



OPEN ACCESS

EDITED BY

Yen-Chiang Chang,
Dalian Maritime University, China

REVIEWED BY

Yi-Che Shih,
National Cheng Kung University, Taiwan
Sumedh Lokhande,
Auro University, India

*CORRESPONDENCE

Wan Xiao
✉ 20030100110009@hainanu.edu.cn

RECEIVED 30 March 2024

ACCEPTED 22 July 2024

PUBLISHED 09 August 2024

CITATION

Xiao W (2024) "Due regard" obligations toward nuclear wastewater discharge from the perspective of sustainable development of the marine environment. *Front. Mar. Sci.* 11:1409668. doi: 10.3389/fmars.2024.1409668

COPYRIGHT

© 2024 Xiao. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

"Due regard" obligations toward nuclear wastewater discharge from the perspective of sustainable development of the marine environment

Wan Xiao*

School of Law, Hainan University, Haikou, Hainan, China

The events of the 2011 Fukushima nuclear accident in Japan have garnered global concern. Despite nuclear power plants addressing numerous energy challenges, they pose substantial risks to environmental safety. The global legal basis to fulfill due regard obligations toward nuclear wastewater discharge involves international nuclear energy and marine environmental protection laws. There is substantive scope of due regard obligations toward nuclear wastewater discharge, including fulfilling international duties, prohibiting marine environmental pollution, preventing transboundary harm, and ensuring procedural obligations. The procedural obligations encompass timely notification of nuclear pollution, scientific assessment, and active consultation and cooperation with the international community. As there are still numerous obstacles to the application of due regard in the discharge of nuclear wastewater, the international marine environment frequently suffers from nuclear pollution. Considering the potential for transboundary environmental harm owing to the discharge of nuclear wastewater, this paper proposes effective solutions to this issue from the perspective of sustainable development of the marine environment. These solutions include formulating specific normative guidelines, clarifying liability for paying transboundary harm compensation, developing unified international assessment standards, and establishing an international platform for mandatory cooperation. Such solutions reinforce the national responsibility of all countries to actively fulfill their due regard obligations and effectively resolve the issue of potential irreversible damage to the marine environment. Additionally, the paper provides suggestions regarding how the international community can address the issue of Japan's nuclear wastewater discharge and other similar issues that may arise.

KEYWORDS

due regard, marine environment, nuclear wastewater discharge, transboundary harm, sustainable development

1 Introduction

The oceans and seas are crucial sources of Earth's biodiversity and hold strategic importance for the world's economy, security, energy, and social development. Countries worldwide are gradually shifting their economic focus from land-based to ocean-based approaches (Weibin and Yongqian, 2020a). However, in recent decades, issues such as oil spills, an imbalance in marine biodiversity, a sharp decline in fishery resources, and the proliferation of marine debris have increased due to excessive exploitation and the continuous expansion of marine activities. These ecological problems in the marine environment have led to serious consequences for both human life and the economy (Lixin and Sijia, 2020a). The Sustainable Development Goal (SDG) for the marine environment was initially proposed at the 1992 United Nations Conference on Environment and Development (UNCED). Critical documents, such as Agenda 21, the Convention on Biological Diversity and the Framework Convention on Climate Change, were deliberated and adopted to promote this goal (Thomas, 1992). To further urge countries to take action toward achieving the sustainable development of the marine environment, the United Nations General Assembly, comprising 193 member countries, adopted the historic 2030 Agenda for Sustainable Development in September 2015. This agenda has established 17 SDGs for the next 15 years, with Goal 14 specifically focusing on "conserving and sustainably using the oceans, seas, and marine resources for sustainable development." These SDGs represent a shared vision of humanity and serve as a comprehensive action plan and blueprint for the betterment of humanity and the planet (Wenxing and Meibo, 2021).

With the continuous growth of economies worldwide and development imperatives, energy consumption has been steadily increasing, with a concomitant expansion of energy-related concerns. Nuclear energy, a clean energy source, produces fewer carbon emissions than fossil fuels. It generates a higher amount of energy per unit mass and operates with greater efficiency¹. Moreover, nuclear energy does not contribute to air pollution or greenhouse gas emissions, thereby causing minimal environmental impact. Therefore, it has become an important strategy and safeguard for countries pursuing sustainable energy development and national energy security (Yunpeng, 2011). While nuclear energy has numerous advantages, it also comes with disadvantages. These include the construction and operation of nuclear power plants, which demand specialized technical expertise and equipment, and the nonrenewable nature of nuclear fuel. Additionally, the potential for accidents related to nuclear reactions and the management of nuclear waste is a significant drawback. For instance, incidents such as the Three Mile Island accident in Pennsylvania, U.S., on March 28, 1979, the Chernobyl Nuclear Power Plant explosion in Ukraine on April 26, 1986 and the Fukushima Daiichi nuclear power plant radioactive leakage in Japan on March 11, 2011, have significantly impacted the

life, health, economies, and sustainable development of local populations (Zhiguo and Jiangtao, 2020). Hence, enhancing the safety measures of nuclear power plants and averting irreparable damage to the environment caused by nuclear pollution are challenges shared by the international community.

While the prohibition of nuclear pollution has become a widespread international consensus (World Nuclear Association, 2022), the international community has formulated a series of legal documents and agreements to regulate the peaceful use of nuclear energy², prevent nuclear pollution³, and address nuclear accidents⁴. The irregular discharge of nuclear wastewater into the sea has resulted in incidents of marine ecological pollution, leading to ongoing concern and controversy within the global community. For instance, on August 24, 2023, the Japanese government officially began releasing⁵ Fukushima nuclear wastewater into the Pacific Ocean (Blume, 2023). This action prompted numerous objections and concerns from neighboring countries, particularly China, South Korea, and Russia, as well as from Japan's domestic fishing industries and export groups (Murakami and Bateman, 2023). According to calculations and predictions by the GEOMAR Helmholtz Centre for Ocean Research Kiel in Germany, the radioactive substances from the Fukushima wastewater discharge will spread throughout much of the marine life and ecosystems in the Pacific Ocean within 57 days (Zhang et al., n.d.). This dispersion could inflict irreversible and significant damage on marine ecosystems. Despite the growing global concern and efforts to regulate nuclear pollution, the complexity and diversity of nuclear wastewater composition and potential hazards, disparities in technological and scientific capabilities among nations, different political and economic interests, and incomplete coverage of relevant issues within existing international frameworks have collectively

1 For example, the energy released by the fissioning of 1 gram of the nucleus of ²³⁵U is equivalent to the combustion of 2.88 metric tons of coal with a heat content of 3×10^7 J/kg and 2.00 metric tons of oil at 4.3×10^7 J/kg. (Reference: Lamarsh J. R., and Baratta A.J. (2001). Introduction to Nuclear Engineering (Third edition), Prentice Hall. p. 90.).

2 International Atomic Energy Agency (IAEA), 17 June 1994, Convention on Nuclear Safety, <https://www.iaea.org/sites/default/files/infocirc449.pdf> (Accessed July 15, 2024).

3 International Atomic Energy Agency (IAEA), 5 September 1997, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, <https://www.iaea.org/sites/default/files/infocirc546.pdf> (Accessed July 15, 2024).

4 International Atomic Energy Agency (IAEA), 26 September 1986, Convention on Early Notification of a Nuclear Accident, <https://www.iaea.org/sites/default/files/infocirc335.pdf> (Accessed July 15, 2024).

5 On March 11, 2011, a magnitude 9.1 earthquake struck off the east coast of Japan, triggering two subsequent tsunamis that hit the Fukushima Daiichi Nuclear Power Plant. Consequently, the fuel cores of Units 1–3 of the power plant suffered meltdowns. To manage the situation, the Tokyo Electric Power Company initiated continuous seawater injection into the containment vessels of these units to cool the cores and recycle wastewater. From the time of the accident to August 2023, more than 1.3 million tons of nuclear wastewater have been collected, treated, and stored in tanks on-site at the plant. Recently, the Japanese government announced that the existing tanks are nearing full capacity, with no additional space available for constructing more tanks on-site. Consequently, the decision has been made to discharge the treated wastewater into the Pacific Ocean.

hindered the establishment of a dedicated international convention specifically to address the discharge of nuclear wastewater. The International Atomic Energy Agency (IAEA), the United Nations specialized agency responsible for nuclear energy and its technological applications, has issued relevant guidelines and recommendations, albeit without legal binding force. The principle of due regard, as a fundamental principle in international maritime (International Tribunal for the Law of the Sea, 2003) and nuclear energy laws, guides the conduct of countries in the maritime domain and the utilization of nuclear energy. This principle serves as a supplementary and auxiliary basis for decision-making (Oxman, 2018) when they face ambiguous legal provisions, scientific uncertainties, and potential risks associated with the discharge of nuclear wastewater into the sea. Nations are obligated to take action with full consideration of potential environmental impacts and the interests of other nations. By implementing preventive measures, conducting environmental impact assessments, and enhancing international cooperation and information sharing, nations can reduce potential transboundary environmental risks and disputes.

Concerning the historical background and jurisprudential origin, due regard obligations are mainly derived from the basic international principles such as *comitas gentium*, the fulfillment of international obligations in good faith, and prohibition of abuse of rights (Lina, 2017). These principles play an essential role in reducing various international disputes (International Seabed Authority, 2018), fostering friendly cooperation among nations in areas such as sustainable development of the marine environment, biodiversity conservation, and exploitation of fishery resources. Crucial international conventions related to the preservation of the marine environment, such as the United Nations Convention on the Law of the Sea⁶ (UNCLOS) and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management⁷ (hereinafter referred to as the “Joint Convention”), have stipulated the “due regard obligations” of each nation. These obligations are a vital mechanism for balancing international rights and responsibilities, preventing the abuse of rights (Fife, 2019), and avoiding international conflicts and disputes. Although no direct provision specifically exists for due regard obligations toward the discharge of nuclear wastewater into the sea in international conventions, the implicit content of this obligation is reflected in other provisions of international law, international principles and customs. Due regard obligations play a significant role in regulating the discharge of nuclear wastewater into the sea as an aspect of marine activities and in preventing marine environmental pollution (International Tribunal for the Law of the Sea, 2001).

6 United Nations Convention on the Law of the Sea. (1982). https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

7 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. (1997). <https://www.iaea.org/sites/default/files/infocirc546.pdf>.

It is widely acknowledged that “due regard” is the only option available to the global community at present and is likely to continue as such, given the lack of unity regarding the formulation, acceptance, and implementation of international law. This paper delves into the legal foundations and scope of obligations regarding due regard in the context of nuclear wastewater discharge. Furthermore, it identifies challenges encountered in international practices and presents recommendations for resolving them. These findings can advance theoretical research on due regard obligations in managing and discharging nuclear wastewater as well as providing recommendations on how the international community can address the issue of Japan’s nuclear wastewater discharge and other similar issues that may arise in the future, thus offering valuable insights for enhancing international cooperation and progress in this domain. Accordingly, due to numerous obstacles in the application of due regard obligations to the issue of nuclear wastewater discharge, incidents of nuclear pollution contaminating the international marine environment continue to occur. Examples of such obstacles include the lack of specific normative guidelines, ambiguity in liabilities for transboundary harm compensation, inconsistent assessment standards, and inadequate international cooperation mechanisms. This paper explores the international legal basis and content of due regard obligations for discharging nuclear wastewater into the sea to provide international solutions for nuclear wastewater treatment. The second section explores the legal foundation of due regard obligations concerning the maritime discharge of nuclear wastewater within the framework of international laws governing nuclear energy and marine environmental protection. The third section examines the substantive and procedural aspects of due regard obligations concerning nuclear wastewater discharge. The scope of due regard obligations for the discharge of nuclear wastewater includes substantive obligations, such as the fulfillment of international obligations in good faith, prohibition of marine environmental pollution, and prevention of transboundary environmental harm. Furthermore, it includes procedural obligations, such as providing timely notification of a nuclear accident, conducting scientific assessments, and proactively consulting and cooperating with the international community. The fourth section discusses and analyzes the practical issues and methods to improve the applications of due regard obligations for nuclear wastewater discharge. Given the potential for transboundary environmental harm owing to the discharge of nuclear wastewater, this paper proposes effective solutions from the perspective of the sustainable development of the marine environment. These solutions include formulating specific normative guidelines, clarifying liability for transboundary harm compensation, developing unified international assessment standards, and establishing an international platform for mandatory cooperation. Such solutions aim to effectively address this issue, thereby reinforcing the national responsibility of all countries to actively fulfill the obligation of due regard. Finally, the fifth section summarizes the key observations and presents the conclusions of the study, clarifying the relevant international obligations regarding Japan’s discharge of nuclear wastewater that must be fulfilled. This provides recommendations regarding how the international community can urge Japan to appropriately fulfill its international responsibility to respond to the issue of marine nuclear pollution.

2 International legal basis for due regard obligations for discharging nuclear wastewater into the sea

Oceans and seas are vital for ensuring human well-being and achieving sustainable development. Maintaining a healthy marine ecosystem is an obligation of every country (Jinxing, 2020). Marine nuclear pollution is characterized by severe ecological destruction, prolonged half-lives of radioactive nuclides and irreversible consequences, often resulting from dumping-related pollution (Linzhuang et al., 2016). Currently, no specific international convention or legal provision is dedicated to addressing the issue of discharging nuclear wastewater into the sea. However, the principle of due regard, an essential legal foundation in international nuclear energy law and marine environmental protection law, is a robust supplementary basis to constrain countries from discharging nuclear wastewater into the sea. Due regard obligations encompass two aspects: first, “regard” implies that a country, when exercising its maritime rights or freedoms, should be aware of and consider the interests of other countries (Hamamoto, 2019). Second, “due” requires countries, in consideration of the interests of other countries, to conduct a benefit analysis and balance its rights or freedoms with those of others to meet the standard of appropriateness (Guobin, 2014). As the United Nations Convention on the Law of the Sea, the Convention on Nuclear Safety, and the Convention on Early Notification of a Nuclear Accident do not explicitly oppose discharging nuclear waste into the sea (Li and Wang, 2023), applying due regard obligations can provide valuable guidance and solutions to address the issue of nuclear wastewater discharge.

2.1 Due regard obligations toward nuclear wastewater discharge from the perspective of international nuclear energy law

The Joint Convention is a vital international legal instrument concerning the safe management of spent fuel and radioactive waste and preventing potential radiological harm to individuals and the ecological environment. The preamble to the Joint Convention states that the ultimate responsibility for ensuring such management rests with individual countries. Article 1 states that the objective of the Joint Convention is to prevent potential hazards during all stages of spent fuel and radioactive waste management by enhancing national measures and international cooperation, thereby protecting individuals, societies, and the environment from harm. The Joint Convention provides detailed and stringent provisions for aspects such as utilizing nuclear materials, constructing nuclear facilities, and managing nuclear waste. In as many as 29 instances, the text emphasizes adopting “appropriate steps...” Furthermore, terms such as “due regard” and “consideration” permeate various clauses, underscoring the significance of the principle of due regard as a fundamental aspect of the Joint Convention. Therefore, all contracting parties of the Joint Convention bear the obligation to regulate their

radioactive waste in accordance with the principle of due regard while simultaneously prohibiting the entry of their radioactive waste into territorial and maritime areas under the jurisdiction of other countries. If the actions of governments or entities of the concerned countries violate the principle of due regard, causing harm to the ecological environment or individuals in other countries due to radioactive waste, national responsibility must be assumed (Barnidge, 2006).

The IAEA established the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and the Convention on Early Notification of a Nuclear Accident in 1986. These conventions aim to enhance international cooperation and the safe development of nuclear energy by setting an international mechanism for assistance and cooperation in the event of a nuclear accident or radiological emergency. This mechanism aims to ensure timely notification and swift provision of assistance to minimize radiological consequences (Shouqiu and Jiwen, 2004). These conventions stipulate that the contracting parties should cooperate with the IAEA to promptly notify and effectively assist in the event of a nuclear accident or radiological emergency. This approach will help minimize damages, protect life, property, and the environment from the impacts of radioactive releases and prevent or mitigate the harm caused by nuclear accidents. Member countries primarily engage in international cooperation for the safe utilization of nuclear energy through the IAEA. The IAEA exercises regulatory oversight over the nuclear materials and the operation of nuclear facilities by member countries. In the event of a nuclear accident, member countries must prevent harm to their ecological environment and adequately consider the interests of other countries. This measure will prevent transboundary environmental damage (*Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, 2010) and ensure that marine ecosystems remain free from nuclear waste. The Convention on Nuclear Safety (CNS), established in 1994, aims to achieve and maintain a high level of nuclear safety worldwide by strengthening international cooperation for the safety and technology of contracting parties' nuclear facilities and taking appropriate measures to prevent accidents with radiological consequences. The Convention on Supplementary Compensation for Nuclear Damage (CSC), enacted in 1997, seeks to establish a global liability regime that supplements national legislation on the compensation measures for nuclear damage (Jiu and Shichao, 2019). It strengthens countries' due regard obligations and makes them cautious in addressing nuclear accidents. Both the CNS and the CSC stipulate that the country that owns the nuclear facility is responsible for nuclear pollution or radiation rests and must take appropriate measures to prevent harm to the environment, life, and property.

Based on the provisions of the international nuclear energy laws and related international treaties, such as the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, the prohibition of nuclear pollution and the prevention of nuclear damage have been recognized by most countries. There is consensus within the international community on preventing nuclear waste from polluting the marine environment and causing transboundary harm. Therefore, international law on the use and

development of nuclear energy is the legal basis for recognizing the need to exercise due regard obligations for discharging nuclear wastewater into the sea (Hui, 2023).

2.2 Due regard obligations toward nuclear wastewater discharge from the perspective of international marine environmental protection law

In 1972, the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (hereinafter referred to as the “London Convention”) in Annex I specifies that materials prohibited from dumping include “high-level radioactive wastes or other high-level radioactive matter, defined on public health, biological, or other grounds, by the competent international body in this field, at present the IAEA, as unsuitable for dumping at sea.” The London Convention emphasizes the concern of the international community, particularly the need to consider public health and the ecological environment when dealing with radioactive waste and materials to protect the marine environment and public health. The prohibition of dumping strong radioactive waste reflects the international community’s adherence to the principle of due regard and cautious approach toward nuclear waste discharge. It underscores the importance of protecting the marine environment. Because of the long-standing international consensus that discharging radioactive substances into the high seas violates the principle of “due regard,” this convention and its protocols embody due regard obligations for protecting the marine environment.

The UNCLOS, established in 1982, serves as the fundamental law regulating maritime issues and the code of conduct governing the ocean-related behavior of countries (Dolliver and Nelson, 2006). It pertains to the common heritage and universal interests of humankind. Due regard is a fundamental principle that permeates various provisions within the convention. Its application is evident in international activities concerning marine environmental protection, navigation safety, and freedom and the interests of developing countries (Nandan and Rosenne, 1993). Article 1 of the UNCLOS defines marine environment pollution and identifies the dumping of waste into the sea as a significant source of marine environmental degradation. Additionally, Part XII of the UNCLOS specifies the obligations of countries to preserve the marine environment from various perspectives. Article 195 stipulates that “in taking measures to prevent, reduce, and control pollution of the marine environment, countries shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another.” Although the UNCLOS does not explicitly mandate fulfilling due regard obligations for discharging nuclear wastewater into the sea, the principle of due regard is fundamental in the convention and an integral aspect of marine environmental protection (International Tribunal for the Law of the Sea, 2003). The essence of due regard is inherent in the provisions related to protecting and preserving the marine environment (International Tribunal for the Law of the Sea, 2011a). Given the immense harm that the discharge of nuclear wastewater into the sea can cause to the marine environment, meeting due regard obligations is imperative.

In June 1992, the UNCED held in Rio de Janeiro, Brazil, approved Agenda 21 (hereinafter referred to as the “Agenda”). The Agenda is a framework document that draws upon the UNCLOS regarding marine environmental protection. The Agenda closely aligns with the UNCLOS and guides all countries’ environmental protection and development strategies (Meili and Junsong, 2020). Chapter 17 of the Agenda focuses on protecting and governing the marine environment, protecting coastal areas, and using and developing marine living resources. Chapter 22 reaffirms the importance of the safe and environmentally sound management of radioactive wastes, clearly stating the prohibition of promoting or allowing the disposal of radioactive waste near the marine environment unless such disposal poses no unacceptable risk to the marine environment or does not interfere with other legitimate uses of the sea, making appropriate use of the concept of the precautionary approach (Zhongying, 2022). Although the Agenda is a nonbinding agreement, it embodies due regard obligations in international marine environmental protection. Nonbinding agreements, such as the 1972 Declaration of the United Nations Conference on the Human Environment and the 1992 Rio Declaration on Environment and Development, address due regard obligations in international marine environmental protection. As international resolutions represent a broad foundation of international law, these agreements serve as critical guiding instruments for preventing and managing marine nuclear pollution.

3 Scope of due regard obligations toward nuclear wastewater discharge

The discharge of nuclear wastewater into the sea involves various marine activities, such as the operation of nuclear power plants, the operation and maintenance of nuclear submarines and aircraft carriers, nuclear fuel reprocessing, the handling of nuclear accidents (e.g., the Fukushima nuclear accident), and marine scientific research, which involves the use of nuclear technology. These activities should all be carried out by fulfilling the due regard obligations based on the provisions of relevant conventions or normative documents and by complying with general principles. Considering the characteristics of the act of nuclear wastewater discharge and the ambiguity⁸ (Gaunce, 2018) surrounding the content of due regard obligations (Hairong, 2020), this paper asserts that the implementation of due regard obligations by states intending to discharge nuclear wastewater into the sea should include both substantive and procedural (Scovazzi, 2019). Substantive obligations should, at the very least, not contravene the requirements of general international law, including fulfilling international obligations in good faith (Hamamoto, 2019), prohibiting marine environmental pollution, and preventing transboundary environmental harm. Procedural obligations should

⁸ The ambiguity of “due regard” lies in the fact that the term is not defined in the Convention, rendering its meaning ambiguous and its application by different decision-makers unpredictable. Consequently, determining the content of due regard obligations is inevitably deferred to the specific circumstances of each particular case in which they apply.

include timely notification, assessment, consultation, and cooperation (Orakhelashvili, 2022).

3.1 Substantive obligations

3.1.1 Fulfilment of international obligations in good faith

The oceans are the very foundation of human life, and human activities such as production and livelihood greatly rely on the oceans (The oceans are the very foundation of human life, 2024). Although the forms of freedom in the high seas are diverse, it is a fundamental principle enshrined in UNCLOS and the Convention on the High Seas that countries should exercise their freedom and rights of the high seas and their jurisdictional waters with “due regard” for the freedom and rights of other countries (Jennings and Watts, 1998). When exercising freedom and rights in the high seas, if there are unreasonable obstacles or conflicts, coordination should occur among the various freedoms to ensure that the obstacles or conflicts are kept within a reasonable range (Yi, 2002). This requires countries to fulfill their international obligations in good faith and consider the marine rights of other countries while exercising their own. For example, in the mixed oxide fuel (MOX) Plant Case (Ireland v. United Kingdom) heard by the ITLOS in 2001, Ireland expressed concerns that the operation of the MOX plant could lead to the discharge of radioactive pollutants into the Irish Sea, potentially causing significant harm to its marine ecosystem and the interests of its fisheries (International Tribunal for the Law of the Sea, 2001). Moreover, Ireland contended that in accordance with the precautionary principle, the United Kingdom must fulfill its international obligations in good faith and demonstrate that operating the MOX plant would not lead to radioactive pollution of the marine environment and subsequent damages owing to such pollution. However, the United Kingdom failed to fulfill these due regard obligations. Consequently, Ireland brought the dispute with the United Kingdom “[concerning] the MOX plant, [...], the international movement of radioactive materials, and the protection of the marine environment of the Irish Sea” to arbitration under Annex VII of the UNCLOS. Furthermore, Ireland requested that the ITLOS adopt provisional measures to prevent the MOX plant from becoming operational. Therefore, from the perspective of international practice, fulfilling international obligations in good faith is a fundamental principle of the Vienna Convention on the Law of Treaties and a basic requirement of the principle of due regard in international maritime law (O’Connor, 1991).

3.1.2 Prohibition of marine environmental pollution

Protecting the marine environment is a general obligation stipulated by the UNCLOS and a general principle of international law. Accordingly, no country or international organization is allowed to pollute the marine environment. However, marine pollution continues to persist in various forms, such as industrial discharges, maritime transportation accidents, illegal dumping of waste, and plastic pollution (OneOcean, 2019). While marine activities not expressly prohibited have a certain level of freedom, they must not cross the “red lines” of polluting the marine environment and must have due regard for the

rights and interests of other countries (Yotova, 2016). This principle has been reflected in relevant disputes and proceedings before the International Court of Justice (ICJ). For example, France conducted several atmospheric nuclear tests over its territory in French Polynesia in the South Pacific region between 1966 and 1972. During the nuclear tests, certain areas were declared “forbidden zones” or “danger zones,” prohibiting normal passage of foreign aircraft and vessels (Nuclear Tests (Australia v. France), 1974). Following France’s announcement of further plans for atmospheric nuclear tests in 1973, Australia and New Zealand approached the ICJ seeking the prohibition of France’s continued tests separately. They claimed that their rights had been violated and requested the ICJ to issue provisional measures to order France to cease all atmospheric nuclear tests (Nuclear Tests (Australia v. France), 1973a and Nuclear Tests (New Zealand v. France), 1973). Australia and New Zealand presented three main reasons for the illegality of France’s nuclear tests. First, the prohibition of atmospheric nuclear tests was a “universal” rule. Second, France’s nuclear tests violated the rights of other countries and their citizens who were affected. Specifically, releasing radioactive particles from nuclear tests severely violated their territorial sovereignty and rights to a safe and healthy environment. Third, releasing radioactive substances led to severe pollution in the high seas, constituting a major violation of the “freedom of the high seas.” Upon preliminary examination, the ICJ found that atmospheric nuclear tests were highly likely to cause irreparable damage to the territories and environments of Australia and New Zealand and ordered provisional measures to that effect on June 22, 1973 (Nuclear Tests (Australia v. France), 1973b). The case ultimately concluded when France terminated nuclear testing in 1974. The court’s order of provisional measures demonstrates that causing significant harm to the marine environment and other countries through maritime activities not expressly prohibited by international law is not permissible. The obligation of countries to prevent marine environmental pollution is a customary legal principle.

3.1.3 Prevention of transboundary environmental harm

The Trail Smelter case of 1941 is the first international precedent that established the principle of “not causing harm to the environment of another country.” This case introduced the idea that countries should be held liable for transboundary environmental harm (Xiaoli, 2008). In the Trail Smelter arbitration case, Canada’s Trail Smelter, zinc and lead was processed and excessive amounts of sulfur dioxide⁹ and other chemical residues were released (Wikipedia, 2024a). This damaged the environment in Washington State in the U.S. Extensive damage was inflicted on crops, trees, pastures, livestock, and buildings. The Permanent Court of International Justice determined that such

⁹ In 1916, 1924, and 1926, approximately 5,000; 4,700; and 9,000 tons of sulfur per month were emitted from the Trail Smelter, respectively—an amount that rose near to 10,000 tons per month in 1903. In other words, about 300–350 tons of sulfur were being emitted daily in 1930. (Notably, one ton of sulfur is substantially the equivalent of two tons of sulfur dioxide or SO₂.) (Reference: Trail Smelter Case (United States v. Canada), Awards of April 16, 1938 and March 11, 1941, United Nations, Report of International Arbitral Awards, Volume III, p.1917.

transnational environmental pollution violated the international principle of “not causing harm to the environment of other countries.” Consequently, Canada was held liable for compensation to the U.S. The Trail Smelter case introduced the important principle that “no country has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein” (Chufeng, 2020). During the early to mid-20th century, international environmental law was still in its infancy, and the precautionary principle for the prevention of transboundary harm had not yet been widely recognized or adopted. This assertion subsequently became the first major legal basis for preventing environmental transboundary harm. In 2001, the ITLOS affirmed the principle of preventing transboundary environmental harm in the Ireland v. United Kingdom dispute arising from constructing a MOX plant¹⁰, which resulted in transboundary nuclear pollution (International Tribunal for the Law of the Sea, 2001). Currently, the principle of preventing transboundary environmental pollution is reflected in various international conventions and declarations. These include the Declaration of the United Nations Conference on the Human Environment (1972), the African Convention on the Conservation of Nature and Natural Resources (1968), the UNCLOS (1982), the International Tropical Timber Agreement (1983), the United Nations Framework Convention on Climate Change (1992), the Rio Declaration (1992), the Agenda 21 (1992), the Convention on Biological Diversity (1992), and the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (2023). Prevention of transboundary environmental harm has become a general principle of international environmental law (Li, 2021). Considering the significant consequences associated with using and disposing of nuclear materials on the environment, heightened caution and strict controls must be exercised. Thus, when addressing issues related to nuclear materials, countries should fulfill their due regard obligations and take appropriate precautions to prevent transboundary environmental pollution.

3.2 Procedural obligations

3.2.1 Timely notification

The Convention on Early Notification of a Nuclear Accident stipulates that in the event of any accident involving facilities or

activities of a state party or of persons or legal entities under its jurisdiction or control, including any nuclear reactor wherever located, and the transport and storage of nuclear fuels or radioactive wastes from which a release of radioactive material occurs or is likely to occur and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another country, the state party shall notify, directly or through the IAEA, those countries that are or may be physically affected. This notification should include information about the nuclear accident, its nature, the time of its occurrence and its exact location (International Atomic Energy Agency, 2023). The Convention on Early Notification of a Nuclear Accident requires the country where the accident occurs to promptly provide relevant information, disclose the potential hazards of the accident to affected countries and populations, engage in consultations with potentially affected countries and minimize the radiological consequences and damages (Dingdai and Wei, 2011). Article 198 of the UNCLOS stipulates that when a country becomes aware of cases in which the marine environment is in imminent danger of damage or has been damaged by pollution, it shall immediately notify other countries likely to be affected and the competent international organizations (United Nations Convention on the Law of the Sea, articles 198). The ICJ affirmed the obligation to provide such notifications in the 2015 Costa Rica v. Nicaragua and Nicaragua v. Costa Rica cases¹¹

3.2.2 Scientific assessment

The prevention and management of marine nuclear pollution rely on international treaties for regulation. Given the global and persistent impact of pollution, scientific and technological support is essential. Environmental impact assessment serves as both a decision-making basis and a statutory procedure. International agreements such as the Joint Convention and the CNS require contracting countries to conduct comprehensive scientific assessments of nuclear energy utilization and disposal safety, with particular focus on potential impacts on individuals, society, and the environment. Therefore, conducting scientific assessments is an indispensable procedural aspect in fulfilling international obligations (Weibin and Yongqian, 2020b). Articles 204 and 206

¹⁰ The MOX plant, located in the UK, is a reprocessing facility that converts nuclear waste into a new type of mixed uranium-plutonium oxide (MOX) fuel. Ireland contends that the establishment and operation of the MOX plant could potentially result in harmful emissions of radioactive waste. Furthermore, according to Ireland, there are risks associated with the transportation of radioactive materials across the Irish Sea and their storage at the facility. In this context, Ireland argues that the UK has violated several obligations under international conventions concerning the protection of the marine environment, prevention and control of pollution and international cooperation.

¹¹ On December 22, 2011, Nicaragua initiated proceedings against Costa Rica “for violations of Nicaraguan sovereignty and major environmental damages to its territory.” In its Application, Nicaragua contended that Costa Rica was carrying out major construction works along most of the border area between the two countries, resulting in significant environmental harm. The Court determined that if the environmental impact assessment confirms that there is a risk of significant transboundary harm, a State planning such activities must fulfill its obligation to exercise due diligence in preventing such harm, including notifying and consulting with the potentially affected State in good faith, as necessary, to determine appropriate measures to prevent or mitigate the risk. Reference: Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua) and Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), Judgment, I.C.J. Reports 2015, p.724, para.168. <https://www.icj-cij.org/sites/default/files/case-related/150/150-20151216-JUD-01-00-EN.pdf>.

of the UNCLOS stipulate that countries shall, following the rights of other countries and to the extent practicable, engage in the observation, measurement, evaluation, and analysis of the risks or effects of pollution on the marine environment employing recognized scientific methods. In particular, countries shall monitor the effects of any activities they permit or engage in to determine whether these activities are likely to pollute the marine environment ([United Nations Convention on the Law of the Sea](#), articles 204 & 206). They shall assess the effects if such activities cause substantial pollution or significant and harmful changes to the marine environment. In accordance with the provisions of relevant conventions, countries must scientifically assess the damage to the marine environment when implementing activities under their jurisdiction or control ([Jinpeng, 2022](#)). In the case of the Pulp Mills on the River Uruguay in 2010, the ICJ concluded that an environmental impact assessment is required if the proposed activities of the actor state are likely to significantly and adversely affect the transboundary environment; assessing the potential environmental impacts of the relevant activities in advance is necessary¹². The ITLOS, in its advisory opinion on the Responsibilities and Obligations of States with Respect to Activities in the Area, explicitly stated that conducting environmental impact assessments is a direct obligation under the United Nations Convention on the Law of the Sea and is also an obligation of customary international law ([International Tribunal for the Law of the Sea, 2011b](#)).

3.2.3 Consultation and cooperation

Articles 197 and 200 of the UNCLOS stipulate that countries shall cooperate directly or through competent international organizations when taking measures to preserve the marine environment. This entails actively exchanging intelligence and information on marine environmental pollution and participating in regional and global cooperative initiatives ([United Nations Convention on the Law of the Sea](#), articles 197 & 200). Furthermore, UNCLOS mandates that countries engage in international consultation and cooperation to eliminate the effects of marine pollution and prevent or minimize damage. Countries shall jointly develop and promote contingency plans for responding to pollution incidents in the marine environment. Marine environmental protection is one of the fundamental principles outlined in the United Nations Convention on the Law of the Sea,

12 In October 2003, the Uruguayan government authorized the construction of a pulp mill near Fray Bentos by the Spanish company ENCE without complying with their obligations of notification and consultation. Consequently, Argentina filed a lawsuit against the Uruguayan government at the International Court of Justice (ICJ). After deliberation, the ICJ issued a ruling in 2010, stating that assessing the potential risks of project plans is a critical component for complying with international obligations. This assessment is essential to facilitate the elimination of potential risks or modify plans to minimize their environmental impact. Without such an assessment, concluding that the actor state has fulfilled its due regard obligations or its duty to prevent risks is difficult. Reference: Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgment of April 20, 2010, I.C.J. Reports 2010, p.59, para.115.

and its objective is to prevent all forms of pollution, encompassing a wide range of pollutants from various sources. While nuclear pollution represents a specific type of marine contamination, its impact on the environment and human health undeniably falls within the purview of regulatory measures ([United Nations Convention on the Law of the Sea](#), articles 199). In the 2001 case of Ireland v. United Kingdom regarding the construction of a MOX plant, the ITLOS highlighted that the obligation to consult and cooperate is a fundamental principle of both Part XII of UNCLOS and general international law in preventing marine environmental pollution ([International Tribunal for the Law of the Sea, 2001](#)).

In conclusion, due regard obligations establish a balance between the rights and freedoms of countries in maritime activities, in addition to the requirement to consider the potential stakes of other countries to avoid conflicts and harm to their interests ([Forteau, 2019](#)). Striking a balance between the interests of all countries and fulfilling international obligations in good faith are fundamental ([Tingting and Jingjing, 2023](#)).

4 Ways to improve the application of due regard obligations toward nuclear wastewater discharge

While due regard obligations play a crucial role in international law, especially in areas such as international marine environmental protection, their practical applications in combating nuclear pollution of the marine environment encounter numerous challenges and obstacles. These include the lack of specific normative guidelines, ambiguity in liabilities for transboundary harm compensation, inconsistent assessment standards and inadequate international cooperation mechanisms. Addressing these challenges requires in-depth research, discussion, and negotiation among international legal scholars, practitioners, and decision-makers. By proposing corresponding strategies or recommendations, stakeholders can further clarify and improve the fulfillment of due regard obligations in international practices concerning the discharge of nuclear wastewater.

4.1 Establishing specific normative guidelines

There is no specialized international convention to prevent and control marine nuclear pollution. The handling of nuclear waste depends on treaties established by the IAEA; however, none is mandatory. While the CNS and the Joint Convention have relevant provisions on safely using and managing nuclear waste, “due regard obligations” remain a guiding principle without imposing procedures or assessments for treating nuclear waste and wastewater, rendering it ineffective. The IAEA’s and other organizations’ preventive requirements and regulations on the discharging nuclear wastewater into the sea are also nonbinding. In practice, countries generally refer to their domestic “marine environmental protection laws” to prevent and control the discharge of nuclear wastewater. Additionally, countries adopt a highly sensitive approach toward the confidentiality of nuclear

facilities and technology, leading to a lack of international regulation and oversight in utilizing nuclear energy. This situation is detrimental to the protection of humanity, the international community, and the marine ecological environment from the hazards of nuclear pollution.

The inadequate regulation by the international community and international organizations regarding the pollution of marine environments, such as nuclear wastewater discharge, necessitates the establishment of specific normative guidelines, which clarify and strengthen the obligations of nuclear energy-producing countries toward protecting the marine environment. Under the guidance of the principle of due regard, such specific normative guidelines should effectively constrain actions that harm the marine environment. Urgently, there is a need to establish specific normative guidelines to construct and enhance international rules and mechanisms for protecting the marine environment. For instance, granting the IAEA independent investigative powers in the event of marine nuclear pollution incidents and robust oversight powers in nuclear waste disposal would help establish a practical and feasible international legal framework. This approach would help prevent and control marine nuclear pollution, thereby avoiding any further destruction to marine ecosystems. For example, investigations and supervision by international organizations played a crucial role in addressing leakage at the Sellafield nuclear facility in the United Kingdom. From 1957 to 2005, Sellafield experienced multiple leakage incidents. Moreover, the European Atomic Energy Community (Euratom) conducted an independent review of the facility under the Euratom Treaty ([Federal Ministry for the Environment et al., 2022](#)), and Greenpeace monitored its nuclear waste discharges ([Greenpeace UK, n.d.](#)). These efforts significantly enhanced the safety management and environmental protection capabilities of the Sellafield facility, thus reducing the risk of future nuclear accidents ([Wikipedia, 2024b](#)).

4.2 Clarifying the liability for transboundary harm compensation

The Trail Smelter arbitration case set an international precedent for establishing governments' liability for environmental harm caused by private activities within their jurisdiction. However, this case merely provided a principled exposition on the liability for compensation. Subsequently, there have been few instances concerning compensation for transboundary environmental harm ([Weifang, 2008](#)). Principle 22 of the Declaration of the United Nations Conference on the Human Environment (1972) stipulates that countries shall cooperate in developing international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such countries to areas beyond their jurisdiction ([Report of the United Nations Conference on the Human Environment, United Nations, A/CONF, 2024](#)). This declaration has established the principle of liability and compensation for damages caused by transboundary pollution. However, it lacks provisions on activities and compensation standards within the jurisdiction of countries, resulting in ambiguity in rights and responsibilities ([Xuyu, 2015a](#)). According to the general legal theory on compensation for transboundary

pollution damage, the country is liable for compensating the affected country due to the inherent danger and transnational nature of the action only when an action not prohibited by international law objectively results in transboundary harm ([Yi, 2011](#)). Some international treaties have addressed civil liability for nuclear pollution: the Vienna Convention on Civil Liability for Nuclear Damage (1963) and the Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material (1971) ([Fu and Li, 2024](#)). However, these conventions have not adopted a strict liability regime and have commonly cited natural disasters as an exemption from liability for damage caused by nuclear accidents ([Xiaosong, 2011](#)). However, the victims of nuclear accidents are often innocent third parties who should not bear the burden of claims or property losses due to the negligence of nuclear facility operators or force majeure factors. Only by implementing a strict liability system can nuclear facility operators be compelled to prioritize safety management and allocate increased resources and technology to prevent accidents and reduce nuclear risks. This approach aligns with the precautionary principle in environmental protection, aiming to safeguard the environment and public health by preventing and mitigating potential risks. Furthermore, the scope of compensation for damages caused by nuclear pollution to the marine environment and the procedures for accountability have not been clearly defined. Consequently, even if some countries neglect their due regard obligations by discharging nuclear wastewater into the sea, it is difficult to assess the consequences, making it challenging for affected countries to obtain timely and sufficient compensation.

The issue of discharging nuclear wastewater into the sea calls for joint efforts by the international community to clarify state responsibility for compensating transboundary damages caused by marine nuclear pollution. Countries must assume international obligations toward marine environmental protection and transboundary environmental harm ([Mingjie, 2009](#)) and be responsible for preventing the discharge of radioactive substances that pollute the marine ecosystem. The marine environmental damages caused by nuclear pollution damage human health, human activities, and marine ecological systems. Accordingly, the scope of compensation for direct losses should include, but not be limited to, personal injury, property damage, harm to marine ecological environments, and other incidental expenses ([Weifeng et al., 2019a](#)). A country that commits an act in breach of the substantive and procedural obligations of due regard under international maritime law should be held accountable for causing harm. Otherwise, there is no need to make the standards of harm caused a prerequisite for establishing state responsibility for preventing and controlling marine nuclear pollution ([Xuyu, 2015b](#)).

4.3 Unifying assessment standards

Currently, nuclear power plants operate in 32 countries, generating approximately one-tenth of the world's electricity ([International Atomic Energy Agency, 2018](#)). However, there is currently no unified international standard for assessing the impacts of marine nuclear pollution. Given the significant role of nuclear power

plants in terms of energy supply, low-carbon emissions, and economic benefits, establishing such standards is crucial for evaluating the impacts of marine nuclear pollution. Unified international standards play a key role in ensuring scientific consistency, promoting international cooperation, enhancing public trust, and mitigating environmental risks. Only by establishing such standards can we enjoy the benefits of nuclear energy while safeguarding the environment and public health, thereby promoting sustainable development. Internationally, the common practice is for each country to adopt its domestic procedures to evaluate the environmental impacts on the marine ecosystem in accordance with relevant international conventions. Due to the diversity of assessment bodies responsible for analyzing the impacts of marine nuclear pollution and the lack of clear definition for indicators affecting the marine environment, such as “significant adverse effects” on the marine environment in relevant conventions, countries interpret and implement these international treaties in ways that favor their interests. Accordingly, the environmental assessment systems and findings made by a particular country concerning marine nuclear pollution often face challenges in gaining international recognition and can easily lead to disagreements within the international community. Despite the inevitable ambiguity and disputes over the interpretation of rules, unified assessment standards can offer clear evaluation frameworks and methods for each country and can reduce disputes arising from different interpretations during the evaluation process, thereby reducing the frequency of international environmental disputes and enhancing the efficiency and effectiveness of international cooperation. Moreover, the relevant international treaties serve only as references for assessing the impacts of marine nuclear pollution. International conventions and agreements contain provisions regarding such assessment. However, the lack of uniform standards (Fard, 2016), enforcement mechanisms, and monitoring functions weaken the commitment of polluting countries to fulfill their international obligations toward assessing marine environmental pollution. Furthermore, factors affecting the marine environment are inherently multifaceted and no complete monitoring system is in place for the dispersion and damages caused by marine radioactive pollutants. Consequently, it is difficult to require countries to undertake comprehensive scientific assessments in accordance with their due regard obligations as stipulated.

The assessment of marine environmental impacts should require countries to use scientific methods to analyze, investigate, research, predict, and evaluate potential impacts or adverse consequences on human life and the marine ecosystem before engaging in activities that may have significant impacts or damages. Achieving international unified assessment standards for preventing marine nuclear pollution should consider the interests of developed and developing countries. When considering how to establish unified assessment standards for marine nuclear pollution and promote active compliance with obligations for environmental impact assessments, developed and developing countries should appropriately consider their respective marine rights and legitimate demands. Based on the principle of due regard in international maritime law, clear and practical implementation guidelines should be formulated. These encompass technical parameters, procedures, timelines for assessments, and the essential contents of assessment reports. By entering into international

conventions, regional treaties and other international legal instruments and establishing assessment indicators based on existing technological capabilities, a unified system for assessing marine environmental impacts can be established (Weifeng et al., 2019b).

4.4 Strengthening international cooperation mechanisms

Articles 1 and 2 in the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency stipulate that contracting parties should cooperate with each other. Furthermore, the IAEA should provide assistance in the event of a nuclear accident or radiological emergency. The goal is to minimize the damages and protect life, property, and the environment from the impacts of radioactive releases, thereby avoiding or mitigating the harm caused by nuclear accidents (International Atomic Energy Agency, n.d). International cooperation on the safe use of nuclear energy primarily occurs through the IAEA (Chang and Zhao, 2012). However, the IAEA's measures for nuclear safety and its regulatory framework have notable limitations. The IAEA only regulates the nuclear safety of materials declared by member countries and is limited in its oversight of nuclear activities conducted by individuals or organizations within each country. Nonmember countries of the IAEA are basically beyond the regulatory reach of their nuclear energy utilization. The IAEA faces several limitations regarding regulation and coordination of nuclear safety. Furthermore, developed countries, which dominate the field of nuclear energy, are generally hesitant to cooperate in nuclear energy's financial and technological aspects. This has resulted in an incomplete international cooperation mechanism for preventing and controlling marine nuclear pollution. The content of international cooperation based on due regard obligations is unclear (Walker, 2012), and incidents of nuclear materials and nuclear wastewater contaminating the marine ecosystem occur from time to time.

Given the significant impact of marine nuclear pollution, the cost and technical requirements for its management are high. Therefore, proactive prevention (Trail Smelter Case (United States v. Canada), 1941) becomes a crucial aspect of marine environmental protection. Unified cooperation, technological exchange, and information sharing among countries are imperative for effectively preventing marine nuclear pollution. When formulating relevant mandatory cooperation mechanisms, the international community should consider providing more assistance to developing countries, particularly in the areas of information sharing and financial support for nuclear safety technology. While respecting the principle of due regard outlined in international maritime law, countries should consider the actual circumstances and interests of developed and developing countries. This can be achieved by seizing the opportunity to establish, under the guidance of the United Nations Environment Programme, a mandatory cooperation mechanism for combating marine nuclear pollution. Such a mechanism shall encompass information sharing, technology transfer, and financial support. An international environmental information exchange system can be established through information exchange and sharing. Furthermore, a unified international cooperation platform can help organize the allocation of funds and facilitate technology

transfer to prevent and control marine nuclear pollution. This will result in a comprehensive international cooperation mechanism, enabling timely information exchange between countries (International Seabed Authority, 2015) responsible for marine nuclear pollution and those potentially affected. Through mutual technological support and the minimization of risks and consequences of marine pollution, the aim is to safeguard the “blue ocean” and foster a shared destiny for humanity’s seas.

5 Conclusions

Marine environmental protection is crucial for global sustainable development and the survival and advancement of humanity. An ocean is a shared heritage of humanity, and protecting the marine environment is necessary to maintain ecological balance and ensure human well-being (Lan, 2016). Protecting the marine environment is a global concern, as pollution and degradation of the marine environment can result in irreversible damage to marine ecosystems and biodiversity (Lixin and Sijia, 2020b). All countries should strengthen their cooperation and take adequate measures to reduce the extent and frequency of marine environmental pollution, thereby advancing global efforts in marine environmental protection.

The discharge of nuclear wastewater from the Fukushima plant in Japan is a global marine environmental issue of utmost importance. In making relevant decisions and taking action, Japan should consult with relevant states and organizations to seek understanding and international cooperation for improved solutions (Chang et al., 2022). It is necessary to consider a variety of domestic and international interests and concerns and stringently fulfil national obligations with due regard, with a view toward promoting regional peace and cooperation and maintaining the international marine environment and ecological safety. This will not only help Japan to recover from the nuclear crisis rapidly but also, more importantly, protect the global marine environment from infringement. In accordance with the requirements of the due regard obligation outlined in the Law of the Sea, Japan is obliged to take all reasonable and effective measures to avert the issue of polluting the marine environment; notify all nations that may be affected with such issue and cooperate fully by holding consultations with the affected nation; comprehensively assess and monitor the impact of such issues on the marine ecosystem using scientific methods; and take precautionary measures to minimize the risks of nuclear wastewater discharge. Meanwhile, the catastrophic consequences of nuclear pollution on the marine environment should be of great concern to the international community, who should actively urge Japan to fulfil its due regard obligations, strengthen international cooperation among nations, and jointly monitor Japan’s disposal of nuclear-contaminated wastewater (Chang et al., 2022). In light of the shortcomings and deficiencies in the international legal system regarding the regulation of nuclear pollution discharge into the ocean, the responsibilities and obligations of nations under international law with regard to the discharge of nuclear pollution must be improved expeditiously. This will enable the

international community to work in tandem to promote continuous development of the global marine environmental protection process.

In summary, the principle of due regard in international maritime law requires countries to fulfill their international obligations in good faith, give reasonable consideration to the marine rights and interests of other countries, and uphold the concept of a community with a shared future for humankind and the principle of sustainable development (Gauce, 2017). Regarding the due regard obligations for discharging nuclear wastewater into the sea, it is necessary to fulfill procedural and substantive obligations. In response to the practical challenges surrounding the implementation of due regard in the context of nuclear wastewater discharge, the international community can improve the prevention and control of marine nuclear pollution by establishing international conventions, clarifying liability for transboundary damages, establishing unified international assessment standards for marine nuclear pollution and enhancing international mandatory cooperation mechanisms. Countries can better exercise their marine rights, protect the marine ecological environment, and achieve sustainable development only by upholding the concept of a maritime community with a shared future (Yuting and Jiayu, 2022), fully recognizing the regulatory role of the due regard principle in international maritime law and effectively fulfilling due regard obligations.

Author contributions

WX: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher’s note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Barnidge, R. P. Jr. (2006). The due diligence principle under international law. *Int. Community Law Rev.* 8, 81–121. doi: 10.1163/187197306779173194
- Blume, L. (2023). Japan plans to release Fukushima water into the Pacific—is it dangerous? (National Geographic). Available online at: <https://www.nationalgeographic.com/premium/article/fukushima-japan-nuclear-wastewater-pacific-ocean> (Accessed June 27, 2024).
- Chang, Y. C., and Zhao, Y. (2012). The Fukushima nuclear power station incident and marine pollution. *Mar. pollut. Bull.* 64, 897–901. doi: 10.1016/j.marpolbul.2012.01.038
- Chang, Y. C., Zhao, X., and Han, Y. (2022). Responsibility under international law to prevent marine pollution from radioactive waste. *Ocean Coast. Manag.* 227, 1–7. doi: 10.1016/j.ocecoaman.2022.106294
- Chufeng, Y. (2020). Enlightenment from international standards of environmental damage compensation: analysis Based on the reform of eco-environmental damage compensation system. *Law Sci. Mag.* 12, 122–123. doi: 10.16092/j.cnki.1001-618x.2020.12.011
- Dingdai, P., and Wei, C. (2011). Exploration and analysis of the Fukushima nuclear accident and related issues in International Law. *Jiangxi Soc Sci.* 10, 161.
- Dolliver, L., and Nelson, M. (2006). “The law of the sea: progress and prospects,” in *Reflections on the 1982 convention on the law of the sea*, vol. 29. Eds. D. Freestone, R. Barnes and D. M. Ong (Oxford University Press, Oxford).
- Fard, S. N. (2016). *Reciprocity in international law: its impact and function* (London: Routledge). doi: 10.4324/9781315652146
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and Consumer Protection (2022). BMUV: euratom. Available online at: <https://www.bmu.de/en/topics/nuclear-safety/overview-nuclear-safety/europe/euratom> (Accessed June 27, 2024).
- Fife, R. E. (2019). Obligations of “due regard” in the exclusive economic zone: their context, purpose and state practice. *Int. J. Mar. Coast. Law* 34, 43–55. doi: 10.1163/15718085-12341047
- Forteau, M. (2019). The legal nature and content of “due regard” obligations in recent international case law. *Int. J. Mar. Coast. Law* 34, 25–42. doi: 10.1163/15718085-23341040
- Fu, B., and Li, H. (2024). Marine environmental governance for nuclear pollution: From the perspective of China’s response to Japan’s Fukushima nuclear wastewater discharge. *Mar. Policy* 167, 106242. doi: 10.1016/j.marpol.2024.106242
- Gaunce, J. (2017). *The general duty of “due regard” under the united Nations Convention on the law of the sea [Master’s Thesis]* (Calgary, Canada: University of Calgary).
- Gaunce, J. (2018). On the interpretation of the general duty of “due regard. *Ocean Yearb. Online* 32, 59. doi: 10.1163/22116001-03201003
- Greenpeace UK Nuclear energy. Available online at: <http://www.greenpeace.org.uk/nuclear/sellafield-nuclear-reprocessing-facility> (Accessed June 27, 2024).
- Guobin, Z. (2014). A discussion on due regard in the united nations convention on the law of the sea. *China oceans. Law Rev.* 2, 80.
- Hairong, H. (2020). On the international obligation of due regard and its implications to China. *Wuhan Univ. Int. Law Rev.* 4, 36. doi: 10.13871/j.cnki.whuilr.2020.04.003
- Hamamoto, S. (2019). The genesis of the “due regard” obligations in the United Nations Convention on the Law of the Sea. *Int. J. Mar. Coast. Law* 34, 7–24. doi: 10.1163/15718085-23341039
- Hui, W. (2023). On environmental damage compensation for discharging nuclear wastewater into the sea. *Law Sci.* 2, 181.
- International Atomic Energy Agency Articles 1 and 2 of the convention on assistance in the case of a nuclear accident or radiological emergency. Available online at: <https://www.iaea.org/sites/default/files/infirc336.pdf> (Accessed July 5, 2023).
- International Atomic Energy Agency (2018). PRIS - Miscellaneous reports - Nuclear Share of Electricity Generation in 2022. Available online at: <https://pris.iaea.org/PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx> (Accessed June 15, 2024).
- International Atomic Energy Agency (2023). Articles 1, 2, and 5 of the convention on early notification of a nuclear accident. Available online at: <https://www.iaea.org/sites/default/files/infirc335.pdf> (Accessed July 5, 2023).
- International Seabed Authority (2015). Submarine cables and deep seabed mining: advancing common interests and addressing UNCLOS “due regard” obligations. *ISA Tech. Study* 14, 33. Available online at: https://www.squirepattonboggs.com/~media/files/insights/publications/2015/08/submarine-cables-and-deep-seabed-mining/techstudy14_final_web.pdf.
- International Seabed Authority (2018). Deep seabed mining and marine cables: developing practical options for the implementation of “due regard” and “reasonable regard” obligations under UNCLOS. *ISA Tech. Study* 24, 27. Available online at: <https://www.isa.org/jm/wp-content/uploads/2022/06/Technical-Study-24-amazon-jan-2020-ersion.pdf>.
- International Tribunal for the Law of the Sea (2001). *MOX Plant Case (Ireland v. United Kingdom). Provisional measures, Order of 3 December 2001*, ITLOS Rep. 99–110. Available online at: https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_10/published/C10-O-3_dec_01.pdf.
- International Tribunal for the Law of the Sea (2003). Joint declaration of Judges *ad hoc* Hossain and Oxman, in Case concerning land reclamation in and around the Straits of Johor (Malaysia v. Singapore), Provisional Measures, ITLOS Reports 2003. Available online at: https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_12/12_order_081003_joint_dec_Hossain_Oxman_en.pdf.
- International Tribunal for the Law of the Sea (2011a). *Responsibilities and obligations of states sponsoring persons and entities with respect to activities in the area, advisory opinion of 1 february 2011*, ITLOS rep. 51. Available online at: https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_17/17_adv_op_010211_en.pdf.
- International Tribunal for the Law of the Sea (2011b). *Responsibilities and obligations of states sponsoring persons and entities with respect to activities in the area, advisory opinion of 1 february 2011*, ITLOS rep. 50. Available online at: https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_17/17_adv_op_010211_en.pdf.
- Jennings, R. Y., and Watts, A. (1998). *Oppenheims. Int. Law, 1, trans. T. Wang et al* Vol. 216 (Beijing, China: Encyclopedia of China Publishing House).
- Jinpeng, W. (2022). On countries due diligence obligations in preventing transboundary environmental damage. *J. Gansu Univ. Pol. Sci. Law* 2, 122.
- Jinxing, M. (2020). The connotation and path of building. A maritime community with a shared future from the perspective of global ocean governance. *Pac. J.* 28, 7. doi: 10.14015/j.cnki.1004-8049.2020.09.001
- Jiu, L., and Shichao, L. (2019). The evolution of international convention on nuclear damage liability and China’s choice. *Acad. Exch.* 1, 80.
- Lan, W. (2016). Environmental protection legislation on prospecting and exploration in the international seabed area – overseas experience and strategy of China. *J. Soc. Sci. Hum.* 4, 93.
- Li, N. (2021). Japan’s decision on releasing nuclear polluted water into sea and international obligation of not causing transboundary environmental damage. *Pac. J.* 29, 5. doi: 10.14015/j.cnki.1004-8049.2021.10.001
- Li, M., and Wang, X. (2023). Legal responses to Japan’s Fukushima nuclear wastewater discharge into the sea—from the perspective of China’s right-safeguarding strategies. *Heliyon* 9, 10. doi: 10.1016/j.heliyon.2023.e15701
- Lina, Z. (2017). Due regard obligations in maritime scientific research. *Soc. Sci. J.* 5, 105.
- Linzhan, M., Hongbin, W., Manhong, L., and Yuntao, G. (2016). *Environment and sustainable development* (Beijing, China: Metallurgical Industry Press).
- Lixin, H., and Sijia, F. (2020a). Research into the governance mechanism for regional marine ecological environment in the south China Sea: from the perspective of global marine ecological environment governance. *Human. Soc. Sci. J.* 38, 18. doi: 10.15886/j.cnki.hnus.2020.06.003
- Lixin, H., and Sijia, F. (2020b). Research into the governance mechanism for regional marine ecological environment in the south China Sea: from the perspective of global marine ecological environment governance. *Human. Soc. Sci. J.* 38, 19. doi: 10.15886/j.cnki.hnus.2020.06.003
- Meili, W., and Junsong, W. (2020). On the governance of marine environmental pollution and protection of the high seas. *Soc. Sci.* 3, 115.
- Mingjie, W. (2009). Legal responsibilities for the international environment in global governance. *Explor. Free Views* 12, 57.
- Murakami, S., and Bateman, T. (2023). Japan to release Fukushima water into ocean from Aug. 24. Available online at: <https://www.reuters.com/world/asia-pacific/japan-release-fukushima-water-into-ocean-starting-aug-24-2023-08-22/> (Accessed May 28, 2024).
- S. N. Nandan and S. Rosenne (Eds.) (1993). *United nations convention on the law of the sea 1982: A commentary, II* (Belgium: Martinus-Nijhoff Publishers).
- Nuclear Tests (Australia v. France) (1973a). *Interim protection, order of. I.C.J. Rep.* 99–100. Available online at: <https://www.icj-cij.org/sites/default/files/case-related/58/058-19730622-ORD-01-00-EN.pdf>.
- Nuclear Tests (Australia v. France) (1973b). *Interim protection, order of. I.C.J. Rep.* 106. Available online at: <https://www.icj-cij.org/sites/default/files/case-related/58/058-19730622-ORD-01-00-EN.pdf>.
- Nuclear Tests (Australia v. France) (1974). *Judgment of 20 december 1974. I.C.J. Rep.* 258. Available online at: <https://www.icj-cij.org/sites/default/files/case-related/58/058-19741220-JUD-01-00-EN.pdf>.
- Nuclear Tests (New Zealand v. France) (1973). *Interim protection, Order of. I.C.J. Rep.* 135–147. Available online at: <https://www.icj-cij.org/sites/default/files/case-related/58/058-19730622-ORD-01-00-EN.pdf>.
- O’Connor, J. F. (1991). *Good faith in international law* (New Hampshire: Dartmouth Publishing).
- OneOcean (2019). Marine pollution. Available online at: <https://www.oceanprotect.org/resources/issue-briefs/marine-pollution/> (Accessed June 27, 2024).
- Orakhelashvili, A. (2022). *Akehurst’s modern introduction to international law* (Philadelphia: Taylor & Francis Group). doi: 10.4324/9781003162117

- Oxman, B. H. (2018). *The principle of due regard, in International Tribunal for the Law of the Sea, the Contribution of the International Tribunal for the Law of the Sea to the Rule of Law 1996-2016* Vol. 113 (Brill, UK: Nijhoff).
- Pulp Mills on the River Uruguay (Argentina v. Uruguay) (2010). *Judgment of 20 April 2010, I.C.J. Reports 2010*, p 28, para.22. Available online at: <https://www.icj-cij.org/sites/default/files/case-related/135/135-20100420-JUD-01-00-EN.pdf>.
- Report of the United Nations Conference on the Human Environment, United Nations, A/CONF.48/14/Rev.1, 1972, p.5. Available online at: <https://www.wcdn.imo.org/localresources/en/KnowledgeCentre/ConferencesMeetings/Documents/A%20CONF.48%2014%20Rev.1.pdf> (Accessed on May 29, 2024).
- Scovazzi, T. (2019). 'Due Regard' obligations with particular emphasis on fisheries in the exclusive economic zone. *Int. J. Mar. Coast. Law* 34, 56–72. doi: 10.1163/15718085-23341041
- Shouqiu, C., and Jiwen, C. (2004). *International environmental law (M)* (Beijing, China: Law Press).
- "The oceans are the very foundation of human life", *Prepared by the Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations*. Available online at: https://www.un.org/depts/los/oceans_foundation.htm (Accessed May 28, 2024).
- Thomas, C. (1992). The united nations conference on environment and development (UNCED) of 1992 in context. *Environ. Pol.* 1, 250–261. doi: 10.1080/096440192084140535
- Tingting, W., and Jingjing, Z. (2023). Due regard' in the BBNJ agreement and China's proposed solutions. *J. Ocean Univ. China (Soc. Sci. Ed.)* 2, 98. doi: 10.16497/j.cnki.1672-335X.202302010
- Trail Smelter Case (United States v. Canada). (1941). *Awards of April 16, 1938 and March 11, 1941, United Nations, Report of International Arbitral Awards*. Volume III, p.1965. Available online at: https://legal.un.org/riaa/cases/vol_III/1905-1982.pdf.
- United Nations Convention on the Law of the Sea Article 198 of the United Nations Convention on the law of the sea. Available online at: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf (Accessed July 11, 2023).
- United Nations Convention on the Law of the Sea Article 199 of the United Nations Convention on the law of the sea. Available online at: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf (Accessed September 15, 2023).
- United Nations Convention on the Law of the Sea Articles 204 and 206 of the United Nations Convention on the law of the sea. Available online at: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf (Accessed August 15, 2023).
- United Nations Convention on the Law of the Sea Articles 197 and 200 of the United Nations Convention on the law of the sea. Available online at: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf (Accessed August 15, 2023).
- Walker, G. K. (2012). *Definitions for the law of the sea: terms not defined by the 1982 convention* (Belgium: Martinus-Nijhoff Publishers). doi: 10.1163/9789004211612
- Weibin, Z., and Yongqian, Z. (2020a). Construction of global marine environmental governance system from the perspective of a maritime community with a shared future. *Pac. J.* 5, 93. doi: 10.14015/j.cnki.1004-8049.2020.05.008
- Weibin, Z., and Yongqian, Z. (2020b). Construction of global marine environmental governance system from the perspective of a maritime community with a shared future. *Pac. J.* 28, 100. doi: 10.14015/j.cnki.1004-8049.2020.05.008
- Weifang, L. (2008). Reflections on compensation for transboundary environmental damages in international law. *Pol. Sci. Law* 9, 109. doi: 10.13634/j.cnki.mes.2019.01.042
- Weifeng, L., Dahai, L., Wenxiu, X., Chunjuan, W., and Quanbin, W. (2019a). Identification and assessment index of direct losses caused by marine environmental pollution. *Mar. Environ. Sci.* 38, 126.
- Weifeng, L., Dahai, L., Wenxiu, X., Chunjuan, W., and Quanbin, W. (2019b). Identification and assessment index of direct losses caused by marine environmental pollution. *Mar. Environ. Sci.* 38, 120–128. doi: 10.13634/j.cnki.mes.2019.01.042
- Wenxing, C., and Meibo, H. (2021). *Introduction to international development* (Shanghai, China: Fudan University Press).
- Wikipedia (2024a). Trail Smelter dispute. Available online at: https://en.wikipedia.org/wiki/Trail_Smelter_dispute (Accessed February 10, 2024).
- Wikipedia (2024b). Sellafeld. Available online at: https://en.wikipedia.org/wiki/Sellafeld#cite_note-115 (Accessed June 27, 2024).
- World Nuclear Association (2022). Radioactive waste management. Available online at: <https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/radioactive-waste-management> (Accessed June 27, 2024). doi: 10.1787/19900325
- Xiaoli, W. (2008). On several international solutions to transboundary environmental pollution. *Pract. Foreign Eco. Relat. Trade* 3, 55.
- Xiaosong, D. (2011). On the improvement of international legal framework for maritime nuclear pollution – A case study of Japan's maritime nuclear pollution. *Spec. Zone Econ.* 10, 250.
- Xuyu, H. (2015a). State responsibility for transboundary pollution damage. *J. Pol. Sci. Law* 5, 154.
- Xuyu, H. (2015b). State responsibility for transboundary pollution damage. *J. Pol. Sci. Law* 5, 157.
- Yi, H. (2002). *The international law of the sea* (Beijing, China: Bohai Tang Culture Company).
- Yi, L. (2011). Analyzing the issue of Japan's discharge of nuclear wastewater into the sea from the perspective of international law. *Pac. J.* 19, 38. doi: 10.14015/j.cnki.1004-8049.2011.12.012
- Yotova, R. (2016). The principles of due diligence and prevention in international environmental law. *Camb. Law J.* 75, 445–448. doi: 10.1017/S0008197316000672
- Yunpeng, Q. (2011). *Energy regulation in Australia: laws, policies, and implications* (Beijing, China: Intellectual Property Press).
- Yuting, W., and Jiayu, B. (2022). Integrated legislation of marine resources based on the sustainable development goals. *Resour. Sci.* 44, 401.
- Zhang, X., Thaler, J., and Zhu, D. The legal case against Japan's Fukushima wastewater decision—the proposed discharge of wastewater from the Fukushima nuclear plant into the Pacific Ocean would violate Japan's legal and environmental obligations. Available online at: <https://thediplomat.com/2021/05/the-legal-case-against-japans-fukushima-wastewater-decision/> (Accessed May 28, 2024).
- Zhiguo, G., and Jiangtao, (2020). "Principles and issues of international law concerning the discharge of Fukushima nuclear wastewater," in the "China Yearbook of the Law of the Sea (2021)" edited by the China Society of Oceanography, (Beijing, China: Law Press), 2021 edition, pages 473–494.
- Zhongying, P. (2022). The United Nations sustainable development goals and their significance for global ocean governance. *Frontiers* 8, 84. doi: 10.16619/j.cnki.rmltxsqy.2022.15.009