
ENVIRONMENTAL PROTECTION AT SEA: A CRITICAL APPRAISAL OF MARPOL'S OPERATIONAL IMPACT

Shyni William, Assistant Professor, Al Azhar Law College

INTRODUCTION

The MARPOL¹ serves as the cornerstone of global maritime environmental regulation, addressing multiple forms of marine pollution. Through its six annexes, MARPOL establishes legally binding standards for the prevention of pollution caused by oil, noxious liquid substances, harmful substances in packaged form, sewage, garbage, and air emissions. Compliance with these provisions requires ship operators to adopt new advanced technologies, maintain pollution and implement systematic operational procedures. While such measures strengthen marine environmental protection, they also introduce substantial operational, financial, and administrative challenges for the shipping industry. The impact is particularly evident in areas such as the adoption of low-sulphur fuels, the installation of ballast water treatment systems, waste segregation practices, and enhanced crew training programs.

Although these regulatory requirements have encouraged a shift toward sustainable shipping practices, they have simultaneously raised concerns regarding high compliance costs, retrofitting of older vessels, and inconsistent enforcement across jurisdictions. Consequently, the effectiveness of MARPOL depends not only on strong regulatory frameworks but also on technological innovation and harmonized global enforcement.

This paper critically examines how MARPOL has shaped maritime operations by balancing environmental imperatives with economic realities. It further explores the achievements and continuing challenges of the regime, highlighting the importance of coordinated international cooperation to ensure uniform compliance and long-term effectiveness.

Marine Pollution

The world's oceans are vital to the ecological balance of the planet, providing oxygen,

¹ International Convention for the Prevention of Pollution from Ships (adopted 2 November 1973, entered into force 2 October 1983) 1340 UNTS 184, as modified by the Protocol of 1978, 1340 UNTS 61

regulating climate, supporting marine biodiversity, and sustaining the livelihoods of millions of people globally. Oceans facilitate international trade, provide food resources, and act as sinks for carbon dioxide. However, human activities, particularly maritime operations, have increasingly endangered the health of marine ecosystems. Oil spills, chemical discharges, sewage, garbage, and air emissions from ships contribute significantly to the degradation of the marine environment.

Marine pollution is one of the most significant forms of environmental pollution, with adverse impacts on ecosystems, human health, and global sustainability. It refers to the presence of harmful substances such as the chemicals, plastics, sewage, oil, and other pollutants directly to the oceans, seas, and other coastal areas, thereby degrading the quality of the marine environment. The causes of marine pollution are diverse, ranging from industrial discharges, oil spills, and shipping activities to agricultural runoff, sewage disposal, and land-based waste mismanagement. Despite the existence of several international conventions and legal frameworks such as the MARPOL, the London Convention 1972, and the UNCLOS² The level of marine pollution continues to rise due to inadequate enforcement, rapid industrialization, and increasing global trade.

In simple terms, marine pollution may be understood as the presence of pollutants in the oceans that disrupt the ecological balance, threaten marine biodiversity, and pose risks to coastal communities that depend on marine resources. Thus, addressing marine pollution requires not only strong legal instruments but also global cooperation, technological innovation, and sustainable development practices.

Environmental Protection at Sea

Environmental protection at sea means ensuring the conservation and sustainable use of the marine environment. The oceans are not only a source of food, oxygen, and climate regulation, but they also support biodiversity, transport, and livelihoods for millions of people worldwide. Human activities such as overfishing, marine pollution, oil spills, and plastic waste pose significant threats to marine ecosystems. Therefore, protecting the seas involves implementing laws, international conventions, and policies that regulate maritime activities, prevent pollution, and promote sustainable resource management. Effective marine protection is

² United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3

essential not only for preserving the health of oceans but also for ensuring the long-term well-being of human societies and the planet as a whole³.

Legal Framework for Environmental Protection at Sea

The legal regime governing environmental protection at sea is primarily based on international conventions that impose obligations on states to regulate, prevent, and control marine pollution. Among these, the United Nations Convention on the Law of the Sea (UNCLOS) and the MARPOL Convention form the twin pillars of international maritime environmental law.

Complementary Treaties and Institutions

Other than UNCLOS and MARPOL, several other instruments complement the global framework for marine environmental protection:

- The London Convention 1972 and the 1996 London Protocol, regulating the dumping of wastes at sea.
- The Ballast Water Management Convention 2004, addressing invasive aquatic species introduced by ballast water discharge.
- Regional agreements, such as the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (1992), which strengthen MARPOL at regional levels.
- The IMO⁴ plays a central role in administering MARPOL, providing technical assistance, and coordinating amendments to annexes to reflect scientific and technological progress.

Emergence of MARPOL

The emergence of the International Convention for the Prevention of Pollution from Ships (MARPOL) can be traced back to the growing environmental awareness and international concern over marine pollution in the mid-20th century. Before MARPOL, the regulation of

³ A.L. Andrady, *Persistence of Plastic Litter in the Oceans*, in *Marine Anthropogenic Litter* 57 (M. Bergmann, L. Gutow & M. Klages eds., Springer 2015).

⁴ International Maritime Organization.

maritime pollution was fragmented and largely inadequate.

Several regional agreements existed, such as the International Convention for the Prevention of Pollution of the Sea by Oil, but there was no comprehensive global framework to address all forms of ship-generated pollution. The increasing frequency of oil spills in the 1960s and early 1970s, including several high-profile incidents such as the Torrey Canyon oil spill in 1967, highlighted the devastating environmental and economic consequences of marine pollution. These disasters emphasized the urgent need for a global legal instrument capable of regulating pollution from ships and ensuring uniform standards for prevention and enforcement. In response to these concerns, the IMO, established in 1948 as a specialized agency of the United Nations, initiated the development of a comprehensive convention to prevent pollution from ships. The result was the MARPOL Convention, adopted in 1973 and entering into force in 1983.

MARPOL represented a paradigm shift in maritime environmental regulation by integrating multiple pollution control measures under a single legal framework. It also incorporated lessons from earlier oil pollution conventions and expanded its scope to include other harmful substances such as chemicals, sewage, and garbage.

Despite its widespread adoption, MARPOL faces several operational challenges. Non-compliance, uneven enforcement across jurisdictions, and evolving environmental threats such as plastic pollution and climate change necessitate continuous evaluation of its effectiveness. This paper aims to critically appraise the operational impact of MARPOL, examining both its achievements and limitations, and to explore strategies to enhance its role in contemporary marine environmental protection.

MARPOL's structure reflects a flexible and adaptive approach to emerging environmental challenges. The Convention consists of six annexes, each targeting a specific type of pollution:

Annex I: Regulation of oil pollution from operational discharges and accidental spills.

Annex II: Control of noxious liquid substances carried in bulk.

Annex III: Prevention of pollution by harmful substances in packaged form.

Annex IV: Regulation of sewage discharge from ships.

Annex V: Control of garbage disposal at sea, including plastics.

Annex VI: Prevention of air pollution from ships, covering emissions of sulphur oxides, nitrogen oxides, and particulate matter.

The adoption of MARPOL was a landmark in international maritime law because it established a binding, universally recognized framework for environmental protection at sea. Its success depended on widespread ratification by member states, integration into national maritime legislation, and the development of enforcement mechanisms such as ship surveys, certifications, and port state controls.

Thus, the emergence of MARPOL was not only a response to catastrophic oil spills but also a recognition that piecemeal regulation was insufficient. It represented a transition to a comprehensive and enforceable global regime for marine environmental protection.

The Erika⁵ case (1999) saw French courts hold the oil company Total liable for ecological damage caused by a tanker spill, marking an important precedent for corporate accountability. Similarly, the Prestige case (2002) before the Spanish Supreme Court highlighted difficulties in allocating liability, underscoring the preventive value of MARPOL compliance.

How MARPOL Protects the Marine Environment

MARPOL is the primary international treaty designed to prevent ship-sourced pollution. It operates through six technical annexes, each targeting a specific type of marine pollution. MARPOL's strength lies in combining preventive measures, technological standards, and enforcement mechanisms.

1. Control of Oil Pollution (Annex I)

Prohibits operational discharges of oil and oily mixtures except under strict conditions (e.g., discharge beyond 12 nautical miles, oil content <15 ppm).

Requires ships to have equipment like oil discharge monitoring systems, oily-water separators, and slop tanks.

⁵ Erika (Court of Cassation, France, 25 September 2012).

2. Noxious Liquid Substances in Bulk (Annex II)

Regulates carriage of hazardous chemicals (e.g., acids, solvents). Mandates prewash procedures and restrictions on discharge into the sea. Protects marine life from long-term chemical contamination.

3. Harmful Substances in Packaged Form (Annex III)

It sets packaging, marking, and documentation standards for hazardous materials. Ensures that chemicals carried in containers, drums, or barrels are safely handled and not accidentally released.

4. Sewage Pollution (Annex IV)

Prohibits raw sewage discharge within 12 nautical miles of land. Requires ships to be equipped with sewage treatment plants or holding tanks. Protects coastal waters from eutrophication and health hazards.

5. Garbage from Ships (Annex V)

Bans disposal of plastics at sea (absolute prohibition). Strictly controls disposal of food waste, paper, rags, glass, and metal. Recognizes the global crisis of marine debris and microplastics.

6. Air Pollution from Ships (Annex VI)

Limits emissions of sulphur oxides (SO_x), nitrogen oxides (NO_x), and greenhouse gases. Establishes Emission Control Areas (ECAs) where stricter standards apply. Encourages adoption of cleaner fuels and energy-efficient technologies.

Enforcement and Sanctions

Enforcement varies across jurisdictions. While some states impose stringent penalties, others lack capacity or political will. This creates disparities in compliance, undermining MARPOL's effectiveness. For example, following the Prestige disaster, Spain faced difficulties enforcing international rules due to the ship's flag of convenience and complex corporate ownership structures.

MARPOL and India

India is a party to the MARPOL Convention and has taken several steps to implement its provisions in national law. As a major maritime nation with a long coastline and busy shipping routes, India recognizes the importance of preventing marine pollution. The country has incorporated MARPOL requirements through the Merchant Shipping Act and related rules, which regulate oil discharge, garbage disposal, sewage treatment, and emission standards for ships operating under the Indian flag. India has also established reception facilities at major ports such as Mumbai, Chennai, and Cochin to manage waste generated by ships. The Directorate General of Shipping oversees compliance, surveys, and certification of vessels to ensure that they meet MARPOL standards.

Despite being committed to MARPOL, India faces challenges in enforcement and capacity building. With its rapidly growing trade, the number of ships calling at Indian ports continues to increase, raising concerns about operational pollution and oil spills. Some ports still lack adequate facilities for handling waste, and smaller vessels often struggle to meet technical requirements due to cost constraints. Moreover, India has to balance strict environmental protection with its development needs, especially since compliance with MARPOL Annex VI requires significant investment in cleaner fuels and emission-reducing technologies. Nevertheless, India has been active in international maritime forums, supporting global efforts to strengthen MARPOL and aligning its domestic policies with the goal of sustainable maritime development.

Critical Analysis

The MARPOL Convention (1973/78) is the most important international treaty for controlling marine pollution from ships. Its six annexes cover oil, chemicals, sewage, garbage, and air pollution, making it one of the most comprehensive environmental laws in the maritime sector. MARPOL takes a preventive approach by regulating discharges and requiring ships to use equipment such as oily-water separators, double-hull tankers, and sewage treatment plants. Over the years, it has helped reduce routine operational pollution and encouraged technological improvements in ship design. The convention is also flexible, as it can be amended quickly through the tacit acceptance procedure, allowing it to respond to new environmental challenges. This adaptability is clear in the development of Annex VI on air pollution. Court decisions such as the *Erika* case in France have reinforced its preventive nature by holding

companies responsible for ecological damage. Overall, MARPOL represents a major step in integrating environmental protection into international maritime law. However, MARPOL also faces several criticisms and limitations. Its reliance on flag state control creates gaps in enforcement, as many ships are registered under “flags of convenience” where governments may lack resources or willingness to monitor compliance. While port state control has strengthened oversight, enforcement remains uneven across different regions. Major oil spills, such as the Prestige disaster, show that even with MARPOL’s rules, risks cannot be fully eliminated, and compensation systems are often slow and limited. Critics also argue that MARPOL does not effectively address climate change, since Annex VI only partly regulates greenhouse gas emissions. Developing countries face further challenges because of the high costs of compliance, creating inequalities between richer and poorer states. Therefore, although MARPOL has significantly shaped global maritime environmental law, its long-term effectiveness depends on stronger compliance, fairer enforcement, and integration with broader international climate strategies.

CONCLUSION

The MARPOL Convention stands as the cornerstone of international efforts to safeguard the marine environment from ship-sourced pollution. Its comprehensive annexes, preventive approach, and adaptive mechanisms have significantly reduced operational discharges and advanced the cause of sustainable shipping. For countries like India, MARPOL has provided both a legal framework and an international obligation to integrate environmental safeguards into domestic maritime law, thereby aligning national interests with global ecological responsibilities. Yet, critical analysis shows that MARPOL’s effectiveness is uneven, as enforcement gaps, reliance on flag states, and the persistence of catastrophic oil spills continue to undermine its full potential. Furthermore, the convention has been slow in addressing pressing issues such as greenhouse gas emissions and the broader challenge of climate change, leaving space for further reform. To remain effective in the decades ahead, MARPOL must evolve to strengthen compliance mechanisms, bridge the divide between developed and developing nations, and integrate climate-related measures into its framework. Enhanced cooperation between flag states, port states, and international bodies will be crucial to closing enforcement gaps and ensuring uniform standards. While MARPOL has already shaped the course of maritime environmental law, its future success depends on continuous adaptation, political will, and equitable implementation across all nations. In this sense, MARPOL is not

merely a treaty but a living instrument, one that reflects the ongoing global commitment to preserving the oceans as a shared resource for humanity and future generations.

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3. MARPOL Annex VI (adopted 26 September 1997, entered into force 19 May 2005).