

## Review Article

# Climate change and maritime law: A review of IMO governance mechanism

Khadija Zulfiqar\*, Yen-Chiang Chang

*School of Law, Dalian Maritime University, Dalian 116026, Liaoning Province, China*

\* Corresponding author: Khadija Zulfiqar, khadijazulfiqar@gmail.com

**Abstract:** International maritime trade has long played a pivotal role in human development; however, its environmental impact cannot be disregarded. Air pollution (that includes Carbon and Sulphur emissions—all together Greenhouse Gases) emanating from ships has emerged as a significant contributor to climate change, prompting growing concern among the international community. The combustion of fossil fuels in ship engines releases pollutants such as sulfur dioxide, nitrogen oxides, and particulate matter into the atmosphere, adversely affecting both human health and the climate. In recognition of the need to tackle this issue, international laws have been established to regulate ship emissions. This research paper analysed the IMO's regulations under international law for mitigating climate change, with a particular focus on various global initiatives controlling sulphur, carbon and GHG emissions. It is suggested that cooperation between public and private interests as well as at regional levels will play a crucial role in combating climate change and promoting global shipping sustainability.

**Keywords:** climate change; marine environment protection law; international maritime organization; international maritime law; law of the sea

## 1. Introduction

The global maritime industry plays a crucial role in facilitating international trade, carrying approximately 80% of the world's goods<sup>[1]</sup>. However, the immense growth of shipping activities has raised concerns regarding its environmental impact, particularly with regards to ship pollution and its implications for climate change. The release of pollutants from ships, such as greenhouse gases (GHGs), sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter, not only degrades marine ecosystems but also significantly contributes to global warming<sup>[2]</sup>.

The impacts of ship pollution on climate change are multifarious and far-reaching. One of the primary concerns is the emission of GHGs, particularly carbon dioxide (CO<sub>2</sub>). According to the International Maritime Organization (IMO), the shipping industry is responsible for nearly 3% of global CO<sub>2</sub> emissions<sup>[3]</sup>. These emissions are projected to rise significantly in the coming years due to the expected growth in global trade and shipping activities. Such a scenario not only exacerbates climate change but also poses a considerable challenge to achieving the targets outlined in the Paris Agreement of the United Nations Framework Convention on Climate Change<sup>[4]</sup>.

Furthermore, ship pollution is not limited to GHGs, the burning of heavy fuel oils by ships releases sulfur and nitrogen compounds, contributing to the formation of acid rain and harmful atmospheric pollutants<sup>[5]</sup>. These pollutants not only affect human health but also have detrimental effects on ecosystems, including marine life and biodiversity. The release of particulate matter from ships further exacerbates air pollution, leading to adverse consequences for both human and environmental well-being<sup>[6]</sup>.

The IMO as a specialized agency of the United Nations has implemented regulations, notably the

International Convention for the Prevention of Pollution from Ships (MARPOL), to control air pollution from ships and minimize their environmental impact<sup>[7]</sup>. MARPOL is the primary legal instrument governing ship pollution because it addresses various forms of pollution, including air pollution, by imposing limits on the emission of pollutants from ships and prescribing guidelines for their control. There are further regulations aiming to limit sulfur and nitrogen oxide emissions, promote the utilization of cleaner fuels, and encourage the adoption of energy-efficient technologies within the maritime industry. The IMO has introduced the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP) to encourage the adoption of energy-efficient technologies and practices in the shipping industry<sup>[8]</sup>.

Effective enforcement of the international law is essential for mitigating the harmful effects of ship-related air pollution and fostering a more sustainable future for global shipping<sup>[9]</sup>. Although in response to these concerns various international conventions and regulations have been developed to mitigate ship pollution and its impact on climate change, challenges persist in effectively controlling ship pollution and reducing its climate impact<sup>[10]</sup>. These challenges include issues of enforcement, compliance, and the need for technological advancements and alternative fuels<sup>[11]</sup>. Additionally, the evolving nature of the maritime industry necessitates a continuous review and improvement of existing regulations to address emerging concerns and promote sustainable shipping practices.

This research paper aims to explore the multifaceted issue of ship pollution and its profound connection to climate change. Additionally, it examines the existing international legal framework and regulations that govern the maritime industry, highlighting their effectiveness, shortcomings, and the need for future improvements.

## **2. Literature review**

As discussed above, ship pollution poses a significant threat to climate change and requires urgent attention from policymakers, researchers, and stakeholders. This research paper provides an in-depth analysis of the impact of ship pollution on climate change, highlighting the need for robust international legal frameworks and regulations to combat this issue effectively<sup>[12]</sup>. By understanding the complexities of ship pollution and its environmental consequences, we can foster sustainable practices in the maritime industry, minimize its ecological footprint, and contribute to a more environmentally responsible and resilient future<sup>[13]</sup>.

Ship-source pollution has emerged as a critical issue within the broader context of climate change, as the shipping industry continues to contribute significantly to greenhouse gas emissions and other pollutants<sup>[14]</sup>. This literature review aims to explore the existing international legal framework governing ship-source pollution in the context of climate change. By examining relevant scholarly works, international agreements, and legal instruments, this review provides a comprehensive understanding of the progress made in regulating ship-source pollution and identifies key challenges and areas for improvement.

### **2.1. International law governing marine pollution—UNCLOS**

United Nations Convention on Law of the Sea (UNCLOS), adopted in 1982, serves as the cornerstone of international law governing maritime affairs. While UNCLOS does not explicitly address climate change, it provides a legal framework for addressing ship-source pollution<sup>[15]</sup>. Under UNCLOS, coastal states have the right to adopt laws and regulations to prevent, reduce, and control pollution from ships within their territorial waters. However, UNCLOS falls short in providing comprehensive regulations specifically targeting greenhouse gas emissions and their contribution to climate change.

### **2.2. The International Maritime Organization (IMO)**

IMO, the specialized agency of the United Nations responsible for regulating international shipping, the

IMO has taken significant steps in addressing ship-source pollution. The IMO adopted Annex VI to the MARPOL in 1997, setting limits on sulfur oxide and nitrogen oxide emissions from ships<sup>[7]</sup>. Subsequent amendments to Annex VI introduced the EEDI and the SEEMP, aiming to reduce carbon dioxide emissions through energy-efficient ship design and operational practices. While these measures mark progress, critics argue that they do not go far enough in curbing greenhouse gas emissions from the shipping industry<sup>[8]</sup>.

### **2.2.1. Sulphur 2020**

The primary regulatory measure implemented in 2020, usually known as IMO 2020, pertains to the reduction of sulphur content in marine fuels. The following is a concise overview of the key points:

The primary modification entailed the decrease in the permissible upper limit of sulphur concentration in marine fuels<sup>[3]</sup>. The previous standard for sulphur content in marine fuels, up until the year 2020, was set at 3.5% sulphur by mass on a global scale. A significant reduction in the permissible sulphur content by mass to 0.5% has been implemented in the majority of regions worldwide<sup>[16]</sup>. This pertains to both the maritime areas beyond national jurisdiction and the maritime zones under the sovereignty of states that have implemented the aforementioned legislation.

Certain regions, referred to as Emission Control Areas (ECAs), had previously implemented more stringent sulphur restrictions prior to the year 2020<sup>[17]</sup>. In the aforementioned regions, the sulphur content threshold has previously been established at 0.1% by mass. These geographical regions encompass certain portions of the Baltic Sea, the North Sea, and North America.

In order to adhere to these laws, ship operators possess a range of compliance alternatives at their disposal. One potential solution is for them to transition to the use of low-sulfur marine fuels, such as marine petrol oil, which inherently adhere to the newly imposed restrictions<sup>[17]</sup>. In addition, an alternative approach involves the installation of exhaust gas cleaning devices, commonly known as scrubbers, which effectively eliminate sulphur dioxide emissions from the exhaust gases of ships<sup>[18]</sup>. This enables the continued utilisation of fuels with higher sulphur content, while simultaneously ensuring compliance with emissions standards.

The enforcement and imposition of penalties for non-compliance with these regulations is under the jurisdiction of each country inside their respective territorial seas. Failure to comply with regulations can lead to various consequences, such as the imposition of fines and the potential detention of the vessel<sup>[19]</sup>.

The IMO 2020 regulations were implemented with the objective of mitigating the adverse environmental and health consequences associated with shipping emissions, including sulphur dioxide (SO<sub>2</sub>) emissions<sup>[17]</sup>. These emissions are known to contribute to air pollution, acid rain formation, and respiratory ailments. The IMO sought to achieve a substantial reduction in detrimental emissions by implementing measures to minimise the sulphur content in ship fuels.

### **2.2.2. GHG emissions regulations**

The IMO has been diligently engaged in formulating regulatory measures aimed at mitigating GHG emissions originating from the shipping sector. The fundamental objective revolves around mitigating the impact of the maritime sector on global climate change. The following are notable advancements and regulatory measures pertaining to the IMO's endeavours in governing GHG emissions:

The IMO announced an initial strategy in 2018 to address the reduction of GHG emissions from ships. In April 2018, the IMO implemented an inaugural plan aimed at mitigating GHG emissions originating from the global maritime industry<sup>[20]</sup>. The primary objective of the strategy is to achieve a minimum reduction of 50% in yearly GHG emissions from global maritime transport by the year 2050, as comparison to the emission levels recorded in 2008. Furthermore, the proposed policy seeks to actively pursue endeavours aimed at

gradually eliminating or reducing the reliance on fossil fuels to the greatest extent feasible<sup>[21]</sup>.

The Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII), which were implemented in 2020, are two measures aimed at assessing and quantifying the energy efficiency and carbon intensity of existing ships. The IMO's Marine Environment Protection Committee (MEPC) made amendments to the MARPOL<sup>[7,16]</sup> Annex VI in November 2020. These amendments were implemented to establish new regulations pertaining to the energy efficiency of ships already in operation (EEXI) and the carbon intensity of ships (CII). The aforementioned laws necessitate that ships adhere to specific energy efficiency criteria, which are determined by the ship's EEXI and CII ratings.

The IMO has been engaged in the ongoing development of additional changes to the MARPOL Annex VI. These additions aim to enhance the energy efficiency standards applicable to newly constructed vessels. The purpose of these modifications is to set a series of increasingly stringent energy efficiency standards for newly constructed vessels, with the objective of promoting the adoption of more fuel-efficient and environmentally friendly technologies.

### **2.3. International law on climate change**

The United Nations Framework Convention on Climate Change (UNFCCC) is a pivotal international treaty that addresses the global challenge of climate change<sup>[4]</sup>. While the UNFCCC primarily focuses on reducing greenhouse gas emissions from various sectors, including energy and industry, its impacts on ship-source air pollution have been significant. This note explores the key aspects of the UNFCCC and its influence on regulating air pollution from ships<sup>[22]</sup>.

**Mitigation commitments:** The UNFCCC establishes a framework for countries to make commitments to mitigate greenhouse gas emissions<sup>[23]</sup>. While the shipping industry is not explicitly included in the quantified emission reduction targets of the UNFCCC, member countries are encouraged to include shipping emissions in their national climate strategies. This provides a platform for countries to voluntarily address air pollution from ships within their broader climate action plans<sup>[23]</sup>.

**IMO's linkage to UNFCCC:** The IMO, as the specialized agency of the UN responsible for regulating international shipping, collaborates closely with the UNFCCC<sup>[23]</sup>. The IMO's regulations, such as those outlined in the MARPOL Annex VI, are aligned with the UNFCCC's objective of reducing greenhouse gas emissions<sup>[23]</sup>. These regulations focus on limiting sulfur and nitrogen oxide emissions and promoting energy-efficient practices, thereby indirectly addressing air pollution from ships<sup>[24]</sup>.

**Paris Agreement and shipping:** The Paris Agreement, a landmark outcome of the UNFCCC, aims to keep the global temperature rise well below 2 degrees Celsius above pre-industrial levels<sup>[25]</sup>. Although the shipping sector is not explicitly included in the Paris Agreement, it recognizes the need to address emissions from international shipping. Article 2.2 of the Paris Agreement urges countries to pursue efforts to minimize the impact of international shipping emissions on climate change<sup>[26]</sup>. This acknowledgement highlights the growing importance of regulating ship-source air pollution to achieve the goals of the Paris Agreement.

**IMO's initial strategy on GHG emissions:** In response to the UNFCCC's call to address shipping emissions, the IMO developed its Initial Strategy on Reduction of Greenhouse Gas Emissions from Ships in 2018<sup>[27]</sup>. This strategy aims to reduce total annual GHG emissions from international shipping by at least 50% by 2050 compared to 2008 levels, while also pursuing efforts towards phasing them out entirely<sup>[28]</sup>. The IMO's strategy aligns with the ambition of the Paris Agreement and demonstrates the influence of the UNFCCC on shaping the industry's response to ship-source air pollution.

**The Paris Agreement:** Adoption of the Paris Agreement in 2015 marked a significant milestone in global

efforts to combat climate change. The Agreement seeks to limit global temperature rise to well below 2 degrees Celsius above pre-industrial levels<sup>[29]</sup>. Although the Paris Agreement does not explicitly mention ship-source pollution, the shipping industry is recognized as a significant contributor to greenhouse gas emissions<sup>[30]</sup>. Parties to the Agreement are encouraged to develop and implement strategies for reducing emissions from international shipping. However, the effectiveness of these strategies largely depends on the willingness of states and the shipping industry to adopt and implement concrete measures<sup>[31]</sup>.

## **2.4. Regional and bilateral agreements**

In addition to international conventions, regional and bilateral agreements have been developed to address ship-source pollution in the context of climate change<sup>[32]</sup>. For instance, the European Union's Monitoring, Reporting, and Verification (MRV) Regulation requires ships calling at EU ports to monitor and report their CO<sub>2</sub> emissions. Similarly, bilateral agreements, such as the Canada-United States Air Quality Agreement, have been established to control air pollution from ships navigating shared waters<sup>[28]</sup>. These agreements demonstrate the growing recognition of the need for regional and bilateral cooperation to address ship-source pollution effectively<sup>[26]</sup>.

The literature reviewed highlights the progress made in developing an international legal framework to address ship-source pollution within the context of climate change<sup>[33]</sup>. While significant strides have been taken, challenges remain in effectively regulating greenhouse gas emissions and other pollutants from the shipping industry<sup>[34]</sup>. These challenges include issues of enforcement, compliance, and the need for technological advancements and alternative fuels<sup>[35]</sup>. Future research and legal developments should focus on strengthening international regulations, fostering greater cooperation among states and stakeholders, and promoting sustainable practices to mitigate the environmental impact of ship-source pollution on climate change<sup>[36]</sup>.

## **3. Analysis**

The regulation of ship-source pollution within the context of climate change is a complex and evolving issue. This analysis examines the international legal framework governing ship-source pollution and its effectiveness in addressing the climate impact of the shipping industry. By evaluating the strengths, weaknesses, and challenges of existing international law, this analysis provides insights into the progress made and areas requiring further attention<sup>[37]</sup>.

### **3.1. Strengths of international law on ship-source pollution**

#### **3.1.1. Framework for cooperation**

The international legal framework, primarily established by the IMO, provides a framework for global cooperation and coordination in addressing ship-source pollution<sup>[38]</sup>. Instruments such as the MARPOL and the associated Annex VI have set binding standards and regulations for reducing air pollution from ships, including greenhouse gas emissions<sup>[39]</sup>. These legal instruments foster collaboration among states, industry stakeholders, and international organizations. More effective implementation requires collaboration among and between States in similar region through effective partnerships under existing environmental agreements. For example, in the North-East Atlantic Sea, there exists The Convention for the Protection of the Marine Environment of the North-East Atlantic (also known as OSPAR Convention) can be effective through new means of implementing regulations for controlling emissions.

#### **3.1.2. Adoption of energy efficiency measures**

The IMO's introduction of the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP) represents a significant step toward promoting energy-efficient practices in the

shipping industry<sup>[40]</sup>. These measures aim to reduce carbon dioxide emissions through improved ship design, equipment, and operational practices. By incentivizing energy efficiency, international law encourages the adoption of sustainable technologies and practices in the maritime sector<sup>[41]</sup>. This step can be taken by shipping agencies under strong control of national regulatory authorities. For example, in China, there has been strong implementation of local regulation on shipping to control emissions.

### **3.1.3. Recognition of regional cooperation**

The existence of regional agreements, such as those within the European Union, demonstrates the recognition of the need for regional cooperation in addressing ship-source pollution<sup>[42]</sup>. These agreements complement the international legal framework by implementing additional measures tailored to regional challenges and encouraging collaboration among neighbouring countries. Regional cooperation can serve as a catalyst for effective implementation and enforcement of international regulations<sup>[43]</sup>. IMO shall work in regional cooperation mechanisms in order to control the emissions effectively. Moreover, IMO representatives can work in few regional organisations for implementation of air pollution control regulations.

## **3.2. Weaknesses and challenges of international law on ship-source pollution**

**Limited scope of regulation:** The international legal framework primarily focusing air pollution from ships, also addresses the gaps in the regulation of other forms of ship-source pollution, such as ballast water discharges and marine litter. At this stage, there is a requirement of comprehensive regulation and governance of all aspects of ship-source pollution is necessary to mitigate the overall environmental impact effectively<sup>[44]</sup>.

**Insufficient ambition:** Critics argue that the existing regulations, including Annex VI of MARPOL, lack sufficient ambition in reducing greenhouse gas emissions from the shipping industry<sup>[24]</sup>. Despite the inclusion of energy efficiency measures, the absence of binding targets for emission reductions and a lack of clarity on alternative fuels hinder significant progress<sup>[45]</sup>. To align with the goals of the Paris Agreement, international law should aim for more ambitious targets and establish a clear roadmap for decarbonizing the shipping sector<sup>[46]</sup>.

**Enforcement and compliance challenges:** The enforcement of international regulations on ship-source pollution remains a challenge. The sheer number of vessels, varying national enforcement capabilities, and limited resources pose obstacles to effective monitoring and enforcement<sup>[47]</sup>. Strengthening enforcement mechanisms and enhancing collaboration among states and regional authorities is crucial for ensuring compliance and deterring non-compliance<sup>[48]</sup>.

**Technological and financial barriers:** The transition to low-carbon technologies and alternative fuels in the shipping industry faces significant technological and financial barriers<sup>[49]</sup>. The development and implementation of sustainable and affordable solutions require substantial investment and research and development efforts. International law should encourage innovation and provide incentives for the adoption of cleaner technologies, while also addressing the financial challenges associated with their implementation<sup>[50]</sup>.

The analysis reveals both strengths and weaknesses in the international legal framework on ship-source pollution within the context of climate change. While international law has laid the foundation for cooperation, adopted energy efficiency measures, and recognized the importance of regional cooperation, challenges persist. The limited scope of regulation, insufficient ambition in reducing emissions, enforcement and compliance challenges, and technological and financial barriers necessitate further attention. Strengthening international regulations, setting more ambitious targets, enhancing enforcement mechanisms, and promoting innovation and financing options are essential to effectively address ship-source pollution and mitigate its climate impact. A collaborative approach involving states, the shipping industry, and international organizations is crucial for achieving sustainable and environmentally responsible shipping practices.

## **4. Suggestions for improving MARPOL Convention, GHG emissions regulations, and Sulphur 2020**

By implementing these suggestions, the international community can strengthen the MARPOL Convention, enhance GHG emissions regulations, and improve compliance with Sulphur 2020 requirements. These measures would contribute to the global efforts in reducing the environmental impact of the shipping industry, fostering sustainable practices, and addressing the urgent challenges posed by climate change.

**Strengthening GHG emissions regulations: Binding emission reduction targets:** Enhance the effectiveness of international law by introducing binding emission reduction targets for the shipping industry<sup>[51]</sup>. Establish clear and ambitious targets aligned with the goals of the Paris Agreement, encouraging the adoption of low-carbon technologies and alternative fuels<sup>[16]</sup>.

**Market-based measures:** Consider implementing market-based measures, such as a carbon pricing mechanism or emissions trading scheme, to incentivize emission reductions in the shipping sector<sup>[52]</sup>. These economic instruments can create financial incentives for shipowners to invest in energy-efficient technologies and practices<sup>[52]</sup>.

**Technology development and research:** Increase support for research and development of innovative technologies and sustainable fuels for the shipping industry<sup>[52]</sup>. Encourage collaboration between governments, research institutions, and industry stakeholders to expedite the development and commercialization of low-carbon solutions<sup>[53]</sup>.

**Strengthening Sulphur 2020 compliance: Stringent enforcement mechanisms:** Enhance monitoring, control, and enforcement measures to ensure widespread compliance with the Sulphur 2020 regulation. Strengthen port state control inspections, increase surveillance technologies, and implement effective penalties for non-compliance to deter violations<sup>[20]</sup>.

**Promoting transparency:** Improve transparency and information sharing regarding compliance with Sulphur 2020 regulations. Develop a centralized reporting system that requires ship operators to disclose their fuel consumption, sulfur content, and emissions data to relevant authorities, facilitating monitoring and verification processes<sup>[54]</sup>.

**Capacity building and awareness:** Invest in capacity-building initiatives, particularly for developing countries, to enhance their ability to enforce Sulphur 2020 regulations effectively. Provide training programs, technical assistance, and financial support to improve compliance capabilities and raise awareness among ship operators, port authorities, and relevant stakeholders<sup>[55]</sup>.

**Enhancing MARPOL Convention: Comprehensive approach:** Expand the scope of MARPOL to cover all aspects of ship-source pollution, including ballast water management, marine litter, and noise pollution. Develop comprehensive regulations and guidelines to address these forms of pollution, aligning with international best practices<sup>[56]</sup>.

**Strengthen regional cooperation:** Promote regional cooperation and coordination among states to effectively implement and enforce MARPOL regulations. Encourage the exchange of information, best practices, and capacity-building efforts among neighboring countries to ensure consistent compliance and enforcement.

**Technology transfer and financing:** Facilitate technology transfer and provide financial support to developing countries for the adoption of cleaner technologies and the implementation of MARPOL requirements. Support initiatives that promote affordable access to sustainable solutions, helping developing nations meet their obligations under the convention<sup>[57]</sup>.

Regular review and update: Establish a regular review mechanism to ensure the continued relevance and effectiveness of MARPOL regulations. Periodically assess emerging challenges, technological advancements, and scientific developments to adapt and update the convention accordingly<sup>[58]</sup>.

## 5. Conclusion

In this research paper, it has been analysed that what is the exiting regulation and framework controlling the ship source of air pollution at international level. It can be concluded that international organisations generally and IMO specifically is implementing strict measures to address the climate change. Therefore, UNFCCC, Kyoto Protocol and Paris Agreement have significant regulations to control ship-source air pollution by creating a global framework for addressing climate change. While the shipping industry is not directly regulated under the UNFCCC, its influence is evident through the IMO's collaboration and alignment with the objectives of the UNFCCC. The Paris Agreement's recognition of the importance of addressing emissions from international shipping further emphasises the need to regulate air pollution from ships. The ongoing efforts of the IMO to develop strategies and regulations for reducing greenhouse gas emissions from ships reflect the influence and guidance of the UNFCCC in combating ship-source air pollution and achieving global climate goals. Moreover, through regional cooperation and public-private partnerships shipping source of air pollution can be significantly controlled as suggested in this research paper.

## Conflict of interest

All authors have read and agreed to the published version of the manuscript, and there is not conflict of interest.

## Abbreviations

GHG	Greenhouse Gas
Sulphur or So <sub>x</sub>	Sulphur Oxides
Nitrogen or NO <sub>x</sub>	Nitrogen Oxide
CO <sub>2</sub>	Carbon Dioxide
IMO	International Maritime Organization
EEDI	Energy Efficiency Design Index
SEEMP	Ship Energy Efficiency Management Plan
UNCLOS	United Nations Convention on Law of the Sea
ECAs	Emission Control Areas
EEXI	Energy Efficiency Existing Ship Index
CII	Carbon Intensity Indicator
MEPC	Marine Environment Protection Committee
EEXI	Energy Efficiency of Ships Already in Operation
UNFCCC	United Nations Framework Convention on Climate Change
MRV	Monitoring, Reporting, and Verification
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
EEDI	Energy Efficiency Design Index
SEEMP	Ship Energy Efficiency Management Plan
Sulphur 2020	Regulation to Control Sulphur Substance from Ships
GHG Emissions Regulations	Regulation to Control Greehouse Gases Emissions from Ships



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