# Implementing precautionary principle in the marine environment under the background of Japan's Fukushima nuclear water discharge

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**Abstract.** After two years of preparation, Japan initiated the release of Fukushima's nuclear-contaminated water into the ocean on 24 Aug. 2023, despite widespread opposition and international boycotts. Japan's rationale for this action primarily revolves around cost-effectiveness when compared to alternative solutions. However, this decision has raised significant global concerns regarding its environmental impact and its implications for international interests, given the interconnectedness of the world's waters. This paper critically examines Japan's decision through the lens of the Precautionary Principle, considering four key components. The analysis reveals that the discharge of nuclear-contaminated water does not align with this principle. Instead, it is argued that Japan should halt the discharge and pursue cooperation with affected nations and international organizations. Given the irreversibility of this action, the Japanese government must commit to rigorous monitoring and research of marine ecosystems and radioactive contaminants, both before and after the discharge, to ensure the least possible harm to the environment. This approach promotes scientific rigour and aligns with the broader goals of environmental protection, fostering international collaboration for a sustainable future.

## 1 Introduction

On 13 Apr. 2021, the Japanese government announced that 1.25 million tons of water radioactively polluted by the damaged Fukushima Daiichi Nuclear Power Plant (FDNPP) would be released into the waters. Trial releases will start in 2023, and the whole process might take 40 years to finish [1]. According to the journal Science, the Japanese government promises that the Fukushima water will be treated to meet regulatory standards and minimize the harm to marine life and the environment. However, the decision was immediately condemned by fisheries organizations, neighbouring countries, and more. During the two-year preparation of releasing wastewater from FDNPP, the international controversy never stops. Plus, the backlash is becoming more serious day by day. On the other side, this July, the International Atomic Energy Agency (IAEA) published a report after a two-year investigation that Japan's dump plan is "consistent with international safety standards". Obviously, the voice around Fukushima nuclear wastewater is becoming dichotomies of "to-do" and "not-to-do". In spite of the reactions above, on 24 Aug. afternoon, Japan began releasing Fukushima's treated radioactive water into the Pacific Ocean as the government had planned two years ago.

Previous studies have primarily relied on an assumed scenario where Japan releases nuclear-contaminated water. This action is anticipated to result in detrimental effects across different sectors, affecting both humanity and the environment. Explored subjects encompass harms transcending borders, compensatory measures, and more. Given that the nuclear-related outcomes might not manifest distinctly within a brief timeframe, substantiating the validity of these findings remains constrained by inadequate evidence. Furthermore, the ongoing opposition to discharging the contaminated water into the Pacific Ocean suggests the potential for a pivotal juncture, potentially prompting Japan to reconsider its stance. However, the truth is that what Japan's government has worked around Fukushima nuclear wastewater becomes inconsistent with certain international laws such as UNCLOS. This article will analyze Japan's responsibility from the perspective of the precautionary principle in environmental science. On the one hand, studying in the lens of risk precautions applies to more scenarios. If Japan decided to manage the wastewater within the island in the end, the conclusion could still work as a referential manual. On the other hand, this study stays at a more objective stand towards international affairs, remaining open to possible future outcomes as time passes and science moves forward. As up-to-date guidance for environmental decision-making, the precautionary principle

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embraces four essential parts, which will be discussed in the Fukushima nuclear wastewater case to get insights from Japan's decision. The article is aimed to provide a practical understanding of the post-story of the Fukushima catastrophe and abiding reference for the international community.

## 2 Definition of precautionary principle

In history, scientists, advocates and policymakers from the U.S. and Europe defined the precautionary principle at the Wingspread Conference, "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically." Four components were listed in the statement: taking preventive action in the face of uncertainty, shifting burdens onto proponents of potentially harmful activities, exploring a wide range of alternatives to possibly harmful actions, and increasing public participation in decision-making. From the perspective of Tickner et al., precaution is the first thing to think about, and it becomes the compass leading science and policy in front of uncertainty. It helps humans to make health-protective decisions in the field of environmental science [2].

It is believed that discharging such a large amount of contaminated radioactive water is unprecedented in history, so how much damage will be caused cannot be surely measured at this stage, and arguments pertaining to how much of damage that will be produced have been raised among professionals and organizations [3]. A scientist at University of Tokyo, Shigeyoshi Otosaka, doubted the wastewater discharge technology's scientific credibility and the potential risks it poses to the ocean. The Tokyo Electric Power Co. (TEPCO), responsible for treating all contaminated water before its release, is the subject of his skepticism. As a marine geochemist, Otosaka emphasizes the necessity for TEPCO to verify the enduring effectiveness of the processing procedures over an extended timeframe. He contends that TEPCO's testing of "repurification" on a limited water volume lacks adequacy [1]. Clearly, the wastewater discharge technology remains doubtful scientifically, leaving much uncertain risk into the ocean forward.

## 3 Taking preventive action in the face of uncertainty

When no strong evidence exists to verify that a factor is safe, it is always necessary to take preventive action to guarantee 100% security in a scenario. The U.S. Federal Aviation Administration (FAA) sticks with the ban on using cellular telephones during flight due to a lack of evidence of safety [4]. The measure was made beforehand to cope with the unknown risks. Concerning the scheme of discharging radioactive water into the ocean to wind up the nuclear accident, Japan's government believes that the risk is too low to deserve efforts in preventing possible threats after radioactive isotopes get into the ocean.

According to the information of so-called Advanced Liquid Processing System (ALPS) published officially by Japan's Ministry of Foreign Affairs (MOFA), MOFA just talked about tritium's impact [5]. Tritium is a type of radioactive contaminant that presents challenges regarding removal from nuclear-contaminated water. It is considered relatively harmless due to its emission of lower-energy beta particles, resulting in minimal damage to living cells [6]. MOFA has indicated that tritium's annual discharge limit is below 22 trillion Bq. This value is notably lower than the discharge quantities observed in numerous other facilities across Japan [5]. Nonetheless, it's important to note that the narrative of releases extends beyond the scope of tritium alone. TEPCO's ALPS can remove more than 62 contaminants before water enters the ocean. However, no existing technology can filter out all the contaminants from the water [6].

The detailed data on dangerous isotopes was not released by TEPCO until the middle of 2018, including ruthenium-106 (106Ru), cobalt-60(60Co) and strontium-90(90Sr) [6]. What is worth paying attention to is that the behaviors of these radioactive are different from tritium and present relatively active incorporation into marine organisms [7]. For example, "137Cs activities in biotic organisms increased ~10 - ~106 times compared to the background level (~10-2 - ~10-1 Bq/kg fresh weight), and Cs activities once reached 480,000 Bq/kg fresh weight (Hexagrammos otakii) in the FDNPP port after the FDNPPA" [7]. Up to now, no study of other radionuclides FDNPPA is available, not to mention what will be brought by all the nuclear-contaminated water [7].

Given the reality of uncertain radioactive risk, Japan still chooses to start releasing the treated water into the ocean, which has broken the principle of taking preventive action in the first place. Based on MOFA's published information, Japan aimed to develop an understanding of the international community with limited scientific support instead of providing systematic measures to prevent possible marine pollution issues beforehand.

## 4 Shifting the burden of proof to the proponents of an activity

As per the timelines calculated by a marine scientific research institute in Germany, radioactive substances could flow across most of the Pacific Ocean within two months following their release, and they can extend to all waters on the planet in the first ten-year. Thus, the ramifications brought by Japan's actions are likely to transcend its own borders. In contemporary times, both the United Nations Conference Declaration and UNCLOS encompass a fundamental legal principle, as outlined by Chang et al. (2022): "States possess, in alignment with the United

Nations Charter and the tenets of international law, the independent entitlement to exploit their resources in accordance with their environmental strategies, alongside the obligation to ensure that activities within their jurisdiction or under their control do not inflict harm upon the environment of other States or areas outside national jurisdiction [3].” If Japan insists on releasing treated water into the ocean, they have the responsibility to provide solid evidence to demonstrate that the activity will not deteriorate other states’ environment.

In the Pulp Mills case, “the International Court of Justice (ICJ) identified the obligation to conduct environmental impact assessment as a requirement under general international law” and “failure to conduct such assessment would fail to fulfil due diligence obligations [8]”. What is more, when Japan has push forward an activity that can potentially pollute the environment, which is discharging contaminated water since 24 Aug. 2023, “the acting State is liable for transboundary harm so long as there is sufficient evidence that the acting State’s conduct will cause serious harm to the development of the environment in the long run, even if immediate material harm was not yet occurred [3].” Evidently, Japan not only refrains from conducting advanced environmental impact assessments but also lacks the capacity to furnish scientifically grounded evidence to counter apprehensions regarding the detrimental effects attributable to its activities over the ensuing three decades.

However, Japan’s Supreme Court has denied the assumption of state responsibility on discharging radioactive water, which is also overlooked in the scheme [8]. International judges like ICJ and ITLOS can be considered for help-seeking [8]. In history, both New Zealand and Australia successfully sued with ICJ on France repeatedly conducting nuclear tests over its territory. However, ICJ’s jurisdiction cannot function without “the consent from both parties”. According to ICJ, Japan proclaimed that “it excluded any dispute arising out of, concerning, or relating to research on, or conservation, management or exploitation of, living resources of the sea”; it hinders the affected countries from seeking supportive opinions under international law [8]. Therefore, the burden of proof for Japan to justify the action of discharging treated water is largely relieved, not to mention that there is no strong evidence to illustrate its harmlessness.

## 5 Exploring a wide range of alternatives to possible harmful actions

When a potentially hazardous material is identified, the precautionary principle encourages people to look for alternatives, and this is how to mitigate the limitation of regulatory policy after risk assessment. In history, the Danish Environment Agency (EPA) decided to eliminate phthalates from toys using the logic above. Considering all the factors, EPA mentioned that these toxic compounds are exposed to the kids, “who are by definition are susceptible to many toxic substances”, other solutions do exist. In this case, why an uncertainty is still acceptable [4]?

In China Central Television’s (CCTV) report, several people familiar with Japan’s decision-making revealed more details about how the discharge plan was determined [9]. Yasuhiro Kawai, a Japan Atomic Energy Commission member, said that most members agreed to choose discharging the contaminated water into the ocean over the other four alternatives. The decision came out officially with a certified report with the credits of committee experts. In fact, Fukushima University of Japan provided five solutions to deal with nuclear-contaminated water: injection into stratum, discharge into ocean, emission through steam, electrolytic release, and solidified landfill. Professor Ryota Koyama recalled that the estimated budget for radioactive water discharge is 3.4 billion yen, much lower than other alternatives, so this option has been chosen [10].

Hajime Matsukubo, the director of affairs of the Japanese non-profit organization, Atomic Energy Information Office, pointed out that the Japanese government gave up other safer alternatives in order to save money. In his interview, he mentioned that the method adopted by the United States is to solidify contaminants with mortar. If they are solidified with concrete, there is no need to worry about the danger of nuclear pollutants flowing out. When nuclear-contaminated water is left for more than 100 years, most substances, such as tritium will decay and disappear so they can be stored safely. Also, in the research article written by Buesseler three years ago, the importance of time has been emphasized when it comes to the unremovable isotopes after the treatment. According to the calculation, “with a 12.3-year half-life, in the 60 years, 97% of all of the tritium would decay, along with several of the other shorter-lived isotopes” [6]. Buesseler suggested that even if the tanks were stored somewhere far from the current FDNPP, the radioactive risk of tank leaks still needs to be assessed in the long run.

## 6 Increasing public participation in the decision-making

As a core principle, public participation matters for environmental sustainability. Thus, any assessment process should be transparent, and it is inclusive of stakeholders for the purposes of interest or influence [2]. One of the reasons for assessing risk in a broader process is that sometimes the relevant issues of uncertainty extend beyond the scientific field, where a group of people can solve alone. Fisher believes that in pluralistic societies, value choices made by one group run counters to the decisions made by the values of all in the community. Therefore, the process of assessing risks and setting policy should involve public agreement and participation [2]. Considering the uncertain high risk of how to deal with nuclear-contaminated water, the authorities should not decide by themselves.

However, based on the reactions of Japanese citizens reported by media, Fukushima resident Sachiko Shido said

that the radioactive water discharge was a decision without their agreement [11]. Back in 2015, TEPCO made written commitments to Fukushima Prefecture and national fishery groups successively, claiming that they would not arbitrarily move it forward without the understanding of relevant parties, including fishery practitioners. These two commitments can still be found on TEPCO's official website and have been recognized by the Japanese government [12]. Given that the two-year preparation of the discharge plan never stopped, and the "testimony" made by Fukushima citizens, Japan's government's decision to discharge nuclear plant water is unilateral and unauthorized. It is true that IAEA, as an international organization, concluded after their safety review of the ALPS-treated water, that the treatment is consistent with international safety standards. Nonetheless, what is emphasized in the report's foreword is that "the release of the treated water stored at Fukushima Daiichi Power Station is a national decision by the Government of Japan and that this report is neither a recommendation or an endorsement of that policy" [13].

Besides the opposition from neighboring countries such as South Korea and China, opposite voices from farther continents have also been heard. Ken Busseler, the marine radiochemist at the Woods Hole Oceanographic Institution in the United States, also pointed out in a recent interview with National Public Radio, that the data provided by Japan is not transparent and comprehensive and cannot prove that the discharged water is safe enough for the marine environment. He said, they only analyzed 40% of the storage tanks, and their test did not cover all the concerns that need to be addressed on radioactive isotopes. In short, the data are provided unilaterally by Japan [14]. On 24 Aug., German Environment Minister Lemke said in a statement that, as environment minister, she was highly critical of any additional discharge of radioactive materials into the ocean. Such programs must be planned and implemented based on science, and the process must be transparent, and local residents must participate in the decision-making and be fully informed, Lemke said [15]. For achieving marine sustainable development, it is crucial to solve the governance dilemma in the long term, and international courts and tribunals are recommended with the principle of public participation (scientific communities, the private sector, NGOs and local populations getting involved in the decision making processes) [16].

## 7 Conclusion

From the perspective of precautionary principles, the Japanese authorities' move on confronting radioactive water after the Fukushima nuclear accident are not matched. When isotopes cannot be completely removed and remain uncertain risks, the government did not continue isolating risks from outside but did the opposite - leaving radioactive risks of many isotopes into the sea forward. In the face of radioactive threats to other countries' territory, the state lacks solid scientific evidence to prove the harmlessness of discharging the treated water, but still insists on pushing forward the plan. According to the informed sources, Japan's decision-makers did list several alternatives. However, they decided based on saving the most fund instead of reducing the most threats. IAEA emphasized that their investigation report does not mean that they support the decision, the truth is that there is no clear voice of understanding and support among fisheries and international organizations. Since the release has started, an independent study monitoring marine biota and radioactive contaminants should have been undertaken. The Japanese government should continue consulting with affected states and relevant organizations to seek the most balanced solutions and international cooperation while be prepared for other alternatives if there is any change in the decision. Besides, always making study involved with public participation may enhance the public education and build confidence in ending the catastrophe.

However, on 23 Jul., NHK reported an update of Japan's government. Foreign ministry officials say they will counter false information regarding the "repurified" water from FDNPP into the ocean. There are two important messages in the news. One is that if AI technology finds any nonfactual content, deletion or refutation will be followed. This announcement implies that the government possesses the sources to intervene the dissemination of information. And what are the exact benchmarks government makes to justify if the content is true or nonfactual? Another message is that the ministry is going to work with the U.S. and South Korea governments to release information supported by scientific evidence. The move goes beyond Japan and intends to turn up the volume of support at an international level. Hence, the information that are accessible to the audience may not be all of them. The study in the essay is based on the available materials. It is necessary to collect more clues about what the Japanese government exactly did on intervening the information flow to have a more comprehensive understanding of the details in nuclear water discharge.

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