The Fukushima Conundrum: Ocean Disposal of Nuclear Waste

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The Japanese Prime Minister, Mr Yoshihide Suga, recently made public a plan to discharge 1.25 million tonnes of treated radioactive water from the Fukushima nuclear plant into the Pacific Ocean, describing it as his country's *"most realistic option."*[1] The decision evoked consternation and rebukes from Japan's neighbours, especially China and South Korea, both of whom share a maritime border with Japan, and would be directly affected by this unilateral decision by the Japanese government. The decision is also being widely viewed as a gross abrogation of Japan's committed responsibilities under the UNCLOS. Japan certainly appears to be abandoning its commitments towards protection and preservation of the marine environment. The Japanese authorities, on the other hand, have been at pains to clarify that all traces of highly radioactive elements (strontium and caesium) have been removed from the storage tanks containing the treated wastewater. However, a lesser radioactive element named tritium, a radioactive isotope of hydrogen, which the Japanese government claims poses a low risk to human health and "zero impact on environment"[2], will, indeed, be part of the disposal[3]. The International Atomic Energy Agency (IAEA) has backed the Japanese claim, saying, *"Japan's chosen water disposal method is both technically feasible and in line with international practice."*[4] The United States, in a tweet by Secretary Anthony Blinken, lauded Japan for its *"transparent efforts"* in following globally accepted standards of nuclear safety.[5] These endorsements notwithstanding, there is no gainsaying the fact that the decision has mostly drawn strong condemnation in the country's neighbourhood as well as in Japan's own coastal communities, owing to persistent and strong apprehensions of the severity of environmental as well as economic costs that the decision may incur. Amidst these contrasting and highly emotive opinions, the whole question

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[1] PTI, "Japan to start releasing radioactive water into sea in 2 years" *The Week*, 13 April 2021 https://www.theweek.in/news/world/2021/04/13/japan-to-start-releasing-radioactive-water-into-sea-in-2-years.html

[2] Yen Nee Lee, "Engineering professor says Japan's plan to dump treated radioactive water in the sea is not dangerous" *CNBC*, 15 April 2021 https://www.cnbc.com/2021/04/16/fukushima-japans-plan-to-dump-radioactive-water-is-not-dangerous-prof-says.html

[3] Maria Soiw, "Backlash to Japan's Fukushima waste water plan quietens as South Korea, China assess the real cost" *This Week in Asia*, 22 April 2021 https://www.scmp.com/week-asia/politics/article/3130507/backlash-japans-fukushima-waste-water-plan-quietens-south-korea

[4] IAEA, "IAEA Ready to Support Japan on Fukushima Water Disposal, Director General Grossi Says" *International Atomic Energy Agency*, 13 April 2021 https://www.iaea.org/newscenter/pressreleases/iaea-ready-to-support-japan-on-fukushima-water-disposal-director-general-grossi-says#:~:text=Director%20General%20Rafael%20Mariano%20Grossi,and%20reviewing%20the%20plan's%20safe

[5] Aristyo Rizka Darmawan, "Toxic reaction to Japan's Fukushima water dump" *The Interpreter*, 22 April 2021 https://www.lowyinstitute.org/the-interpreter/toxic-reaction-japan-s-fukushima-water-dump

of ocean disposal of radioactive waste has once again risen to the fore and is likely to stir a wide-ranging debate regarding the health of the seas, radioactive waste-management, the effectiveness of international law, and the very future of nuclear energy.

Japan's Crisis of Trust

This year, Japan marks the tenth anniversary of the triple disaster that hit its shores on March 11, 2011, when a massive earthquake set off a *tsunami* that swept inland to destroy the Fukushima Daiichi nuclear power plant (see **Figure 1**).

Fig 1*: Fukushima Daiichi Nuclear Power Plant Disaster in 2011*

Source: BBC (2021) https://www.bbc.com/news/world-asia-56252695

More than 18,000 people died during these series of disasters, and nearly half a million lost their homes and livelihood. Alongside Chernobyl, it is the only nuclear accident classified as "Level 7", which is the highest category on the International Atomic Energy Agency's International Nuclear and Radiological Event Scale (INES).[6] Fears of radioactivity wreaked havoc in the region, severely affecting the region's coastal communities, which largely depended on agricultural businesses, fisheries and forestry. Apart from the ban on these sorts of Japanese products by its neighbouring countries, the Fukushima Prefecture also witnessed a local food avoidance, which led to economic hardship and had a severe and negative impact on indicators of psycho-social wellbeing such as community attachment, local identity, and culture.[7][8]

[6] Georg Steinhauser, Alexander Brandl, and Thomas E Johnson. "Comparison of the Chernobyl and Fukushima nuclear accidents: a review of the environmental impacts." *Science of the total environment* 470 (2014): 800-817.
[7] Sagar Sharma, and Monica Sharma. "Self, social identity and psychological well-being." *Psychological Studies* 55, no. 2 (2010): 118-136.
[8] Yoshitake Takebayashi, Michio Murakami, Shuhei Nomura, Tomoyoshi Oikawa, and Masaharu Tsubokura. "The trajectories of local food avoidance after the Fukushima Daiichi nuclear plant disaster: A five-year prospective cohort study." *International Journal of Disaster Risk Reduction* 46 (2020): 101513.

According to the "Integrated Fukushima Ocean Radionuclide Monitoring (InFORM) Network", traces of radioactive isotopes Cesium-134 and Cesium-137 from Fukushima were found in seawater and marine organisms throughout the Pacific, extending as far as the North American shoreline.[9]

Apart from its economic impacts, this catastrophic disaster had a fundamental impact in the social and political spheres as well. It was a rude wakeup call for a generation of Japanese people, which suddenly had to come to terms with the fact that even the world's most developed nations are neither immune-from nor prepared-to handle the emerging risks and uncertainty. It also marked a watershed moment in the recent political history of the country, as largescale, antinuclear protests erupted on the streets. The public outcry forced the government to immediately shut down 11 out of the 50 active nuclear reactors in the country, which then caused a significant drop in the electricity generation in the country — of the order of a whopping 40 per cent! By May 2011, all nuclear plants were ordered to shut down for testing and review.[10] The anti-nuclear protests coincided with the prime ministerial term of Shinzo Abe, whose administration's nuclear policy magnified the dilemma of the citizens, many of whom were opposed nuclear arsenals and wanted Japan to sign and ratify the 2017 UN Treaty on the Prohibition of Nuclear Weapons.[11]

One of the consequences of the anti-nuclear movement in Japan was an increase in reliance on oil and natural gas imports to meet the gaps in electricity generation. In the year 2020, Japan committed to building 22 new coal-fired plants at 17 different sites all over the country.[12] Struggling to meet the shortfall in energy supply, Japan's dependence on coal had steadily risen up to a 32 per cent share in the country's total energy generation in 2018. This dependence undermines the country's commitment to the Paris Agreement, where it has committed to cutting its emissions 26 per cent below 2013 levels by 2030, a target that has already been criticised for being 'highly insufficient'. The Global Climate Risk Index[13] has consistently ranked Japan as the most risk-affected country globally due to its high vulnerability and exposure to extreme weather events. In 2019, the United Nations rejected PM Abe's request to address the UN Climate Summit, due to his government's promotion of coal. Amidst such convergence of crises, the nuclear waste dumping is likely to add to Japan's political and environmental woes.

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[9] Ken O Buesseler, Steven R. Jayne, Nicholas S. Fisher, Irina I. Rypina, Hannes Baumann, Zofia Baumann, Crystaline F. Breier et al. "Fukushima-derived radionuclides in the ocean and biota off Japan." *Proceedings of the National Academy of Sciences* 109, no. 16 (2012): 5984-5988.

[10] Kimberly Amadeo, "Japan's 2011 Earthquake, Tsunami and Nuclear Disaster" *The Balance*, 27 September 2020 https://www.thebalance.com/japan-s-2011-earthquake-tsunami-and-nuclear-disaster-3305662

[11] Masakatsu Ota, "Japanese Nuclear Policy After Hiroshima, After Abe, And After Nov. 3" *War on the rocks*, 14 September 2020 https://warontherocks.com/2020/09/japanese-nuclear-policy-after-hiroshima-after-abe-and-after-nov-3/
See Also: "Treaty on the prohibition of nuclear weapons" *Office of Disarmament Affairs, United Nations* https://www.un.org/disarmament/wmd/nuclear/tpnw/

[12] Ewan Halliday, "Japan's Nuclear Question: The Impossible Implementation of a Necessary Program" *The McGill International Review*, 19 April 2021 https://www.mironline.ca/japans-nuclear-question-the-impossible-implementation-of-a-necessary-program/

[13] David Eckstein, Vera Kunzel and Laura Schafer, "Global Climate Risk Index 2021" *Germanwatch*, January 2021 https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf

Dumping of Nuclear Waste into the Ocean

Radioactive waste is typically classified in the following categories: Very Low-level Waste (VLLW), Low-level Waste (LLW), Intermediate-level Waste (ILW), and, High-level Waste (HLW). It is important to note that the currently prevailing protocol for the disposal of nuclear waste, the "London Protocol" of 2006, allows for the dumping of LLW during emergency conditions under a strict consultative process and under the guidance of competent authority. Currently, LLW and VLLW form the bulk of the volume of radioactive waste from nuclear power production processes, and, according to IAEA estimates, nearly 80 per cent of these have been placed in disposal (see Table 1).

Table 1: Nuclear Waste Inventory (IAEA Estimates, 2018)

Category	Solid Radioactive Waste in Storage (m^3)	Solid Radioactive Waste in Disposal (m^3)	Proportion of Waste Type in Disposal
VLLW	2,356,000	7,906,000	77%
LLW	3,479,000	20,451,000	85%
ILW	460,000	107,000	19%
HLW	22,000	0	0%

Source: World Nuclear Organisation
https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx

The dumping of nuclear waste, which included nuclear reactors from nuclear-powered submarines and core plates of nuclear icebreakers, into the ocean, was a common occurrence until the 1970s, when environmental movements began to raise demands for regulation of this practice.

In fact, until the late 1950s, there was no recognised international institution or agreement or standards and procedures for radwaste disposal in the oceans. One of the outcomes of the United Nations Conference on the Law of the Sea (1958) was the assignment of these responsibilities to the International Atomic Energy Agency (IAEA). The IAEA set up its first "Advisory Group Meeting on Radwaste Disposal into the Oceans and Seas" in 1957, and took active steps to address this emerging crisis. In 1958, a panel of experts from nine countries was constitute to look into the issue. This panel, amidst sharp geopolitical differences and denials on the subject, eventually tabled the influential "Brynielsson Report", which noted that the range of properties of radioactive wastes was vast, while knowledge about the oceans was very limited. The report recommended that, "*At present, the release into the sea of highly-radioactive wastes from the irradiated fuel cannot be recommended as an operational practice… Wastes of low, and intermediate activity may safely be disposed of into the sea under controlled and specified conditions.*"[14]

The Geneva Convention on the High Seas (1958), now well known as UNCLOS I, also took notice of the subject and its Article 25 notes, *"Every State shall take measures to prevent pollution*

[14] Edward Duncan Brown, "International Law and Marine Pollution: Radioactive Waste and Other Hazardous Substances." *Natural Resources Journal* 11 (1971): 221.
See Also:
Jacob Darwin Hamblin. "Environmental diplomacy in the Cold War: the disposal of radioactive waste at sea during the 1960s." *The International History Review* 24, no. 2 (2002): 348-375.

of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations."[15]

It was only in the 1970s when, inspired by Jacques Yves Cousteau's pioneering efforts to film the underwater world, popular environmental literature such as *The Silent Spring* and *The Frail Ocean*, and taking advantage of the widespread cultural and political impact of the "First United Nations Conference on the Human Environment" of 1972, the marine conservation movement, led by non-governmental organisations, began to question the unregulated disposal of radioactive waste into the oceans.[16]

The "Inter-Governmental Conference on the Convention on the Dumping of Waste at Sea", also known as the "London Convention", came into force in 1975, and this led to a voluntary moratorium on low level radioactive waste (LLW) dumping, in 1983.[17] Almost simultaneously, the "UNCLOS Convention" of 1982 devoted a substantial part of its text— Part XII — to the Protection and Preservation of the Marine Environment. Article 197 of the UNCLOS states,

> "*States shall cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organizations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features.*"

These encouraging developments notwithstanding, as many as thirteen countries continued to use the oceans as a dumping site, right up to 1993, when the Contracting Parties to the London Convention adopted a landmark resolution banning ocean dumping of LLW altogether (see **Figure 2**).

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[15] United Nations Convention on the High Seas, Geneva, 1958 https://www.gc.noaa.gov/documents/8_1_1958_high_seas.pdf

[16] Lasse Ringius, "Environmental NGOs and regime change: the case of ocean dumping of radioactive waste" *European Journal of International Relations* 3, no. 1 (1997): 61-104.

[17] Kirsti-Liisa Sjoeblom and Gordon Linsley, "Sea disposal of radioactive wastes: The London Convention 1972" *IAEA Bulletin* 36, no. 2 (1994): 12-16.

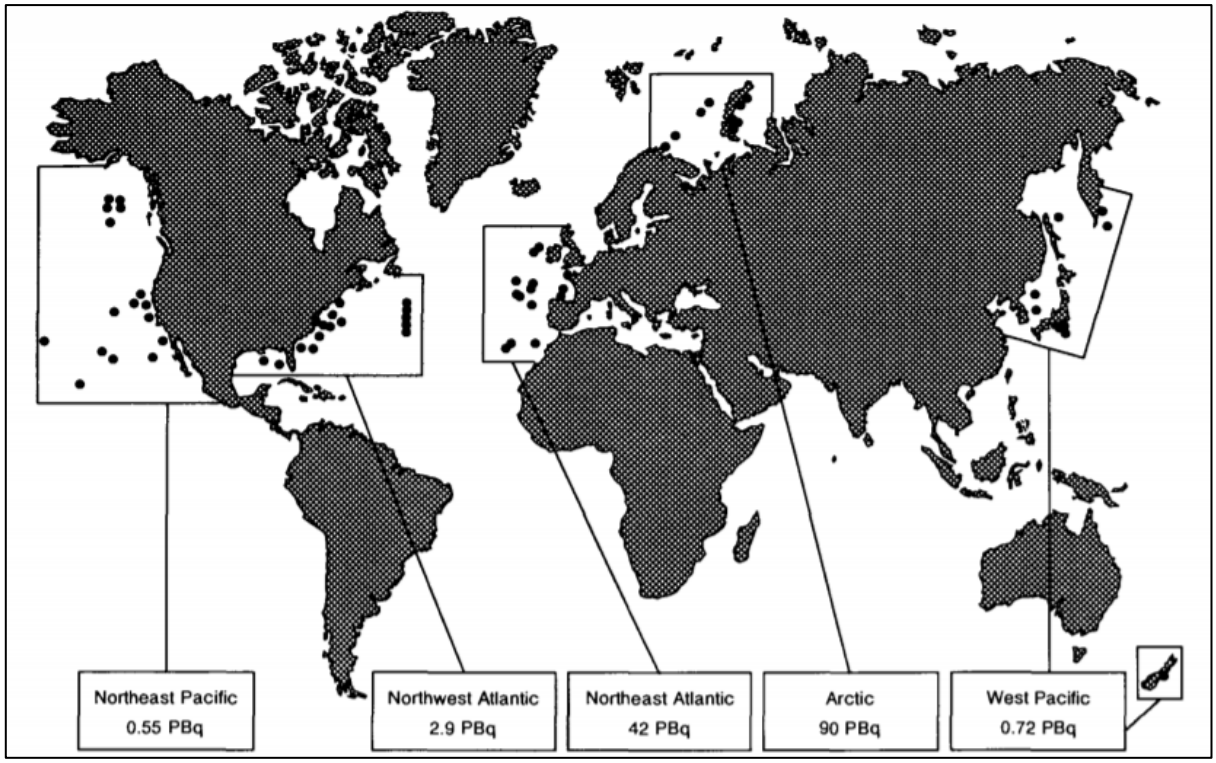

Fig 2: Ocean Disposal of Radioactive Waste

Source: Kirsti-Liisa Sjoeblom and Gordon Linsley, "Sea Disposal of Radioactive Waste: The London Convention 1972" *IAEA Bulletin 36, No 2 (1994): 12-16.*

This was a watershed moment in marine conservation history. Alexei Yablokov penned a seminal report, written after the 15th "Consultative Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter", highlighting the scale of the damage done to the oceans by Russia. This, he wrote, included, "*17,000 containers of radioactive waste, 19 ships containing radioactive waste, 14 nuclear reactors, including five that still contain spent nuclear fuel; 735 other pieces of radioactively contaminated heavy machinery, and the K-27 nuclear submarine with its two reactors loaded with nuclear fuel.*"[18] However, it would be grossly unfair to single out Russia as the sole offender, since similar practices had been prevalent elsewhere in the world, too. European nations, for instance, had dumped nuclear waste containing over 700 000 Ci of radioactivity into the Irish Sea, the English Channel, and the wider Atlantic Ocean, while the United States had dumped nearly 110,000 containers of nuclear waste containing over 94 000 Ci radioactivity off the coast of California, Massachusetts and other states. [19][20]

[18] Lakshman D. Guruswamy, and Jason B Aamodt. "Nuclear arms control: The environmental dimension." *Colo. J. Int'l Envtl. L. & Pol'y* 10 (1999): 267.
See Also: Mark E. Mount, Michael K. Sheaffer, and D. T. Abbott, "Estimated inventory of radionuclides in former Soviet Union naval reactors dumped in the Kara Sea. No. UCRL-JC-114680-VGS; CONF-930843-1" *Lawrence Livermore National Lab.*, CA (United States), 1993.
[19] WF Holcomb, "A history of ocean disposal of packaged low-level radioactive waste" *Nuclear Safety* 23, no. 2 (1982): 183-197.
[20]John R. Emshwiller and Dionne Searcey, "Nuclear Waste Sits on Ocean Floor" *The Wall Street Journal*, 31 December 2013 https://www.wsj.com/articles/SB10001424052702304773104579268563658319196

In 1996, the "London Dumping Convention" of 1972 was replaced by the "London Protocol", which came into force in 2006. The new protocol upheld the precautionary approach in tackling dumping of pollutants into the oceans and stated that, "*the polluter should, in principle, bear the cost of pollution.*"[21] It banned the dumping of high-level radioactive waste (HLW), but, allowed for IAEA-regulated LLW disposal. Many non-governmental organisations, as well as State authorities such as the South Korean Ministry of Oceans and Fisheries, have repeatedly argued that the Fukushima ocean disposal is an international issue and in sharp violation of international arrangements such as the London Convention and Protocol as well as the United Nations Convention on the Law of the Sea (UNCLOS).[22] These critics have argued that Japan's government has decided to opt for the cheapest quick fix available, forgoing other viable alternatives (see Table 2). However, it must be noted that both UNCLOS and London Convention lack any enforcement mechanisms, which means that the concerns of the neighbouring States will have to be tackled primarily through diplomatic channels.

Table 2: Radioactive Waste-disposal Options and Proposals

Options/Proposals	Examples
Near-surface disposal at ground level, or in caverns below ground level (at depths of tens of metres)	• Suitable for LLW and short-lived ILW • **Implemented** for LLW in many countries, including the Czech Republic, Finland, France, Japan, Netherlands, Spain, Sweden, UK, and the USA.
Deep geological disposal (at depths between 250 m and 1000 m for mined repositories, or 2000 m to 5000 m for boreholes)	• Suitable for long-lived ILW and HLW (including used fuel) • Most countries have **investigated** deep geological disposal and this is, indeed, the official policy in several countries. • Implemented in the USA for defence-related transuranic waste at WIPP. • Preferred sites selected in France, Sweden, and the USA. Facility under construction and due to begin operations in 2023 in Finland. • Geological repository site selection process commenced in the UK and Canada.
Disposal at subduction zones	• **Investigated** by the USA. • Not implemented anywhere. • Not permitted by international agreements.
Sea disposal	• **Implemented** by Belgium, France, Germany, Italy, Japan, Netherlands, Russia, South Korea, Switzerland, UK, and USA. • Not permitted by international agreements.
Sub seabed disposal	• **Investigated** by Sweden and UK (and organizations such as the OECD Nuclear Energy Agency). • Not implemented anywhere. • Not permitted by international agreements.

[21] Protocol to The Convention on The Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (1996) https://www.epa.gov/sites/production/files/2015-10/documents/lpamended2006.pdf
[22] Aristyo Rizka Darmawan, "Toxic reaction to Japan's Fukushima water dump" *The Interpreter*, 22 April 2021 https://www.lowyinstitute.org/the-interpreter/toxic-reaction-japan-s-fukushima-water-dump

Disposal in ice sheets (proposed for wastes that are heat-generating)	• **Investigated** by USA. • Rejected by countries that have signed the Antarctic Treaty or committed to providing solutions within national boundaries.
Disposal in outer space (proposed for wastes that are highly concentrated)	• **Investigated** by USA. • Investigations now abandoned due to cost and potential risks of launch failure.

Source: *World Nuclear Organisation* *https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx*

The storage tanks at Fukushima held wastewater that had been contaminated with nucleotides such as caesium-137, carbon-14, tritium, cobalt-60, iodine-129, plutonium-239. Except for radioactive tritium and carbon-14, the Japanese government has claimed that the rest of the radioactive elements have been removed. Critics argue that the Advanced Liquid Processing System (ALPS), which is the treatment process used by Tokyo Electric Power Co. (TEPCO) at the Fukushima plant, fails to capture dangerous isotopes such as those of tritium, ruthenium, cobalt, and strontium, with absolute accuracy.[23] In the aftermath of the 2011 disaster, most of the radioactive material fell into the Pacific Ocean, which led to mass precautionary evacuation and the destruction of the fishing economy of the region. Experts argue that the accumulation on the seafloor of radioactive isotopes, especially tritium, which can organically bind with other molecules, will affect the marine biota, thus affecting the food chain.[24]

The "United Nations Scientific Committee on the Effects of Atomic Radiation" (UNSCEAR) in its 2020 report entitled, "*Levels and Effects of Radiation Exposure due to the Accident at the Fukushima Daiichi Nuclear Power Station: Implications of Information Published since the UNSCEAR 2013 Report"*, noted that the committee had not found any adverse effects on the health of Fukushima residents due to radiation impact.[25] The IAEA, which has, as has been stated earlier, extended its support for the Japanese decision, has been actively engaged in the post-disaster cleanup and recovery at the Fukushima plant, and providing technical guidelines and systematic assessment of safety for the storage tanks. The Director General of the IAEA added that, *"The Japanese Government's decision is in line with practice globally, even though the large amount of water at the Fukushima plant makes it a unique and complex case."*[26]

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[23] Dennis Normille, "Japan plans to release Fukushima's wastewater into the ocean" *Science*, 13 April, 2021 https://www.sciencemag.org/news/2021/04/japan-plans-release-fukushima-s-contaminated-water-ocean

[24] "Japan: UN experts 'deeply disappointed' by decision to discharge Fukushima water" *UN News*, 15 April 2021 https://news.un.org/en/story/2021/04/1089852
See Also: Rick Steiner, "The danger of Japan dumping Fukushima wastewater into the ocean" *The Hill*, 17 April 2021 https://thehill.com/opinion/energy-environment/548726-the-danger-of-japan-dumping-fukushima-wastewater-into-the-ocean

[25] UNSCEAR, "Levels and effects of radiation exposure due to the accident at the Fukushima Daiichi Nuclear Power Station: implications of information published since the UNSCEAR 2013 Report" *United Nations Scientific Committee on the Effects of Atomic Radiation,* 2020 http://www.unscear.org/docs/publications/2020/UNSCEAR_2020_AnnexB_AdvanceCopy.pdf

[26] "IAEA Ready to Support Japan on Fukushima Water Disposal, Director General Grossi Says" *IAEA Newsletter*, 13 April 2021 https://www.iaea.org/newscenter/pressreleases/iaea-ready-to-support-japan-on-fukushima-water-disposal-director-general-grossi-says

Implications

The Question of Trust. Given its long and painful history with industrial and nuclear disasters, Japan remains in a dilemma on the question of nuclear energy. Lessons from the Minamata Bay disaster, where industrial waste dumping led to mercury poisoning in the 1950s, are still afresh in public memory, and such accidents continue to inform public opinion, practices, and beliefs. The 2011 triple disaster exposed the heightened vulnerability of the island nation to climate change and the cascading nature of emerging risks. While studies have shown that radiation levels have fallen below harmful limits in the region, economic activities in the region, especially fishing, have failed to revive. This highlights the importance of trust in policymaking. The decontamination process, which has been approved by the IAEA, has failed to engender the trust of the coastal communities and neighbouring States, several of which apprehend that they will be directly exposed to the radwaste disposal. A peculiar example of this trust deficit was on display when the Japanese government, in order to allay public fears regarding radioactivity, decided to lower the radiation limit from 500 to 100 becquerels per kilogram of fish. While the move was intended to protect the livelihoods of local communities, it ended up escalating anxiety and food avoidance in the region. While the IAEA's nod is critical for establishing institutional transparency, the matter of nuclear waste disposal will require trust-building at all levels of governance to restore the faith of States and affected communities.

The Limits of International Law. Japan's unilateral decision to release radioactive waste exposes the glaring shortcomings of international law, which remains non-binding in nature, to tackle the issues of transboundary environmental harm. The London Convention (1972) of marine pollution defines Dumping as, *"(i) any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea; (ii) any deliberate disposal at sea of vessels, aircraft, platforms or other man-made structures at sea."* This definition does not take into account radioactive material disposed-off from land as a case of dumping. There have been political and scientific efforts in the past that actually advocated deep seabed disposal of nuclear waste by lobbying for a State recognition of the differences between the terms "dumping", "emplacement", "encasement", "insertion" and "dropping".[27] This raises the possibility that the release of Fukushima discharge might not even get covered under the international dumping convention.

Radioactive Waste. The IAEA-monitored process of radioactive disposal has proven effective, but the lack of alternatives for High-level Radioactive Waste continues to represent a defeat in argument against nuclear power. Disposal in deep geological repositories has been suggested as a safe option for HLW, but it remains a prohibitively costly and dangerous option, especially for countries with small nuclear programmes. The IAEA has proposed a 'Multinational Repository' concept to promote multilateral cooperation for the management of radioactive waste, incorporating three different options: (1) an "add-on" concept in which where a larger facility accepts waste from smaller ones; (2) a "supranational concept", in which a facility with international management and control is established: and, "partnering scenarios", in which

[27] Naomi Oreskes, *Science on a Mission* (University of Chicago Press, 2021), 83

countries collaborate in a multinational repository.[28] The concept of a shared nuclear-waste facility at the international, regional or multinational level is expected to enhance nuclear security, promote environmental protection, and increase technical capacity and knowledge.[29]

The "Clean Energy" Dilemma. Unlike a decade ago, when climate change failed to garner public attention on a scale comparable with the question of radioactive waste, the contemporary period provides a conducive environment to debate the role of nuclear energy in the transition to clean energy and public acceptance of new technologies. However, building public trust on matters of nuclear energy is a treacherous task due to the historical iconography of death, disarmament and gross institutional failure.[30] Advocates of nuclear energy as a clean alternative to fossil fuels must take into consideration the question of trust and intention as these will be critical to their endeavours. These factors will themselves be affected by a range of subordinate ones, including, amongst others, geographical proximity to nuclear sites, international cooperation, trust in nuclear-energy governing institutions, transparency, political leanings, and, advances in technology.[31] The Fukushima radioactive disposal at sea is a case where all these factors will be at play.

About the Author

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[28] Charles McCombie, Neil Chapman, and Ewoud Verhoef, "Progress with Initiatives for Multinational Disposal of Radioactive Wastes" *Arius/COVRA* (2016).
[29] Borut Strazisar, "Shared Nuclear Waste Repository: Is It Wanted or Unwanted?" *Environmental Policy and Law* 47, no. 5/6 (2017): 165-169.
[30] Karen Bickerstaff et al, "Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste" *Public understanding of science* 17, no. 2 (2008): 145-169.
[31] Shirley S. Ho, "Communicating about nuclear energy and climate change" In *Oxford Research Encyclopedia of Climate Science* 2016.