**Introduction**

In 2011, Tohoku Earthquake and Tsunami brought catastrophic damage to Japan. Numerous facilities in East Japan regions were either destroyed or severely damage, especially the nuclear powerplant in Fukushima. This tragedy presented the Japanese government with a tremendous task in terms of dealing with the million tons of contaminated water in tanks. The Japanese government recently proposed releasing the treated water into the ocean, however this proposal has sparked substantial controversy and criticism from environmentalists, local communities, and neighbouring countries. This essay will analyse the impact of Fukushima's wastewater to the environment, the social perception of the company and the country, and investigate the alternatives for dealing with the wastewater.

**Environmental Impact from Fukushima's Wastewater**

The release of Fukushima's wastewater causes three major environmental impacts including water pollution, negative influence on marine creatures and ecosystem, as well as impact on food chain.

To commence with, the direct environmental impact caused by Fukushima's wastewater is water pollution. The wastewater from Fukushima contains a variety of radioactive isotopes, including caesium-137, strontium-90, and tritium, which cause water pollution (Chen & Liu, 2020). When polluted water is released into the ocean, it can quickly spread and endanger marine life. Certain radioactive isotopes can persist in the water for decades, making it difficult to anticipate the long-term environmental impact of Fukushima's wastewater. Besides, the treated wastewater may remain heavy metals. Heavy metals collected by fish and shellfish could enter the human food chain (Wang et al., 2019). Eventually, water pollution can harm marine organisms and lead to water quality degradation.

Moreover, the marine creatures and ecosystem will be negatively affected by the Fukushima’s wastewater. Radioactive isotopes in the wastewater can cause mutations, growth abnormalities, and other effects on marine creatures. According to a study, low levels of radiation exposure can have a major impact on marine creatures' survival, growth, and reproduction (Hirai et al., 2018). This reflect that marine creatures are sensitive to the radiation exposure. In addition, Sato et al. (2020) discovered that radioactive caesium can harm DNA and hinder reproduction of marine life. It demonstrates that Fukushima’s wastewater decreases the population and variety of marine life. Therefore, releasing Fukushima’s wastewater into ocean causes irreversible marine ecosystem disaster.

Furthermore, the impact on food chain must be considered when releasing liquid included radioactive contaminants into the ocean. Human health concerns can be raised ultimately when radioactive contaminants existing in the food chain. Radionuclides from contaminated saltwater can be accumulated by wild marine life, including fish and crabs, and radionuclides are transferred up the food chain to apex predators, including human being (UNSCEAR, 2013). According to a study, the levels of cesium-137 and strontium-90 in the fishes captured around Fukushima were higher than the fishes caught in the Pacific Ocean (Buesseler et al., 2012). Seafood harvested off the coasts of Japan and other nations become contaminated. Therefore, long-term intake leads to negative health consequences via biomagnification.

**Impact on Social Perception**

Apart from environmental issue, releasing Fukushima's wastewater affects the social perception of Japan government, namely, global public health concern, trust issue, and endangering fishing and aquaculture industry.

Releasing the wastewater into the ocean rises public health concern globally. Radioactive elements are known to accumulate in fish and other marine animals, which can then be consumed by humans, leading to an increased risk of cancer and other health issues (Watanabe et al., 2013). Caesium isotopes from the Fukushima nuclear disaster were identified in Pacific Bluefin tuna fished off the coast of California (Fiedler et al., 2016). It demonstrates radioactive pollution can travel across large distances and across oceans. There are serval countries, including South Korea and China, disagree with the release of Fukushima's wastewater regarding the potential health concerns. Apart from that, United States has also raised concerns about public health. Subsequently, the release of Fukushima's wastewater attracts public attention to Japan government doubting the health issues.

Besides, the trust issue towards Japan government occurs when Japan decided to release the Fukushima's wastewater into the ocean. The public, including Japanese citizens and people from other countries, is wondering whether the decision was made based on scientific evidence or economic concerns. Japan government has never revealed its considerations towards this topic. Slovic et al. (1991) illustrated that trust in government is an important component in moulding public perception of environmental issues. Lack of transparency and public trust can lead to a negative impact on policy effectiveness. As a result, trust issue towards Japan government appears while government rejects to demonstrate the reason.

In addition, Japanese fishing and aquaculture industry criticizes the Japan government whether Japan willing to protect citizens’ livelihoods. After the Fukushima nuclear disaster in 2011, the amount of fish catch was declined dramatically. As of 2019, the fishing industry in Japan had lost over 1.6 billion dollars because of the nuclear disaster (Hino et al., 2019). Further release of Fukushima's wastewater will shrink the fishing and aquaculture industry. The loss of income and employment may have long-term effects among the affected communities. Eventually, release of Fukushima's wastewater lead to the loss in fishing and aquaculture industry which fails the expectation of society.

**Alternatives for Solving Fukushima's Wastewater**

Instead of releasing Fukushima's wastewater into the ocean, there are numerous methods to deal with the massive amount of wastewater. For instance, evaporate the water and store the resulting solids, inject the wastewater into deep underground, release wastewater into the atmosphere via vaporization and condensation, and use advanced water treatment technologies.

Evaporating the water and storing the resulting solids can be an alternative for releasing wastewater into ocean. According to the study from Yan’s team (2021), evaporating the water via solidification can remove up to 99% of the radioactive isotopes from the wastewater. After that, the solids produced can be stored in segregating containers for disposal. Comparing to the proposed solution, this method enables Japan produce harmless treated water which may help Japan government receive support from the other stakeholders.

Injecting the wastewater into deep underground is another alternative for releasing wastewater into ocean. The Japanese government studied the feasibility of deep underground injection and found that it is a technically feasible alternative (Metcalfe, 2021). Besides, the presence of deep geological formations in Japan increases the feasibility of this method. Rock is a good radiation isolator. The distance between earth surface and deep underground further weakens the strength of the radiation. Eventually, it is possible to protect the world and Japan citizens from the Fukushima's wastewater.

Release radioactive particles into the atmosphere is one of the alternatives. Some scientist suggested that This method utilizes vaporization and condensation which removes most of the radioactive isotopes from the wastewater and releases them into the atmosphere. This method has been used successfully in other nuclear facilities (Güiza et al., 2021). However, the radioactive particles are possible to spread across a long distance due to the wind. Therefore, this alternative needs further investigation.

The last alternative for solving Fukushima's wastewater relies on the advanced water treatment technologies. The use of photocatalysis to break down pollutants, which involves the use of a photocatalyst and light source. Titanium dioxide is a well-known photocatalyst that has been investigated for the removal of caesium from wastewater (Zhang et al., 2020). Eventually, the wastewater is treated to become less radioactive.

**Conclusion**

The release of Fukushima's wastewater into the ocean is a complicated issue that involves environment and social considerations. Japan government should bear up social responsibility and listen to the opinions from citizens and other countries while considering the release of wastewater. There are several alternatives suggested for controlling the influence towards different stakeholders during the process of handling radioactive water.

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