international commitment is needed through the development of a legally binding international instrument on plastic pollution, including in the marine environment (UNEP, 2022).

The problem of litter in the ocean has a global scale and intergenerational impact, in addition to being a complex cultural and multisectoral issue that claims huge ecological, economic, and social costs worldwide (TURRA *et al.*, *Op. Cit.*). The new Resolution expresses in its text the need to promote cooperative measures at national and international level with the objective of reducing plastic pollution in the ocean, including existing plastic pollution, in addition to emphasizing the importance of providing scientific and socioeconomic assessments related to this type of pollution (UNEP/EA.5/L.23/Rev.1).

Still on international measures aimed at mitigating marine pollution, from the 5th International Conference on Marine Debris in 2011, the Honolulu Strategy emerged as a global framework of comprehensive efforts aimed at reducing the impacts of marine debris worldwide, whether ecological, on human health or on the economy (NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION). The Strategy builds on the Honolulu Commitment, with a new collaborative approach to reducing the incidence of solid waste in the ocean, as well as the damage it causes to marine habitat, biodiversity, and the local and global economy (TURRA *et al.*, *Op. Cit.*).

The Honolulu Strategy is considered a major soft law advance in the field (STOETT, 2019). The Commitment agrees with the intention of several groups to combat the problem of litter at sea, while the Strategy has the scope to serve as a management tool to minimize the impacts caused by this debris, from actions that control its marine and terrestrial sources and that reduce the levels of waste already present in the environment. The Honolulu Strategy plays an essential role in supporting sustainable and structured solutions for the existence of waste in the ocean. The accumulation of debris – specifically plastics – in the seas is a global problem, which transcends borders and originates from various sources, arising from anthropogenic activity. The problem, as already pointed out, is a shared responsibility among States and among different sectors of society (TURRA *et al.*, *Op. Cit.*).

The International Convention for the Prevention of Pollution from Ships (MARPOL, 1973) is another global, but binding

instrument that, in its Annex V,²¹ in regulation 3, prohibits the disposal of waste outside special areas, including the dumping of all kinds of plastics at sea; and in rule 5, which provides for the disposal of garbage in special areas, prohibits the throwing of all plastic objects, such as ropes and fishing nets made of synthetic material and plastic garbage bags.

The International Maritime Organization, in turn, adopted in 2018 an action plan to address plastic litter from ships, aiming to improve existing regulations and introduce new support measures to reduce marine plastic litter from ships. The plan emphasizes IMO’s commitment to meeting the targets of the 2030 Agenda, in particular SDG 14, noting that plastic litter enters the marine environment as a result of a wide range of land and sea activities. Both macro and microplastics persist in the ocean and result in harmful effects on marine life and biodiversity, as well as negative impacts on human health and activities such as tourism, fishing, and shipping. Despite the existing international regulatory framework to prevent marine plastic litter from ships, however, discharges at sea continue to occur (IMO, MEPC 73/19/Add.1 Annex 10), which demonstrates that such standards do not achieve the expected effect.

At the national level, as well, there are also public policies aimed at waste management and the mitigation of marine pollution, whose regulatory framework is Law Number 12,305/2010, known as Brazil’s National Policy on Solid Waste (PNRS), which defines polluting substances, or debris inserted into the seas, such as discarded

materials, substances, objects or goods, arising from human activities in society, and whose final destination is proceeded, proposes to proceed or is obliged to proceed, in solid or semi-solid states, as well as gases contained in reservoirs and liquids whose particularities make their release into the sewage network or bodies of water impracticable (BRASIL, 2010).

Specifically, regarding plastic, several bills are being processed in the Brazilian National Congress – at least 135, proposed between 1995 and 2019: however, there is no specific guideline or legislation to address the issue. Even with the absence of a specific national guideline for plastics, many Brazilian states and municipalities develop their own norms and rules to address the problem, mostly with a focus on banning certain products (PERTUSSATTI, 2020).

Brazil is one of the countries that produces the most plastic waste on the planet, which would account for approximately 1 kg of plastic waste per inhabitant weekly (WWF, 2019). This data reflects the pressing need for the country to directly deal with the management of plastic waste domestically.

In this sense, in 2019, the National Plan to Combat Marine Litter (PNCLM) was launched, which is composed of a diagnosis

of the problem of litter at sea in the country, bringing a governance model, implementation axes, guidelines and indicators in order to combat litter at sea. The PNCLM provides, among other initiatives, the development of regionalized plans, applied to the problems of each location in the country (TURRA *et al.*, 2021). The lack of sufficient information on the problem of litter at sea in Brazil and the need to expand the diagnosis for the effective implementation of executive and structuring actions, however, reinforce the urgency of the partnership with the Academia, aiming to guarantee the construction of adequate knowledge, as well as the commitment of various sectors of society, in order to enable a true implementation of the Plan (BRASIL, 2019).

In the context of multisectoral engagement, when it comes to the environment and, specifically, litter in the ocean, civil society organizations present themselves as important figures for raising public awareness about the problem, elucidating its origins, impacts and stimulating the development of mitigation strategies. Recognizing that the multiple and cascading risks posed by marine litter and plastics make them multipliers of threats is the first step (UNEP, *Op. Cit.*).



6. The gaps that still exist: microplastics as part of the problem

Despite the wide variety of international legal norms aimed at addressing marine pollution, it is worth noting that there are still important gaps. More specifically, when it comes to marine plastic pollution, a slow and progressive path is being traced towards a specialized global governance²² aimed at mitigating the effects of this type of pollution. Microplastics and marine plastic litter are a preventable problem, as much of the plastic waste that ends up in the ocean is the result of poor management. These wastes, however, are not adequately dealt with at the international level, both in mandatory and voluntary instruments (UNEP, *Op. Cit.*).

UNCLOS does not specifically address the pollution of the marine environment by plastic waste, so effective measures are not provided to achieve the necessary protection and preservation of the ocean. The Basel and Stockholm Conventions, which can be applied to the reduction of terrestrial sources of marine plastic litter and microplastics, have limited application. Under the Stockholm Convention, for example, the application of packaging constitutes the main sector of the plastics market. Globally, it is estimated that 32% of packages escape from collection systems,²³ reaching the marine environment. Chemicals migrate from these packages to food, but these substances may not fall under the Convention's regulations. Thus, at a global level, the production, use and disposal of large volumes of chemical substances used in the manufacture of plastics are not regulated by this instrument (UNEP, *Op. Cit.*).

Despite all these international legal mechanisms, whether hard or soft law, gaps remain. There is no agreement that effectively prevents and minimizes marine plastic pollution, particularly from land-based sources. Resources and technical cooperation are lacking, especially in efforts to improve waste collection systems. There is a lack of coordination between the various frameworks, instruments and platforms dealing with plastic pollution (significantly improved cross-sectoral coordination is needed, with collaborative efforts by multiple stakeholders and much closer intergovernmental cooperation). There is also still no institutionalized effort to assess the state of plastic pollution, in addition to the lack of standards aimed at monitoring the release of plastic waste into the environment, including the ocean. As a consequence, there are considerable uncertainties about the quantities, sources and transmission routes of marine plastic pollution (SIMON, 2018).

International legal instruments have considered plastic waste to be one of the most urgent environmental problems and are moving to act against it; however, this movement is still quite limited, and there is no global governance arrangement that addresses the entire life cycle of plastics. The issues related to plastics in the environment are multiple and comprehensive, and international law has not evolved with the same agility with which the problem transcends national borders. A new legally binding international agreement proves essential to fill gaps and effectively address

marine plastic pollution (*idem*, 2018).

Resolution UNEP/EA.5/L.23/Rev.1, at this point, shows itself as promising in filling these gaps, especially by expressly mentioning and recognizing that microplastics are part of the marine pollution problem. Before that, however, despite the focus that the international community had already given to the problem of plastics in the ocean, the 26th United Nations Conference on Climate Change (COP 26), held between 1 and 12 November 2021, an important forum for global discussions on the climate emergency and related environmental issues, did not directly address the issue. The Global Environment Facility Report for the 26th COP recognized that life on Earth fundamentally depends on clean air and water, biodiversity, healthy oceans, and lands, in addition to a stable climate; and, by identifying that the climate emergency influences on sea level rise, flooding, coastal erosion, increase in extreme weather events, bleaching of coral reefs and ocean acidification (UN, 2020), made no mention of plastics in the seas and their effects.

This lack of pronouncement on plastic pollution is not in line with a holistic approach to the problem, as greenhouse gas emissions occur at all stages of the plastic life cycle, including extraction and

transport of raw materials, manufacturing, waste treatment and entry into the environment. Plastics released into the environment also slowly release greenhouse gases, and the presence of (micro)plastics in the ocean seriously interferes with the sea's carbon-fixing capacity (SHEN, 2020). The increase in dissolved CO₂ causes a shift in the balance of inorganic carbon species in the ocean and moves the ocean's pH to the acidic side. As a result, the relative amount of available carbonate decreases, causing ocean acidification. Along with plastic pollution, other phenomena such as acidification and warming of the seas, eutrophication and chemical pollution are major stressors that operate to negatively affect the health and resilience of the ocean (NETHERLANDS, 2020), which, on its turn, is essential for adapting to the climate emergency.

The new Resolution on marine plastic pollution, as well brings in its text the observation that plastic pollution, in marine and other environments, can be of a transboundary nature and must be tackled, together with its impacts through a full life cycle approach to plastics (UNEP/EA.5/L.23/Rev.1). This represents a promising approach, which could lead to the elimination of important legal gaps at the international level.

economy by interfering with the provision of ecosystem services.

Marine pollution, which results from various activities — and can be in the form of plastic waste dumped on coastal coasts, oil slicks that run along the entire coast

of Northeast Brazil, or *Sargassum sp.* that causes the death of other species — enters the sphere of responsibilities, appearing as a question that concerns everyone, individually and collectively: it is a shared responsibility.

To a greater or lesser extent and, in line with the sanctions established in the relevant regulations, marine pollution is characterized as being a transboundary phenomenon that must be treated as a common responsibility. Each potentially polluting agent can (and must) become a responsible agent, according to the precepts related to sustainable development: this is essential for the maintenance of adequate conditions in the biosphere and the present

and future survival of human populations under conditions of quality and dignity.

This chapter is dedicated to demonstrating that marine pollution has been addressed both by International Law and by Brazilian domestic law for several decades, with legal approaches evolving along with the advancing of scientific knowledge on the subject. At this point, it should be noted that the subsistence of important legal gaps, such as the issue of plastic waste management in the ocean, has recently begun to be addressed by the international community in a more emphatic way, which certainly demonstrates the urgency and relevance of the topic in question.

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Notes

1 Cross-border damages can be considered as damages that disrespect the legal-political boundaries between States. Transboundary pollution is defined as pollution that originates in one locality but, when crossing the border by water or air routes, can cause damage to the environment in another country. See (SOARES, 2001, p. 211), ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT., 2001) and (Studies in Methods, 1997).

2 The option for “mitigation” or “mitigate” stems from the observation, after analyzing the data collected in this and other researches, that when it comes to marine pollution in international documents, such as reports and strategies, often when talking about public policies and other measures to address the problem, the “mitigate” action is used as the most appropriate, especially in short-term strategies. In this sense, the Honolulu Strategy predicts that “marine debris has numerous economic implications, which should be considered when developing strategies and policies to mitigate the problem” (in the original: marine debris has numerous economic implications, which should be considered when developing strategies and policies to mitigate the issue) and the 2019 UNEP report, Strategies to Reduce Marine Plastic Pollution from Land-based Sources in Low and Middle - Income Countries, which reveals that the “immediate measures taken to mitigate the leakage of waste from plastic in the oceans, stopping waste, improving plastic waste collection and its environmentally sound disposal are prioritized as short-term strategies” (in the original: taking immediate actions to mitigate plastic waste leakages into oceans by stopping littering, improving plastic waste collection and their disposal in environmental sound manner are prioritized as short-term

strategies). In: UNEP, 2011; GAMARALAL-AGE, P.J.D.; ONOGAWA, 2019.

3 Regarding the definition of pollution provided in the UNCLOS, the International Court of the Law of the Sea, in the Separate Opinion of Judge Wolfrum regarding the Mox Plant case, emphasizes that the notion of pollution is defined in article „, paragraph 1(4), of the Convention. Such a definition contains two elements, namely, the introduction of substances or energy - and radioactivity in the form of dust or otherwise qualified as such - and that such an introduction would likely result in deleterious effects such as damage to living resources and marine life, among others. (author translation). See: INTERNATIONAL TRIBUNAL FOR THE LAW OF THE SEA. The MOX Plant Case (Ireland v. United Kingdom), Provisional Measures. Separate opinion of Judge Wolfrum.

4 In the original: “‘Article 1. Use of terms and scope. 1. For the purposes of this Convention: (...) (4) pollution of the marine environment’ means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities; (...).” In: UNITED NATIONS. United Nations Convention on the Law of the Sea, 1982.

5 The conflict involved the governments of the United States of America and Canada and originated due to damage caused to the state of Washington, arising from the emission of sulfur dioxide by a Canadian company. Until that moment, no case of transboundary air pollution had been dealt with by any

international court, and the possibility of making an analogy with cases of transboundary water pollution was raised. See: UNITED NATIONS. Trail smelter case (United States, Canada). Reports of International Arbitration Awards. 16 April 1938 and 11 March 1941. p.1963.

6 ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT. Glossary of Statistical Terms – Transboundary Pollution, 2001. Studies in Methods, Series F, No. 67, United Nations, New York, 1997. Available at: <https://stats.oecd.org/glossary/detail.asp?ID=2754>.

7 Point source pollution can be traced back to a single identifiable point where the pollutant originated – for example, a company’s sewage pipe or the Deep Horizon oil drilling rig leak. Diffuse source pollution cannot be attributed to a specific place or time and has a very diffuse source. Examples include agricultural runoff or urban stormwater runoff. In: POTTERS, Geert. *Op. cit.*, p. 17.

8 It is important to mention that the UNCLOS interacts with several other treaties, which indicates its unique character as a “living” instrument. Although it is considered the “Constitution of the Oceans”, its interpretation and application are considered flexible and responsive to emerging problems. In this sense, specifically regarding art. 194, the discussions involving its application will be presented at an opportune moment in this work. In: KOJIMA, Chie. South China Sea Arbitration and the Protection of the Marine Environment: Evolution of UNCLOS Part XII Through Interpretation and the Duty to Cooperate. Asian Yearbook of International Law, Volume 21, 2015, DOI: https://doi.org/10.1163/9789004344556_010. Available at: https://brill.com/view/book/edcoll/9789004344556/B9789004344556_010.xml.

9 Many companies and sectors of the plastics industry adopt a dual strategy of lobbying and high-profile advertising, claiming that

“waste” is a consumer behavior problem that can only be solved with recycling, preventing an awareness of risks of the continued production of these materials is implemented and disseminated. In: HEINRICH BÖLL FOUNDATION. *Op. cit.*, p. 34-35.

10 After 48 hours on land, the algae begin to decompose and release toxic gases such as hydrogen sulfide and ammonia, which affect the respiratory, cardiovascular, and neurological systems.

11 In 2018, the Mexican Caribbean coast received a massive influx of pelagic *Sargassum* sp. that accumulated and decomposed on the beaches producing organic decomposition products that turned the water cloudy and brown. In: RODRIGUEZ-MARTINEZ, R. E; et. al. *Op. cit.*, p. 201.

12 The cost imposed on ecosystem services over the lifetime of plastics produced in 2019 alone has been estimated at approximately \$3.1 trillion. In: WORLDWIDE FUND FOR NATURE. Plastics: the cost to society, the environment, and the economy. Published in Sept.2021 by WWF, p.39. See: <https://www.wwf.no/assets/attachments/Plastics-the-cost-to-society-the-environment-and-the-economy-WWF-report.pdf>.

13 These general principles governing transboundary pollution, specifically in the marine environment, are the same as those governing transboundary air pollution, transboundary pollution of shared freshwater resources and other forms of transboundary pollution.

14 In the Stockholm Declaration of 1972, Principle 21: “(…) States have the sovereign right to exploit their own resources in application of their own environmental policy and the obligation to ensure that activities that lead to cable, within its jurisdiction, or under its control, do not harm the environment of other States or of areas situated outside any national jurisdiction”. In the 1992 Rio Declaration, Principle 2: “States (...) have the sovereign right to exploit their own resources

in accordance with their own environmental and development policies, and the responsibility to ensure that activities carried out under their jurisdiction or under its control do not cause damage to the environment of other States or areas that are outside the limits of national jurisdiction”.

15 Article 194 of the Convention, inserted in Part XII of the document, describes a general rule of international law, providing for the obligation to prevent, reduce and control pollution of the marine environment. In: UNITED NATIONS. United Nations Convention on the Law of the Sea. Montego Bay, December 10, 1982. Available at: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

16 Judge de Castro cited this formulation as a rule of customary law in his dissent before the International Court of Justice in the Nuclear Tests case (Australia v. France), judgment of December 20, 1974, ICJ Reports (1974), 388- 389. In: INTERNATIONAL COURT OF JUSTICE. Nuclear Tests (Australia v. France). Judgment of 20 December 1974 – Dissenting Opinion of Judge de Castro. Available at: <https://www.icj-cij.org/public/files/case-related/58/058-19741220-JUD-01-08-EN.pdf>.

17 The “1972 Convention on the Prevention of Marine Pollution from Dumping of Waste and Other Materials”, abbreviated the “London Convention”, is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its aim is to promote effective control of all sources of marine pollution and to take all possible measures to prevent pollution of the sea from dumping waste and other materials. Currently, 87 States are Parties to this Convention. In: INTERNATIONAL MARITIME ORGANIZATION. CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING OF WASTES AND OTHER MATTER. Available at: [Documents/LC1972.pdf.](https://wwwcdn.imo.org/localresources/en/OurWork/Environment/</p></div><div data-bbox=)

18 The Convention on Biological Diversity entered into force on December 29, 1993, and has 3 main objectives: the conservation of biological diversity; the sustainable use of components of biological diversity; and the fair and equitable sharing of benefits arising from the use of genetic resources. In: UNITED NATIONS. CONVENTION ON BIOLOGICAL DIVERSITY. 1992. Available at: <https://www.cbd.int/doc/legal/cbd-en.pdf>.

19 This Convention dates from November 29, 1969, having been registered with the International Maritime Organization on May 25, 1975, and enacted in Brazil in 2008. In: BRAZIL DECREE No. 6,478, OF JUNE 9, 2008. Promulgates the International Convention on Intervention on the High Seas in Cases of Accidents with Oil Pollution, made in Brussels, on November 29, 1969, and the Protocol on Intervention on the High Seas in Cases of Pollution by Substances Other Than Oil, done in London, November 2, 1973. Brasília, Official Gazette of the Union, 6.10.2008. Available at: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2008/decreto/D6478.htm.; UNITED NATIONS. International Convention relating to intervention on the high seas in cases of oil pollution casualties. Treaties and international agreements registered or filed and recorded with the Secretariat of the United Nations, New York, vol. 970, 1982. Available at: <https://treaties.un.org/doc/Publication/UNTS/Vol-ume%20970/v970.pdf>.

20 Through decision BC-14/12, the COP approved amendments to three annexes to the Convention: Annex II (categories of waste requiring special consideration – subject to the Prior Informed Consent Procedure): addition of the new entry Y48 covering all waste from plastic, including mixtures of plastic waste, except for plastic waste covered by entries A3210 (in Annex VIII) and B3011 (in Annex IX); Annex VIII (presumably hazardous waste

– subject to the Prior Informed Consent Procedure): addition of new entry A3210 covering hazardous plastic waste; Annex IX (waste presumed to be non-hazardous – not subject to the Prior Informed Consent Procedure): addition of new entry B3011, replacing current entry B3010 after a specific date, covering plastic waste consisting exclusively of a non-halogenated polymer or resin, polymers selected fluorides or mixtures of polyethylene, polypropylene and/or polyethylene terephthalate, provided that the waste is recycled in an environmentally correct manner and is almost free from contamination and other types of waste.

21 MARPOL Annex V contains regulations dealing with waste management and strictly prohibits the disposal of plastics. In 2013, new regulations came into effect that impose stricter waste management procedures and documentation requirements for all vessels, as well as fixed and floating platforms and a general ban on the disposal of all waste unless disposal is expressly stated, provided for in the regulations. In 2018, Annex V was further strengthened by amending the criteria for determining whether cargo residues are harmful to the marine environment and revising the Waste Record Book to include a new category of e-waste.

22 In this regard, on March 2, 2022, during UNEA-5, representatives of 175 States met and drafted Resolution UNEP/EA.5/L.23/Rev.1, based on three initial draft resolutions of several nations, establishing an Intergov-

ernmental Negotiating Committee, which will begin its work in 2022, with the ambition to complete a legally binding draft global agreement by the end of 2024. This is considered to be the most significant multilateral environmental agreement since the agreement from Paris. In: UNITED NATIONS ENVIRONMENT PROGRAMME. Historic day in the campaign to beat plastic pollution: Nations commit to develop a legally binding agreement. Press release – Environmental-mental rights and governance. Available at: <https://www.unep.org/news-and-stories/press-release/historic-day-campaign-beat-plastic-pollution-nations-commit-develop>.

23 From this percentage, it is estimated that there are significant economic costs arising from the release of plastic waste into the environment, especially for its involvement in reducing the productivity of vital natural systems, such as the ocean, as well as in the obstruction of urban infrastructure. The cost of such post-use externalities for plastic packaging, plus the cost associated with greenhouse gas emissions from their production, has been conservatively estimated, through 2016, at \$40 billion annually – exceeding the profit of the plastic packaging industry. In: WORLD ECONOMIC FORUM, ELLEN MACARTHUR FOUNDATION AND MCKINSEY & COMPANY. The New Plastics Economy — Rethinking the future of plastics, 2016. Available at: <https://ellenmacarthurfoundation.org/the-new-plastics-economy-rethinking-the-future-of-plastics>.

