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Post-Fukushima innovation: establishing a regional marine environmental cooperation mechanism in Northeast Asia with global implications

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On September 20 2024 China and Japan reached four consensuses on the discharge of Fukushima ALPS-treated water into the sea. This not only eased the tense trade relations between the two states but also provided an important opportunity to build a new type of marine environmental protection cooperation in Northeast Asia. In fact there are multiple environmental protection communication mechanisms in Northeast Asia but there is a lack of truly binding regional environmental protection legal frameworks such as the Espoo Convention the Aarhus Convention. We should take advantage of this opportunity to reach a consensus on cooperation between China and Japan on the discharge of Fukushima nuclear wastewater into the sea combine the actual situation between states in Northeast Asia learn from improve the relatively mature cross-border environmental protection mechanism in Europe rely on the existing regional environmental protection cooperation mechanism available in Northeast Asia to improve upgrade it promote the construction of a new Northeast Asian marine environmental protection legal mechanism contribute Northeast Asian wisdom examples to the world's marine environmental protection cause.

KEYWORDS

regional marine environmental cooperation mechanism, Fukushima accident, ALPS-water, Northeast Asia, NOWPAP

1 Introduction

On August 24, 2023, Japan began to discharge ALPS-treated nuclear wastewater (hereinafter referred to as ALPS-water) into the sea (Murakami and Bateman, 2023). As a countermeasure, China immediately suspended the import of Japanese seafood (Oxford Analytica, 2023). This is considered to be the most severe countermeasure against Japan's ALPS-water discharge plan, which fully reflects China's political stance of vigorously advocating for ecological civilization construction in recent years (Huang, 2024; Liang et al.,

2024; An et al., 2024). Some critics noted that China's import ban might exceed the necessary scope (Tsuyoshi, 2023). Additionally, some highly influential media outlets have sharply criticized China's countermeasures against Japan's ALPS-water discharge policy, suggesting that China's actions have political motives rather than being based on scientific evidence (Kawashima, 2023).

One year after Japan discharged nuclear wastewater into the sea, China and Japan reached a consensus on the discharge of nuclear contaminated water from the Fukushima Daiichi Nuclear Power Plant into the sea (China and Japan Reach Agreement on Ocean Discharge of Fukushima Nuclear-Contaminated Water, Ministry of Foreign Affairs the PRC). This agreement not only brings a turning point to the tense Sino-Japanese trade relations but also represents the two states' cooperative attitudes toward the subsequent treatment of nuclear wastewater discharged into the sea. The consensus reached by the two states on the discharge of nuclear wastewater from Fukushima has important guiding significance for future cooperation on marine environmental protection and pollution control among states in Northeast Asia and has created an opportunity to build a regional marine environmental protection cooperation mechanism in Northeast Asia. First, global climate change and accompanying natural disasters are frequent, and the Fukushima nuclear power plant accident caused by an earthquake and tsunami is likely to occur again in the near future. Therefore, the risk of cross-border nuclear pollution has become a new environmental challenge that human society must face together, highlighting the importance of building a regional environmental protection cooperation mechanism. Second, the reason why the follow-up treatment of the Fukushima nuclear accident caused strong condemnation and aquatic product trade boycotts from Northeast Asian states such as China, South Korea and Russia was that Japan, when dealing with issues that would inevitably cause cross-border nuclear pollution hazards, lacked joint consultation and discussion with relevant states and arbitrarily decided to discharge nuclear wastewater into the sea. This fully demonstrates that Northeast Asia currently lacks a legal mechanism that can truly address transboundary marine environmental protection.

At present, the Trump administration of the United States has once again withdrawn from the Paris Agreement, indicating that the development of international environmental cooperation has once again suffered a major setback. Therefore, it will be almost impossible to build a new global marine environmental protection cooperation mechanism as a way for the international community to address the risk of nuclear pollution. In addition, there are obvious differences in the level of environmental protection in different regions of the world. For example, Europe has basically established a relatively complete cross-border environmental protection cooperation mechanism, while the environmental protection mechanism in Northeast Asia is still at the superficial communication level, and it is extremely difficult to formulate unified nuclear risk response standards. Furthermore, the geographical environment, history and culture of different regions and states may also lead to the separation of environmental governance methods and concepts between states and the lack of political mutual trust. Therefore, for the marine environmental protection cause in Northeast Asia, building a new regional marine environmental protection legal mechanism is a realistic choice. To this end, we need to address the shortcomings of the existing marine environmental cooperation mechanism in Northeast Asia, learn from the successful experiences of other regions, and seize the current historical opportunities to actively promote the construction of a new marine environmental protection legal mechanism in Northeast Asia.

The purpose of this short communication is to explain the nature and significance of the consensus reached by China and Japan on the issue of the discharge of Fukushima nuclear wastewater into the sea, explore the necessity of establishing a new transboundary marine environmental cooperation mechanism in Northeast Asia, discuss relevant international experience, the current situation and the shortcomings of regional environmental cooperation, and propose ways to improve these mechanisms. Although promoting closer political mutual trust is very important, it is not the main focus of this article, as we will discuss this topic in detail in future research.

2 Methodology

This paper mainly adopts the legal doctrine method and case study method as the main research methods. As one of the most widely used methods in legal research, the legal doctrine method focuses on examining the development of legal texts, legal systems and legal reforms (Gao, 2023). This paper's analysis of numerous international conventions and environmental cooperation mechanisms must apply the legal doctrine method, which can enable the author and readers to have a clearer understanding of the legal texts, functions and deep-level legal principles discussed in this article (Webley, 2016). To enhance the comprehensiveness of this study, we also adopted the case study method as the key research method. This method enables researchers to conduct a detailed analysis of specific cases, examine a number of highly influential international environmental dispute cases, identify relevant rules that can be applied to marine environmental disputes, and determine its reference significance for the construction of a new marine environmental protection mechanism in Northeast Asia.

3 The nature and significance of the agreement reached between China and Japan on the discharge of Fukushima nuclear wastewater into the sea

The China–Japan agreement not only reached a consensus on the issue of the discharge of Fukushima nuclear wastewater into the sea but also promoted regional cooperation in marine nuclear pollution monitoring led by China and Japan and involving relevant states. The conclusion of the agreement established a

code of conduct between states and therefore has legal significance (Cai, 2023). Japan's discharge of nuclear wastewater into the sea has brought crisis to marine environmental protection and environmental governance in Northeast Asia. The cooperation consensus reached by China and Japan on the discharge of nuclear wastewater into the sea has provided an opportunity to promote the establishment of a new type of marine environmental protection cooperation mechanism in Northeast Asia.

3.1 The China–Japan agreement is a treaty-like document

First, the China–Japan agreement has the general characteristics of a broad treaty. International treaties can be divided into broad and narrow senses. In the broad sense, a treaty refers to an international agreement between two or more subjects of international law that is intended to create mutual rights and obligations, regardless of its name and specific form (Zhu and Li, 2008). Commonly used treaty names include agreements, conventions, protocols, etc. The agreement reached between China and Japan on the issue of nuclear wastewater is a bilateral agreement between China and Japan, two subjects of international law, that aims to create rights and obligations on issues related to nuclear wastewater treatment.

Second, although the China–Japan agreement has the general characteristics of a broad treaty, it does not conform to the basic connotation of a treaty. The basic connotation of a treaty is defined in three main aspects: the contracting party, the form of the agreement, and the content of the agreement (Zhu and Li, 2008). First, in terms of the contracting parties, a treaty requires that there must be two or more subjects of international law (Hogg, 1980). China and Japan are both independent sovereign states and are recognized subjects under international law, so they meet the subject requirements of the treaty. Second, in terms of form, the subjects of international law should reach a consensus on the treaty. China and Japan have reached four consensuses on nuclear wastewater, and their consensus has been released by the two states' foreign ministries (Ministry of Foreign Affairs of Japan, 2024). Third, in terms of content, the treaty intends to create rights and obligations under international law. An international document must intend to create rights and obligations under international law, which is the key factor in distinguishing whether different types of international documents constitute legal treaties (Zhu and Li, 2008). Judging from the content of the China–Japan agreement, Japan's main obligations include conducting marine EIA, ensuring that interested states have the right to participate in international monitoring arrangements covering key aspects of sea discharge under the IAEA framework, and can independently take samples for testing. The China–Japan agreement stipulates the rights and obligations of China and Japan in terms of content and even stipulates the rights of third states (other interested states). Despite this, the China–Japan agreement does not meet the content requirements of a legal treaty because the two states do not intend to abide by the agreement as international law does. The so-called intention of states to abide by the agreement as international law means that the content of the agreement signed by the state is intended to establish international legal rights and obligations for each other; that is, the implementation of the agreement will be based on international law. The International Law Commission report has three meanings of "based on international law": first, the agreement is governed by international law rather than other legal systems or even domestic law; second, international law applies to the agreement, indicating that the agreement is legally binding under international law, thus distinguishing it from political agreements or moral agreements; and most importantly, third, the agreement must indicate the intention of the contracting parties to abide by it as law (Zhu and Li, 2008). For an international document to constitute a legal agreement, the state must have the intention to create rights and obligations under international law; otherwise, it is a political statement and is not legally binding.

Finally, the China–Japan agreement is a treaty-like document. Treaty-like documents are also called quasitreaties. Unlike international treaties, treaty-like documents refer to documents in which the contracting parties have no intention to create mutual rights and obligations under international law and do not constitute legal documents between the contracting parties (Klabbers, 2023). Although treaty-like documents are not legally binding, they establish norms of behavior between states and are therefore international documents with legal significance, also known as "informal international law" (Cai, 2023). The agreement reached between China and Japan on the discharge of nuclear wastewater from Fukushima has the general characteristics of an international law agreement but lacks the intention to create mutual rights and obligations under international law, so it is a "quasitreaty document" in nature. Even though the agreement is not legally binding, it has legal significance, as it was officially announced by the diplomatic departments of China and Japan.

3.2 The positive significance of the China–Japan agreement on marine environmental governance

The conclusion of the China–Japan agreement has a dual positive significance for marine environmental protection and environmental governance in Northeast Asia. The positive significance of the China–Japan agreement is directly reflected in the handling of the issue of Japan's nuclear wastewater discharge into the sea and the improvement of trade relations between states in the region. It also indirectly promotes the first cooperative exploration of major marine pollution incidents between states in Northeast Asia and provides cooperative experience and opportunities for the construction of future regional environmental protection cooperation mechanisms.

First, the China–Japan agreement reached the following four consensuses on the issue of the discharge of Fukushima nuclear wastewater into the sea: first, Japan explicitly commits to fulfilling its obligations under international law, doing its utmost to avoid

negative impacts on human health and the environment, and conducting continuous evaluations of the impacts on the marine environment and marine ecosystems. Second, given the concerns of China and all other stakeholders, Japan welcomes the establishment of a long-term international monitoring arrangement within the International Atomic Energy Agency (IAEA) framework covering key stages in the discharge of nuclear-contaminated water and will ensure that China and all other stakeholders can participate substantively in the arrangement and that these participating states can carry out independent sampling and monitoring as well as interlaboratory comparisons (ILCs). Third, both sides agree to continue to have constructive, science-based dialog with a great sense of responsibility for the ecosystem, the environment, and human life and health to address concerns over the discharge of nuclear-contaminated water into the ocean properly. Fourth, China states that it has taken temporary emergency precautions against aquatic products of Japanese origin according to relevant Chinese laws and regulations and WTO rules. After China participates substantively in the long-term international monitoring within the IAEA framework and the independent sampling and other monitoring activities by participating states are carried out, China will begin to adjust the relevant measures on the basis of scientific evidence and gradually resume imports of Japanese aquatic products that meet the regulation requirements and standards. The above four consensuses have essentially eased the negative relationships among stakeholders caused by Japan's dictatorial implementation of actions that may cause cross-border environmental hazards and have basically planned a positive path for stakeholders to cooperate jointly in dealing with the Fukushima nuclear wastewater issue.

Second, the implementation of the China–Japan agreement is also the first time that the states in Northeast Asia have actively explored joint cooperation in the governance of marine nuclear pollution, which also provides an opportunity and practical experience for the construction of a marine environmental protection cooperation mechanism in Northeast Asia. The nuclear wastewater discharge incident has forced China, Japan, Russia, South Korea and other states to face the lack and inadequacy of the marine environmental cooperation mechanism in Northeast Asia. In particular, facing new marine environmental pollution problems such as nuclear wastewater discharge, compared with Europe, Northeast Asian states lack effective mechanisms for environmental pollution warning, problem consultation and joint governance (Shapiro and Gottschall, 2011; Leung et al., 2020). Therefore, Japan can completely ignore the demands and concerns of other interested states when making the decision to discharge contaminated nuclear water into the sea (Fu and Li, 2024). The conclusion of the China–Japan agreement not only eased the tense environmental concerns and trade relations between regional states caused by Japan's nuclear wastewater discharge into the sea but also provided an unmissable opportunity for Northeast Asian states to build a new marine environmental protection cooperation mechanism.

4 The necessity and international experience of establishing new regional marine environmental protection cooperation mechanisms

Environmental impact assessment is an important system in international environmental law and a state obligation under general international law (Payne, 2011). The main reason why the issue of the discharge of nuclear wastewater from the Fukushima nuclear power plant into the sea has caused widespread controversy is that it did not complete the state obligation of a transboundary environmental impact assessment for the proposed activity, nor did it fully consult and communicate with the relevant stakeholders that may be affected; rather, it decided to discharge the wastewater into the sea on its own. The establishment of a transboundary EIA mechanism in Northeast Asia can not only ensure that the states in Northeast Asia better fulfill their obligations under the Convention but also improve an important part of the early warning mechanism for cooperation in marine environmental protection in Northeast Asia.

4.1 International law on transboundary EIA

International treaties such as the United Nations Convention on the Law of the Sea (UNCLOS), the Convention on Biological Diversity (CBD), the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (JOC), the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972 London Convention) and the Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction under the United Nations Convention on the Law of the Sea (BBNJ Agreement) all stipulate national environmental impact assessment obligations for proposed activities that may have transboundary environmental impacts (see Supplementary Table 1).

4.2 Regional practical experience of transboundary EIA mechanisms

Since marine pollution is more diffuse than land pollution (O'Hagan et al., 2020), to better manage marine pollution, some states and regions have established marine environmental protection cooperation mechanisms that are consistent with regional environmental protection goals on the basis of the characteristics of their regions (van Hoof et al., 2014; Directive 2008/56/EC, 2008). To promote the renewal of Northeast Asia's marine environmental protection cooperation mechanism, we need to combine the characteristics of Northeast Asia, consider learning from and improving Europe's more mature EIA and public participation cooperation mechanisms, integrate Northeast Asia's

existing cooperation mechanisms, and innovatively build a new marine environmental protection cooperation mechanism suitable for Northeast Asia.

First, the Convention on Environmental Impact Assessment in Transboundary Areas (hereinafter referred to as the "Espoo Convention") can provide a procedural reference for the environmental impact assessment mechanism in Northeast Asia. Considering that domestic project activities may have transboundary environmental impacts, EU member states signed the Espoo Convention in 1991, placing the original domestic transboundary environmental impact assessment mechanism in a transboundary context, and on this basis, established the European Transboundary Environmental Protection and Prevention Cooperation Mechanism (Song, 2011). Second, for public participation and joint decision-making in project activities that may have transboundary environmental impacts, some provisions of the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (hereinafter referred to as the "Aarhus Convention") can be referred to. After the Espoo Convention was adopted and came into effect, the Aarhus Convention adopted by the EU in 1998 established a mechanism for public participation in transboundary environmental impact assessment, further improving, strengthening and deepening regional environmental protection and cooperation (An et al., 2024).

Notably, the Espoo Convention and the Aarhus Convention are valid only between the member states that have signed the convention in Europe. Northeast Asian states certainly cannot directly apply the Espoo Convention or the Aarhus Convention to solve the problem of cross-border marine pollution caused by Japan's discharge of nuclear wastewater. However, the states in Northeast Asia can use the relatively mature cross-border environmental impact assessment cooperation mechanism that has been established in Europe as a reference template for building an environmental protection cooperation mechanism in Northeast Asia to strengthen marine environmental protection cooperation among Northeast Asian states and prevent individual states from taking arbitrary actions by taking advantage of the current deficiencies in environmental protection legal regulations in Northeast Asia, thereby threatening and undermining the common interests of coastal states.

It can be seen that the establishment of a regional cross-border environmental cooperation mechanism can not only effectively reduce the occurrence of cross-border environmental pollution incidents (such as the Bystroe Canal case) but also further promote environmental protection cooperation among states in the region (see Supplementary Table 2). It can be said that the cross-border environmental protection cooperation mechanism plays a vital role in regional environmental protection, problem prevention and dispute resolution. In this context, this article attempts to further analyze the current intercountry environmental protection cooperation mechanism in Northeast Asia and its shortcomings while considering the theoretical and practical experience of European cross-border environmental cooperation and discussing the possibility and necessity of building a new regional environmental protection cooperation mechanism in Northeast Asia.

5 Current state and shortcomings of environmental cooperation mechanisms in Northeast Asia

Northeast Asia has established a number of regional environmental cooperation mechanisms, which are divided into comprehensive environmental cooperation mechanisms and specialized environmental cooperation mechanisms. However, these mechanisms have limited cohesion and binding force among members, especially after the "ALPS-water treatment and discharge incident" in Japan, which exposed many deficiencies (Peng et al., 2016).

5.1 Current state: comprehensive and specialized regional environmental protection cooperation mechanisms intertwine and overlap

The comprehensive environmental cooperation mechanisms in Northeast Asia mainly include the Northeast Asia Conference on Environmental Cooperation (NEACEC), the Northeast Asia Subregional Program on Environmental Cooperation (NEASPEC) and the China-Japan-ROK Environment Ministers' Meeting (TEMM).

First, the NEACEC is a mechanism for environmental cooperation in Northeast Asia involving China, Japan, Russia, South Korea, and Mongolia, established with the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP), and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), which serve as observers. Second, the NEASPEC is an intergovernmental environmental cooperation framework in Northeast Asia established by international organizations and the six states of China, Japan, Russia, South Korea, Mongolia and North Korea. It adopts a consensus-based decision-making mechanism to strengthen environmental cooperation in Northeast Asia and solve various environmental problems in the region. Moreover, the TEMM is an important channel for communication on the environmental policies established among the environment ministers of the three states.

The specialized environmental cooperation mechanisms in Northeast Asia mainly include the East Asian Acid Rain Deposition Network (EANET) for acid rain, the Sand and Dust Storm Monitoring Network for sandstorm monitoring and early warning, the regional cooperation mechanism for air pollution and wetland protection, and the Northwest Pacific Marine and Coastal Environmental Protection, Management and Development Action Plan (hereinafter referred to as "NOWPAP") for marine protection. NOWPAP, as part of the UNEP (United Nations Environment

Programme) "Regional Seas Project", was jointly adopted by China, Japan, Russia and South Korea in 1994.

Together, the abovementioned environmental cooperation mechanisms constitute the current family of regional cooperation mechanisms in Northeast Asia (see Supplementary Table 3). However, the implementation of Japan's ALPS-water discharge plan has fully demonstrated that the substantive binding force of these cooperation mechanisms is very limited and cannot effectively protect the marine environment in Northeast Asia.

5.2 Deficiencies of the current regional environmental protection cooperation mechanism in Northeast Asia

First, although Northeast Asian states such as China, Japan, and South Korea all have legal awareness and attitudes toward environmental prevention and have made provisions for domestic transboundary environmental pollution incidents through domestic legislation, they lack a cooperative consensus on how to negotiate and manage transboundary environmental pollution incidents (Ogihara et al., 2016). First, China's Environmental Protection Law clearly stipulates that when formulating development and utilization plans and constructing projects that have an impact on the environment, an environmental impact assessment shall be conducted in accordance with the law. Development and utilization plans that have not undergone an environmental impact assessment in accordance with the law shall not be organized and implemented; construction projects that have not undergone an environmental impact assessment in accordance with the law shall not be started (Environmental Protection Law of the People's Republic of China, 2014). Second, Japan's Basic Environmental Law clearly stipulates that the state should take necessary measures to ensure that when a legal person engages in activities such as changing the shape of land, constructing new buildings, or other similar activities, it should conduct a survey, forecast, or assessment of the impact of such activities on the environment in advance and give due consideration to environmental protection on the basis of the results (Basic Environmental Law, 1993). Again, South Korea also stipulates in the Framework Act on Environmental Policy that the state should conduct strategic environmental impact assessments, environmental impact assessments, and small-scale environmental impact assessments so that any plans and development projects that have an impact on the environment can be formulated and implemented in an environmentally sustainable manner, with the ultimate goal of maintaining the suitability of environmental standards and protecting the natural environment (Framework Act on Environmental Policy, 2017). Finally, Russia also stipulates the obligation to conduct an environmental impact assessment in the Federal Law on Environmental Protection (Federal Law on Environmental Protection No. 7-FZ, 2002). From the above, all states in Northeast Asia fully recognize the important role of the EIA mechanism in domestic environmental protection and have formulated EIA obligations for the initiators of proposed activities in their states. However, for environmental incidents that may occur across borders, there is a lack of a truly effective joint consultation mechanism among states.

Second, environmental protection cooperation in Northeast Asia is trapped in a "prisoner's dilemma". Bottlenecks in ocean management and the obstacles that cause most of these problems arise primarily from states' resistance to cooperative management and working within established rules (Cavallo et al., 2019). Currently, the environmental cooperation established in Northeast Asia is almost entirely consultative in nature, with a lack of political mutual trust and necessary cooperation between states (He et al., 2008). In addition, there is a lack of effective marine environmental protection cooperation mechanisms in Northeast Asia. To seize control over regional environmental governance, Northeast Asian member states have established numerous overlapping environmental protection cooperation mechanisms, leading to intensified competition among these mechanisms (Yoon, 2007). Regional environmental mechanisms, purportedly established for cooperation, have become arenas for the struggle for dominance by member states, turning cooperation into competition and leaving the region without truly effective marine environmental protection mechanisms.

Finally, Northeast Asia lacks an effective early warning and decision-making mechanism for cross-border environmental pollution. After the Fukushima nuclear accident, the states in Northeast Asia did not conduct effective consultations and discussions on how to address Japan's nuclear contaminated water, which may have caused cross-border environmental pollution. When Japan finally decided to deal with the contaminated nuclear water by discharging it into the sea, Northeast Asia did not have an effective interstate consultation and decision-making mechanism, a cross-border environmental impact assessment mechanism for discharging water into the sea, or a subsequent marine environment monitoring mechanism. Faced with possible cross-border environmental pollution problems, the states in Northeast Asia are helpless in how to stop the discharging activities into the sea and can only express their dissatisfaction with Japan's behavior through trade sanctions and restrictions on the import of aquatic products. When there are no major transboundary environmental problems, environmental cooperation mechanisms such as NOWPAP and TEMM can still be used to communicate environmental issues between states, but they disappear when a real transboundary environmental crisis occurs.

All of the above situations show that the existing environmental protection mechanism is unable to cope with major environmental risks in Northeast Asia, which poses a daunting challenge to the national interests of the affected states (Chang et al., 2024; Chang and Zhao, 2022). Therefore, while constantly showing its determination to protect the environment (An et al., 2024), China should consider how to better unite other countries in Northeast Asia and build a higher-quality cooperation framework for the environmental protection cooperation mechanism.

6 Improvement directions of the marine environmental protection cooperation mechanism in Northeast Asia

In view of the inability and dilemma of multiple existing environmental protection cooperation mechanisms in Northeast Asia in solving the problem of ALPS-water discharge into the sea in Fukushima, Japan, Northeast Asia urgently needs to establish a deep cooperation mechanism for marine environmental protection that covers overall interests and builds a consensus on environmental protection. In this context, we can learn from and improve the successful environmental risk early warning rules in other regions and transform them into cross-border EIA rules that can be applied among states in Northeast Asia.

6.1 Innovating the application of the EU EIA mechanism in Northeast Asia

Establishing a transboundary EIA and marine environmental coordination mechanism in Northeast Asia is the core of marine environmental protection in Northeast Asia. The EIA mechanism is an important part of the risk early warning mechanism for transboundary environmental issues and aims to promote the transparency of information on the process and results of transboundary EIA (Chen and Xu, 2024). For the sea discharge plan that may cause transboundary environmental hazards, Japan did not conduct a prior transboundary environmental impact assessment; did not conduct sufficient consultation, discussion or joint decision-making with the relevant states; and was able to smoothly implement the sea discharge plan without any obstacles. The above situation fully demonstrates that Northeast Asia currently lacks a transboundary EIA mechanism and a public participation mechanism. The Espoo Convention and the Aarhus Convention adopted in Europe have established relatively comprehensive transboundary EIA mechanisms and public participation mechanisms, which deserve special reference (see Supplementary Figure 1).

However, since the level of mutual trust and cooperation experience between states in Northeast China is obviously not comparable to that of the EU, the specific content of the transboundary environmental impact assessment mechanism in Northeast Asia cannot be copied from the provisions of the Espoo Convention and the Aarhus Convention and must be adjusted according to the characteristics of Northeast Asia. The core goal is to provide greater autonomy to the initiators of environmental activities, but at the same time, there must be a bottom line of mandatory regulations.

First, the main procedures of the Northeast Asian transboundary EIA mechanism envisioned in this paper are the same as those of the Espoo Convention and the Aarhus Convention, namely, notification, public participation, EIA report creation and decision-making, and implementation of proposed activities. When a country plans to carry out a proposed activity, the initiator of the proposed activity must notify the affected party in advance to participate in the cross-border EIA of the activity. The project can only be formally implemented after it is confirmed that it will not cause damage to the transboundary environment or that the method with the least damage has been adopted. In addition, the implementation process of the proposed activities will be supervised by member states and the Environmental Protection Mechanism Committee to ensure that the public can fully participate in the decision-making process.

In addition, the specific procedures for the implementation of the transboundary environmental impact assessment mechanism in Northeast Asia cannot simply copy the provisions of the Espoo Convention and the Aarhus Convention but should be adjusted according to the characteristics of Northeast Asia. First, when judging whether a country's proposed activities require a transboundary environmental impact assessment, the initiator of the proposed activity can first decide whether to conduct an EIA after information screening. Second, in terms of the legal choice for conducting a transboundary environmental impact assessment, it can be conducted in accordance with the domestic law of the initiator of the proposed activity. Since the EIA procedure regulations of various states are relatively mature and different, to avoid increasing friction due to "sovereignty transfer", the EIA procedure can be conducted in accordance with the domestic law of the initiating country (Wang and Xu, 2023). Third, in terms of alternatives to the proposed activities, the initiator of the proposed activities shall consider the alternatives to the proposed activities as appropriate and provide them to the stakeholders to judge whether the proposed activities will cause serious harm to the marine environment. Fourth, in terms of the generation of EIA reports, a special scientific and technical institution can be established to conduct professional evaluation of the report and notify the stakeholders of the evaluation results. The comments made by the initiator of the proposed activities on the relevant states should be considered and reflected in the final EIA report. This can not only ensure the joint participation of all member states but also make the opinions of all parties more scientific and objective. Fifth, in terms of monitoring after the implementation of the proposed activities, considering the widespread spread of marine nuclear pollution, in addition to allowing relevant states to take samples for monitoring at the discharge points of nuclear contaminated water, monitoring points can also be set up in the coastal areas of relevant states to achieve "point-to-surface" all-round cooperative monitoring (see Supplementary Table 4). When significant environmental risks arise, the initiators of environmental activities must suspend construction, jointly initiate environmental reinspections and conduct substantive consultations.

The difference and connection between the transboundary EIA mechanism envisioned above and the Espoo Convention and the Aarhus Convention is that it gives greater autonomy to the initiators of environmental activities but also stipulates stricter information sharing obligations and the right of relevant interested states to stop projects. When the above EIA mechanism is applied to the incident of Japan's ALPS-water discharge, Japan can still unilaterally decide to discharge ALPS-water but must allow other Northeast Asian states to

monitor marine environmental risks (this part will be detailed in Section 6.2). Once a major environmental risk is identified, Japan should suspend discharge and conduct multilateral consultations and re-examination of the environmental risks. When conditions are more mature, states in Northeast Asia can agree on a more stringent marine environmental protection mechanism; that is, before any project that may cause cross-border environmental impacts is carried out, a multinational joint cross-border EIA must be carried out.

6.2 Innovating and integrating existing environmental protection cooperation and monitoring mechanisms

Establishing a monitoring mechanism for marine environmental protection in Northeast Asia is an important part of achieving long-term marine environmental security (Hildebrand et al., 2013). After a transboundary EIA mechanism suitable for Northeast Asia is built, the existing environmental protection cooperation mechanism in Northeast Asia must be upgraded to achieve long-term monitoring of regional marine environmental protection.

In fact, Northeast Asia currently has an existing regional marine environment monitoring mechanism, namely, the NOWPAP mentioned above, which was jointly adopted by China, Japan, Russia and South Korea in September 1994. NOWPAP is centered on four major cities in four states and has set up a regional coordination office (RCU) to coordinate and establish four regional activity centers (RACs), namely, the Special Monitoring and Coastal Environmental Assessment Activity Center (CEARAC), the Data and Information Network Regional Activity Center (DINRAC), the Marine Environmental Emergency Preparedness and Response Regional Activity Center (MERRAC) and the Pollution Monitoring Regional Activity Center (POMRAC) (UN Environment Programme-NOWPAP, 2025). NOWPAP members cover almost all the major affected states of ALPS-water. The four monitoring points established have natural geographical advantages, a good cooperation foundation and stronger pertinence in this nuclear wastewater monitoring issue (see Supplementary Figure 2).

First, under the IAEA framework, by upgrading the monitoring functions of NOWPAP, which has China, Japan, Russia and South Korea as members, international monitoring arrangements covering the key links of nuclear wastewater discharge into the sea can be promoted more efficiently and quickly. The IAEA is undoubtedly one of the international organizations most capable of ensuring that states cooperate on the issue of nuclear wastewater discharge (Li et al., 2023). In the absence of a long-term monitoring mechanism for Fukushima nuclear wastewater (Yue and Yang, 2024), NOWPAP clearly has sufficient historical, geographical and functional advantages in the task of monitoring marine nuclear pollution in Northeast Asia. First, in terms of history, NOWPAP member states include important stakeholders such as China, Japan, Russia and South Korea and have a foundation of cooperation of nearly 30 years. Second, in terms of geography, NOWPAP has established four coordination and monitoring centers centered in Beijing, China; Toyama, Japan; Vladivostok, Russia; and Daejeon, South Korea, to jointly undertake environmental monitoring and cooperation in the Northwest Pacific Ocean (Regional Coordinating Unit, 2025). Third, in terms of functions, the function of the NOWPAP monitoring mechanism when it was first established was to monitor the marine environment in the northwest Pacific and conduct marine environmental assessments. The main goals of the four monitoring points are to jointly monitor marine environmental issues, exchange information related to marine protection, conduct environmental assessments, and hold expert meetings (Wang and Wu, 2025; Kong et al., 2022). To solve the problem of the long-term monitoring mechanism for Fukushima nuclear wastewater, the IAEA can take the lead, and relevant stakeholders, such as China, Japan, Russia, and South Korea, can use the marine monitoring mechanism established through NOWPAP as a zoning management tool for long-term marine environmental monitoring to achieve multiparty joint monitoring among interested states (as shown in Figure 1).

6.3 Overall construction of a new marine environmental protection mechanism in Northeast Asia

On the basis of fully absorbing and reforming the environmental cooperation mechanisms of other regions and integrating and upgrading the existing environmental cooperation mechanisms in Northeast Asia, our initial plan is to build a new regional marine environmental cooperation mechanism based on NOWPAP, which would integrate marine environmental protection, technological innovation and knowledge sharing, economic incentives, and cooperation. The overall concept is illustrated in Figure 2.

Scholars have maintained both optimistic and pessimistic views on the effectiveness of NOWPAP in the past (Mark V, 2000; Haas, 2015). Today, as a regional cooperation mechanism aimed at safeguarding the marine environment—and one that includes key states involved in the issue of Japan's nuclear wastewater discharge—NOWPAP presents itself as the most practical legal foundation for properly addressing this incident. Therefore, we should proactively promote the enhancement of this mechanism, aiming to establish it as a model for regional environmental cooperation in the new era.

7 Conclusion

Compared with Europe, Northeast Asia clearly has many shortcomings in terms of the development of environmental cooperation mechanisms and cannot cope with the environmental challenges of the new era. However, it is clear that the construction of a regional environmental cooperation mechanism in Europe is

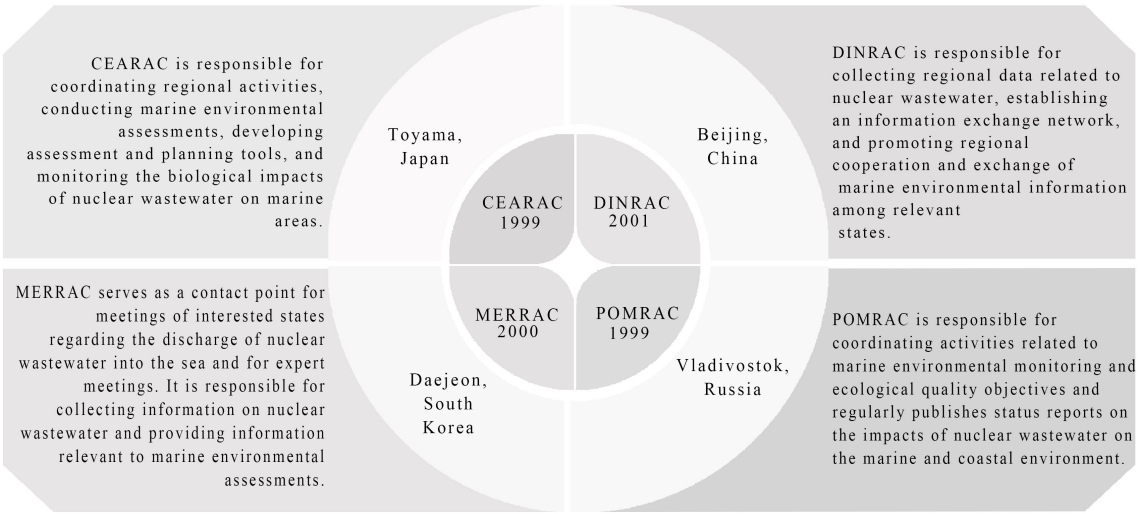

FIGURE 1
Schematic diagram of the work of NOWPAP led by the IAEA as a tool for the management of nuclear wastewater in the ocean.

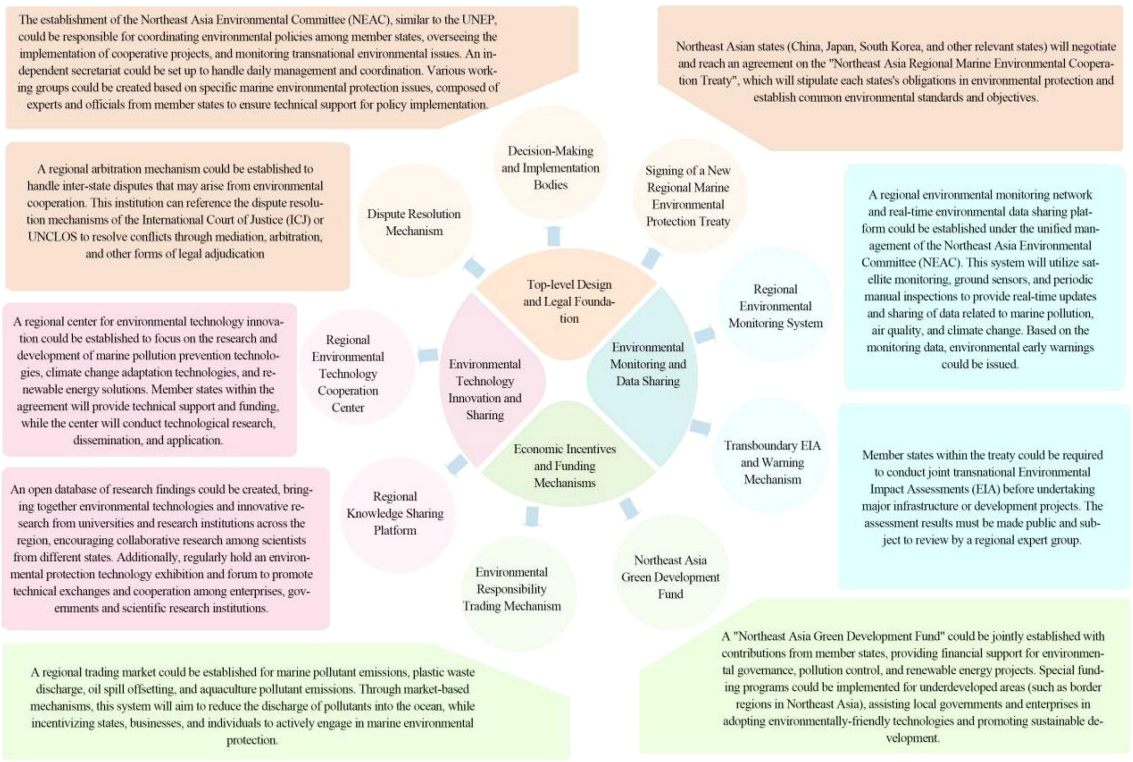

FIGURE 2
Conceptual diagram for upgrading NOWPAP.

long and arduous (Protocol, 2017; Lee, 2002). While Japan's ALPS treatment of water discharge poses a major challenge to marine environmental protection, it also provides us with an opportunity to reflect on and update the marine environmental protection mechanism in Northeast Asia. The core goal of this article is that in the context of the reality that global environmental protection has once again fallen into a development trough, we should focus on building a more efficient regional environmental cooperation legal framework and achieve gradual progress in international environmental cooperation.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Author contributions

RA: Conceptualization, Formal Analysis, Funding acquisition, Supervision, Writing – original draft, Writing – review & editing. XL: Conceptualization, Formal Analysis, Visualization, Writing – original draft, Writing – review & editing. YX: Conceptualization, Formal Analysis, Writing – original draft, Writing – review & editing.

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Conflict of interest

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

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2025.1526483/full#supplementary-material

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Glossary

ALPS	Advanced Liquid Processing System
GTI	the Great Tumen Initiative
NEASPEC	Northeast Asia Subregional Environmental Cooperation Program
UNCLOS	United Nations Convention on the Law of the Sea
CBD	Convention on Biological Diversity
1972 London Convention	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
JOC	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
BBNJ Agreement	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
TEMM	Trilateral Environment Ministers Meeting
UNEP	United Nations Environment Program
UNDP	United Nations Development Program
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
NOWPAP	Northwest Pacific Action Plan
RCU	Regional Coordination Office
RACs	Regional Activity Centers
CEARAC	Coastal Environmental Assessment Regional Activity Center
DINRAC	Data and Information Network Regional Activity Center
MERRAC	Marine Environmental Emergency Preparedness Response Regional Activity Center
POMRAC	Pollution Monitoring Regional Activity Center
EANET	East Asian Acid Rain Settlement Network
EIA	Environmental Impact Assessment