



# The Impact of Japan's Announcement on Nuclear Wastewater Discharge on Consumer Behavior: An Analysis Based on Behavioral Economics Theory

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**Abstract.** Employing behavioral economics theory and statistical methodologies, including regression analysis, this study examines consumer purchasing patterns on the HKTV Mall platform, with particular emphasis on seafood products. By mining and analyzing a dataset detailing the volume, origin, and category of items bought, we delve into the consumer behaviors and psychological underpinnings of the Hong Kong marketplace. The investigation focuses explicitly on consumer responses to the Japanese government's decision to release Fukushima's nuclear-contaminated water into the ocean. The research provides a nuanced assessment of the Japanese government's declaration's repercussions on Hong Kong consumers' purchasing decisions, thereby offering insight into larger global consumer attitudes. It leverages authentic transactional data to ascertain consumer sentiments, encapsulating the concept that purchase choices serve as a proxy for public opinion or a form of 'voting with one's wallet.' This paper offers a lens through which to observe the broader implications of the Japanese government's actions on environmental, social, and governance (ESG) standards. By illuminating the interplay between governmental policy decisions and market behavior, this paper contributes to a deeper understanding of the dynamics at play in consumer decision-making processes in the face of environmental concerns. As such, it underscores the potential for consumer behavior analysis to inform policy discourse and ethical business practices in an increasingly ecologically conscious global economy.

**Keywords:** Behavioral economics, Consumer behavior, Fukushima nuclear accident contaminated water, ESG, Regression analysis

## 1 INTRODUCTION

On January 13, 2023, the Japanese government ignored strong questioning and opposition from the international community and announced that it would forcibly initiate the discharge of contaminated water from the Fukushima nuclear accident into the sea. The Japanese side's vision is to ignore external opposition, transfer risks to the world, continue the pain to all humanity, become a destroyer of the ecological environment and a global marine polluter. This would not only infringe on the health, development and

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R. Magdalena et al. (eds.), *Proceedings of the 2024 9th International Conference on Social Sciences and Economic Development (ICSSSED 2024)*, Advances in Economics, Business and Management Research 289,

[https://doi.org/10.2991/978-94-6463-459-4\\_85](https://doi.org/10.2991/978-94-6463-459-4_85)

environmental rights of people of all countries, but also result in the violation of their own moral responsibilities and international legal obligations. The Japanese government's announcement of discharging nuclear contaminated water would also place itself in the international dock and Japan would inevitably be condemned by the international community for a long time, because in today's globalized world, the government's environmental policies are responsible to all the people around the world and are inevitably under the supervision of all countries. "Environmental politics therefore provides one of the best spaces available to study the emergence of new modes of governance that have arisen in response to globalization." [1] Environmental, Social and Governance, also known as ESG (Environmental, Social and Governance), evaluates the sustainability of business operations and their impact on social values from three dimensions: environmental, social, and governance. The concept of ESG was actually proposed relatively early. The search for a relation between environmental, social, and governance (ESG) criteria and corporate financial performance (CFP) can be traced back to the beginning of the 1970s. [2] In terms of the environment, ESG principles require companies to take proactive environmental protection measures to reduce negative impacts on the environment, such as reducing carbon emissions, conserving energy, and reducing waste generation. In terms of society, ESG principles require companies to actively fulfill their social responsibilities, pay attention to employee welfare, product quality and safety, consumer rights protection, and also actively participate in social welfare activities. In ESG, the government also plays a pivotal role. Unfortunately, the Japanese government has not fulfilled its relevant obligations and has decided unilaterally to forcibly initiate the discharge of contaminated water from the Fukushima nuclear accident, failing to achieve the goals of coordinated economic and environmental development: "Coordinated development is a development aggregation that emphasizes integrity, comprehensiveness, and internality. It is not the 'growth' of a single system or element but rather the comprehensive development of multiple systems or elements under the beneficial constraints and regulations of coordination." [3] Behavioral economics is a discipline that studies the psychological, emotional, and social factors that influence people's decision-making. "...on the new approach's capacity to generate a wide range of cogent testable hypotheses and to provide the social scientist with tools relevant for understanding a broad spectrum of observed human behaviors." [4] It not only focuses on how people make decisions, but more importantly, explores why they make certain behaviors. We can also understand this by using the prospect theory because it effectively combines psychological research and economic research: "According to prospect theory, people's aversion to losses is higher than their benefits, so consumers tend to use familiar ways to trade in familiar markets." [5] In this case, Japanese government's announcement brought unfamiliarity and uncertainty to the market, which triggered consumers' concerns. This paper aims to observe consumer behaviors in Hong Kong and compare the purchase of Japanese products before and after the Japanese government's announcement of discharging contaminated water from the nuclear accident into the sea. The purchase of Japanese products is compared with the purchase of products from 12 European countries, which are relatively far from Japan. Therefore, according to common sense, they would not be affected by nuclear accident contaminated water in the foreseeable future. This study aims to conduct in-

depth research on the psychological mechanisms behind consumer behavior, explore the motivation and significance of people making decisions, and attempt to expose the decrease in consumption willingness of Hong Kong consumers due to the irresponsible announcement of the Japanese government: "willingness is the subjective probability of individuals engaging in specific behaviors, and through the same concept extension, purchase intention refers to the probability of consumers willing to take specific purchasing behaviors." [6]. Due to the fact that the Japanese government only announced the discharge of contaminated water from a nuclear accident on January 13, 2023, there was no change in the quality of Japanese products at that time. Therefore, this study is of great value in exploring consumer behavior due to changes in psychological expectations since the quality of products as an unrelated variable remained the same from the very beginning to the end. This article will start with HKTVmall's sales data and explore the impact of the Japanese government's announcement of the discharge of contaminated water from the Fukushima nuclear accident on the consumer behavior of Hong Kong citizens towards Japanese products.

## **2 DATA EXPLORATION AND STATISTIC**

### **2.1 Data set**

The data set used in this article is taken from HKTVmall, one of the leading retail chain stores under Hong Kong Television Limited, which is also one of the most commonly used online shopping platforms by Hong Kong consumers. HKTVmall provides exclusive agents for international brands and its own brand goods, including beauty and skin care products, cosmetics, perfume, health care products, body and hair care products, mother and child products, and daily necessities. The database of this study contains daily platform wide trading data information in the market from December 21, 2022 to February 5, 2023. Each piece of data is recorded on a transaction record basis, including basic information about the traded goods, price information, buyer information, and various other detailed information. This dataset has a total of over 5 million record samples (5,597,689 to be specific).

### **2.2 Data Analysis**

On January 13, 2023, the discharge plan of contaminated water from the Fukushima nuclear accident is announced. We first counted the total daily orders of Japanese goods and analyzed the average daily sales of goods before and after the announcement. According to Figure 1, on the HKTVmall platform before and after November 13, the average daily sales of Japanese products from December 21, 2022 to December 12, 2023 were HKD 23027416.67, while from March 14, 2023 to May 5, 2023, the average daily sales of Japanese products were HKD 18061695.65, a significant decrease of approximately 23.564%.

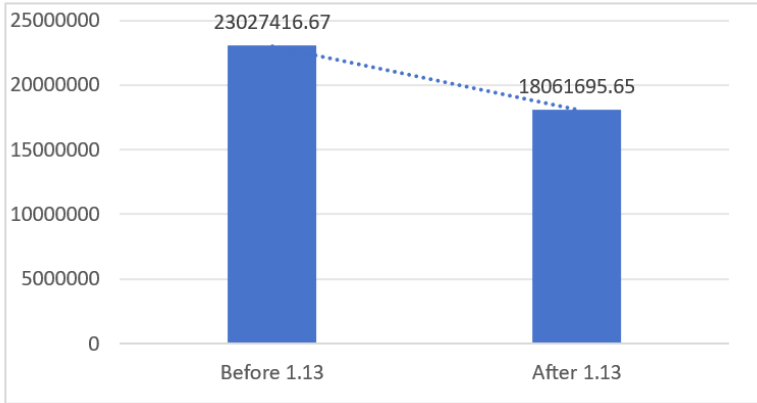


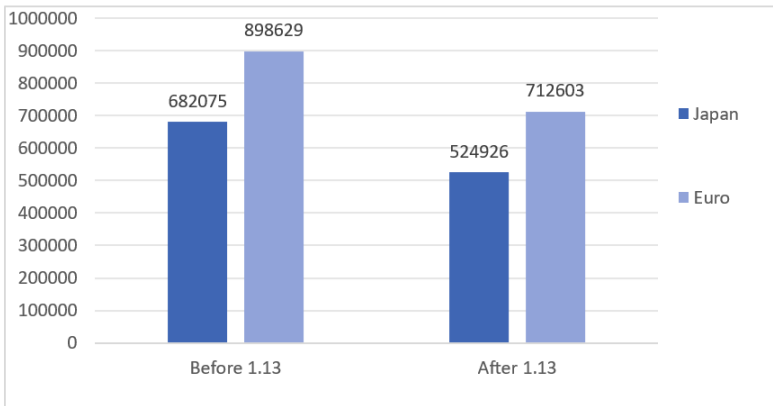
Fig. 1. Daily average sales volume of Japanese goods before and after January 13, 2023

Due to Fukushima being located in the southern part of northeastern Japan, there are many fishing ports of all sizes around the Fukushima nuclear power plant. The nearest one is Ukedo Fishing Port, and the local seafood has exceeded nuclear radiation levels by many times compared with the normal level. The seafood industry was supposed to be most directly affected by the discharge of nuclear contaminated water, and the Japanese government's discharge plan was bound to expand this pollution to a wider range of regions in the future. So studying consumer attitudes towards Japanese seafood products can provide the most intuitive way to explore the attitudes of Hong Kong consumers. Therefore, we mainly analyzed the sales situation of products in the four categories of Seafood, Water, Frozen Meat, and Body Care, which are relatively typical and directly or indirectly related to water. For reference comparison, and considering that countries involved in East and Southeast Asian may also experience water pollution in the future and trigger consumer aversion, this article avoid these countries and ultimately selects product sales data from 12 European countries (including the United Kingdom, Germany, France, Italy, Sweden, Switzerland, Spain, Portugal, Belgium, Iceland, Netherlands, Finland, etc.) as the control group during the same period. It is feasible to use them as a control group since the purchase of products from 12 European countries that are relatively far away from Japan would not be affected by the announcement in the foreseeable future just according to common sense.

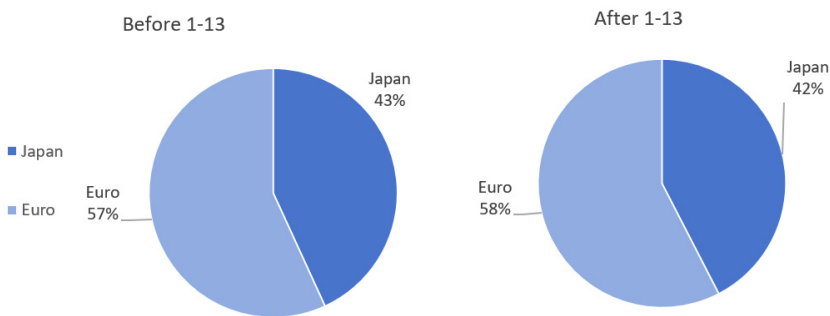
**The sales of Japanese Frozen Seafood encountered setbacks.**

The most typical and important type of products among all the products is Seafood, which is the Japanese product that people are most concerned about after the Fukushima nuclear leak incident. “After the Fukushima nuclear accident, about  $7.7 \times 10^5$  TBq radioactive material was released into the atmosphere. Radioactive substances were released into the environment, of which 19% are spread on the Japanese land and 80% enter the sea. Less than 1% of the oceanic water settles in Eurasia, North America and other regions.” [7] As a result, the sea was affected the most. Seafood is produced in the ocean and is closely related to the water used to cultivate these seafood products. If

the ocean is polluted, people's first thought is that the quality of seafood in the polluted waters will decrease, and there may even be food safety risks. As a result, Seafood becomes a very good analysis object for us to analyze the changes in sales volume of seafood and we can effectively explore consumer psychology and determine whether there is consumer resistance caused by Japanese nuclear wastewater. From Figure 2, it can be seen that the average daily sales of Frozen Seafood from Japan decreased by about 23.04% after January 13th, while the average daily sales of Frozen Seafood from 12 European countries decreased by about 20.70%. The sales volume of Japanese Frozen Seafood has significantly decreased compared with that of European Frozen Seafood. In addition, part of the reason for the decrease in daily sales may be due to seasonal factors, but the decline in sales of Frozen Seafood in Japan is more significant.



**Fig. 2.** Comparison of the average daily sales volume of Frozen Seafood between Japan and Europe before and after January 13, 2023



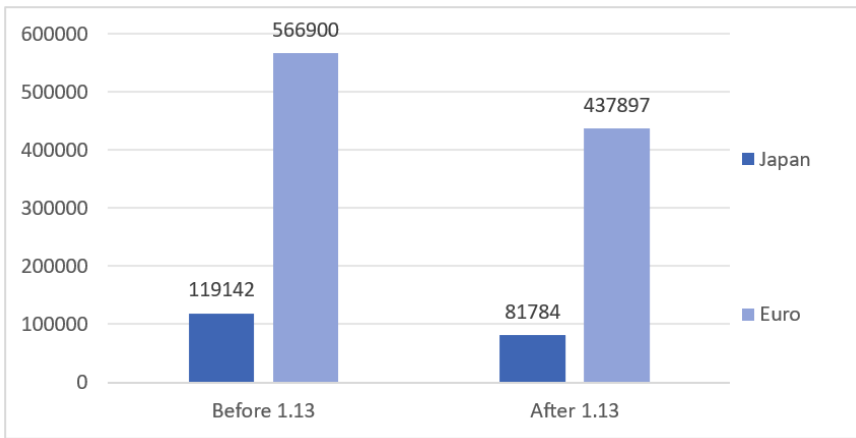
**Fig. 3.** The ratio of Japanese and European Frozen Seafood sales before and after January 13, 2023

*Note: Frozen Seafood can be classified into the following three levels based on its secondary classification: 'Frozen Seashell', 'Frozen Shrimp and Crab', 'Frozen Fish', 'Other Frozen Seafood'.*

Before 1.13, the ratio of average daily Frozen Seafood sales from Japan to the average daily Frozen Seafood sales from 12 European countries was approximately 0.7590:1, while after 1.13, the ratio of average daily Frozen Seafood sales from Japan to the average daily Frozen Seafood sales from 12 European countries was approximately 0.7366:1. From the comparison in Figure 3, it can be seen that the average daily Frozen Seafood from Japan has decreased significantly, with a greater degree of decline than the 12 European countries, and a significant decrease in market share.

**The market was resisting Japanese-production 'Water'.**

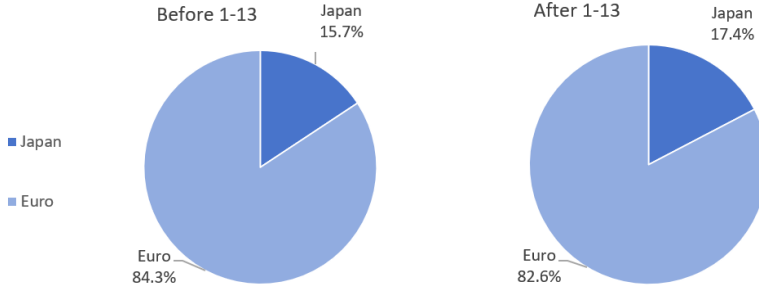
Water is also a good analytical object. "Epidemiological and clinical studies have shown that low-dose radiation may cause diseases such as cataract." [8] Due to worries about the harm of radiation that may jeopardize people's health, people lose the proclivity to purchase Japanese drinking water. Although the announcement of nuclear wastewater discharge would not affect the quality of Japan's water sources instantly and lead to a decrease in the quality of bottled water and other assortments of drinking water, people may be psychologically inclined to label Japan's water as "nuclear radiation" due to the Japanese government's announcement of nuclear wastewater discharge.



**Fig. 4.** Comparison of average daily Water sales in Japan and Europe before and after January 13, 2023

As shown in Figure 4, after 1-13, the average daily water sales from Japan decreased by about 31.36%, which is greater than the decrease in European aquatic products (22.76%). Meanwhile, the ratio of the average daily water sales from Japan before 1.13 to the average daily water sales from 12 European countries was approximately 0.2102:1, and after 1.13, the ratio changed to 0.1868:1.

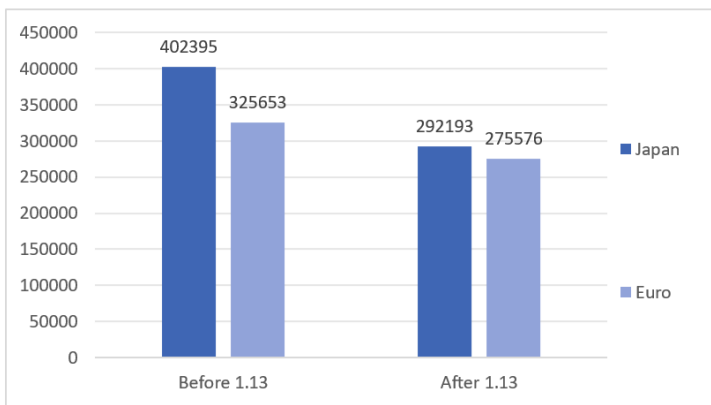
From comparison in Figure 5, it can be seen that the average daily water sales volume from Japan has decreased significantly, with a greater degree of decline than in 12 European countries, and a significant decrease in market share.



**Fig. 5.** The ratio of Water sales in Japan and Europe before and after January 13, 2023

**The market also resists the salable Japanese 'Body Care' products.**

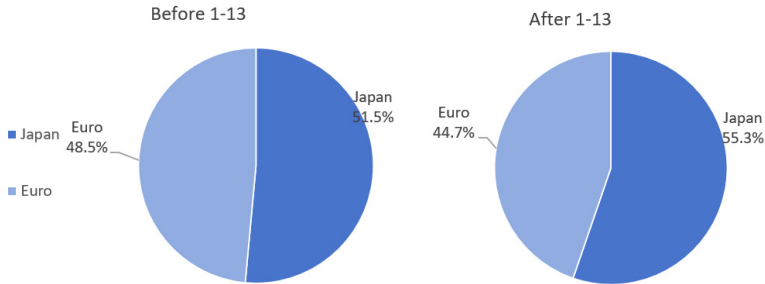
Body Care is also a very good research subject. It was once considered a commodity that was very popular in the international market, but now some challenges emerge. The production process of Body Care cannot be separated from water, and many types of Body Care even contain water directly or use water during use, which may trigger consumers' concerns. As analyzed in the second part of the previous text regarding Water, although the Japanese government only announced the discharge of nuclear wastewater, this action did not immediately have any impact on the quality of Japan's water sources. However, people may be psychologically inclined to label Japan's water as "radioactive", although this was not the fact at that time. Therefore, Body Care, which is closely related to water, may also be affected in sales due to this psychological factor.



**Fig. 6.** Comparison of average daily Body Care sales in Japan and Europe before and after January 13, 2023

As shown in Figure 6, the average daily body care sales from Japan decreased by about 27.39%, while the average daily body care sales from 12 European countries

decreased by only 15.38%. It can be seen from the Figure 7 that, before 1.13, the ratio of the average daily body care sales from Japan to the average daily body care sales from 12 European countries was about 1.2357:1. After 1.13, the ratio of the average daily body care sales from Japan to the average daily body care sales from 12 European countries was about 1.0603:1. It can be seen that the average daily body care sales from Japan have decreased significantly, with a greater degree of decline than European products, and their market share has significantly decreased.



**Fig. 7.** Sales ratio of body care products in Japan and Europe before and after January 13, 2023

*Note: Category Body Care includes 'Bar Soap', 'Bath Salt & Bubble Bath', 'Body Lotion', 'Body Wash', 'Cotton & Cotton tip', 'Deodorant & Talcum Powder', 'Earplugs', 'Scrubs & Exfoliants Treatments', 'Sun Protection & After Sun Care', 'Wet Wipes'.*

### 3 REGRESSION ANALYSIS

This paragraph will further explore and analyze the sales data of Japanese products before and after the announcement of 1-13 Japanese nuclear wastewater discharge, with the aim of exploring whether Nissan's products have suffered resistance from the international market due to the Japanese government's announcement that does not comply with the spirit of ESG, resulting in a decline in sales at last. In the regression analysis, we will further control for other variables that may affect sales and strictly explore the negative impact of this ESG event on Nissan's product sales. Table 1 shows the detailed explanation of regression variables.

**Table 1.** Detailed Explanation of Regression Variables

Classification	Variant	Definition
Response variable	Price	Daily sales of the product
Independent variables	Time	Trading time, date later than 1.13 is 1, otherwise 0
	Origin	Products Made in Japan are 1, otherwise 0
	Order_time_range	Time range for placing orders, divided every 3 hours
	Sub_cat_3	level classification of trading products



Category Frozen Seafood includes: 'Frozen Seashell', 'Frozen Shrimp and Crab', 'Frozen Fish', 'Other Frozen Seafood'.

Category Body Care includes 'Bar Soap', 'Bath Salt & Bubble Bath', 'Body Lotion', 'Body Wash', 'Cotton & Cotton tip', 'Deodorant & Talcum Powder', 'Earpicks', 'Scrubs & Exfoliants Treatments', 'Sun Protection & After Sun Care', 'Wet Wipes'

Single price                      The unit price of the traded product

Utilizing 'Time' and the interaction term 'Origin\*Time,' this article conducted an OLS regression on the daily sales of products over the course of one month. This analysis controlled for variables including 'single\_price', 'order\_time\_range,' 'sub\_cat\_3\_name,' among others. The purpose of this approach was to mitigate the effects of the unit price of products, the timing of orders, and to account for the impact of more granular product classifications. The regression results (detailed in Table 2) revealed that products originating from Japan were more adversely affected than those produced in European countries within categories such as Frozen Seafood, Water, and Body Care. More importantly, the interaction term 'Origin\*Time' was found to have a negative coefficient of correlation with a p-value less than 0.05, indicating statistical significance. This suggests that the sales of Japanese Frozen Seafood, Water, and Body Care products experienced a substantial decline following the announcement of Japan's decision to discharge nuclear wastewater into the ocean post-January 13th.

**Table 2.** Results of Regressions

	Frozen Seafood (1)	Water (2)	Body Care (3)
Const	5775.5791***	827.231***	176.9021***
Time(after1-13)	-603.889**	-27.2390	77.7929***
Origin*Time	-0.837***	-1032.6373***	-167.7516***
Single_price	0.1939	3.1626***	1.0711***
Order_time_range			
9-12	-1354.245***	99.6218	-89.8701***
12-15	-1579.497***	-137.3608	-111.4339***
15-18	-1614.041***	-122.0970	-120.7863***
18-21	-1129.690**	-477.0542	-101.0134***
21-24	-131.3109	-947.3361**	-42.5737**
Sub_cat_3	<i>Controlled</i>	<i>Controlled</i>	<i>Controlled</i>
No. of observations	8796	9287	44856

## 4 SUMMARY

Through in-depth analysis of HKTVmall data and the application of the Ordinary Least Squares regression model (OLS), this study has made significant findings. Specifically,

after Japanese government announced on January 13, 2023 that it would discharge nuclear wastewater into the sea, the market sales of frozen seafood, drinking water, and personal care products from Japan were significantly affected compared to similar products from 12 typical European countries. This result reveals the challenges faced by Japanese markets about consumers' scant trust in product sources, high concerns about food safety, and the fragility of exports of Japan. Further more, we have also noticed more details which reveal a significant decline in sales of products from Japan, which not only reflects consumers' high concern for environmental safety, but also demonstrates their increased concern for food sources and quality. This study goes beyond simple observations of consumer behavior and emphasizes the profound impact of psychological anticipation changes on the market. Japan's decision to discharge nuclear wastewater had not only sparked heated debate domestically, but also caused instability in the international market.

This study highlights the deep concern of consumers towards product quality and safety, as well as the growing sensitivity of the public to food safety and environmental issues. This reminds us that the issues in product sales not only involve an economic perspective, but also a call for sustainable development and global environmental health. Therefore, businesses and policy makers need to recognize that the maintenance and sustainability of the ecological environment are key factors in shaping the market landscape. The export frustration of Japan products is a warning. In order to ensure the quality of products, the government and enterprises need to strengthen their attention to environmental protection and food safety, and take effective measures.

In the context of globalization, the decisions of one country may have a wide-ranging impact on other countries, therefore cross-border cooperation and transparency of information are crucial. China has been making great efforts to protect the environment in this context of globalization: "China has introduced many policies to protect the environment. The old Environmental Protection Law was first adopted and implemented on December 26, 1989, and it has since been revised several times. The new Environmental Protection Law was officially implemented on January 1, 2015." [9] Looking forward to the future, various organizations are supposed to work together to seek more environmentally friendly and sustainable production and consumption solutions, ensuring that our actions not only have a positive impact on the economy, but also have a responsibility for the environment and society at the same time.

In summary, although the announcing discharge of nuclear wastewater has brought trouble to both Japanese citizens and people around the world, we still hope that governments of various countries and the international community can adopt scientific and practical methods to jointly face this challenge and urge the Japanese government to promote its own sustainable development and management. Just as Fiji's Acting Prime Minister Kamekamega said, "Japan's plan has made us highly vigilant. We have learned a lesson. Although the process is very difficult, we cannot leave the same regret for future generations." [10]

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