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LEGAL CHALLENGES IN REGULATING MARINE POLLUTION FROM MICROPLASTICS: AN INTERNATIONAL PERSPECTIVE

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ABSTRACT

Marine pollution from micro plastics has become a pressing global issue, threatening marine biodiversity, ecosystem health, and human well-being. This paper explores the legal challenges in regulating marine pollution caused by micro plastics from an international perspective. It begins by defining micro plastics and highlighting their environmental and socio-economic impacts. The paper then examines the existing international legal frameworks, including the United Nations Convention on the Law of the Sea (UNCLOS), the Basel Convention, and MARPOL, analysing their strengths and limitations in addressing micro plastic pollution. Additionally, it explores key legal gaps, such as the lack of enforceable standards, fragmented jurisdictional authority, and insufficient monitoring mechanisms. Drawing on case studies, the paper discusses the interplay between international, regional, and national approaches to regulation. Marine pollution from microplastics poses a significant threat to ecosystems, biodiversity, and human health. This article explores the status quo of international legal frameworks addressing microplastic pollution, identifies gaps and challenges, and suggests pathways for more effective regulation. Drawing on a comparative analysis of international treaties, regional cooperation mechanisms, and domestic approaches, it argues for a cohesive global response to this pressing environmental issue. Finally, it proposes actionable recommendations, including strengthening international agreements, enhancing collaboration, and adopting a life-cycle approach to plastic regulation. This research emphasizes the urgency of addressing micro plastic pollution through robust, enforceable, and globally coordinated legal mechanisms.

Keywords: *International law, Micro plastics, Marine litter, Marine Environment protection, Maritime Community with a Shared Future.*

INTRODUCTION

Because of their many uses and affordable cost, plastic products are utilized extensively in modern life, which leads to a significant volume of plastic garbage. Microplastics are tiny plastic particles that are usually less than five millimetres in diameter. They can be purposefully made, as the microbeads used in personal care items, or they might result from the decomposition of bigger plastic debris. Maritime plastic trash and microplastics pose major dangers to the maritime ecosystem.[2] These particles are pervasive pollutants that enter marine

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[2] GESAMP, Proceedings of the GESAMP International Workshop on Assessing the Risks Associated with Plastics and Microplastics in the Marine Environment 3–12 (2020).

environments through industrial run-off, improper waste disposal, and degradation of plastics in oceans. Once in the marine environment, microplastics become virtually indestructible due to their resistance to natural decomposition processes.[3]

In recent years, microplastics in the ocean have been detected in many ocean and polar researches conducted in worldwide. Microplastics come from a wide variety of sources and are distributed in all corners of the ocean. According to research investigations, marine microplastics arise from massive plastic fragments, and another portion comes from raw materials flowing into the water, such as resin particles, plastic abrasives in personal care items, and cleaning chemicals.[4] Microplastics numerous chemical contaminants can readily enter saltwater due to its huge specific surface area and small particle size, which can have a compound harmful effect on marine species.

They are especially dangerous because of their small size, which enables them to enter all layers of marine ecosystems, from surface waters to deep-sea sediments. Hazardous substances, including heavy metals and persistent organic pollutants (POPs), are known to be absorbed and transported by microplastics, increasing their negative effects on the environment and human health.

Even though the issue of marine microplastic litter has drawn a lot of attention from the global community and has been brought up frequently in meetings and reports of international organizations and non-governmental organizations, efforts to prevent and control marine microplastic pollution have not yielded positive results, and management effectiveness is still not very high. This paper focuses on examining the causes of the challenges in managing marine microplastic litter and suggesting improved legislative regulations.

OVERVIEW OF THE SCALE OF THE PROBLEM

Marine life is being threatened by microplastics. Plankton and huge predators like whales are among the marine species that consume microplastics because they mistake them for food. This consumption throws off feeding schedules, causes famine, and occasionally causes death. Studies have shown that microplastics are present in over 50% of marine species examined, signifying the pervasiveness of the issue.[5]

Ecological processes including habitat building and nutrient cycling are negatively impacted by microplastics. Deposition of microplastics hinders the growth and reproduction of coral reefs, which are already under stress from climate change. The same is true for mangroves and other coastal ecosystems that serve as organic barriers to prevent erosion.

Through salt and shellfish, microplastics have made their way into the human food chain. Toxicological effects such as inflammation, endocrine disruption, and even carcinogenicity can result from consuming them. Although research on the scope of these dangers is ongoing, preliminary results point to a serious public health issue.

[3] Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), Sept. 22, 1992, 2354 U.N.T.S. 67 (entered into force Mar. 25, 1998).
[4] Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 69.
[5] Damian Carrington, Microplastics May Be Linked to Inflammatory Bowel Disease, Study Finds, THE GUARDIAN (Dec. 22, 2021), https://www.theguardian.com/society/2021/dec/22/microplastics-may-be-linked-to-inflammatory-bowel-disease-study-finds.

Tourism, aquaculture, and fisheries all suffer financially as a result of marine pollution caused by microplastics. Particularly in underdeveloped nations that depend on marine resources, contaminated fish supplies and damaged coastal habitats cause financial losses and endanger livelihoods.

IMPORTANCE OF ADDRESSING MICROPLASTIC POLLUTION UNDER INTERNATIONAL ENVIRONMENTAL LAW

Microplastic pollution is a transboundary issue, as plastics discarded in one region can drift across oceans to impact distant ecosystems. No international treaty has the primary objective of preventing and regulating marine plastics pollution. The United Nations Convention on the Law of the Sea (UNCLOS)[6] this calls for a worldwide approach to mitigation and regulation. The United Nations Convention on the Law of the Sea (UNCLOS) and other contemporary international legal frameworks give a general directive to stop marine pollution, but they are vague on microplastics.

The Mediterranean Regional Plan for Marine Litter Management is an excellent illustration. Even while its objective is to reduce marine litter from both terrestrial and marine sources, it also applies to marine plastic trash. States must address marine plastic pollution and the deficiencies of international instruments by meeting self-determined national targets and timeframes as part of the plan's binding nature.

Given the global nature of the problem, nations must cooperate to address the root causes of microplastic production and ensure the sustainable management of marine resources. Strong international laws and frameworks are necessary to hold polluters accountable, encourage technological innovation, and harmonize national regulations.

An extensive variety of legal instruments handle concerns of marine plastics. First, multiple treaties govern numerous sources of marine plastics. UNCLOS remains the sole enforceable pact that governs land-based sources, which account for 80% of all plastics discarded of in the ocean.[7]

OBJECTIVE OF THE ARTICLE

This article aims to critically evaluate the adequacy of current international legal frameworks addressing microplastic pollution. It seeks to:

1. Identify gaps and challenges in existing treaties and agreements.
2. Compare and analyse approaches adopted in different jurisdictions and regions.
3. Propose innovative and feasible legal solutions to mitigate the impact of microplastics on marine environments and beyond.

[6] United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 (entered into force Nov. 16, 1994).
[7] Nilufer Oral, From the Plastics Revolution to the Marine Plastics Crisis: A Patchwork of International Law, in Richard Barnes & Ronán Long (eds.), Frontiers in International Environmental Law: Oceans and Climate Challenges: Essays in Honour of David Freestone 288 (Leiden: Brill 2021).

INTERNATIONAL LEGAL FRAMEWORKS ON MICROPLASTIC POLLUTION

In order to handle one of the most important environmental issues of the twenty-first century, this study emphasizes the urgent necessity for strong international legal frameworks.

Often called the "constitution for the oceans," the United Nations Convention on the Law of the Sea (UNCLOS) is one of the most extensive international agreements regulating the use and preservation of marine areas. UNCLOS, which was ratified by 168 parties and adopted in 1982, offers a legal framework to address a number of marine environmental protection issues.

Articles 192 to 194 of UNCLOS form the cornerstone of its environmental protection regime:

Article 192: General Obligation to Protect the Marine Environment
This article imposes a binding obligation on all States to protect and preserve the marine environment. While broad in scope, it establishes the foundational principle that nations must ensure their activities do not harm the oceans.

Article 193: Sovereign Right to Exploit Resources Article 193 recognizes the sovereign rights of States to exploit their natural resources, provided that such exploitation is conducted in accordance with their duty to protect and preserve the marine environment. This creates a balance between environmental protection and economic development.

Article 194: Measures to Prevent, Reduce, and Control Pollution Article 194 is more specific in outlining the steps nations must take to combat marine pollution. It includes: Adoption of measures to prevent, reduce, and control pollution from land-based sources, vessels, seabed activities, and atmospheric inputs. Obligation to ensure that pollution does not spread beyond national jurisdictions or cause harm to other States.

Though they don't specifically address microplastics or offer comprehensive recommendations on how to battle this particular type of pollution, these regulations are crucial in addressing overall marine pollution.

Limitations of UNCLOS in Addressing Microplastics

UNCLOS was drafted long before the scale and nature of microplastic pollution were scientifically understood. Consequently, it does not explicitly reference plastics or microplastics, leaving a significant regulatory gap in addressing this emerging threat.

The convention addresses broad categories of marine pollution, such as pollution from land-based sources, ships, and seabed activities, but lacks targeted provisions for pollutants like microplastics, which often originate from consumer products, industrial processes, and the breakdown of macro plastics.

While UNCLOS obligates States to protect the marine environment, it relies heavily on national implementation and self-regulation, which can vary significantly in effectiveness. There is no dedicated enforcement body or mechanism to ensure compliance with pollution-related provisions. For instance, States with limited resources or political will may not implement robust measures to prevent microplastic pollution.

Land-based activities like industrial processes, urban runoff, and wastewater discharge are responsible for a large amount of microplastic pollution. Despite encouraging states to address land-based pollution, UNCLOS offers little in the way of binding obligations or guidelines to

regulate particular contaminants, such as microplastics. Inability to Address Trans boundary Pollution Adequately Microplastics are inherently transboundary pollutants, traveling across oceans via currents and wind. UNCLOS lacks a framework for coordinated action among States to address cross-border impacts, leading to regulatory fragmentation and inefficiency.

EFFORTS TO SUPPLEMENT UNCLOS

Recognizing its limitations, international efforts have sought to complement UNCLOS through other treaties and frameworks:

MARPOL (International Convention for the Prevention of Pollution from Ships): Focuses on ship-sourced pollution but does not address micro plastics from land-based sources.[8]

Regional Seas Conventions: These provide supplementary frameworks for regional cooperation but lack global applicability.

United Nations Environment Assembly (UNEA) Resolutions: While not legally binding, these resolutions highlight the global consensus on the need to tackle plastic and microplastic pollution.

Although UNCLOS is still a fundamental component of international maritime environmental law, its broad application and lack of detail about microplastics highlight the need for modern, targeted legal frameworks. In light of new threats, closing these gaps is essential to guaranteeing the maritime ecosystem is fully protected.

STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPS): ADDRESSING MICROPLASTIC POLLUTION

The Stockholm Convention on Persistent Organic Pollutants (POPs)[9] is a global treaty adopted in 2001 under the auspices of the United Nations Environment Programme (UNEP). Persistent organic pollutants are dangerous chemicals that stay in the environment, bioaccumulation through the food chain, and endanger both human health and the environment. Its main goal is to eradicate or limit their production and usage.

Although the convention's primary focus is on chemical pollutants, some plastic products and additives that are classified as POPs are also covered by it. Because of the intricate interactions between plastics and POPs in marine habitats, this significance also applies to the larger context of microplastic pollution.

Applicability to Certain Plastics and Additives

The Stockholm Convention applies to plastics that either contain or are coated with persistent organic pollutants. These include plastics treated with POPs as flame retardants, stabilizers, or other additives. For example, polybrominated biphenyl ethers (PBDEs), commonly used as flame retardants in plastics, are listed under the convention as substances to be eliminated or restricted.

[8] S. Harding, Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity, Secretariat of the Convention on Biological Diversity, Montreal, QC, Canada (2016).
[9] Stockholm Convention on Persistent Organic Pollutants, May 22, 2001, 2256 U.N.T.S. 119 (entered into force May 17, 2004).

Plastics coated with or containing persistent organic pollutants are subject to the Stockholm Convention. These consist of plastics that have been treated with POPs as stabilizers, flame retardants, or other additives.

For instance, the convention lists polybrominated biphenyl ethers (PBDEs), which are frequently used as flame retardants in plastics, as compounds that should be regulated or removed.

Microplastics act as carriers for POPs present in the marine environment. They adsorb these pollutants due to their hydrophobic nature and high surface-area-to-volume ratio.

Once ingested by marine organisms, microplastics transfer these adsorbed POPs, causing toxic effects that bioaccumulation and biomagnified through the food chain.

The convention mandates parties to take measures to reduce or eliminate releases of POPs into the environment, including the marine ecosystem. While it does not explicitly target microplastics, its provisions indirectly apply to the POPs carried by them.

Challenges: Inadequate Coverage of Non-POP Microplastics

A critical limitation of the Stockholm Convention is its focus on chemical pollutants that meet the specific criteria of persistence, bioaccumulation, and toxicity.

Many microplastics, especially those not treated with POPs or additives, fall outside the scope of the convention. For example, polyethylene or polypropylene particles, which make up a large portion of marine microplastics, are not inherently covered by the treaty.

The convention addresses pollutants based on their chemical composition and toxicological properties, but microplastics pose significant physical risks to marine life, such as ingestion and entanglement, which are beyond the scope of POPs regulation.

The treaty predates the widespread recognition of microplastic pollution as an environmental crisis. Consequently, it does not provide specific guidelines or measures to address plastics as a distinct category of pollutants.

While the convention overlaps with marine pollution issues, it is not specifically designed to address oceanic environments comprehensively. This creates a gap in regulating plastic waste that contributes to microplastic pollution in marine ecosystems.

The effectiveness of the Stockholm Convention depends on national implementation, which varies widely among parties. Many countries, particularly developing nations, face challenges in identifying, regulating, and phasing out POP-containing plastics, let alone addressing non-POP microplastics.

IMPLICATIONS AND WAY FORWARD

Need for Supplementary Legal Frameworks

To address the broader scope of microplastic pollution, new international treaties or protocols are needed that build upon the foundations of the Stockholm Convention but include all types of microplastics.

Harmonization with Existing Treaties

Integrating the Stockholm Convention's provisions with frameworks like the Basel Convention (on hazardous waste) or MARPOL could create a more comprehensive approach to managing plastics in marine environments.

Expanding the POPs List

The inclusion of additional chemicals associated with plastics under the Stockholm Convention could indirectly reduce certain types of microplastic pollution.

Global Monitoring and Research

Strengthening research initiatives to better understand the interaction between microplastics and POPs in marine environments is essential. Improved data can inform international negotiations and policy-making.

MARPOL (INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS): ADDRESSING MICROPLASTIC POLLUTION

One of the most important agreements to stop maritime pollution from shipping is the International Convention for the Prevention of Pollution from Ships (MARPOL). The International marine Organization (IMO) oversees the administration of MARPOL, which was adopted in 1973 and modified by a 1978 agreement. It is commonly considered a pillar of marine environmental legislation. Each of the six annexes to the treaty addresses a different source of marine pollution, such as sewage, oil, hazardous materials, and trash.

Even while MARPOL is essential in lowering ship-generated pollution, its ability to address microplastic pollution is constrained by its exclusive focus on ship-generated waste and its omission of important sources of microplastic, like fishing gear and industrial runoff.

Regulations on Waste Discharge at Sea

MARPOL includes several provisions aimed at controlling pollution from waste discharge:

Annex V: Guidelines for Preventing Shipboard Trash Pollution

Annex V directly addresses the disposal of garbage, including plastics, from ships into the marine environment. Key provisions include: A complete ban on the discharge of plastics into the sea, including synthetic ropes, fishing nets, and plastic bags. Mandates for ships to maintain garbage management plans and logbooks to record waste disposal. Requirements for port reception facilities to handle ship-generated waste.

Control of Accidental Plastic Pollution

MARPOL requires ship operators to prevent accidental discharge of garbage during regular operations or emergencies, emphasizing preventive measures such as proper stowage and containment of plastic materials.

Fishing Gear Management

Annex V also addresses abandoned, lost, or discarded fishing gear, which is a significant source of marine plastic pollution. It mandates reporting requirements for fishing vessels but does not impose strict penalties or comprehensive recovery obligations.

Regulations on Ballast Water and Other Discharges

MARPOL does not specifically address microplastic particles that may be carried by ballast water or released as trash from shipboard activities, even while it covers pollutants like oil and toxic liquids under other annexes.

Lacunae: Lack of Focus on Microplastic Sources

Limited Scope of Annex V: Although Annex V bans the discharge of plastics, it does not address microplastics specifically, such as those resulting from wear and tear of fishing gear or microbeads from cleaning agents used on ships.[10] Microplastics generated onboard or transported as cargo residues are not explicitly covered, leaving significant gaps in regulation.

Fishing Gear and Ghost Gear: Abandoned, lost, or discarded fishing gear (often referred to as "ghost gear") contributes significantly to microplastic pollution. While Annex V includes provisions for reporting lost gear, it lacks enforcement mechanisms to ensure compliance or mandates for the retrieval of lost gear.

Exclusion of Land-Based: Microplastic Sources MARPOL focuses exclusively on pollution originating from ships and does not address land-based sources of microplastics, such as industrial runoff, wastewater discharges, or urban debris that eventually enters marine environments.

Challenges in Monitoring and Enforcement: Monitoring ship compliance with Annex V's provisions is logistically challenging, especially on the high seas where enforcement is weak. The lack of standardized reporting and limited penalties for violations further undermines the convention's effectiveness in addressing plastic pollution.

Overlooked Pathways of Micro plastic Release: Pathways such as shipboard cleaning operations, maintenance activities (e.g., hull scraping), and ballast water discharges are not explicitly regulated, allowing microplastics to enter marine ecosystems unchecked.

UN ENVIRONMENT ASSEMBLY (UNEA): TACKLING MARINE LITTER AND PLASTIC POLLUTION

The United Nations Environment Assembly has discussed marine plastic litter and microplastics, and has recently adopted a series of resolutions on this matter.61 In particular, the Assembly also established the ad hoc open-ended expert group on marine litter and microplastics to 'identify the range of national, regional and international response options, including actions and innovative approaches, and voluntary and *legally binding governance strategies and approaches'*.[11]

The United Nations Environment Assembly (UNEA) is the world's highest-level decision-making body on environmental issues. Established in 2012, UNEA operates under the auspices of the United Nations Environment Programme (UNEP) and provides a global platform for

[10] MARPOL Annex V, Regulation 1(13) (rev. 2017).
[11] UNEP Resolution on Marine Litter and Microplastics, UNEP/EA.3/Res.7, ¶ 10(d) (Jan. 30, 2018) (emphasis added).

member states to discuss and address pressing environmental challenges, including marine litter and plastic pollution.[12]

The legislative tools that are already in place at the international and regional levels are still crucial for combating the pollution caused by marine plastics. Coherent legislation and implementation will be encouraged by collaboration and coordination across sector-specific tools and between several regulatory tiers at the national, regional, and international levels. In the meantime, a new paradigm centred on using a lifetime approach ought to be taken into account. This could significantly contribute to prevention of marine plastics litter and microplastics.[13] Growing understanding of "upstream" pollution issues necessitates preventing and minimizing the formation of plastic waste at an early stage of plastic production. A lifecycle approach has recently gained popularity as momentum for sustainable production and consumption, despite the fact that it is not entirely represented in the current legislative framework. To support the development of initiative solutions across the whole plastics lifecycle, from design to recyclability, multi-stakeholder partnerships should be encouraged.

Through resolutions and voluntary initiatives, UNEA has played a significant role in promoting international collaboration and increasing awareness of plastic pollution, especially microplastics. Even though its conclusions are frequently non-binding, UNEA is essential in creating the world's narrative and establishing the framework for future legally binding agreements.

Resolutions on Marine Litter and Plastic Pollution

Since its inception, UNEA has adopted several key resolutions aimed at addressing marine litter and plastic pollution:

UNEA-1 (2014): Marine Plastic Debris and Microplastics

This resolution recognized the growing threat of marine litter and microplastics and urged member states to take action to reduce the discharge of plastics into the oceans.[14] UNEA called for research into the sources, pathways, and impacts of microplastics to inform policy responses.[15]

UNEA-2 (2016): Oceans and Seas

Focused on the sustainable management of oceans and highlighted the need to combat marine pollution, including plastics. Encouraged regional cooperation and partnerships to address plastic pollution.[16]

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[12] Giulia Carlini & Konstantin Kleine, Advancing the International Regulation of Plastic Pollution Beyond the United Nations Environment Assembly Resolution on Marine Litter and Microplastics, 27 Rev. Eur., Comp. & Int'l Envtl. L. 234, 243 (2018).

[13] UNEP, Report on the Work of the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics at its Fourth Meeting, UNEP/AHEG/4/7, ¶¶ 129–160 (Nov. 18, 2020), at 17–22.

[14] Elvira Pushkareva, United Nations Environment Programme (UNEP), Max Planck Encyclopaedia of International Law, ¶ 21 (2014).

[15] UNEP, Resolution Adopted by the United Nations Environment Assembly at Its First Session, UNEP/EA.1/INF/8, at 7–10 (May 30, 2014).

[16] UNEP, Reports of the Thirteenth Meeting of the Conference of the Parties to the Basel Convention, UNEP/CHW.13/18, UNEP/CHW.13/INF/37/Rev.1 (May 8, 2018); UNEP/CHW.13/INF/37 (Apr. 6, 2017).

UNEA-3 (2017): Towards a Pollution-Free Planet

This resolution aimed for a comprehensive approach to combat pollution, including the reduction of single-use plastics and addressing microplastics in cosmetics and industrial applications. UNEA launched initiatives to engage stakeholders, including businesses and civil society, in combating plastic pollution.[17]

UNEA-4 (2019): Addressing Single-Use Plastics

Highlighted the environmental and socio-economic impacts of single-use plastics, urging member states to adopt policies to reduce their production and consumption. Promoted innovation and the use of alternative materials to replace single-use plastics.[18]

UNEA-5 (2022): Resolution to Develop a Global Plastics Treaty

A landmark resolution where UNEA agreed to initiate negotiations for a legally binding global treaty to end plastic pollution. This treaty is expected to address the entire lifecycle of plastics, including design, production, and disposal, providing a more holistic approach to tackling marine litter and microplastics.

ROLE IN GLOBAL AWARENESS AND VOLUNTARY ACTIONS

Global Awareness

UNEA has been pivotal in framing plastic pollution as a global crisis, emphasizing its impacts on marine ecosystems, biodiversity, human health, and economies.

Through its resolutions, UNEA has drawn attention to the need for urgent action and encouraged nations to prioritize plastic pollution in their domestic environmental agendas.

UNEP's campaigns, such as the "Clean Seas Campaign," amplify UNEA's messages, engaging millions of individuals and organizations worldwide.

Voluntary Actions and Partnerships

Global Partnership on Marine Litter (GPML): UNEA supported the creation of this partnership, which brings together governments, NGOs, and industry stakeholders to share knowledge, best practices, and solutions to marine litter.[19]

Plastics Circular Economy Initiatives: UNEA[20] promotes voluntary commitments from industries to transition towards a circular economy, emphasizing waste reduction, recycling, and the use of sustainable alternatives.

Innovative Financing Mechanisms: Encourages investment in waste management infrastructure and technologies to prevent plastic pollution, particularly in developing countries.

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[17] UNEP, Resolution Adopted by the United Nations Environment Assembly at Its Third Session, UNEP/EA.3/Res.7, preamble (Jan. 30, 2018).
[18] UNEP, Resolution Adopted by the United Nations Environment Assembly at Its Fourth Session, UNEP/EA.4/Res.6, preamble (Mar. 28, 2019).
[19] Global Partnership on Marine Litter, Purpose, Function and Organization, Framework Document (2018).
[20] United Nations Environment Assembly (UNEA), Resolution 1/6 on Marine Plastic Litter and Microplastics, UNEP/EA.1/6 (2014).

Scientific Research and Data Sharing

UNEA resolutions emphasize the need for scientific studies on the impacts of microplastics, particularly on marine biodiversity and human health.

UNEP facilitates global data-sharing platforms and promotes the use of science in policymaking.

Capacity Building and Technical Assistance

UNEA supports capacity-building initiatives to help nations, particularly developing countries, implement effective measures to combat plastic pollution.

Examples include providing technical assistance for waste management systems and developing national action plans.

Catalysing Regional and National Actions

UNEA resolutions often inspire regional agreements, such as the ASEAN Framework on Marine Debris, and national policies, including bans on single-use plastics and microbeads.

These resolutions serve as a benchmark for governments to align their domestic regulations with global priorities.

Challenges in Regulating Marine Pollution from Micro plastics

The intricacy of the sources, processes, and effects of microplastic-induced marine pollution creates special regulatory issues. Even if the problem is becoming more widely acknowledged, the existing legal and political structures are unable to offer a unified and practical strategy to lessen this environmental catastrophe.

An extensive examination of the main obstacles to microplastic contamination regulation may be found below.

Fragmented Governance

One of the most significant challenges in addressing microplastic pollution is the fragmented nature of global governance. While various international treaties and agreements regulate aspects of marine pollution, none provide a comprehensive framework specifically targeting microplastics. For instance, the United Nations Convention on the Law of the Sea (UNCLOS) offers broad mandates for marine environmental protection but lacks specificity regarding microplastics. Similarly, the Stockholm Convention on Persistent Organic Pollutants (POPs) addresses certain chemical additives in plastics but excludes non-toxic microplastics.

This lack of a dedicated treaty creates regulatory gaps and inconsistencies, making it difficult to develop uniform global policies.[21] Compounding this issue is the overlapping jurisdiction of international organizations such as the International Maritime Organization (IMO), which administers MARPOL, and the United Nations Environment Programme (UNEP), which oversees initiatives like the UN Environment Assembly (UNEA). The COP to the Basel Convention is a good example: it adopted guidance in collaboration with the IMO on how to

[21] Karen Raubenheimer & Alistair McIlgorm, Can the Basel and Stockholm Conventions Provide a Global Framework to Reduce the Impact of Marine Plastic Litter? 96 Marine Policy 285, 286 (2018).

improve the sea–land interface to ensure that waste offloaded from a ship, which previously fell within the scope of MARPOL, is managed in an environmentally sound manner.[22] These bodies often operate independently, leading to duplication of efforts and inefficiencies. The absence of a central coordinating authority further hampers the development of a unified strategy to tackle microplastic pollution on a global scale.

Enforcement Issues

Effective enforcement of existing regulations on marine pollution faces significant hurdles when applied to microplastics. Unlike visible pollutants such as oil spills, microplastics are nearly invisible to the naked eye, making their detection and monitoring highly challenging. Microplastics originate from diverse sources, including industrial run-off, breakdown of larger plastic debris, and wastewater discharge, making it difficult to attribute pollution to specific activities or jurisdictions. This diffuseness complicates accountability, as polluters cannot easily be identified or held responsible.

Additionally, most international treaties, including UNCLOS and MARPOL, rely heavily on national governments for enforcement. However, enforcement capacity varies widely among countries, with developing nations often lacking the resources, infrastructure, or political will to implement robust measures against microplastic pollution.[23] Even in countries with advanced monitoring systems, enforcement mechanisms are limited. For instance, MARPOL prohibits the discharge of plastics at sea but lacks detailed provisions for tracking and penalizing microplastic-related violations. This enforcement gap allows microplastic pollution to persist largely unchecked, particularly on the high seas, where jurisdictional enforcement is inherently weak.

Scientific Uncertainty

Microplastics represent a relatively recent environmental concern, and scientific understanding of their long-term ecological and health impacts remains incomplete. While studies have documented the ingestion of microplastics by marine organisms, their subsequent effects on biodiversity, food webs, and ecosystem health are not fully understood. For instance, researchers are still investigating how microplastics, once ingested, affect the reproductive and survival rates of marine species or how they influence the bioavailability of toxic substances such as persistent organic pollutants (POPs).[24]

This scientific uncertainty poses a significant challenge to the formulation of regulatory thresholds and standards. Policymakers require evidence-based guidelines to establish permissible levels of microplastics in marine environments and food chains. However, the lack of conclusive data on safe exposure levels complicates this task. Moreover, the complexity of microplastic pollution encompassing various sizes, shapes, and chemical compositions makes it difficult to develop standardized methodologies for assessing their environmental impact. As a result, regulatory efforts are often hindered by the absence of clear scientific benchmarks.

[22] UNEP/CHW.13/18 & UNEP/CHW.13/INF/37/Rev.1 (May 8, 2018); UNEP/CHW.13/INF/37 (Apr. 6, 2017).
[23] International Convention for the Prevention of Pollution from Ships, London, Nov. 2, 1973, 1340 U.N.T.S. 184, as Amended by the Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships of 1973, Feb. 17, 1978, 1340 U.N.T.S. 61.
[24] Stockholm, May 22, 2001, in force May 17, 2004, 2256 U.N.T.S. 119.

Cross-Border Nature of Microplastics

The transboundary nature of microplastic pollution adds another layer of complexity to regulatory efforts. Microplastics are highly mobile pollutants, capable of traveling thousands of kilometres across oceans through currents, wind, and other natural forces. For example, plastic waste generated in one country can degrade into microplastics and reach the shores or marine environments of neighbouring or distant nations. This cross-border movement blurs lines of accountability and complicates efforts to implement localized regulatory measures.

Despite the global nature of the problem, there are currently no binding transboundary legal instruments specifically addressing microplastics. While regional agreements, such as the Regional Seas Conventions, have attempted to address marine litter collectively, their scope is often limited to specific geographic areas and lacks global applicability.[25] Additionally, the absence of mechanisms for Tran's boundary cooperation and dispute resolution leaves countries without a framework to manage the cross-border impacts of microplastic pollution.[26] This lack of coordination fosters an environment of regulatory fragmentation, where countries adopt disparate approaches that fail to address the interconnected nature of marine ecosystems.

COMPARATIVE ANALYSIS OF REGIONAL FRAMEWORKS

EU's Single-Use Plastics Directive

The **European Union's Single-Use Plastics Directive**, adopted in 2019, represents one of the most progressive and comprehensive regional efforts to combat plastic pollution. The directive focuses on reducing the production and consumption of single-use plastics, which are a significant source of microplastic pollution.

Key measures include: Banning certain single-use plastic products, such as cutlery, plates, and straws, for which alternatives are readily available. Mandating extended producer responsibility (EPR) schemes, requiring manufacturers to bear the costs of waste management and cleanup.[27] Setting ambitious recycling targets for plastic packaging and encouraging innovation in sustainable materials.

The directive's focus on preventive measures, such as reducing plastic production and consumption, distinguishes it as a proactive approach to addressing the root causes of microplastic pollution. The plan's binding character includes self-determined national objectives and timetables that States should reach, which are relevant to marine plastic trash and counteract the weaknesses of international instruments.[28] Additionally, its binding nature ensures uniform implementation across EU member states. However, challenges remain in

[25] The UNEP Regional Seas Programmes for the Protection of the Marine Environment contribute to facilitating effective implementation of obligations, taking into account regional characteristics. Several regions have adopted regional seas conventions and legally binding instruments on different sources of pollution, such as land-based sources in the form of an annex or protocol. In addition, some regions have adopted Action Plans on marine litter, recognizing marine plastics as the main sources.

[26] For example, the Baltic Sea; East Asian Seas; the Mediterranean; the Northeast Atlantic; Northwest Pacific; the Wider Caribbean Region.

[27] Elizabeth A. Kirk & Naporn Popattanachai, Marine Plastics: Fragmentation, Effectiveness and Legitimacy in International Law-Making, 27 Review of European, Comparative & International Environmental Law 222, 227 (2018).

[28] The Regional Plan on Marine Litter Management in the Mediterranean (adopted Dec. 2013; entered into force July 8, 2014), art. 7 & Annex II.

enforcement and compliance, particularly in harmonizing regulations across diverse economies within the EU. Despite these limitations, the directive serves as a model for other regions to adopt stringent, preventive measures to curb plastic pollution.

ASEAN Framework on Marine Debris

The ASEAN Framework on Marine Debris, adopted in 2019, is a regional initiative aimed at addressing marine pollution in Southeast Asia, a hotspot for plastic leakage into the oceans.[29] The framework emphasizes regional cooperation and coordination among ASEAN member states to manage plastic waste effectively.

Key components include: Promoting knowledge-sharing and capacity-building among member states. Encouraging public-private partnerships to develop sustainable waste management systems. Supporting community-based initiatives to reduce plastic waste at the source.

While the framework underscores the importance of collective action and regional solidarity, its non-binding nature limits its enforceability. Member states retain significant discretion in implementing its provisions, resulting in uneven progress.[30] Additionally, the framework lacks clear funding mechanisms and accountability measures, which hinders its effectiveness. Nevertheless, it highlights the potential of regional cooperation in addressing transboundary environmental challenges, particularly in regions with shared marine ecosystems.

LESSONS FROM HISTORICAL TREATIES

The Montreal Protocol as a Model for Global Cooperation

The Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in 1987, is widely regarded as one of the most successful international environmental treaties. It provides a valuable historical precedent for addressing global environmental crises, offering several lessons applicable to the regulation of microplastic pollution:

Binding Commitments: The protocol established legally binding obligations for signatory countries to phase out the production and consumption of ozone-depleting substances (ODS). This ensured accountability and uniformity in implementation, a feature notably absent in many current frameworks addressing plastic pollution.[31]

Comprehensive Scope: By targeting both the production and use of ODS, the protocol addressed the problem at its source, a strategy that could be mirrored in global agreements on microplastics.

[29] Association of Southeast Asian Nations (ASEAN), In Proceedings of the ASEAN Conference on Reducing Marine Debris in ASEAN Region, Bangkok, Thailand, June 22–23, 2019, available at https://asean.org/34th-asean-summit-bangkok-thailand20-23-june-2019.

[30] Youna Lyons, MeiLin Neo, Amanda Lim, Yuke Ling Tay & Vu Hai Dang, Status of Research, Legal and Policy Efforts on Marine Plastics in ASEAN+3: A Gap Analysis at the Interface of Science, Law and Policy, COBSEA and NUS, 348–49 (2020), available at https://cil.nus.edu.sg/research/special-projects/#pollution-from-marine-plastics-in-the-seas-of-asean-plus-three (accessed Dec. 5, 2024).

[31] Nicole Wienrich, Laura Weiand & Sebastian Unger, Stronger Together, the Role of Regional Instruments in Strengthening Global Governance of Marine Plastic Pollution, Institute for Advanced Sustainability Studies, 36–39 (2021).

Scientific Foundation: The treaty was underpinned by robust scientific research, which provided clear evidence of the environmental and health risks associated with ODS. A similar reliance on scientific data is essential for developing effective microplastic regulations.

Flexibility and Adaptability: The protocol included provisions for regular amendments and updates, allowing it to evolve in response to new scientific findings and technological advancements.

Importance of Binding Commitments and Financial Mechanisms

Financial tools like the Multilateral Fund, which gave developing nations financial support to fulfil their duties under the treaty, also contributed to the success of the Montreal Protocol. This addressed the issues of countries with limited resources and guaranteed fair participation. Similar approaches could be crucial in the fight against microplastic pollution, especially when it comes to helping developing nations fund research projects, waste management facilities, and monitoring systems.

In order to address the transboundary character of microplastic pollution, binding agreements and funding mechanisms are essential. Although they are useful for increasing awareness and encouraging cooperation, voluntary frameworks are not equipped to compel changes at the systemic level. A comprehensive and successful plastics and microplastics treaty can be created by following the Montreal Protocol's paradigm of combining legal duties with fair financial support.

PROPOSED SOLUTIONS TO ADDRESS MARINE POLLUTION FROM MICROPLASTICS

International, regional, and domestic initiatives must be integrated into a multidimensional strategy to combat microplastic pollution. This section offers all-encompassing plans for creating a worldwide treaty, coordinating regional frameworks, fortifying national laws, encouraging innovation and research, and improving oversight and enforcement systems. The goal of these solutions is to address the difficulties of microplastic pollution by developing a coherent and efficient framework.

Developing a Global Treaty on Plastics and Microplastics

The Montreal Protocol (1987), designed to phase out ozone-depleting substances (ODS), is widely regarded as one of the most successful international environmental agreements. Key Elements: Binding commitments for all parties to phase out ODS within specified timelines. Regular scientific assessments and updates to adjust targets based on technological advancements and emerging knowledge. Establishment of the Multilateral Fund to provide financial and technical assistance to developing countries, ensuring equitable implementation. Outcome: Nearly 99% of ODS eliminated by 2020, with significant recovery observed in the ozone layer. Strong compliance mechanisms, including penalties for non-compliance, ensured accountability. European Union’s Circular Economy Action Plan Case Study: The EU's Circular Economy Action Plan (2015) emphasizes reducing waste through recycling, reuse, and sustainable production. Key Elements: Binding targets for recycling rates (e.g., 55% of municipal waste to be recycled by 2025).

Harmonizing Regional Efforts

OSPAR Convention for the Protection of the North-East Atlantic Framework: A regional agreement that integrates member states' efforts to reduce marine pollution, including marine litter. Success: Implemented a Regional Action Plan on Marine Litter. Established harmonized monitoring standards for plastic pollution across member countries. Promoted cross-border collaboration in waste management and marine conservation.

Enhancing Domestic Legislation

Norway's Micro bead Ban Policy Implementation: Norway implemented a ban on the use of micro beads in cosmetics and personal care products, targeting a key source of microplastic pollution. Impact: This targeted legislation significantly reduced microplastic emissions into marine ecosystems and set a benchmark for other countries to follow.

Strengthening Monitoring and Enforcement

AI-Driven Monitoring in the EU Technological Integration: The European Union has successfully incorporated AI and satellite technologies to monitor waste management systems and plastic pollution hotspots. These tools provide accurate, real-time data on microplastic distribution and ocean currents. Impact: AI-enhanced monitoring has improved compliance checks and enabled precise interventions, reducing pollution in targeted areas.

Developing a Global Treaty on Plastics and Micro plastics

Addressing the fragmented governance that presently impedes effective control requires a specific international treaty aimed at plastics and microplastics. Reducing, recycling, and managing plastics sustainably throughout their lifecycle should be required by such a pact. Binding agreements mandating countries to phase out toxic plastic items, restrict the export of plastic trash, and make investments in sustainable alternatives would be an essential element.

The pact must include explicit enforcement procedures, like frequent compliance checks and sanctions for non-compliance, to guarantee responsibility. The Montreal Protocol serves as a reminder of the value of adaptability, permitting regular revisions in response to new scientific findings or developments in technology. The pact should also place a high priority on equitable implementation, offering developing nations financial and technical support through Multilateral Fund-style arrangements. This would ensure global participation and address disparities in resources and infrastructure among nations.

Harmonizing Regional Efforts and Enhancing Domestic Legislation

The Trans boundary character of microplastic pollution necessitates regional cooperation. Coordinated action can be facilitated by establishing regional agreements modelled after effective frameworks such as the EU's Single-Use Plastics Directive. For instance, legally enforceable regional agreements that prioritize shared marine ecosystems could be advantageous for areas such as Southeast Asia, which is a hotspot for plastic leakage. These frameworks ought to give priority to regional waste management plans, establish uniform guidelines for pollution monitoring, and provide incentives for the cross-border adoption of sustainable substitutes.

Encouraging regional collaboration in technology and knowledge exchange is equally crucial. Low- and middle-income nations can benefit from the best practices and technologies shared

by high-income nations with sophisticated waste management systems. Joint research projects, data-sharing websites, and regional conferences can promote cooperation, expedite work, and cut down on duplication. By using coordinated strategies, a united front against microplastic contamination is created and efforts in one area are not jeopardized by inaction in nearby places.

The foundation of enforcing microplastic laws is strong local legislation, even though regional and international frameworks are essential. Case studies from nations with sophisticated policies offer insightful information. As an illustration of the effectiveness of focused legislation, Norway's ban on microbeads in cosmetics has considerably decreased one source of microplastic contamination. Likewise, Japan's strict industrial plastic waste management laws demonstrate the value of all-encompassing domestic action programs.

International goals, like those established by UNEA resolutions or a potential global plastics convention, must be reflected in national laws. Important efforts include creating action plans specific to local circumstances, funding public awareness initiatives, and incorporating laws governing microplastics into larger environmental policies. Furthermore, encouraging businesses to embrace sustainable practices with tax breaks or subsidies might hasten the shift to a circular economy by lowering dependency on single-use plastics and encouraging recycling advancements.

Investing in Research and Innovation to Strengthening, Monitoring and Enforcement

Addressing the information gaps and technological difficulties related to microplastic pollution requires both scientific study and technological innovation. More money is needed to research the effects of microplastics on the environment and human health, create efficient removal methods, and create substitute materials that reduce reliance on plastic. Promising avenues for innovation include enhanced filtration systems for wastewater treatment plants and biodegradable polymers.

Industries and academic institutions should be encouraged to invest in research and pilot projects by governments and international organizations. By pooling the resources and knowledge of several stakeholders, public-private partnerships have the potential to spur innovation. The creation of international research centres and data-sharing networks would guarantee that scientific discoveries are extensively shared and successfully implemented. The adoption of sustainable alternatives can be further accelerated by encouraging cross-sector collaboration, especially in industries like packaging, textiles, and fisheries.

For laws and agreements addressing microplastic contamination to be effective, monitoring and enforcement are essential. Artificial intelligence (AI) and satellite technology have the potential to completely transform the tracking and monitoring of pollution by offering real-time information on hotspots for plastic trash, ocean currents that carry microplastics, and the efficiency of waste management systems. These technologies increase the accuracy of compliance assessments and allow for more targeted treatments.

Enforcement can be improved by giving international organizations, like UNEP, the authority to apply sanctions for transgressions of international treaties. Transparency and accountability would be improved by establishing a centralized database for reporting the amount of plastic waste generated and microplastic pollution levels. Building capacity at the national and regional levels also requires training programs for environmental agencies, customs authorities,

and other enforcement organizations. Joint patrols or coordinated inspections between neighbouring nations are examples of collaborative enforcement procedures that can bolster efforts to fight transboundary microplastic pollution.

CONCLUSION

Plastic production keeps up with the amount of marine plastic trash that ends up in the oceans. Most ocean plastics eventually break up into microplastics, which affect nearly every element of the marine environment. Even while some countries have implemented well-received waste management systems and made significant commitments, the worldwide plastic problem still affects the ocean. The international community is urging countries to implement creative measures that would lower the yearly quantity of plastic debris that enters the ocean in the absence of a legally binding agreement or accord that would hold plastic polluters accountable for all of the plastic goods they produce.

The findings point to significant flaws in the international management of marine microplastics, including the jumble of current laws, the absence of a particular international agreement, and the lack of effective disciplinary measures and specialized enforcement agencies. To better control marine microplastic contamination globally, both the substantive and procedural aspects of international law must be improved. This includes, among other things, establishing specialized institutions and effective disciplinary procedures to ensure adherence to international law, drafting a specialized international convention on marine microplastic contamination, and amending existing treaties within the global legal framework to promote coherence and harmonization. Promoting a more robust and effective global response to the growing issue of marine pollution caused by microplastics requires these steps.