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# International Legal Systems in Tackling the Marine Plastic Pollution: A Critical Analysis of UNCLOS and MARPOL

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**Abstract:** Marine plastic pollution (MPP) has become one of the most pressing environmental challenges, severely affecting marine ecosystems and human health. Even though international agreements such as UNCLOS and the International Convention for the Prevention of Pollution from Ships (MARPOL) of the International Maritime Organization (IMO) exist, the existing laws are often being introduced to question the inability of the present laws to do something about the escalating issue of plastic pollution. This study uses a doctrinal legal approach to examine how UNCLOS and MARPOL respond to marine plastic pollution (MPP) with a focus on their ability to handle land-based and ship-based MPP. Gaps in these frameworks are underlined, such as a lack of enforceable requirements under UNCLOS on reducing plastic rubbish from LBS and disparities in implementing MARPOL's regulations on plastic discharges from ships. This paper also explores activities of organizations such as the United Nations Environment Programme (UNEP), with a focus on the Regional Seas Programme and the Global Programme of Action. Although a lot has been achieved, much remains to be done to resolve the problem of marine plastic pollution. This paper concludes with a series of practical proposals aimed at refining international laws, strengthening enforcement, and encouraging collective action at the international level. The proposed measures are aimed at advancing a circular economy model, strengthening legal infrastructure, and fostering a single global response against marine plastic pollution.

**Keywords:** marine plastic pollution; UNCLOS; MARPOL; IMO; UN environment programme; best environmental practices; global programme of action



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## 1. Introduction

Pollution is one of the most pressing issues faced by the contemporary world, and people have greatly contributed to pollution in different ways. It affects land and the atmosphere, but most prominently waters, which account for almost 71% of the earth's surface [1–3]. Water pollution is particularly alarming as it causes the spread of numerous viruses and diseases. Although land pollution is also the source of numerous diseases, oceanic water evaporates, mixes with the air, and returns as rain, bringing pollution back to the land. This cyclic process thus creates a dual burden on ecosystems [4,5]. Therefore, marine pollution does not just affect the marine ecosystem and marine life, but it also has a significant impact on human life [6,7].

The article of the United Nations Convention on the Law of the Sea (UNCLOS) defines pollution of the marine environment as "The introduction of materials or energy by humans, either directly or indirectly, into the marine environment, involving estuaries" [8]. This definition highlights three key components: elevated pollutant concentrations in

various media, such as water, soil, and marine organisms, often termed contamination; the contaminants themselves; and the potential for significant ecological and human health impacts [9].

Marine plastic pollution (MPP) has emerged as one of the most urgent environmental issues of the 21st century. The rapid increase in plastic debris within oceans is having severe consequences for marine ecosystems, human health, and economic stability. Despite the widespread use and benefits, plastics have become a persistent pollutant due to their slow degradation, leading to extensive environmental damage over decades [10]. Studies have demonstrated that there is a substantial amount of plastic garbage in the world's oceans, which contributes to the loss of marine biodiversity and poses health hazards to humans through the food chain [11–14]. The production and consumption patterns of modern civilisation have exacerbated the problem, with approximately 80% of marine debris originating from land-based sources (LBS) [15]. This issue is further compounded by the increasing use of single-use plastics and the growing human population, which together contribute to the rising levels of marine litter [11].

MPP impacts are broad and severe. It poses ecological threats to marine life through entanglement, ingestion, and habitat disruption. Additionally, it facilitates the spread of invasive species and harmful substances [16]. The consequences on the economy are as severe, including industries like tourism, fishing, and maritime operations, with substantial expenses linked to cleanup activities and harm to marine sectors [17]. Furthermore, the contamination of human food sources with microplastics poses potential health risks, emphasising the urgent need for effective regulatory measures [18,19].

International legislation designed to tackle MPP has been instituted, although its efficacy is being questioned [20]. The United Nations Convention on the Law of the Sea (UNCLOS) and the International Maritime Organization's (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) are pivotal to these initiatives. UNCLOS provides a legal framework defining the rights and responsibilities of nations in using the oceans. Part XII focuses on protecting the marine environment and mandates states to prevent and control pollution from any source [8]. Similarly, MARPOL Annex V specifically prohibits the disposal of all plastics into the sea and regulates the disposal of other types of garbage from ships [14,21]. Notwithstanding these frameworks, the challenge of MPP persists, largely due to limitations and gaps in these regulations [22,23]. For example, while MARPOL has stringent rules for ship-based pollution, enforcement varies by country, and illegal dumping continues to be a problem [24,25]. Similarly, UNCLOS addresses pollution broadly but does not provide specific mechanisms for reducing plastic waste from LBS [13,14,24,26].

Furthermore, several challenges hinder the effectiveness of existing international regulations in addressing MPP. The fragmented framework of international law poses a significant challenge in addressing plastic pollution, as it overlaps with diverse fields like maritime regulations, environmental protection, and waste management, leading to inconsistencies and a lack of unified governance. The United Nations General Assembly (UNGA) has recognised this phenomenon of international law fragmentation, which complicates the implementation and enforcement of comprehensive solutions to complex environmental issues like MPP [27–30]. Another significant challenge is the focus of international maritime environmental law on downstream activities, often overlooking upstream sources of plastic pollution. While MARPOL addresses pollution from ships, it does not adequately tackle land-based sources, which contribute a substantial portion of marine plastic debris [31]. Effective management of plastic waste requires robust regulations that encompass the entire lifecycle of plastics, from production and consumption to disposal and recycling.

Internationally, the legal and governance frameworks addressing MPP have been fragmented and insufficient. While conventions such as UNCLOS and the 1974 Paris Convention have established some guidelines for managing marine pollution from LBS, these measures have often lacked binding obligations and comprehensive enforcement mechanisms [32]. The challenge of MPP requires a cohesive and multifaceted legal approach that integrates sustainable production, waste management, and marine environmental protection at global, regional, and national levels [33].

This paper utilises a doctrinal legal methodology to evaluate the efficacy of existing international legal frameworks in managing MPP, with a specific focus on UNCLOS and MARPOL. Through rigorous analysis, it identifies critical deficiencies and proposes enhancements aimed at bolstering regulatory effectiveness and safeguarding marine ecosystems from plastic contamination [34]. This issue's severity is highlighted by its significant effects on marine biodiversity, human health, and essential economic sectors, including fisheries and tourism. Plastic debris in marine environments degrades into microplastics, infiltrating the food chain and posing significant health risks [14,35]. Moreover, the economic ramifications encompass substantial costs associated with beach clean-ups, damage to fishing equipment, and reductions in tourism revenue [14]. Despite the existence of regulatory frameworks, such as UNCLOS and MARPOL, these instruments often suffer from inadequate enforcement mechanisms and lack binding obligations [32]. Effectively addressing MPP demands a unified global strategy that integrates sustainable production practices, robust waste management systems, and comprehensive marine environmental protection initiatives [33]. This research underscores the imperative for enhanced international collaboration and stringent regulatory measures to mitigate the pervasive threat posed by marine plastic pollution. Section 1 provides the study's background. Section 2 examines the impacts of MPP on marine ecosystems and human well-being, establishing a foundation for understanding its antecedents. Section 3 highlights the ecological and economic impacts of MPP. Section 4 analyses various international legal instruments and governance frameworks addressing MPP. Sections 5 and 6 evaluate UNCLOS and MARPOL frameworks, respectively. Section 7 offers a comprehensive discussion and conclusion.

## 2. From Source to Sea: Assessing the Ecological and Human Health Impacts of Micro-Plastics in Marine Ecosystems

Plastics are versatile materials that offer numerous benefits to society and individuals in their daily lives. However, the accumulation of plastics in the environment is a significant concern, and due to their slow degradation, this issue will persist for decades. The generation of litter is one of the primary consequences of the production and consumption models adopted by modern civilisation. Waste is a critical environmental problem that demands increased attention in the search for solutions, especially with regard to marine pollution [10]. Solid waste-related marine pollution is emerging as a global issue with consequences that extend across generations. There is evidence that this problem is persistent and worsening, despite decades of efforts in many countries to prevent and reduce marine litter. This trend can be attributed to the growing prevalence of single-use consumption practices and increasing human populations [11]. Approximately 80% of the billions of tonnes of rubbish that are dumped—intentionally or unintentionally—into the seas each year originate from LBS [15]. Due to the historical perception of the seas as places to dispose of trash, persistent pollutants have now become significant contributors to environmental issues.

Globally, plastic pollution is recognised as a significant problem caused by human activities, which has profound impacts on marine and coastal ecosystems [36]. Anthropogenic sources contribute to an unprecedented and continuous accumulation of plastic

pollutants in various aquatic environments, resulting in the disruption of ecosystem structure, functioning, and, ultimately, the direct or indirect degradation of ecosystem services and values. The primary sources of these pollutants, which reach the ocean through various means, include both land-based and sea-based sources [37]. Although the complete effects of MPP on the environment and human health are still unknown, they have the potential for significant impacts, especially concerning "microplastics". These microplastics are increasingly being released into domestic wastewater streams and are formed as larger plastic debris degrades over time. These particles are also commonly found in skincare products and synthetic apparel [38]. Human exposure to and consumption of microplastics have been linked to an increasing number of disease disorders [6,7,39]. The magnitude of potential health effects on humans might be evaluated by the discovery made by the University of Ghent in 2014: an individual may invest up to 11,000 small pieces of plastic in their seafood annually [40].

The biological effects of MPP are numerous and diverse, including endangering wildlife through choking and starvation, facilitating the spread of invasive alien species (IAS) and other potentially harmful organisms to new areas, and transporting toxic chemicals and persistent organic pollutants (POPs), among others [16]. According to an investigation that collected samples of Arctic Sea ice from five different locations, an investigation that analyzed Arctic Sea ice samples from five distinct locations found concentrations exceeding 12,000 microplastic fragments per liter, indicating the widespread presence of plastic waste and microplastics throughout the world's oceans. are now widespread in the world's oceans [41]. Currently, an estimated 9–13 million tonnes of plastic waste enter the ocean every year. However, considering the reported plans of the widespread petrochemical industry to expand plastics production, partly as a precautionary measure due to the potential decrease in demand for their fuels in response to global warming, this figure could significantly increase. Plastic, along with microplastic debris, has a detrimental impact on society, the environment, and the economy. This includes the injury or death of a marine species and its entry into the food web, which raises health concerns [42].

The establishment of ideas and strategies for reducing marine microplastic contamination is in great demand [43]. The lack of expertise in this field is driving the expansion of research on the topic. Recent studies have revealed that certain types of polymers can undergo biodegradation by various bacteria, bacterial consortia, biofilm-forming bacteria, and fungi [44]. Biodegradation is influenced by various parameters, such as the type of microorganism, polymer form, their physicochemical properties, and environmental conditions. Plastic pollutants are dispersed throughout ecosystems in multiple forms and sizes, including megaplastics, macroplastics, mesoplastics, and microplastics.

Microplastics, including both primary and secondary particles, are extensively distributed in the water, sediments, and organisms of marine and coastal ecosystems [45]. Microplastic levels in coastal and marine ecosystems globally range from 0.001 to 140 particles/$m^3$ in water and 0.2 to 8766 particles/$m^3$ in sediments. The accumulation rate of microplastics in coastal and marine species varies from 0.1 to 15,033 counts. Consequently, plastic pollution has a broad range of negative consequences, including ecological and socioeconomic implications. Entanglement, toxicological consequences from plastic ingestion, asphyxia, hunger, organism dispersal, rafting, provision of novel habitats, and the emergence of invasive species are all significant ecological effects that pose increasing risks to biodiversity and trophic connections [46]. Degradation—alterations in ecosystem condition—and alterations to marine systems are related to the loss of ecosystem services and value. Consequently, this new pollutant has a detrimental impact on socioeconomic factors, including tourism, shipping, fisheries, and the well-being of people.

Presently, environmentally friendly alternatives to plastic, derived from recyclable materials, are entering the market [47]. Practical measures to combat plastic pollution include preventing the accumulation of plastic pollutants from various sources, promoting the 3Rs (reduce, recycle, reuse), raising awareness and enhancing capabilities, and enforcing manufacturer accountability [48]. Existing and implemented policies, laws, regulations, and efforts at the regional, global, and national levels are crucial in minimising plastic waste in marine and coastal areas.

## 3. Ecological and Economic Impacts of MPP

Although the majority of marine litter accumulates in coastal areas, plastic, including microplastics, is dispersed across the ocean, with higher deposition occurring in the convergence regions across all five subtropical ocean gyres [49]. Plastic pollution has long been recognised as a significant danger to the marine ecosystem. Specifically, the effects of MPP will be discussed in this section.

### *3.1. Threats to Marine Life*

Marine organisms face significant threats from MPP, including entanglement and ingestion [50]. Entanglement in abandoned fishing gear, known as ghost nets, and other plastic debris, like packaging materials, can lead to severe physical harm or death for marine animals. Studies have shown that ghost nets continue to trap and kill marine life for extended periods, varying based on factors such as the type of gear and its location. This entanglement can result in injuries or death for various marine species, including whales, dolphins, seals, and seabirds, who often become trapped by their necks, flippers, or wings [39,51].

Ingestion of plastic debris also poses a critical threat to marine organisms. Animals may mistake plastic particles for food, leading to intestinal blockages or malnutrition due to the lack of nutrients, which can cause starvation [52]. Additionally, microplastics, tiny plastic particles resulting from the breakdown of larger debris, have been found to bioaccumulate across all levels of the food web. These microplastics can carry harmful pollutants, including persistent organic pollutants (POPs), heavy metals, and plastic additives, which can be toxic to marine life. The transfer of microplastics through trophic levels can amplify their harmful effects, impacting entire ecosystems [39,51].

### *3.2. Contamination of Human Food Sources*

The pervasive presence of microplastics in foods consumed by humans, especially through wild-caught fish, raises significant concerns about the potential health implications. Recent studies revealing that microplastics were found in the digestive tracts of a substantial percentage of various fish species highlight the extent of MPP. Specifically, research showing that 66% of 498 studied fish species contained microplastics [53], alongside findings from New Zealand where three-quarters of commercially caught fish were contaminated [19], underscores a critical environmental and public health issue.

From a researcher's perspective, the ingestion of microplastics by marine organisms not only signifies a direct threat to marine life but also poses a significant risk to human health. The consumption of whole organisms such as sardines and shellfish, which are not gutted before consumption, exacerbates this risk by increasing exposure to both the physical presence of plastics and the toxic chemicals they may carry [18,19].

### *3.3. Psychological and Emotional Effects*

There is substantial evidence indicating that marine litter can negatively impact the mental health benefits individuals derive from the ocean's aesthetic and therapeutic value. Therefore, a study highlights that the presence of marine litter can disrupt the mental health

benefits associated with natural environments, as these spaces are often used for relaxation and recreation [17]. Likewise, plastic pollution and marine litter—global partnership facilitated by the UNEP—indicates that Marine Plastic Pollution (MPP) adversely affects not only the environment but also its cultural and spiritual activities. The existence of plastic litter in the sea can interfere with traditional practices and reduce cultural value that goes along with the coast, as has been reported by Trash Free Maryland [50]. However, the frustration of cultural rituals and failure in maintaining a spiritual relationship that many communities have with the ocean, which is vital for their cultural legacy, is caused by plastic pollution in the ocean.

### *3.4. Economic and Socio-Cultural Consequences*

Marine litter also has considerable indirect impacts, particularly on small-scale fishing, tourism, and recreation industries. These indirect costs, though challenging to quantify, can disproportionately affect individuals whose livelihoods depend on coastal activities [54]. For example, small-scale fisheries face reduced catches and damage to vessels and gear, leading to devastating economic consequences. The European Union (EU) estimates that the fishing sector loses up to EUR 65 million annually due to vessel and gear damage, as well as decreased catches resulting from ghost fishing, where abandoned gear continues to trap marine species.

Tourism and recreation industries also experience significant losses due to marine litter. Polluted beaches can deter tourists, leading to a decline in local revenue. The costs associated with cleaning up beaches are substantial; the EU spends up to EUR 645 million per year on these efforts. In addition to these indirect impacts, marine litter incurs direct economic costs. Accidents caused by navigation hazards and fouling from marine debris can lead to substantial expenses for maritime operations. Ensuring the safety and cleanliness of coastal and marine environments is essential for maintaining the economic viability of activities such as fishing, tourism, and recreation [17].

In addition to these indirect impacts, marine litter poses direct economic costs. Accidents caused by navigation hazards and fouling from marine debris can incur significant expenses for maritime operations. Ensuring the safety and cleanliness of coastal and marine environments is crucial for maintaining the economic viability of activities such as fishing, tourism, and recreation [17,55]. New worldwide developments have greatly increased the global strategy of dealing with the problem of plastic pollution in various countries. The United Nations Environment Assembly (UNEA) has come through with many resolutions geared towards marine plastic pollution. Thus, it is evident that a global layered response is necessary. With the negotiations and the prospect of enacting the Global Plastics Treaty, which will establish enforceable rules for managing a state's plastic waste to occur across the world, it is evident that the international community is approaching a pivotal moment in addressing this urgent issue m. This current advancement reflects the transition to a larger regulatory regime with legally binding instruments supporting the United Nations Convention on the Law of the Sea (UNCLOS) and the International Convention for the Prevention of Pollution from Ships (MARPOL).

## 4. International Legal and Governance Frameworks for Addressing MPP

Sustainable production and consumption [56], the circular economy [33,57], waste management, freshwater resource management, biodiversity protection, and marine pollution are among the environmental issues that require a comprehensive blend of legislation to be effectively implemented at regional, global, and domestic levels of governance [33]. This is necessary to tackle the increasing challenge of plastic waste in the environment as a whole, and the multifaceted problem of MPP in particular [58]. Because of this, the

MPP challenge is commonly linked to the extensively acknowledged phenomenon of international law [32] fragmentation, as well as related issues with legal coherence [27,59].

However, historically, the international legal approach has tended to focus on the framework provided by international maritime environmental law, often overlooking the need for control over the "upstream" activities that contribute to plastic waste. Nevertheless, it is increasingly evident that laws pertaining to freshwater resource environmental management will be crucial in combating MPP. The effective establishment and implementation of relevant international water law regulations will be crucial, especially in the case of vast transboundary watercourses that carry a significant portion of the plastic waste that ultimately reaches the seas.

### *4.1. Historical Legal Framework: Marine Pollution from LBS in International Law*

MPP is primarily defined as a pollution issue arising from LBS within the framework of international marine environmental legislation, which has been subject to treaty protections for over 50 years. State parties were required by the Convention for the Prevention of Marine Pollution from Land-Based Sources, 1974 (Paris Convention 1974) [60,61] to take action to completely eradicate pollution of the maritime area concerning chemicals listed in Annex A, Parts I and III, as well as to severely restrict contamination of the marine area about substances included in Annex A, Part II. However, the Paris Convention 1974 was widely perceived as having limited legally binding obligations and a weak normative basis. Article 4(3) of the Paris Convention 1974 emphasised the importance of developing new guidelines and standards, including "specific regulations or standards governing the quality of the environment, discharges into the maritime area, such discharges into watercourses and emissions into the atmosphere as affect the maritime area, and the composition and use of substances and products" [60]. Therefore, while acknowledging the complexity of the challenge and the need for diverse legal approaches to tackle LBS, the Paris Convention 1974 explicitly recognised the substantial impact of pollutants transported through watercourses and the crucial role of freshwater pollution control measures. This fact remains applicable to MPP as well.

UNCLOS [62], which addresses the issue of LBS in Articles 207, 194, and 213 of its text, provides the overall worldwide legal framework that exists today. Nonetheless, UNCLOS is frequently viewed as legally ambiguous and devoid of explicit and mandatory obligations for the state parties, as it takes a similar approach to that outlined in the Paris Convention 1974. For example, Article 207 of UNCLOS only mandates that States "adopt laws and regulations to prevent, reduce, and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines, and outfall structures, taking into account internationally agreed rules, standards, and recommended practices and procedures" [8]. Nevertheless, there have been limited globally recognised guidelines or norms that can guide national regulatory actions and be acknowledged under international law or state practice [63]. Commentators emphasise that, in contrast to this lack of normative clarity, UNCLOS does not impose any obligations to adhere to norms or standards, nor does it establish a specific timeframe for taking action. They also associate these shortcomings with an increased risk of legal fragmentation [64].

While the UNEP utilised the 1985 Montreal Guidelines [9] as "recommended practices and procedures" with the explicit aim of assisting states in developing national legislation and elaborating more specific international instruments, these guidelines were also perceived as overly general and lacking specificity. It seems that they have received relatively limited support in terms of state practice. The International Law Association (ILA) [65] first adopted model rules in 1972. Articles 207 and 213 of UNCLOS have faced criticism for attempting to "incorporate all possible contaminants originating from land under a

single all-encompassing article", despite the fact that the various pollutants from LBS that harm the marine ecosystem have distinct origins, characteristics, and impacts [66]. As a consequence of this persistent issue, marine plastic has been classified under the broader category of "litter" and has not historically received prioritised attention, despite the continuous call to address it throughout the development of international standards on pollution from LBS [67].

Article 194(1) of UNCLOS says "to safeguard and sustain the marine environment", which amounts to a compelling due diligence requirement to "take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities" [8].

Article 194(2) of UNCLOS speech makes it abundantly evident that this expansive duty includes a general need for states to govern all pertinent, possibly harmful conduct under their control in a way that prevents contaminants of the marine environment within other maritime states' territorial waters in marine areas outside of their national jurisdiction: "States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other states and their environment and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this convention" [8].

It is evident that these fundamental marine pollution provisions of UNCLOS necessitate that states exercise due diligence concerning various inputs of plastic waste, with a specific emphasis on addressing pollution in significant drainage basins, including international watercourses. This focus is supported by established knowledge regarding global dispersal patterns, sources, and the extensive range of adverse impacts caused by MPP. Article 213 of UNCLOS explicitly states that when it comes to the prevention, mitigation, and control of pollution from LBS more generally, the responsibility of due diligence is both mandatory and crucial. "States shall enforce their laws and regulations adopted following Article 207 and shall adopt laws and regulations and take other measures necessary to implement applicable international rules and standards established through competent international organisations or diplomatic conference to prevent, reduce and control pollution of the marine environment from land-based sources" [8].

Current soft-law rules and standards are not completely underdeveloped regarding the management of pollution in international watercourses compilation of pertinent "internationally agreed rules, standards and recommended practices and procedures", which could help clarify the legal precautions required of states to meet the aforementioned diligence standards [8], which are generally lacking in detail. Especially, the Montreal Guidelines from UNEP in 1985 suggest in Guideline 5(3) that, "if discharges from a watercourse which flows through the territories of two or more States or forms a boundary between them are likely to cause pollution of the marine environment, the states concerned should cooperate in taking necessary measures to prevent, reduce and control such pollution" [68].

Furthermore, Guideline 5(2) urges non-coastal states to "cooperate in preventing, reducing, and regulating pollution of the marine ecosystem originating or predominantly originating from discharges within their territories into or through water basins or watercourses that flow into the marine environment" [68]. Chapter 17, Paragraph 24 of Agenda 21, which focuses on the protection of the seas and oceans, is valuable in that it recognises the need to adopt a comprehensive, multi-sectoral approach to safeguard the marine ecosystem as a whole. It emphasises the commitments that states have already made regarding marine biodiversity [69] and calls for additional action by the UNEP concerning the is-

sue. Ultimately, this resulted in the adoption of the Global Programme of Action for the Preservation of the Marine Ecosystem from Land-Based Activities (GPA) in 1995 [70–72].

It has long been acknowledged that a more comprehensive global regulatory framework is needed for the distinct issue of LBS. In the long run, a global convention might be prepared "based on additional knowledge gained in the establishment and implementation [73] of regional, sub-regional, and bilateral treaties and taking into consideration principles or guidelines at the global scale developed within the framework of UNEP" [74], according to the 1982 Montevideo Programme for the expansion and periodic assessment of environmental law. The establishment of a comprehensive framework "for the long-term development of a worldwide treaty on pollution from terrestrial sources" is listed as one of the key objectives of the 1985 Montreal Guidelines. However, instead of adopting a legally binding global convention, the international community eventually embraced a non-binding instrument that included a formal declaration of standards and was accompanied by a detailed action plan [63]. This was a response to the UN Secretary–General's strong plea to the Committee on Preparation for the 1992 UNCED Conference in Rio to modify the global conventional framework by incorporating LBS and establishing "general principles for global application that would inspire, motivate, and guide national and regional measures" [69,75]. Similarly, the Table 1 summarizes key findings on marine plastic pollution (MPP) and its broad impacts. It highlights that 80% of ocean plastic originates from land-based sources, with serious economic consequences, such as EUR 65 million in annual losses to EU fisheries and EUR 645 million in beach cleanup costs. Additionally, it underscores the health risks of microplastic ingestion, threats to marine biodiversity, cultural disruptions, and the ineffectiveness of current legal frameworks like MARPOL and UNCLOS, due to weak enforcement and limited jurisdiction.

**Table 1.** Key findings on Marine Plastic Pollution (MPP) and economic impacts.

| Aspect | Findings/Results | Sources |
| --- | --- | --- |
| Marine Plastic Pollution (MPP) | 80% of ocean plastic waste originates from land-based sources (LBS) | [10,15] |
| Economic Impact on Fisheries | EU fishing sector loses EUR 65 million annually due to damage from plastic waste | [17] |
| Economic Impact on Tourism | EU spends EUR 645 million annually on beach cleanups | [17] |
| Impact on Marine Biodiversity | Microplastics in marine organisms; 66% of 498 fish species studied contained microplastics | [19,53] |
| Health Impacts of Micro-plastics | Ingesting microplastics was linked to health issues such as endocrine disruption | [6,7] |
| Cultural Impact | Marine litter affects cultural practices and spiritual connections to oceans | [55] |
| International Legal Efforts | UNEA and Global Plastics Treaty negotiations aim to create enforceable global plastic waste management rules | [23,33] |
| MARPOL and UNCLOS Effectiveness | MARPOL bans ship-based plastic discharge, but enforcement varies by jurisdiction | [14,21] |

Under the direction of UNEP [70,72,76,77], GPA was approved and is now in operation. The GPA is a soft-law agreement that reaffirms states' obligations under UNCLOS and other agreements. It is intended to serve as a "resource for national or regional authorities when developing and implementing long-term plans to prevent, reduce, regulate, or eliminate marine degradation caused by land-based activities" [70]. The goal of the GPA process is to foster and strengthen voluntary multi-stakeholder engagement in key sectoral areas that contribute to LBS [76]. To address this issue, a global multi-stakeholder collaboration on marine litter was formed in 2012 under the GPA's auspices. The Intergovernmental Review Meetings, which convene periodically to assess the implementation of the GPA [77], have endorsed numerous statements highlighting the importance of freshwater resource

management in mitigating LBS pollution. For instance, the 2001 Montreal Declaration commits the 80 national government members to, among other things, "integrating and implementing coastal area and watershed management practices, and enhancing regional, global, and national governance processes", emphasising concerns about litter pollution and alterations in the quality of freshwater inflows [78].

An appeal was made to the UNEP Secretariat to conduct an analysis of alternatives and possibilities regarding the legal aspects of addressing LBS under the GPA. Additionally, a commitment to continue focusing on "enhancing the integrated approach to protecting coastlines and marine environments, particularly from environmental threats posed by excessive nutrients, sewage, marine litter, and microplastics" was included in the more recent 2018 Bali Declaration, which was ratified by the EU and 60 national governments. The 2030 Agenda for Sustainable Development Goals (SDGs), specifically SDG-14 (to conserve and sustainably use the oceans, seas, and marine resources), is connected to the problem of coastal and marine pollution caused by wastewater, marine litter, and microplastics [41] in agreements of the United Nations Environment Assembly (UNEA) that have been passed since the Bali Declaration. The fact that MPP, in particular, and land-based sources, in general, are specifically addressed in the 2030 Agenda speaks volumes about the current importance provided to these issues [34].

The due diligence norms anticipated by state actors are influenced by the extensive network of traditional methods addressing LBS in various regional seas despite persistent challenges in their effective implementation. Such instruments include:

- The 1976 Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution to the 1980 Athens Protocol [61] and the 1996 Syracuse Protocol for the Preservation of the Mediterranean Sea [79] Against Pollution from LBS and Activities [80];
- The Quito Protocol of 1983 for the Safety of the South–East Pacific Against Contamination from LBS [81];
- The 1990 Protocol for the Preservation of the Marine Environment against Waste from LBS supplements the 1978 Kuwait Regional Convention for Cooperation on the Protection of the Marine Ecosystem from Pollution;
- The OSPAR Convention 1992 for the Preservation of the North-East Atlantic Marine Environment;
- The Helsinki Convention of 1992 for the Preservation of the Baltic Sea's Marine Environment;
- The Bucharest Convention 1992 on the Preservation of the Black Sea Against Pollution, which included the 1992 Protocol on Protection of the Black Sea Marine Environment Regarding Pollution from LBS;
- The 1983 Cartagena Convention for the Protection and Development of the Marine Environment of the Western Caribbean Region and the Aruba Protocol 1999 on LBS of Marine Pollution;
- The Jeddah Protocol 2005 for the Preservation of the Marine Environment from LBA in the Gulf of Aden and Red Sea;
- The 2010 Nairobi Protocol for Protecting the Marine and Maritime Environment of the Southwestern Indian Ocean from LBS; and
- The Abidjan Additional Protocol of 2012 to the Abidjan Convention Regarding Collaboration in the Southern African and Western Central Region's Protection and Reconstruction of the Marine and Coastal Ecosystem from Land-Based Activities.

Certain conventional arrangements have made significant progress in their practical implementation, although the outcomes achieved so far vary considerably. This discrepancy can be attributed primarily to differences among the involved state parties in terms of

their financial, technical, and administrative capacities, as well as their normative and institutional development [82]. For instance, the LBS Protocol for the Mediterranean has developed comprehensive national and regional action plans with specific deadlines and action items. Additionally, the legally binding document, the Regional Strategies on Marine Litter Management in the Mediterranean Sea, sets forth precise measures and operational objectives to achieve good environmental status in the Mediterranean Sea. One of the targets is to reduce beach litter by 20% across the entire basin by 2024. These factors make the plan remarkable.

### *4.2. The GPA and Washington Declaration: International Efforts to Combat Land-Based Marine Pollution*

Under Agenda 21, UN Environment received an invitation to organise an intergovernmental conference on safeguarding the marine environment from LBS. UN Environment accepted the offer and scheduled a meeting for 23 October to 3 November 1995, in Washington, D.C [69]. The GPA and the Washington Declaration were the two documents effectively endorsed by the EU and 109 other nations during the meeting [83].

Figure 1 illustrates a structured flowchart outlining the analytical framework for Marine Plastic Pollution (MPP), beginning with identifying sources and assessing ecological, economic, and cultural impacts. Similarly, it progresses through legal evaluations (UNCLOS, MARPOL), global initiatives (e.g., UNEA), and culminates in actionable policy recommendations. By making it easier for states to fulfil their UNCLOS [8], a mandated obligation to maintain and safeguard the marine environment, the GPA aims to halt the degradation of the marine environment resulting from LBS [84]. The GPA encompasses not only the prevention, mitigation, and management of marine pollution but also the remediation of pollution and measures that aid in the restoration of the marine ecosystem from the impacts of pollution [70]. Thus, the GPA surpasses the scope of relevant UNCLOS clauses. The objective of the Programme of Action is to serve as "a resource of conceptual and practical guidance" for the fulfilment of existing responsibilities and agreements, including those established after Agenda 21 and UNCLOS, as well as for the development of new initiatives. Three chapters of the GPA offer suggestions for regional, national, and international action [70].

Figure 2 illustrates the sources of Marine Plastic Pollution (MPP), showing that land-based sources contribute 80%, while ship-based sources account for 20%. This emphasizes the dominant role of land-based activities in driving oceanic plastic pollution. The GPA encourages states to develop national plans of action (NPAS) within the framework of integrated coastal area management at the national level. Similarly, provisions for identifying and evaluating issues, prioritising issues, choosing management approaches and measures, defining standards for judging the efficacy of strategies and programs, and guaranteeing program support elements (like funding, human resources, and lawful and enforcement mechanisms) should all be included in the NPAS [85]. Integrated coastal region management, watershed management, reducing poverty, assessment of environmental impacts, the preservation of important habitats and threatened animals, vertical policy integration, collaboration, caution, and equity between generations [70] are just a few of the principles and methods that the GPA calls on states to implement. States are encouraged to incorporate clean production practices, environmentally friendly and efficient technologies, product substitution, Best Available Techniques (BATS), and Best Environmental Practices (BEPS) into their policies and initiatives. However, potential actions encompass governmental measures, market-based tools that consider the polluter pays principle and cost internalisation, technical assistance and collaboration, education, and awareness-raising campaigns. However, waste reuse, recycling, and treatment are specifically mentioned, along with the significance of institutional frameworks, resource mobilisation [70], monitoring, and

reporting. Some of the recommended criteria for evaluating the NPAs include flexibility, equity, cost-effectiveness, and environmental effectiveness.

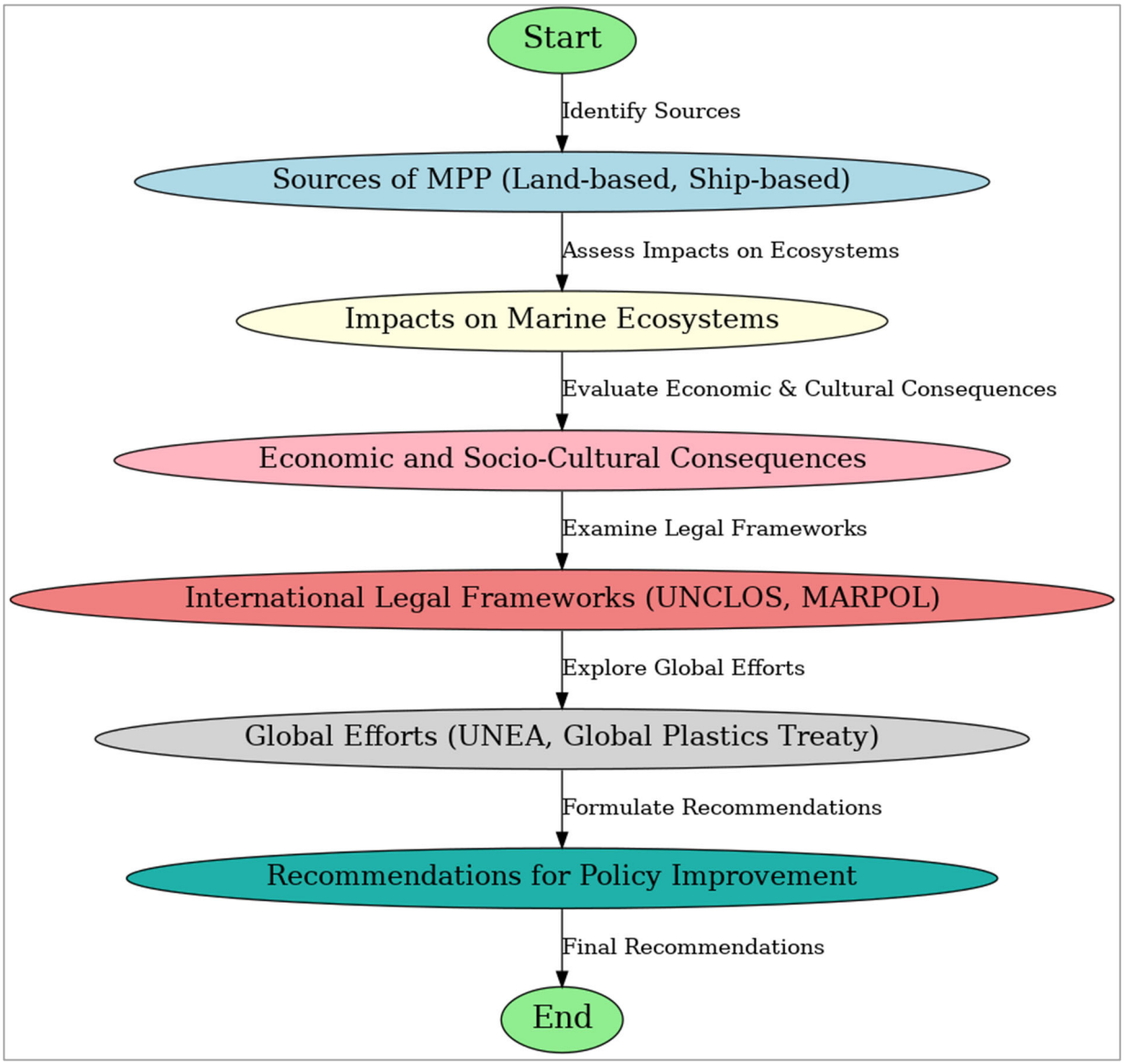


**Figure 1.** Flowchart for the Marine Plastic Pollution framework source (created by author).

Figure 3 highlights the levels of different marine species that have consumed microplastics. Among marine animals, fish take in the largest amount of microplastics (over 65%), with seals in second place, seabirds third, whales fourth and turtles fifth. Similarly, the GPA emphasises the need for enhanced regional collaboration to protect the marine environment from LBS. Thus, it encourages governments to strengthen existing regional agreements and initiatives, and, if required, establish new ones. Similarly, the GPA provides guidelines for developing regional action plans that align with the NPA approach. It highlights various considerations in this regard, including capacity-building plans and policy harmonisation. Thus, the GPA specifically encourages landlocked governments to actively engage in regional initiatives [70,86]. However, governments are advised to seek collaboration from multilateral finance organisations and other institutions in the planning and implementation of regional agreements, particularly in developing-country areas, regarding the institutional aspects of regional and sub-regional arrangements [70,72]. It further emphasises the critical importance of successful international collaboration in

the implementation of the GPA, especially in areas such as financial support, technology transfer, and capacity building. One suggestion for mobilising expertise and skills is the establishment of a clearing-house system. Moreover, it is advised to regularly examine both the status of the marine environment and the GPA's implementation [70,72]. Under the GPA, the mobilisation of resources and the establishment of effective institutional frameworks are viewed as primary objectives of international cooperation. Similarly, the GPA also emphasised the need for the formulation of international legally binding instruments concerning the implementation of the prior informed consent (PIC) process for certain hazardous substances in international trade, as well as instruments addressing persistent organic pollutants (POPS), including a dedicated section on sewage and wastewater treatment. These tools were approved in 1998 and 2001, respectively [87].

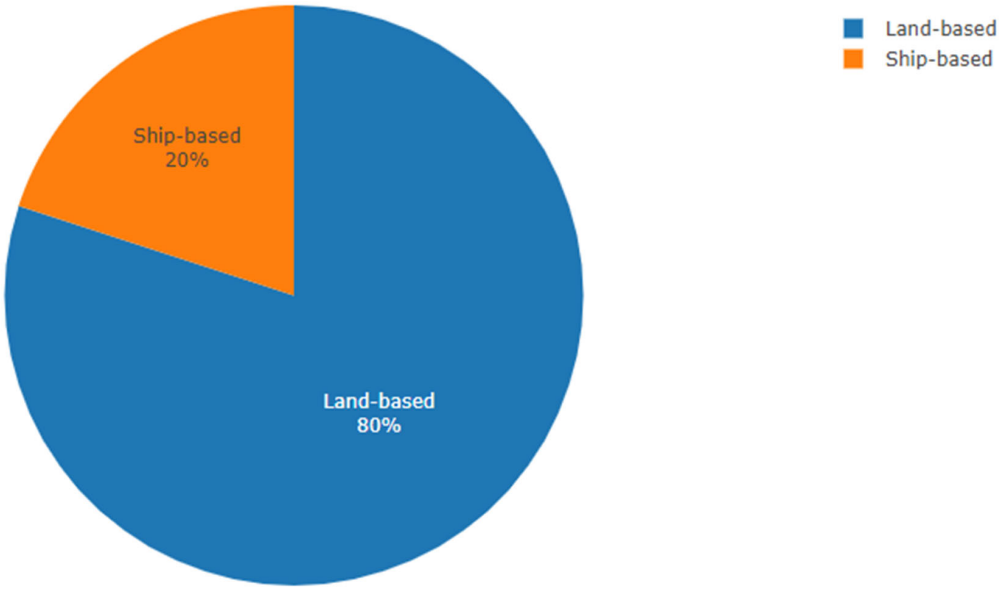


**Figure 2.** Plastic pollution sources.

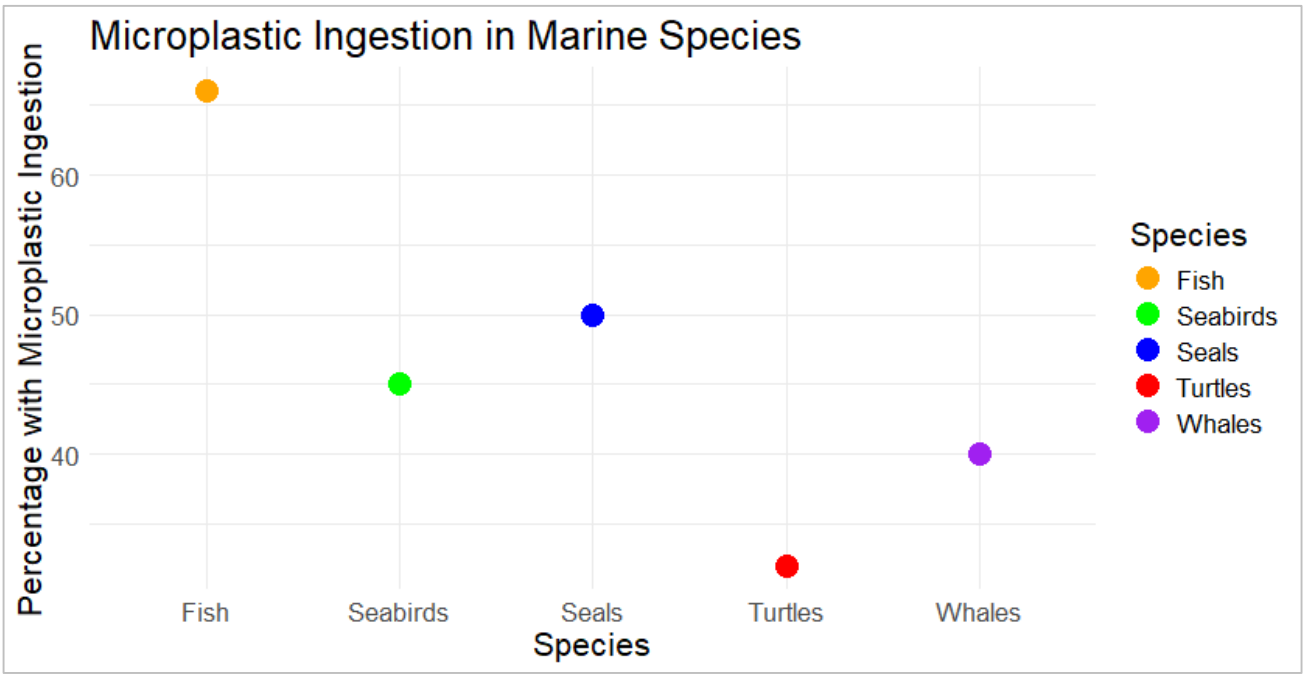


**Figure 3.** Marine biodiversity and microplastic ingestion.

### *4.3. The Global Environment Facility's Strategic Focus Areas: Biodiversity Conservation and International Waterways*

The Global Environment Facility (GEF) plays a crucial role in implementing the GPA, particularly in the areas of international waters and biodiversity conservation. The GEF has been assigned a specific role in this context. It has been tasked with supporting the implementation of the GPA, focusing on priority areas such as biodiversity conservation and the protection of international waterways. The GEF's Operational Strategy, adopted in 1995, identifies the management of LBS of pollution as a top priority for action in its international waterways' focal region. The issue of MPP has also been addressed in GEF-sponsored publications, as well as during the GEF-6 and GEF-7 replenishment periods.

#### 4.3.1. GEF Initiatives: International Water Law and Cross-Border Management

Projects addressing cross-border water management, safeguarding water supplies, and preserving important groundwater and surface water resources in Small Island Developing States (SIDS) are supported by the GEF's focus area on international waterways [88]. This aligns with the objectives of the GPA to prevent, minimise, and regulate marine debris originating from LBS, especially those that affect international waters. The International Law Commission (ILC) [8] worked on legislating the marine environment-related regulations of the 1994 draft articles [89] that would ultimately serve as the cornerstone of the 1997 UN Watercourses Convention, which was the initial globally applicable binding tool in the field that is also widely accepted as indicative of the context in customary international law [90]. The ILC was motivated by the state parties' tardiness in adopting meaningful measures for the implementation of what is currently known as Article 23 of the 1997 UN Watercourses Convention, which was initially enacted by the commission in 1991 and mandates that, "watercourse states shall, individually and, where appropriate, in cooperation with other states, take all measures with respect to an international watercourse that are necessary to protect and preserve the marine environment, including estuaries, taking into account generally accepted international rules and standards" [86].

Figure 4 presents the economic impact of marine plastic pollution, each year, losses in tourism and beach cleanups hit €600 million, while those in the fishing industry stay lower. It makes obvious that coastal areas face too much burden and costly maintenance for public buildings. As Article 23 is located in Part IV of the 1997 UN Watercourses Convention, which addresses the responsibilities of watercourse nations for ecosystem protection, it can be understood as an acknowledgment of the interconnections between freshwater and marine environments and the environmental issues associated with them. It essentially signifies the official recognition of "the increasingly significant problem of pollution transported into marine ecosystems through international watercourses" within the framework of customary international law pertaining to freshwater resources [89]. It is widely recognised that LBS, primarily rivers, contributes to approximately 85 percent of the pollution entering the marine environment. Therefore, this acknowledgment has been long overdue [91]. The importance of riverine pollution loading for LBS marine pollution is further made worse by the MPP problem. Article 23 of the UN Watercourses Convention also reaffirms duties that have long been recognised in international maritime environmental law despite their normative weaknesses and lack of specificity [8,60,92].

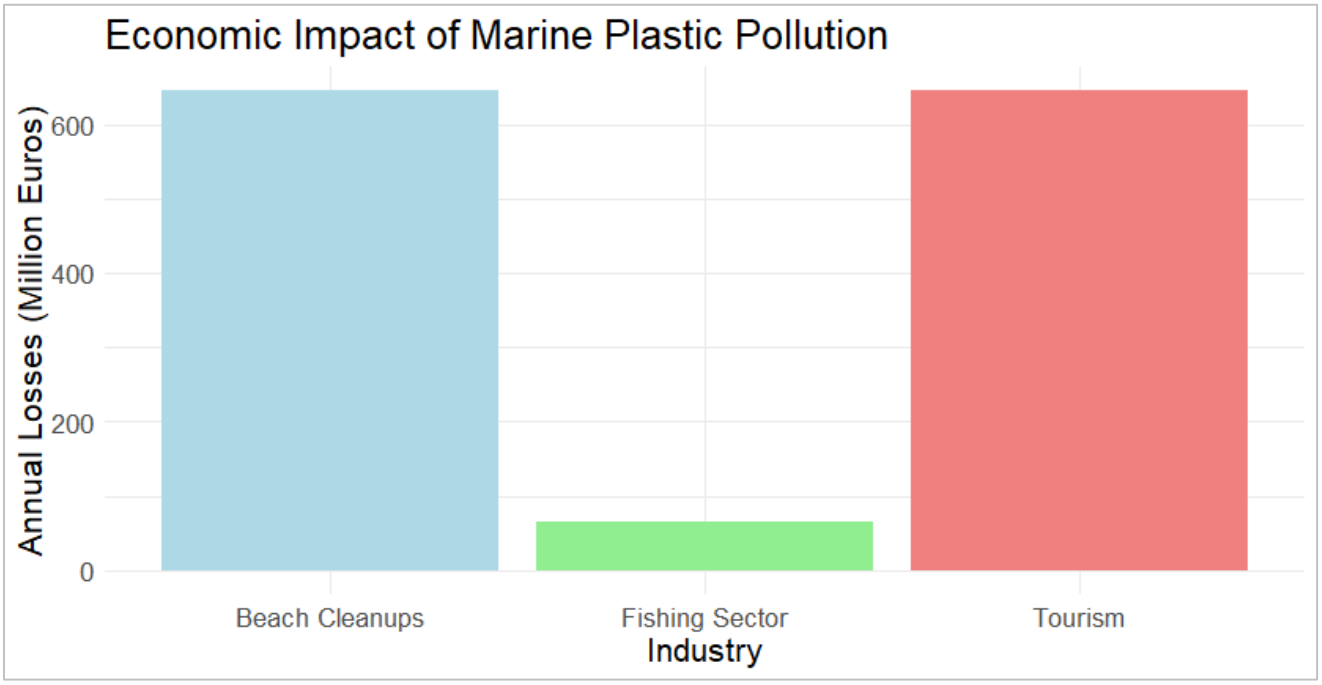


**Figure 4.** Economic impact.

Figure 5 shows a steady and significant rise in marine plastic pollution from 8 million in 2010 to over 21 million tons by 2020. Because of this trend, we must act quickly and implement tougher regulations on waste management everywhere. Article 23 of the UN Watercourses Convention, along with its other provisions, imposes a commitment of due diligence on watercourse states. It says that they must "take all of the steps required of which they are competent, financially and technologically" [86,89,93], either individually or jointly when appropriate. The precautionary principle is presumed to apply due to the interconnection with Articles 20–22 and the need that such action be done "on an equitable basis" [89,93]. Article 23 sets itself apart from other ecological obligations typically found in water resources conventions by encompassing the collective global interest of all states in safeguarding the broader marine environment, rather than solely focusing on preventing harm to adjacent watercourse states [82].

Conventions addressing marine pollution may directly place obligations on states regarding the management of transboundary rivers, in addition to international, regional, or basin-level water agreements. For instance, the 1992 OSPAR Convention specifically requires coastal state parties, such as Germany, France, and the Netherlands, as well as riparian countries along the Rhine, to restrict discharges into the river that eventually reach the North Sea. Although this provision, which can be found in Annex I of Article 2(1) of the Convention for the Protection of the Marine Environment of the North–East Atlantic, 1992 [84], does not place any new obligations on these states, it does clarify the normative status of their existing obligations regarding LBS pollution [94]. Similarly, discharges into the Danube River by Romania and Bulgaria would be subject to the requirements outlined in the 1992 Bucharest Convention on the Protection of the Black Sea from Pollution, as well as its Protocol on Pollution from LBS.

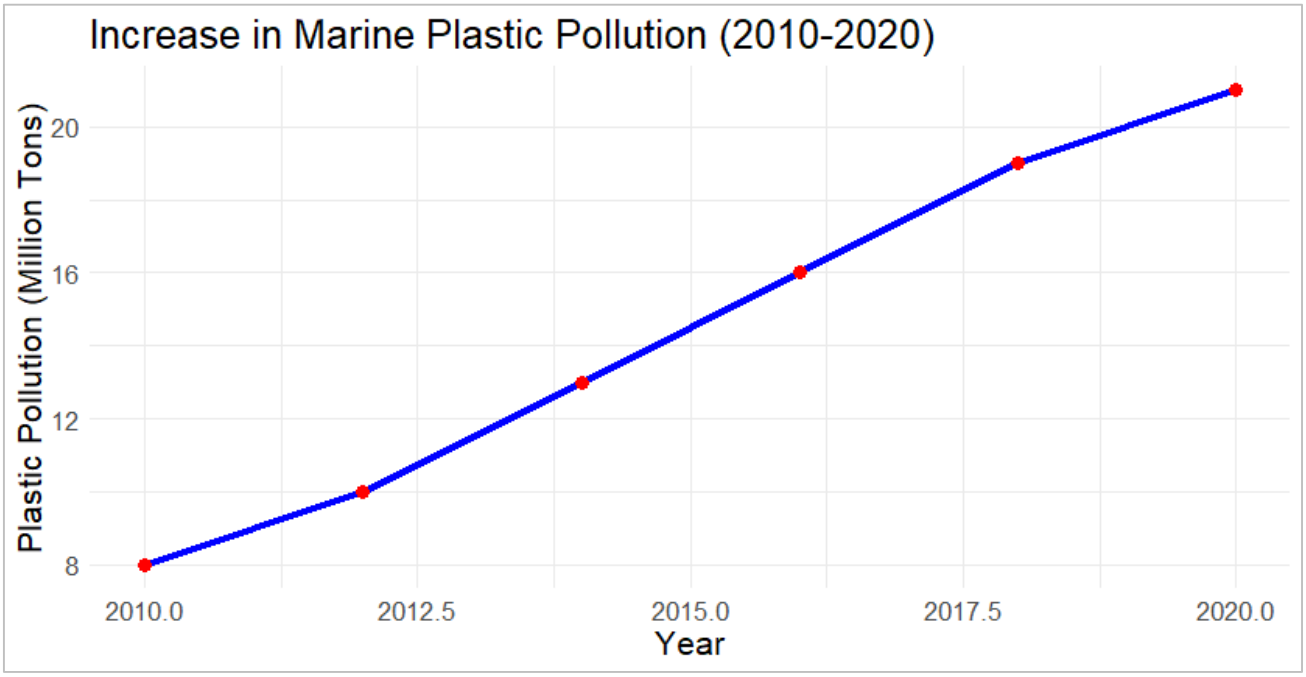


**Figure 5.** Marine Plastic Pollution over time.

#### 4.3.2. Biodiversity Protection

The GEF is the primary multilateral fund dedicated to addressing this issue and has been a significant global source of funding for biodiversity conservation. Spanning from July 2022 to June 2026, the GEF's eighth programming term, known as GEF-8, is primarily focused on biodiversity protection. The success of achieving the post-2020 global biodiversity framework, including the implementation of the new framework at the UN Biodiversity Conference (COP-15) in Kunming, China, relies on this assistance. Rivers and streams play a crucial role in the transit of plastics from interior areas to the coast. According to research, approximately 34,000 out of the 100,888 river and stream outlets included in the study release macroplastic debris into the ocean. Consequently, an estimated 0.9 to 2.8 million tonnes of plastic waste entered the marine ecosystem in 2015. Eighty percent of the plastic debris released into the ocean by rivers worldwide comes from around 1700 rivers. Southeast Asia and West Africa's urban rivers, even the smaller ones, are the primary sources of plastic pollution [95]. Therefore, controlling and managing watercourses is essential to preventing marine plastic waste from LBS. Although environmental considerations had a significant role in the creation of this body of legislation, its regulatory effects on the reduction of plastic pollution are still very negligible.

Although UNCLOS provides for detailed legal framework for the protection of marine environments, its guidance on how to address land-based sources of plastic pollution is vague and lacking in deterrence [81]. Because there are no clear-cut enforcement policies and definite targets, UNCLOS has a hard time making inroads against MPP. What are the promises of influence and policy across this research? Therefore, it is essential to clarify and evaluate which regulatory policies are most suitable, based on the findings presented in this study. It is recommended that this information be discussed as a separate sub-section before the conclusion.

#### 4.3.3. Collaborative Action

In order to conserve biodiversity, the GEF supports feasible measures that promote the ethical utilisation of resources, enhance public awareness of their significance, and foster collaboration among important organisations and individuals to drive action. This aligns

with the objective of the GPA to encourage cooperation between nations and stakeholders in combating marine pollution and preserving biodiversity.

### 4.4. Policy and Practical Implications

This study highlights several critical policy implications for international and national marine governance. It promotes the value of legally binding agreements that are specific to combat marine plastic pollution (MPP). Critical recommendations include enhancing the surveillance of already established maritime conventions, including UNCLOS and MARPOL, ensuring that such standards have amended enforceable provisions that target plastic emission reduction from land- and sea-based activities [82]. Adopting a comprehensive and legally enforceable Global Plastics Treaty based on common global benchmarking should be high on the agenda for international plastic waste management issues. The treaty should provide proactive measures to avoid pollution and effective ways of removal while creating measurable tasks for every providing nation. Thus, the report advocates for improved integrated freshwater–marine pollution governance, while understanding the pivotal role freshwater streams play in facilitating plastics into the oceans. Further, the strategy needs to promote the use of global Best Available Techniques (BATs) and Best Environmental Practices (BEPs) so as to significantly reduce plastic waste at its source [58]. Developing countries need to build their capacities to enable meaningful cooperation and successful implementation in any part of the world. This study will also align with the goals that are established in SDG-14, which aims at protecting and wisely managing our seas. Progression of marine sustainability and pollution management on a worldwide scale can be positively impacted, in large measure, through the reform of economics and by promoting a circular economy.

## 5. UNCLOS: International Legal Framework for MPP

This section will examine the relevant provisions of UNCLOS, which serve as the primary international legal framework for protecting the marine environment from plastic pollution originating from LBS. UNCLOS is an international legal framework that serves as a comprehensive organisation for the preservation and sustainable use of the oceans and their resources [28,69,96,97]. It also establishes various guidelines for the preservation and protection of the marine realm. The convention was adopted on 10 December 1982, during the third UNCLOS (1973–1982) and came into effect on 16 November 1994 There are 170 parties in it right now, with the EU among them [8]. Although the agreement "establishes the legal framework within which all activities in the oceans and seas must be conducted", it also encompasses LBSs that may have an impact on the marine environment within its scope. Due to its extensive coverage and comprehensive nature, UNCLOS is often referred to as the "constitution that governs the oceans" [98,99].

Figure 6 displays a histogram illustrating the distribution of microplastic particle counts in marine samples. It appears from the data that the most common particles counted in multiple samples were between 35 and 50, meaning there is considerable to high contamination of microplastics in many areas. UNCLOS adoption has played a crucial role in the development and codification of the law of the sea. Numerous substantive provisions of the agreement are acknowledged as reflecting customary international law, either as a result of their adoption or during the negotiations, or because they are a formalisation of prior customary rules [100,101]. The convention, referred to as the zonal management strategy, aims to harmonise and balance the interests of individual nations across its various sections. In order to protect the common interests of the global community, it also provides a framework for international cooperation in maritime affairs (integrated management approach). This dual strategy is yet another unique feature of UNCLOS [102,103].

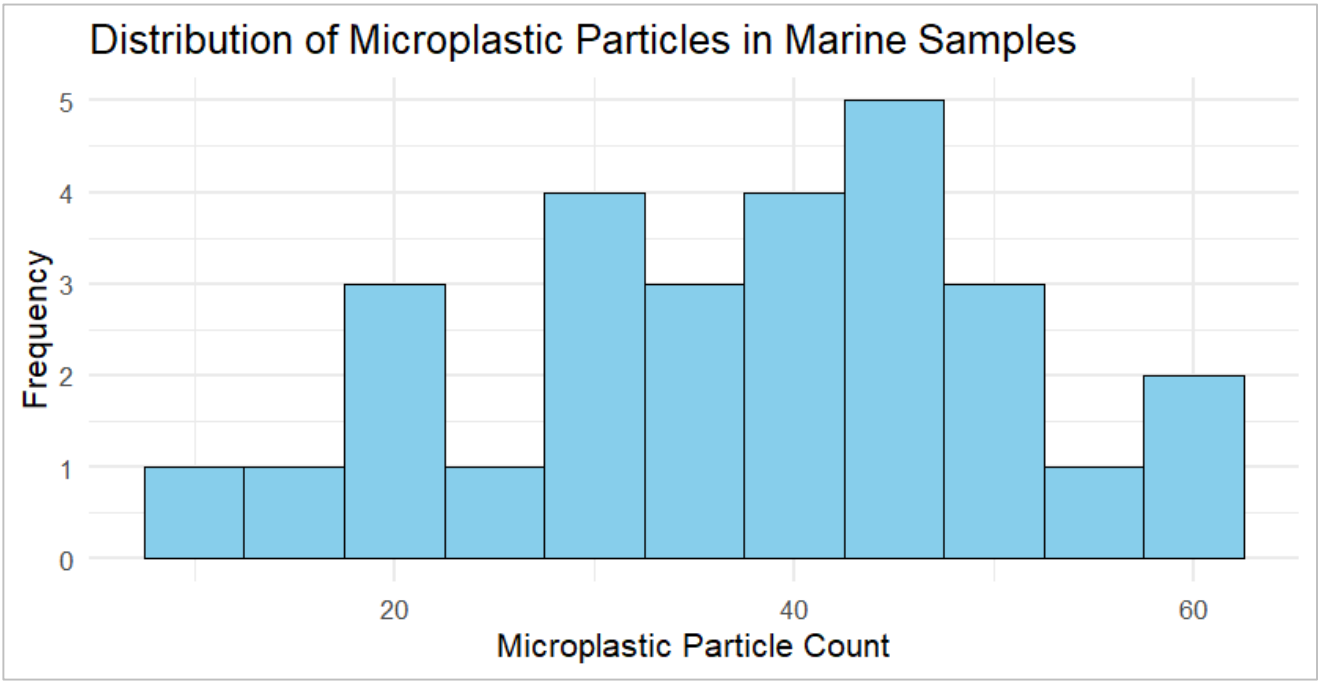


**Figure 6.** Histogram of microplastic ingestion counts.

The convention has several rules that address environmental protection. The subject is primarily covered in UNCLOS Part XII, which offers a unified framework for the preservation of maritime environments [58]. UNCLOS is the first international agreement in the world that explicitly declares the general obligation of states to protect and preserve the marine environment by addressing all forms of pollution. UNCLOS introduced these wide-ranging duties, leading to a substantial shift in promoting marine sustainability from a state of considerable freedom to pollute the oceans to a global framework of stringent pollution control. Under UNCLOS, a healthy marine environment is recognised as a matter of shared concern that transcends the interests of individual nations [101–104].

### *5.1. Normative Framework for MPP Mitigation: Analysing UNCLOS Part XII*

UNCLOS Part XII is divided into 11 sections and comprises 46 articles. The initial section includes several legal principles that govern the Part XII system. The wording and spirit of Principle 7 of the Stockholm Declaration 1972 [105] and other contemporaneous publications were followed in the drafting of the principles. Article 192, which constitutes the opening sentence of Part XII, establishes the general obligation of governments to protect and preserve the marine environment. The global legal framework for mitigating MPP revolves around this obligation. The following subsection focuses on the specific requirements outlined in UNCLOS Part XII (3) and elucidates its normative content in Part XII (2).

### *5.2. Institutions Associated with UNCLOS*

While UNCLOS must be interpreted as a whole, it is composed of various sections, some of which are considered constitutive in nature, while others amend and codify existing laws [102,106–108]. These elements subsequently establish new institutions, enact new laws, and introduce new concepts. In this regard, UNCLOS has adopted numerous resolutions that highlight the importance of operational protocols and early investments in pioneering research on polymetallic nodules [102,106–108]. Furthermore, UNCLOS Part XII addresses the protection and preservation of the marine environment, including the need for effective measures to combat marine plastic pollution. This issue is increasingly

critical as plastic pollution threatens marine biodiversity, disrupts ecosystems, and impacts human health, underscoring the urgency for robust legal frameworks and international cooperation [109].

#### 5.2.1. Division for Ocean Affairs and the Law of the Sea (DOALOS)

The Division for Ocean Affairs and the Law of the Sea (DOALOS), operating under the Office of Legal Affairs, has consistently received recognition for its role in promoting the wider acceptance and consistent implementation of UNCLOS. It also plays a critical role in addressing MPP through its support of the convention. Following the convention's adoption, DOALOS was entrusted with the responsibilities assigned to the Secretary–General and the tasks related to its entry into force during the 52nd UNGA in 1998. Specifically, the division monitors advancements in all relevant fields to provide an annual report to the UNGA on matters concerning ocean affairs and the legal status of the sea.

Moreover, the division formulates recommendations to the UNGA and other intergovernmental forums to enhance comprehension of the convention. This ensures that the division is capable of addressing requests for advice and assistance from states in implementing the convention. Additionally, the division acts as the secretariat of UNCLOS, offering information, advice, and support to states to foster a better understanding of the convention, related agreements, their broader acceptance, uniform and consistent application, and effective implementation. This includes addressing pollution from land-based sources, such as plastics, which significantly impact marine ecosystems. In addition, by providing guidance, facilitating international cooperation, and promoting the effective enforcement of these legal frameworks, DOALOS helps member states meet their obligations to control and reduce MPP [110].

Additionally, it creates suggestions for the UNGA and other intergovernmental forums to enhance public knowledge of the convention. This guarantees that the division can react to requests from states for guidance and support in putting the convention into practice [111]. Furthermore, the division functions as the UNCLOS secretariat, offering states guidance, support, and information to enhance public knowledge of the convention and its associated agreements, as well as to ensure their widespread ratification, uniform and consistent application, and efficient execution.

Furthermore, DOALOS contributes to mitigating marine plastic pollution through various activities. It assists countries in developing and enforcing national regulations aligned with UNCLOS provisions related to marine pollution. This includes providing technical support and capacity-building to improve national and regional approaches to plastic waste management. DOALOS also supports international initiatives, such as the Global Partnership on Marine Litter (GPML), which focuses on collaborative efforts to tackle marine litter, including plastics. By facilitating these global partnerships and promoting best practices, DOALOS enhances the effectiveness of international and national strategies to address plastic pollution in marine environments [109,112].

#### 5.2.2. International Tribunal for the Law of the Sea (ITLOS)

Established in 1982 by UNCLOS, the International Tribunal for the Law of the Sea (ITLOS) is an unbiased court that adjudicates cases related to the interpretation and application of the convention. The tribunal consists of 21 independent members who are selected based on their high standing in the field of maritime law, ensuring their impartiality, integrity, and expertise [113]. UNCLOS grants eligibility to the state parties to utilise the tribunal, and it may also be accessed by other organisations or bodies under specific circumstances. The tribunal possesses jurisdiction over any matter brought before it in accordance with the convention. Furthermore, the tribunal's jurisdiction extends to sub-

jects explicitly mentioned in any other agreement that confers authority upon the tribunal. In certain situations, the tribunal may also offer recommendations under international agreements regarding the objectives of the convention.

Furthermore, ITLOS's jurisdiction under UNCLOS extends to disputes concerning the protection and preservation of the marine environment, a category that encompasses marine plastic pollution. Part XII of UNCLOS, which addresses marine environmental protection, mandates states take measures to prevent, reduce, and control pollution from various sources, including plastics [114]. Although ITLOS has not yet specifically adjudicated a case solely focused on plastic pollution, its role in interpreting Part XII provides a legal framework that could address such issues.

The tribunal's potential involvement in marine plastic pollution disputes could involve determining whether states have fulfilled their obligations under UNCLOS to manage plastic waste effectively and to cooperate in the prevention and control of marine pollution [115]. ITLOS's decisions and advisory opinions on these matters could significantly influence state practices and international standards related to marine plastic pollution. For instance, the tribunal's approach to general pollution cases and its interpretation of UNCLOS principles could set precedents for addressing the specific challenges posed by marine plastic pollution, including the legal responsibilities of states to mitigate and manage plastic waste [116]. Such precedents could enhance global efforts to combat plastic pollution and strengthen the implementation of international environmental agreements.

## 6. IMO's MARPOL Framework: Addressing Marine Pollution from Sea-Based Sources

The IMO is the principal entity responsible for the continuous evolution of laws and policies related to ship pollution. This specialised UN agency plays a pivotal role in overseeing several key treaties that address civil responsibility, marine pollution control from ships, and dumping at sea. Among these, the MARPOL [117] and the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter [118], along with its 1996 Protocol [119], are particularly significant in combating plastic pollution from maritime sources [117,120]. MARPOL, initially adopted in 1973 and modified by the Protocol of 1978, constitutes the primary international framework for preventing pollution from ships. Its Annex V specifically targets the prevention of pollution by garbage from ships, including plastics, which are a major component of marine litter [121]. The London Convention, established in 1972, and its 1996 protocol provide comprehensive guidelines for the control of marine pollution by prohibiting the deliberate disposal of wastes at sea. These instruments collectively form the backbone of international efforts to mitigate marine pollution, particularly from plastics.

The implications of UNCLOS for the IMO and the instruments agreed upon under its auspices have been extensively analysed by the IMO Secretariat. According to a 1987 evaluation by the IMO Secretariat, UNCLOS "depends on them for the effective implementation of its general principles", but rather assumes the existence of specific regulations and anticipates future ratifications by the IMO [122]. This indicates that UNCLOS provides a broad legal framework, while the detailed regulatory measures are left to the IMO's conventions and protocols. In 2018, the IMO's Marine Environment Protection Committee (MEPC) established an action plan specifically aimed at preventing and minimising marine litter from ship-based sources, supporting SDG 14, which focuses on conserving and sustainably using the oceans, seas, and marine resources [123]. This action plan includes several measures, such as enhancing the enforcement of existing regulations, promoting the development of port reception facilities, and encouraging research and innovation to address the issue of marine litter from ships [21,124].

The relationship between UNCLOS and the IMO conventions underscores a complementary framework where UNCLOS sets out broad principles, and the IMO develops specific regulatory measures to implement these principles. For instance, Article 211 of UNCLOS specifically mandates that states shall establish international rules and standards to prevent, reduce, and control pollution of the marine environment from vessels, taking into account IMO standards [123]. This article effectively integrates the IMO's regulatory mechanisms into the overarching legal framework provided by UNCLOS. Moreover, the IMO's continuous efforts in updating MARPOL and other related conventions reflect an adaptive approach to emerging environmental challenges. The adoption of amendments to MARPOL Annex V, which prohibits the discharge of all plastics from ships, exemplifies the dynamic nature of maritime environmental law in response to the growing problem of plastic pollution [54,121].

The 2018 MEPC action plan is a testament to the IMO's proactive stance in addressing marine litter. It aligns with the precautionary principle, a key tenet of international environmental law, which advocates for preventive measures in the face of potential environmental harm [52]. By fostering international cooperation and encouraging member states to adopt stringent measures against marine litter, the IMO's initiatives contribute significantly to global marine environmental protection efforts.

## 7. Discussion

MPP poses a significant environmental and legal challenge that extends beyond national borders, requiring a multifaceted approach. Although international legal frameworks such as UNCLOS and the MARPOL exist, they are currently insufficient in addressing the scope of the problem. This analysis evaluates these frameworks, highlights their shortcomings, and suggests necessary improvements. Historically, the recognition of marine pollution from LBSs has evolved significantly. The UN Environment's establishment of the Regional Seas Programme and the GPA were pivotal in addressing this issue. The GPA remains a crucial platform, offering guidance for action at all governance levels. Awareness of MPP expanded rapidly in subsequent years, with the international community emphasising the issue at forums such as the UNCSD in 2012, the UNEA, the UNGA, and Ocean Conferences. States established procedures under UNEA to explore potential solutions, recognising the need for action and setting objectives and targets. Numerous nations and stakeholders now advocate for an international accord to address this global crisis.

Biodiversity conventions and chemicals and waste conventions also address MPP from unique perspectives. The urgency of addressing MPP is underscored by its pervasive impact on marine ecosystems, public health, and economic stability. To effectively mitigate this crisis, the international community must adopt a more integrated and proactive approach, emphasising precise, enforceable regulations and innovative solutions. UNCLOS provides a comprehensive legal framework for marine environmental protection, outlining states' responsibilities to prevent and control pollution. However, its provisions are broadly defined and lack the specificity required to address the unique challenges posed by plastic pollution. Due to the scale and impact of LBS on marine environments, this oversight is significant. Moreover, UNCLOS relies heavily on state implementation, resulting in varied enforcement and effectiveness. States often prioritise economic interests, leading to insufficient measures against MPP. Therefore, UNCLOS should include clear provisions for definitions, responsibilities, and enforcement to address plastic pollution effectively.

MARPOL, particularly Annex V, focuses on ship-generated waste and explicitly prohibits the disposal of plastics at sea. However, enforcement of these provisions is inconsistent across jurisdictions. Many states lack the infrastructure or political will to enforce MARPOL's regulations effectively, leading to continued illegal dumping and poor waste

management practices. Additionally, MARPOL's narrow focus on maritime sources neglects the significant contributions of land-based activities to MPP. Strengthening MARPOL Annex V requires stringent compliance measures, improved monitoring, and expanded coverage of land-based sources. Furthermore, the ecological impacts of MPP extend beyond visible pollution, with microplastics presenting an insidious threat to marine life and ecosystems. Current international legal instruments do not adequately address the pervasive nature of microplastics, which bioaccumulate and biomagnify through the food web, ultimately impacting human health. This deficiency calls for a comprehensive legal approach, including stringent regulations on the production, use, and disposal of plastics, and measures to mitigate microplastic pollution.

Similarly, MPP poses significant health risks due to the presence of microplastics in marine organisms consumed by humans. Studies have shown widespread contamination of seafood with microplastics, carrying toxic chemicals and potentially harmful organisms. The ingestion of microplastics through seafood has been linked to various health disorders, including endocrine disruption, carcinogenic effects, and other chronic health issues. Current international frameworks do not adequately address these human health risks, underscoring the need for more stringent and comprehensive regulations on plastic production and disposal to safeguard public health. Addressing health risks requires research on microplastics, integrating findings into policies, and educating the public on responsible plastic use. Additionally, MPP disrupts socio-cultural practices and the cultural significance of marine environments, negatively affecting mental health and diminishing the aesthetic and therapeutic value of coastal areas. These socio-economic impacts highlight the urgent need for robust regulatory measures and effective waste management systems.

In addition, the fragmented nature of international governance exacerbates the challenge of addressing MPP. The lack of coordination among various international agreements and organizations leads to overlapping jurisdictions and regulatory gaps. A cohesive global strategy is essential, integrating the principles of the circular economy and emphasising the 3Rs (reduce, reuse, recycle). This strategy should involve binding international agreements with clear, enforceable obligations and a unified approach harmonizing national regulations with international standards. However, it is crucial that effective management of MPP requires coordinated efforts among nations, international bodies, and stakeholders. Enhanced international collaboration is crucial, fostering partnerships for scientific research, sharing best practices, and developing innovative solutions to reduce plastic waste. Legal frameworks must facilitate such collaboration, creating platforms for dialogue, cooperation, and mutual assistance. Monitoring systems must track pollution accurately and ensure transparency. Furthermore, a novel integrated and comprehensive legal instrument is needed to reduce plastic production, enhance waste management, and promote a circular economy, with mechanisms for regular review. Policies should adopt the 3Rs (reduce, reuse, recycle), incentivise sustainable production, and invest in research for biodegradable solutions. National laws must align with international standards, with better enforcement through infrastructure, funding, and training.

Protection of marine plastics from pollution (MPP) is regarded as one of the most important global measures to be implemented to resolve the increasing plastic pollution issue. In answer to the urgent need to cooperate, the United Nations Environment Programme (UNEP) has reacted by supporting the treaty, with emphasis on establishing law-enforceable rules for the reduction and management of plastic waste abroad. Now, with the continued devastation wrought to marine ecosystems by MPP, the treaty offers an essential opportunity to establish strong international rules for reducing plastic waste between states. Through the creation of standard global management, recycling, and the reduction of plastic waste, the treaty is the secret to harmonizing policies within arrange-

ments like UNCLOS and MARPOL. Such strategies would allow for countries to follow standard rules in the sense that regulatory standards will be effectively followed across borders. Beyond dealing with land-based plastics, the treaty aims to curb lesser-known plastic-causing sources of debris in the ocean, arising from ships and other maritime activities. Moreover, the Global Plastics Treaty may promote the large-scale adoption of Best Available Techniques (BATs) and Best Environmental Practices (BEPs) by industries, encouraging the circular economy transition. Under these standards, the treaty would promote the innovation of recycling and reduce reliance on disposable plastics and sustainably manufactured industrial products.

The Global Plastics Treaty, which learns from the successful action taken by countries such as Kenya and Norway on plastic waste, can heighten this momentum by establishing a global template for concerted action. This treaty is a critical step towards SDG 14—the conservation of marine ecosystems in a sustainable way.

## 8. Conclusions

This study critically examined the effectiveness of international legal frameworks, particularly UNCLOS and MARPOL, in addressing the growing challenge of marine plastic pollution (MPP). The primary objective was a determination of the sufficiency of the existing laws with regard to the collection of plastic waste from both shoreline and vessel waste dumps. An examination of legal doctrines revealed significant problems with enforcement, narrow jurisdictional reach, and the absence of meaningful responsibilities to control marine plastic pollution. The study findings revealed that although the UNCLOS and the MARPOL provide basic structures, they lack the required mechanisms to address the current plastic waste challenges decisively. This study highlighted the socio-economic and cultural impact of MPP, especially its impact on fisheries, tourism, and people living along the coast. Moreover, such efforts as UNEA resolutions and the proposed Global Plastics Treaty suggest great progress is being made toward more effective governance. It is obvious that current international laws should be changed so as to be more effective in addressing the magnitude and weight of the plastic crisis. This involves taking enforceable legal instructions, promoting the use of circular economy practices, and promoting international cooperation among others. Improving institutional coordination and involving all involved stakeholders at all levels will be imperative in making effective and sustainable countermeasures against marine plastic pollution.

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