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EDITED BY

Yen-Chiang Chang,
Dalian Maritime University, China

REVIEWED BY

Hao Huijuan,
Ningbo University, China
Muhammad Rheza Ramadhan,
Ministry of Finance of the Republic of
Indonesia, Indonesia

*CORRESPONDENCE

Xia Cao

✉ xcao@must.edu.mo

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Dilemma in global governance of marine plastic pollution and regulatory coordination: convention reconstruction via integrated international law

Biao Luo, Xia Cao* and Kerun Sun

Faculty of Law, Macau University of Science and Technology, Taipa, Macau SAR, China

Global governance of marine plastic pollution is facing fragmented regulations and conflicting enforcement. Drawing on Art. 207 of the United Nations Convention on the Law of the Sea (UNCLOS), this study, by examining overlapping jurisdiction across 17 international instruments, including the London Dumping Convention, the International Convention for the Prevention of Pollution from Ships (MARPOL Convention), and the limited effectiveness of regional regimes such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), identifies a gap between “soft law priorities” and “hard law absence”, particularly regarding microplastic control. To address this, the paper proposes an integrated framework—an umbrella convention plus specialized protocols: vertically, aligning the Global Plastic Treaty (GPT) with the Paris Agreement’s carbon market mechanisms; horizontally, enhancing cross-border technology transfer and extended producer responsibility (EPR) through the Basel Convention amendments and mutual recognition of regional standards. Key GPT provisions include: 1) transforming the precautionary principle into a no-regression clause, setting global plastic production caps with regular reviews; and 2) clarifying the Marine Protected Area (MPA)-specific rules under the Marine Biodiversity of Areas Beyond National Jurisdiction (BBNJ Agreement) with enforceable thresholds and a “do no harm” clause. The study further advocates mandatory jurisdiction authorized to the International Tribunal for the Law of the Sea (ITLOS) under a multi-stakeholder governance model, following China’s “Blue Circle” pilots. All these options will hopefully help overcome land–sea governance fragmentation and lead to coherent global regulation of marine plastic pollution.

KEYWORDS

international environmental law, marine plastic pollution, convention integration, precautionary principle, common but differentiated responsibilities

1 Introduction

Marine plastic pollution, featured by its transboundary nature, environmental persistence, and ecotoxicological impacts, has undeniably ascended to the forefront as a pressing global environmental challenge (UNEP, 2016). Comprehensive scientific monitoring efforts have illuminated the extent of this pollution, revealing alarming concentrations of plastic debris across various marine ecosystems. For instance, the study conducted in the South China Sea indicated a median abundance of microplastics (>0.3 mm) reaching 1.9×10^5 items/km², with polypropylene (PP) and polyethylene (PE), constituting approximately 84.7% of the floating plastic debris; furthermore, around 54.5% of marine organisms sampled were found to contain these plastic particles (Chen et al., 2022, p. 3). These findings underscore the pervasive distribution of microplastics and their potential for bioaccumulation within marine food webs, thereby posing significant potential threats to the ecosystem and food security.

Projections based on current trends have painted an even more alarming picture of the future pollution levels. Predictive models suggest that, if current production and waste management practices persist, annual plastic inputs into the ocean are poised to reach staggering 23–37 million tons by 2040. This volume is equivalent to an accumulation of approximately 50 kg of plastic debris per meter of global coastline (Lau et al., 2020, p.1457), highlighting an urgent need for transformative changes in plastic production, consumption, and waste governance systems. Notably, plastics constitute approximately 85% of all marine litter, significantly complicating remediation efforts and necessitating a shift towards source reduction strategies and circular economy approaches (UNEP, 2021).

The detrimental effects of marine plastic pollution can extend to both ecological security and human health. Empirical studies have detected microplastics in the digestive tracts of over 65% of North Atlantic fish species (Foekema et al., 2013, p. 451), raising concern about the potential for trophic transfer and impacts on fish populations. Furthermore, some ground-breaking research has even identified microplastics within human placental tissue (Ragusa et al., 2021), underscoring the potential for trans-generational exposure. The 2025 official report of the United Nations Conference on Trade and Development (UNCTAD) has revealed that the global plastic production has surged to 436 million tons annually, with 75% of plastic products ultimately becoming waste that enters marine ecosystems. Yet, the existing international legal framework regulates less than 30% of the plastic life cycle, creating a pronounced governance paradox, which may address two underlying issues: first, a disproportionate research focus on post-pollution remediation with insufficient attention to regulating land-based sources; second, the absence of effective legal constraints on transboundary transfers of plastic waste, which undermines source-reduction mechanisms. All these findings call for an urgent need for robust international governance frameworks and comprehensive policy interventions to address the multi-faceted challenges posed by marine plastic pollution to both ecosystem security and human health.

2 Review of marine plastic pollution regulations—the case of UNCLOS

2.1 Definition and general obligation

UNCLOS provides a broad definition of marine pollution encompassing plastic debris and establishes general obligations for prevention and mitigation (UNCLOS, Art. 194).¹ This definition, seemingly comprehensive, lacks specific provisions directly addressing the unique challenges posed by plastic pollution in terms of persistence, fragmentation into microplastics, and potential for long-range transportation (Hammer and Kotze, 2021, pp. 45–47). Despite the absence of specific plastic-related provisions, UNCLOS establishes a comprehensive framework with provisions directly or indirectly applicable to governance of marine plastic pollution. For example, Art. 194 imposes a general obligation upon States to take all necessary measures, using the best practicable means in accordance with their capacities, to prevent, reduce, and control marine environmental pollution from any source—thus requiring both national initiatives, such as legislation, prohibitions, and waste governance schemes, and coordinated regional or international action to limit the entry of plastics into the ocean.

However, this broad expression has been criticized for its lack of specificity and enforceability, leading to inconsistent implementation and limited effect on reducing plastic pollution. To remedy this, Art. 195 prohibits the transference of pollution or its transformation into another form, thereby blocking the loophole of exporting plastic waste or shifting the problem to other jurisdictions or the high seas. This provision is particularly relevant in the context of plastic waste trade, where developed countries tend to export their plastic waste to developing countries with lax environmental regulations, exacerbating the marine plastic pollution (Law, K. L. 2017, p. 215).

2.2 Quick response and cooperative mechanisms

Art. 198 of UNCLOS requires States to promptly notify potentially affected States and competent international organizations when imminent or actual plastic pollution damage occurs, such as large-scale leakage events or the discovery of dense accumulation zones with transboundary impacts. This provision is crucial for ensuring timely responses to plastic pollution incidents and preventing further environmental damage. Articles 202 and 203 strengthen the cooperative dimension, the former mandating joint scientific research, data exchange, and the development of assessment standards, and the latter calling upon developed States

¹ Art. 1(4) defines marine pollution as “The introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in deleterious effects such as harm to living resources and marine life, hazards to human health, hindrance to marine activities, impairment of sea-water quality, and reduction of amenities”.

to provide developing States with technical, financial, and capacity-building assistance to enhance plastic waste management and monitoring systems.

However, the implementation of these provisions has been hampered by a lack of funding and political will, particularly from developed countries (Werksman, 2016, p.123). Art. 204 imposes continuous monitoring obligations on States, requiring assessment of domestic industrial and policy impacts on marine plastic pollution and the publication of relevant data. The enforcement mechanisms in Articles 213–233 provide a range of compliance tools, including port State inspections, coastal State enforcement, and flag State responsibilities, enabling investigation, prosecution, and sanctioning of actors engaged in illegal dumping or discharge of plastics. However, the effectiveness of these enforcement mechanisms is limited by jurisdictional challenges and a lack of coordination among States (Churchill and Lowe, 1999, p.256). Finally, Art. 235 codifies State responsibility and liability under international law for failure to meet marine environmental obligations, while also mandating domestic legal mechanisms to ensure prompt and adequate compensation for pollution damage, thus providing the remedial backbone of plastic pollution governance under UNCLOS. However, the application of this provision to plastic pollution cases has been rare, due to the difficulty in establishing a causal link between specific sources of plastic pollution and specific environmental damages (Sands and Peel, 2018, p.789).

3 Tracing the root cause of dilemmas

Judging from the above analysis of the existing legal provisions, it highlights a structural mismatch between the scale of pollution and the level of legal response, providing empirical grounds for reforming the international legal framework. The current international legal framework exhibits deep structural deficiencies in addressing marine plastic pollution—deficiencies that form interlocking dual fault lines, severely constraining global governance effectiveness. These structural fault lines stem from both the ambiguity of existing legal obligations and the potential for misuse of international judicial opinions, thereby undermining the coherence and legitimacy of the international legal framework.

3.1 Ambiguity of obligations

A central issue lies in the ambiguity of obligations under UNCLOS. Art. 207 requires States to adopt laws and regulations to prevent, reduce, and control pollution from land-based sources—including rivers, estuaries, pipelines, and outfalls—while taking into account internationally agreed rules, standards, and recommended practices. Yet, this provision lacks quantified targets, specific timelines, and robust procedural mechanisms, rendering obligations a non-operational declaration rather than binding commitments (Tanaka, 2015, p. 145). The absence of clear benchmarks and enforcement mechanisms creates a significant

legislative gap, making it difficult to attribute liability for transboundary pollution and enabling coastal States to evade substantive emission-reduction duties (Bodansky, 2012, p.34). This ambiguity undermines the effectiveness of UNCLOS in addressing the root causes of marine plastic pollution, which are predominantly land-based.

To make up for this defect, some cross-regional States may choose to weaponize the advisory opinions of the international judicial bodies. For instance, the opinions of ITLOS and the International Court of Justice (ICJ) on marine environmental protection risk are being reframed as legal bases for transnational pollution litigation or even for illegitimate adjudication. Such instrumentalization has already produced adverse regional effects; notably, in the South China Sea Arbitration, where findings on marine environmental damage were deliberately portrayed by certain States as universally binding precedent, thereby furnishing a pretext for maritime legal confrontations targeting specific nations (Schofield, 2017, p.89). This selective interpretation and application of international legal principles might undermine the credibility of international law, exacerbate geopolitical tensions, and hinder cooperative efforts to address marine plastic pollution. The potential for political manipulation of legal interpretations necessitates a more cautious and nuanced approach to the application of international judicial opinions in the context of marine environmental protection.

3.2 Overlapping jurisdictions

Overlapping jurisdictions and conflicting rules constitute the second structural deficiency, further complicating the already fragmented international legal landscape for marine plastic pollution control. The Basel Convention's Plastic Waste Amendments (Basel Convention Amendments, 2019), adopted at the 2019 Conference of the Parties, represent a significant international effort to regulate plastic pollution and are legally binding on its 189 Parties. The amendments introduce a Prior Informed Consent (PIC) procedure, requiring exporting States to notify the competent authorities of the importing State in writing, obtain explicit written consent before shipment, and comply with strict requirements on environmentally sound management, standardized packaging and labeling, and re-import obligations. By restructuring the control regime, the amendments classify contaminated and mixed plastic waste as hazardous, subject to strict regulation, while allowing free trade only in specific categories of clean, single non-halogenated polymers that are uncontaminated and directly recyclable (Clapp, 2020). This aims to ensure that plastic waste is managed in an environmentally sound manner, minimizing its potential to end up in the marine environment (Medaglia, 2019, p.56).

However, three fundamental barriers undermine effective implementation. First, ambiguity in key terms—such as “environmentally sound management”, “almost free from contamination”, and “not to an extent that would hinder environmentally sound recovery”—lacks uniform international

interpretation, granting Parties excessive discretion. For example, the multiple qualifiers in Annex IX, entry B3010, on “non-hazardous plastics” have triggered divergent interpretations in practice, leading to inconsistent application of the regulations (Cosier and Hoagland, 2022, p.112). This ambiguity creates loopholes that may be exploited by unscrupulous actors seeking to circumvent the rules. Second, weak enforcement capacity limits effectiveness. The amendments rely heavily on domestic legal transposition, yet disparities in enforcement capability—particularly in developing States—are pronounced. Evidence collection difficulties, local protectionism, and corruption severely erode regulatory impact; in some documented cases, criminal networks systematically evade controls through “legal” customs declarations concealing illicit waste (United Nations Office on Drugs and Crime, 2013, p.34). This lack of effective enforcement undermines the entire purpose of the Basel Convention amendments. Finally, design loopholes further restrict efficacy: exemptions for direct reuse risk being exploited to bypass oversight, and the allowance of Art.11 for bilateral agreements with non-Parties may, absent strict adherence to environmentally sound management principles, create hazardous channels for regulatory circumvention (Gregson et al., 2020, p.78). These loopholes provide avenues for the continued flow of plastic waste to countries with inadequate waste management infrastructure, ultimately contributing to marine plastic pollution. Therefore, while the Basel Convention amendments take a step forward in the right direction, the effectiveness of these amendments is contingent on addressing these fundamental barriers and strengthening international cooperation to ensure consistent and robust implementation.

3.3 Regulatory fragmentation

The fragmentation of the current international legal framework is particularly pronounced in the regulation of plastic waste, leading to significant dilemmas in global governance. The Basel Convention, presently the only multilateral environmental agreement (MEA) specifically addressing plastic waste, introduced amendments to its Annex system with far-reaching implications (Basel Convention, 1989). These amendments aimed to strengthen the control of transboundary movements of plastic waste, particularly those destined for recycling or disposal in developing countries with less stringent environmental regulations (Cunningham, 2020, p.23).

However, the interaction between the Basel Convention and other international instruments further complicates the regulatory landscape. The Decision on the Control of Transboundary Movements of Wastes Destined for Recovery (1992) of the Organization for Economic Co-operation and Development (OECD) initially incorporates the waste categories listed in the Basel Convention’s Annexes. However, the restructuring of Annexes II, VIII, and IX under the Basel Convention amendments was not automatically mirrored in the OECD framework, creating a legal disconnect that leaves transnational regulatory “grey zones” open to exploitation for regulatory arbitrage (Hickman, 2020, p.45). This divergence in regulatory standards

allows for the circumvention of stricter Basel Convention controls by classifying plastic waste as destined for “recovery” within the OECD framework, even if the actual recovery processes are environmentally unsound (Ruiz and Gregory, 2018, p.123).

Of the further concern is the potential conflict between Articles 4 and 11 of the Basel Convention. Art. 4 generally restricts the transboundary movement of hazardous waste, and Art.11 permits special arrangements through bilateral or regional agreements. To some extent, the flexibility in both provisions reflects a pragmatic approach to later-on treaty designing, but the absence of harmonized standards for environmentally sound management risks may weaken the Convention’s core regulatory function. The proliferation of bilateral agreements under Art. 11, without adequate safeguards, could create loopholes for the continued flow of plastic waste to countries with inadequate waste management infrastructure, undermining the overall effectiveness of the Basel Convention in preventing marine plastic pollution (Vijver et al., 2019, p.56).

While the Conference of the Parties has adopted guidance documents such as the Framework for the Environmentally Sound Management of Hazardous and Other Wastes, these non-binding texts provide limited clarification of key terms—particularly regarding environmental criteria for plastic waste disposal. The Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal (2002) were pioneering at the time but are now outdated relative to the evolving scale and complexity of plastic pollution, and their lack of binding legal force has diminished their influence on national practice (UNEP, 2002). The lack of clear and enforceable standards creates uncertainty and allows for inconsistent implementation, hindering the effective regulation of plastic waste and contributing to the continued influx of plastics into the marine environment.

3.4 Enforcement conflicts

A core challenge in governing marine plastic pollution lies in the high level of fragmentation within the international legal system, which directly generates overlapping jurisdictions and enforcement conflicts. This fragmentation manifests in several ways, including conflicting provisions, inconsistent implementation, and a lack of coordination among relevant international organizations. Negotiations under the process titled “Ending Plastic Pollution: Towards an International Legally Binding Instrument” reveal deep divisions among States over plastic production reduction targets—an emblematic manifestation of systemic normative disjunction and a key obstacle to achieving a unified global approach (Clapp and Swanston, 2009, p.27).

In the sphere of ship-source plastic pollution, Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) has, since 1988, prohibited the discharge of any plastic into the sea, forming a cornerstone of operational pollution control. By contrast, the 2019 Basel Convention Plastic Waste Amendments classify contaminated plastics as hazardous waste,

subjecting their transboundary movement to the PIC procedure. While MARPOL frames shipborne plastic waste as an emission from navigation, the Basel regime treats it as hazardous waste in trade, resulting in jurisdictional competition and dual regulatory standards for the same material. This divergence in legal characterization creates confusion and undermines the effectiveness of both regimes in addressing ship-source plastic pollution (Hoagland and Beaulieu, 2012, p.145).

This legal divergence creates acute enforcement dilemmas. In the 2013–2019 Philippine–Canada Plastic Waste Dispute (Global Alliance for Incinerator Alternatives, 2019), Philippine authorities ordered the re-export of seized plastic waste under the Basel regime, while the vessel’s flag State invoked MARPOL Annex V to contest port-State jurisdiction, by claiming on the absence of authority to trace shipborne waste under MARPOL. The impasse reflects the absence of coordination between the International Maritime Organization (IMO) framework and the United Nations Environment Program (UNEP)-administered Basel regime: neither a unified classification standard for plastic waste nor rules for resolving treaty conflicts exist.

The consequences extend beyond enforcement to market behavior. Empirical research indicates that global plastic producers are subject to more than 40 heterogeneous domestic and international regulatory frameworks, many of which exhibit inconsistent objectives and lack systemic coherence (Baršauskaitė and Irschlinger, 2023, p.67). This regulatory fragmentation not only weakens incentives for the adoption of circular economy practices but also creates opportunities for businesses to exploit loopholes and circumvent stricter regulations, thereby impeding the transition toward more sustainable practices. Structurally, this fragmentation manifests in three parallel treaty clusters: 1) The UNCLOS system and derivative agreements (e.g., the UN Fish Stocks Agreement and the BBNJ Agreement) focus on biodiversity beyond national jurisdiction, with only broad provisions on land-based plastic pollution; 2) The IMO framework, centering on MARPOL and the London Convention, targets operational discharges from vessels but omits full life-cycle plastic management; and 3) The chemicals and waste control regime, led by the Basel and Stockholm Conventions, imposes restrictions on transboundary waste movement and certain persistent organic pollutants in plastic production, but leaves over 1,500 known hazardous additives outside regulatory scope. This fragmented approach fails to address the entire life cycle of plastics, from production to disposal, and leaves significant gaps in the regulatory framework.

This tripartite division produces regulatory gaps: the Stockholm Convention governs only listed additives; MARPOL bans shipborne dumping but not river-borne plastics; the Basel Amendments strengthen trade controls but cannot limit primary plastic production within States. Parallel legislative processes exacerbate the problem: while the UN Lisbon Declaration and BBNJ Agreement stress urgency without setting quantitative targets, the EU’s revised Waste Shipment Regulation bans exports of plastic waste to non-OECD countries, and the WTO’s Dialogue on Plastics Pollution and Environmentally Sustainable Plastics Trade (DPP) seeks trade-linked reduction mechanisms. Lacking top-level

coordination, these initiatives sometimes conflict, diverging from the inclusive principles of soft-law instruments like the Honolulu Strategy.

Historically, the roots of fragmentation lie in a sectoral “patchwork” approach since the 1972 London Convention: IMO handles ship-source pollution (MARPOL Annex V, 1973), UNEP addresses chemicals (Stockholm Convention), and regional treaties manage specific seas (e.g., OSPAR). This path dependency has classified marine plastic pollution into discrete categories—“ship waste,” “hazardous waste,” “chemical pollutants”—with amendments confined to treaty-specific adjustments. The result is: The 2016 MARPOL didn’t integrate its tightening of dumping prohibitions with the Basel waste definitions; the 2019 Basel did not align its expansion of plastic waste control with the chemical scope of the Stockholm Convention. The Philippine case exemplifies the resulting triple bind: MARPOL offers no traceability, Basel is resisted under navigation rights, and domestic law conflicts with treaty primacy. This historical context highlights the need for a more integrated and holistic approach to marine plastic pollution governance.

Addressing overlapping jurisdiction demands dismantling structural barriers. Experience shows that treaty amendments alone cannot achieve systemic integration: the Basel Amendments’ three-tier control system for Annexes II, VIII, and IX does not automatically align with the OECD’s “amber/green” waste procedures; MARPOL’s absolute ban principle overlaps with the London Convention’s dumping rules without a hierarchy of application. A more comprehensive approach is needed, involving enhanced coordination among international organizations, the harmonization of legal standards, and the development of mechanisms for resolving treaty conflicts.

3.5 Structural constraints

The current governance framework for marine plastic pollution reflects a structural imbalance—soft law predominates while binding instruments remain underdeveloped. This reliance on non-binding guidelines and recommendations, rather than legally enforceable obligations, creating huge challenges in achieving effective and consistent global actions. The 1985 UNEP Montreal Guidelines for the Protection of the Marine Environment against Pollution from Land-based Sources, for example, provide principled guidance on preventing transboundary pollution and designating special protection zones. Yet their non-binding nature significantly weakens enforceability, relying solely on voluntary national implementation. This stands in sharp contrast to regionally binding instruments such as the 2019 EU Single-Use Plastics Directive (SUPD), which establishes quantifiable obligations through detailed provisions banning oxo-degradable plastics, defining the regulatory scope for bio-based plastics, and covering composite-material products. SUPD demonstrates the potential for legally binding measures to drive significant reductions in plastic pollution within a defined jurisdiction.

The prioritization of soft law exacerbates regional disparities in governance outcomes. Specific though, there often lacks verifiable

data on the effectiveness of soft law instruments. Comparative studies have suggested that the regions with stronger legally binding frameworks tend to achieve better environmental outcomes. For example, in the North-East Atlantic, legally binding measures under the OSPAR Convention have been associated with reductions in certain types of marine litter (OSPAR Commission, 2017). In contrast, the regions relying primarily on soft law approaches may experience slower progress or even worsening trends, due to financing and technical capacity gaps. This divergence exposes three inherent limitations of soft laws: 1) Voluntary compliance rarely translates into consistent domestic legislation; 2) The absence of harmonized, enforceable technical standards leaves emerging issues such as microplastic control in a regulatory vacuum; and 3) Ambiguous provisions on technology transfer and financial assistance undermine capacity-building in developing States. The lack of concrete commitments and accountability mechanisms weakens the effectiveness of soft laws in addressing the complex and multifaceted challenges of marine plastic pollution.

The “soft-law priority” trap stems from an inversion of normative hierarchy: when binding obligations are absent due to a lack of treaty consensus, soft laws fill the gap as a provisional measure. However, if such arrangements turn rigid, they may impede the development of binding treaty regimes with robust review mechanisms and measurable targets, allowing normative fragmentation to devolve into enforcement failure. In the context of a deeply integrated global plastics value chain, soft laws cannot compel implementation of extended producer responsibility across borders, nor can they ensure traceability in transboundary plastic waste transfers—leaving critical breaks in the governance chain. The absence of legally binding obligations and enforcement mechanisms allows for the continued flow of plastic waste to countries with less stringent environmental regulations, and finally undermining efforts to reduce marine plastic pollution. Therefore, a shift towards more legally binding and enforceable international agreements is essential to address effectively the global challenge of marine plastic pollution.

3.6 Breakdown of technology transfer and financing mechanisms

The technology transfer framework in international plastic pollution governance suffers from severe implementation gaps, hindering the ability of developing countries to effectively manage plastic waste and reduce marine pollution. Art. 10 of the Basel Convention establishes an obligation for developed States to transfer environmentally sound technologies to developing States. Yet, the absence of binding funding benchmarks and breach-liability clauses has rendered the provision largely ineffective. While precise global data on technology transfer in plastic waste governance is limited, the evidence available suggests that the provision has not been fully implemented, and developing countries continue to face significant challenges in accessing and utilizing environmentally sound technologies.

Two systemic problems underpin this weakness: First, the “environmentally sound management” principle lacks corresponding rights for recipient States, creating a risk of responsibility shifting from waste-generating countries to recipient countries. As a result, developing countries become dumping grounds for plastic waste from developed countries, without having the capacity to manage it properly (Gutberlet, 2016, p.45). Second, technology transfer from developed States is often limited to end-of-pipe equipment donations, neglecting mechanisms for sharing core patents on upstream plastic reduction. This narrow focus on end-of-pipe solutions fails to address the root causes of plastic pollution and limits the ability of developing countries to develop their own sustainable plastic management systems (Ehrenfeld and Hoffman, 2013, p.123). Fragmented financing mechanisms further entrench governance asymmetries.

Current technical assistance relies on voluntary funding channels such as the Global Environment Facility (GEF), whose scale is orders of magnitude below the actual need. While precise figures on the funding gap for plastic waste governance in developing countries are difficult to obtain, estimates suggest that the current level of funding is insufficient to meet the needs (Parker, 2018, p.78). Critically, the Basel Convention lacks standards for assessing technology suitability, resulting in a risk of funding projects incompatible with sustainable development goals (Basel Convention, 1989). This can lead to investments in technologies that exacerbate environmental problems, such as incineration facilities, which can contribute to air pollution and greenhouse gas emissions (Conca, 2015, p.56).

This dysfunction reflects a misalignment between binding treaty provisions and soft commitments. While the Basel Plastic Waste Amendments regulate transboundary transfers, they fail to embed a mandatory cost-sharing formula for technology transfer. In contrast, regional practice offers workable innovations. For example, the EU’s EPR Directive imposes a plastic packaging tax, earmarking a portion of revenues for recycling technology upgrades in developing countries (EEA, 2019). The Regional Knowledge Centre for Marine Plastic Debris (RKC-MPD) of the Association of Southeast Asian Nations (ASEAN) are promoting knowledge sharing and capacity building among member states (ASEAN, 2018). These models demonstrate that enhancing funding effectiveness requires integrating treaty obligations with market-based mechanisms—providing an empirical foundation for the consolidation of a future global plastics agreement. A more comprehensive approach is needed, involving mandatory contributions from developed countries, clear standards for technology suitability, and a focus on upstream solutions that reduce plastic production and promote circular economy principles.

3.7 Patchiness of monitoring standards

Divergent technical pathways for microplastic monitoring in regional marine governance regimes are eroding the scientific evidentiary basis for attributing transboundary pollution responsibility. The lack of standardized monitoring methodologies and data collection protocols makes it difficult to compare data across

regions and assess the overall impact of microplastic pollution on marine ecosystems. While specific examples of regulatory conflicts between regional initiatives may be difficult to verify, the general point remains valid: inconsistent monitoring standards hinder the ability to accurately assess and address transboundary pollution.

Examples are generally found in the different approaches to microplastic monitoring adopted by various regional organizations. Some regions may prioritize the identification of polymer types using laboratory-based techniques such as Fourier-transform infrared spectroscopy (FT-IR), while others may focus on rapid, *in situ* assessment of particle abundance using techniques such as Raman spectroscopy. Both approaches do have their merits, but the lack of standardized protocols and data conversion methods makes it difficult to compare data across regions and assess the overall impact of microplastic pollution on marine ecosystems (Hermesen et al., 2018, p.56).

This methodological incompatibility can produce systematic bias in biodiversity assessments within identical marine zones. When different monitoring methods are applied in the same area, the results may vary significantly, leading to inaccurate assessments of the ecological impacts of microplastic pollution. This inconsistency directly contravenes Art. 204 of UNCLOS, which requires the use of “recognized scientific methods” in pollution assessment. However, the interpretation of “recognized scientific methods” is itself subject to debate and may vary across regions, further contributing to the problem of fragmented monitoring standards (Warner, 2014, p.123).

The legal ramifications of such technical divergence amount to a structural detriment to States’ cooperative obligations under international law. More critically, different monitoring methods may quantify different parameters (e.g., polymer mass concentration vs. particle number concentration). When there is no metrological conversion standard, datasets become legally incommensurable. Consequently, when microplastics travel across national boundaries, the lack of standardized monitoring data may add difficulty in establishing necessary causal links for damage liability claims under Art. 235 of UNCLOS—effectively disabling the operational mechanism for transboundary pollution accountability. Therefore, the development and implementation of standardized monitoring protocols and data collection methods are essential for effective marine plastic pollution governance.

3.8 Dispute settlement mechanisms in a vacuum

A fundamental procedural deficiency in global marine plastic pollution governance lies in the absence of effective judicial remedies for transboundary damage liability. This lack of robust dispute settlement mechanisms undermines the ability to hold States accountable for their contributions to marine plastic pollution and hinders the development of a more effective and equitable governance framework. The jurisdiction of the International Tribunal for the Law of the Sea (ITLOS) is circumscribed by the UNCLOS consent-based jurisdiction

principle: under Art. 288, it may only adjudicate disputes concerning the interpretation or application of the Convention (ITLOS, 2012). This principal blocks ITLOS to address disputes related to marine plastic pollution, particularly those involving complex scientific and technical issues that may not fall neatly within the scope of UNCLOS (ITLOS, 2015).

Procedural entanglement between sovereignty disputes and environmental claims further undermines the system. Although specific examples of States using environmental claims to settle sovereignty disputes may be sensitive and difficult to secure, one thing is certain: the overlap between environmental and sovereignty issues may complicate dispute settlement processes and impede the resolution of marine plastic pollution disputes. This concern prompts caution in international tribunals, as environmental litigation that effectively advances territorial or maritime entitlements could undermine the tribunal’s jurisdictional legitimacy.

Regional cooperation frameworks have attempted to bypass jurisdictional barriers but remain structurally constrained. While specific data on the effectiveness of regional initiatives may be out of reach, a consensus is that regional initiatives often face challenges related to sovereignty sensitivity and deficits in technical trust, which can weaken their efforts to effectively address transboundary marine plastic pollution. Collectively, these initiatives reveal that sovereignty sensitivity and deficits in technical trust remain core impediments to constructing viable regional dispute settlement mechanisms. This requires building trust among States, promoting transparency and accountability, and developing innovative approaches to dispute resolution that are tailored to the specific challenges of marine plastic pollution governance.

4 Options: normative hierarchy of an umbrella convention plus thematic protocols

4.1 Vertical dimension: steering role of GPT

To overcome the current governance impasse, a restructured framework centering around a prospective GPT is essential. This GPT would serve as a central pillar of governance, establishing binding reduction targets and cross-treaty coordination mechanisms to achieve top-down normative integration. This approach acknowledges the urgent need for a comprehensive and legally binding framework to address the multifaceted challenges of marine plastic pollution (UNEP, 1985).

Rooted in the principle of progressive obligations in international environmental law, GPT, drawing inspiration from Art. 4.3 of the Paris Agreement, could mandate Parties to establish national action plans with quantifiable targets for reducing primary plastic production. These targets would be subject to periodic compliance reviews by the Conference of the Parties, promoting transparency and accountability. To ensure effective implementation, GPT could incorporate enforcement mechanisms, such as trade sanctions or other appropriate measures, for Parties that fail to meet their obligations.

At the core of the innovation of GPT is a breakaway from the existing rigid single-treaty governance, thus achieving deep synergy with climate, biodiversity, and chemicals regimes. GPT may foster a holistic approach to plastic and microplastic pollution governance. For example, on climate actions, GPT may integrate with the Paris Agreement's Sustainable Development Mechanism (Art. 6.4), exploring options for incorporating plastic recycling and sustainable plastic production practices into carbon credit markets, thereby incentivizing climate-friendly approaches to plastic management ([Organisation for Economic Co-operation and Development, 1992](#)). A separate working group may be established under GPT to specially take charge of developing globally accepted thresholds in terms of volume, concentration, and toxicity of microplastic. In chemicals governance, GPT may complement the Rotterdam and Stockholm Conventions by establishing information exchange mechanisms and promoting the development of safer alternatives to hazardous plastic additives. In biodiversity, GPT's marine plastic flux targets would directly contribute to achieving the "pollution prevention" goals of the Kunmin–Montreal Global Biodiversity Framework, strengthening protections for the vulnerable ecosystems.

A diversified Global Plastics Governance Fund may also be established under GPT to support implementation efforts, particularly in developing countries. This fund may draw on various sources, including mandatory contributions from developed countries, voluntary contributions, and the EPR fees levied on private sector actors based on the quantity of primary plastics they place on the market ([EU, 2019](#)). These revenues will be earmarked for upgrading waste-governance infrastructure, promoting sustainable consumption and production patterns, and supporting technology transfer in developing countries. Guided by the principle of common but differentiated responsibilities (CBDR), the fund may prioritize the needs of particularly vulnerable groups, such as small island states, ensuring equitable access to resources and technical assistance.

The potentiality for GPT to drive vertical integration is already emerging in regional practices. For example, certain regional bodies have begun to align their marine debris action plans with the principles of the draft GPT, imposing certain obligations on their members. The EU has also amended its Single-Use Plastics Directive to prevent certain practices that could undermine the objectives of GPT ([EU, 2019](#)). These examples confirm that by embedding clear obligations, GPT can bridge structural gaps left by the existing regimes, providing a legal anchor for full life-cycle governance of plastics at global level.

4.2 Horizontal dimension: synergistic empowerment through thematic protocols

Thematic protocols focusing on specific aspects of plastic pollution, such as EPR and technology transfer, are crucial for providing GPTs with horizontal integrative capacity and ensuring their effective implementation.

The EPR Protocol plays a pivotal role by extending mandatory recycled-content requirements to a broad range of plastic products.

This would incentivize the use of recycled materials and reduce reliance on primary plastics, contributing to a circular economy for plastics. Furthermore, the EPR Protocol may establish a "Plastic Credit Bank" to facilitate the implementation of the EPR schemes and promote transboundary cooperation. Under the polluter-pays principle, those countries that choose to export plastic waste may be required to contribute to regional plastic pollution funds, providing financial resources for waste-treatment infrastructure in recipient countries. This would extend EPR into the realm of transboundary harm remedies, internalizing the environmental costs associated with plastic waste exports.

The Technology Transfer Protocol (TTP) aims to bridge capacity gaps in global plastics governance by facilitating access to environmentally sound technologies for developing countries. Drawing on relevant provisions from other international agreements, a hybrid North-South and South-South assistance mechanism may be developed via a blended fund. Contributions to this fund may reflect the principle of CBDR, with developed countries providing a significant share of the financial resources and emerging economies contributing through technology provision. Priority may be given to microplastics-monitoring technologies, enabling developing countries to improve their capacity to assess and address this growing threat. This framework will promote both technology transfer and capacity building, leading to reduced reliance on traditional aid models and fostering greater self-reliance in developing countries.

Protocol interaction can generate mutual reinforcement. For example, the EPR-driven upgrades in developing countries' production lines—triggered by recycled-content targets—can be financed by the blended fund through the provision of specific equipment. Meanwhile, revenues generated through the Plastic Credit Bank can help offset the recipients' co-financing obligations, creating a closed funding loop and ensuring the sustainability of the system.

Domestic legal incorporation mechanisms are essential for ensuring the enforceability protocols. Drawing on successful examples from national legislation, such as the EPR implementation plans that require plastic packaging firms to pay a recycling-disposal levy, the EPR Protocol can encourage Parties to incorporate similar measures into their domestic legal frameworks. This will strengthen the domestic execution of international environmental obligations and promote greater accountability for plastic pollution control.

To control the transboundary microplastic pollution, the EPR protocol and TTP can jointly function. TTP needs to prioritize the developing countries in the dissemination of affordable and standardized microplastic monitoring technologies, including funding for the FT-IR equipment and training for its operation, ensuring data compatibility across borders. The EPR Protocol serves to mandate extended responsibility for microplastic emissions. Producers of products known to shed microplastics (e.g., synthetic textiles, tires) may be required to invest in and implement source-capture technologies (e.g., advanced filtration systems for washing machines), with their efforts audited and recognized under the GPT framework. TTP may also stimulate innovation in intellectual property governance. A special

framework for limited compulsory licensing is necessary under this protocol to allow developing countries to access key technologies at affordable prices while preserving incentives for innovation.

4.3 Depth dimension: pathways for mutual recognition of regional standards

Harmonization and mutual recognition of regional standards can provide a foundational layer for global plastic pollution governance by bridging the systemic disconnect between monitoring data and certification regimes. By promoting consistency and comparability across different regions, mutual recognition can facilitate the effective implementation of GPT and promote greater cooperation in addressing marine plastic pollution.

One potential model for promoting regional cooperation is through integrated land–sea governance initiatives that link upstream waste management practices with downstream monitoring efforts. These initiatives can leverage innovative technologies, such as blockchain-based traceability platforms, to enhance transparency and accountability in cross-border plastic waste management. Advancing regional mutual recognition requires overcoming dual challenges of sovereignty concession and standards compatibility. Joint certification committees can be established to comprise representatives from customs agencies, environmental authorities, and industry associations. These committees are responsible for verifying the authenticity of data and resolving disputes related to cross-border plastic waste management, promoting both sovereignty and operational efficacy.

The use of blockchain technology can also enhance the legal character of traceability systems. By providing a secure and transparent record of plastic waste flows, blockchain data can serve as evidence in both private and public-law contexts, facilitating dispute resolution and environmental regulation enforcement. These examples demonstrate the potential for regional cooperation and innovative technologies to strengthen the implementation of GPT and promote a more effective and equitable global governance framework for marine plastic pollution.

4.4 Reality dimension: challenge of political feasibility of normative structure

While the integrated framework of an umbrella convention with specialized protocols presents a legally coherent and scientifically grounded solution for marine plastic pollution, its political feasibility is being encountered with significant headwinds in the current geopolitical landscape. The primary obstacle lies in the entrenched positions of key negotiating blocs within the Intergovernmental Negotiating Committee on Plastic Pollution (INC) process. The divide between the “High-Ambition Coalition” (advocating for binding production caps and strict chemical controls) and the “Like-Minded Group” (which includes major plastic-producing nations like China and emphasizing national circumstances and voluntary measures) mirrors a

fundamental conflict between environmental urgency and economic sovereignty (Scanlon, 2025). This divergence was starkly evident at INC-5.2, where a consensus remained elusive, which hampered not only by substantive disagreements but also by challenges in procedural trust and leadership efficacy within the committee (Earth Negotiations Bulletin, 2025).

Furthermore, the principle of CBDR, a cornerstone of global environmental governance, has become a contentious point of negotiation, particularly regarding the establishment of a financial mechanism. The question of who should fund the transition and compensate for historic pollution remains a major stumbling block. The impending entry into force of the BBNJ Agreement in early 2026 offers both a precedent and a complicating factor. While it demonstrates that complex multilateral environmental agreements are achievable and will create synergistic momentum for marine plastic governance, it also risks treaty fatigue and resource competition, diverting diplomatic attention and financial resources away from GPTs.

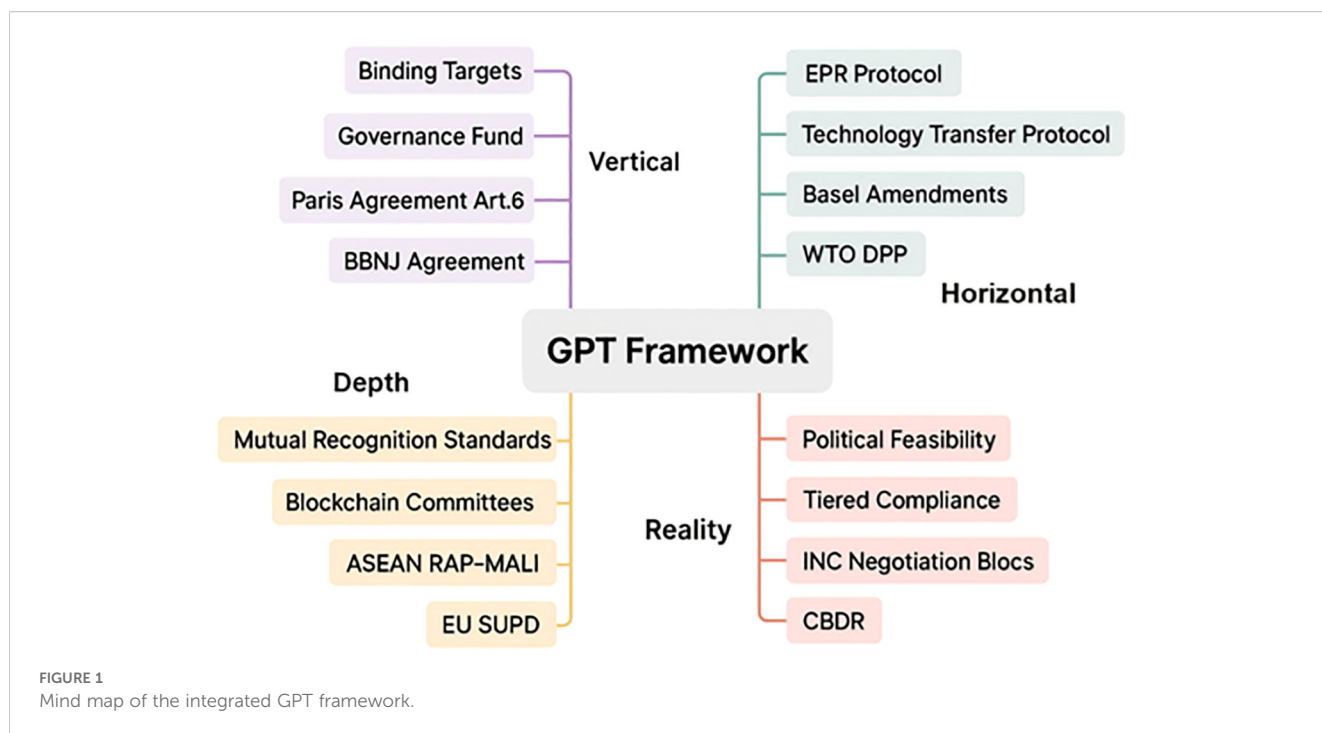
Therefore, the path forward for the proposed framework necessitates not only technical excellence but also strategic diplomacy. Building bridges between blocs through framing plastic production caps as a climate mitigation imperative (linking to Art. 6 of the Paris Agreement) and designing flexible, tiered compliance mechanisms that acknowledge different national capacities could be crucial. The following figure illustrates the above four dimensions, their key elements, and connected regimes. However, to overcome ultimately the political impasse also require unprecedented levels of political will, compromise, and leadership to transform this robust legal architecture into a tangible global reality (See Figure 1).

5 Innovative construction and implementation of institutional instruments

5.1 Quantitative transformation and threshold anchoring of the precautionary principle

The application of the precautionary principle in global marine plastic pollution governance is evolving from abstract obligations toward more concrete and quantifiable legal standards. This shift reflects a growing recognition of a need for measurable benchmarks to guide policy decisions and ensure effective implementation. At the heart of this transformation lies the articulation of environmental thresholds that can function as both scientific indicators and legally enforceable triggers.

Establishing precise thresholds for plastic pollution impacts is a complex and ongoing process, but the idea of using such thresholds to activate specific management actions is gaining momentum. For example, a comprehensive ecological risk assessment can identify a critical concentration of microplastics in seawater or sediments that is likely to cause irreversible harm to marine ecosystems. Once codified, such thresholds can serve as objective triggers for



mandatory emission-reduction obligations by contracting parties under GPT.

Importantly, the transformation of precaution into quantifiable thresholds resonates with developments in other international regimes. In climate governance, for instance, the 1.5°C temperature threshold under the Paris Agreement provides a widely accepted benchmark for collective actions (Bodansky, 2016, p.289). Similarly, the maximum allowable catch quotas in fisheries treaties illustrate how scientific limits can be institutionalized as binding obligations. Drawing from these analogies, GPT can introduce marine-plastic-specific standards, such as caps on primary plastic production, limits on annual per-capita plastic leakage, or binding requirements for recycled content in packaging materials.

The quantitative transformation of the precautionary principle is particularly critical for microplastics. Given their persistence and bioaccumulation, a system can be developed under GPT by following the EU's practice to gradually phase out intentionally added primary microplastics in products. For secondary microplastics, ecological risk assessments should be conducted based on carrying capacity thresholds for key marine ecosystems (e.g., coral reefs, mangrove forests). Where the thresholds are exceeded, a mandatory national action plan should be launched for source control, thus providing a science-based, legally defensible trigger for action.

China's recent "Blue Circular Economy" pilots have offered some valuable insights into the threshold-based and operable governance tools. By setting minimum recycled-content quotas in packaging and integrating blockchain traceability for vessel waste discharges, these pilots transform precautionary concerns into enforceable quantitative obligations at national and regional levels. Such experiments highlight how localized innovations can be scaled up and incorporated into the GPT protocols, thereby bridging the current gap between soft-law principles and hard-law enforceability.

By converting ecological risk limits into binding legal criteria, GPT can promote a proactive and science-based governance framework. This can not only proceduralize the precautionary principle but also anchor it in measurable obligations, reducing interpretative ambiguity and enhancing accountability among contracting parties. Ultimately, quantitative thresholds can serve as a linchpin for transforming precaution from a guiding norm into a robust legal instrument in global marine plastic pollution governance.

5.2 Refinement of the MPA governance rules under the BBNJ Agreement

The BBNJ Agreement establishes a significant legal framework for conserving biodiversity in areas beyond national jurisdiction, offering opportunities to refine and strengthen the MPA governance rules in the context of marine plastic pollution. By clarifying the relationship between the BBNJ provisions and the regional MPA measures, the BBNJ Agreement can promote a more coherent and effective approach to protecting vulnerable marine ecosystems from plastic pollution.

One key aspect of this refinement is the operationalization of the MPA governance rules based on established environmental principles. The BBNJ Agreement can, through provisions such as a "non-derogation" clause, provide a framework for ensuring that the regional MPA measures are consistent with broader international obligations and scientific standards.

In practice, the relationship between the BBNJ standards and the regional MPA measures are hierarchically structured. Where the regional MPA measures exceed the BBNJ's minimum standards, the regional rules are given priority, allowing for more ambitious conservation efforts in specific areas. However, this priority is

subject to certain legal tests, such as requirements for scientific justification, balancing of interests, and procedural legitimacy.

When both the regional and BBNJ standards conflict, equivalence assessments should be developed by some scientific and technical bodies for final decisions. If BBNJ sets a higher benchmark, the regional MPAs should pass this assessment to retain their rules. To ensure the integrity of this process, procedural safeguards should be established, such as periodic reviews of the MPA performance and clear rules for the allocation of the burden of proof in cases of suspected non-compliance.

Looking ahead, normative evolution under the BBNJ-MPA governance may reveal several key trends. These include the development of dynamic MPAs that adapt to the changing environmental conditions, the application of the EPR principles to address plastic pollution sources, and the formalization of criteria for assessing the validity of the regional MPA measures.

Further procedural innovations may include the recognition of full-water-column monitoring as a must of related assessments, bridging an enforcement gap in the existing legal frameworks. The adoption of indicators to measure and compare toxicity may create more solid evidence for legal enforcement.

5.3 Paradigm shift and digital empowerment in dispute settlement mechanisms

The dispute settlement framework for international marine plastic pollution is shifting from traditional adversarial litigations towards a more pluralistic and cooperative approach. This transformation is driven by several factors, including the growing recognition of the limitations of the existing dispute settlement mechanisms, the increasing use of digital technologies to monitor and track plastic pollution, and the emergence of innovative approaches to dispute resolutions that emphasize collaboration and consensus-building.

The heart of this shift is the substantive expansion of the jurisdiction of ITLOS. The development of legal principles related to transboundary environmental harm, such as the inclusion of plastic pollution within the scope of compulsory dispute settlement and the introduction of a reversed burden of proof, all help to empower ITLOS to address marine plastic pollution disputes.

A further innovation lies in the establishment of alternative dispute resolution mechanisms that promote dialogues and cooperation among parties. These mechanisms draw on diverse legal and cultural traditions, integrating principles of mediation and conciliation to facilitate mutually agreeable solutions.

Digital technologies are playing an increasingly important role in supporting multi-actor governance of marine plastic pollution. The use of AI-based detection systems, blockchain traceability platforms, and community recycling networks can enhance transparency and accountability in plastic waste management, enabling more effective monitoring and enforcement. Data sharing from satellite observation systems can also improve the

skills to track cross-border plastic flows and identify pollution sources, supporting evidence-based decision-making and promoting greater cooperation among countries.

Regional cooperation is further embedding the co-governance paradigm. Collaborative initiatives that integrate on-site plastic recycling facilities with waste reception infrastructure can significantly improve recovery rates for vessel plastics. Efforts to link environmental labels to economic incentives, such as tariff reductions for recycled plastic packaging, can promote circular economy practices and reduce reliance on virgin plastics.

6 Connecting regional practices with global institutions

6.1 Normative practice and institutional tensions in the ASEAN regional coordination

The ASEAN Regional Action Plan on Marine Litter (RAP-MALI) provides a valuable example of regional cooperation in addressing marine plastic pollution, highlighting both the potential and the challenges of implementing effective governance frameworks (ASEAN, 2021). By integrating standardized monitoring with differentiated capacity-building, RAP-MALI offers a regional institutional model that can inform global efforts to combat plastic pollution.

One of the key strengths of RAP-MALI lies in its emphasis on standardized monitoring methodologies. By adopting a uniform method for microplastic detection, the ASEAN member states can improve the comparability of data and enhance their capability to track transboundary pollution flows. This can facilitate more effective cooperation and targeted interventions to address pollution sources.

The experience of ASEAN also highlights the importance of addressing regional disparities in enforcement capacity through the tiered obligations. GPT can adopt a similar approach, allowing countries with limited monitoring capacity to employ alternative compliance indicators, subject to approval and verification. This framework is designed to respect regional realities while maintaining structural coherence, providing a normative pathway to overcome governance fragmentation.

China's domestic and regional engagement illustrates a multi-layered approach to marine plastic pollution governance. Domestically, the Law on the Prevention and Control of Solid Waste Pollution (revised in 2020) reinforces regulatory measures on land-based pollution sources, while the Marine Environmental Protection Law (Art. 56) explicitly links land-based pollution control to solid waste regulation, thereby transposing elements of UNCLOS obligations into the national law (NPC, 2020). At regional level, China has participated actively in the Regional Action Plan on Marine Litter (RAP MALI) adopted in 2019 under UNEP's COBSEA framework, which has established a cooperative platform for capacity building and monitoring in the East Asian Seas (UNEP, 2019). In parallel, ASEAN has adopted its Regional Action Plan for Combating

Marine Debris (2021–2025), while the ASEAN Plus Three Marine Plastics Debris Cooperative Action Initiative (2018) and the East Asia Summit Leaders' Statement (2019) have provided additional soft-law instruments to foster policy convergence among China, Japan, Korea, and the ASEAN states (ASEAN, 2018; EAS, 2019). In all these measures China's dual roles are highlighted: embedding international norms within its domestic legal framework while simultaneously supporting regional standard harmonization and cooperative mechanisms, thereby contributing to a more coherent transboundary governance framework.

6.2 EU practice in the extended producer responsibility

EU has emerged as a leader in implementing the EPR schemes to address plastic pollution, providing valuable lessons for the development of a global framework under GPT. Through a nested framework of directives and regulations, EU has advanced EPR into a new regulatory dimension, promoting a more circular and sustainable approach to marine plastic governance (European Commission, 2022).

By extending obligations beyond conventional recycling duties, EU has institutionalized cross-border, full life-cycle internalization of environmental costs. This means that producers are held responsible for the environmental impacts of their products throughout their entire life cycle, from design and production to end-of-life management. One example is the use of revenues from national plastics packaging taxes to fund environmental projects in other countries, promoting regional cooperation and shared responsibility for addressing plastic pollution (European Commission, 2025).

The capitalization of the EPR revenues marks a deeper institutional shift, with the European Investment Bank (EIB) issuing “blue bonds” securitizing the member states' plastics tax revenues. This innovative approach to environmental financing can mobilize significant capital for projects that promote sustainable plastic governance (European Investment Bank, 2019; Financial Times, 2024). Jurisdictional expansion now has non-EU exporters subjected to the EPR levies; for example, a company shipping products to EU is required to pay for eco-contributions, setting an enabling precedent for global supply chain liability.

Enforcement is underpinned by a digital certification regime, with the EU “Plastic Product Digital Passport” requiring data disclosure and banning the circulation of uncertified goods. Linked to the EPR accounts, cross-border dispute settlement can progress more smoothly (European Commission, 2025; Trustrace & Vogue Business, 2024). The EU's experience suggests that multi-layered EPR frameworks can interplay with national eco-tax regimes, regional compensatory flows, and global linkages between plastics taxation and the GPT framework.

To sum up, the EU experience demonstrates that EPR has gone far beyond a narrow environmental policy tool and has developed into a legal and financial nexus restructuring the global plastics economy—redistributing ecological costs, institutionalizing chain-

based responsibility, and innovating new mechanisms of environmental financing. These components have provided essential structural modules for the GPT framework and highlighted the feasibility of extended-responsibility-based transboundary governance as a viable paradigm for overcoming a tragedy of the marine commons.

6.3 Innovative responses by the small island developing states

The small island developing states (SIDS) occupy a unique position in the global governance of marine plastics. While they are suffering some of the most severe impacts of plastic pollution, they have also taken a lead in pioneering innovative solutions. Their vulnerabilities, paired with active engagement, have provided valuable insights into creating a more equitable and effective global strategy for tackling plastic pollution.

The Cloud Nation Project by Tuvalu serves as a poignant example of such innovation. In response to the existential threat posed by rising sea levels and coastal erosion, Tuvalu has initiated this project to safeguard its national sovereignty and environmental data. The Cloud Nation Project involves the use of advanced digital technologies, including blockchain, to preserve critical national records and authenticate data on coastal erosion attributed to plastic pollution. This initiative symbolizes Tuvalu's adaptive strategy toward climate resilience and environmental advocacy.

By utilizing blockchain technology, Tuvalu has created verifiable and immutable records of environmental changes, which serve as vital evidence in international legal proceedings. This technology enables Tuvalu to link coastal erosion directly with plastic pollution, forming the basis for its claims in climate-compensation cases. Notably, Tuvalu sought compensation from ITLOS by arguing that the full life-cycle carbon emissions of plastics should be considered under the marine environmental protection obligations as defined in Part XII of UNCLOS. Tuvalu's legal argument seeks to establish a shared accountability of plastic-producing States for the territorial damages it has suffered. While Tuvalu's compensation demands haven't been entirely endorsed, the landmark judgment did categorize microplastics less than 5 mm as “pollutants” under Art. 1 of ITLOS. This seminal decision has created a precedent for future cases and underscored the critical nexus between plastic pollution and broader ecological degradation.

And the deeper significance of Tuvalu's litigation lies in its attempt to reshape the doctrinal basis of state responsibility for environmental damage. Tuvalu's legal team urged to reinterpret Art. 194 of UNCLOS (“prevention of transboundary pollution”) by including “a carbon leakage control duty” arguing that plastic-producing states should be held historically accountable for the territorial loss suffered by SIDS due to the rise of sea levels related to climate change. The tribunal has ultimately denied Tuvalu's compensation, but a consensus has reached that where plastic pollution has a “significant contributory link” to the rise of sea levels, coastal states may invoke proportional liability under Art. 47 of the Draft Articles on State Responsibility. This has helped to open

new pathways for climate litigation and establishing a clearer legal basis for holding states accountable for their contributions to climate change (ILC, 2001).

Furthermore, Tuvalu's pioneering use of digital evidence-gathering methods has prompted ITLOS to establish formal standards for admitting such innovative evidence. In its evidentiary ruling, the Tribunal has set three admissibility standards for blockchain-authenticated environmental data: 1) Data-collection devices must be certified by the International Organization for Standardization. 2) Blockchain nodes must be operated by at least three sovereign entities to ensure neutrality 3) Raw data must contain verifiable biotic-contact evidence demonstrating ecological impact. These standards represent a direct institutional response to Tuvalu's innovative approach and provide a crucial foundation for future environmental litigation. These standards may help form the backbone of a GPT protocol on digital evidence, ushering governance into an era of algorithmic justice and promoting greater transparency and accountability in environmental decision-making.

6.4 China's "Blue Circle" paradigm innovation and global significance

The "Blue Circle" model originated with the "Ocean Cloud Warehouse," pioneered in Jiaojiang District, Taizhou, Zhejiang Province in 2019. It has since evolved into a comprehensive governance system led by government, spearheaded by businesses, coordinated by industries, and engaged by the public (Tazhou Municipal People's Congress Standing Committee, 2025). Its core innovations are reflected in three mechanisms:

First, digital traceability and credit building, leveraging blockchain and Internet of Things (IoT) technology to achieve visual traceability of the entire "sea to shelf" process. When each plastic bottle is collected by a fisherman, a smart device records location, time, and collector information, generating an immutable blockchain certificate. Recycling companies can use this certificate to apply for international certification (such as verification under the EU carbon tariff mechanism), resulting in a 165% premium on marine plastics. By 2025, Taizhou had recycled a cumulative 54,500 tons of marine plastics.

Second, market incentives and shared prosperity are being promoted. The "Blue Alliance Shared Prosperity Fund" has been established to return 20% of the revenues from marine plastic trading to frontline collectors (for example, fishermen receive an average monthly income increase of 1,200 RMB). Green loans are also being adopted to support recycling companies in upgrading their equipment (a total of 123.2 million RMB of low-interest loans has been issued). This governance effort has resulted in over 61,800 people participating in the initiative, covering over 5,300 fishing vessels, and an average annual increase of 13,000 RMB per person for low-income coastal communities.

Third, standardization and legal safeguards are being implemented. The Regulations of Taizhou City on the Management of Marine Plastic Waste (the first specific local regulation for marine plastic control in China), which came into

effect in October 2025, establish the following systems: supporting and encouraging companies to pay labor remuneration above market price or purchase certified marine plastic waste; supporting recycling companies to obtain carbon labels through international certification; and local governments providing financial support for low-value recycling projects. Furthermore, in the practice and planning of cross-border collaboration between China and ASEAN, although the "Blue Circle" initiative is currently primarily promoted domestically (covering nine counties in Zhejiang Province and expanding to other provinces like Shandong, Hainan), this model has already initiated international integration through the following channels:

First, the construction of technology sharing platforms. China is exporting marine IoT technology to ASEAN through the "Digital Silk Road". For example, China and Malaysia are collaborating to promote 5G-Advanced network coverage and plan to launch an AI-powered marine ranch demonstration project in 2025, integrating plastic pollution monitoring and traceability capabilities.

Second, the Framework of the Regional Comprehensive Economic Partnership (RCEP). Initiatives are underway to promote the extension of ocean governance rules, explore mutual recognition of marine plastic carbon footprint certification standards (Chi, 2024), and simplify procedures for the cross-border movement of recycled plastics under the Basel Convention (e.g., exempting certified plastics from prior informed consent).

Third, a regional pilot program in the Mekong Delta to adapt the "Blue circle" model. This involves using GEF funding to build a blockchain traceability platform; requiring recyclers to pay performance bonds (which may be converted into ecological compensation if the plastic is not recycled in compliance); and aiming to increase the proportion of cross-border recycled plastic labels that are mutually recognized. Currently, the ASEAN countries have varying standards for recycled plastics, lacking a regional mutual recognition system, hindering the development of a cross-border recycling industry chain (ASEAN Secretariat, 2023).

Finally, comparative advantage over the EU model and the SIDS model (See Table 1).

6.5 From diagnosis to remedy: aligning the GPT framework with governance gaps

The preceding analysis, from the overarching gaps in UNCLOS to the intricate challenges of regional enforcement and microplastic monitoring, delineates a clear set of structural dilemmas obstructing effective marine plastic pollution governance. The proposed GPT framework, complemented by innovations from regional and national practices, is designed not as a generic panacea but as a targeted intervention to address these specific shortcomings. The following synthesis elucidates how the GPT framework (See Table 2) provides concrete solutions to the problems identified in Chapter 3, with particular emphasis on the critical issue of microplastic pollution.

This targeted alignment demonstrates that the GPT framework moves beyond abstract recommendations to offer a coherent

TABLE 1 Comparative analysis of regional plastic governance models.

Dimensions	EU EPR system	Small island states initiative	China's "Blue Circle"
Technical Path	Mandatory recycling rate targets	Reliance on international aid and soft law frameworks	Blockchain traceability + market premium mechanism
Social inclusiveness	Costs primarily borne by enterprises	Lack of sustainable funding for community participation	Benefits accrue to low-income groups
Cross-border adaptability	Strict standards but difficult to transfer	Lack of technological autonomy	Lightweight solutions

operational blueprint. Its strength lies in its ability to convert identified systemic weaknesses into structured, actionable mechanisms. By explicitly incorporating microplastic management across its vertical, horizontal, and depth dimensions—from production caps and chemical controls to standardized monitoring and enforceable thresholds—the GPT framework ensures that this pervasive and insidious fraction of plastic pollution receives the specific and urgent regulatory attention it demands, thereby closing a critical gap in the current international environmental law landscape.

7 Conclusion

This study has showed that the current governance of marine plastic pollution is suffering from persistent fragmentation and conflicting enforcement, largely attributable to the structural imbalance between the proliferation of "soft law" instruments and the absence of binding "hard law" mechanisms. By analyzing the

overlapping jurisdiction of the existing treaties—such as the London Dumping Convention, the MARPOL Convention, and regional regimes like the OSPAR Convention, it is evident that neither voluntary guidelines nor narrowly defined regional frameworks are sufficient to provide systemic solutions to cross-border and multi-source plastic pollution, especially in the emerging domain of microplastic regulation.

To address these shortcomings, this paper advances a framework for the reconstruction of the international legal order through "an umbrella convention", i.e. GPT, supplemented by specialized protocols. Vertically, GPT should be integrated with the existing global climate instruments, notably the Paris Agreement's carbon market mechanisms, thereby introducing enforceable reduction targets and economic incentives for compliance. Horizontally, protocols on EPR and technology transfer—aligned with amendments to the Basel Convention and supported by regional mutual-recognition arrangements—can provide the institutional depth necessary for life-cycle regulation

TABLE 2 Mapping governance gaps to targeted solutions in the proposed GPT framework.

Identified governance gaps (Chapter 3)	GPT framework solutions	Emphasis on microplastics
3.1 Ambiguity of Obligations (UNCLOS Art. 207)	Quantifiable targets & enforceable thresholds embedded in the core convention.	Establishment of global thresholds for microplastic concentration in water and sediments, transforming the precautionary principle into operational standards.
3.2 & 3.3 Overlapping Jurisdictions & Fragmentation (e.g., Basel vs. MARPOL)	Umbrella convention providing top-down coordination and serving as a normative anchor for synergistic implementation across regimes.	A unified classification standard for plastic waste under GPT prevents forum shopping. Specific protocol on microplastics harmonizes measures across chemical, waste, and biodiversity treaties.
3.4 Enforcement Conflicts (e.g., Philippine-Canada dispute)	Harmonized standards and mutual recognition arrangements under thematic protocols.	A standardized monitoring methodology for microplastics (e.g., polymer types, size classes) creates legally commensurable data for enforcement and liability claims.
3.5 Institutional Constraints (Soft-Law Priority)	Hard-law binding obligations under GPT, with robust compliance mechanisms.	Mandatory phase-out of intentionally added primary microplastics and binding measures to reduce secondary microplastic emissions from textiles and tires.
3.6 Breakdown of Tech Transfer & Financing	Dedicated Governance Fund & Technology Transfer Protocol with blended finance and mandatory contributions.	Priority funding for deploying affordable microplastic monitoring technologies (e.g., FT-IR spectrometers) in developing countries and transferring source-capture technologies.
3.7 Patchiness of Monitoring Standards	Protocol on Mutual Recognition requiring adherence to ISO-certified monitoring devices and data-sharing protocols.	Blockchain-based traceability and standardized data collection for microplastic pollution, enabling transboundary damage attribution and fulfilling Art. 204 obligations of UNCLOS.
3.8 Dispute Settlement in a Vacuum	Mandatory jurisdiction delegated to ITLOS under the convention, with rules for digital evidence.	The admissibility standards of ITLOS for blockchain-authenticated data (as tested in Tuvalu) empower SIDS and coastal states to litigate microplastic pollution damage effectively.

(Basel Convention, 2019). Furthermore, embedding no-regression clauses, global production caps, and enforceable thresholds under the BBNJ Agreement could reinforce precautionary governance and ensure consistency across the marine-protected areas.

Ultimately, effective governance of marine plastics also require binding adjudicatory mechanisms and inclusive multi-stakeholder participation. The delegation of mandatory jurisdiction to ITLOS, coupled with governance innovations drawn from China's "Blue Circle" pilots, illustrates the feasibility of bridging land-sea regulatory divides and strengthening structural accountability. Only through such systemic reconstruction—anchored in binding obligations, coordinated enforcement, and equitable responsibility-sharing—enable the international community to overcome the dilemmas of fragmented governance and move toward a coherent and durable regulatory framework for marine plastic pollution.

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