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THE IMPACT OF THE DISCHARGE OF TREATED WATER FROM THE FUKUSHIMA DAIICHI NUCLEAR POWER PLANT ON THE ECONOMY OF COMMUNITIES IN FUKUSHIMA

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ABSTRACT

This study aims to analyze the impact of treated water discharge from the Fukushima Daiichi Nuclear Power Plant into the Pacific Ocean on the economy of communities in Fukushima during 2023–2024. The Fukushima Daiichi Nuclear Power Plant, operated by Tokyo Electric Power Company (TEPCO), was severely damaged by the earthquake and tsunami that struck Japan on March 11, 2011, resulting in a nuclear accident. Following the accident, contaminated water generated through the reactor cooling process was treated and stored in tanks. In 2021, the Japanese Government decided to gradually discharge the treated water into the sea, with the discharge beginning in August 2023. This policy generated international debate and concerns regarding its environmental and socioeconomic impacts. This study employs a qualitative descriptive method with a deductive approach. Secondary data were obtained from literature reviews, academic journals, government reports, international institutional documents, and other relevant sources. The findings indicate that the treated water discharge has economic implications for communities in Fukushima, particularly through changes in consumer perceptions regarding the safety and reputation of Fukushima products. These perceptions may influence demand, sales, prices, trade, and community income, especially in the fisheries and agricultural sectors. In addition, concerns about the long-term sustainability of the marine environment and fishery resources may affect the livelihoods of communities dependent on natural resources. Therefore, the discharge of treated water from Fukushima Daiichi is not only an environmental issue but also has economic, social, and international dimensions that may influence the sustainability of local livelihoods.
Keywords: *Fukushima Daiichi; Treated Water Discharge; Economic Impact; Fisheries; Agriculture*

ABSTRAK

Penelitian ini bertujuan untuk menganalisis dampak pembuangan air olahan dari Pembangkit Listrik Tenaga Nuklir (PLTN) Fukushima Daiichi ke Samudra Pasifik terhadap perekonomian masyarakat di Fukushima selama periode 2023–2024. PLTN Fukushima Daiichi yang dioperasikan oleh Tokyo Electric Power Company (TEPCO) mengalami kerusakan parah akibat gempa bumi dan tsunami yang melanda Jepang pada 11 Maret 2011 dan mengakibatkan kecelakaan nuklir. Setelah kecelakaan tersebut, air terkontaminasi yang dihasilkan dari proses pendinginan reaktor diolah dan disimpan dalam tangki. Pada tahun 2021, Pemerintah Jepang memutuskan untuk membuang air olahan tersebut secara bertahap ke laut, yang mulai dilaksanakan pada Agustus 2023. Kebijakan ini menimbulkan perdebatan internasional serta kekhawatiran mengenai dampak lingkungan dan sosial ekonomi. Penelitian ini menggunakan metode deskriptif kualitatif dengan pendekatan deduktif. Data sekunder diperoleh melalui studi literatur, jurnal akademik, laporan pemerintah, dokumen lembaga internasional, dan sumber relevan lainnya. Hasil penelitian menunjukkan bahwa pembuangan air olahan tersebut menimbulkan implikasi ekonomi bagi masyarakat Fukushima, terutama melalui perubahan persepsi konsumen terhadap keamanan dan reputasi produk Fukushima. Persepsi tersebut dapat memengaruhi permintaan, penjualan, harga, perdagangan, dan pendapatan masyarakat, khususnya pada sektor perikanan dan pertanian. Selain itu, kekhawatiran terhadap keberlanjutan lingkungan laut dan sumber daya perikanan dalam jangka panjang dapat memengaruhi mata pencaharian masyarakat yang bergantung pada sumber daya alam. Dengan demikian, pembuangan air olahan dari PLTN Fukushima Daiichi tidak hanya merupakan persoalan lingkungan, tetapi juga memiliki dimensi ekonomi, sosial, dan internasional yang dapat memengaruhi keberlanjutan mata pencaharian masyarakat lokal.
Kata Kunci: *Fukushima Daiichi; Pembuangan Air Olahan; Dampak Ekonomi; Perikanan.; Pertanian*

1. Introduction

Following the end of the Cold War, the study and practice of international relations have undergone significant developments in understanding the various forms of threats faced by states. Security concerns are no longer oriented solely toward traditional issues such as armed conflict, military power, and interstate rivalry, but have also expanded to include non-traditional issues related to human welfare, the environment, health, the economy, and various cross-border problems. According to Bob Sugeng Hadiwinata (2019), non-traditional issues encompass various problems that affect national interests,[1] societal welfare, and challenges that cannot be addressed solely through traditional security approaches. One issue closely related to non-traditional security is the utilization of nuclear technology and the management of the waste generated from its use.

Nuclear energy is one form of technological development utilized by various countries to meet their energy needs, particularly as a source of electricity generation. The utilization of nuclear energy provides benefits in terms of energy supply; however, at the same time, it raises concerns regarding safety, the management of radioactive materials, and their potential impacts on the environment and society. Therefore, the management of waste and contaminated water generated by nuclear facilities is not merely a domestic issue for countries utilizing nuclear technology, but may also develop into an issue with social, economic, environmental, and international dimensions.

Japan is one of the countries that utilizes nuclear technology as a source of electricity. One of the most significant nuclear facilities in the history of Japan's energy sector is the Fukushima Daiichi Nuclear Power Plant, located in Okuma Town, Fukushima Prefecture, on the eastern coast of Japan. The power plant began operations in 1971 and was managed by the Tokyo Electric Power Company (TEPCO)[2]. Initially, the utilization of nuclear energy through the Fukushima Daiichi Nuclear Power Plant was part of Japan's efforts to meet its energy needs and support national economic development.

However, on March 11, 2011, Japan experienced a massive earthquake followed by a tsunami. The disaster caused severe damage to the Fukushima Daiichi facilities and resulted in a nuclear accident. Damage to the reactor cooling systems caused fuel meltdowns in several reactors, resulting in long-term challenges for the Fukushima region concerning safety, the environment, regional recovery, and the livelihoods of local communities. The incident not only affected infrastructure and the environment but also had significant social and economic consequences for communities living in and around Fukushima.

One of the major issues that emerged following the Fukushima nuclear accident was the increasing volume of water used to cool the damaged reactor fuel. This cooling water became mixed with groundwater and rainwater that entered the nuclear facility area. The contaminated water subsequently had to be treated and stored before further management could be undertaken. For many years, TEPCO used numerous storage tanks to contain the treated water. However, storage capacity in the Fukushima area became increasingly limited as the volume of water requiring management continued to increase.

This situation subsequently prompted the Japanese Government to decide to discharge the treated water from Fukushima into the sea. In 2021, the Japanese Government officially adopted a policy to discharge the treated water from the Fukushima Daiichi Nuclear Power Plant into the Pacific Ocean[3]. The Japanese Government stated that the water had undergone treatment through the Advanced Liquid Processing System (ALPS), which aims to reduce various radionuclides to levels that meet established standards before discharge. The policy was gradually implemented beginning in August 2023.

Japan's policy attracted international attention because of its implications for marine environmental safety and the sustainability of marine resources. The International Atomic Energy Agency (IAEA) conducted an assessment of Japan's plan and stated that, if implemented in accordance with the established requirements, the discharge plan was consistent with international safety standards[4]. Nevertheless, the policy continued to generate debate and concerns among various stakeholders, particularly regarding perceptions of its potential impacts on the marine environment, fishery products, health, and the livelihoods of communities dependent on marine resources.

This issue is highly relevant to the economic conditions of communities in Fukushima Prefecture. Fukushima has fisheries, agriculture, and various other economic activities that are closely associated with natural resources. For communities whose livelihoods depend on these sectors, environmental conditions and public perceptions regarding the safety of Fukushima products are important factors affecting the sustainability of their economic activities. In the fisheries sector, for example, consumer concerns regarding the safety of seafood may affect demand, prices, sales, and the income of business operators. Thus, the issue is not only concerned with whether scientific evidence indicates the presence or absence of contamination, but also with how perceptions and concerns regarding Fukushima may influence the economic activities of local communities.

Economic impacts may also emerge through concerns regarding the reputation of Fukushima products. Fishery and agricultural products originating from an area that has experienced a nuclear accident face challenges associated with stigma and consumer

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concerns. Such conditions have the potential to generate economic losses even when the safety of the products has been declared to meet certain standards. Therefore, it is important to distinguish between direct environmental impacts and economic impacts that arise through changes in perceptions, market demand, trade, and consumer behavior.

Previous studies have examined the Fukushima issue from various perspectives. Some studies have focused on the technical aspects of the treatment and safety of Fukushima water, while others have examined policy governance, the role of international institutions, and public perceptions regarding the plan to discharge the treated water. Research concerning coastal communities in Fukushima has also identified concerns regarding potential social and economic impacts, particularly on fisheries, agriculture, tourism, and the reputation of local products. However, some studies on public perceptions were conducted before the discharge of treated water into the sea actually began, and therefore primarily describe concerns or perceptions regarding potential future impacts.

Meanwhile, studies on the economic impacts have also been conducted on a broader scale, including analyses of the fisheries sector, trade, and potential economic consequences resulting from import restrictions on Japanese products. Nevertheless, research specifically examining the economic conditions and changes experienced by communities in Fukushima after the treated-water discharge policy began to be implemented in 2023, particularly during the 2023–2024 period, still provides considerable room for further investigation. In other words, there is a research gap between studies addressing concerns or predicted impacts prior to the discharge and the need to examine the economic conditions that occurred after the policy was actually implemented.

This research gap is important because the 2023–2024 period represents the initial phase of the implementation of the Fukushima treated-water discharge policy. During this period, developments in the fisheries sector, changes in product sales and prices, community income, trade in Fukushima products, and various Japanese government policies aimed at assisting communities and businesses in addressing potential economic impacts can be observed. By examining conditions after the policy was implemented, this research can provide a more empirical understanding of whether economic changes occurred among communities in Fukushima and how such changes were associated with the treated-water discharge policy.

Accordingly, this research does not begin with the assumption that the discharge of treated Fukushima water automatically caused an economic decline among local communities. Instead, it seeks to identify and analyze the forms and extent of the economic impacts that occurred, including potential changes in income, fishing activities, product prices and sales, consumer demand, trade, and other economic sectors associated with the livelihoods of Fukushima communities. This approach is important to distinguish between impacts directly attributable to the treated-water discharge policy and impacts arising through public perceptions, market changes, trade policies adopted by other countries, and other economic factors.

Based on the foregoing discussion, research on the impact of the Fukushima treated-water discharge on the economy of Fukushima communities during 2023–2024 is important to undertake. This research is expected to address the identified research gap by providing an analysis of the economic conditions of Fukushima communities during the period following the commencement of the treated-water discharge into the sea. Furthermore, this research is expected to provide an understanding of the relationship between nuclear-issue management policies, environmental issues, public perceptions, and the economic conditions of local communities from an international relations perspective.

Based on the background described above, this research is entitled “The Impact of the Fukushima Daiichi Treated Water Discharge on the Economy of Fukushima Communities in 2023–2024.”

2. Theoritical Framework

Since this article focuses on the the impact of treated water discharge from the Fukushima Daiichi Nuclear Power Plant into the Pacific Ocean on the economy of communities in Fukushima during 2023–2024, it adopts a series of relevant conceptual frameworks.

2.1 The concept of Sustainable Development Goals (SDGs) Goal 14

Sustainable Development Goals (SDGs) are a sustainable development program. SDGs were adopted by all countries that are Members of the United Nations (UN). This sustainable development program was approved in September 2015 to achieve peace and prosperity for humans and the earth [5].

There are 17 SDGs as the core agenda which is a challenge for all countries. With the 17 goals of the UN sustainable development program, countries are recognized as being able to end poverty, improve health, improve education, reduce inequality, and spur economic growth while preserving oceans and forests by 2030 [5].

The 14th SGD goal is Life Below Water, explaining actions in conserving and sustainably utilizing maritime, sea, and ocean resources for sustainable development. The 14th goal prioritizes the government to maintain, protect, and preserve the sea [5].

Local governments must maintain the marine

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environment so that it remains in good condition and does not experience damage or extinction. This conservation effort is important for the survival of humans in the future.

2.2 The Concept of Blue Economy

Blue Economy is a concept that encourages economic development and growth. The goal is to improve the economy and life without sacrificing the sustainability of the marine environment and coastal areas due to limited marine resources.The importance of marine conservation is to eradicate poverty and improve a sustainable economy, food security, and sources of livelihood.

The core of a sustainable economy in the Blue Economy is the existence of the same pattern between economic, social, and marine environmental protection interests in development[6]. The Blue Economy is not only for profit but also focuses on sustainable business and economic growth in the marine environment.

2.3 The Concept of Human Security.

The concept of Human Security was introduced by Mahbub ul-Haq in the Human Development Report of the United Nations Development Programme 1994 (HDR UNDP 1994) defining human security through two aspects, namely security from chronic threats such as hunger, disease, and repression. The second meaning is interpreted as protection from sudden disturbances and endangering daily life either at home, at work, or in society.

In UNDP 1994 seven aspects are interconnected in the concept of human security, namely economic security, food security, health security,environmental security, personal security, community security, and political security.

Based on UNDP 1994, its statement regarding the seven categories of human security that are interconnected with each other is the most basic threat to the value of human life. Thus, human security that focuses on non-traditional issues individually can be in the form of violence, poverty, the threat of epidemics, environmental damage, economic instability, and so on[7].

3. Research Methods.

A research method is a scientific approach or procedure used by researchers to obtain, process, and analyze data, and to draw conclusions from it, in order to answer research questions or achieve research objectives.

3.1 Research Type And Approach

In this study, the researcher used a descriptive research design with a qualitative method approach. The descriptive-qualitative research method is an approach that aims to describe or depict naturally occurring phenomena without intervening in or manipulating the variables under study. The descriptive method is a research approach designed to provide a systematic overview of a phenomenon. In a qualitative context, this method does not focus on hypothesis testing but rather on an in-depth exploration of an event or experience.

3.2 Sources and types of research data

In this study, the researcher utilizes secondary data sources derived from books, electronic journals, internet-based government documents, online news, and literature reviews.

3.3 Data collection technique

the researcher used data collection techniques include library study methods by reviewing books, the internet, and existing documents. Then, the data analysis technique used in this study is qualitative data.

4. Results And Discussion

4.1 Advanced Liquid Processing System (ALPS) and Implementation Mechanisms

The strategy to release 1.30 million cubic meters of treated nuclear wastewater involves releasing the liquid through a dedicated 1-kilometer-long undersea tunnel off the coast of Okuma Town into the Pacific Ocean[8]. TEPCO utilizes the Advanced Liquid Processing System (ALPS) a series of chemical precipitation, adsorption, and filtration processes designed to strip 62 types of radionuclides from the water before transfer to discharge tanks.

a. Technical Limitations and the Tritium Challenge

Despite multi-pass ALPS processing, tritium (^3H) remains in the discharged water[9]. Chemically, tritium is an isotope of hydrogen containing one proton and two neutrons; when it reacts with oxygen, it forms tritiated water (HTO). Because HTO is chemically identical to ordinary water (H_2O), standard filtration, reverse osmosis, or chemical precipitation methods cannot separate tritium from water on an industrial scale[9].Click or tap here to enter text.

While tritium emits weak beta particles that cannot penetrate human skin, internal exposure occurring through ingestion of contaminated water or bioaccumulated seafood can deposit radiation directly into soft tissues[9]. Once ingested, tritium distributes throughout body water within days, posing potential biological hazards such as cellular damage or elevated long-term cancer risks if ingested at high levels over prolonged periods [9].

b. Operational Discharge Volumes (2023–2024)

To ensure compliance with safety standards, TEPCO dilutes the ALPS-treated water with massive volumes of seawater prior to discharge, reducing tritium concentrations below 1,500 Becquerels per liter (Bq/L)—one-fortieth of Japan's national regulatory standard and well below the World Health Organization's (WHO) drinking water guideline (10,000 Bq/L).

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Table 1: Detailed Operational Batches of ALPS Treated Water Discharge (2023–2024)

Batch / Phase	Operational Period	Volume Discharged (m3)	Total Tritium Content (TBq)
Batch 1	August 24 – September 11, 2023	7,788	~1.1
Batch 2	October 5 – October 23, 2023	7,810	~1.0
Batch 3	November 2 – November 20, 2023	7,838	~1.0
Batch 4	February 28 – March 17, 2024	7,851	~1.4
Batch 5	April 19 – May 7, 2024	7,800	~1.3
Total (Cumulative)	August 2023 – May 2024	~39,087	~5.8

Source: Compiled from TEPCO Holdings and METI Progress Reports, 2024.

The operational dataset in Table 1 details the volume and radiological parameters across the initial five discharge batches executed between August 2023 and May 2024. Throughout this period, TEPCO released a cumulative volume of approximately 39,087 m3 of ALPS-treated water containing a total tritium activity of roughly 5.8 TBq. Operational volume per batch remained strictly regulated, averaging around 7,800m3 over a 17-to-19-day cycle per phase. By applying extensive seawater dilution prior to ocean release, tritium concentrations were kept below 1,500Bq/L a level well below both Japanese regulatory limits and the WHO drinking water guidelines 10,000 Bq/L.

. While these metrics validate TEPCO's technical compliance with radiological safety standards during initial operations, the long-term continuation of this process over an estimated 30-year operational timeframe continues to fuel public skepticism, regional geopolitical friction, and trade resistance.

4.2 Economic Impact on Agricultural and Plantation Sectors Indirect Pathways of Contamination Risks

Agricultural and plantation activities in Fukushima are physically located inland; however, they rely heavily on regional hydrological networks. Fukushima Prefecture features major river systems, including the Abukuma, Natsui, and Same rivers, which flow through coastal estuaries adjacent to the Pacific Ocean. Riverine estuaries, groundwater tables, and coastal precipitation systems create natural interactions between marine environments and inland agricultural water supplies[10]. Farmers voiced deep concerns that coastal radiation dispersal could enter agricultural soil and irrigation networks during severe weather events or sea-fog drift.

a. Empirical Analysis of Crop Monitoring Data

To evaluate whether the wastewater discharge physically compromised agricultural yield or crop biology, the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) alongside the Fukushima Prefectural Government conducted rigorous multi-year growth tests across distinct agricultural zones. Monitoring focused on staple crops, particularly rice (*Oryza sativa*), evaluating stem height, seed count per ear, and radioactivity levels.

Table 2: Comparative Rice Growth and Physical Yield Data across Fukushima Cities (2022–2024)

City / Region	Distance from FDNPP (km)	Year	Average Stem Length (cm)	Average Seed Count per Ear	Radioactivity Screening Result
Soma City *(Coastal Zone)*	42.9	2022 2023 2024	101.8 96.4 98.5	477 436 429	Below Detection Limit (<25 Bq/kg)

City / Region	Distance from FDNPP (km)	Year	Average Stem Length (cm)	Average Seed Count per Ear	Radioactivity Screening Result
Koriyama City *(Central Valley)*	59.7	2022 2023 2024	92.6 93.0 90.0	419 376 379	Below Detection Limit (<25 Bq/kg)
Aizu Wakamatsu *(Inland Mountain)*	98.0	2022 2023 2024	101.7 95.9 99.2	467 447 455	Below Detection Limit (<25 Bq/kg)

Source: Compiled from Fukushima Prefectural Agricultural Research Centre Official Datasets, 2024.

The empirical dataset in Table 2 presents a longitudinal analysis of rice crop parameters across three geographically distinct regions in Fukushima Prefecture between 2022 and 2024. Physical indicators specifically average stem length and seed count per ear exhibited minor fluctuations across Soma, Koriyama, and Aizu Wakamatsu, reflecting standard seasonal meteorological variations rather than radiological impairment. Crucially, radiological screening across all testing sites consistently yielded results below the analytical detection limit 25 Bq/kg, satisfying Japan's stringent standard for general foodstuffs 100 Bq/kg and remaining far below the Codex Alimentarius safety threshold 1,000 Bq/kg. These findings demonstrate that the ocean discharge policy has not physically compromised inland agricultural safety, highlighting that the economic losses suffered by the agricultural sector stem primarily from reputational damage (fuhyo damai) and market perception rather than biological contamination.

Reputational Damage (*Fuhyo Damai*) and Market Distortions

Despite empirical proof of physical safety, the agricultural sector suffered from severe **reputational damage** (*fuhyo damai* or "harm caused by rumors/reputation degradation"). In agricultural economics, consumer perception often dictates market value regardless of scientific testing.

1. **Price Discounting:** Wholesalers in Tokyo and Osaka wholesale markets applied a systematic "Fukushima discount" to peaches, rice, and beef originating from the prefecture, pricing them 10% to 25% lower than identical produce from neighboring Miyagi or Yamagata prefectures.
2. **Export Market Exclusions:** Major agricultural trading partners imposed blanket bans or stringent certification requirements on food imports from Fukushima[11]. China, Hong Kong, and Macau extended agricultural import suspensions, while Taiwan required specialized radiation inspection certificates[11]. This loss of export avenues created domestic oversupply, further depressing farmgate prices and squeezing local agricultural household margins.

4.3 Economic Impact on the Fisheries Industry and Geopolitical Trade Shock.

a. Direct Disruption to Marine Capture Fisheries

The fisheries industry in Fukushima has borne the most direct, severe, and acute economic losses resulting from the water discharge policy. Prior to the 2011 nuclear accident, Fukushima's fishing fleet landed over 25,000 metric tons of seafood annually, valued for its high culinary standing in Japanese markets (*Joban-mono*). Following a decade of slow recovery under strict monitoring, coastal fishermen were attempting to rebuild commercial operations when the 2023 discharge began.

Following the discharge:

- ✓ **Erosion of Consumer Trust:** Public perception regarding marine safety plunged. Consumers both within Japan and across East Asia expressed deep skepticism regarding TEPCO's ability to safely manage long-term wastewater filtration without accidental leakage.
- ✓ **Occupational Decline:** Facing persistent price collapse and societal stigma, younger generations increasingly abandoned marine fishing. The number of active commercial fishermen in Fukushima dropped below 1,000 workers in 2023–2024 a fraction of pre-2011 levels—threatening the structural continuity of maritime culture.

b. Geopolitical Fallout and International Trade Embargos.

The execution of the wastewater discharge quickly escalated into a major geopolitical and international trade conflict within East Asia:

Figure 1 : Cascade of Geopolitical Trade Restrictions Following the ALPS Water Discharge (2023)

Note: Diagram illustrates the policy flow and trade embargoes imposed by neighboring East Asian nations following TEPCO's ocean discharge in August 2023. Compiled from GACC (2023), METI (2023), and MAFF (2024)

The initiation of the ALPS treated water discharge immediately catalyzed a severe international trade shock, escalating into a major geopolitical conflict across East Asia. As illustrated in **Figure 1**, this trade shock manifested through distinct policy responses and supply chain disruptions:

1) **China's Total Ban:** Immediately following the August 24, 2023 discharge, the General Administration of Customs of China announced a **total suspension of all aquatic product imports originating from Japan**. China was previously Japan's single largest export destination for seafood, purchasing over USD 600 million (approx. ¥87 billion) annually, including sea cucumbers, scallops, and tuna.
2) **Hong Kong and Regional Bans:** Hong Kong, Japan's second-largest seafood export market, immediately banned seafood imports from ten Japanese prefectures (including Fukushima, Tokyo, Miyagi, and Chiba). South Korea maintained its strict ban on seafood from eight Japanese prefectures, enacted in 2013[11].
3) **Impact on Domestic Supply Chains:** Deprived of international export outlets, tons of high-value seafood (such as Hokkaido and Tohoku scallops) were diverted back into domestic markets, causing wholesale market prices across Japan to crash by 30% to 50% in late 2023.

c. Government Financial Interventions and Subsidies.

To prevent widespread bankruptcies across the maritime sector, the Japanese Government created two major emergency support funds totaling **¥80 billion (approx. USD 550 million)**, later expanded with emergency contingency funds exceeding **¥100 billion**:

- ✓ **Fisheries Reputational Fund (¥30 Billion):** Designed to purchase, freeze, and store excess seafood inventory (primarily scallops and flounder) to prevent price collapses.
- ✓ **Sustainable Fisheries Support Fund (¥50 Billion):** Allocated to assist fishermen in changing target species, upgrading processing facilities, and finding alternative export markets in Southeast Asia and North America.

Despite these subsidies, local fishing associations emphasized that state financial aid cannot replace open market access, commercial autonomy, or long-term community livelihoods.

4.4 Macroeconomic Impacts on Fukushima Prefecture (2022–2024).

The cumulative shocks across agriculture, plantations, marine fisheries, and food processing reflected directly in Fukushima's regional macroeconomic indicators.

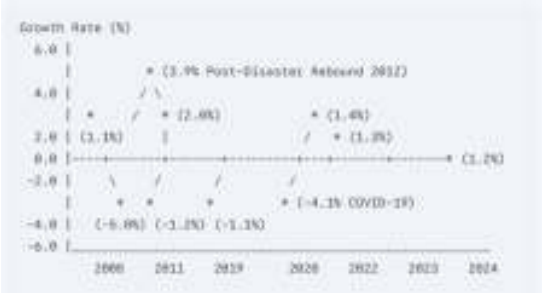

Figure 2: Real Economic Growth Rate Trends *(Japan National vs.Tohoku/Fukushima Region)*

Source: Adapted from Ministry of Economy, Trade and Industry (METI Tohoku Bureau) Datasets, 2024.

As shown in **Figure 2**, following historical disruptions—such as the 2008 Global Financial Crisis (-5.0%), the 2011 Great East Japan Earthquake (-

1.2%), and the 2020 COVID-19 pandemic (-4.1%) Fukushima's regional economy underwent a temporary post-pandemic recovery reaching **1.4% growth in 2022**. However, as the treated water discharge commenced and international trade bans took effect, regional economic growth decelerated to **1.3% in 2023** and dropped further to **1.2% in 2024**. This slowdown highlights how international trade friction and reputational damage continue to constrain macro-level regional recovery, despite massive public expenditures on infrastructure reconstruction.

5. Conclusion

This study demonstrates that Japan's policy of discharging ALPS-treated water from the Fukushima Daiichi Nuclear Power Plant into the Pacific Ocean has generated significant, measurable actual and potential economic impacts on local communities in Fukushima during the 2023–2024 period.

- ✓ **Actual Economic Impacts:** Primarily manifested as severe market disruptions driven by global trade embargos (most notably from China, Hong Kong, and South Korea) and acute reputational damage (*fuhyo damai*). These factors directly reduced revenues across marine capture fisheries, seafood processing networks, and agricultural sectors, forcing the Japanese state to deploy over ¥100 billion in emergency financial subsidies.
- ✓ **Potential Economic Impacts:** Involve long-term ecological risks, including potential chronic bioaccumulation of tritium and trace radionuclides in coastal ecosystems. These risks threaten to permanently alter local occupational structures, erode community resilience, and disrupt traditional ocean-dependent livelihoods.

From a theoretical standpoint, the discharge policy directly challenges the core tenets of **SDG 14 (Life Below Water)**, the **Blue Economy**, and **Human Security**. Addressing these challenges requires policy interventions that go beyond short-term financial compensation. Restoring long-term economic stability to Fukushima will require transparent, multi-stakeholder environmental monitoring, active diplomatic negotiations to lift international trade bans, and sustained public communication to rebuild global trust in Fukushima's agricultural and maritime products.

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