Research in Economics and Management
ISSN 2470-4407 (Print) ISSN 2470-4393 (Online)
Vol. 9, No. 2, 2024
www.scholink.org/ojs/index.php/rem

Original Paper

Ecological Safety and Regional Cooperation in the Asia-Pacific

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Received: May 17, 2024 Accepted: June 1, 2024 Online Published: June 24, 2024

doi:10.22158/rem.v9n2p42 URL: http://dx.doi.org/10.22158/rem.v9n2p42

Abstract

On August 24, 2023, the discharge of nuclear-contaminated water from Fukushima into the ocean, an action that has sparked widespread concern and apprehension within the international community, particularly among nations in the Asia-Pacific region. This issue transcends mere environmental concerns, touching upon transnational cooperation and regional policy coordination. The strategic significance of the Asia-Pacific region in international studies is underscored by the concentration of multiple national powers engaging in complex strategic games to achieve their respective national interests and objectives. This paper aims to outline the context of nuclear wastewater discharge, analyze the potential environmental risks, and explore the threats to the marine ecological safety of neighboring countries. It discusses how this decision has become both a challenge and an opportunity for cooperation among Asia-Pacific nations in terms of environmental protection and marine ecological safety. Additionally, the paper employs the Graph Model for Conflict Resolution (GMCR) method, based on existing multilateral cooperation frameworks such as regional marine cooperation organizations and international legal norms, to study the challenges and opportunities for regional cooperation in the context of nuclear wastewater discharge. This research may offer insights and guidance for mitigating current threats to marine ecological safety in the Asia-Pacific, and for constructing a more sustainable and resilient regional marine governance structure.

Keywords

Marine Safety, Regional Cooperation, Nuclear Wastewater, Asia-Pacific Region, Graph Model for Conflict Resolution (GMCR) Analysis

1. Introduction

1.1 Research Background

As globalization progresses and the geopolitical landscape evolves, the interaction among countries within various regions has become increasingly frequent. Against the backdrop of increasing complexity and integration in international relations, nations in the Asia-Pacific region engage in strategic games to expand their power and benefits, focusing on their respective national interests and goals. These strategic interactions are evident not only in traditional security fields but are increasingly apparent in emerging non-traditional security issues such as environmental governance and marine ecological safety.

In March 2011, Fukushima Daiichi Nuclear Power Plant suffered severe damage due to an earthquake and tsunami, leading to continuous water injections to cool the reactors. Concurrently, groundwater and rainwater seeped into the site, entering the damaged reactor and turbine buildings. This water, coming into contact with melted fuel, fuel debris, and other radioactive materials, formed nuclear-contaminated water.They has treated and diluted this water using an Advanced Liquid Processing System (ALPS) and stored it in specially prepared tanks. By June 2023, approximately 1,000 such tanks stored over 1 million cubic meters of treated water. However, as storage space dwindled, People faced the challenge of how to handle this wastewater. Despite multiple filtration systems removing most radioactive materials, certain substances, such as tritium, could not be effectively eliminated.

On August 24, 2023, the Fukushima Daiichi Nuclear Power Station began the gradual discharge of treated radioactive wastewater into the Pacific Ocean, planning to eventually release over 1 million tons of radioactive water into the sea. Facing international pressure and environmental concerns both domestically and internationally, they continued to advance its wastewater discharge plan while also attempting to alleviate tensions through communication with the international community. This action signifies that the negative impacts of the Fukushima nuclear accident, persisting for over a decade, continue to evoke a fearful response to nuclear energy worldwide, contributing to a conflicted attitude towards the future of nuclear power and highlighting the importance of regional cooperation in managing marine nuclear pollution.

This paper aims to explore the impact of Fukushima nuclear wastewater discharge decision on the marine ecological safety of the Asia-Pacific region and how this event might foster opportunities and challenges for multilateral cooperation in the area. The Fukushima nuclear incident’s aftermath, particularly the planned discharge of treated nuclear wastewater, has garnered widespread attention and concern among neighboring countries. This decision affects not only environmental protection and marine ecological safety but also touches on trust, cooperation, and conflict among nations. By analyzing the environmental impacts of nuclear wastewater discharge and the potential for regional cooperation, this paper aims to provide a multidimensional perspective to understand the mechanisms of interaction among countries in the Asia-Pacific region. How to maintain national interests while finding common ground to jointly face environmental challenges and promote stability and cooperation in the region is not only key to solving environmental issues but also crucial for maintaining peace and development in the area.

1.2 Literature Review

Currently, domestic research on the impact of nuclear wastewater discharge into the ocean on the marine ecological safety of the Asia-Pacific region has been systematically and comprehensively carried out. This research covers aspects such as potential environmental and ecological damage caused by nuclear wastewater, methods and means for affected parties to seek relief, and global ocean governance. In their article published in the Journal of Pacific Studies, Yang Zhenjiao and Luo Lingyun analyze the impact of nuclear leak on marine ecological safety. Their study highlights the threat posed by the Fukushima nuclear accident to marine ecology, emphasizing its long-term effects on marine biodiversity and genetic health. They critique the handling of this crisis, noting a lack of transparency, and the shortcomings of international law in dealing with such ecological disasters. They propose the necessity of improving international cooperation and legal systems to effectively address and mitigate such environmental impacts. (Yang & Luo, 2011)

Chen Haiyan and Yang Chunyu, in their publication in China Radiation Health, focus on the potential impacts of radioactive substances in wastewater on the environment through marine currents, groundwater, or carbon cycling, which pose long-term low-dose pollution risks to human health. They discuss the potential global environmental impacts of nuclear wastewater, elucidate the associated health risks, and the psychological health issues that may arise. (Chen, et al., 2022)

There is also theoretical research on international law concerning discharge of nuclear wastewater. Li Yi, in an article published in the Journal of Pacific Studies, points out that actions not only violate the obligations to the entire international community but also breach the responsibilities under the United Nations Convention on the Law of the Sea, the London Dumping Convention, and the Convention on Early Notification of a Nuclear Accident. Moreover, since actions do not meet the exemption conditions specified in the London Dumping Convention, the institution cannot invoke the exception clauses of this convention to absolve itself of responsibility. (Li, 2011)

Zhang Shi'ao, in the article "Legal Issues of the Fukushima Nuclear Wastewater Discharge Plan from the Perspective of Radioactive Waste Disposal," discusses the international legal applicability of the Fukushima nuclear wastewater discharge plan from the perspective of radioactive waste management. This examination addresses the challenges the plan poses to global nuclear safety governance, highlighting the limitations and inefficiencies of current international atomic energy laws and technical documents in dealing with "abnormal waste" resulting from accidents. It also explores the potential intergenerational risks to the global marine environment posed by domestic legal framework and regulatory approaches, as well as possible violations of the principles of "reasonableness" and "radiation environmental impact assessment" under international law. (Zhang, 2022)

A review of the existing literature reveals that there are numerous studies on the impact of nuclear wastewater discharge on marine ecology and the application of international law. However, discussions on how to effectively manage such transnational environmental issues at the regional level remain relatively limited. Most existing research focuses on the policies and technological responses of

individual countries, lacking in-depth analysis of regional cooperation frameworks and multi-national policy coordination. In this context, this study aims to explore the impact of Fukushima nuclear wastewater discharge decision on the marine ecological safety of the Asia-Pacific region and how this event could bring opportunities and challenges for multilateral cooperation in the area. This might provide insights and inspiration for marine ecological safety and regional collaborative cooperation.

1.3 Research Approach and Methodology

This study employs a comprehensive methodological framework aimed at deeply understanding the environmental and regional cooperation impacts of nuclear wastewater discharge. Initially, through an extensive literature review, this research compiles and analyzes related academic papers, government reports, and international organization documents to build a comprehensive understanding of existing studies and policy discussions. Furthermore, by reviewing the literature, this research gathers profound insights and recommendations from experts in the field, not only enriching the theoretical analysis but also providing a practical perspective on the issue. Additionally, this study employs the Graph Model for Conflict Resolution (GMCR) to analyze the dynamic relationships and potential resolution strategies among multiple stakeholders, a method particularly suited for scenarios involving complex interests and strategic choices. Through this multimethodological approach, the study aims to provide a multidimensional perspective to understand and explain the impacts of nuclear wastewater discharge on the marine ecological safety and regional cooperation in the Asia-Pacific region, as well as the opportunities and challenges posed in this context.

2. Current Status and Impact of Nuclear Wastewater Discharge

The issue of nuclear wastewater discharge originates from the accident at Fukushima Daiichi Nuclear Power Station in 2011. This disaster was triggered by the Great East Earthquake and the subsequent tsunami, which damaged the nuclear reactors and released a significant amount of radioactive materials. As a response measure, water used to cool the damaged reactors accumulated, and over time, the volume of this contaminated water continued to increase. (Hou, 2021) To manage the so-called “nuclear wastewater,” the Tokyo Electric Power Company (TEPCO) have implemented various measures. Among these is the use of a system called the Advanced Liquid Processing System (ALPS), which filters and removes most of the radioactive materials from the water. However, even after treatment, the water still contains certain radioactive substances that cannot be completely eliminated with existing technologies. The government announced plans to begin discharging treated nuclear wastewater into the sea starting from August 24, 2023. This decision immediately sparked widespread concern and attention from the international community, particularly in the Asia-Pacific region. Environmental organizations, neighboring countries, and the public around the globe have expressed serious concerns about the potential long-term impacts on marine ecosystems, fishery resources, and human health. The International Atomic Energy Agency (IAEA) has issued a statement indicating that it believes the actions regarding the Fukushima nuclear wastewater discharge are in accordance with international standards.

(International Atomic Energy Agency, 2021) The authorities claim that the Fukushima nuclear wastewater has been appropriately treated and that its discharge into the ocean is harmless. However, investigations by technical experts from various countries have found that the Fukushima nuclear wastewater still contains many difficult-to-treat nuclear elements and numerous harmful substances. The hasty discharge of nuclear wastewater into the sea poses significant risks to humanity, the global marine environment, and marine life in the affected waters(Pei & Chen, 2023) . According to media, Rafael Grossi, the Director General of the International Atomic Energy Agency (IAEA), visited on July 4, 2023. During his visit, Grossi presented the final report on the safety of Fukushima nuclear wastewater discharge into the ocean, assessing that actions complied with international standards, leading to the decision to proceed with the discharge. However, the feasibility, safety, and potential impacts of the IAEA's endorsement on marine ecological development warrant in-depth investigation and research.

The government and Tokyo Electric Power Company (TEPCO) emphasize that the discharged water will be thoroughly treated and that its radioactive levels will comply with international safety standards. Nonetheless, there remains extensive debate and uncertainty about how these standards will be adhered to and the potential impacts on the environment and regional safety. Therefore, the decision has not only raised concerns regarding environmental and health issues but has also sparked discussions on international law, regional cooperation, and transnational regulation. (Qi et al., 2023)

3. Marine Ecological Safety Challenges in the Asia-Pacific Region

Radioactive substances are abundant in nuclear wastewater, and similar substances that can decay and emit radiation autonomously exist in nature and human society, often undetectable by the human eye. Among the radioactive elements present in nuclear wastewater, tritium has the highest content, while carbon-14, ruthenium-106, cobalt-60, and strontium-90 have relatively long degradation times. Radioactive elements can accumulate in fish, shellfish, and other seafood through the food chain, potentially leading to genetic mutations in marine life. When these radioactive elements are discharged into the marine environment via nuclear wastewater, they are easily absorbed by marine organisms, posing threats to their living environment and leading to radioactive pollution, which could ultimately impact the marine ecological environment over time.

3.1 Vulnerability of Marine Ecosystems in the Asia-Pacific Region

The marine ecosystems in the Asia-Pacific region are particularly vulnerable, impacted by a variety of factors. The region includes some of the world's largest coral reef systems, numerous wetlands, and important marine biodiversity hotspots. These ecosystems not only provide habitats for marine life but also support the regional economy, especially the fishing and tourism industries. However, these ecosystems are facing threats from climate change, ocean acidification, overfishing, and pollution, making them increasingly sensitive and vulnerable to new stressors such as nuclear wastewater discharge. (Hande, et al., 2023)

3.2 Vulnerability of Marine Ecosystems in the Asia-Pacific Region

3.2.1 Loss of Biodiversity

The accumulation of radioactive materials can pose a direct threat to marine life, especially to species that are exposed to low levels of radioactivity over prolonged periods. This can lead to a decline in biodiversity, affecting the overall health and stability of the entire ecosystem.

3.2.2 Disruption of the Food Web

Radioactive contamination can accumulate in the marine food chain, affecting multiple levels from plankton to larger fish and marine mammals. This accumulative effect may lead to a reduction in certain species, thereby impacting the balance of the entire food web. (Editorial Board, 2023)

3.2.3 Sustained Impact on Fishery Resources

Fisheries are a vital part of the economy for many countries in the Asia-Pacific region. The discharge of nuclear wastewater may contaminate fishery resources in certain areas, affecting fishery yields and quality, and consequently impacting the economy and livelihoods of local communities. As a major consumer of aquatic products, We faces significant threats to the safety of its seafood, which jeopardizes national health and safety. The contribution of our fisheries development to the stability of global food production is clearly evident, with substantial values generated from mariculture and fishing. (Pei & Jiang, 2022) Our country has become a major player in global distant water fisheries, with the main fishing grounds for its catches mostly located in the Pacific Ocean. Thus, the nuclear wastewater discharge is closely linked to the development of the global fishery economy. In addition to the threats to the output and safety of the catch, the crew and fishing vessels venturing out to sea also face risks of radiation exposure, which undoubtedly would have a substantial impact on the development of the fishery economy.

4. Opportunities and Challenges of Multilateral Cooperation in the Asia-Pacific Region

4.1 The Role of Multilateral Cooperation in Addressing Environmental Issues

Multilateral cooperation is crucial for addressing the challenges of transboundary environmental issues. The cooperation among neighboring countries triggered by the nuclear wastewater discharge can take various forms, including international dialogues, joint research projects, policy coordination, and the sharing of best practices and technologies. Through multilateral cooperation, countries can share information, enhance transparency, jointly develop solutions, and build trust. Particularly in cases involving shared resources and public goods, multilateral cooperation is essential for coordinating policies and actions. (Man & Zhang, 2019)

4.2 Current International Legal and Policy Framework

International legal and policy frameworks play a crucial role in addressing environmental issues. For example, the United Nations Convention on the Law of the Sea (UNCLOS) provides a fundamental framework regarding the rights and obligations of states in protecting the marine environment. International organizations like the International Atomic Energy Agency (IAEA) also have relevant

safety standards and guidelines. However, these frameworks and guidelines often lack enforcement mechanisms, posing challenges to their application in practice. (Yuan, 2022)

4.3 Opportunities and Challenges

The decision to discharge nuclear wastewater into the ocean has not only garnered global attention regarding environmental protection and public health but has also become a testing ground for multilateral cooperation in the Asia-Pacific region. This emergency provides an opportunity for countries in the region to face environmental challenges together, strengthen cooperation, and improve regional governance systems and structures. However, it also presents several challenges in harmonizing the interests and perspectives of different countries, establishing effective communication mechanisms, and developing joint response strategies.

Firstly, the decision has prompted countries in the Asia-Pacific to reevaluate and optimize their cooperation on marine ecological safety. Faced with a common environmental threat, these countries have the opportunity to strengthen cooperation through sharing information, scientific research, and monitoring and assessment programs. Such regional cooperation can facilitate in-depth discussions about marine pollution, radiation safety standards, and environmental impact assessments, thereby promoting scientific and technological progress in related fields. However, there are significant challenges in the process of cooperation. Different countries may have vastly different views on nuclear wastewater discharge, reflecting their divergent national interests, economic dependencies, and environmental policies. For example, countries that rely on marine resources may express more concerns about potential pollution impacts. Thus, establishing an effective multilateral dialogue mechanism that can appropriately balance and reconcile these differences becomes a major challenge.

Secondly, the nuclear wastewater discharge raises questions about the structure and efficiency of regional cooperation. The Asia-Pacific region needs more robust and effective mechanisms to handle such transboundary environmental issues. This may include establishing new regional agreements, enhancing the functions of existing institutions, or forming specialized multinational collaborative working groups to oversee and manage such events. These efforts can not only enhance trust and collaboration within the region but also improve readiness and capacity to respond to future environmental challenges.

Finally, the decision also highlights the importance of international law and global environmental governance. It reminds the international community of the need to strengthen the global environmental governance structure to ensure that all countries take responsible actions in protecting the environment and public health. Through this incident, Asia-Pacific countries have the opportunity to play a more active role in global environmental governance, promoting the establishment of more fair and effective international environmental laws and policies.

In summary, the decision to discharge nuclear wastewater brings a regional environment full of challenges and opportunities for multilateral cooperation in the Asia-Pacific. By strengthening cooperation and coordination, the countries of the Asia-Pacific region have the opportunity to collectively address these challenges, protect the marine environment, and promote long-term sustainable

development in the region. This is not only about responding to current environmental threats but also about how to enhance regional cooperation, improve scientific and technological capabilities, and optimize the global environmental governance structure. The challenges and opportunities will shape the future trajectory of environmental policy and international cooperation in the Asia-Pacific region.

5. Analysis of the Possibility of Marine Ecological Cooperation in the Asia-Pacific Region—Based on the GMCR Model

5.1 Explain the GMCR Model

GMCR, the full name of which is Graph Model for Conflict Resolution, is a mathematical model for analyzing and resolving conflicts. By constructing a graphical model of the conflicting parties and their strategic actions, it predicts and identifies possible solutions. (Li & Fang, 2020) This model is capable of considering the preferences, strategic choices, and potential decision outcomes of all parties involved, thus aiding in understanding and managing complex conflicts of interest among multiple parties. In analyzing the issue of the nuclear wastewater discharge, the Graph Model for Conflict Resolution (GMCR) can be applied to explore the potential strategies and possible solutions involving all relevant parties, thereby deriving methods to resolve multi-party conflicts. It does so by constructing a decision graph to simulate the action choices and potential outcomes of various stakeholders. (Yang & Xu, 2022)

5.2 Identifying the Decision-makers in the GMCR Model

1) The Government and Tokyo Electric Power Company (TEPCO): The implementing parties for the discharge of nuclear wastewater

2) Neighboring countries and regions: Countries and regions that may be affected by the discharge.

3) The residents: The direct affected parties of the nuclear wastewater discharge.

4) International organizations and environmental groups: Organizations concerned with environmental protection and marine ecological safety.

5.3 Analyzing the Possible Strategies for Decision-makers

1) The Government and Tokyo Electric Power Company (TEPCO): “Continued discharge” (discharging nuclear wastewater into the ocean) or “Suspension of discharge” (discharging nuclear wastewater through other means, storing nuclear wastewater). This reflects the different choices they faces in dealing with the issue of nuclear wastewater, with each option having its environmental, political, and social implications.

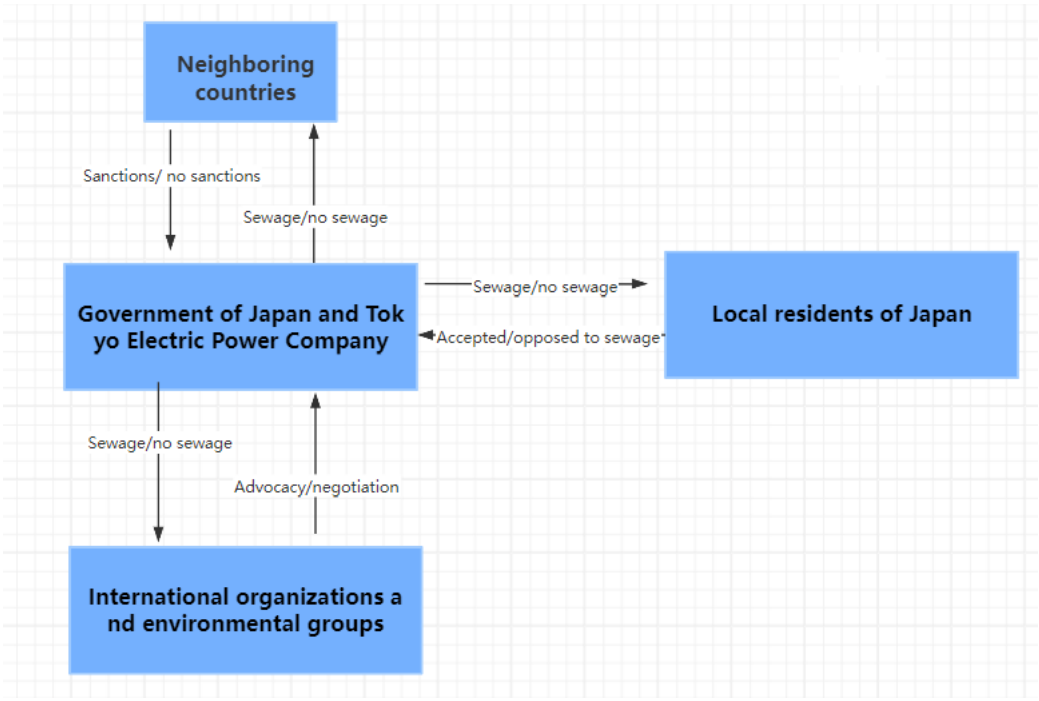
2) Neighboring countries and regions: Imposing or not imposing sanctions on their seafood industry. This reflects the potential reactions of neighboring countries to the nuclear wastewater discharge plans, with sanctions being seen as a direct opposition and pressure tactic against the discharge behavior. This strategy aims to influence the decision-making, prompting it to reconsider or modify its nuclear wastewater treatment plans.

3) The residents: Supporting or opposing the ocean discharge of nuclear wastewater. This reflects the concerns and responses of residents to the nuclear wastewater discharge plans. Through supporting or

opposing the discharge, the residents attempt to influence the decisions of the government and relevant companies, urging them to consider alternative treatment and discharge methods or adopt safer and more environmentally friendly approaches.

4) International organizations and environmental groups: Whether to protest and engage in advocacy activities, and whether to engage in dialogue and negotiations with governments. This demonstrates the important role international organizations and environmental groups play in global environmental issues, as well as their efforts in promoting environmental protection and sustainable development.

5.4 Analyzing Strategies and Preferences



Under this framework, the government may lean towards economic benefits and the urgency of nuclear wastewater disposal, with its primary preference being to discharge nuclear wastewater into the ocean, followed by other disposal methods, and finally storing the nuclear wastewater. Its primary goal is to alleviate fiscal pressure while avoiding resistance from the residents and sanctions from neighboring countries.

Neighboring countries may be more concerned about environmental safety and long-term impacts. Their preferred strategy is to impose sanctions on seafood products to compel to refrain from discharging nuclear wastewater into the ocean. Additionally, they hope to garner opposition from residents against the discharge plans.

Local residents' main strategy is to oppose the ocean discharge of nuclear wastewater. They hope the authorities will treat the nuclear wastewater in a non-polluting manner to avoid adverse effects on local fisheries development.

International organizations may advocate for seeking more environmentally friendly solutions, such as enhancing nuclear waste treatment technology or exploring alternative approaches. Their possible strategies may include lodging protests, engaging in dialogue with governments, and proposing alternative solutions.

In conclusion, regional coordinated governance and multilateral cooperation in the Asia-Pacific region are feasible. The most feasible coordinated decision would be for the authorities to optimize its nuclear wastewater treatment methods. Through simulating different decision paths, potential balancing points or compromise solutions may be found. One possible solution could be a transparent discharge process under regional cooperation and supervision, or seeking international assistance to improve nuclear waste treatment technology. Building upon this, promoting multi-level governance, optimizing cooperation mechanisms in the Asia-Pacific region, and seeking reasonable and balanced interpretations of divisive incidents in regional cooperation can be pursued. This state not only avoids environmental pollution but also garners support from residents and neighboring countries, contributing to the stability of international relations and the advancement of multilateral cooperation. Identifying pathways for cooperation and conflict resolution leads to more comprehensive and effective response strategies.

6. Conclusion

This study focuses on the discharge of nuclear wastewater by the authorities and its impact on the marine ecological security of the Asia-Pacific region, analyzing in depth the complexity of this issue in terms of environmental protection and governance. The historical background and current practices of the nuclear wastewater discharge reveal the potential risks it may pose to marine ecosystems and human health. Due to the uniqueness and vulnerability of marine ecosystems, the long-term environmental impacts of nuclear wastewater discharge may result in biodiversity loss, disruption of food chains, and negative impacts on regional fisheries resources and coastal communities' livelihoods.

While the government's decision aims to address the ongoing accumulation of nuclear wastewater, its impact extends far beyond national borders. The discharge of nuclear wastewater not only poses a potential threat to marine ecosystems but also adds new complexity to interactions among countries in the Asia-Pacific region at political, economic, and social levels. This event highlights the importance of regional cooperation in addressing transboundary environmental issues, while also revealing the challenges such cooperation faces in practice, including conflicting interests among different countries, differing assessments of environmental impacts, and limitations of international legal and policy frameworks.

Nevertheless, the Fukushima nuclear wastewater discharge incident also presents opportunities for cooperation in the Asia-Pacific region. It prompts countries in the region to prioritize common environmental security issues and encourages them to enhance cooperation in scientific research, policy coordination, and technological innovation. Through such cooperation, not only can environmental risks

be mitigated, but also mutual understanding and trust among countries in the region can be enhanced, laying the foundation for long-term stability and development in the region.

Further analysis based on the GMCR model reveals the possible actions and preferences of parties when facing the issue of nuclear wastewater discharge. The government and Tokyo Electric Power Company (TEPCO) face the dilemma of balancing domestic and international pressures and environmental responsibilities, while neighboring countries, the residents, and international organizations are striving to influence the decision-making process to ensure environmental safety and public health. Through this analysis, we can see that despite differences and conflicts, it is possible for countries in the Asia-Pacific region to find a balance point that protects the environment and preserves the interests of all parties by seeking common solutions, such as strengthening nuclear waste treatment technology and establishing transparent monitoring mechanisms.

In summary, the Fukushima nuclear wastewater discharge is not only an environmental issue but also a complex issue involving international relations, regional cooperation, and global governance. Through this event, countries in the Asia-Pacific region have the opportunity to strengthen cooperation, collectively address environmental challenges, and promote stability and cooperation in the region. This is not only crucial for solving environmental problems but also an important way to maintain regional peace and development.

However, the government's lack of sufficient exploration of alternative solutions and transparency in decision-making and international communication in dealing with environmental risks and ecological impacts is highly inadequate and urgently needs improvement. Every choice affects the future, and the fate of humans and nature are interconnected.

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