

A Study on Application of the CBDR Principle in IMO Instruments: Advancing Equity and Effectiveness in GHG Reductions for Ships Operating in Areas Beyond National Jurisdiction (ABNJ)

Junghwan Choi ¹, Sangseop Lim ², and Seokhun Kim ^{3,*}

¹ Dalian Maritime University Law School; junghwanchoi@dlnu.edu.cn

² Korea Maritime & Ocean University Division of Navigation Convergence Studies; limsangseop@kmou.ac.kr

³ Pai Chai University IT Management Information Department; kimshn@pcu.ac.kr

* Correspondence

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Abstract: *This study investigates how the international shipping sector can fairly and effectively reduce greenhouse gas (GHG) emissions in Areas Beyond National Jurisdiction (ABNJ) by integrating the principle of Common But Differentiated Responsibilities (CBDR) into International Maritime Organization (IMO) regulations. Current IMO instruments, such as MARPOL Annex VI, employ uniform obligations via the No More Favourable Treatment (NMFT) principle; however, this approach insufficiently addresses disparities in technological and economic capacity between developed and developing states and complicates enforcement for ships registered under Flags of Convenience (FOC). By comparatively analyzing major international environmental law instruments—including the UNFCCC and the Paris Agreement—this paper diagnoses gaps and conflicts between the NMFT paradigm and the CBDR principle within the IMO context. Legal and institutional reform proposals are presented to embed differentiated responsibilities, technical and financial support mechanisms, and improved enforcement for GHG emission reduction from ships operating in ABNJ. Integrating the CBDR principle into IMO regulatory frameworks is argued as essential to enhance regulatory legitimacy and to achieve both equity and effective decarbonization of the global shipping sector in compliance with 2050 climate neutrality goals.*

Keywords: Maritime Decarbonization; Greenhouse Gas Emissions; CBDR Principle (Common But Differentiated Responsibilities); Areas Beyond National Jurisdiction (ABNJ); No More Favourable Treatment (NMFT) Principle; Flag of Convenience (FOC)

1. Introduction

Climate change and global warming have emerged as critical environmental issues directly linked to human survival, causing severe ecosystem disruptions such as sea-level rise, ocean acidification, and extreme weather events [1]. In recent years, the global average temperature has risen approximately 1.2°C above pre-industrial levels, and ocean surface temperatures are approaching their highest recorded levels since 1870, with the rate of increase continuing to accelerate [2]. This climate crisis represents a transboundary global challenge that cannot be adequately addressed by individual countries alone.

Against this backdrop, the international shipping industry is recognized as a significant source of global Greenhouse gas (GHG) emissions, accounting for approximately 3% of the total, with a substantial portion occurring in Areas Beyond National Jurisdiction (ABNJ) [3]. Nevertheless, current international climate frameworks largely concentrate on emissions occurring within national borders, overlooking the regulation of shipping emissions in ABNJ. Notably, there are structural limitations such as difficulty in clearly identifying the nationality of ships' operation and registration, as well as ambiguous attribution of emission responsibilities due to the involvement of multiple stakeholders in global maritime transport.

To address these issues, the International Maritime Organization (IMO) has introduced a series of technical and operational regulations aimed at decarbonizing the shipping sector. Representative examples include Energy Efficiency Design Index (EEDI), Energy Efficiency Existing Ship Index (EEXI), and Carbon Intensity Indicator (CII), which function as tools to assess vessel energy efficiency and reduce GHG emissions based on the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78) Annex VI [4]. However, these regulations still rely heavily on flag state enforcement and have been criticized for insufficiently considering the technological and economic disparities between developed and developing countries. In parallel with IMO's global regulations, regional measures particularly led by the European Union (EU) have been strengthened. The EU is expanding the application of the Emissions Trading Scheme (ETS) to the shipping sector, imposing price signals on maritime emissions, and promoting the transition to low-carbon fuels through the FuelEU Maritime regulation [5]. While these regional initiatives aim to complement the limitations of IMO regulations, they simultaneously raise concerns regarding regulatory overlap and potential conflicts of norms. In line with the 2023 IMO Strategy on Reduction of GHG Emissions from Ships, which aims to achieve net-zero GHG emissions from international shipping by or around 2050, this study adopts the official terminology to reflect differentiated national circumstances and ensure consistency with international agreements.

In the case of vessels operating on the high seas, effective regulatory and supervisory authority primarily rests with the flag state, making it essential for flag states to implement legal and institutional measures to fulfill decarbonization responsibilities for their fleets. In practice, many ships operate under flags of convenience, whose regulatory enforcement capacities are often weak or whose willingness to comply with international norms is limited, thereby complicating effective decarbonization regulation in ABNJ [6].

In this context, the principle of Common But Differentiated Responsibilities (CBDR) offers a crucial legal foundation for establishing a more equitable and effective regulatory system for shipping decarbonization. The CBDR principle, central to international environmental law, especially the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, provides legitimacy for imposing differentiated obligations by reflecting historical responsibilities, economic capabilities, and technological conditions between developed and developing countries. However, the current IMO regulatory framework does not substantively incorporate the CBDR principle, leading to various challenges including disproportionate regulatory burdens between developed and developing countries, gaps in policy implementation, and a lack of normative legitimacy.

Accordingly, this study analyzes the application of the CBDR principle in international environmental law and examines how it is concretely codified in the UNFCCC and the Paris Agreement. Based on this analysis, the study reviews the relationship between IMO's GHG regulatory framework, particularly MARPOL 73/78 regulations, and the potential for normative alignment or conflict. Furthermore, the research seeks to explore legal and institutional approaches to effectively integrate the CBDR principle into regulations addressing shipping emissions in ABNJ, and how such integration could strengthen international enforcement jurisdiction. Ultimately, this paper aims to propose ways to substantively incorporate the CBDR principle within the institutional framework of the IMO, thereby achieving GHG reduction targets in the shipping sector while harmonizing with the broader international climate law regime.

2. Research Backgrounds

2.1 Climate Change and GHG Emissions from International Shipping

International shipping, which accounts for approximately 90% of global trade, is regarded as an efficient and economical mode of transportation [3]. However, the continuous expansion of shipping activities poses a significant challenge to achieving the climate goals set by the Paris Agreement. According to the Fourth IMO GHG Study (2020), GHG emissions from the global shipping sector, including domestic, international, and fisheries, reached approximately 1.076 billion tons CO₂ equivalent in 2018, with carbon dioxide accounting for about 98% of this total [7]. This represents approximately 2.89% of total global GHG emissions, exceeding the emission volumes of major developed countries such as Canada, France, and the United Kingdom. If the shipping industry were considered a single country, it would rank as the world's 6th to 8th largest emitter [8].

The shipping sector has seen a steady increase in GHG emissions over recent decades, with an average annual growth rate of 2.3% between 2014 and 2018, significantly faster than the overall global average of 1%. The IMO warns that if this trend continues, shipping emissions could account for up to 17% of global emissions by 2050 [9]. Beyond GHGs, combustion of ship fuels produces sulfur oxides (SO_x), nitrogen oxides (NO_x),

particulate matter (PM), and black carbon (soot), which deteriorate air quality in port areas and increase the incidence of respiratory and cardiovascular diseases, posing serious public health risks [10]. Black carbon is particularly concerning as it deposits on Arctic snow and glaciers, accelerating their melting [10]. Additionally, carbon dioxide absorption by the ocean causes ocean acidification, threatening coral reefs and mollusk survival, while nitrogen compounds contribute to marine eutrophication, causing harmful algal blooms and hypoxic zones that adversely affect marine ecosystems.

The IMO began addressing CO₂ emissions from ships by adopting MARPOL 73/78 Annex VI in 1997 [11]. In 2003, the Marine Environment Protection Committee (MEPC) was requested to develop mechanisms for reducing GHGs in shipping through IMO Resolution A.963(23) [11]. The first binding GHG reduction measure was introduced in 2011 with EEDI. Subsequently, measures such as the Ship Energy Efficiency Management Plan (SEEMP), Data Collection System (DCS) for fuel consumption reporting, and mandatory use of low-sulfur fuel were implemented. Under the mandate of the UNFCCC, the international community, led by the IMO, continues to discuss methods for calculating and reducing emissions from international shipping. Both technical and operational approaches, such as energy efficiency indices and fuel management plans, and market-based mechanisms like emissions trading schemes, carbon taxes, and carbon funds are actively being considered. At the 80th MEPC meeting in July 2023, the IMO adopted an enhanced target to achieve net-zero GHG emissions from shipping by 2050 [9]. Specifically, it set interim targets to reduce emissions by at least 20 percent, with up to 30 percent ambition by 2030, at least 70 percent, with up to 80 percent ambition by 2040, and 100 percent by 2050 or shortly thereafter, relative to 2008 levels [9]. However, the 2030 and 2040 targets are voluntary benchmarks without legal binding force. To achieve these goals, an integrated ‘basket of measures,’ including a Goal-Based Fuel Standard and a GHG Pricing Mechanism, is scheduled for implementation starting in 2027.

Among these measures under consideration is the introduction of a system that would impose a cost per ton of carbon dioxide emitted by international ships. While such costs may impose financial burdens on shipping companies, they could accelerate the transition to zero or carbon-neutral fuels, such as LNG, methanol, green hydrogen, and green ammonia. The GHG emissions from the shipping industry affect not only the quantity of emissions but also have profound impacts on climate, ecosystems, human health, and socioeconomic sectors. A multifaceted response is urgently needed to achieve sustainable shipping, including strengthened international cooperation and regulations, promotion of eco-friendly fuels, technological innovation, and introduction of carbon pricing mechanisms.

2.2. The Impact of Ship Emissions in ABNJ and Its regulatory Gaps

Although the total volume of pollutants generated by ship activities is relatively small compared to land-based sources, the environmental impact of air pollutants emitted from ships should never be overlooked. In particular, SO_x, NO_x, PM, and GHGs emitted from ships cause air pollution, acid rain, and climate change, deteriorating air quality in marine and coastal areas and adversely affecting the health of nearby populations [12]. Unlike emissions from land-based sources, air pollutants from ships can disperse widely without boundaries, exhibiting a transboundary nature that crosses coastal waters, thereby contributing significantly to the degradation of air quality in densely populated coastal states [13]. Such air pollution from ships is not confined to the territorial waters of any single country but can occur anywhere along international shipping routes worldwide [14]. Effective regulation and reduction efforts against these pollutants require multilayered cooperation at international, regional, and domestic levels.

In practice, most ships transit through ABNJ, which fall outside the territorial jurisdiction of coastal states. Within these areas, the primary regulatory responsibility lies with the flag state. This legal framework is based on Articles 91 and 94 of the United Nations Convention on the Law of the Sea (UNCLOS), but significant disparities exist among flag states regarding administrative capacity and willingness to enforce regulations [15]. Some states allow ship registration but effectively neglect substantive oversight, creating regulatory gaps in marine environmental protection. This institutional limitation is prominently manifested through the proliferation of the FOC system. FOC states provide lower taxes, lenient registration requirements, and lax environmental and safety standards, serving as popular registration venues for shipowners seeking to circumvent stricter regulations in their own countries. Panama, Liberia, and the Marshall Islands are representative examples of such states. These countries register a substantial portion of the world’s merchant fleet, which weakens the effectiveness of international environmental regulations under the flag state responsibility principle.

In fact, implementation gaps exist depending on the flag state even for regulatory measures adopted by the IMO, such as EEDI, CII, and the revised 2023 GHG Strategy. Although the IMO applies No More Favourable Treatment (NMFT) principle, which requires uniform standards for all ships, this principle paradoxically limits port states' ability to impose additional sanctions or stricter regulations on FOC vessels [16]. To address these shortcomings, regional Port State Control (PSC) regimes, including the Paris Memorandum of Understanding (Paris MoU) and the Tokyo Memorandum of Understanding (Tokyo MoU), have been established to inspect foreign ships for safety and environmental compliance, and to impose measures such as detention or fines for violations [17]. These MoUs are intended to ensure the implementation of international conventions by authorizing member states to inspect all foreign-flagged ships calling at their ports without discrimination, regardless of whether the ship's flag state is a party to the MoU. While these MoUs serve as operational agreements outlining practical arrangements and specific technical matters, they are generally considered informal instruments with political or ethical significance rather than legally binding obligations for the parties [17]. Moreover, these PSC regimes have limited inspection frequencies and are concentrated primarily in developed regions, thereby limiting their effectiveness as truly global enforcement mechanisms.

3. Research Methodology

3.1 Aim of The Study

This study aims to explore legal and institutional measures for incorporating the principle of CBDR into the regulatory framework for GHG reduction in the international shipping industry. To this end, it examines how the CBDR principle has been applied and developed within international environmental law and the UNFCCC regime, analyzing its implications for potential application in the IMO regulatory frameworks. In particular, the study diagnoses the current status and limitations of MARPOL 73/78 Annex VI, and proposes legal reforms to strengthen responsibility sharing and enforcement jurisdiction over ship emissions in ABNJ. Furthermore, this research seeks to contribute to the establishment of an institutional foundation for decarbonization regulations in the shipping sector. It aims to ensure both effectiveness and equity by enhancing the linkage between the UNFCCC and IMO regulatory frameworks.

The research methodology combines literature review and doctrinal legal study. First, the research explores how the CBDR principle has developed normatively and been applied practically in international climate law, including the UNFCCC, to identify relevant implications for the shipping sector. Second, the study analyzes MARPOL 73/78 Annex VI and related IMO measures such as EEDI, EEXI, and CII, assessing their enforcement mechanisms, legal limitations, and possible improvements. Third, the study scrutinize legal overlaps and conflicts among UNCLOS, the UNFCCC, and the IMO to identify ways to strengthen enforcement in ABNJ. It concludes by proposing amendments to MARPOL 73/78 Annex VI that integrate the CBDR principle. This study aims to develop legal and policy proposals by integrating theoretical review with empirical analysis, thereby contributing to the establishment of a fair and effective decarbonization transition system in the shipping sector.

3.2 Research Question

This study poses the following research questions to assess the feasibility and substantive implications of incorporating CBDR principle into decarbonization regulations in the shipping sector:

1. How has the CBDR principle evolved and been applied within the broader framework of international environmental law and the UNFCCC, and what normative insights can be drawn from these experiences to inform GHG regulation in maritime contexts?
2. What is the current relationship between the IMO's regulatory framework on GHG emissions such as MARPOL 73/78 Annex VI and the CBDR principle, and what legal, structural, or normative limitations emerge from this relationship?
3. If the CBDR principle were to be applied to ship emissions in ABNJ, what legal and institutional reforms would be necessary regarding the allocation of responsibilities and the exercise of enforcement jurisdiction?
4. How can normative frameworks related to the UNFCCC facilitate the integration of the CBDR principle into the IMO's regulatory regime for shipping, and what specific approaches should be taken in revising MARPOL 73/78 Annex VI to realize this integration?

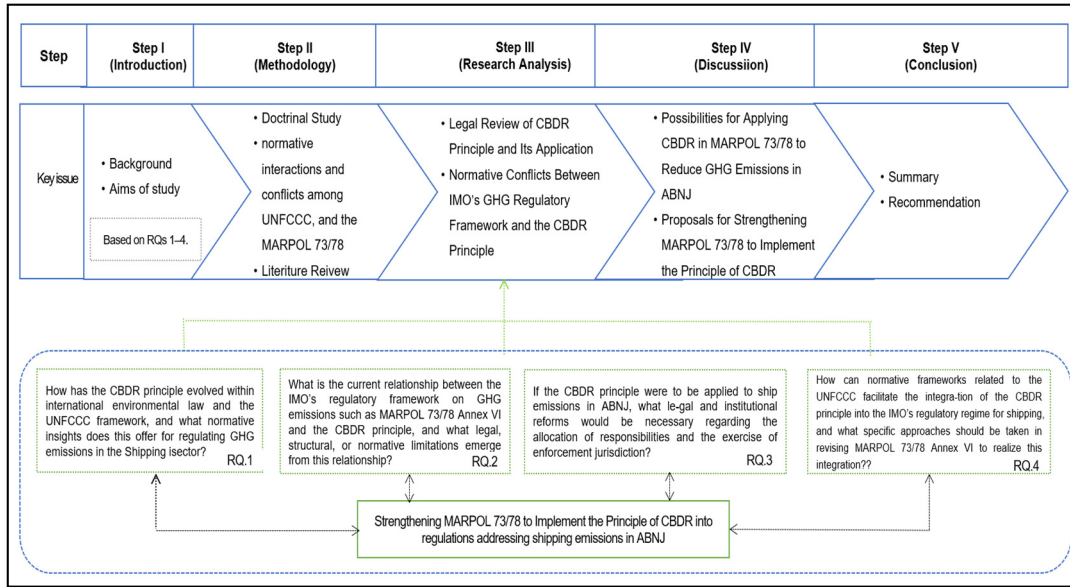


Figure 1. Research Questions

3.3 Literature Review

The reduction of GHG emissions in the international shipping sector has emerged as a critical issue in the global response to climate change, with regulatory frameworks primarily developed under the auspices of the IMO. However, the IMO’s regulatory regime is founded on the principle of NMFT, which applies uniform standards to all ships, thereby creating normative tensions with the principle of CBDR.

Chen (2021) analyzes the inherent tension between CBDR and NMFT, noting that attempts to implement equity in shipping regulations often conflict with NMFT’s universalist stance [18]. He particularly highlights that while developing countries advocate for flexible regulations based on CBDR, the IMO’s commitment to universality and formal equality prevents the acceptance of such differentiated approaches [18]. This concern is further deepened in the work of Dominioni and Martínez Romera (2025), who evaluate the 2023 IMO GHG strategy as an effort to incorporate not only the CBDR principle of UNFCCC but also the equity and just transition concepts embodied in the Paris Agreement [19]. They emphasize the necessity of procedural participation guarantees, capacity building, and technological support for Small Island Developing States (SIDS) and Least Developed Countries (LDCs) [19].

Palassis (2014) analyzes normative conflicts between developed and developing countries during the IMO’s market-based measures (MBMs) adoption process, attributing delays in institutionalizing CBDR to conflicting interests and political constraints in policy formation [20]. Kopela (2013) highlights the need for coordination mechanisms to institutionalize CBDR in shipping regulation through regime interaction between IMO and UNFCCC frameworks [21].

From the perspective of marine environmental protection, the legitimacy and enforceability of regulations in ABNJ represent major challenges. Wang and Pan (2024) argue that environmental governance in ABNJ should evolve into an implementation-centered mechanism that applies CBDR flexibly, encompassing technology transfer, financial support, and capacity building, rather than relying on rigid state responsibility theories [22]. They particularly underscore the potential for linkage between the principles of the Biodiversity Beyond National Jurisdiction (BBNJ) agreement and IMO norms, advocating for multilateral governance [22].

In terms of technological and industrial realities, Shi and Gullett (2018) [23], and Shi (2014) [24] analyze the industrial influence of major Asian shipbuilding nations (China, Japan, South Korea), emphasizing that CBDR should function not merely as a declarative ideal but as a concrete standard reflecting structural industrial and technological disparities. This suggests that the application of CBDR must transition into substantive regulation accounting for differences in technological capacity and economic capability among states. Furthermore, Tanaka (2016) critiques the traditional flag state-centered regulatory approach as ineffective in ABNJ and calls for enhanced roles of port states and coastal states [25].

Accordingly, Marten (2016) [26], Molenaar (2007) [27], Zhang and Dong (2022) [28], and Reed (2011) [29] emphasize the need for global expansion of the PSC regime to strengthen emission monitoring and enforcement in ABNJ. Standardized emission data systems, multilateral information-sharing mechanisms, and preventive inspection frameworks are identified as key instruments through which CBDR can secure enforceability.

Choi & Lim (2025) propose that the Particularly Sensitive Sea Area (PSSA) regime can develop into a regional, area-based marine environmental protection norm within ABNJ through its connection with the BBNJ Agreement [6]. They suggest the necessity of effectively utilizing the IMO regulations to prevent vessel source pollution in ABNJ.

Existing literature predominantly focuses on the legal conflicts between CBDR and NMFT, policy tensions between developing and developed countries, or the feasibility and limitations of institutional adoption based on technical conditions. In contrast, this study centers on the issue of ship emission responsibility in dual jurisdictional zones, particularly ABNJ, and analyzes how CBDR can be institutionally integrated with strengthened enforcement jurisdiction. It proposes the flag state responsibility and PSC mechanisms as key enforcement tools, moving beyond normative discourse to explore practical regulatory implementation methods. Moreover, this study empirically examines the interactions among multilayered international maritime governance regimes including UNFCCC, IMO, UNCLOS, and the BBNJ agreement and explores the feasibility of an integrated regulatory strategy centered on CBDR.

This research contributes academically by proposing institutional alternatives to reform the GHG reduction regime in international shipping. It does so by outlining a differentiated implementation framework that seeks to balance equity with effectiveness.

4. Legal Basis of CBDR Principle and Its Application

4.1 The Significance and Development Background of the CBDR Principle

The principle of CBDR was first formally articulated in Principle 7 of the 1992 Rio Declaration. This principle states that ‘States shall cooperate in a spirit of global partnership to conserve, protect, and restore the health and integrity of the Earth’s ecosystem, and shall bear common but differentiated responsibilities taking into account different contributions to global environmental degradation [30].’ It particularly emphasizes that developed countries should shoulder greater responsibility in international efforts toward sustainable development, considering their historical contribution to environmental degradation as well as their possession of technological and financial resources [31].

The CBDR principle embodies a dual meaning: all states share a common responsibility for environmental issues, but the level of responsibility varies according to historical emissions, economic capacity, technological capability, and implementation capacity of each state [32]. At the 1992 Rio Conference, developing countries contested equal responsibility sharing with developed countries, stressing equitable burden-sharing and insisting that developed countries’ historical responsibilities take precedence in GHG reduction [33]. Accordingly, CBDR was established as an international consensus demanding differentiated measures for each country [33].

The principle began to be progressively incorporated into environmental agreements from the 1970s and rapidly expanded in major treaties concerning ozone layer protection and climate change since the 1990s [34]. Examples of international environmental conventions adopting the CBDR principle include:

Table 1. An Overview of International Environmental Conventions that Adopt the Principle of CBDR

Content	Convention	Provisions
Ozone Regime	The Vienna Convention	Article 2(1)
	The Montreal Protocol 1987	Article 5(1-3), 10(1-3), 10A (a & b)
Climate Change Regime	UNFCCC	Article 3(1&2), 4(2) (a&b), Article 12
	The Kyoto Protocol	Article 3(1), 11(2) (a & b)
	The Paris Agreement	Article 2(2), 3, 4(3) (5) (15)
Biodiversity Conservation Regime	The Convention on Biological Diversity 1992	Article 15(7), 16, 17(1), 18(1)(2), 20, 20(2&4), 21(1)
	The Nagoya Protocol 2010	Article 8(a&b), 22, 23, 25
The Land Conservation Regime	United Nations Convention to Combat Desertification (UNCCD) 1994	Articles 5, 6, 7, 17
Hazardous wastes regime	Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Article 4A

However, not all environmental agreements consistently adopt the CBDR principle. For instance, the 1994 United Nations Convention to Combat Desertification (UNCCD) and the 1998 Rotterdam Convention do not explicitly include it [35]. Thus, the legal nature of CBDR whether it possesses binding legal force or constitutes customary international law remains contested [36].

Notably, some developed countries, including the United States, have opposed the CBDR principle due to concerns that it imposes unfavorable obligations on them or overly reduces the responsibilities of developing countries [37]. The U.S., for example, rejected participation in the Kyoto Protocol partly because of its differential reduction obligations [38]. The International Tribunal for the Law of the Sea (ITLOS), while addressing preventive principles in advisory opinions related to environmental matters, has not clearly expressed a definitive position on the legal binding force of CBDR [39]. In academia, views vary: some regard CBDR as a fundamental principle of international environmental policy, while others classify it as an emerging principle or institutional soft law. Given these discussions, prevailing opinion holds that CBDR has not yet crystallized as customary international law [40, 41].

Nonetheless, CBDR possesses substantial normative significance and functions as a legal basis for differentiated obligations among parties in treaties such as the UNFCCC and the Paris Agreement [42]. In contrast, at the general international law level, it is often regarded as soft law. The CBDR principle transcends the traditional reciprocity-based approach of international law by presenting a new paradigm for realizing environmental justice and equity, and through its repeated appearances in international instruments, it has become a central principle within international environmental law [43].

Furthermore, the effective implementation of differentiated responsibilities demands moving beyond a simplistic developed-developing country distinction. International agreements increasingly classify states with more nuanced criteria such as economic capacity, technological capability, and environmental contribution, while also considering national interests, sensitivity to specific environmental issues, pollutant characteristics, and regional particularities [44]. For example, the International Tropical Timber Agreement (ITTA) differentiates countries based on the importance of timber production and use, and recommends technology transfer and financial assistance from developed countries [45].

Regardless of debates over its binding legal status, the CBDR principle operates as a vital normative foundation underpinning international environmental law's direction and legitimacy, particularly in discussions of environmental justice and equitable responsibility sharing.

4.2 Specification of the CBDR Principle within the UNFCCC and the Paris Agreement

CBDR principle is most concretely applied within the climate change regime and is explicitly incorporated in UNFCCC and the Paris Agreement. Article 3(1) of the UNFCCC provides that all Parties share a common responsibility, but differentiated responsibilities should be borne by each country according to their respective capabilities and socio-economic conditions. This differentiated approach is operationalized through the distinction between Annex I and non-Annex I Parties and has functioned as a core principle to facilitate the effective implementation of the climate change convention [46].

The Paris Agreement inherits and advances the CBDR principle within the UNFCCC by moving beyond the traditional dichotomy of developed and developing countries, establishing a flexible regime on NDCs [47]. This reflects the blurring boundaries between developed and developing countries in reality, designing a system wherein all countries participate in climate action while contributing in a differentiated manner based on their responsibilities and capabilities.

The UNFCCC was concluded on the basis of the principle of 'common but differentiated responsibilities and respective capabilities.' Accordingly, Article 4(2) imposes GHG reporting obligations solely on developed countries, while Article 4(3) limits financial support obligations to them as well. Here, developed countries refer to Annex I Parties under the Kyoto Protocol, which are subject to GHG reduction obligations. However, some developed countries failed to meet their reduction targets by 2012, leading developing countries to continuously demand responsible implementation by developed countries [48]. Particularly, in UN negotiations, developing countries have strongly urged developed countries to extend their reduction obligations for the post-2012 commitment period until 2020, and based on this premise, negotiations have proceeded toward a new regime in which both developed and developing countries participate in climate action post-2020 [49].

Thus, the UNFCCC and the Paris Agreement embrace the CBDR principle as foundational to climate change response and have entrenched it as a binding norm within domestic legal frameworks. This signifies that the CBDR principle has been firmly established as an international legal framework in the field of climate change.

4.3 Normative Conflicts Between IMO's GHG Regulatory Framework and the CBDR Principle

4.3.1 IMO's Regulatory Framework for ship's GHG Emission

International legal responsibility refers to the legal accountability for breaches of international law, and only subjects under international law can bear such responsibility. Since the primary subjects of international law are states, states are likewise the bearers of international legal responsibility. Accordingly, regulations on ship GHG emissions under UNCLOS are regarded as lawful regulations, and all states bear the obligation to reduce and prevent ship's GHG emissions to preserve the marine environment. The Kyoto Protocol imposes reduction obligations on Parties listed in Annex I, while detailed regulations regarding vessel source pollutants under UNCLOS are established through the IMO [50]. Furthermore, considering that the Kyoto Protocol delegates discussions on regulating GHG emissions from ships engaged in international navigation to the IMO, there is no doubt that the IMO is the most legitimate body under international law in practice [50].

The regulation of GHG emissions through the IMO must be implemented in accordance with the Non-Discrimination Principle applied in the regulation of ship-based pollutants under UNCLOS [51]. First, UNCLOS is a codification of customary international law, which has long bound all states to obligations for marine environmental protection. The current UNCLOS provisions stipulate general obligations for marine environmental protection and the occurrence of international legal responsibility. Article 237 of UNCLOS states that 'nothing in this Convention shall prejudice the rights and obligations of States under any other international agreement respecting the prevention, reduction, and control of pollution of the marine environment,' and that obligations under special conventions for marine environmental protection shall be performed consistently with the general principles and objectives of UNCLOS [52]. Therefore, when a new convention imposes specific obligations, such obligations must be fulfilled in accordance with that special convention but also in a manner consistent with the general principles and purposes of UNCLOS. Consequently, IMO discussions on ship GHG emission regulations should not impose reduction obligations solely on Annex I Parties under the Kyoto Protocol but should be approached in line with the general principles and objectives of UNCLOS.

Second, developing countries claim a differentiated common responsibility that embraces the Polluter Pays Principle. Under this principle, developed countries acknowledge the current generation's responsibility for past pollution activities and agree to mandatory reduction obligations, while all countries share a common duty to protect the environment for future generations [53]. Countries such as China, India, and South Korea, which were not included in Annex I at the time of the Kyoto Protocol, have achieved remarkable economic growth, and their GHG emissions now exceed those of developed countries and are expected to continue increasing [54]. Accordingly, there is growing support for including emerging economies among those subject to reduction obligations. Differential responsibilities are imposed based on countries' historical emissions, reflecting their historical responsibility [54].

4.3.2 Conflict and Harmonization between the Implementation Principle of MARPOL 73/78 and the CBDR Principle

MARPOL 73/78, the most significant IMO convention for preventing various vessel-source pollutants, is fundamentally based on the principle of NMFT, which serves as its core implementation mechanism [55]. This principle ensures that all ships are subject to the same regulations regardless of their flag state or whether that state has ratified the convention. Under this principle, all IMO member states have the authority to inspect ships entering their ports for compliance with the convention and may impose uniform regulations irrespective of the ship's flag state.

The 2011 MARPOL 73/78 Annex VI amendments introduced technical and operational measures to reduce ship-originated GHG emissions, such as EEDI and the SEEMP. These measures apply equally to all ships without distinguishing between developed and developing countries, consistent with the NMFT principle, and PSC serves as a key enforcement mechanism. However, this uniform, technology-based regulatory approach fundamentally conflicts with CBDR principle emphasized under UNFCCC and the Paris Agreement for climate change response.

The CBDR principle demands differentiated obligations and substantive support for developing countries based on their historical emissions and economic and technological capacities [56]. MARPOL 73/78 framework does not account for these inter-state differences and has been criticized for insufficient institutionalization of financial support and technology transfer. Although the 2011 and 2023 MARPOL 73/78 Annex VI amendments

incorporated provisions for implementation delays and technical cooperation at the insistence of some developing countries, the substantive financial support and institutional effectiveness remain limited [57]. Moreover, the shift in decision-making from unanimity to majority voting during the 2011 amendment process raised concerns about procedural legitimacy [57]. This departure from IMO's traditional treaty-making procedures may undermine the acceptance of the convention's implementation by developing countries and weaken its international legitimacy.

Although the technical regulations under MARPOL 73/78 have applied primarily to new ships since 2013, given the increasing GHG emissions from the international shipping sector and future projections, the dominant assessment is that technical regulations alone are insufficient to achieve reduction targets. Technical approaches alone fail to adequately consider the diverse conditions and capacities of developing countries and have limitations in ensuring the effectiveness and equity of the regulatory system.

The conflict between the MARPOL 73/78 framework and the CBDR principle acts as a major obstacle to securing both the effectiveness and fairness of ship GHG reduction policies. To address this, the following institutional improvements are required: (1) expanded phased implementation delays for developing countries, (2) establishment of substantive technology transfer and financial support mechanisms, and (3) the creation of policy dialogue platforms to explore the harmonization between the non-discrimination principle and the principle of differentiated responsibilities. Furthermore, enhancing normative coherence through institutional linkage between IMO and UNFCCC and establishing a fair regulatory system within the shipping industry will be key to improving international legitimacy and acceptance.

5. Possibilities for Applying CBDR in MARPOL 73/78 to Reduce GHG Emissions in ABNJ

5.1 Challenges and Enforcement Limitations of Ship GHG Emissions in ABNJ

ABNJ refer to marine areas that fall outside the sovereignty and jurisdiction of any single state, encompassing the high seas and the deep seabed beyond national exclusive economic zones [6]. These zones fall outside the direct enforcement jurisdiction of individual states under UNCLOS, necessitating multilateral cooperation and international legal norms for effective marine environmental protection and resource management. In particular, GHG emissions from ships in ABNJ pose serious environmental challenges but face multiple constraints and limitations in terms of regulation and enforcement.

According to UNCLOS, the primary jurisdiction over vessels operating in ABNJ fall under the flag state. The flag state is obligated to enact and enforce marine pollution prevention legislation applicable to vessels flying its flag or registered under its authority, ensuring that such legislation is at least equivalent in effect to rules established by international organizations or diplomatic documents. Furthermore, the flag state regulates ship design, construction, equipment, and manning standards, oversees compliance through periodic inspections and certificate issuance, and holds responsibility to promptly investigate violations and initiate legal proceedings if necessary [58]. However, the flag state system suffers from significant limitations in enforcement capacity within ABNJ. States other than the flag state cannot exercise direct regulatory enforcement, and when flag states fail to act decisively against violations by their vessels, the effectiveness of pollution prevention diminishes markedly. Particularly, ships registered under FOC, which often lack a clear genuine link with the flag state, find regulatory evasion easier, thereby exacerbating vulnerabilities in the international marine environmental protection regime. Although UNCLOS requires the existence of a genuine link, the absence of concrete standards means regulatory avoidance via FOC remains unresolved [58].

On the other hand, coastal states may exercise port state jurisdiction when a violating vessel voluntarily enters their port following a marine pollution incident occurring beyond their territorial sea [59]. Port states have authority to conduct post-incident investigations and initiate legal actions; however, this authority is limited in several respects. First, enforcement depends on the voluntary port entry of the offending vessel [59]. Second, port state jurisdiction applies only to violations of international standards related to pollutant discharge and does not extend to violations concerning ship design, construction, equipment, or manning [59]. Third, jurisdiction is confined to incidents occurring in high seas without territorial connection and does not cover breaches of unilateral domestic regulations. Fourth, the flag state's priority right means that if the flag state initiates proceedings, port state actions are suspended for a defined period. While the port state control system supplements the flag state regime by expanding universal jurisdiction to regulate illegal pollution, its enforcement scope, procedures, and application remain limited, necessitating institutional enhancements and multilateral cooperation at the level of the IMO and other international organizations to ensure effectiveness.

Regulation of ship GHG emissions in ABNJ is exposed to legal and institutional gaps and regulatory evasion risks due to enforcement limits inherent in flag state jurisdiction, the FOC issue, and structural constraints of port state jurisdiction. To overcome these challenges, it is imperative to strengthen international cooperation led by the IMO, introduce advanced monitoring technologies, establish differentiated support frameworks reflecting the CBDR principle, and develop mechanisms to prevent regulatory evasion by FOC vessels. In particular, the application of the CBDR principle can enhance regulatory effectiveness by providing financial, technical, and capacity-building assistance to developing flag states, many of which operate FOC vessels, thereby incentivizing stricter compliance and enabling more effective oversight. This approach addresses structural disparities and encourages broader participation by reducing the economic and administrative burdens associated with enforcing GHG regulations on FOC ships operating in ABNJ. At the same time, to prevent potential carbon leakage and the misuse of differentiated responsibilities, such support should be accompanied by transparency and accountability measures, including monitoring, reporting, and verification (MRV) requirements, thereby ensuring that CBDR-based assistance promotes responsible enforcement rather than regulatory evasion by FOC states.

5.2 Proposals for Strengthening MARPOL 73/78 to Implement the Principle of CBDR

IMO has established a normative framework such as SOLAS and MARPOL 73/78 to ensure maritime safety and marine environmental protection. To guarantee effective implementation, it operates PSC and the Member State Audit Scheme, which has been in effect since 2016 [60]. In particular, IMO applies uniform standards to all ships, including those of non-party states, based on the feasibility of enforcement at the vessel level through NMFT principle. However, recent IMO efforts to address climate change, especially the reduction of GHG emissions from ships, have evolved into a global environmental issue requiring political and economic considerations beyond mere technical regulation. Amendments to MARPOL 73/78 Annex VI and GHG reduction measures have generated conflicts with principles of other international legal regimes such as the UNFCCC and WTO [61]. Developing countries demand differentiated responsibilities and support based on the principle of CBDR, while developed countries insist on uniform regulation grounded in the NMFT principle, intensifying normative tensions [18]. These issues are particularly pronounced in ABNJ where national sovereignty does not extend.

ABNJ constitutes areas outside the sovereign control of any state under the law of the sea, and although shipborne GHG emissions here directly impact global climate change, the current regulatory framework reveals significant limitations including the absence of enforcement jurisdiction, disparities in enforcement due to flag state jurisdiction, and institutional gaps. When flag states have limited legal and administrative capacity, effective regulation of ships is virtually impossible, undermining the effectiveness of the MARPOL 73/78.

Therefore, effective regulation of shipborne GHG emissions in ABNJ requires more than strengthening technical standards. It necessitates clearly defining national GHG reduction responsibilities and establishing institutional mechanisms capable of ensuring substantial implementation. To this end, reflecting the CBDR principle within the MARPOL 73/78 is essential, with explicit moral and legal responsibilities based on developed countries' historical emissions, linked to international cooperation mechanisms such as technology transfer, financial support, and capacity building. State responsibility-based regulation can complement the limitations of the NMFT principle and serve as a practical compromise foundation in future discussions on the introduction of MBMs [55].

Furthermore, MARPOL 73/78 should be revised to move beyond its current technology-centric approach by explicitly delineating national implementation responsibilities for GHG emission reductions, including mechanisms for assessment, enforcement, and sanctions to ensure effective compliance. The proposed regulations on the 'Responsibility of States for Principle Application' may include the following: (1) a clear delineation of national responsibilities that reflect the CBDR principle and account for historical emissions as recognized under the UNFCCC; (2) rules of priority and mechanisms for avoiding conflicts among the UNFCCC, WTO, and IMO legal regimes; (3) explicit provisions addressing exceptional circumstances such as climate-related disasters, armed conflict, or state incapacity; (4) interpretative guidelines aimed at minimizing trade disputes and sovereignty-related controversies arising from divergent legal interpretations; and (5) flexible regulatory measures that accommodate technical constraints, including shipwrecks or loss of critical data. GHG-related provisions within the MARPOL 73/78 cannot adequately address the complex and imbalanced challenges of climate change under the NMFT principle alone. Particularly, it is imperative to integrate a multi-layered implementation framework reflecting the CBDR principle along with support mechanisms for

developing countries to fill regulatory gaps in ABNJ. Such institutional evolution will simultaneously enhance fairness and sustainability in international shipping and reinforce the international legitimacy of marine environmental governance.

6. Conclusion

This study conducted a multilayered analysis of the limitations of the international regulatory framework addressing ship GHG emissions in ABNJ, the application of the principle of CBDR, and directions for improving the MARPOL 73/78. While GHG emissions from the shipping sector pose a significant obstacle to achieving global climate goals, effective enforcement in spaces like ABNJ where national sovereignty does not extend is hindered by the flag state system and MARPOL 73/78's technology based regulatory approach. Regulatory evasion by flag of convenience ships, enforcement deficits, and structural constraints on port state jurisdiction are major factors limiting the existing regime's effectiveness. The CBDR principle has become a crucial standard in international climate law such as under the UNFCCC, reflecting historical responsibility and differences in countries' economic and technological capabilities. It provides a key logical foundation for establishing equitable obligations and support systems in the shipping sector. However, the current MARPOL 73/78, based on NMFT principle, lacks substantive differentiation in responsibility sharing among countries.

This study performed an in-depth analysis focusing on the regulation of ship GHG emissions in ABNJ, the applicability of the CBDR principle, and directions for IMO MARPOL 73/78 improvements. The application of the CBDR principle can enhance the effectiveness of regulatory frameworks by delivering financial, technical, and capacity-building support to developing flag states. Since many of these states serve as major FOC registries in the shipping industry, targeted and differentiated assistance can foster stricter compliance and bolster oversight capabilities. It can mitigate structural inequities and promotes broader international participation by reducing the economic and administrative burdens associated with enforcing GHG regulations on FOC vessels operating in ABNJ.

Thus, the main conclusions and implications of the study are as follows: First, within international environmental law and the UNFCCC regime, the CBDR principle has evolved as a core criterion to ensure equity by considering historical responsibility and economic and technological disparities between developed and developing countries. This normative experience provides important legal grounds and guidance for imposing differentiated responsibilities and designing support policies in shipping sector GHG regulations, particularly essential for overcoming frequent flag of convenience issues and enforcement limits of flag state jurisdiction in ABNJ.

Second, IMO's current GHG regulatory framework, especially MARPOL 73/78 Annex VI, strengthens vessel based technical standards grounded on the NMFT principle, but faces inherent limitations in effectiveness due to tensions with the CBDR principle. Restrictions on port state jurisdiction and regulatory gaps in ABNJ continue to pose obstacles for reducing emissions in the shipping sector.

Third, the effective implementation of the CBDR principle in ABNJ requires a clear allocation of responsibilities, the enhancement of enforcement jurisdiction, and the establishment of differentiated systems for financial, technological, and capacity-building support. Such cooperative framework should be implemented based on interagency coordination and harmonization among IMO, UNFCCC, WTO, and other international bodies, together with integrated monitoring, reporting systems, and transparency enhancement.

Fourth, the MARPOL 73/78 should evolve institutionally beyond technology-based standards to explicitly specify national level implementation responsibilities for GHG reduction, incorporating mechanisms for assessment and sanctions to ensure compliance. The proposed 'Responsibility of States for Principle Application' should include the following key elements:

- Reflection of the UNFCCC CBDR principle and historical responsibility
- Priority rules and conflict avoidance mechanisms for the application of UNFCCC, WTO, and IMO agreements
- Clear provisions for exceptional circumstances such as climate disasters, war, and state dysfunction
- Establishment of interpretive principles to prevent trade disputes and sovereignty conflicts arising from regulatory interpretation differences
- Flexible regulations accounting for technical limitations such as shipwrecks and data loss

Such institutional enhancements will increase the practicability of implementing CBDR within MARPOL, minimize conflicts between international legal regimes, and enhance the effectiveness of GHG reduction in the shipping sector.

Finally, this study emphasizes the need for legal and institutional reforms concerning GHG reduction and CBDR application in ABNJ and suggests the following areas for further research: empirical studies on capacity building and international cooperation models for developing countries; analyses of interactions between IMO norms and regional regulations such as the EU's CBAM; and exploration of integrating advanced monitoring technologies and new MBMs with the CBDR principle.

This study confirms that the realistic and legal incorporation of the CBDR principle, multilayered institutional reforms of the MARPOL 73/78, and multilateral international cooperation can fill the regulatory gap for shipping GHG emissions in ABNJ, contributing to achieving carbon neutrality by 2050 and sustainable marine environmental protection. This will establish a core legal and policy foundation for the future of the international shipping industry and global climate change response.

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