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Microplastic Pollution in the Aquatic Environment of Bangladesh: A Legal Critique

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ABSTRACT

Microplastics are ubiquitous in the aquatic environment of Bangladesh. Microplastics are thought to pose a major risk for aquatic ecosystems (i.e., inland water bodies and marine ecosystems). The microplastic contamination of marine habitats and inland water bodies has raised significant concern. Microplastics from untreated industrial waste disposal, household plastic trash, sewage sludge, soil accumulation, shipbreaking plastic debris, fishing nets, and other sources are present in the inland and marine habitats of Bangladesh. The study determines the overall risk of microplastic contamination in the aquatic ecosystems of Bangladesh. The study identifies institutional shortcomings and gaps in national and international legislation to address the microplastic contamination, highlighting the need for stronger regulatory frameworks and enforcement mechanisms to effectively mitigate this environmental issue. The study recommends implementing a "good faith cooperation" strategy among the neighbouring coastal states to control microplastic pollution in the Bay of Bengal, as the contamination in the marine ecosystem is transboundary in nature. To curb marine microplastic pollution, strict adherence to several international laws, such as UNCLOS and MARPOL, Annex V of MARPOL, is required by Bangladesh. Furthermore, it is suggested to modify the existing domestic legal mechanisms, such that precautionary measures should be preferred to remedial measures to address the irreparable loss caused by microplastics in the aquatic environment of Bangladesh. Comprehensive rules on 'Extended Producer Responsibility' should be implemented to hold plastics manufacturers accountable. Sanctions-based legislation alone is inadequate to deal with the issues. The Government of Bangladesh should offer fiscal incentives for the installation of effluent treatment plants to dispose of industrial plastic wastewater that later fragments into microplastics. The doctrinal method is followed to develop the theoretical premise for the legal implications of microplastics in aquatic ecosystems. This study focuses on the inland water bodies and marine habitats of Bangladesh.

Keywords: Microplastic, Aquatic Environment, Legal Gaps, Bangladesh

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INTRODUCTION

The production of plastic materials has increased worldwide, with 413.8 million metric tons produced in 2023 compared to 1.5 million metric tons in 1950 (Statista, 2025). Due to excessive production, poor management, and insufficient recycling rates, plastics can be found everywhere in the world, from the polar regions to the equator and from the tops of mountains to the deep oceans (Mishra et al., 2021). If nothing is done to clean up the water bodies, experts have warned that by 2050, the amount of plastic waste in water bodies would surpass the number of fish (MacArthur, 2016). Aquatic creatures, including fish, crabs, and prawns, may consume microplastics, which could have an impact on human health by way of the food chain (Zawad et al., 2024).

Microplastics (MPs), which are plastic particles smaller than 5 mm originating from various sources, pose a major threat to aquatic ecosystems and human health (Piexoto et al., 2019). MPs' pollution of the aquatic environment is currently a serious global environmental concern (Zawad et al., 2024). The problem of MPs' pollution in Bangladesh is getting worse as well (Kawser et al., 2024). Bangladesh was the first nation to implement restrictions on plastic bags in 2002, following the early identification of the issue (Xantosh and Walker, 2017). Bangladesh is the second largest producer and exporter of ready-made garment products, which may contribute microfiber pollution to the water bodies (Swazan and Das, 2022). One of the main factors of MPs contamination in the environment is improper treatment of plastic debris (Kawser et al., 2024). Bangladesh discharges untreated waste into waterways that connect with its major water courses (Miah et al., 2023). Bangladesh introduces MPs into the marine environment through the Bay of Bengal (Kawser et al., 2024). MPs are spreading across the food chain and eventually into the human digestive system (Haque et al., 2023), raising concerns about potential health risks associated with microplastic consumption. Thus, the presence of MPs in water bodies garnered a lot of research interest (Parvin et al., 2021).

From a legal perspective, research on MPs in aquatic environments receives minimal attention in Bangladesh. To this effect, the study points out the shortcomings of national and international laws aimed at regulating MPs in aquatic environments. The study also notes that MPs in the aquatic environment can be difficult to detect and manage without high technology. Several mitigation strategies are suggested by the study: improving waste management strategy (e.g., installing an effluent treatment plant), enforcement of existing laws, putting in place a 'good faith cooperation' strategy in the regional context, and enacting 'extended producer responsibility' regulations in Bangladesh. It is also necessary to implement financial incentives for proper plastic waste disposal and recycling to produce energy.

METHODOLOGY

The doctrinal research approach is employed to conduct the legal study. The method aids in the development of the theoretical framework and concepts pertinent to the research investigation. This study utilizes both primary and secondary data collection methods. Primary data are obtained from legal sources such as national legislation, international conventions, covenants, treaties, and reports from various international organizations. The

critical legal study (CLS) of legal instruments substantiates the research's claim and identifies the precise discrepancies in existing national and international laws.

Secondary data are obtained from various textbooks, journals, newspapers, legal reviews, case reports, opinions, and policy discussions among governments, non-governmental organizations, and international entities regarding the problem. The majority of the collected data is gathered to corroborate the findings derived from the analysis of national and international legislation concerning microplastic contamination in Bangladesh's aquatic environment.

MICRO-PLASTIC IN THE AQUATIC ENVIRONMENT OF BANGLADES

Microplastic

Every year, more than 400 million tons of plastic are manufactured worldwide. Plastic breaks down into microplastics, which are particles smaller than five millimetres, and then into nanoparticles, which are particles smaller than 0.1 micrometres (Hasan, 2019). MPs can be categorized into primary and secondary groups based on their origins (kasmuri et al., 2022). Primary MPs are polymers that are designed to be as small as possible. Under the broader definition of microplastic size, pellets composed of virgin plastic can also be classified as primary microplastics. In exfoliating hand cleansers and face scrubs, microplastic "scrubbers" have taken the role of conventionally used natural ingredients, including pumice, oatmeal, and powdered almonds (Pourebrahmi and Pirooz, 2023). Tiny plastic particles that are produced as bigger plastic garbage breaks down both on land and at sea are referred to as secondary MPs. A variety of physical, biological, and chemical processes can cause plastic garbage to break apart, gradually reducing its structural integrity. Extended exposure to sunlight causes the polymer matrix in plastics to oxidise due to ultraviolet (UV) radiation, which destroys bonds. Over time, the fragments continue to shrink until they are as small as microplastics. Microplastics are believed to have the potential to decompose into nanoplastics, even though the smallest microparticle currently found in the oceans has a diameter of 1.6 μm. The creation of biodegradable plastics could serve as a replacement for traditional plastics. However, they could potentially be a source of MPs (Nabi et al., 2021).

Micro-Plastic Pollution in the Aquatic Environment of Bangladesh

Microplastics, due to their very tiny size, are easily consumed by aquatic life. When smaller aquatic animals (primary consumers, such as zooplankton) ingest microplastic pollution, they are then transferred to secondary consumers, like large fish, and finally to tertiary consumers, like humans, causing significant disruptions to the food chain (Devriese et al., 2015). According to the World Bank (2021), Bangladesh produces about 3,000 tons of plastic garbage every day, of which only 36% is recycled. Floodwaters during the monsoon season take this waste straight into rivers and down the shore (Naeem, 2025). A hotspot for marine trash is the Bay of Bengal, particularly around the shore of Bangladesh. Research indicates that more than 70% of the debris discovered in nearshore areas is made of plastic (Bera et al., 2021). A recent study has reported that the Bay of Bengal and adjoining rivers have high concentrations of MPs (Kumar et al., 2022). It’s also been reported that MPs in the Bay of Bengal are generated from industrial or wastewater discharge, settlement areas, local

fishing activities, and recreational and tourism activities (Rakib et al., 2022). Plastic waste from the land is dumped straight into the BOB through groundwater, rivers, canals, sewers, floods, tides, or atmospheric deposition (BOBLME, 2011). Bangladesh lacks domestic waste treatment facilities, so all urban wastewater with plastic and microplastic debris either directly or indirectly enters into the river (Alam et al., 2021). Each year, 4 million tons of plastic debris are released into the Bay of Bengal by all of the rivers in Bangladesh and India (Kumar et al., 2022). By 2060, Bangladesh is expected to release 3 million tons of plastics into the Bay of Bengal (Labreton & Andrady, 2019).

According to recent studies, up to 3 billion microscopic bits of micro-sized plastics could be released into the Bay of Bengal daily by the combined flows of the Padma, Brahmaputra, and Meghna rivers (Napper et al., 2021). The Karnaphuli River and the Pashur River, respectively, receive city trash containing microplastics from Chattogram and Khulna, polluting aquatic life in Bangladesh. The 177 rivers that discharge into Bangladesh's Sundarban mangrove ecosystem cause plastics to accumulate over time in the sediments and surface water (Adyel and Macreadie, 2021). Fishing nets, lost fishing gear, and plastic debris can all be drifted towards the Sundarbans. Due to unregulated relief goods packaged with plastics, more than 56 tons of plastic litter were observed in the Sundarbans immediately following the cyclone Amphan in 2020. A significant volume of plastic entering the Sundarban region can ravage the aquatic lives of the coastal mangrove forest (Ghosh, 2020). The degradation of large plastic into microplastics in the aquatic life of Sundarban mangroves will be negatively impacted for a long time as water toxicity would rise (Kumar et al., 2022). Various aquatic creatures in the Sundarbans, including sharks, fish, turtles, mollusks, crabs, prawns, and zooplankton, contain MPs that eventually transfer to the food chain (Sarker et al., 2022).

The Bangladesh tannery sector is another source of land-based plastic pollution that has the potential to seriously harm aquatic ecosystems (Chakraborty et al., 2013). The Buriganga is one of Bangladesh's most important urban rivers due to its location (Akber et al. 2020). There is a significant load of microplastics (MPs) in this river's sediment, water, and aquatic biota, which includes fish, crabs, and snails (Haque et al., 2023). Municipal plastic waste and industrial plastic waste are also major sources of MPs in the inland aquatic ecosystem of Bangladesh. Some tourists and locals also throw plastic waste straight into lakes and ponds (Islam et al., 2022). A recent investigation of “cotton cloth sampling" discovered that MPs made up 0.49, 1.48, and 4.01% of the total suspended solids (by weight) in Dhanmondi Lake, Ramna Lake, and Hatirjheel Lake, respectively (Shadia et al. 2020).

LEGAL FRAMEWORKS ON THE MICROPLASTIC POLLUTION IN THE AQUATIC ENVIRONMENT

The study examines national and international laws pertaining to MPs in aquatic environments. Given the transboundary nature of MPs in marine ecosystems, international legal provisions are necessary to investigate.

International Legal Frameworks

Significant international treaties, guidelines, conferences, and protocols address pollution in aquatic ecosystems. Very few MPs' control mechanisms are traced out in the international legal provisions, which has resulted in inadequate enforcement and oversight of pollution management in aquatic ecosystems. In addition, Bangladesh, being a developing state, does not adhere to any of the current legal provisions concerning the strategy for managing marine plastic trash, port management, and the sustainable use of shipbreaking yards. These legal uncertainties of MPs' pollution in the aquatic ecosystems have led to investigating the following international legal instruments.

Protection of Marine Eco-system under the 'UNCLOS 1982'

The safeguarding of the marine environment constitutes a fundamental commitment under international law for all governments, which were urged to enhance their focus on the risks posed by MPs to the ocean through international conventions and treaty. The fundamental objectives of this regime, articulated in the preamble of the United Nations Convention on the Law of the Sea (UNCLOS), encompass the "equitable and efficient utilization" and "conservation" of ocean resources, aimed at fostering "the realization of a just and equitable international order" (Mendenhall, 2023). Part XII of UNCLOS delineates explicit regulations and standards concerning terrestrial pollution, which have minimally influenced, if at all, state conduct regarding plastic pollution. It is noteworthy because it is the first attempt to outline a broad framework and structure for a legal regime that configures the duties, responsibilities, and authority of states in the protection of the maritime environment. The Convention's Part XII addresses the preservation and conservation of the marine ecosystem. The Convention expressly requires states to safeguard and conserve the marine environment (UNCLOS 1982, Art. 192).

As a member state of the convention, Bangladesh must protect and safeguard the marine ecosystem. It requires States to take all necessary steps in accordance with this Convention to prevent, lessen, and control pollution of the marine environment from any source, using the best available and reasonable methods within their capabilities. Member States are to take all necessary steps in accordance with this Convention to prevent, lessen, and control pollution of the marine environment from any source, using the best available and reasonable methods within their capabilities (UNCLOS 1982, Art. 194 [2]). States are required to ensure that operations that fall within their purview of 'no harm' to the neighbouring states or their ecosystems (UNCLOS 1982, Art. 194 [3]).

According to the UNCLOS 1982, member states must introduce garbage management plans (GMPs). Henceforth, it highlights the precautionary principles authorizing the states to take proactive measures to avert injury. Wait for scientific certainty to prove the marine pollution is unnecessary. Pollution from land-based sources (industrial discharge, agricultural runoff), atmospheric sources (airborne contaminants reaching the sea), dumping, etc. is expressly addressed (UNCLOS 1982, Art. 194 [3]). It addresses pollution from ships and offers a framework for controlling discharges that may include plastic. Member States are required to take action to stop, lessen, and manage pollution of the marine environment from land-based sources, which are the main source of MPs

(UNCLOS 1982, Art. 207). To address particular marine pollution challenges, UNCLOS urges governments to sign regional agreements that permit customized microplastic policies.

Challenges of the 'UNCLOS' to Avert Microplastic Pollution

The UNCLOS, 1982 approach is too general to meet the specific threats like MPs in marine ecosystems. The Convention says that governments must protect the marine environment, but it doesn't include any specific, legally binding steps to stop pollution, especially new problems like MPs and trash on land. The facilities and infrastructure required for the appropriate disposal of ship waste are lacking in many developing nations like Bangladesh. The list includes insufficient resources for monitoring and enforcement, limited port receiving facilities, and subpar waste management systems.

However, microplastics (small plastic particles less than five millimetres in size) are not specifically mentioned by UNCLOS (the United Nations Convention on the Law of the Sea) as a distinct marine pollution. UNCLOS lacks strong procedures to enforce pollution management measures, notably those pertaining to MPs, and mostly depends on member states' voluntary compliance. Coastal governments abide by standards that merely specify what they should do; they do not specify penalties. When parties fail to fulfil their commitments for maritime environmental protection, UNCLOS, the foundation of the global framework for marine environmental protection, cannot impose sanctions on them (Ma & Liu, 2023). MPs, or marine pollutants, are trans-boundary in nature, with particles often transported by ocean currents. Clear procedures for dealing with these transboundary effects and holding states responsible for MPs that harm other jurisdictions are not provided by UNCLOS, which creates challenges in enforcing accountability and ensuring effective marine environmental protection across borders.

In respect of jurisdiction and enforcement, the Convention faces challenges very often. The difficulty of implementing UNCLOS is best exemplified by the South China Sea. The treaty accuses China, a member, of violating its terms by using its "nine-dash line" to claim almost the entire territory (Wisnugroho, 2023). Any legal system will inevitably have some degree of non-compliance; as long as it stays within acceptable parameters, there should be no excessive concern. A minimum of one-third of total member states violate the provision of the UNCLOSC. Such a level of non-compliance undermines the UNCLOSC's credibility and integrity. Additionally, such a higher degree of noncompliance damages the marine ecosystem (Churchill, 2013) by leading to overfishing, habitat destruction, and pollution, which threaten marine biodiversity and the health of oceanic environments.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989

In order to reduce the production of hazardous waste and regulate its cross-border movement, the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, which was adopted in 1989, is an important international agreement (Kummer, 1992). The Convention requires countries to ensure that hazardous wastes are managed responsibly and promotes the development of national programs and plans to stop and lessen hazardous waste production (Wu, 2022). The Basel Convention's 2019 amendment specifically covers some types of plastic waste, drawing

attention to the problem of plastic pollution on a global scale. This amendment lessens the possibility of inappropriate disposal, which can lead to the microplastic pollution of marine life, by regulating the transboundary movement of plastic trash. The Basel Convention seeks to prevent the dumping of improperly managed trash in nations with poor infrastructure by demanding prior informed agreement for the export of hazardous and mixed plastic waste (Basel Convention 2019, Amendment to Annexes II). The Convention backs ideas like encouraging people to make less waste and making people who make waste responsible for getting rid of it properly. These ideas can help MPs.

Weakness of the Convention to Address the Microplastic Pollution

Since MPs frequently come from sources other than transboundary waste movement (such as tire wear, textile fibers, and the breakdown of plastics that are already in the environment), the Convention does not specifically address them. Enforcing adherence to the Convention's terms is challenging due to inadequate enforcement and monitoring systems, especially in poor nations that are most susceptible to garbage dumping. Domestic waste management systems, a significant source of microplastic contamination, are not adequately addressed by the Convention, although controlling transboundary trash is crucial. The Convention mainly ignores downstream effects like microplastic contamination because it fails to hold wealthy countries sufficiently responsible for the life cycle of the plastic items they manufacture (Kummer, 1992).

Micro-plastic Pollution and the Regime of International Convention for the Prevention of Pollution from Ships (MARPOL, 1973/78)

The 1973 MARPOL Convention aims to minimize unintentional releases of oil and other hazardous materials and to prevent operational releases that could pollute the marine environment (Saikot et al., 2025). Parties are required to implement the Convention's provisions for ships under their jurisdiction and flying their flag. Ships must create and carry out waste management plans, which must include protocols for handling and reducing plastic trash. MARPOL mandates that ports provide facilities for receiving waste from ships, including plastics. This lessens the pollution caused by MPs and helps stop the unlawful dumping of plastics (Hussain et al., 2023). Ships are not allowed to release any plastics into the ocean, including packaging materials and synthetic fishing gear, according to MARPOL Annex V. By stopping macroplastics in the marine environment from decomposing into MPs, this clause indirectly addresses some sources of MPs, such as the breakdown of larger plastic debris that can contribute to microplastic pollution (MARPOL Convention 1973, Annex V).

Challenges to Combat with Micro-Plastic Pollution under the MARPOL Regimes

The convention places little emphasis on preventing MPs from entering the marine environment via ship-based sources, instead focusing on visible debris (MARPOL, Annex V). MPs from other sources, including synthetic fibres or industrial abrasives, which can potentially be discharged from ships, are not governed by MARPOL. Land-based activities are the primary source of MPs contamination. The major contribution of land-based MPs that infiltrate marine habitats is not addressed by MARPOL (Lau et al, 2020). Nonetheless, Bangladesh acceded the MARPOL Convention, 1973 and later acceded the Annex V of the

Convention (MOS, GOB), the country has not put any enabling laws into place to carry out the MARPOL Convention at the national level (Saikot et al, 2025). In order to enforce its legal obligations, MARPOL, like other international treaties, is dependent on the institutional, financial, and regulatory capability of the member states. Coordination between legislative, administrative, and enforcement efforts is essential for effective control of MPs pollution in marine eco-system (Xu & Chang, 2017). Bangladesh can't provide sufficient arrangements to comply with MARPOL. But in 2004, the Department of Shipping in Bangladesh prepared the draft of the Marine Environment Conservation Act 2004 (Karim, 2010). Unfortunately, the draft law has not yet to enact.

Montreal Guidelines for the Protection of the Marine Environment against Pollution from Land-Based Sources 1985

The United Nations Environment Programme (UNEP) adopted the Montral Guidelines as a series of non-binding guidelines to combat marine pollution from land-based sources. The Guidelines set the stage for tackling problems like MPs (microplastics), which mostly come from terrestrial activities, by acknowledging that land-based sources contribute significantly to marine contamination. 80% of litter worldwide originates from land-based sources and enters the marine ecosystem (Hasan, 2017). The guidelines include a checklist for national laws and the creation of international, regional, or sub-regional agreements (Hasan, 2017). The guidelines require the negotiation of internationally accepted norms and regulations. The annexes provide recommendations on control methods. The Guidelines strongly emphasize the principle of prevention, which includes waste management and treatment systems that subtly address the causes of microplastics, such as inappropriate plastic waste disposal. To this effect, the Guidelines address the no-harm principle, stating that it is the responsibility of the states to ensure that discharges from land-based sources inside their jurisdiction do not contaminate the marine environments of other states or regions outside of their national borders (Montreal Guidelines 1985, para. 3). Under Appendix I of the Guidelines, states have the responsibility to take measures for a zero discharge approach, uniform regional emission standards, environmental assessment activities, and the declaration of specially protected areas (Montreal Guidelines, Appendix I).

Challenges to Avert Microplastic Pollution under the Montreal Guidelines, 1985

The Guidelines are not legally binding, meaning countries are not obligated to implement them, leading to inconsistent and often inadequate application across different regions. MPs from modern sources like synthetic textiles, tire wear, and industrial processes were not considered in the guidelines, making them insufficient to tackle these specific pollutants. The Guidelines do not adequately address the role of consumer behaviour, product design, or industrial practices in generating MPs, leaving a significant gap in preventive strategies. Though the guidelines emphasize regional cooperation to prevent, reduce, or control pollution from land-based sources, it is practically not possible in many parts of the world due to financial and geopolitical differences. The guidelines fail to formulate the principle of beneficial neighbourliness. Currently, there are relatively few institutional elements in place to regulate marine pollution from land-based sources on a global and regional scale, which hampers effective cooperation and enforcement of pollution control measures across different nations. Some successful examples of advancement can be seen in regional marine

areas, such as the North East Atlantic, where developed states exist in the region. Success is also evident in regions like the Mediterranean and Baltic Sea, which include both developed and developing nations (Hasan, 2019). The guidelines fail to address the special needs of the developing and least developed regions. In the regions of the world where developing states constitute the majority, such as South Asia and parts of Africa, conditions are still rudimentary. Knowledge gaps, lack of high-tech equipment, inadequate participation by local governments, insufficient incentives for creative ventures, and corruption at all levels hinder the protection of marine ecosystems in South Asia and Africa (Hasan, 2019).

In Bay of Bengal regions, there are no regional binding legal instruments relating to preventing, reducing, or controlling plastic pollution from land-based sources. Even Bangladesh can't manage MPs in maritime boundaries due to weak management systems of waste disposal in coastal urban centres like Chittagong and Khulna, ineffective land-based plastic pollution regulations, financial incapacity, a lack of political commitment, and a lack of interstate collaboration through regional legal frameworks (Naeem, 2025).

United Nations Conference on Environment and Development (UNCED) 1992

In the field of international environmental governance, the 1992 Rio de Janeiro United Nations Conference on Environment and Development (UNCED) is considered a seminal occasion. Agenda 21 of Chapter 17 includes guidelines and recommendations regarding the degradation of the Marin environment due to a variety of causes (Hasan, 2019). Though the Declaration is not legally binding, it provides the environmental principles (i.e., the precautionary principle, the no harm principle, and the polluter pays principle) that have significant legal effects as a customary rule of international law. However, the Declaration recommends member states adhere to its action plan to protect the marine environment on a global, regional, and national level. The Declaration emphasizes the necessity of an integrated approach to managing marine and coastal ecosystems. UNCED established the framework for multi-stakeholder programs like the Global Partnership on Marine Litter (GPML) to fight plastic and marine pollution (McCammon, 1992).

Challenges to Curb Micro-Plastic Pollution in the Aquatic Eco-system under the Premise of UNCED

The UNCED did not specifically mention MPs or plastic pollution as separate issues. MPs were not yet acknowledged as a significant environmental issue at the time of the summit. Because of this, its frameworks and guiding principles are still too broad to adequately address the unique problems presented by MPs. Because UNCED results lacked strong monitoring and enforcement mechanisms, countries implemented them inconsistently (Prudencio, 1993). Weaknesses include implementing the polluter pays principle as the principle challenge to assess the exact environmental cost that allows polluters to avert responsibility. This is especially troublesome when it comes to transboundary concerns where international cooperation and compliance are essential, i.e., microplastic contamination in marine ecosystems. UNCED did not foresee developing pollutants like microplastics and instead focused on old pollutants like heavy metals and oil spills. This oversight has reduced its applicability in addressing today's issues.

Stockholm Convention on Persistent Organic Pollutants (POPs, 2001)

In order to protect the environment and human health, the Stockholm Convention on Persistent Organic Pollutants (POPs) addresses the precautionary approach of Article 15 of the Rio Declaration against substances that accumulate in living things, persist in the environment for extended periods of time, and pose serious hazards (Stockholm Convention, 2001). Persistent organic pollutants, some of which are linked to MPs (for example, as additives), are intended to be eliminated or their usage restricted by this convention. Plastic additives, including stabilizers and flame retardants, include a variety of persistent organic pollutants (POPs). The convention reduces the amount of POPs released into the environment and their presence in the environment by regulating or outlawing a number of them (Stockholm Convention, 2001). The Convention indirectly lessens the harmful effects of MPs in marine environments by focusing on substances like DDT and PCBs (polychlorinated biphenyls), which cling to MPs.

Weaknesses of the Convention to Address Micro-Plastic Pollution in the Aquatic Environment

Persistent organic pollutants, not plastic or microplastics, are the subject of the Convention. The physical characteristics or origins of MPs in the marine environment are not regulated by it (Boethling et al, 2009). Since the main goal of the Stockholm Convention is to regulate chemical pollutants, MPs are not specifically addressed by it. At the time of the treaty's adoption, MPs were not generally acknowledged as a significant problem. Only a particular list of POPs is the focus of the convention. It does not include a wide range of substances related to plastics, including endocrine disruptors and unregulated additions. Tire wear, textile fibres, and improperly handled plastic trash are examples of land-based sources of MPs that are not covered by the Convention. Due to institutional, budgetary, and technical limitations, many developing nations like Bangladesh find it difficult to execute the agreement, which reduces its efficacy in tackling POPs and how they interact with MPs.

National Legal Frameworks

As a coastal country with abundant aquatic biodiversity and an extensive system of rivers that flow into the Bay of Bengal, Bangladesh confronts escalating challenges from aquatic pollution, particularly from micro-plastics. Although there isn't a dedicated law in Bangladesh that specifically focuses on regulation of micro-plastics, several current legal frameworks indirectly tackle certain elements of aquatic plastic pollution. An examination of the national legal structure shows both advancements and notable deficiencies.

The Bangladesh Environment Conservation Act, 1995 (BECA)

Basically, the Environment Conservation Act is the cornerstone of Bangladesh's environmental laws. This law provides the Department of Environment (DoE) the authority to regulate waste, monitor industrial activities, and reduce pollution. This law deals with the handling of industrial waste, which includes plastic and polymer-based items. Although the law does not expressly address microplastics, it does allow for the regulation of pollutants discharged into aquatic habitats. According to the Act's Section 2(f), "pollution" is defined as the contaminating of air, water, soil, or other natural elements that potentially endanger the ecosystem or public health. This includes plastics, which are ubiquitous pollutants found in

soil, water, and marine environments. Section 6 of the Act forbids any action that could harm the environment. This clause can limit activities that emit plastics, including inappropriate trash disposal, industrial effluents, and plastic litter. The DoE has the authority to regulate and control environmental contamination. Theoretically, this wide mandate may include MPs as a component of overall environmental deterioration (Fracchia, 2005). The Act includes provisions to penalize polluters. The scope can be extended to industries and entities responsible for plastic waste that contributes to microplastic pollution in the aquatic environment (BECA, Section 15).

Weakness of the Act to Control MPs

The Act mostly imposes remedial measures (Siddiqui, 2025). The act fails to adopt precautionary approaches to reduce irreparable damage caused by microplastics in the aquatic ecosystem of Bangladesh. Degradation of the aquatic environment by microplastic occurs, causing irreparable damage that is not possible to restore only by remedial measures. There are no incentives offered by the Act to encourage voluntary adherence to the rules and regulations, which further exacerbates the challenges in managing microplastic pollution effectively. The DoE fails to control microplastic waste hazards in aquatic environments, which exacerbates the degradation of these ecosystems and contributes to the ongoing pollution crisis. The Act is ineffective in controlling MPs' pollution in aquatic environments because of the DoE's lack of institutional accountability (Siddiqui, 2025), which results in insufficient enforcement of regulations and failure to impose adequate penalties for violations. Inadequate fines under the Act lead to entrepreneurs infringing the law. The maximum penalty for noncompliance under the act is now 10 lac BDT. On average, an ETP with a capacity of about 50 m^3/hour would cost 13.3 million BDT per year to operate. Even if an enterprise receives two annual fines from the DoE, paying the fine rather than implementing an ETP would still be more cost-effective, as the total cost of the fines would be significantly lower than the annual operating cost of the ETP (Haque, 2017).

The Environment Conservation Rules 2023 (ECR)

The rules establish acceptable boundaries for pollutants discharged into water bodies, particularly those from plastic waste-generating enterprises. This helps stop untreated industrial discharge of plastics into aquatic habitats. The ECR classifies industries into four groups based on the potential environmental impact: green, yellow, orange, and red category industries (ECR 2023). Stricter environmental regulations (i.e., Environmental Impact Assessment Report and Effluent Treatment Plant) apply to "red" industries, such as those that manufacture plastics or packaging materials (ECR, Rule 5).

Weakness of the Rule to Control MPs

Municipal and industrial units must use waste management techniques that lessen the quantity of contaminants, especially plastics, released into the environment (ECR, Rule 5). A significant gap in the ECR's approach to this emerging environmental issue is the lack of any specific provision for monitoring and mitigating micro-plastic contamination in aquatic habitats. Most of the industrial units around Dhaka City have no effluent treatment plan (Kibria et al., 2015). Even though all textile dyeing facilities listed in the ‘red category’ in Bangladesh are required to install and run ETPs, the current situation demonstrates how

ineffectively the laws are being enforced. Currently, there are 5000 operational textile dyeing facilities nationwide; however, as of March 2019, only 1765 effluent treatment plants had been established in Bangladesh, according to DoE data (Ahsan, 2019 & Amey, 2021). Lack of integrated and effective laws, government actions, enforcement, and DoE's institutional inadequacy and monitoring are the main reasons for not complying with the existing ETP regulations.

EIA is a must before initiating red-category industries in Bangladesh (ECR, Rule 5). Due to a lack of judicial oversight over EIA procedures (Kabir & Momtaz, 2011) and inadequate sector-wise technical and procedural guidance for project proponents and EIA consultants (Lohani et al., 1997), the rules are less effective in controlling MPs in the aquatic environment of Bangladesh, leading to increased pollution and degradation of aquatic ecosystems.

Other Act and Rules in Bangladesh

The Marine Fisheries Act of 2020 established a total marine protected area of 7,367 square kilometres, or around 8.8% of Bangladesh's whole exclusive economic zone, until January 4, 2022. In order to kill, stun, disable, or capture fish or to aid the marine environment, Section 27 forbids the use of explosives, poison, or other toxic substances. Although the act focuses on managing fisheries, it is not integrated with more general environmental and pollution control regulations. The Act disregards land-based sources of microplastics, such as untreated sewage, industrial waste, and urban runoff, which are significant contributors to marine microplastic pollution.

Even though the Act permits monitoring and surveillance, it lacks the enforcement authority necessary to identify and address microplastic pollution in marine environments, particularly beyond the immediate coastal areas. Plastics used in ships are among the hazardous and non-hazardous waste produced during shipbreaking that must be properly managed, according to the Shipbreaking and Recycling Rules, 2011. The Department of Environment (DoE) requires shipbreaking yards to obtain environmental clearance certifications prior to starting operations (Ship Breaking and Recycling Rules 2011, Rule 11). This ensures the assessment and reduction of environmental impacts, including potential leaks of plastic trash. Because regulatory agencies generally lack the necessary resources and capacity, rule enforcement is frequently lax. Micro-plastic pollution may therefore be exacerbated by the inappropriate disposal of plastic trash during shipbreaking operations. While environmental pollution management and the preservation of coastal ecology and biodiversity are not sufficiently addressed, shipbreaking and recycling rules in Bangladesh primarily concentrate on labour rights and occupational health and safety (Jahan & Rahman, 2023).

In 2021, the relevant ministry released Solid Waste Management Rules in accordance with Extended Producer Responsibility (EPR) guidelines found in clause 20 of the Environment Conservation Act of 1995. Although EPR is covered in length in Chapter 9 of the policy, it appears that producers have limited awareness of the regulations or are not using them (Begum, 2024). The rule's Schedule 2 describes how to handle solid trash, whereas Schedule 1 lists dangerous household items. Along with information about landfills

and other relevant topics, the policy also discusses operating rules for solid waste incineration, such as emission norms and radioactivity limits. Included are detailed formats for depositing and processing garbage. These rules become useless as they are not applied correctly (Begum, 2024). Although solid trash is the main emphasis of the regulations, wastewater treatment—a significant entry point for microplastics into marine environments—is not adequately covered. The informal sector, which handles a sizable amount of trash recycling in Bangladesh, lacks adequate infrastructure to successfully reduce MPs in aquatic environments

WAY FORWARD TO REDUCE MICROPLASTIC POLLUTION IN THE AQUATIC ENVIRONMENT OF BANGLADESH

Recommendations under International Perspective

The reduction of MPs is primarily a technical issue that requires the assistance of cutting-edge technology, and the primary cause of MP pollution's growing severity is that it cannot be adequately addressed by current technology. The goal of marine scientific research is to comprehend, manage, and efficiently process marine data in order to use and safeguard the ocean (Montserrat, 2004). Most international conventions investigated in the present study have insufficient legal provisions to avert MPs in aquatic environments. International conventions should be amended, addressing the microplastic pollution in the aquatic environment.

Existing international conventions ought to give preferential considerations to vulnerable developing states such as Bangladesh, including transfer of "know-how," scientific information, scientific data, financial support, qualified personnel, and adequate equipment to combat with micro plastic pollution. In addition to international collaboration, the solutions should be tailored to meet the specific needs of reducing micro plastics in each developing state.

To avoid ship-related maritime pollution, especially plastic trash that degrades to microplastics, UNCLOS 1982 mandates international cooperation. Capacity-building initiatives, information and best practice sharing, and cooperative monitoring and enforcement initiatives could achieve cooperation among nations to effectively reduce maritime pollution and manage plastic waste in the oceans. (Hussain, 2023). Geopolitical tensions can be reduced, and coastal nations can work together to conserve the maritime environment by adhering to the positive faith principle (Ma & Liu, 2023). States that are close to one another can handle regional maritime issues by using their shared legal frameworks. Good-faith cooperation is the practical implementation of the law, and coastal governments' involvement in regional cooperation is a strategy of how they are upholding their duties under international law. For instance, Mediterranean states established a model for cooperation in managing marine pollution by implementing functional national jurisdiction over their waters. As part of their collective cooperation on issues of shared interest, like marine environmental protection, France, Italy, and other Mediterranean states have jointly established specially protected areas on the marine environment and biological resources in the region (Ma & Liu, 2023).

As MPs are transboundary in nature, Bangladesh, Myanmar, India, and Sri Lanka should develop good faith cooperation under UNCLOS. These countries should share actual data and knowledge and enhance surveillance to curb plastic garbage in seawater. As per the legal requirement of UNCLOS, Bangladesh must introduce a garbage management plan for all ships. It is necessary to offer ship operators, port operators, and other stakeholders training and capacity-building initiatives, as well as adequate port reception facilities for ships. For example, the International Maritime Organization (IMO) has produced a number of training materials and guidelines for port facilities and ships about trash management. Several countries have also established monitoring and enforcement mechanisms to prevent pollution in sea water. For instance, the Australian Maritime Safety Authority (AMSA) enforces regulations and sanctions vessels that violate the law (Druel & Gjerde, 2014). Many countries have tightened their regulations to prevent marine pollution from ship-generated rubbish in compliance with UNCLOS 1982. For example, the European Union's Regulation (EC) No. 1013/2006 specifies rules for the movement of garbage, including ship trash, both inside and beyond the EU. In a similar vein, ships are required to have a waste management plan that conforms to Annex V of MARPOL under the Maritime Plastic Pollution Research and Control Act of 1987 in the US (Hussain, 2023).

Bangladesh could reduce microplastic contamination in the marine ecosystem by establishing a comprehensive regulatory framework to regulate ship garbage discharge. Bangladesh should implement certain best practices by setting up sufficient facilities and infrastructure, like trash reception areas at ports, for the removal of waste from ships. Efficient oversight and enforcement systems, such as routine ship inspections to verify adherence to rules and sanctions for noncompliant vessels, and creating public awareness campaigns as to the value of appropriate trash disposal and the harm that marine pollution causes to the environment (Esteves, 2014). MPs in seawater can be effectively controlled by regulating the behaviour of plastic debris entering the marine from the source (Ma & Liu, 2023). Bangladesh must modify its legal and social policy regarding the management of the entire life cycle of plastic items, as plastic debris can separate into MPs after lengthy chemical and physical reactions.

Regional organizations could support initiatives to curb transboundary MPs in the Bay of Bengal and the Sundarbans Delta. For instance, regional organizations like the South Asian Association for Regional Cooperation (SAARC), the India-Bangladesh Joint Working Group on Conserving the Sundarbans, the Joint River Commission, and the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) can reduce and manage transboundary discharge and raise public awareness of the need to control plastic pollution (Adyel and Macreadie, 2021). Participating in volunteer-driven cleanliness initiatives with the local population will guarantee long-lasting, meaningful, and successful conservation efforts for the Bay of Bengal and the aquatic environment of the Sundarbans mangrove. To combat plastic pollution and lessen microplastic contamination in the Bay of Bengal and the Sundarban delta's sediments and surface water, recycling plastics and then turning them into energy can also be a sustainable strategy (Kumar et al., 2022).

Recommendations under National Perspective

Precautionary approaches in the BECA 1995 should be enforced to stop the source of microplastics. Since the remedial measure is insufficient to address the irreparable damage caused by microplastics in the aquatic environment, enforcing the precautionary principle under the act could be an effective solution for controlling microplastics. The Ministry of Environment must introduce comprehensive rules on Extended Producer Responsibility to control plastic pollution that breaks down into microplastic pollution. Producers could be held liable even for a product that reaches the end of its lifecycle. A comprehensive EPR rule might ensure the safe disposal, recycling, and efficient reuse of plastic waste.

The weaknesses of the existing EIA rules must be removed to properly control industrial plastic waste disposal in the aquatic environment. Judicial review should be introduced to strengthen the EIA mechanism. Penalties for EIA consultants who provide inaccurate or misleading information in EIA reports ought to be included. The ECR must contain clauses pertaining to public involvement throughout the whole EIA process, as well as monitoring and feedback mechanisms and proponent obligations (Kabir and Momtaz, 2011). Compliance with international environmental protection standards is crucial for the management of the shipbreaking industry in Bangladesh. It is necessary to modify the Ship Breaking and Recycling Rules, 2011, including a stringent procedure for disposing of plastic litters that do not cause microplastic contamination in the aquatic environment of Bangladesh.

Strict legal enforcement and a typical sanctions-based strategy alone won't cut down on industrial discharge of untreated waste water (Amey, 2021), as these measures often fail to address the underlying economic motivations for pollution. The government must provide financial incentives for industries to implement environmentally friendly safeguards, such as installing ETP. The government must provide financial incentives for industries to implement environmentally friendly safeguards, such as installing ETP. By 2015, it was estimated that 150 CETPs (Common Effluent Treatment Plants) had been constructed all over India with subsidies (Sakamoto et al., 2019). Bangladesh ought to use similar strategies to promote the voluntary building of ETPs and the establishment of central effluent treatment facilities in the industries. A properly installed ETP in the industrial sector might lower the amount of plastic waste that is disposed of by industry, which would lessen the microplastic contamination in Bangladesh's inland water bodies. Bangladesh should implement preferential tax treatment, easy bank loans, and duty-free importation of tools and machinery for companies and industries involved in the manufacturing of biodegradable alternatives to plastics and microplastics. Bangladesh should utilize the enormous jute production capacity to produce affordable biodegradable microplastic substitutes and offer incentives to companies that engage in such activities (Hossain et al., 2021). Subsidies to the recycling sector of the plastics industry could reduce microplastic contamination in Bangladesh's aquatic environment, rather than supporting the plastics manufacturing sector.

Concluding Remarks

Controlling the MPs in Bangladesh must be a reasonable choice, not a voluntary one. Poor management practices, unsuitable recycling methods, and insufficient enforcement of laws and regulations in Bangladesh have all contributed to the widespread pollution of

microplastics in the aquatic environment. The present research could provide useful guidelines for policymakers to strengthen legal mechanisms, implement institutional reforms, and initiate administrative initiatives aimed at controlling and mitigating MPs in Bangladesh's aquatic environment. Involvement of all stakeholders, including the government, industrialists, and the local vulnerable community, is a must for promulgating sustainable solutions for MPs in the aquatic environment.

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