

LEGAL REPERCUSSIONS FOR DAMAGE CAUSED BY MICROPLASTICS TO THE ENVIRONMENT

REPERCUSSÕES JURÍDICAS DOS DANOS CAUSADOS PELOS MICROPLÁSTICOS AO MEIO AMBIENTE

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ABSTRACT

Objective: The growing presence of microplastics in the environment, along with their possible environmental impacts, has become an emerging issue and this work proposes to investigate the problem from a legal point of view.

Problem: The work is based on the research question: "Is there a legal basis for the damage caused by microplastics to the environment?". To answer this question, the research conducts a detailed analysis of existing environmental legislation and its applicability to the damage caused by microplastics.

Methodology: The methodology adopted for this work involves a literature review of the existing literature on the environmental impacts of microplastics, as well as a detailed study of the laws and regulations related to plastic pollution. In addition,



relevant case law is analysed to identify how courts have handled cases related to plastic pollution.

Results: The results of this research have significant implications for environmental law, providing clear guidelines on how the harms caused by microplastics can be legally addressed. The study also contributes to the general understanding of the ecological impacts of microplastics, offering a comprehensive overview of the harmful effects of these pollutants on the environment.

Contributions: This work is a relevant contribution to the intersection between law, ecology, biology and chemistry.

Keywords: environmental law, microplastic pollution, environmental pollution.

RESUMO:

Objetivo: A crescente presença de microplásticos no meio ambiente, juntamente com seus possíveis impactos ambientais, tornou-se uma questão emergente e este trabalho se propõe a investigar o problema do ponto de vista jurídico.

Problema: O trabalho tem como base a pergunta de pesquisa: "Existe fundamento jurídico para os danos causados pelos microplásticos ao meio ambiente?". Para responder a essa pergunta, a pesquisa realiza uma análise detalhada da legislação ambiental existente e sua aplicabilidade aos danos causados pelos microplásticos.

Metodologia: A metodologia adoptada para este trabalho envolve uma revisão bibliográfica da literatura existente sobre os impactos ambientais dos microplásticos, bem como um estudo detalhado das leis e regulamentos relacionados com a poluição por plásticos. Além disso, é analisada a jurisprudência relevante para identificar a forma como os tribunais têm tratado os casos relacionados com a poluição por plásticos.

Resultados: Os resultados desta investigação têm implicações significativas para o direito ambiental, fornecendo diretrizes claras sobre a forma como os danos causados pelos microplásticos podem ser tratados legalmente. O estudo contribui também para a compreensão geral dos impactos ecológicos dos microplásticos, oferecendo uma visão abrangente dos efeitos nocivos destes poluentes no ambiente.

Contribuições: Este trabalho é um contributo relevante para a intersecção entre o direito, a ecologia, a biologia e a química.

Palavras-chave: direito do ambiente, poluição por microplásticos, poluição ambiental.

1 INTRODUCTION

Plastic pollution has been a problem that has worsened worldwide in recent decades, impacting the planet by remaining in the environment, threatening wildlife, spreading toxins, and contributing to global warming. In all their forms of impact, ranging from humans to the elements of nature such as air, land, and water, as well as



flora, fauna, and microplastics, which are a tiny fragment of plastic less than five millimeters in size (HIDALGO-RUZ et al. 2012), have become a growing concern in terms of environmental pollution (THOMPSON et al., 2009). However, the legal approach to dealing with this emerging problem remains uncertain.

The development of this work aims to evaluate and point out the legal consequences of the damage caused to the environment by microplastics and the main question guiding this research is whether "There is a legal basis for the damage caused by microplastics to the environment?".

The research will also strive to comprehend how the law can be used to mitigate the environmental impacts of these materials. As pointed out by Hardesty et al. (2017), current legislation on plastic waste is inadequate to deal with the scale and complexity of the microplastic problem. It is therefore crucial to explore new legal approaches that can be used to protect the environment from this persistent way of pollution. Due to their small size and durability in the environments where they have been located, microplastics can contaminate different habitats and enter the food chain, resulting in negative impacts on biodiversity (THOMPSON et al., 2009).

The origin of these microplastics is varied and can come from the fragmentation of larger plastics or direct industrial production for use in cosmetics and cleaning products (FENDALL; SEWELL, 2009). To answer this central question, it is necessary to analyze the current legal framework and identify whether there are specific laws dealing with the issue. To this end, an analysis will be made of existing legislation and case law relating to microplastic pollution and its impact on the environment. According to Nellyana et al. (2023), international law does not yet specifically address the issue of microplastics. On the other hand, national and regional laws have emerged to combat this problem.

This study aims to assess the legal consequences of the damage caused by microplastics to the environment. It seeks to identify the legal responsibilities in the civil, administrative, and criminal spheres of plastic-producing companies for repairing the damage caused.

2 THEORETICAL REVIEW

Microplastic pollution has become a growing problem of great concern, and



these tiny fragments of plastic can be found in almost every environment, from the oceans to the soil and even in the air we breathe, causing serious damage to fauna, flora, and human health (WAGNER et al., 2014).

Microplastics are defined as particles smaller than 5mm, originating mainly from the wear and tear of larger plastic products (derived from petroleum) or manufactured specifically for use in products such as cosmetics and clothing (ANDRADY, 2011). The presence of these particles in various parts of the ecosystem has attracted the attention of the scientific and legal community.

Current environmental legislation does not specifically address microplastic pollution. However, several general principles of environmental law can be applied to the problem. The polluter pays principle, for example, holds that those who cause damage to the environment should be held responsible for their actions regardless of fault or intent (KISS; SHELTON, 2007).

In addition, international legislation is also beginning to recognize the threat of microplastics. For example, the Stockholm Convention on Persistent Organic Pollutants recently recognized the impact of microplastics as an emerging issue to be discussed (UNEP, 2018).

However, despite increased awareness of the problem of microplastics, there is still a long way to go in terms of regulation and accountability. The implementation of stricter laws and regulations on the production, use, and disposal of plastics is an urgent need (BARNES et al., 2009).

The damage generated by microplastics to the environment has been a topic of growing concern in both the scientific and legal spheres and the properties of longevity and resistance of plastic that initially contributed to its popularity have proven to be highly damaging to the environment (THOMPSON et al., 2009).

Studies show that microplastics are present in almost all terrestrial and aquatic environments, including oceans, rivers, lakes, and soils (BARBOZA et al., 2018). Once in the environment, these tiny fragments of plastic can cause a variety of problems, including the death of animals through ingestion and the contamination of natural habitats (ROCHMAN et al., 2013).

From a legal point of view, the consequences of the damage caused by microplastics to the environment are complex. Existing environmental legislation often does not specifically address the problem of microplastics or is not stringent enough to deal with the magnitude of the problem (HANK et al., 2013). In addition, the global



nature of microplastic pollution makes it difficult to hold offenders accountable (XANTHOS; WALKER, 2017).

On the other hand, some researchers argue that the principles of international environmental law, such as the precautionary principle and the polluter pays principle, could be applied to address issues related to microplastics (FAURE; NOLLKAEMPER, 2007). However, implementing these principles in concrete cases has proved challenging. The damage caused to the environment by microplastics is numerous and well-documented. They also include ocean pollution, damage to marine life, and birds, and contamination of the food chain, as well as possible impacts on human health (THOMPSON et al., 2004; WRIGHT; KELLY, 2017). However, the legal consequences of this damage are still an emerging field of study.

However, there are some examples of legislation that seek to address the impacts of microplastics and in some jurisdictions, legislation has been introduced to ban the use of microplastics in certain products. For example, the Microbead Control Act in the United States prohibits the manufacture or placing on the market certain personal care products that contain plastic microbeads (H.R.1321, 2015).

Yet, despite these legal measures, the problem of microplastics is global and transcends national borders. As such, there is an urgent need for international legal approaches to deal with this issue (BORRELLE et al., 2020). Some suggested approaches include the international regulation of trade in plastics and the integration of microplastics into existing international legislation on persistent organic pollutants (POPs) (XANTHOS; WALKER, 2017).

According to National Geographic (2023), the United Nations (UN) last surveyed 193 recognized countries and 2 non-member observers in 2022, for a total of 195 countries. Of the 193 countries recognized by the UN, 192 countries had their environmental legislation applied to plastic, with only 167 countries showing some concern about the use of plastic bags and 65 countries showing no concern at all, as shown in Figure 1.





Figure 1: Number of countries with legislation on plastic bags. Credits: UNEP, 2018.

On the other hand, when it comes to plastic microbeads, according to UNEP, 2018, plastic microbeads are small plastic particles that have been widely used in industry as personal care products, scrubs, paints, and even in some food products. However, the use of these microbeads has been a cause for concern due to their negative environmental impacts.

These microspheres are too small to be filtered by water treatment systems, which means that many of them end up in oceans, lakes, and rivers. Once in the aquatic environment, plastic microbeads can be ingested by marine organisms, causing damage to marine life, and potentially entering the food chain (PATERNIANI; DA SILVA, 2012). Another worrying point is that microplastics have been observed to absorb chemical pollutants from the surrounding environment, which makes them potentially more harmful to the balance of biomes by carrying these pollutants up the food chain (WARDROP et al., 2016).

Considering these environmental issues, some countries and regions have adopted measures to restrict or ban the use of plastic microbeads. For example, in 2018, the European Union banned the use of plastic microbeads in rinse-off products such as scrubs and toothpaste (UNEP, 2018).

In addition, organizations and consumers are becoming increasingly aware of the problems associated with the use of plastic microbeads, promoting more sustainable and biodegradable alternatives (COELHO, 2023).

In summary, the use of plastic microbeads around the world has been a growing concern due to their environmental impacts leading to regulations and bans in some places, as well as an increase in the search for more environmentally friendly alternatives (OLIVATTO, 2018).

Figure 2 lists other figures, different from the survey carried out with plastic bags, of countries that direct their laws towards the use of these microbeads in industry.

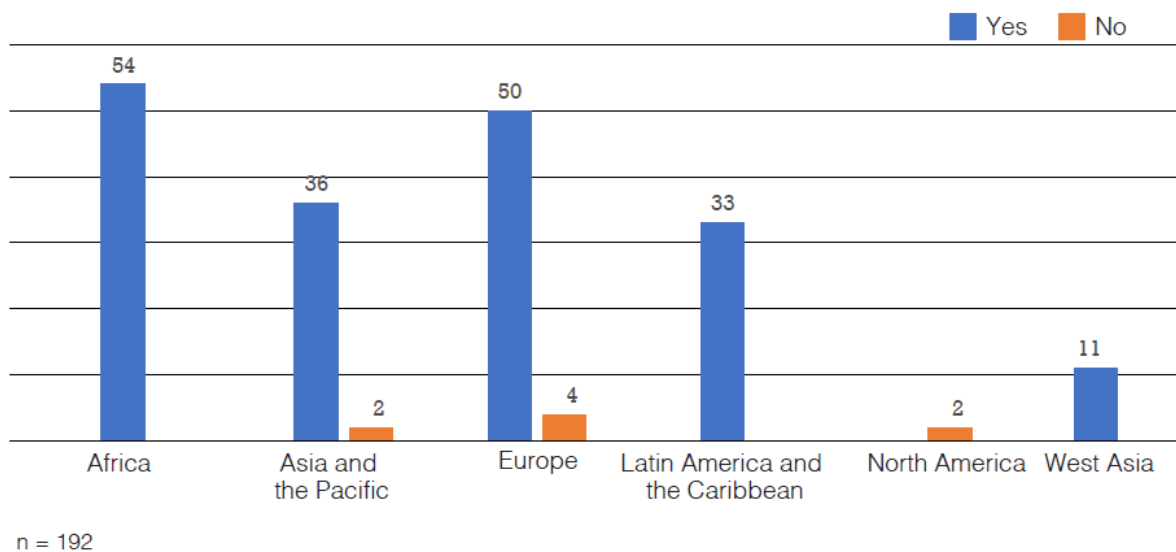


Figure 2: Distribution of countries with and without legislation on plastic microbeads. Credits: UNEP, 2012.

Portugal defines extended producer responsibility regimes for certain single-use plastic products throughout the Decree-Law No. 83/2022 of December 9 that completes the transposition of Directive (EU) 2019/904. This decree points to efforts to implement extended producer responsibility measures to deal with the growing problem of plastic pollution and this may include setting up collection and recycling systems as well as imposing recycling targets on producers. The purpose is to lead manufacturers to design more sustainable products, taking responsibility for the waste generated by their products (PRESIDENCY OF THE COUNCIL OF MINISTERS, 2022; RODRIGUES, 2022).

In Japan, extended producer responsibility, also known as "Extended Producer Responsibility" (EPR), is regulated to deal with waste management and the promotion of environmental sustainability. The EPR system in Japan was introduced to encourage producers to take responsibility for the complete life cycle of their products, from manufacturing to disposal. Legislation related to extended producer responsibility in Japan is known as the Product Recycling Law, which was implemented in 1997, renamed the Home Appliance Recycling Law in 1998, and later revised in 2003. This law establishes requirements for producers to be responsible for collecting, treating, and recycling their products at the end of their useful life. Producers are required to form management organizations to manage the process of recycling waste related to their products. In addition, Japan has adopted the "pay-as-you-throw" principle, where the costs associated with waste management are borne by manufacturers,

encouraging them to design greener products and promote recycling (GOVERNMENT OF JAPAN, 1998).

In Canada, Extended Producer Responsibility (EPR) refers to a concept in which producers of certain goods have the responsibility to manage the complete life cycle of their products, including the collection and proper management of the waste generated by these products at the end of their useful life. The aim is to encourage the reduction of environmental impact and promote sustainability. Under the EPR, producers are encouraged to implement programs for the collection, recycling, and proper disposal of waste related to their products. This can include setting up deposit and return systems, specific collection points, or other methods to ensure that waste is dealt with in an environmentally responsible manner. The specific laws and regulations relating to Extended Producer Responsibility may vary between Canada's provinces, as environmental management is often a provincial competence. However, Canada has adopted the recycling fee system, the same method adopted by Japan and the state of California in the United States of America (HERAT, 2009).

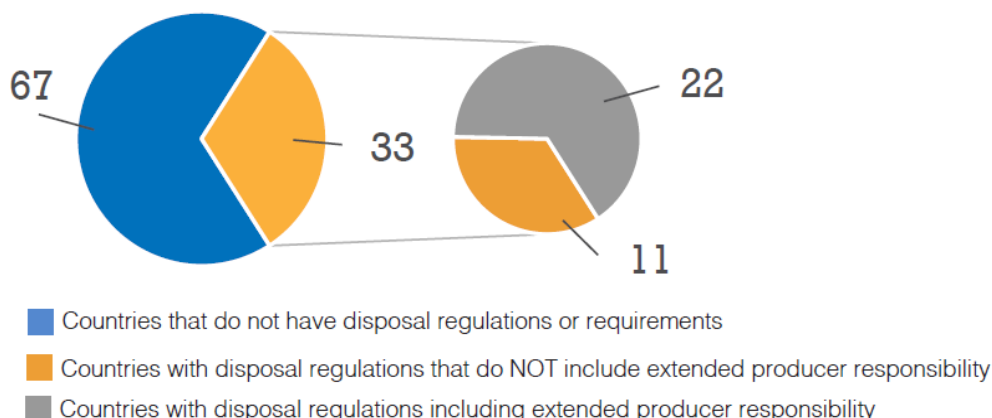
Extended producer responsibility (EPR) aims to give producers responsibility for the environmental impacts of their products throughout their entire life cycle, including the post-consumption phase. In the context of plastics, EPR implies that manufacturers are responsible not only for the production and sale of products but also for proper waste management, recycling, and minimizing the environmental impacts associated with plastics (DEMAJOROVIC; MASSOTE, 2017).

The European Union, for example, has taken a broader approach to extended producer responsibility, setting bold targets for plastic recycling and banning certain single-use plastic products. These measures aim to reduce plastic pollution and promote a circular economy (RODRIGUES, 2022).

It is important to note that extended producer responsibility is only part of the solution to the problem of plastics in the environment, and holistic approaches involving consumers, governments, and industry are key to effectively tackling this issue (DENIS; VETTORAZZI, 2011).

However, only a few countries have implemented specific laws and regulations related to EPR, while others may have different approaches to dealing with waste management. The adherence to EPR can vary based on environmental policies and the legislation of each nation as shown in Figure 3.





n = 192

Figure 3: Number of countries applying extended producer responsibility. Credits: UNEP, 2018.

Ultimately, although there are some legal tools to deal with the damage caused by microplastics, it is clear that more needs to be done and the need for an international and coordinated legal approach to deal with the impacts of microplastics on the environment is evident.

3 METHODOLOGY

The methodology for approaching the topic "Legal Consequences of the Damage Caused by Microplastics to the Environment" is a combination of bibliographical research, a case study, and data analysis.

Initially, extensive bibliographic research will be carried out to gain an in-depth understanding of the subject. The research will focus on scientific and legal literature, including articles published in journals, books, and official documents. Existing laws relating to microplastic pollution will be examined, as well as relevant court decisions (ERIKSEN et al., 2014).

In the next step, the choice of a representative case study is important due to the nature of the problem and the fact that it also has clear legal implications with a focus on a place where polymer pollution has caused significant damage to the environment and has led to litigation or changes in legislation (THOMPSON et al.,



2009).

Data collection will involve both primary and secondary sources, with primary sources likely to include legal documents, court records, interviews with experts in the field, and secondary sources considering governmental and non-governmental reports, academic publications, or media reports.

The analysis of the data collected will follow a qualitative approach. The data will be systematically classified and interpreted to identify patterns, trends, and relationships. The data analysis will seek to establish a link between the damage caused by microplastics to the environment and the resulting legal consequences, including changes in legislation and court decisions (HAHLADAKIS et al., 2018).

4 RESULTS

The study carried out on the legal consequences of the damage caused by microplastics to the environment for the workplace revealed several interesting and worrying findings. Initially, the data collected indicated that microplastic pollution is a global reality that affects all ecosystems, from the oceans to terrestrial regions, and the presence of these materials has direct and indirect implications for human health and biodiversity (THOMPSON et al., 2009).

Figure 4 clearly shows the extent of the impact of plastic and, consequently, microplastic pollution around the world, listing the countries that dump the most plastic waste into the seas.



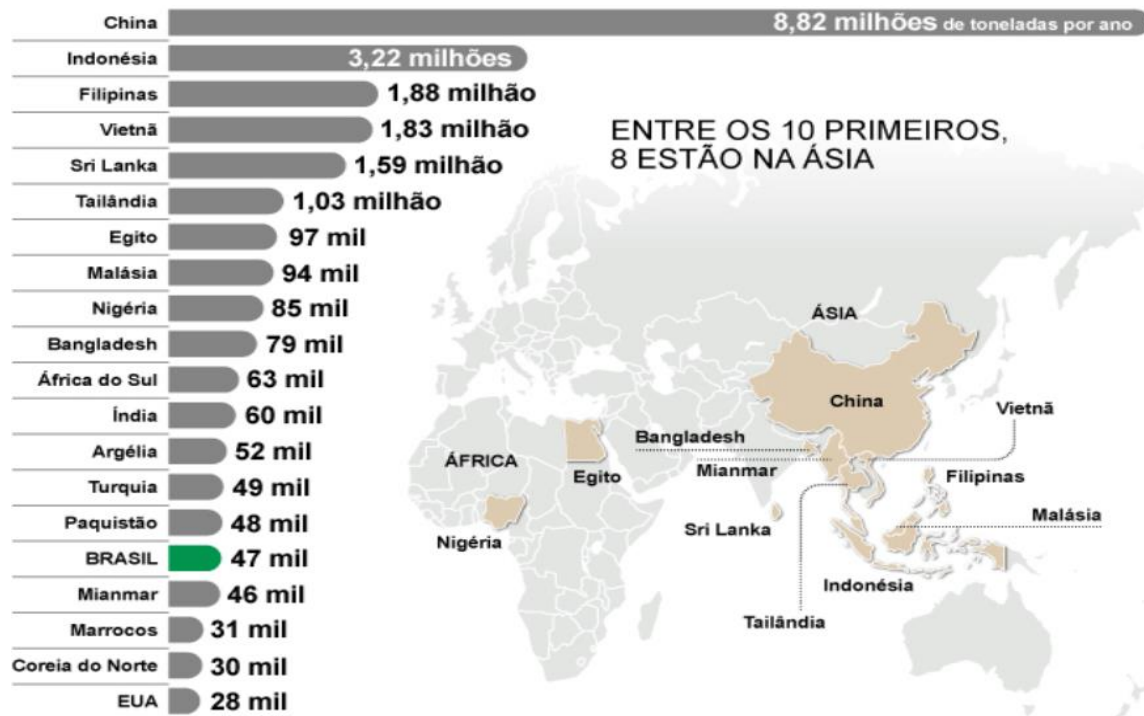


Figure 4: Disposal of plastic in the oceans by country. Source: An ocean of plastic. Credits: Liana Melo, 2017.

In the same context, Figure 5 shows a map illustrating the level of protection in all Brazilian states, showing that there is still a long way to go in terms of environmental legislation applied to plastics and there is no standardized understanding between the environmental agencies in each state (BUZO; TECCO, 2020). This lack of standardization means that conflicts start to cause slowdowns in processes and decision-making for the preservation, protection, and enforcement of the law against violators (MOURA, 2016).

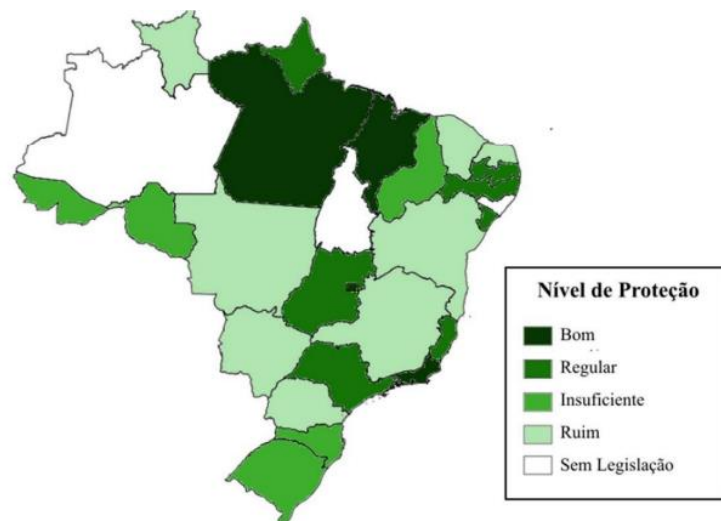


Figure 5: Brazilian states and their levels of protection according to their legislation. Credits: Buzo & Tecco, 2020

In legal terms, many national and international legislations are not prepared to deal with this specific type of pollution and the lack of a clear legal definition of what microplastics are and what their environmental impact is makes it difficult to apply appropriate sanctions (HAHLADAKIS et al., 2018).

Data analysis has also shown that despite the growing awareness of the problem of microplastics there is still a general lack of effective public policies to prevent and mitigate their impacts (XANTHOS; WALKER, 2017) and this occurs in developing countries, where the infrastructure for managing plastic waste is often inadequate (JAMBEK et al., 2015).

The data collected indicates that the legal consequences of the damage caused by microplastics to the environment are constantly evolving, reflecting the growing awareness of the seriousness of the problem. Global environmental legislation has adapted to incorporate the emerging challenge of microplastics, with several countries introducing specific laws to deal with this issue (HAHLADAKIS et al., 2018).

Data analysis suggests that current policies are insufficient to fully address the damage caused by microplastics. In many cases, existing laws were created before the microplastic problem was fully understood and therefore do not specifically address this type of pollution (XANTHOS; WALKER, 2017). Furthermore, although certain activities that lead to microplastic pollution may be illegal under existing environmental legislation, enforcement is often weak (HARTLEY et al., 2019).

However, there are also signs of progress. In some jurisdictions, courts have begun to recognize microplastic damage as a form of pollution that can result in legal liability. This sets an important precedent and may encourage greater accountability in the future (ROCHMAN et al., 2013). In addition, some countries are beginning to consider specific laws for microplastics, reflecting the growing recognition of the seriousness of this form of pollution (GALGANI et al., 2013).

However, for the legal consequences to be truly effective, deeper changes will be needed and this includes the creation of stronger and more specific laws, better enforcement of existing laws, greater public awareness of the damage caused by microplastics, and a global effort is needed to tackle this problem, given that microplastics do not respect national borders (WRIGHT et al., 2013).

The results used in the methodology applied, show that the issue of microplastics in the environment presents significant challenges for legal systems



around the world and the damage caused by microplastics is of such magnitude that it requires a robust and coherent legal response. First of all, the data obtained shows that most legal systems are not equipped to deal with the issue of microplastics yet. The pervasive and persistent nature of microplastics in the environment challenges traditional legal approaches based on notions of ownership and liability. (HAHLADAKIS et al., 2018).

Furthermore, research has shown that there is a lack of agreement regarding how to define and measure the harm caused by microplastics and this makes it difficult to establish legal liability and calculate appropriate compensation (GALGANI et al., 2013).

However, despite these challenges, we also find evidence of progress in some jurisdictions. For example, in the European Union, the Marine Strategy Framework Directive requires member states to take measures to reduce marine litter, including microplastics (EUROPEAN PARLIAMENT AND COUNCIL, 2008). Similarly, in California, the California Ocean Waters Act explicitly recognizes microplastics as a distinct category of pollution (CALIFORNIA LEGISLATIVE INFORMATION, 2015).

Therefore, based on the results obtained, it can be concluded that there is an urgent need to revise existing legal regulations and create new public policies to combat microplastic pollution. In addition, it is essential to increase public awareness and environmental education about the dangers of microplastics to human health and the environment, considering that these innovative responses are still in their early stages and further legal development is needed. Thus, the results suggest that more research and legal debate are needed to effectively address the legal consequences of microplastic damage to the environment.

5 DISCUSSION

The results of the research showed that the damage caused by microplastics to the environment has the potential for serious legal consequences and microplastic pollution is an emerging and complex issue that requires a robust legal approach to ensure accountability of polluters and promote actions to mitigate the problem (Galloway, 2015). According to the literature review, the lack of more adequate legislation to guide actions on who should be held responsible for microplastic pollution



can contribute to the delay of legal decisions at state, national and global level, which threatens not only biodiversity, but also human rights and economic sustainability (Rochman et al., 2013; Geyer et al., 2017).

According to Melo (2019), Brazil emerges among Latin American countries as the only one among the 20 largest emitters of plastic in the oceans, appearing in Figure 6 as the fourth largest producer of plastic waste in the world (Barata & Tosta, 2022).

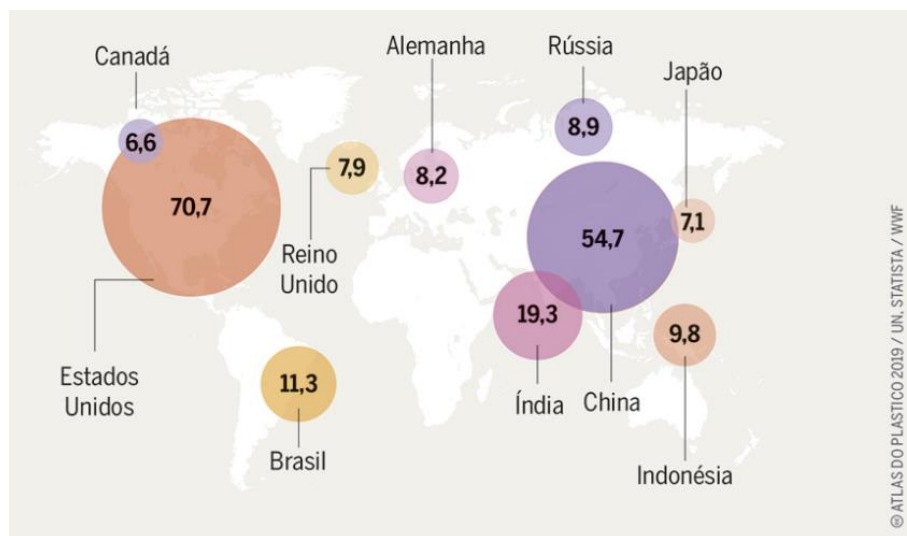


Figure 6: World's largest plastic producers in millions of tons. Credits: Heinrich Böll Foundation Brazil, 2020.

This survey indicates that although Brazil has one of the best and strictest environmental laws, much needs to be done to ensure that the results are positive, and there is an urgent need to deliberate on this issue.

The reality is that the generation of plastics has already surpassed that of other manufactured products. This condition simply reflects the versatility of plastic for the reality of modern human life. However, its high use in almost all production chains, combined with inefficient and deficient waste management systems, has led to a serious scenario for terrestrial and aquatic environments. The persistence of this waste in the environment has been shown to be most aggravating in the form of particles (Microplastics - MPs) that form from exposure to the weather. The recent disturbing discoveries of these plastics in food and drinking water and the evidence of human exposure, the long-term effects of which on health are largely unknown, are yet another reason to seek a firm legal framework to resolve procedural doubts arising from lawsuits concerning microplastic contamination. Several aspects of microplastic

pollution (MPs) seem to be overlooked in the formulation of laws. This, coupled with an apparent lack of indices to determine the impact of existing regulations, makes it essential to step up efforts to make case law more robust.

Currently, international legislation, which varies between countries, is based on the following premises:

i. Regulation of the entry of plastic into the market through manufacture or production, the types of bans and other restrictions on production, taxation and tax incentives for producers and exemptions from bans;

ii. Regulation of the distribution of plastic at the retail level through the imposition of fees or taxes on consumers and end users, restrictions or disincentives to use, mandatory alternative reusable products, taxes and tax incentives for resellers;

iii. Regulation of plastic post-use or disposal through mandates for product waste collection and recycling, extended producer responsibility, take back or deposit refund requirements, waste disposal fees and fines for improper disposal;

iv. Trade regulation through plastic import bans or restrictions;

v. Regarding microbeads, measures are being proposed to phase out the use of microbeads.

(UNEP, 2018)

To date, almost 127 countries around the world have enacted some form of national legislation to address the plastic problem. This number represents that the concept of worldwide legislation has begun to try to keep pace with this unfolding global challenge. In some countries without national legislation, it is seen that the legal heads of government in states, cities and municipalities have stepped up the search for local legislation that mitigates the use of plastic bags. In terms of regional trends regarding the establishment of specific legislation to minimize the impact of plastic on the environment, Europe leads the way with 44 countries having enacted some form of legislation to regulate plastic bags (UNEP, 2018).

We understand that this legal movement is just the beginning of a real legal battle on behalf of the environment and populations around the globe.

The analysis of the data revealed that existing legislation is not sufficient to deal with situations of microplastic contamination, raising the need to develop new laws and guidelines. In this sense, these results are in line with previous studies that point to the inadequacy of current policies in addressing the challenge of microplastics (Xanthos & Walker, 2017).



These results may also indicate a need for greater comprehensiveness and clarity regarding the attribution of responsibility in all legal spheres (Local, Regional and National), understanding that the time is ripe for effective measures.

The research also identified an increase in litigation related to microplastic pollution, suggesting a growing recognition of the seriousness of this problem and the right to a healthy environment. This result corroborates the literature on the subject, which observes an increase in the search for environmental justice through the courts (Peeken et al., 2018).

The implications of these findings are manifold. Furthermore, identifying the flaws in current legislation can guide the legal reforms needed to adequately address the problem of microplastics, and evidence of the increase in litigation can serve as a warning to potential polluters about the legal consequences of their actions.

The results of this research reinforce the urgency of a more effective legal response to microplastic pollution. Like technology, and as pointed out by Wagner and Lambert (2018), environmental law needs to evolve to deal with new challenges, such as microplastics, in order to guarantee environmental protection.

6 CONCLUSION

This work explored in depth the legal consequences of the damage caused by microplastics to the environment, offering a comprehensive analysis of the legal responsibility of companies and individuals who contribute to this serious environmental and public health problem.

The results show that despite the existence of various environmental laws at international, national and local level aimed at limiting plastic pollution, there is still a clear lack of specific regulations aimed at microplastics, allowing companies to continue producing, using and disposing of products with microplastics without facing legal consequences.

In addition, it was found that the damage caused by microplastics to the environment is long-term and often irreversible, affecting not only marine biodiversity, but also humans through the food chain. The lack of adequate legal accountability contributes to the persistence of this alarming problem.

As such, the study highlights the urgent need to draw up legal reforms to



specifically tackle the issue of microplastics and thus reflect current scientific knowledge about the devastating impacts on the environment and human health. Furthermore, it is crucial to ensure that these laws are effectively enforced and that violations result in penalties that are severe enough to discourage harmful behavior.

In this study, it was possible to identify that the damage caused by microplastics to the environment brings with it a series of legal consequences and that excessive use combined with improper disposal of these materials, in addition to harming fauna and flora, also violates a series of existing environmental standards at national and international level.

The analysis revealed that there is a significant gap in the legal system concerning the use and disposal of microplastics and although there is widespread recognition of the threat posed to the environment, few countries have specific legislation to deal with the problem (Browne et al., 2015) it also suggests an urgent need to review and update existing laws to address this emerging environmental challenge.

In addition, the study revealed that the penalties imposed for violations of environmental regulations related to microplastics are often inadequate. Often, these fines are insufficient to deter offenders or compensate for the damage caused to the environment (Thompson et al., 2009).

This reinforces the need to review existing laws and regulations to ensure that they effectively prevent microplastic pollution.

In summary, this study has revealed the inherent relationship between the damage caused by microplastics to the environment and the resulting legal consequences, and the findings signal the urgent need for a comprehensive review of existing laws and regulations to mitigate the damage caused by microplastics to the environment.

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