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Charting a course for marine sustainability: legal and policy coordination in developing countries amidst trade and shipping turbulence

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Introduction: Trade fluctuations and maritime sanctions have a range of potential adverse impacts on the maritime sector, including port congestion, operational restrictions, fuel supply disruptions and others, leading to increased fuel consumption and higher pollutant emissions, and even a greater risk of marine pollution incidents, further challenging marine sustainability. Developing countries, especially Least Developed Countries (LDCs), Landlocked Developing Countries (LLDCs), and Small Island Developing States (SIDS), are particularly vulnerable to such trade and shipping turbulence. This study aims to explore how developing countries can leverage multilateral legal frameworks to advance marine environmental protection in response to the challenges posed by trade and shipping turbulence, focusing on enhancing legal and policy coordination under international law. Specifically, the study addresses the following key questions: (1) how trade and shipping turbulence generates regulatory and compliance risks that threaten marine sustainability; (2) how developing countries can strengthen their legal and policy coordination within the International Maritime Organization (IMO); (3) how developing countries can align trade and marine environmental goals in the World Trade Organization (WTO); (4) how developing countries can reinforce port state and flag state control as legal enforcement tools; (5) what differentiated legal and policy recommendations can be drawn for LDCs, LLDCs, and SIDS.

Methods: This study employs a combination of literature reviews and case study analyses to explore how developing countries can strengthen legal and policy coordination within the IMO and WTO frameworks, and through port and flag state regulatory cooperation. Existing literature, policy documents and relevant international cases are analyzed to identify best practices and examine the challenges and opportunities for developing countries.

Results: The analysis concludes that achieving marine sustainability requires embedding equity safeguards into IMO and WTO processes, strengthening regional cooperation frameworks, and enhancing national legal capacities. In terms of concrete measures, developing countries need to actively participate in international rule-making processes and advocate for technological and financial support to mitigate these adverse impacts, thereby chart a course for marine sustainability.

Discussion: The global maritime system is undergoing a profound transformation that presents both risks and opportunities for vulnerable developing countries, including LLDCs, LDCs, and SIDS. To navigate this new landscape, these nations require robust legal and policy coordination to mitigate trade risks and promote sustainable shipping. However, a severe scarcity of locally driven, policy-relevant research perpetuates their vulnerability in global governance. The international community must therefore move beyond token inclusion and deliberately invest in building domestic research capacity for these vulnerable states, thereby amplifying their voices.

KEYWORDS

marine sustainability, legal and policy coordination, developing countries, trade and shipping turbulence, multilateral legal frameworks, marine environmental protection, international law, International Maritime Organization (IMO)

1 Introduction

The global maritime landscape has undergone significant turbulence in recent years, characterized by trade fluctuations and maritime sanctions (Verschuur et al., 2023). A series of disruptions to international trade and shipping systems has emerged, which have manifested as delayed cargo movements, fluctuating freight rates, fragmented supply chains, volatile fuel prices and, most critically, an increased risk of marine environmental degradation (Rožić et al., 2022). These challenges have a cumulative effect, placing considerable strain on a global maritime sector that is already vulnerable (UNCTAD, 2024a). In this context, marine sustainability faces simultaneous and intense challenges in terms of the regulation of shipping and trade and the governance of the marine environment.

Developing countries, particularly those that are heavily dependent on trade by sea but have limited capacity to be adaptive, are vulnerable to trade turbulence. Their economic reliance on shipping is often coupled with limited institutional effectiveness, inadequate infrastructure and persistent resource shortages (UNCTAD, 2024b; Birchall et al., 2025). These inherent weaknesses increase their vulnerability to turbulence and undermine their ability to comply with evolving international regulations. Nevertheless, they remain key players in global marine sustainability initiatives due to their extensive coastlines, diverse marine ecosystems, and ongoing reliance on maritime access for trade, fisheries, and vital services. Against this backdrop, legal and policy coordination is understood in this paper as a dual approach: 'legal' highlighting binding frameworks such as international conventions, national statutes, and enforcement mechanisms, while 'policy' captures softer instruments, including strategic plans, institutional practices, and regional cooperation platforms. Such coordination, rather than focusing solely on compliance, as a structured effort to connect domestic regulations, international engagement and regional cooperation in support of marine

sustainability, has become a critical strategic tool for developing countries (UN-Oceans, 2024).

This article explores how vulnerable developing countries can navigate these challenges by enhancing legal and policy countermeasures at international, regional and domestic levels. It proposes an approach to legal and policy coordination that builds links between national legal reforms and participation in global institutions, such as the International Maritime Organization (IMO) and the World Trade Organization (WTO), in conjunction with regional or national-level strategies for port and flag state regulation. It argues that strategic engagement with global institutions, capacity-building in enforcement regimes, and regional cooperation are essential to achieving a sustainable and inclusive maritime order. Together, these efforts offer a realistic toward institutional resilience and long-term environmental protection.

Following the Introduction, Section 2 provides a brief review of the existing literature on how trade and shipping turbulence threatens marine sustainability. Section 3 assesses institutional responses through the IMO, WTO and port and flag state mechanisms. Section 4 draws on case studies of the Least Developed Countries (LDCs), Landlocked Developing Countries (LLDCs) and Small Island Developing States (SIDS) to illustrate the need for differentiated policies, culminating in a set of recommendations with reflections on equitable governance tailored to each group. In the Conclusion section, the study presents a framework through which developing countries can balance environmental priorities with trade-related constraints, based on a synthesis of institutional analysis and case-based evidence.

2 Literature review

The marine sustainability has become increasingly intertwined with global trade dynamics and shipping patterns in our

interconnected world. This literature review examines three critical dimensions of this challenge: first, the direct ecological impacts of trade and shipping turbulence; second, the institutional gaps that prevent equitable solutions; and third, the emerging but understudied role of developing states as active participants in shaping maritime governance norms.

2.1 Trade and shipping turbulence as a threat to marine sustainability

Recent global trade disruptions stemming from the pandemic, geopolitical conflicts, and energy market fluctuations have significantly destabilized maritime shipping networks, creating structural risks for marine sustainability (UNCTAD, 2024c; Verschuur et al., 2020). These disruptions manifest in two primary environmental threats.

First, vessel rerouting to avoid conflict zones or sanctioned areas results in longer, less efficient voyages that substantially increase greenhouse gas emissions and particulate pollution. Moreover, fuel supply uncertainties frequently compel operators to use cheaper, higher-pollution bunker fuels. These shifts contribute to the increased emission of greenhouse gases (GHGs), sulfur oxides (SOx), nitrogen oxides (NOx), and particulate matter, thereby undermining the targets set by international frameworks such as the IMO's Initial Strategy on GHG Emissions (Reuters, 2024a).

Second, Port congestion is another significant pressure point. During periods of trade turbulence, sudden shifts in cargo volume often overwhelm port facilities, particularly in developing countries with limited berth capacity, outdated logistics systems, and weak pollution monitoring infrastructure. Idle ships waiting offshore continue to burn fuel, releasing pollutants into coastal and urban airspaces. Additionally, operational stress may reduce adherence to best practices in ballast water management and waste disposal, increasing the risk of invasive species transfer and direct marine pollution (Kraus, 2023).

The environmental strains arising from these disruptions are closely intertwined with regulatory and operational pressures. Longer routes and unpredictable congestion increase the likelihood of non-compliance with emission limits and fuel-quality standards under MARPOL Annex VI (Animah et al., 2018), while overburdened terminals often struggle to maintain adequate monitoring of ballast water and waste management required by MARPOL Annex V and the Ballast Water Management Convention (Outinen et al., 2024). For many developing countries, these operational adjustments translate into uneven enforcement rather than deliberate non-compliance: inspectors are too few, technical standards evolve faster than domestic legislation, and reporting systems remain fragmented. Consequently, legal exposure grows not from disregard of norms, but from the widening gap between regulatory pace and implementation capacity.

These threats are compounded by regulatory paralysis. Rapid changes in global regulatory expectations, for instance, the expansion of Emission Control Areas (ECAs) or the enforcement of new energy efficiency requirements, pose challenges for maritime

operators in and around developing countries. Rapid shifts in maritime rules overwhelm compliance capacities, particularly in jurisdictions with weak enforcement, causing shipowners to delay retrofits and prolong reliance on older, high-emission vessels (Li et al., 2024). Developing states bear disproportionate costs from these dynamics, lacking both the resources for environmental monitoring and green transitions, often becoming unregulated pollution sinks when sanctions divert shipping traffic to their waters (Ferrario et al., 2022; Reuters, 2024b).

In summary, trade and shipping turbulence has exposed and deepened structural vulnerabilities in the marine governance systems of developing countries. The environmental consequences are not incidental but structural, arising from the intersection of commercial imperatives and regulatory capacity gaps. Addressing these issues calls for a comprehensive legal and policy coordination for developing countries at both international and national levels.

2.2 Institutional gaps: the IMO, WTO, and regional arrangements

Developing countries often face challenges in the maritime sector due to a lack of legal expertise, financial resources, and potential political pressures (Shaffer, 2006; Waqas, 2014). Research has documented the structural constraints faced by SIDS, LDCs, and LLDCs. These states often suffer from limited port infrastructure, fragmented regulatory capacity, and dependence on foreign vessels for trade access (UNCTAD, 2023a; Verschuur et al., 2022b). Scholars have highlighted the disproportionate burdens placed on these states, as implementing international law demands significant state capacity, including domestic officials' knowledge of treaties and institutions and their engagement in capacity-building programs, as well as institutional integration across governance levels to harmonize planning and accountability mechanisms (Gacutan et al., 2022; Young, 2023).

Current maritime governance institutions fail to equitably address these mounting challenges, particularly for vulnerable states. The IMO is central to ensuring maritime safety, security, and environmental standards (Hebbbar et al., 2020). Much of the literature focuses on the evolving role of the IMO in setting technical and regulatory standards, especially under MARPOL Annex VI and the Initial IMO GHG Strategy (Joung et al., 2020; Serra and Fancello, 2020). There is notable study which assesses the impacts of IMO's operational, goal-based short-term measures on LDCs and SIDS, finding that financing retrofits or acquisitions of compliant ships poses disproportionately heavy burdens on developing states (Psarafitis and Zis, 2021). It is also noted that major climate finance tools like the Green Climate Fund remain poorly adapted to the risk profiles and administrative capacity of SIDS, limiting their access to decarbonization funding (Habib and Parris, 2025). The WTO is increasingly analyzed as a site where climate measures intersect with trade law, especially in relation to carbon adjustment mechanisms and Special and Differential Treatment (Bellora and Fontagné, 2022; Dominioni and Esty, 2024). The WTO's dispute settlement system offers developing

countries a rule-oriented mechanism for resolving trade disputes (Amaral and Barral, 2018). However, developing countries often lack legal expertise in WTO law, face financial constraints, and fear political and economic pressure (Shaffer, 2006). Regional cooperation, especially the port state control (PSC) is essential for addressing cross-border maritime challenges and promoting sustainable ocean governance. Developing states lack resources for advanced PSC analytics. For instance, Bangladesh's nascent ocean governance struggles with IUU fishing surveillance despite its vast EEZ (Alam et al., 2021).

This institutional landscape creates a self-reinforcing cycle where vulnerable states face prohibitive compliance costs, leading to reduced participation in rulemaking processes and further marginalization. Studies therefore highlight the tension between environmental ambition and enforcement feasibility, particularly in developing states (Zhang et al., 2023; Dong et al., 2022).

2.3 Research contribution: recasting developing states as proactive norm entrepreneurs

Emerging evidence suggests developing states are increasingly asserting themselves through strategic institutional engagement, as demonstrated by Alliance of Small Island States (AOSIS)'s successful advocacy for loss and damage provisions in climate agreements (Klöck et al., 2024) and small states' strategic use of ITLOS advisory opinions to advance equity principles (ITLOS, 2024). However, developing countries are usually treated as recipients of technical assistance, rather than as active shapers of global maritime norms.

The path to truly inclusive marine sustainability demands a deliberate shift in how the international community treats developing states from passive stakeholders to norm entrepreneurs, meaning actors that actively advance new legal principles or institutional practices rather than simply adapting to existing rules. The examples noted above, AOSIS's advocacy for loss and damage provisions in climate negotiations and the strategic use of ITLOS advisory opinions to advance equity principles, illustrate how vulnerable states can exercise such agency. LLDCs, LDCs, and SIDS are conspicuously under-represented in the global academic discourse on the very rules that shape their trade, environmental and maritime futures. As a result, when new conventions or complex WTO agreements are negotiated, these groups contribute significantly less legal analysis or empirical evidence. Addressing the research gap is the first and indispensable step. Original data collection, rigorous legal analysis, and empirical studies need to be conceived, executed, and published for LLDCs, LDCs, and SIDS. However, few existing publications have analyzed compare how LLDCs, LDCs, and SIDS utilize institutional mechanisms within IMO, WTO, and regional processes, or assess how their policy statements and alliances are translated into negotiations, agenda setting, or rule development.

In response to the above gaps, the paper makes two interrelated contributions. First, it provides a legal analysis of how trade

turbulence, evolving IMO regulations, WTO rules, environment linkages, and enforcement mechanisms such as port state and flag state control shape the regulatory environment confronting developing countries. This lays the analytical foundation for understanding the structural constraints they face. More distinctively, it contributes to mapping institutional strategies of LLDCs, LDCs, and SIDS within major maritime and trade governance bodies and recasting them as proactive norm entrepreneurs rather than mere recipients of structural norms. The analysis carries policy-oriented implications, suggesting that effective marine sustainability requires not just technical assistance but a fundamental redistribution of institutional power to empower developing states in global decision-making processes.

3 Legal and policy coordination in developing countries for marine sustainability

Maritime environmental governance requires not only compliance with international standards but also strategic coordination across legal and policy frameworks. For developing countries, aligning national priorities with global sustainability goals demands active engagement with international organizations, adaptation of domestic legal systems, and effective enforcement mechanisms. Three key frameworks are particularly relevant: (1) the IMO, which sets binding environmental standards; (2) the WTO, whose trade rules influence access to green maritime technologies; and (3) national and regional enforcement regimes, particularly Port State Control and Flag State Control (FSC), which determine practical compliance. This section examines how developing countries can navigate these frameworks to advance marine sustainability while addressing their unique capacities and constraints.

3.1 International Maritime Organization

As the UN agency responsible for global shipping regulation, the IMO plays a central role in sustainable ocean governance. However, developing countries often struggle to engage effectively due to limited technical, financial, and institutional capacity.

3.1.1 Regulatory framework and institutional mechanisms

The IMO governs maritime pollution through conventions like MARPOL 73/78 Convention (International Convention for the Prevention of Pollution from Ships), which addresses oil, chemicals, sewage, garbage, and air pollutants (Karim, 2015; Uddin and Karim, 2018). Complementing this, the Hong Kong Convention (Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships) establishes standards for safe and environmentally sound ship recycling, while the Ballast Water Management Convention tackles invasive species transfer (Čulín, 2018; Outinen et al., 2021).

These instruments are developed and maintained through the IMO's committee system, particularly the Marine Environment Protection Committee (MEPC), which formulates policies like the 2023 Revised greenhouse gases (GHGs) Strategy targeting net-zero emissions by 2050, mandating energy efficiency and alternative fuels (Sahin, 2024; Tuğdemir Kök et al., 2025). The Pollution Prevention and Response (PPR) Sub-committee supports this work by developing technical guidelines on issues ranging from black carbon mitigation to biofouling management (Hebbbar et al., 2020). This multi-layered governance structure (Figure 1) enables the IMO to address both conventional pollution concerns and emerging environmental challenges.

3.1.2 Governance challenges for developing states

Despite this robust framework, developing countries still face systemic barriers to effective implementation. The IMO's regulatory framework on pollution prevention has far-reaching implications for developing countries, particularly in the context of marine litter, oil discharges, and atmospheric emissions from ships. Although Annex VI of MARPOL sets global standards on air pollution, many developing countries lack adequate infrastructure to monitor and enforce such provisions (IMO, 2023a). These gaps have led to reliance on externally funded pilot programs to implement ship-based energy efficiency measures. Beyond compliance, pollution prevention also requires capacity-building at the institutional level, particularly in developing ports. Countries have increasingly advocated within the IMO for the principle of 'equitable capability thresholds' when developing global standards, ensuring that obligations do not exceed domestic enforcement capacity.

Preparedness and response to marine pollution incidents remain critical but under-supported in many developing countries. This includes the capacity to respond to oil spills,

hazardous chemical releases, and other maritime accidents. A key focus of the Global Initiative (GI) of IMO is to strengthen oil spill preparedness through regional coordination, technical training, and policy development (IMO/IPIECA, 2025). These policy preferences reflect a wider pattern: preparedness is not only a technical issue but also a governance issue, where developing countries push for structural inclusion in safety planning, equipment allocation, and regional coordination frameworks.

The Ballast Water Management Convention (BWMC) represents a key area where scientific standards and institutional capacity diverge significantly between developed and developing countries. Implementing ballast water treatment systems requires substantial investment in ship retrofitting and port reception facilities, both of which remain scarce in low-income regions. Furthermore, as ballast water is closely linked with biodiversity protection, states have requested greater integration between the BWMC and national biodiversity action plans under the Convention on Biological Diversity (CBD). Thus, the demand is not for exemption but for harmonized frameworks, sequencing obligations to match technological diffusion and resource availability.

Developing countries are central to the ship recycling industry but remain under-represented in discussions on sustainable shipbreaking (ElMenshawey et al., 2024). Although the Hong Kong Convention entered into force in 2023, full implementation remains uneven (IMO, 2025a). Ultimately, the debate on ship recycling highlights the need for a just transition model, one that enables modernization without marginalizing traditional maritime economies. In response to the need, the SENSREC (Safe and Environmentally Sound Recycling of Ships) project of IMO serves as a core implementation mechanism of ship recycling, offering technical assistance, legislative guidance, and capacity-building programs tailored to the needs of developing countries (IMO, 2025b).

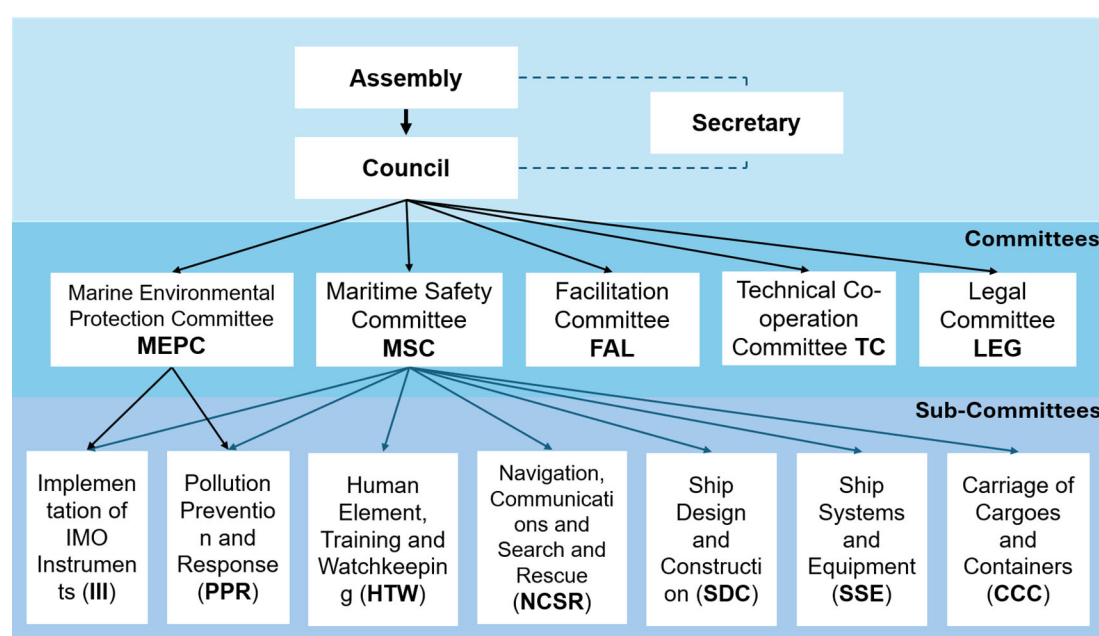


FIGURE 1
IMO governance hierarchy (visualized by authors).

3.1.3 Key implementation issues

Three critical implementation challenges dominate current debates. Regarding pollution prevention, while MARPOL Annex VI sets global air pollution standards, many developing countries rely on externally funded pilot programs for basic compliance monitoring, creating unsustainable dependencies. In ballast water management, the stringent requirements have proven particularly problematic for small island states, where vessels serving domestic archipelagic routes cannot meet the retrofit costs. In recent IMO sessions, Pacific Island and Southeast Asian nations have raised concerns about the unintended consequences of non-compliance penalties, which may disproportionately impact small carriers operating in archipelagic waters (Wang et al., 2021). Bangladesh, India, and Pakistan handle over 80% of the world's end-of-life vessels, yet often under conditions that fall short of environmental and labor safety benchmarks (TBS Report, 2025). While these states have begun upgrading facilities to meet Hong Kong Convention standards, many smaller recycling nations lack domestic legal frameworks, such as comprehensive legislation, enforcement mechanisms, and regulatory institutions, and the financial capacity, such as stable funding, investment incentives and credit facilities, to support compliance.

These implementation challenges have spurred calls for more nuanced approaches, including phased compliance timelines linked to capacity-building milestones. Technical assistance is the backbone of equitable maritime rulemaking, and the IMO's Integrated Technical Cooperation Programme (ITCP) plays a crucial role in this domain. The ITCP provides training, advisory services, and institutional support to developing countries and has been aligned with global climate finance mechanisms, such as the GHG Trust Fund and GreenVoyage2050, to integrate capacity-building with decarbonization efforts (IMO, 2024). However, despite its broad mandate, the ITCP faces persistent delivery challenges, including disparities in regional access and limitations in linguistic coverage. For instance, many developing countries have reported difficulties in fully utilizing available resources due to language mismatches and inadequate regional coordination.¹ In response, the IMO has initiated efforts to modernize the program, shifting toward blended learning formats, regional training hubs, and enhanced stakeholder feedback mechanisms (MarineLink, 2024). These developments reflect a growing recognition that capacity-building must not be a peripheral component of rulemaking, but a structural pillar that ensures inclusivity and long-term compliance. Increasingly, developing countries are not only recipients of assistance, but also active contributors in shaping how technical cooperation is conceptualized and delivered across the IMO system.

3.1.4 Legal and policy coordination under IMO

Legal and policy coordination emerges as the central condition for translating international obligations into workable national frameworks. The IMO's rule-making and technical assistance

mechanisms are formally integrated, yet in practice they often operate on parallel tracks: one normative, one operational. Developing countries frequently report that legal drafting support, technical cooperation, and compliance assessment remain fragmented across separate committees and funding channels. Strengthening coordination means aligning these functions: ensuring that domestic legislation implementing MARPOL or the Hong Kong Convention is backed by synchronized training, data sharing, and financial mechanisms. It also requires procedural innovation within the IMO, such as joint review sessions between legal and technical bodies, and inclusive consultation processes that give smaller delegations timely access to draft instruments. Such measures would not only enhance compliance but also embed equity into the governance architecture itself (Psaraftis and Kontovas, 2020).

In addition, a persistent challenge lies in the procedural dimension of coordination. Developing countries participate in IMO negotiations through regional alliances such as the African Maritime Transport Charter or Pacific IMO Coordinating Committee, yet their influence remains limited by resource and linguistic constraints. Enhancing coordination thus requires institutional reforms that strengthen procedural equity - ensuring earlier access to draft instruments, transparent voting procedures, and dedicated support for multi-language documentation (Dominioni, 2025). Such measures, grounded in the principle of common but differentiated responsibilities (CBDR), would move the IMO's governance closer to substantive equality rather than formal participation.

In sum, legal coordination within the IMO is both a normative and operational challenge. For developing countries, strengthening this coordination means embedding differentiated obligations within the IMO's treaty regime while building procedural guarantees that sustain equitable participation. The next section turns to how similar tensions play out within the WTO framework.

3.2 World trade organization

While lacking an explicit environmental mandate, the WTO significantly influences marine sustainability through its trade governance framework. The organization's rules on tariffs, subsidies, technical standards, and intellectual property directly shape developing countries' access to green maritime technologies and their capacity to implement IMO regulations (Xing and Yao, 2023). This creates both challenges and opportunities for aligning trade policy with environmental objectives in the maritime sector (Gentile, 2009).

3.2.1 Liberalization of trade in environmental goods and services

One of the most immediate and practical ways to advance marine sustainability through WTO is liberalizing trade in environmental goods and services (EGS). Technologies such as exhaust gas cleaning systems, ballast water treatment units, LNG propulsion systems, and digital emissions monitors are essential for compliance with IMO

¹ Report of MEPC 81 (MEPC 81/16).

regulations. Yet, many of these products are subject to import tariffs, licensing restrictions, or certification requirements that limit their availability, particularly in developing countries. By advocating for expanded and regularly updated EGS lists, along with special and differential treatment for lower-income members, developing countries can lower the cost of compliance and accelerate the adoption of green technologies in the maritime sector (Bacchetta et al., 2024). Also, WTO working groups (Figure 2) should further explore a dedicated sub-category of ‘marine sustainability technologies’ within EGS negotiations, enabling targeted tariff reductions and technical assistance mechanisms.

3.2.2 Maritime subsidies

Maritime subsidies remain another area of systemic ambiguity. Current WTO disciplines under the Agreement on Subsidies and Countervailing Measures (SCM) primarily focus on regulating trade-distorting financial support, such as those contributing to overcapacity and unfair competition (WTO, 2024). However, the legal status of environmentally oriented subsidies remains unclear. Government support for port electrification, vessel retrofitting, or the construction of low-emission ship often falls into a grey area under existing SCM disciplines. Developing countries have a strong interest in clarifying these rules to preserve the policy space needed to promote green investment, without triggering trade dispute or sanctions.

3.2.3 Trade facilitation

Trade facilitation represents a further opportunity. As maritime infrastructure upgrade to meet commercial and environmental standards, customs protocols, documentation requirements, and

transit regulations must evolve in parallel. The WTO Trade Facilitation Agreement (TFA) provides a platform for negotiations and working groups to explore how simplified and digitized trade processes can support the deployment of green maritime technologies (WTO, 2017). For instance, developing countries should propose the piloting of ‘green lanes’ or preferential clearance for environmentally certified vessels. These schemes could first be tested under bilateral or regional frameworks and later scaled through WTO commitments.

3.2.4 Intellectual property rights

Moreover, intellectual property rights (IPRs) sit at a key intersection between trade and marine sustainability (Burrell et al., 2023). Many green maritime technologies are protected by patents held in developed countries, limiting affordability and access for developing countries. The WTO’s Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) includes flexibilities, such as compulsory licensing and technology transfer provisions, which could be adapted to the maritime context. Developing countries could advance a ‘TRIPS-plus’ agenda that explicitly calls for equitable access to green innovation technologies, thereby promoting a more climate-resilient and environmentally sound global shipping industry.

3.2.5 Effective participation

In all these areas, effective participation in WTO processes is essential. However, many developing countries lack the legal and technical capacity to track negotiations, draft proposals, or evaluate trade-environment linkages (WTO, 2025). Regional alliances and South-South cooperation initiatives can help consolidate expertise

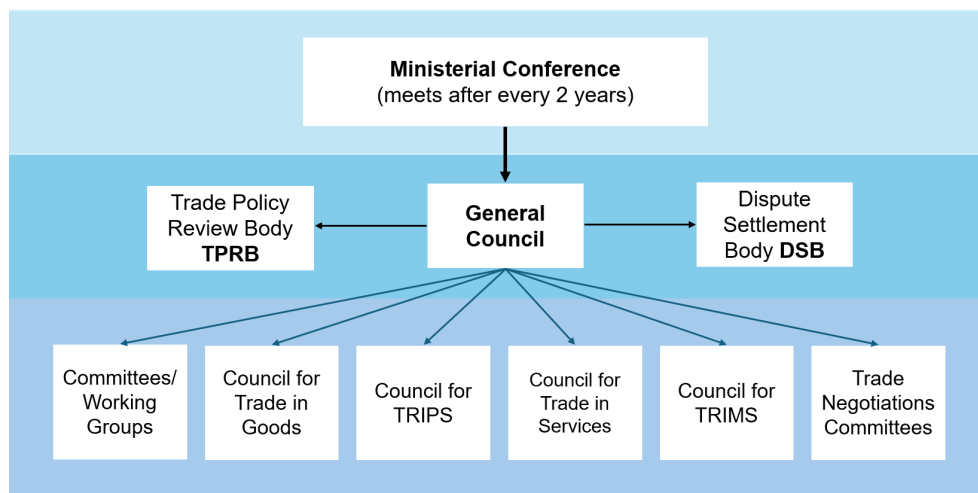


FIGURE 2
WTO institutional structure (visualized by authors).

and coordinate advocacy strategies. In addition, partnerships with academic institutions and civil society organizations can support the production of evidence-based proposals, tailored to the specific challenges and opportunities for developing countries.

Taken together, the WTO should not be viewed solely as a constraint but as a potential catalyst for marine sustainability. By embedding environmental goals more explicitly through legal clarification, procedural innovation, and equitable rule-making, the WTO can play a constructive role in enabling marine sustainability. Through strategic use of WTO mechanisms and decision-making forums, developing countries can build a global trade regime that is not only economically efficient but also environmentally just.

The WTO framework requires careful reforms to fully support marine sustainability while respecting development needs. First, expanding and regularly updating the EGS list to include maritime-specific technologies would reduce implementation costs for developing countries. Second, creating safe harbor provisions for legitimate environmental subsidies would provide policy certainty. Third, targeted implementation support through the TFA's Category C mechanism could help address capacity constraints. Finally, maritime-specific adaptations of TRIPS flexibilities would facilitate technology transfer without undermining innovation incentives. Through these balanced reforms, the WTO can evolve into an effective partner for achieving equitable maritime sustainability.

3.3 National and regional enforcement regimes

While engagement with international institutions such as the IMO and WTO is essential, the day-to-day enforcement of maritime environmental standards depends on national and regional regulatory regimes, particularly Port State Control and Flag State Control (Zhu and Xing, 2021a, 2021b). These mechanisms form the backbone of international compliance and are especially critical for developing countries striving to meet global marine sustainability targets while contending with limited institutional capacity.

3.3.1 Port state control

Port State Control refers to the authority exercised by coastal states to inspect foreign vessels visiting their ports for compliance with international regulations on safety, security, and environmental protection (IMO, 2023b). Through such inspections, port states can screen for regulatory violations, detain vessels that pose environmental risks, and enforce obligations set by MARPOL and other IMO conventions. For developing countries, strengthening PSC regimes offers a practical avenue to protect marine environments and asserting regulatory sovereignty. However, efforts of enforcement are often undermined by structural limitations, including inadequate technical training, reliance on outdated inspection procedures, and the shortage of standardized equipment and data management systems (Karahalios, 2025; Yuan et al., 2020).

Regional agreements such as the Paris MoU (for Europe and the north Atlantic)², Abuja MoU (for West and Central Africa)³, the Indian Ocean MoU⁴, and the Tokyo MoU (for Asia-Pacific region)⁵ provide platforms for technical cooperation, mutual recognition of inspections, and joint training programs. By actively participating in these frameworks, developing countries can enhance consistency in enforcement, avoid redundant inspections, and strengthen the skills of maritime inspectors. Establishing national centers of excellence for PSC training, supported by regional contributions and international development partners, can further professionalize inspection mechanisms and increase deterrence against environmental non-compliance.

3.3.2 Flag state control

Flag State Control (FSC), by contrast, assigns responsibility to the state whose flag a vessel flies to ensure compliance with international obligations. For many developing countries, especially those operating open registries or so-called 'flags of convenience', it is difficult to monitor their vessels that operate abroad, are owned by foreign entities. These registries may prioritize revenue generation over stringent compliance, resulting in inconsistent enforcement and reputational damage (Watterson et al., 2020). The 2025 flag performance assessments from the Paris MOU and Tokyo MOU reveal concerning trends (Table 1). The current blacklists and low-performance categories remain dominated by LDCs, LLDCs, and SIDS. African and Pacific Island states feature prominently, reflecting capacity constraints in these regions. Several states (e.g., Comoros, Togo, Palau) appear on both MOUs' lists, indicating structural governance challenges.

To address this, developing countries must undertake reforms to modernize their flag registry systems. This includes implementing stricter vetting procedures, digitizing registration processes, and requiring periodic audits for vessels flying their flags. Ratification of and compliance with the IMO's Instruments Implementation Code (III Code) can help establish clear performance benchmarks and facilitate peer review. In addition, transparent registry governance, including the public disclosure of ownership and compliance records, can discourage regulatory evasion and attract responsible operators.

2 Paris Memorandum of Understanding on Port State Control (Paris MoU). (2025). Official website. Available online at: <https://www.parismou.org> (Accessed September 2025).

3 Memorandum of Understanding on Port State Control for West and Central African Region (Abuja MoU). (2025). Official website. Available online at: <https://abujamou.org> (Accessed September 2025).

4 Memorandum of Understanding on Port State Control in the Indian Ocean Region (Indian Ocean MoU). (2025). Official website. Available online at: <https://www.iomou.org> (Accessed September 2025).

5 Tokyo Memorandum of Understanding on Port State Control in the Asia-Pacific Region (Tokyo MoU). (2025). Official website. Available online at: <https://www.tokyo-mou.org> (Accessed September 2025).

TABLE 1 Low performance flags (compiled by authors).

Medium to very high risk	Paris MOU black-list countries 2025-2026		Tokyo MOU low performance states 2025-2026	
	Saint Kitts and Nevis		Djibouti	
	Togo		Comoros	
	Palau		Sao Tome and Principe	
	Guinea-Bissau		Belize	
	Belize		Mongolia	
	Vanuatu		Iran	
	Ukraine		Palau	
	Comoros		Sierra Leone	
	Viet Nam		Cook Islands	
	Moldova, Republic of		Togo	
	Tanzania, United Republic of		Saint Kitts and Nevis	
	Cameroon		Tanzania	

3.3.3 Integrated enforcement strategies

While the PSC and FSC regimes present implementation challenges, they are still some of the most direct and effective tools for improving marine sustainability. By targeted investments in environmental capacity, institutional coordination, and legal reform, developing countries can move beyond mere compliance to build more resilient and credible maritime systems.

The most effective enforcement frameworks combine PSC and FSC mechanisms through integrated approaches. There is also significant potential for integrating PSC and FSC regimes through shared databases, coordinated inspection, and joint enforcement strategies. For instance, real-time vessel tracking systems, pollution monitoring technologies, and risk-based inspection frameworks can be adopted across port and flag state authorities to improve coverage and efficiency. Establishing regional maritime information-sharing platforms could provide cost-effective tools for developing countries to strengthen environmental compliance.

Legal reform is crucial to support these institutional efforts. National maritime legislation must clearly define environmental violations, prescribe penalties proportionate to the harm caused, and allocate clear jurisdictional responsibilities among relevant enforcement authorities (Xing et al., 2022). Coordination among ministries of transport, environment, and justice is necessary to ensure that international obligations are fully translated into enforceable national rules. Public engagement through maritime awareness campaigns and civil society watchdog functions can also enhance transparency and accountability.

4 Case studies and recommendations

The implementation of marine sustainability policies requires careful consideration of the distinct challenges faced by different

categories of developing nations. LDCs, LLDCs and SIDS each confront unique structural barriers that demand tailored policy solutions. These groups have articulated their concerns through various interventions in international forums, providing valuable insights for developing targeted support mechanisms (Figure 3).

4.1 Least developed countries

LDCs face significant structural challenges in adapting to maritime sustainability, primarily due to limited technical capacity, constrained access to financing, and weak institutional support. Although their contribution to global greenhouse gas emissions is negligible, they remain highly vulnerable to the secondary effects of maritime decarbonization, particularly in areas such as food security vulnerabilities, trade disadvantage cycle, climate adaptation deficits, and institutional participation gaps.

4.1.1 Food security vulnerabilities

Climate change induces erratic rainfall, droughts, and floods, directly reducing crop yields. In Ethiopia, households adopting combined adaptation practices (e.g., drought-resistant crops and water harvesting) reduced food insecurity by 18–32% compared to single-practice adopters (Begashaw et al., 2024). Without such measures, malnutrition rates escalate, 36% of Somali children under five face acute malnutrition due to climate-induced crop failures (Ibrahim et al., 2025). Meanwhile, LDCs face acute food security risks tied to maritime policy changes due to their exceptional dependence on seaborne imports (UNCTAD, 2023b). These nations import most of staple foods via shipping routes, creating dangerous exposure to decarbonization measures that may

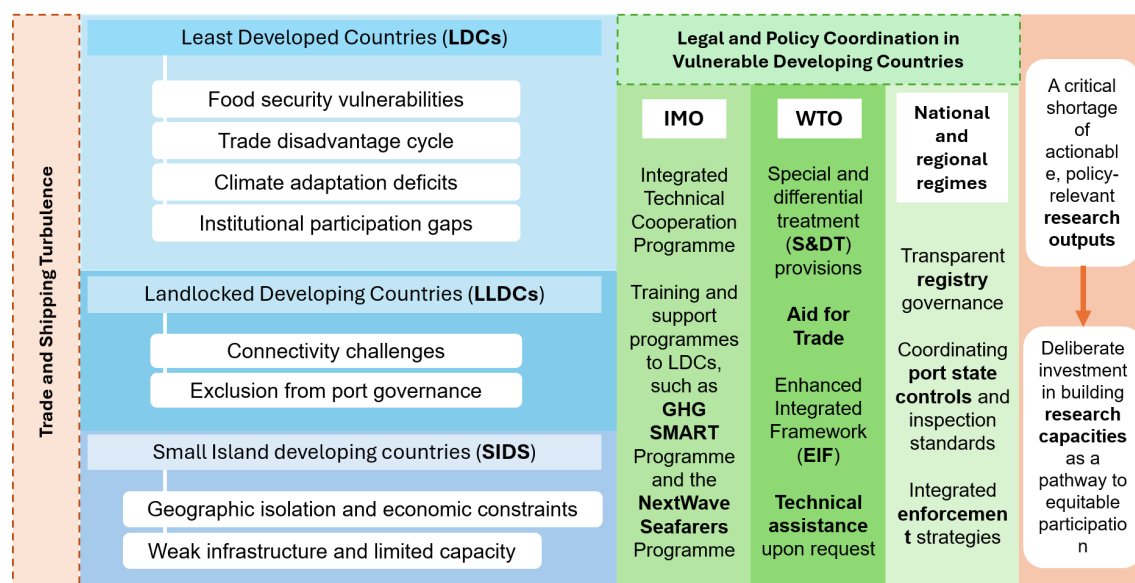


FIGURE 3
Legal and policy coordination in developing countries (visualized by authors).

increase transport costs. Against this backdrop, they have called for broader access to financial and technical support mechanisms. For example, during the 82nd session of the Marine Environment Protection Committee (hereinafter referred to as 'MEPC 82'), the delegation of Tanzania warned that rising shipping costs linked to decarbonization policies could worsen food insecurity in low-income countries, urging the IMO to include food security as a formal criterion in impact assessments.⁶

4.1.2 Trade disadvantage cycle

WTO World Trade Report 2024 shows that the 46 LDCs are home to more than 880 million people, over one-tenth of humanity, yet they still account for barely 1% of world merchandise trade. This share has been essentially flat since 1995 and has slipped below 1% in the last two years, underscoring how little progress these economies have made toward fuller integration in the global marketplace.⁷

One major reason for their marginal role is that trading is simply much more difficult for them. Moving manufactured goods or services across borders is roughly 50% more costly for LDCs than for high-income economies.⁸ African LDCs face tariff disadvantages on agricultural exports compared to non-LDC competitors, worsened by climate-induced production delays (Flentø and Ponte, 2017). These elevated trade costs arise both from their own comparatively restrictive trade policies and from their limited ability to comply with foreign regulations and standards,

which in turn translates into higher barriers in their export destinations.

The same frictions that impede trade also deter investment. LDCs attract significantly less foreign direct investment (FDI) than peers that began at similar income levels.⁹ In agriculture-dependent LDCs, investors often cite inadequate land registries and weak legal systems as critical institutional bottlenecks that heighten perceived risk and reduce expected returns.¹⁰

Consequently, LDC export profiles remain narrow and undiversified. They rely heavily on commodities, ship relatively simple products, and concentrate their trade on a limited number of partners.¹¹ This structure limits their participation in global value chains, restricts knowledge spillovers, and keeps productivity growth subdued.

Looking ahead, the long-term outlook is sobering. Even if all LDCs maintain neutrality between rival trading blocs, thereby avoiding the imposition of higher trade costs on any major group, the global economy in 2050 could still be 2.8% smaller than if deeper integration had occurred.¹² More importantly, LDCs themselves would continue to lag-behind, as the limited diffusion of knowledge and persistently weak productivity growth would prevent the kind of income convergence needed to close the development gap.

4.1.3 Climate adaptation deficits

Climate change is already undermining growth prospects in the world's most vulnerable economies. As a least-developed country

⁶ Report of MEPC 82 (MEPC 82/17).

⁷ World Trade Report 2024, p. 26.

⁸ World Trade Report 2024, p. 31.

⁹ World Trade Report 2024, p. 34.

¹⁰ World Trade Report 2024, p. 52.

¹¹ World Trade Report 2024, p. 9.

¹² World Trade Report 2024, p. 55.

and large-island state, Madagascar is experiencing more erratic rainfall and faces disproportionate recovery costs after cyclones and droughts, burdens that its limited fiscal space makes hard to shoulder (Kunawotor et al., 2022). LDCs lack resources for scalable solutions. For example, only few of Bangladeshi coastal farmers access climate-resilient seeds or irrigation infrastructure (Rakibul and Khalid Md., 2014).

Yet global climate policy could also open new development pathways. According to the World Trade Report 2024, well-designed policies such as carbon pricing, if embedded in cooperative frameworks that target net-zero emissions by 2050, could raise real incomes in LDCs like Madagascar compared with a scenario of delayed or fragmented climate action, especially through mechanisms such as a global emissions trading scheme that channels resources toward low-carbon investment and resilience.¹³ Madagascar has aligned itself with the revised IMO Greenhouse Gas Strategy adopted in 2023, welcoming the inclusive, participatory process that shaped it and urging that IMO working documents and technical materials continue to be made available in French so francophone delegations can fully engage.¹⁴

Sea-level rise threatens LDC ports (e.g., Bangladesh, Mozambique), disrupting fish exports and raising logistics costs (Hasanspahic et al., 2021). Without resilient infrastructure, annual losses could even worse. LDC ports face a dual climate challenge, requiring modernization while adapting to intensifying environmental threats. LDCs therefore have sought multilateral cooperation to support green port development. One illustrative case is Tanzania, where the Port of Dar es Salaam, supported by the World Bank's Tanzania Gateway Project, has undergone terminal upgrades and dredging to improve infrastructure (World Bank, 2017, 2022). While enhancing logistical efficiency, the project also reflects the potential for green infrastructure development in LDCs. As a representative example of green port upgrades in the least developed world, it demonstrates the tangible role multilateral finance can play in building foundational capacity.

4.1.4 Institutional participation gaps

Structural barriers continue limiting LDCs' engagement in maritime governance despite procedural accommodations. Although the WTO's agenda has widened and its membership has grown, least-developed and other small, vulnerable economies still encounter practical barriers that keep them on the sidelines. Special and differential treatment (S&DT) provisions are meant to level the playing field, yet many governments complain that the language is too vague and the associated reporting and review procedures are so intricate that the flexibilities become almost unusable.¹⁵ At MEPC of IMO, Madagascar called for enhanced technical cooperation and warned that language barriers risk marginalizing non-English-speaking states, emphasizing that

'language should not become a barrier to participation in rule-making'.¹⁶ As a result, LDCs and similar members typically negotiate as coalitions rather than as individual delegations, and in technical bodies such as the Committee on Agriculture of WTO they ask significantly fewer questions, preferring to add their names to initiatives tabled by others instead of launching their own.¹⁷

The WTO does provide technical assistance on request, and programs such as the Enhanced Integrated Framework (EIF) channel funds and expertise to help LDCs build trade-related capacity, cut poverty and empower women.¹⁸ A concrete example is the Women Exporters in the Digital Economy (WEIDE) Fund, a joint WTO-ITC (International Trade Centre) facility that trains women entrepreneurs in LDCs to adopt digital tools and expand their online sales.¹⁹ Yet the 2024 World Trade Report concedes that these supports, while valuable, remain insufficient. 'Reform by doing' initiatives, streamlined procedures, simplified notifications, targeted coaching, could make day-to-day participation easier, but the Report warns that more deliberate measures are still needed to ensure that LDCs can seize the new opportunities and move from passive observers to active stakeholders in every aspect of WTO work.²⁰

4.1.5 Implementation pathways and recommendations for LDCs

LDCs face a triple constraint of technology, finance, and institutional capacity in their maritime sustainability transition. The core of their legal strategy, therefore, lies in institutionally linking international obligations with external support and securing legitimate policy space for the green development of domestic industries.

1. At the IMO level: legalizing a phased compliance timeline

To address the compliance capacity deficit of LDCs, a legally binding 'phased compliance timeline' linked to the outcomes of technical assistance and capacity-building should be designed within future amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL). This mechanism can be realized by adding a special provision (lex specialis) specifically for LDCs. Its legal pathway is as follows: First, a trigger mechanism would allow an LDC member state to initiate the process by submitting a formal notification to the IMO's Marine Environment Protection Committee (MEPC), accompanied by a National Maritime Sustainability Capacity Gap Assessment Report. Second, the MEPC would verify the applicant's capacity gap based on a set of objective assessment criteria (e.g., Gross National Income per capita, UNCTAD's Liner Shipping Connectivity Index, adequacy of port reception facilities). Finally, strict extension conditions would require the LDC, upon conclusion of an initial grace period, to submit a Progress and Future Compliance Roadmap demonstrating that it has, in good faith, utilized the assistance to achieve tangible progress. This serves as the legal basis for approving a limited-term extension. This design balances

¹³ World Trade Report 2024, p. 130.

¹⁴ MEPC 81/16, Add.1, Annex 16, p.36.

¹⁵ World Trade Report 2024, p. 106.

¹⁶ Report of MEPC 81 (MEPC 81/16).

¹⁷ World Trade Report 2024, pp. 107-108.

¹⁸ World Trade Report 2024, p. 121.

¹⁹ World Trade Report 2024, p. 124.

²⁰ World Trade Report 2024, pp. 110-111.

flexibility with accountability while adhering to the principle of *pacta sunt servanda* (agreements must be kept).

2. At the WTO level: activating a legal safe harbor for green transition

The WTO framework offers two key legal entry points for the green maritime transition of LDCs. First, regarding domestic industrial support, LDCs can jointly advocate for a new ministerial decision on 'trade and environmental sustainability' to restore and modernize the principle of 'non-actionable subsidies' that has lapsed under the Agreement on Subsidies and Countervailing Measures (SCM). Specifically, this involves proposing the establishment of a 'Green Development Box' for LDCs. Domestic subsidies provided by LDCs for port electrification, vessel modernization, and green fuel research and development would be legally classified as non-actionable, thereby automatically exempting them from countervailing duty investigations and providing a secure legal policy space.

Second, concerning technology access, the legal effect of Article 66.2 of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) must be strengthened. Currently a 'best-effort' incentive clause, it should be transformed into a more enforceable mechanism through a three-pronged strategy. This includes: promoting an authoritative interpretative decision at the TRIPS Council to clarify that 'incentives' must be 'specific, reportable, and verifiable'; strengthening the notification and review mechanism to require developed countries to report in detail on the concrete measures taken and results achieved in transferring green maritime technologies; and exploring the establishment of an 'incentive-compliance linkage' mechanism, encouraging developed countries, when granting patents to their domestic enterprises, to require the submission of a preferential technology licensing scheme for LDCs.

3. At the national and regional levels: strengthening domestic legal frameworks and regional cooperation

At the national level, LDCs must strengthen their domestic legal systems to support international commitments. The primary task is to reinforce flag State responsibility by fully transposing the IMO's Instruments Implementation Code (III Code) into domestic law, reforming the Flag State Control (FSC) system, and enhancing performance to avoid being blacklisted by regional Port State Control organizations. Furthermore, LDCs should proactively resolve conflicts between domestic and international law. For instance, following Bangladesh's example, they can clarify the applicability of the Hong Kong Convention (on ship recycling) and the Basel Convention (on transboundary hazardous wastes) through domestic legislation and regional coordination, providing clear legal guidance for the sustainable development of key national maritime industries like ship recycling.

At the regional level, cooperation with organizations such as the Maritime Organization of West and Central Africa should be deepened. By harmonizing port state control and inspection standards, LDCs can enhance the region's overall enforcement and bargaining power, thereby transforming themselves from vulnerable bystanders into active participants in the maritime sustainability transition.

4.2 Landlocked developing countries

Landlocked developing countries face unique structural challenges in maritime sustainability governance due to their geographic isolation from coastal areas. While completely dependent on maritime trade routes for economic survival, they remain excluded from direct participation in port governance decisions that critically affect their trade competitiveness and environmental outcomes. This paradox creates complex policy dilemmas that demand innovative solutions.

The fundamental constraint lies in LLDCs' complete reliance on transit states for maritime access. WTO data reveals these nations face trade costs approximately 30% higher than coastal developing economies, with agricultural and manufactured goods particularly affected.²¹ Sixteen African LLDCs, representing 30% of the continent's population, demonstrate how connectivity challenges can constrain regional integration.²² These costs stem not just from physical distance but from regulatory hurdles, with the average LLDC shipment crossing 3–4 borders before reaching port.

Recent initiatives show LLDCs actively working to overcome these disadvantages. The Caspian-Black Sea-European green corridor project, involving Kazakhstan, Uzbekistan, Azerbaijan and Georgia, illustrates how landlocked states are actively engaging in sustainability discussions through regional partnerships ([CAREC Program, 2023](#)). Uzbekistan's 'land-linked' strategy, emphasizing digital transit systems and rail-sea intermodal solutions, demonstrates innovative approaches to reducing both costs and emissions in supply chains ([IRU, 2023](#)). Similarly, a draft strategy identifies Uzbekistan's ambitions to build green freight networks by leveraging rail-sea synergies to reduce GHG emissions ([UNESCAP, 2023](#)).

Climate vulnerability compounds these challenges. LLDCs face exposure to changing rainfall patterns that disrupt critical transit routes, while lacking resources for adaptation. The 2023 UN statement by Botswana's Foreign Affairs Minister highlighted growing LLDC demands for equitable infrastructure access and participation in transport governance forums ([UN, 2023](#)). These nations increasingly advocate for 'transit clauses' in maritime environmental regulations and formal consultation rights in IMO proceedings affecting transit corridors.

4.2.1 Implementation pathways and recommendations for LLDCs

The legal strategy for LLDCs must revolve around their right of access to and from the sea under UNCLOS. The core objective is to translate this macro-level right into concrete procedural safeguards and substantive accommodations within IMO and WTO rulemaking, as well as in bilateral relations with transit states.

1. At the IMO level: proceduralizing the Transit-Dependency Impact Assessment

To ensure that the trade lifelines of LLDCs are not disproportionately harmed by new IMO regulations, it should be

²¹ *World Trade Report 2024*, p. 45.

²² *World Trade Report 2024*, p. 45.

proposed that a mandatory ‘Transit-Dependency Impact Assessment’ be formally introduced into the IMO’s existing rule-making process. The core legal elements of this procedure would include: a proportionality analysis of the additional costs imposed on LLDCs by a new regulation; an assessment of the availability of economically viable alternative routes for affected LLDCs, which would serve as a strong legal basis for special consideration; and the establishment of a mandatory prior consultation obligation, requiring the IMO to organize formal consultations between proponent states and affected LLDCs before finalizing key regulations. By embedding this procedure within the Comprehensive Impact Assessment (CIA) or Formal Safety Assessment (FSA) frameworks, the concerns of LLDCs can be systematically integrated into the decision-making process.

2. At the WTO level: activating the transit provisions of the Trade Facilitation Agreement

Article 11 (Freedom of Transit) of the Trade Facilitation Agreement (TFA) provides a powerful legal tool for LLDCs. They should collectively propose, in the WTO Committee on Trade Facilitation, the development of an interpretative guide on the implementation of TFA Article 11 in the context of port transit. This guide should clarify two core points: first, it should elaborate on the principle of ‘non-discrimination’, requiring that the standards and efficiency of port handling for LLDC cargo be no less favorable than those for domestic or third-country cargo; second, it should establish the legitimacy of ‘preferential treatment’, affirming that providing ‘green lanes’ for priority customs clearance for LLDC goods transported using sustainable technologies is a legitimate trade facilitation measure consistent with the TFA’s objectives and does not violate the most-favored-nation principle.

3. At the bilateral/regional level: concluding binding Maritime Sustainability Cooperation Agreements

LLDCs should negotiate and sign a new generation of legally binding bilateral or regional cooperation agreements with key transit countries. An effective model Transit State-LLDC Maritime Sustainability Cooperation Agreement should include the following core legal provisions: national treatment and legal protection for infrastructure investments; a single-window electronic data interchange system based on international standards, with corresponding legal liabilities; an efficient and final *ad-hoc* arbitration mechanism for dispute settlement; and clauses on liability exemptions and coordination in cases of force majeure. Through such agreements, transit facilitation can be transformed from a political commitment into an enforceable legal right, enabling a more structured participation in marine sustainability governance.

4.3 Small island developing countries

Small Island Developing States (SIDS) face a unique convergence of challenges in implementing maritime

sustainability policies. Their geographic isolation and economic constraints create a perfect storm of vulnerabilities: they pay 60% more in transportation costs than other developing nations while simultaneously confronting existential climate threats.²³ At the same time, they are among the most severely affected by sea level rise, ocean acidification, and marine pollution. SIDS face a particularly acute dilemma: they are highly dependent on shipping while lacking the capacity to manage the environmental externalities that accompany this reliance.

The primary challenge for SIDS lies in their weak port infrastructure and extremely limited regulatory and fiscal capacity for maritime governance (Verschuur et al., 2022a; Lai et al., 2022). As the IMO accelerates the implementation of global decarbonization policies, such as carbon pricing, fuel standards, and emissions monitoring, SIDS risk bearing disproportionate compliance burdens if these mechanisms are not designed with their structural limitations in mind. Therefore, unlike LLDCs, which focus on transit governance, or LDCs, which emphasize capacity building, SIDS consistently advocate for the explicit inclusion of the principle of Common but Differentiated Responsibilities (CBDR) in the design of maritime decarbonization policies (Chen, 2021). They argue that the primary responsibility for climate governance should lie with major emitters, not be shifted onto structurally weaker nations.

At international forums like MEPC 82, SIDS have articulated a powerful equity-based critique of current maritime policies.²⁴ Pacific nations have consistently demanded recognition of their special circumstances, with Fiji insisting on ‘polluter pays’ principles, Tuvalu warning of climate colonialism in food import impacts, and Vanuatu calling for ‘leave no one behind’ transition frameworks. The Solomon Islands have proposed concrete solutions like dedicated GHG funds for vulnerable states, while Cook Islands have challenged regressive financial models that would impose disproportionate costs on small island economies.²⁵

Regional cooperation initiatives show promising pathways forward despite these challenges. The Green Pacific Ports Initiative has made tangible progress through energy audits at 12 major ports, solar microgrid installations in five nations, and training for over 200 officials in green port management (Pacific Community, 2022). A recent \$50 million partnership with the Green Climate Fund aims to scale up these efforts through hybrid energy systems, climate-resilient infrastructure upgrades, and advanced digital monitoring tools (Pacific Community, 2023).

Considering these characteristics and concerns, SIDS require institutional safeguards to ensure equitable participation in global maritime decarbonization frameworks. It is recommended that the IMO integrate a ‘burden-adjusted contribution’ principle into carbon pricing designs, establishing exemption or buffer mechanisms tailored specifically for SIDS. Furthermore, transparency must be enhanced in the allocation of carbon revenue, ensuring a dedicated share for green infrastructure and capacity-building in SIDS. Finally, collective platforms such as

²³ World Trade Report 2024, p. 45.

²⁴ Report of MEPC 82 (MEPC 82/17).

²⁵ MEPC 82/17, Add.1, Annex 15, pp.15–21.

AOSIS should be formalized within IMO negotiation processes, enabling SIDS to shape the agenda and exercise procedural safeguards. Only through such measures can SIDS ensure their survival and development while participating meaningfully in the green transformation of global maritime governance.

4.3.1 Implementation pathways and recommendations for SIDS

Given their overlapping existential climate vulnerability and extreme economic dependence, the legal strategy for SIDS should focus on translating the CBDR principle into operable institutional safeguards and innovatively leveraging their sovereign rights as coastal states under UNCLOS.

1. At the IMO level: translating the CBDR principle into a calculable legal formula

To move the CBDR principle beyond political declaration, SIDS should advocate for embedding an automatic, transparent, and calculable 'legal formula for revenue-sharing and contribution exemptions' into the legal text of the IMO's future global market-based measure (e.g., a carbon levy). The core of this formula would be the design of a 'vulnerability adjustment coefficient', used to directly modify the required contributions of SIDS or determine their share of revenue returns. To ensure its legitimacy and objectivity, this coefficient must be a weighted composition of legally recognized, internationally accepted variables, such as: UNCTAD's Liner Shipping Connectivity Index (to quantify economic vulnerability), the ND-GAIN Index (to quantify climate vulnerability), and an innovative 'maritime governance burden index' (defined as the ratio of Exclusive Economic Zone area to land territory area) to reflect their disproportionate jurisdictional responsibilities.

2. At the WTO level: seeking an innovative interpretation of the GATT general exceptions

SIDS can construct a legal argument based on Article XX(g) of the GATT 1994 (relating to the conservation of exhaustible natural resources) to support the imposition of non-discriminatory environmental service fees on high-emission vessels transiting their Exclusive Economic Zones (EEZ). The key to this legal defense is, first, to argue that their coral reef ecosystems within the EEZ are 'exhaustible natural resources', and second, to ensure the fee system is designed to meet the strict requirements of the Article XX chapeau, that it does not constitute arbitrary or unjustifiable discrimination or a disguised restriction on international trade. This requires that the fee be scientifically based and its revenue be earmarked for environmental protection. This approach aims to balance the right of freedom of navigation under UNCLOS with the legal obligation of coastal states to protect the marine environment (UNCLOS, Article 192).

3. At the national and regional levels: exercising sovereign rights under UNCLOS for marine spatial planning

The most direct legal tool for SIDS is to activate their coastal state rights under UNCLOS, which must follow a 'domestic legislation plus international approval' pathway. First, SIDS can designate areas requiring special protection through domestic legislation such as a Marine Spatial Planning Act. Subsequently, in accordance with Article 211(6) of UNCLOS, they can submit a formal application to the IMO to designate the area as a 'Particularly Sensitive Sea Area' (PSSA). Once

PSSA status and its 'Associated Protective Measures' (APMs), such as compulsory ship routing systems or dynamic speed reduction zones, are approved by the IMO, they become legally binding on all international shipping. By including dynamic adjustment mechanisms in their proposals, SIDS can ensure that these protective measures are both legally enforceable and scientifically adaptive, thereby effectively protecting their vulnerable marine ecosystems.

5 Conclusion

The above analysis demonstrates that achieving marine sustainability in the context of trade and shipping turbulence requires differentiated, equity-oriented approaches that address the structural realities of distinct groups of developing countries. Least Developed Countries face persistent capacity and financing constraints, which heighten their vulnerability to food insecurity and trade disadvantages when maritime decarbonization measures raise shipping costs. Landlocked Developing Countries, while entirely dependent on maritime transit, remain excluded from direct port governance, underscoring the need for transit-state cooperation mechanisms and formalized roles in international regulatory processes. Small Island Developing States encounter the compounded pressures of geographic isolation, climate vulnerability, and high transport costs, making the integration of the Common but Differentiated Responsibilities principle into IMO decarbonization frameworks essential for safeguarding their development prospects.

Across these contexts, the case studies and Member State (as recorded in MEPC proceedings) interventions reveal a consistent demand for three policy priorities. First, global institutions such as the IMO and WTO must ensure that climate and trade regulations incorporate explicit equity safeguards, including food security assessments, transit-specific provisions, and burden-adjusted contributions to climate finance. Second, regional cooperation platforms, from African port state control networks to Green Pacific Port Initiatives, should be strengthened as intermediaries that translate global rules into context-specific implementation strategies. Third, national-level reforms should align legal frameworks, institutional mandates, and technical capacity-building with these multilateral and regional commitments.

Despite IMO training programs and WTO special and differential treatment (S&DT) provisions, vulnerable developing states remain underrepresented in both bodies and underperform in key regional agreements such as the Paris MOU and Tokyo MOU. This exclusion is compounded by a scarcity of policy-relevant academic research conceived, conducted, and published by and for these countries. Without such research outputs, developing countries struggle to formulate robust negotiating positions, perpetuating their vulnerability in global governance frameworks. Closing this gap requires more than token inclusion; it demands deliberate investment in building research capacities within these nations. This includes funding original data collection, supporting legal analyses of how international treaties interact with domestic realities, and producing empirical studies on the costs and benefits of proposed regulations. Sustainable marine governance will remain elusive until

the voices of vulnerable developing states are meaningfully amplified, enabling effective legal and policy coordination in developing countries (LLDCs, LDCs, and SIDS) amidst trade and shipping turbulence.

Marine sustainability governance in developing countries is thus not solely a matter of compliance with global standards, but of coordinated legal and policy design that links domestic reforms with active, informed participation in international decision-making. Embedding equity considerations into both rule-making and implementation, and providing the institutional and financial means to act on them, will be critical to transforming vulnerable maritime stakeholders into empowered contributors to a sustainable, inclusive, and resilient ocean economy.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary Material](#). Further inquiries can be directed to the corresponding authors.

Author contributions

QN: Formal Analysis, Funding acquisition, Writing – original draft, Writing – review & editing. WX: Conceptualization, Methodology, Visualization, Writing – review & editing.

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Supplementary material

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