# Chapter 3: Risk Communication for Radiation Hazards

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## Introduction

Following the accident at TEPCO’s Fukushima Daiichi Nuclear Power Station, it was necessary to respond to a hydrogen explosion, a broken reactor, and the dispersal of radioactive material. Specifically, this included dealing with on-site accidents such as cooling and decommissioning, and off-site accidents such as decontamination, long-term evacuation, rumor measures, and compensation.

The government and public bodies repeatedly took an ad hoc approach to crisis communication immediately after the accident, as well as problems related to price drops in agriculture, forestry and marine products and a drop in the tourism industry due to reputational damage and so on (cesium-134, cesium-137), questions related to thyroid cancer (Iodine-131) in the typical health surveys of prefectural citizens, and “communication” regarding radioactive pollution including issues related to the accumulation of close to 1.1 million tons of treated water (mainly tritium).

A similar problem has also occurred in terms of a conflict of views between the government and public bodies and the sentiment of residents over offsite nuclear disaster prevention and wide-area evacuation plans following the restart of other nuclear power plants. Of all the issues and lessons learned from the accident at TEPCO's Fukushima Daiichi Nuclear Power Plant, the issue of how to confront and deal with radioactive contamination and related communication is an extremely difficult one.

This is because a “trilemma” exists of having to simultaneously solve three related, but different, issues concerning settings standards to “minimize the exposure risk of health damage to the general public”, issues concerning risk communication to “minimize the subjective risk of feelings of anxiety”, and issues concerning distribution and normalization of the market to “minimize the industrial risk of economic damage”.

In this chapter, we first organize the issues of confused communications and reputational damage following the accident. We then discuss the above-mentioned three issues highlighted therein, analyzing the radioactive contamination problems that still remain for food safety, the issue of “regulatory values” and “reference values”, and the tritium water issue.

## 1. Crisis communication and risk communication

The Government Accident Investigation makes the following recommendations regarding risk communication.

> In order to build a relationship of trust between the people and government agencies and to transmit appropriate information that does not cause confusion or distrust in society, the parties need to incorporate the risk communication approach of mutually exchanging risk information and opinions and building consensus all the while establishing a relationship of trust. The government needs to establish an appropriate organization and consider the provision of information to the people in an emergency that is quick, accurate, easy to understand, and does not cause misunderstanding. Depending on the method of public relations, it may unnecessarily cause anxiety among the populace (…)[1]

As for the cause of confusion over the use of the word "crisis communication," the Independent Accident Investigation report points to a loss of trust, even though the number of technical terms regarding the health damage caused by nuclear disasters and radioactivity increased.

> Most people cannot understand the radiation dose figures. It is hard to understand what the standard is and how dangerous it is or not. Although some yardstick was needed to indicate the risk, the accident response confused the public by giving various numbers for food contamination and schoolyard dose standards (...) The core of the crisis is probably that the government lost the people's trust in the government during the crisis. Just as crisis communication ultimately results in building trust between the government and the public, a crisis cannot be overcome without the cooperation of the government and the public.[2]

Reports from each accident investigation were submitted one year after the accident, when the accurate dose distribution and extent of radioactive contamination were not clear, and there was continued confusion in the communication of radiation health effects. These reports also mention the term risk communication, but it was crisis communication immediately after the accident that was pointed out as an emergency response.

Here again, we consider three issues of crisis communication immediately after the accident, looking back on the scientific community’s loss of trust and the problem of refererence values, as well as crisis communication and risk communication, and the distinction between emergency response and long-term response.

(1) The scientific community’s loss of trust: formulating “reference values” for safety

First of all, one of the communication challenges immediately after the TEPCO Fukushima Daiichi Nuclear Power Plant accident was the distrust towards the political and scientific communities that was set in the early stages. The cogent point is the fact that, following the TEPCO Fukushima Daiichi Nuclear Power Plant accident, this distrust went beyond the boundaries of the nuclear industry and nuclear experts ridiculed as the “nuclear village” to become a general mistrust of the scientific community, including those in radiation research, meteorology, and at specific universities. This was particularly pronounced in the process of formulating “reference values”.

Facile labelling dubbing the side that emphasized radiation safety as “government bootlickers” and the side emphasizing radiation risk as “anti-government” is a typical example, and in the immediate wake of the earthquake, there was even a website called “Government Bootlickers wiki” that “classified those academics who stated the radiation risk should not be overestimated as ‘bootlicking academics’ and criticized them”.[3]

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[1] Cabinet Office, Government of Japan, 2012, p. 463.
[2] Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident, 2012, p. 395.
[3] The word originally was meant to refer to scholars hired by the government, and not simply those that were a part of the establishment. Now it is used to refer to those who align themselves with the government and authorities, or who

Not only nuclear engineering, which promotes nuclear power, but also radiologists, who emphasize safety, were labeled as bootlicking academics. They were apparently seen as not close enough to the concerns of the populace, that is, they were taking the state's position. This could also be called a confrontation between a threshold hypothesis and a non-threshold hypothesis (Linear Non-Threshold [LNT] hypothesis) concerning low-level radiation.[4] The former takes the position that, regarding the deterministic effect ("the effect that always appears when a certain amount of radiation is received"), the degree of radiation increase due to radioactive material contamination has no effect from acute exposure, and stochastic effect and late effect are also extremely low.[5] The latter takes the position that based on precautionary principles, it is dangerous given that the dose limit in Japan is 1 mSv/year for stochastic effects and late effects.

Experts emphasizing the safety of radiation and those emphasizing the dangers repeatedly refuted each other on the Internet via Twitter, using it to insult each other as the "safety trolls" and "danger trolls".

Professor Shunichi Yamashita and Professor Noboru Takamura of Nagasaki University became radiation health risk management advisors in Fukushima Prefecture immediately after the accident, going around explaining, "we would like residents to have a sense of safety" and "the level is such that there is absolutely no need to worry about the health effects if measures to avoid unnecessary internal exposure are taken." Professor Takamura recalls that the day he gave his first lecture, he was asked for the first time, "Are you a government bootlicker?"[6] However, after giving a lecture in Iitate Village on March 25, 2011, which emphasized safety, Iitate Village was established as a planned evacuation zone several weeks later, the whole village being evacuated, so it is also true that their discourse did lead a certain number of people in Fukushima Prefecture to become distrustful. Additionally, rather than discussing the specific pollution and exposure situation, assertions made by Associate Professor Keiichi Nakagawa of the University of Tokyo were entirely focussed on "preaching" to residents based on risk assessments such as the causal relationship between radiation and carcinogenesis, and it has even been pointed out that this resulted in a greater distrust of experts.[7]

The process of the loss of experts' prestige was summarized briefly by Professor Sakura Osamu of the University of Tokyo as follows. "A nuclear power plant that had repeatedly been claimed to be safe had caused a severe accident and that triggered a drop in confidence. Trust was further decreased when even after the accident, the nuclear engineering experts repeatedly issued messages on TV etc. that everything was all right. Even the radiation protection specialists and doctors played a part in shifting responsibility from TEPCO and the government to the public with their messages of everything is all right, don't make a fuss. This chain was reproduced and expanded, consolidating distrust in the government, the electric power companies, and the experts."[8]

Furthermore, the pessimistic scenario presented by researchers other than radiologists, as well as the intense government attack clouded the general public's calm and rational judgment, and the fact that it also had an impact on the government itself had a large impact. Take, for example, the press conference at the First Diet Members' Office Building on April 29, 2011 for the resignation of

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receive funds or payments from corporations and businesses. For example, the following source refers to scholars with this word to denote those that receive financial aid. See Sasaki, 2011, pp.102–104.

[4] Nakamura, 2013, pp.7–9.

[5] See Annals of the ICRP 28 (1978), 41 (1984), 60 (1991), 62 (1991).

[6] There are a number of studies that investigate the difference in how information is spread depending on one's position (conservative, sceptical, etc.). See, for example, Ichinose et al., 2018; Valaskivi et al., 2019; Tsubokura et al., 2018.

[7] Kagura, 2013.

[8] Sakura, 2016, pp.168–178.

Cabinet Office advisor Toshiso Kosako, a professor at the University of Tokyo. On April 19, the Ministry of Education, Culture, Sports, Science and Technology, set the dose standard for schoolyards at 3.8 μSv/hour (20 mSv/year) saying "there is no problem using the school building and playground as usual for schools where the air dose rate is less than 3.8 μSv/hour," based on advice from the Nuclear Safety Commission "concerning temporary thoughts regarding the use of schools and schoolyards in schools in Fukushima Prefecture". This 3.8 μSv/hour was the standard set when designating Iidate Village and Minamisoma City, Namie Town, and part of Kawamata Town as planned evacuation areas on April 11, in addition to the 20-kilometer area where evacuation orders were issued from March 12. It is assumed that the upper limit of a dose standard of 1 mSv to 20 mSv in an existing exposure situation in the ICRP Publication 103 of 2007 was adopted.

Professor Kosako attacked this as "adhoc".

"The number of radiation workers at nuclear power plants employing about 84,000 who reach this upper limit of a radiation dose of 20 millisieverts a year is extremely small. Asking this number for infants, toddlers, and elementary school students is not only unacceptable in academic terms, but also in terms of my personal humanism."

"Accepting this would mean the end of my academic career. I don't want my children to experience that."

"In addition to strongly protesting the use of the numerical value of 20 millisieverts per year as a standard for use in schoolyards such as elementary schools etc., I demand a review."

Professor Kosako asserted "it should be operated at a level close to normal radiation protection standards." In other words, they should be aiming for "1 mSv/year".

The questioning of Professor Tatsuhiko Kodama, Center for Advanced Science and Technology, The University of Tokyo, in the Lower House's Labor and Welfare Committee on July 27, 2011 also had a great impact. Commenting on avoiding exposure of children outside the area and the need for radiation measurement and decontamination for that, as well as the lack of government measures for these, Professor Kodama said, "I express my wholehearted anger." "What is the Diet doing when 70,000 people are wandering lost from their homes?" This statement was also taken up by much of the media.

The statements of these two men have something in common. First, the fact that both took place in the Diet-related venues of the Diet Members' Office Building and the Lower House Welfare and Labor Committee. Second, they both criticized the government, the government's policies, and delays in its measures. Third, both statements were extremely emotional and spontaneous.

Although Kosako resigned at the press conference where he made the above allegation, Hideaki Karaki, former Vice President of the Science Council of Japan, believes that a reconfirmation of "radiophobia" and a "1mSv myth" accompanied the Kosako's resignation.[9] Unlike debates in the mass media and the Internet, emotional expressions of criticism of the government and the Diet by scientists in public places such as the Diet and a direct appeal to public opinion had a serious impact in the midst of the crisis.

Regarding the air dose, the strict value at the reference level (20 to 100 mSv/year) in an emergency exposure situation indicated by the International Commission on Radiation Protection is set to 20

[9] Karaki, 2013.

mSv/year. Using this as a reference, an air dose of 3.8 μSv/hour was set as a guideline for restricting living assuming residence in a wooden house for 16 hours and outdoor activities for 8 hours, and based on this, a planned evacuation area was designated on April 11, 2011 and the schoolyard dose standard set on April 19.[10] However, the government subsequently set an additional exposure dose at 1 mSv/year, and this was converted into an air dose rate, calculating a standard of 0.23 μSv/hour.[11]

The remarks made by Kosako and Professor Kodama are one of the factors for the revision of the target value from 20 mSv/year (3.8 μSv/hour) to 1 mSv/year. For better or worse, this 0.23 μSv/hour had important policy implications.

First is the problem of decontamination and intermediate storage facilities. 0.23 μSv/hour became the rough standard for decontamination of contamination priority survey areas under the Act on Special Measures concerning the Handling of Pollution by Radioactive Materials.[12] This decontamination standard of 0.23 μSv/hr brought about an interpretation that it was unsafe if this value was not achieved, and became the rationale for generating a huge decontamination project. In addition, collecting radioactive materials through decontamination created problems in transferring contaminated soil to intermediate storage facilities, recycling soil, and long-term soil waste.

Shunichi Tanaka, former Chairman of the Nuclear Regulation Authority, points out the problem of decontamination as follows.

> The problem is that although it should be scientifically safe, an awareness that 'it's not safe unless it's been decontaminated" spread from political considerations.[13]

He is pointing out the problem that decontamination targets were fixed, which caused numerous problems.

Secondly, there is the problem of prolonged evacuation and lifting area evacuation orders.

An additional exposure dose of 1 mSv/year was set for returning home, and this converted into an air dose rate of 0.23 μSv/hour was an important criterion for lifting evacuation orders. Officially, the authorized standard for cancelling the evacuation order was 20 mSv/year (equivalent to 3.8 μSv/hour) or less, the government's standard for lifting an evacuation order, but this was deemed only an "essential condition that the annual cumulative dose estimated from the air dose rate in the area be less than 20 millisieverts" and basically, the criterion for ending evacuation was "to aim as a long-term goal for less than 1 millisievert per year of additional exposure dose received by an individual after residents return and conduct daily life."[14] In other words, in the long run, this 1 mSv/year became the basis for determining the end point for evacuation.

Third, it was also the basis for the "reference value" for radioactive substances in food that was changed in 2012. This will be described later in the next section.

The remarks made by Professors Kosako and Kodama were extremely influential, and were said to be the de facto standard for decontamination and calling of the evacuation in terms of reviewing the target value from 20 mSv/year (3.8 μSv/hour) to 1 mSv/year.. The infallibility of the administration,

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[10] Ministry of Education, Culture, Sports, Science and Technology, 2011.
[11] The value per year was calculated at 0.19μSv/h from living in a wooden house for 16 hours with outdoor activity for 8 hours. Natural radiation (Japan's average 0.04μSv/h) was then added to reach 0.23μSv/h.
[12] Ministry of the Environment, 2011.
[13] Interview with Shunichi Tanaka, November 20, 2019.
[14] Cabinet Office, Government of Japan, 2018.

which makes it difficult to change what it has once decided, also had an impact on policies in the long run.

(2) Crisis communication and risk communication - the distinction between emergency response and long-term response: the infallibility of immediate response

One more problem with communication immediately after the Fukushima nuclear accident was that no distinction was made between crisis communication and risk communication (the distinction between emergency communication and communication for understanding long-term risk).

From immediately after the accident, the mass media began to report on the risks and safety of radioactive material diffusion in a balanced way. After March 11, the progression of the accident itself, evacuation, the spread of radioactive materials, and planned power outages were reported.. And while reporting measures against radiation exposure as well as "radioactivity has led to agricultural, water, marine, and soil pollution", they repeatedly reported that "there is no immediate health effect" and it was now "safe".[15]

A remote cause comes from the fact that after the accident, Yukio Edano, former Chief Cabinet Secretary, used the expression "no immediate effect". On November 8, 2011 in the Lower House's Budget Committee, former Chief Cabinet Secretary Edano stated, "I said there was no immediate harm to the human body or health a total of seven times. Of those, five times referred to food and drink, so I didn't say that it would have no immediate effect as a general statement, but there's a set reference value that will damage your health if you drink contaminated milk for a year, so I said repeatedly that there was no immediate problem if you just happened to drink it once or twice." Former Chief Cabinet Secretary Edano also said in a hearing with the Government Accident Investigation that these were his own words and not based on a memo penned by a bureaucrat. The expression "immediately" is a word that is often used as a legal term or a court term, and as such was a term that could be expected from former Chief Cabinet Secretary Edano, who was a lawyer. His statement "it has no immediate effect" was interpreted as a vague expression of the effects of radiation, and was subjected to various criticisms.

However, he has also testified that he was trying to convey simultaneously the two points that "acute exposure is not a problematic value, but we don't know if there is a cumulative effect of exposure", and "cumulative exposure for a long time (on the spot) may be a problem." Effects that appear at high doses within a short period of time within a few weeks are called "acute effects", and injuries that occur a few months to years after a relatively low dose exposure are called "late effects". The expression "no immediate effect" was by no means incorrect if his main implication was in terms of the degree of radiation dose to try to avert the "late effects of cumulative exposure" at low doses rather than the "late effects of acute exposure" at high doses in a situation where the degree of radiation dose immediately after the accident, the degree of diffusion of radioactive materials, and the degree of exposure were unknown, and, in fact, his statement can be said to accurately represent the situation that required attention at the time.

However, after the passage of a certain amount of time, this statement started to be perceived as a message that did not deny the possibility of "late effects", in other words, they may not be immediate but there will be effects later, "if the radiation dose increases, it will have an effect", "if you continue to be exposed, it will have an effect".[16] It most likely was a factor in prolonging anxiety. In other words, although it may have had significance as crisis communication in the immediate aftermath, it should be pointed out that more careful explanation was required to avoid misunderstanding and that

[15] Kagura, 2011; Sakô, 2013, pp. 156–171.
[16] Okamoto et al., 2012; Kawamoto, 2013.

long-term risk communication required different wording.

In an emergency, there is no problem with actively conducting inspections and measurements. Actively inspecting and measuring are significant in themselves in eliminating residents' anxieties and stabilizing the market.[17] Infrequent inspections and measurements in an emergency are in themselves perceived as not being proactive in grasping the degree of contamination, and risk creating doubts as to whether information is being hidden, or something is being overlooked or slipping through.

At the stage where the degree of pollution and the scientific mechanism for the transfer of radioactive substances to agricultural products are unclear, excessive measures regarding reference values and inspection systems are the ironclad rule where “a swing and miss” is tolerated, but “watching a ball go through” is not.

The problem was that they could not decide the timing and end points for reviewing the reference values and inspection system. On this point, Senior Research Fellow Ichiro Yamaguchi of the National Institute of Health Sciences, who was involved in the formulation of the “reference value” for radioactive substances in food in 2012, blames the lack of public interest and questions in the Diet, no such opinion being voiced by either the producers or the consumers.

> My expectation at the time was that there was a great deal of interest in society, so I thought that this discussion would continue, but it didn't last.
> You do this after you get opinions from local governments or opinions from producers and consumer groups, but we got zero opinions, so there was nothing to consider. Since there was also no rule to review it after a few years, there was nothing the bureaucrats could do.[18]

He also said it was not so easy for the government and politics to change what had once been decided.

> [Regarding why current food safety standards were too high and why they could not be lowered] There was concern about reputational damage including the local residents, so once it had been raised it was difficult to lower it easily. I know scientifically the various reference settings are wrong, but the problem is that the initial reference values were set too high.[19]
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> They were set excessively out of consideration for safety, but I think there was a feeling of overkill. Our call was it would be okay to eat continuously or consume large amounts every day. We should have taken into account that regulation could lead to unbalanced diets as well as a long-term perspective, but there was no leeway for that. The standards should have been returned to normal after things returned to normal, but that’s difficult because you’d be accused that ‘the government has deceived us’.[20]

Communication that addresses residents' anxiety is a necessary measure in an emergency. However, with the passage of time and as it becomes probabilistically and scientifically clear that, to a certain extent, there is no problem and it is safe, it is necessary to review or switch styles. If this is not incorporated into the system, however, the infallibility of the government will lead to a prolonging of the immediate response. As a result, a standard once set determines the inspection system over the long-term, becoming a factor that causes enormous costs.[21]

The lack of trust in “science” during emergencies and the loss of trust in the government and scientific

[17] This switch also did not occur with regards to food safety problems, including radiation measurements, systematic testing, and BSE.
[18] Interview with Ichiro Yamaguchi, March 3,2020.
[19] Interview with Ex-Cabinet Office staff, November 29, 2019.
[20] Interview with Goshi Hosono, December 19, 2019.
[21] Sekiya, 2016b, pp.143–153.

community have left a long-standing problem of communication. It created the fundamental problem of public information such as the government not being trusted, and science was differentiated according to who was speaking, leading to the problem that proper scientific communication was also not trusted. In this regard, Goshi Hosono, former Special Advisor to the Prime Minister and inside the administration, recalled as follows.

> [About dealing with hoaxes and fake news at the time of the disaster] we held a long, open press conference at the time. There were people within the government of the opinion that "it's better to strongly refute it" or "it's better to restrict the reporters' questions", but I explained to the best of my ability in the conviction that the cause of the anxiety lay with the government. However, as a result, domestic rumors weren't suppressed and [the problem of treated water etc.] spread to South Korea. When I think about it now, we could have rubbed them out a little more strongly in the early stages.[22]

In other words, it is difficult to easily establish reliable communication once trust has been lost. The administration at the time was also fully aware of this, and was unable to give a strong message on safety issues even after the passage of time. As a result, false understandings and discourse were left unaddressed for a long time.[23]

This is a common issue in evacuation. Unless accurate information on radiation is available immediately after the accident itself, area evacuation and excessive protective measures in the case of an emergency are unavoidable. However, due to the lack of trust in the government and the scientific community, it was difficult to switch to a more appropriate response including immediate evacuation, post-accident inspection systems, health surveys, reviews of standards, waste problems, etc., thereby dragging out the emergency response for a long time. Former Special Advisor Hosono, who was involved in the emergency response at the time, recalled as follows.

> Considering that 10 years have passed, it's necessary to switch "modes" for thyroid and treated water from crisis assessment to recovery and normal time assessment. It's too harsh to make Fukushima Prefecture decide to switch; it's a question for the government to decide.[24]

This shows that the government entered a bottleneck because it was unable to create an exit strategy from crisis to normal times.

However, changing the criteria later is not easy. It is clear that when setting the standard, it is necessary to fix the "time axis" and "conditions" in the initial stage.

(3) The relationship between science and politics in a crisis

Pointing out that the science and technology advisory function by people with specialized knowledge was very weak immediately after the accident and that there were problems such as the long stream of Cabinet Secretariat advisors appointed, the Independent Accident Investigation recommended strengthening the science and technology advisory function as a solution to these problems.[25] In addition, according to the Government Accident Investigation, "given that depending on public relations public anxiety can be unnecessarily created, consideration should be given to assigning a

[22] Interview with Goshi Hosono, December 19, 2019.

[23] Furthermore, there are similarities with the line of argument regarding evacuees. The influx of evacuees into an area may potentially cause friction with the population and lead to the collapse of the community or a number of other social issues. As such, as long as correct information regarding the accident and radiation is being withheld overreacting and evacuating even if you are outside of the designated area is justified. Thus, although it is necessary to limit overreaction after some time has elapsed, the government and the scientific community may not be able to due to a loss of trust in their authority.

[24] Interview with Goshi Hosono, December 19, 2019.

[25] Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident, 2012, p.349.

communication expert, for example, who can give appropriate advice to the Chief Cabinet Secretary in charge of public relations in a crisis or emergency."[26]

It is the government's chief science advisor in the United Kingdom and the director of the Office of Science and Technology Policy (Aide for Science and Technology) in the United States who are supposed to provide scientific advice during normal times and in times of emergency, also conveying information at times to the populace. The points made by both the above-mentioned Accident Investigations are most likely referring to this, but this kind of post remains unrealized even today.

In terms of a nuclear accident, in the event of an emergency, the only change we see is that the chairman of the Nuclear Regulation Authority has taken over the position of providing advice instead of the Nuclear Safety Commission chair, with no new organization or position in charge of communication being established. Leaflets on risk communication in normal times and risk communication forums have been held at the Consumer Affairs Agency and the Reconstruction Agency and so on, but apart from a committee on radiation debating existing reference values, no institution (function) has to date been established for officially conducting scientific evaluations of radiation problems after the accident or for communicating.

Currently, with regard to low-dose exposure to radioactive material contamination and food safety after the Fukushima nuclear accident, there have been endless discussions on safety/danger among researchers, in markets, media, and online, and rather than say controversies over the risks have converged, the current state is one of an "unsolved solution" as a result of the radiation dose and air dose contained in food having decreased significantly. Therefore, the phenomenon known as reputational damage still remains.

A failure to switch from this emergency precautionary crisis stage to the sharing of normal time risks, as well as the loss of trust in the professional community, is a remote cause of poor communication over the long run. It means that Japan has failed to switch from emergency crisis communication to normal risk communication.

## 2. Reputational damage

Against a backdrop of such communication, it is reputational damage that has made the people of Fukushima suffer over the past 10 years. Despite agricultural, forestry and marine products being below the provisional and reference values, they are avoided by consumers simply because they are produced in Fukushima Prefecture. It still suffers from such rumors. This is because there is still a sense of residual anxiety that radioactive materials may still contaminate them. A few years after the accident, as shown in Figures 1 and 2 below, the sense of anxiety in Japan started to fall, but it remains high overseas, especially in neighboring countries such as Korea and Taiwan.

### (1) What is reputational damage?

In general, reputational damage refers to "economic damage caused by a cessation of consumption or tourism by people's perception as dangerous food, goods, and land that were supposed to be 'safe' with the large-scale media coverage of a certain incident, accident, environmental pollution, or disaster."[27]

In the initial stages of the accident, the economic damage caused by people not purchasing products

[26] Cabinet Office, Government of Japan, 2012, p.426.
[27] Sekiya, 2003, 2011.

below the standard set by the government at which it was officially deemed to be safe was referred to as “so-called reputational damage” (according to the guidelines for nuclear damage compensation, this was dubbed “so-called reputational damage”). “Safety” is a major premise at a time when reputational damage becomes a problem, and farmers, fishers, and distributors understand this to some extent. However, since it is difficult to gain the understanding of all consumers and people involved in the distribution business who take into account consumer trends, economic damage will continue. Even if there are no safety issues, agricultural products and marine products whose image has been slightly hurt are removed from the consumer's options, and product values will drop. If this continues, they will be removed from the distribution route.

In the post-war era, this phenomenon of reputational damage has been a problem in 1954 when contamination through nuclear fallout of the boat, the Daigo Fukuryu Maru, saw tuna become unsellable in a “radioactive panic” that damaged the fishing industry, the 1974 radiation leak accident on the nuclear ship Mutsu, and the 1981 release of cobalt-60 at the Tsuruga Nuclear Power Plant (some direct civil compensation was made in the Tsuruga nuclear accident). In the 1986 Civil Agreement signed between the operator and the local municipality when building the Hokkaido Electric Power Tomari Nuclear Power Plant, reputational damage and compensation were made explicit for the first time stating that when “a reduction in prices of agricultural, forestry and marine products and other economic losses occur due to reputation”, this will be called“reputational damage” and measures such as compensation will be taken as distinct from compensation for damage caused by the release of radioactive materials due to an accident.

The problem here is the distinction in a nuclear disaster between “actual damage” and “reputational damage only”. In the event of a nuclear accident or trouble, the release of radiation or radioactive material can be measured by a monitoring post, etc., so a distinction is made between “actual damage” caused by radiation (a higher radiation dose), and “reputational damage only”, for which there is no measurement. The Act on Compensation for Nuclear Damage states that the former case, the “actual damage” in the event of radiation (higher radiation dose), is to be compensated by the business operator and the government. Regarding the latter case of “reputational damage only” unaccompanied by radiation effects (increased radiation dose), the cause is deemed to be overreacting consumers fuelled by the media, and compensation is not provided because the operators and the state are not responsible. However, the issue raised by “reputational damage” is that compensation should be provided in some form as long as economic damage has occurred.

In the case of the 1999 JCO criticality accident, the approximately 15.4 billion yen in damages was mostly related to “reputational damage”. It was subsequently discussed at the Nuclear Damage Investigation Committee established by the Ministry of Education, Culture, Sports, Science and Technology, and other venues, and given the size of economic damage and the fact that the actual accident was the cause, the legal interpretation was changed, the Act on Compensation for Nuclear Damage being applied for the first time. Based on this, it was decided in the Intermediate Guidelines on the Determination of Nuclear Damage and the Third Addendum (damage related to reputational damage in the agriculture, forestry and fisheries and food industries) that even those that suffered economic damage that could be considered “so-called reputational damage” would be eligible for compensation for damages in the Fukushima nuclear accident as well.

(2) Reputational damage following the Fukushima Daiichi Nuclear Power Plant accident

Immediately after the Fukushima nuclear accident, a considerable amount of radioactive material was undeniably dispersed, the type of nuclide, amount, and diffusion range of the radioactive material being unknown, and, moreover, radioactive material was detected in crops and seafood, but it was not known to what extent it would increase. In such situations, it is often difficult to make a clear distinction between the contaminated and uncontaminated, the safe and unsafe. Therefore, it is reasonable in both preventive and emotional terms to avoid them. This was the reputational damage in the immediate aftermath.

However, over a period of time, air dose measurement, soil measurement, radioactive material monitoring of agricultural products, and inspection of all rice bags in Fukushima Prefecture was carried out, and safety was secured as a result of various measures to prevent absorption as the different rates of absorption by product type became clear. An inspection system was established and information on the inspection results was provided. The aversion to agricultural products themselves also eased. Even so, distribution did not recover easily due to its prolonged hiatus after the accident. As a result, the total shipment value of safe crops did not recover. This was reputational damage after the passage of a certain amount of time.

At the current stage, almost all agricultural and marine products in circulation are in a state of “ND (Not Detected)” (the content of radiation is below the “detection limit value”, which is the minimum value that can be measured by inspection equipment). At such a time, the general understanding is that some wild forest products such as mushrooms and edible wild plants, wild animals, and marine products are over the N.D. This is well known in Fukushima Prefecture, and few people see this as reputational damage.[28]

Furthermore, since 2015, agricultural products over the N.D. have not been produced as a result of reduced radiation doses and potassium fertilization of paddy fields for agricultural products in managed fields excluding these. Nevertheless, there is still a sense of aversion to these products. The current reputational damage is economic damage that occurs in this state of N.D.

And this reputational damage is the issue at the core of the trilemma, which will be explained next, and is a longstanding problem in Fukushima Prefecture.

## 3. Radiation disaster trilemma: exposure risk

First, let us consider “exposure risk”, one of the trilemmas in a radiation disaster. Immediately after the accident, experts set reference values with the aim of “minimizing health damage as a radiation exposure risk for the general public”. This was, in other words, an attempt by the government to define “safety (physical safety)” regarding environmental radioactivity.

On March 17, 2011, when the Fukushima Nuclear Power Plant accident occurred due to the Great East Japan Earthquake and concern over radioactive material pollution began, the amount of radioactive materials in foods was stipulated based on the provisions of Article 20, Paragraph 2 of the Act on Special Measures Concerning Nuclear Emergency Preparedness setting a “provisional regulation value”, and regulatory measures such as food shipping restrictions were established. The standard was 500 Bq/kg (200 Bq/kg for dairy products).

Subsequently on October 27, 2011, the Food Safety Commission established as a food health impact assessment for radioactive substances that past epidemiological data indicated that “concerning additional radiation doses due to the ingestion of contaminated food, the value to be taken into consideration when managing food safety appropriately is set at approximately 100 mSv over a lifetime”. On October 28 the following year, the Minister of Health, Labor and Welfare, Yoko Komiyama, stated at a press conference that she would set the standard annual exposure dose to 1

[28] Fukushima Prefectural Government, 2019.

mSv. In line with this, on April 1, 2012, the Food Safety Commission, based on Article 11 Paragraph 1 of the Food Sanitation Act, set their standards (general food: 100 Bq/kg, milk and baby food: 50 Bq/kg, drinking water: 10 Bq/kg) using an annual intake of 1 mSv as a base and taking into account the guideline standards applied to nuclear accidents by the codex committee (International Food Standards Organization). This was subsequently approved by the Radiation Council after later consultation.

In other words, in the sense that shipping restrictions were not applied on March 17, the government officially defined "safety" as "the provisional regulation value (500 Bq/kg, dairy products 200 Bq/kg) or less". However, criticism remained and aiming for internal exposure of 1 mSv, it was decided on April 1, 2012 to refer to a "reference value of 100 Bq/kg (dairy products 50 Bq/kg) based on discussions at the Food Safety Commission. However, reputational damage was still not dispelled.

On April 20, 2012, the Ministry of Agriculture, Forestry and Fisheries sent in the name of the Director of the Food Industry Bureau a notification to the directors of food industry associations to ensure businesses conducting voluntary radioactivity inspections used "reliable analyses" and albeit voluntary inspections also made decisions based on governmental standards. However, this was followed by a series of criticisms from the Japan Consumer Federation, the Food Safety and Surveillance Citizens Committee, and others.

These were all aimed at "minimizing health damage as a radiation exposure risk for the general public", and were set by the Nuclear Emergency Response Headquarters based on the technical advice of the Nuclear Safety Commission immediately after the earthquake, and a year later based on scientific agreement or scientific advice from committees of experts such as the Food Safety Commission and Nuclear Regulation Authority under the government's responsibility.

It is appropriate to lower the standard according to the level when moving from emergency to normal times. However, as can be seen from the background described above, various standards were created using the principle of "1 mSv/year".

## 4. Radiation disaster trilemma: subjective risk

Next, let us consider "subjective risk".

Subjective risk refers to how an individual perceives "safety/danger" and whether or not they have feelings of "security/anxiety". It exists separately from scientific security, and is formed by taking into account the communication and trust of the parties, and is not easily controllable.

In subsequent investigations and research such as the Independent Accident Investigation and the *Anatomy of the Yoshida Testimony*, the trap of the safety myth with regard to nuclear safety regulations was explained saying they "preferred small peace of mind over great safety". It was pointed out that because making preparations for emergencies and contingencies in order to ensure "great safety" caused "unnecessary anxiety and misunderstanding among residents", not implementing countermeasures and showing a defenceless front ensured a "small peace of mind" for residents, which brought about the perplexing situation of not being prepared being good preparation. However, this claim does not mean that "small peace of mind" should be neglected and "great security" be the sole focus. In the case of radiation disasters, the "minimization of emotions of anxiety as a subjective risk" must be achieved simultaneously, that is, the relationship is one where if "small peace of mind" is not taken into consideration when designing "safety" assurances, then "great safety" will not be achieved either. That is the tricky aspect.

Since radioactive materials were undeniably dispersed in the Fukushima nuclear accident, it was natural for people to be anxious to a certain extent about radioactive materials that were detected. For example, suppose that 50 Bq/kg was detected in a certain food, relative to the reference value for radioactive cesium in food of 100 Bq/kg. For the government who defines "safety" and those who regard 100Bq/kg as "safe", this food is "safe" and if harm occurs, it will be "so-called reputational damage". However, for those who consider 0Bq/kg or 10Bq/kg to be "safe", this food is "dangerous" and means "not reputational damage but real damage". There is no difference in that both positions are based on the premise of "safety" and whether or not there is reputational damage. However, because different people have different safety standards, discommunication over "safety" occurs. This can be said to be a difference in perception regarding the "allowable amount" of risk an individual can tolerate, including the content in foods and the reference value for annual exposure.

Incidentally, after the accident, three patterns were seen among people who were concerned about the inspection system and food monitoring for radioactive substances.

First, there were those who asserted their distrust of monitoring, measurement methods, and inspection systems. It is a discourse asserting "they select and measure in low places (where contamination is unlikely to occur)", "inspections are omitted", and "some things might 'slip through' in the sampling". However, with the passage of time, the performance of this monitoring, measurement methods, and inspection system itself has been acknowledged, and the number of people with doubts has fallen.

Fukushima Prefecture has carried out surveys on every bag of rice and every head of cattle, which is more than the state required monitoring surveys. However, while conducting such close inspections was of great significance in disclosing safety in the early stages, with radioactive substances over the detection limit no longer being detected and compensation, etc. also assured, they could not continue spending and full inspection of every bag of rice will no longer be carried out in the whole prefecture from 2020, and head-by-head cow inspections will be switched to farm-by-farm inspections.

Second, there are those who argue that the risk of radiation should be as low as possible. They claim "a range exists below 100 Bq/kg (radioactive substances are included)," "It's real harm because there's some radioactive substance," "Even if it's below N.D., it's not zero," "The less radioactive substances, the better, so you should avoid products from Fukushima Prefecture." First and foremost, however, it is not known that almost all foods distributed are N.D. Currently, 80% of people do not know that the foods in circulation are almost N.D.[29]

However, even in this group, people from Fukushima Prefecture tended to make this kind of claim in an attempt to prevent internal exposure as much as possible, even those who understood that scientifically speaking the risk was small and the meaning of the reference value, and N.D. On the other hand, in the case of people outside the prefecture, many people made this type of claim without understanding the meaning of the reference value or N.D.

Thirdly, there are those people who are trying to renew their anger at TEPCO for causing the accident through rumormongering and who fan their resentment of TEPCO by taking this anger out on farmers and farm-related people. These people insist, "This is not about reputation," "I hate the word 'reputational damage, " and "I don't buy it just in case", "I don't buy it because I'm angry."

[29] Sekiya, 2016a, 2019a.

Although, for many people, invisible radiation pollution is “frightening” in itself, and they cannot be blamed for having that fear, even if the emotion is unscientific. Atavistically speaking, fear is one of the “safety valves” humans have innately acquired to protect themselves from unknown risks and threats. Furthermore, in the Fukushima nuclear accident, information on the diffusion of radioactive materials was not notified promptly or properly to the public at an early stage due to the delay in the release of SPEEDI calculation results based on the unit release amount, and it took time to publish the monitoring results immediately after the accident.[30] For that reason, it was unavoidable that people became suspicious.

It is also reasonable in some sense to take preventive measures in these early stages when the scientific facts are not subjectively clear, and at the stage where the scientific facts remain subjectively in doubt.[31]

A particular feature of radiation hazards is that they can physically be clearly asserted when the dose is low (unless the immediate consequences are not known as a result of a large release into the environment). Consequently, administrative bodies such as the ruling administration and local governments, people involved in affiliated companies, and scientists strongly assert that food, goods, and land are “safe”. However, many people are not immediately convinced that they are safe for various reasons, such as the fact that safety is not understood, the sender of information is not trusted, or there is little information. These risk communication gaps have long existed.

After the earthquake, the government including the Ministry of Health, Labor and Welfare and the Consumer Affairs Agency, continued to attach great importance to making residents understand the standards aimed at minimizing this exposure risk. However, the current status ten years on is that the gap between the reference values implemented with the aim of “minimizing health damage as a radiation exposure risk to the general public” and the risk communication carried out with the aim of “minimizing anxiety as a subjective risk” remains unchanged. “Minimizing anxiety as a subjective risk” consists of guaranteeing reassurance, and ultimately establishing the trust of the people in the government and thereby “greater security”.

## 5. Radiation disaster trilemma: economic risk

(1) Domestic economic damage

Accident response costs for the Fukushima Nuclear Power Plant amounted to 21.5 trillion yen in 2016 (8.0 trillion yen for decommissioning and contaminated water measures, 7.9 trillion yen for compensation, 4.0 trillion yen for decontamination, 1.6 trillion yen for the interim storage facility).[32] Note that the compensation amount as of March 2020 was 9.5 trillion yen (this is the agreed amount, not the amount of damage residents suffered).

Looking at the agreed amount by item of compensation, items related to corporations and sole proprietors amount to some 3 trillion yen. Disposal in the immediate aftermath, shipping restrictions, and relocation costs associated with the establishment of a warning zone are limited to the initial period. Therefore, most consist of profits not realized had there been no accident, lost business opportunities, lost sales channels or markets, lower prices, and inspection costs. So-called

[30] Cabinet Office, Government of Japan, 2012, p. 219.
[31] In addition to this, it is also necessary to consider lowering the actual standard of “safety”. Before the Fukushima Daiichi nuclear accident, "safety" meant "zero release of radioactive materials". However, after the accident, the government officially declared that "safety" meant "anything less than the provisional regulation value of 500 Bq/kg, or 200 Bq/kg for dairy products," as a means of not imposing shipping restrictions. After April 1, 2012, the standard value became 100 Bq/kg, or 50 Bq/kg for dairy products.
[32] Ministry of Economy, Trade and Industry, 2016.

reputational damage accounts for a large portion.

- Table 1 Status of agreed amount by compensation item

| | Agreed amount |
|---|---|
| 1. Items related to individuals | \1,992.0 bil |
| Inspection expenses, etc. | \275.7 bil |
| Mental damages | \1,086.8 bil |
| Voluntary evacuation, etc. | \362.5 bil |
| Inability to work damages | \266.9 bil |
| 2. Items related to corporate/sole proprietors | \3,011.6 bil |
| Operating loss | \529.5 bil |
| Shipping restriction damages & reputational damage | \1,824.6 bil |
| Collective compensation (operating loss, reputational damage) | \252.5 bil |
| Indirect damages, etc. | \404.8 bil |
| 3. Common/Other | \1,878.9 bil |
| Loss or decrease in property values, etc. | \1,411.6 bil |
| Ensuring housing damages | \442.2 bil |
| Fukushima Public Health Management Fund | \25.0 bil |
| 4. Decontamination, etc. | \2,601.3 bil |
| TOTAL | \9.483.9 bil |

In the initial stages of the accident, it was officially stated that it was safe if it was below the standard set by the government, and the economic damage caused by people not purchasing products below this standard was referred to as “so-called reputational damage” (in the compensation guidelines, this is called “so-called reputational damage”).

“Safety” is a major premise when reputational damage becomes an issue, and farmers, fishermen, and distributors understand this to a certain extent. However, since it is difficult to gain the understanding of distributors, who take into account the trends of all the consumers and people involved, economic damage persists.

Even if there are no safety issues, agricultural products and marine products that have a slightly worse image, are removed from the consumer's options, and the value of the product falls. If this continues, it will be removed from the distribution route.

After the Fukushima nuclear accident, not only items subject to shipping restrictions, but also items subject to price drops and transaction refusals tended to expand to similar items as well as items from the same production area. For example, when it became clear that rice straw was contaminated and that cows from Fukushima Prefecture were contaminated, prices of agricultural products in neighboring prefectures, where pollution was not confirmed and shipping restrictions were not enforced, fell.[33] Depending on the item, the impact of reputational damage spread to price drops in Miyagi Prefecture, which had a low degree of pollution, seafood from Iwate Prefecture, and

[33] Furuya et al., 2011, pp.5–17.

agricultural products produced in Ibaraki Prefecture.

(2) Economic damage overseas: the problem of export restrictions

Especially overseas, some people had the image that the regions of eastern Japan outside Fukushima Prefecture, and even western Japan, were contaminated. In Japan six years on, anxiety over agricultural, forestry and marine products from Fukushima Prefecture had decreased. However, there was high concern in Asia and Europe, especially in neighboring countries. This was not limited to Fukushima, but also covered "eastern Japan" and "Japanese" agricultural products, marine products, drinking water, and visits. In particular, a certain level of anxiety persisted over "eastern Japan" (Figures 1 and 2).

Furthermore, such rumors led to a drop in the price of foods from Fukushima Prefecture and neighboring prefectures, food from eastern Japan, and export restrictions banning overseas transactions. When refusals of this kind persist, "fixed distribution" occurs. It is not easy to regain distribution when shelves at stores are taken over by other products. In the case of overseas, the barrier of import restrictions acts in the same way in the sense of obstructing distribution. As a result, economic damage persists.

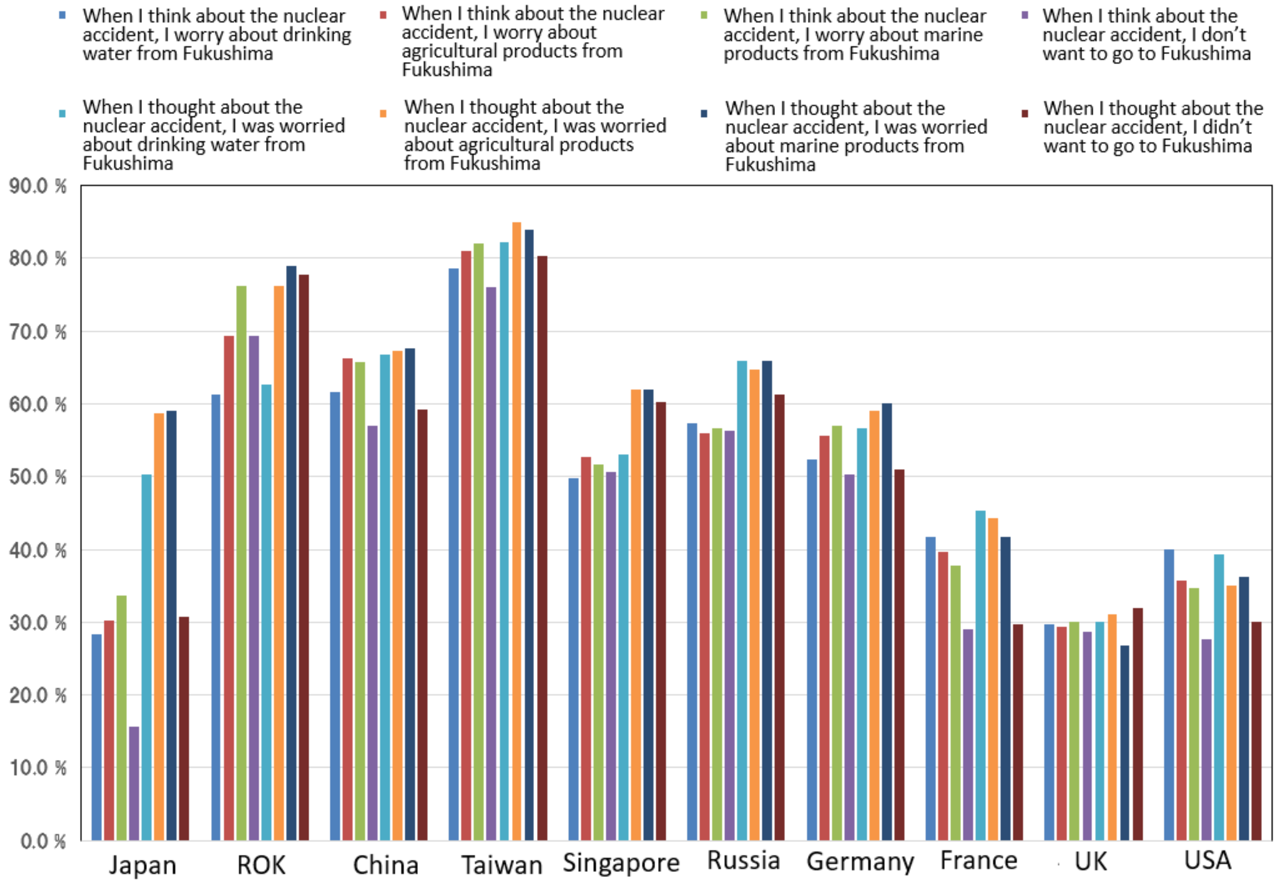
Thus, the trilemma of "exposure risk", "subjective risk" and "economic risk" remain entrenched.

When viewed in hindsight, the "bag-by-bag inspection" of rice and the "head-by-head inspection" of cattle can be said to have been measures to solve all of these risks. The "bag-by-bag inspection" of rice, which has been conducted in Fukushima Prefecture since 2012, inspected nearly 10 million bags annually, and since 2015 no cases have exceeded the reference value, and 99.99% have N.D. (below the detection limit value). The "head-by-head inspection" of cattle has also been conducted since JFY 2011, but there are no cases over the reference value.

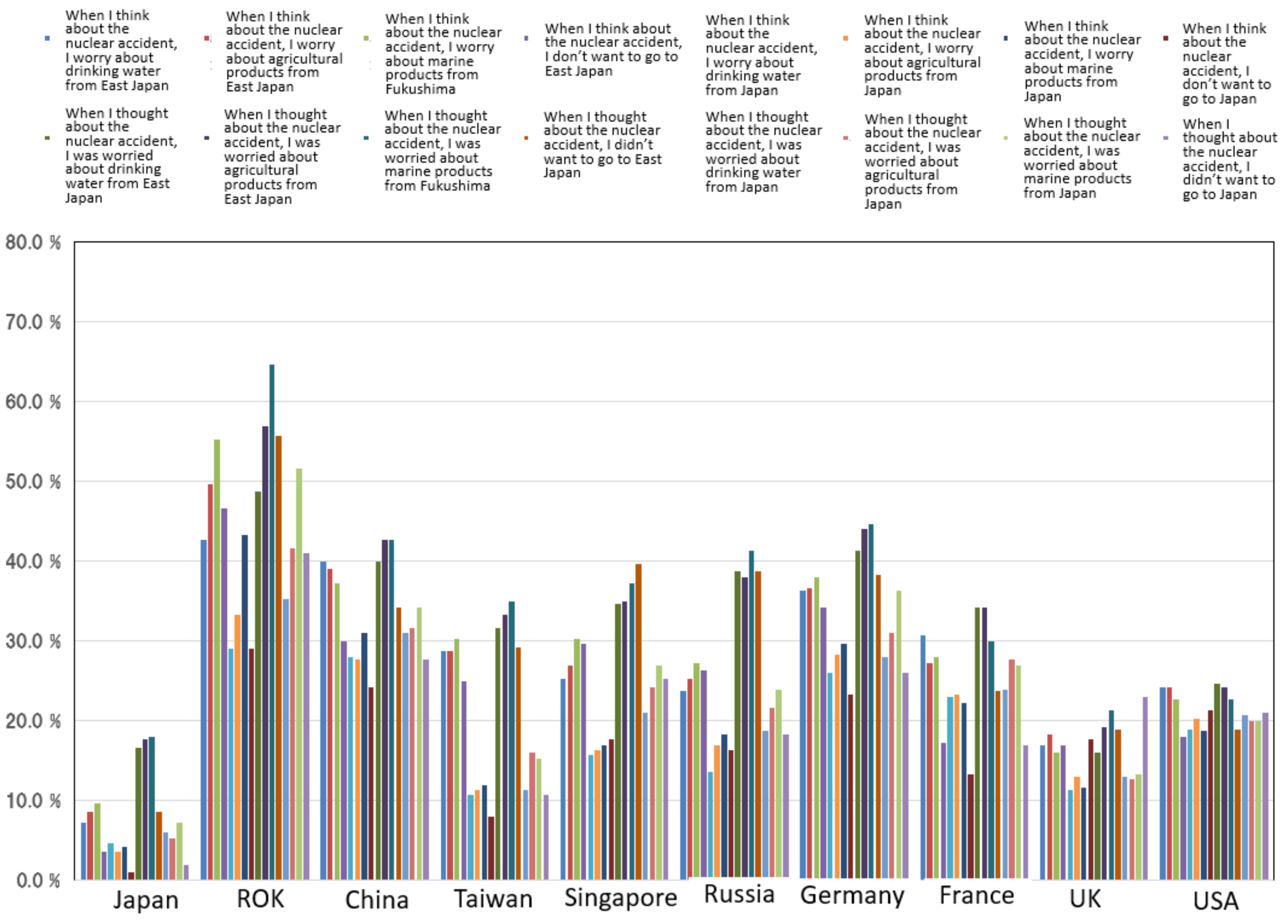
As a result, "exposure risk" was minimized. In addition, the guarantee of safety as a result of the inspection system and the inspection results greatly contributed to the minimization of "subjective risk". Anxiety levels for most Fukushima residents, who know the results of this bag-by-bag inspection, were noticeably reduced.[34] Along with this, the distribution of agricultural products also became active. Apart from the inspection costs, it is clear that inspection also contributed to the minimization of "economic risk".

[34] Sekiya, 2016b, pp.143–153.

- Figure 1 Anxiety about Fukushima Prefecture in foreign countries (present and past)



- Figure 2 Foreign countries' anxiety over East Japan and Japan as a whole (present and past)[35]




Additionally, even if briefing sessions and radiation education on risk communication conducted by government agencies etc. explain "exposure risk", this does no more than explain the risk assessment on the exposure situation, the pollution situation, and the causal relationship between radiation and cancer. Whether it contributes to the minimization of "subjective risk" depends on the individual. Furthermore, it is not directly linked to the "minimization of economic risk".

As long as the radiation hazard trilemma of "exposure risk", "subjective risk", and "economic risk"" remain an issue, countermeasures for reputational damage must simultaneously solve this trilemma. Inappropriate task setting can be said to have caused this confusion.

### 6. "Contaminated water" and tritium

Another major problem left after the Fukushima nuclear accident is the problem of contaminated water.

By infiltrating contaminated areas including buildings and nuclear reactors, tsunami seawater, water for cooling debris (molten fuel), rainwater, groundwater, and so on were all contaminated with

[35]This is according to an internet monitor survey conducted by the author in February 2017, which was implemented in the largest city of each country and divided according to age (20-60 years) and gender. Each country, including Japan (Tokyo), South Korea, Taiwan (Taipei, Kaohsiung), China (Beijing, Shanghai), Singapore, United States (New York), United Kingdom (London), Germany (Frankfurt), France (Paris), and Russia (Moscow), yielded 300 responses.

various nuclides. "On April 2, it became clear that highly contaminated water was flowing out into the sea from the concrete part near the water intake of Unit 2,"[36] and although the release of this contaminated water was carried out on April 4, 2011, this was later criticized and TEPCO was forced to store it.

To clean up such high concentrations of contaminated water, TEPCO started operating cesium removal devices such as Kurion and SARRY from 2011, as well as ALPS, a device for removing 62 types of multinuclides, and a mobile strontium removal device to decontaminate the site.

Following the accident, TEPCO has taken various measures to prevent an increase in this contaminated water. The operational target for the emission concentration of tritium is less than 1,500 Bq/L, groundwater bypass water being released in 2014 and subdrain water in 2015. In 2016, a frozen soil wall that freezes the area around the reactor building was started to prevent an inflow of groundwater. Be that as it may, it is still increasing. As part of the decommissioning process, the problem of what to do with the water that has been gradually increasing since the accident consists of "contaminated water countermeasures" and "contaminated water treatment".[37]

(1) Fishery issues and contaminated water

The issue of contaminated water is above all else an issue for the fishing industry. With an extremely low radiation dose, "exposure risk" is not the problem. However, the problem is that "economic risk" manifests itself because there is a feeling of anxiety known as "subjective risk" from certain people as well as overseas.

Reputation is a real "economic risk" for fisheries and locals, but the government, TEPCO, and experts do not explain how to control "economic risk," but instead repeat an insufficient explanation on "exposure risk", leading to discrepancies between the two.

The fishing industry in Fukushima Prefecture has been forced to undergo "trial operations" since 2012. The Fukushima Prefecture Fisheries Association has decided to set as a voluntary standard a policy of 50Bq/kg, which is half the reference value of 100Bq/kg for general foods in the country, and to not ship products that exceed 50Bq/kg. In addition to demonstrating their stance of guaranteeing the safety of their product by using tighter safety standards than the national standards, which is especially true for marine products that cannot be fully inspected, it takes into consideration the fact that the neighboring prefectures of Miyagi and Ibaraki Prefectures, which started operating earlier, voluntarily decided on a standard of 50 Bq/kg.[38]

It was then decided to perform a "screening test", which is an inspection to determine that the radioactive cesium concentration does not exceed the reference value of 100 Bq/kg. In order to achieve this reference value of 100 Bq/kg, the state's screening methods ensure there is no possibility of exceeding the reference value by stipulating 50 Bq/kg as the screening level to ensure that the value is definitely below 100 Bq/kg, and setting the detection limit to 25 Bq/kg, a quarter of this screening level. However, in Fukushima Prefecture, in order to achieve 50Bq/kg, which is half that figure, the screening level was set to 25Bq/kg and the detection limit to 12.5Bq/kg or under.[39] Since 2011, a total of more than 50,000 samples have been tested, and as a result, it was confirmed that the radiation dose contained in the catch has fallen.

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[36] Cabinet Office, Government of Japan, 2012, p. 344.
[37] As of the end of November 2019, water treated in multi-nuclide removal facilities, as well as strontium treated water, reached a total of 1,173,142 tons stored in 989 tanks.
[38] Nemoto et al., 2018, pp.23–26.
[39] Ibid.

Immediately after the nuclear accident, about 21% of total catches exceeded the current reference value (100 Bq/kg) in the March-June 2011 period, but thereafter, those exceeding the reference value gradually decreased, and in January 2019, there was only one sample that exceeded the reference value.

The purpose of this trial operation was to catch a small amount of fish stocks that were allowed to be shipped, and to investigate the assessment of distribution in the local product and consumer markets. Three different fish types were trialled in 2012, but by the end of March 2017, the number had increased to 97. With the lifting of shipping restrictions on the common skete on February 25, 2020, all shipping restrictions for marine products in the sea area of Fukushima Prefecture were lifted, and "all fish stocks" became the subject of trial operations.

However, with a drop in the number of distributors such as local brokers and fishery processors and brokers in the surrounding area, the difficulty in recovering production, and the long time it took to recover, distribution routes were taken up by another product centers, making recovery of consumer markets insufficient, and so the catch has remained at around 20% of levels prior to the earthquake. In 2010 before the earthquake, Fukushima Prefecture was 17th in the country with 80,000 tons and a production value of 18.2 billion yen, making it one of Japan's leading fishing franchises, but after the earthquake, its appearance was completely changed and production value in 2016 was 7.9 billion yen, which was a large regression back to 29th place in Japan.

<u>(2) The issue of contaminated water problem and ocean release</u>
Under normal nuclear power plant operations, tritium is discharged into oceans and lakes as warm wastewater. The standard for this normal tritium emission is calculated based on a concentration of 1 mSv/year for an adult normally drinking a daily amount of water (2.6 L) for one year, and the declared concentration limit is 60,000 Bq/L, a lower value (1/40). Therefore, it is often said that ocean discharge is safe and the least expensive.

On December 10, 2013, the Contaminated Water Treatment Countermeasures Committee put together its "Preventive and multi-layered contaminated water treatment measures at TEPCO's Fukushima Daiichi Nuclear Power Station - Through comprehensive risk management", and from December 25, 2013, the Tritium Water Task Force was established and examined methods for treating contaminated water. Five disposal options were examined regarding this tritium water: "geological injection", "underground burying (concrete solidification)", "ocean release", "steam release", and "hydrogen release". Based on the discussions of this Task Force, it was assumed that there was no tritium separation technology that could be put to practical use at that stage, and while there would be no scientific impact on the living sphere (human bodies and surrounding organisms), it was argued that carrying out this disposal would inevitably have social and economic ramifications such as reputation damage and impact on the fisheries industry, discussions that were taken up by the Subcommittee on Treatment of Treated Water Including Polynuclide Removal Equipment. This Subcommittee's regulations state that its "objective is to carry out a comprehensive study, including social viewpoints such as reputational damage, based on knowledge gathered in the Tritium Water Task Force Report." It was established mainly to discuss economic impacts such as reputational damage and countermeasures therefor. This was precisely because it was believed that the social impacts of disposal would be significant.

The original purpose of the Subcommittee was, taking into account the five disposal methods and the current status of continuous storage, to consider what kind of economic impact would occur depending not only on disposal methods for the treated water, but also on when decisions were taken, when disposal commenced, starting time, and the amount to be treated, as well as whether or not countermeasures existed. In the end, the details were sorted out, but they have failed to identify any direction other than environmental release.

Elsewhere, although not included in the five options, there were many opinions about continuing above-ground storage and long-term storage at the hearing held by the secretariat of the Subcommittee in 2018, which were added to their discussions.

Incidentally, methods other than ocean release also have their own significance. Taking into consideration the opinion of local residents, higher cost steam discharge was selected over lower cost river discharge for the contaminated water generated from dealing with the accident at the Three Mile Nuclear Power Plant in 1979. This is because local residents preferred this as the result of consensus building. As for "geological extraction" that injects more than 2,500 meters underground, there is no hope of burying the vitrified remains of high-level radioactive waste if a consensus cannot be reached. This is not just a matter of whether the cost is low or high, but is also a touchstone for whether consensus can be formed in future decommissioning and radioactive waste treatment.

(3) The issue of contaminated water and the trilemma

The main problem with this treatment of contaminated water is minimizing the "economic risk" revolving around fisheries.

Regulatory standards for minimizing "exposure risk" have been set (setting of reference values), and water has been released off-site at other nuclear power plants as well, and although there is the question of controlling total amounts, scientific safety is guaranteed.

In terms of minimizing "subjective risk", unlike the prefectural health survey on thyroid cancer related to radioactive iodine-131, and radioactive contamination such as cesium-134 and cesium-137, which was a problem immediately after the earthquake, the number expressing a great deal of concern is low.

This is an extremely serious issue that may have an additional adverse impact on Fukushima Prefecture's fishing industry, which is in the process of recovery, and that by hindering the recovery of Fukushima Prefecture's fishing industry, may have a decisively detrimental effect.

Regarding the disposal of contaminated water, it is necessary to consider a national consensus and understanding, the understanding of other countries, the degree of recovery in industries like fishery and marine product industries in the Hamadori area, as well as measures to curb the impact of disposal. At present, although people are highly interested in the treatment of contaminated water, their understanding of the nature of tritium itself, the concentration of other nuclides contained in the water after ALPS treatment (including retreatment), and disposal methods is poor.[40] In addition, a lack of understanding in other countries regarding the current situation in Fukushima Prefecture is also apparent, witness export restrictions in other countries and essentially defeats at the WTO (see Figures 1 and 2 above).

Additionally, only a short time has passed since shipping restrictions have been lifted on Fukushima's fishing industry's main fishing stocks, and the industry has not recovered to a stage of sufficient strength, and countermeasures for economic impacts have not been fully considered.

Moreover, as a measure to reduce the social impact of this contaminated water, nothing more than

[40] Sekiya, 2019b, pp.38–43.

conventional measures for reputational damage have been implemented, and while stronger qualitative and quantitative measures countering rumors are required, there has currently been no breakthrough. Given the current status of national consensus and understanding as well as the current status of understanding in foreign countries, economic impacts are inevitable.

What needs to be given precedence both inside and outside Japan is 1) the adequate dissemination of results from radiation dose measurements in Fukushima Prefecture, the current results of Fukushima Prefecture food product inspections, full information about the inspection system, and the formulation of measures for informing and spreading information; 2) the recovery of related industries such as Fukushima Prefecture's fisheries, and securing time to solidify the distribution base, and 3) considering the economic impact of treating contaminated water. If it is disposed of as it is, it will impose a further burden on related industries including Fukushima Prefecture and fishermen.

That is why even though reputation is a real "economic risk" for fisheries and locals, the government, TEPCO, and experts do not explain how to control "economic risk," but instead repeat an insufficient explanation on "exposure risk", leading to discrepancies between the two.

Reputational damage concerning cesium has not been completely eradicated either domestically or overseas. Nevertheless, the government and scientists still think that a scientific explanation can solve this problem of treated water including tritium. This is where the problem lies.

## 7. Nuclear disaster prevention and wide-area evacuation plans

Finally, I would like to consider nuclear disaster prevention

In 2011, based on the Disaster Prevention Measures for Nuclear Facilities (so-called Disaster Prevention Guidelines) formulated by the Nuclear Safety Commission, an EPZ of 8 kilometers was to be evacuated in the event of a nuclear power plant accident. However, following the accident, Fukushima Prefecture issued 2 kilometers, and the government, ignoring the above disaster prevention guidelines, issued 3, 10, and 20-kilometer evacuation orders in quick succession. While noting about this that "confirmation and support were insufficient, and the information and evaluations on which the instructions were based were inadequately provided", the Independent Accident Investigation also held that "it was a preventive response, and as a result, we recognize that they were able to prevent the radiation exposure of residents." The Parliamentary Accident Investigation was negative about multistage evacuation, stating in the early stages, "Had it been possible to read ahead, such as inducing evacuation outside the 20km area, this may possibly have eased the burden placed on residents by multistage evacuation." As for the Government Accident Investigation, it pointed out that the problem was that a PAZ (Precautionary Action Zone), a zone set up by the IAEA for "a severe accident as a prerequisite for disaster prevention measures based on lessons learned from the Chernobyl accident" and "to immediately evacuate when there is a risk of radioactive material release", was not introduced.

How, then, has the current nuclear disaster preparedness been modified based on these lessons learned from the TEPCO Fukushima Daiichi Nuclear Power Station accident? Let us consider them from three perspectives.

(1) Nuclear disaster prevention and "protective measures"

The first point is the concept of protective measures in the event of a nuclear accident.

One is the evacuation standard. In emergency response and nuclear disaster prevention plans based on the current Nuclear Emergency Preparedness Guidelines and using ideas introduced by the IAEA, multistage evacuation is not to be carried out, but is to take place using a PAZ immediately and a UPZ (Urgent Protective action planning Zone) at the stage when 500 μSv/hour is reached, which is the operational intervention level OIL1 for UPZ, using the value at the monitoring post as a standard. In other words, inhabitants are asked to stay where they are on the assumption that they will be exposed up to 500 μSv/hour. Considering the risk of turmoil in an evacuation, "exposure risk" is tolerated. However, from the residents' standpoint, they are being told to stay put while being exposed to exposure risk, so it is difficult to minimize their "subjective risk".

Another is the exit test (screening test). 1) Residents within the PAZ (5 km) will be evacuated immediately and not be inspected as this evacuation precedes the release of radioactive material. 2) Basically, when you evacuate outside the UPZ (30 km), you will undergo an "exit inspection". 3) In order to give precedence to speedy evacuation to outside the area, vehicles are first inspected without inspecting everyone individually. If it is not under 40,000 cpm (β ray), a representative occupant is inspected. If this representative is not below the operational intervention level OIL 4 of 40,000 cpm, then all occupants will be inspected. In short, not inspecting everyone is the basis.

This is one of the ways to increase the speed of exit inspection. People will be exposed if they stay for a long time in a place where the dose is rising. This is also an appropriate measure to minimize exposure risk because as many people as possible will be evacuated to a distance in a short time. However, since they are not tested, it is difficult to minimize subjective risk.

For example, in the case of the JCO criticality accident, Tokaimura conducted a simple screening for almost all the residents, although the radioactive material was not scattered in large quantities and there was almost no exposure. This played a major role in reducing feelings of anxiety in the long run. It contributed to minimizing subjective risk.

In the Great East Japan Earthquake, not all evacuated residents and citizens of the prefecture were screened. In the Fukushima nuclear accident, about 20% of people were not screened even in the warning zone, and since it was not mandatory, most people were not screened outside the warning zone immediately after the accident.[41] As a result, this led to a situation where the half-life was as short as one week, and the situation of radiation exposure immediately after the accident due to iodine that affects the thyroid gland was not known. Not knowing the radiation dose immediately after this is a factor causing long-term anxiety for residents, and is an issue that creates concern all the way up to prefectural health surveys.

The lesson of the Fukushima nuclear accident was meant to be that, in order to contain confusion immediately after the accident, it is necessary to simultaneously minimize both exposure risk through prevention via the evacuation of residents and subjective risk by curbing confusion via the confirmation that evacuation has taken place. It has not, however, been put to good use thereafter.

(2) Nuclear disaster prevention and "assumptions"

The second point is the concept of "assumptions". Assumptions in nuclear disasters do not fit into the concept of "disaster mitigation".

Natural disasters assume damage and sacrifice and cannot be prevented, and are premised on the fact that it is difficult for everyone to evacuate. Although various expressions exist like the scale is "the largest ever" or "the scientific maximum", the "maximum" is premised on the assumption that a

[41] Sekiya, 2019c.

disaster on an expected scale will not occur. That is why the idea of "disaster mitigation" is established in order to reduce the damage and sacrifice as much as possible.

On the other hand, in nuclear disaster prevention, "assumptions" are directly attached to the extremely highly valued safety of the nuclear power plant, and nuclear disaster prevention (at least nuclear disaster prevention after the Great East Japan Earthquake) presupposes that all target people evacuate.

The transformer fire that occurred during the 2007 Niigata Chuetsu-oki Earthquake in Unit 3 of the TEPCO Kashiwazaki-Kariwa Nuclear Power Plant was an accident that hinted at the need for measures to be taken against compound disasters in which a natural disaster and a nuclear accident occur simultaneously. Nevertheless, only Niigata Prefecture considered the possibility of compound disasters. NISA had called compound disasters "an extremely unlikely event"[42] and maintained up until March 2011 that the occurrence of a nuclear disaster and wide-area evacuation would not actually occur. It was common for both nuclear regulators and operators to avoid the very "assumption" of a major disaster such as a compound disaster.

Even today, there is a fixed assumption that accidents will be similar to the Fukushima nuclear accident. According to the Nuclear Regulatory Agency, IAEA standards were adopted when formulating guidelines for nuclear disaster countermeasures, and the maximum UPZ of 30 km specified by the IAEA was adopted. On top of that, it was based on a conservative view of seeking maximum safety for nuclear disaster prevention and the fact that damage from the Fukushima nuclear accident had subsided within a range of approximately 30 kilometers.

> The Japanese situation at the time was the idea of 'go conservatively, be on the safe side' and against the backdrop of the two facts that it actually exceeded 30 at Iitate in Fukushima, but said it was on the safe side. We thought no one would say it was tiny, and it would be enough to say it was on the safe side. That's what happened in Fukushima. I think that was the background.[43]

This problem of limiting "assumptions" also appears in assumptions about "emission amounts" in the regulatory standards. In the TEPCO Fukushima Daiichi nuclear accident, the amount of cesium-137 released was 15 petabecquerels (=15,000 terabecquerel)[44], but the Nuclear Regulation Authority confirmed that the amount of cesium-137 due to containment vessel damage in the Kawauchi Nuclear Power Plant inspection was assumed to be 5.6 terabecquerel.

Based on lessons learned from the Fukushima nuclear accident, the Nuclear Regulation Authority argues that "it does not mean that an accident on a larger scale will not occur", but as a reference, assuming that the release amount of "cesium-137 due to containment vessel damage" when a serious accident occurs is 100 terabecquerel, and the basic idea being that there is no problem because the effective dose is sufficiently low outside the PAZ (May 28, 2014, 9th Nuclear Regulation Authority meeting), individual assumptions are made for containment vessel damage.[45]

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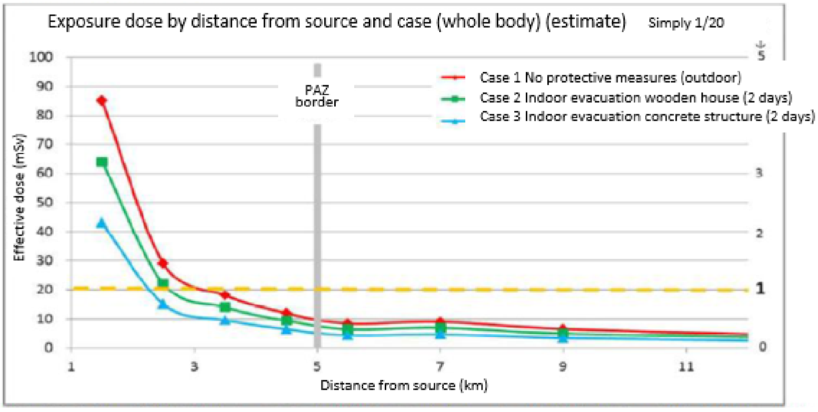
[42] Nuclear and Industrial Safety Agency, 2009.
[43] Interview with Ex-Cabinet Office staff, November 29, 2019..
[44] See, Nuclear and Industrial Safety Agency. (2011, June 6). Announcement; Government of Japan. (2011, June). Report for the IAEA Ministerial Conference on Nuclear Safety; in section 2.2. concerning nuclear disasters in chapter 2 on radiation exposure, unified basic data on health effects of radiation is organized according to figures such as "the comparison between estimated amounts of radionuclides released from the Chernobyl nuclear power plant accident and the TEPCO Fukushima Daiichi nuclear power plant accident."
[45] Nuclear Regulatory Authority Mid-level Hearing with Tetsuya Yamamoto and Shunichi Tanaka.

- ➢ Within 5 km from the emission source (within the PAZ), the dose reduction effect is great depending on the distance (thus, evacuation is effective as a preventive protective measure).
- ➢ On the other hand, at a distance of 5 km or more from the emission source, the dose reduction effect due to indoor evacuation, etc. can be reliably expected rather than the dose reduction effect depending on the distance.
- ➢ From the above, from the viewpoint of reducing radiation exposure when passing through the radioactive bloom, indoor evacuation is an effective means at a distance of 5 km or more.




- In light of the lessons learned from the Fukushima Daiichi Nuclear Power Station accident, the total amount of radioactive material released is confirmed by tests to be less than 100 terabecquerels of cesium 137 for the assumed containment vessel failure mode, even if a serious accident occurs. The above calculation is based on the assumption that 100 terabecquerels will be released. For the preconditions of the calculation, refer to Document 2 of the 9th NRA in 2014 (held May 28, 2014).
- In addition, in the tests on the Kawauchi Power Station, the emission amount of cesium 137 confirmed for the assumed containment vessel failure mode was 5.6 terabecquerel (7 days) (1/20th of 100 terabecquerel).

NB 1 terabecquerel = 1012 becquerels = 1 trillion becquerels: 1/1000th of a petabecquerel

Source: Former NRA Chair Tanaka, explanatory materials, February 2017

Although strict regulatory standards have been laid down in light of reflections on the accident with the aim of achieving a robust defense, they are based on the premise that this regulation perforce ensures that a large amount of radioactive substance will not be emitted. In other words, the more stringent the regulations and the more stringent the standards are, the more paradoxical becomes the paradox of underestimating the assumptions for an accident. Regarding this point, a former staff member of the Cabinet Office (nuclear disaster prevention), stated as follows.

> My awareness is that the NRA has returned to its former (zero-risk, no accident) thinking. The Regulatory Agency, including the chairman of the Authority, has explained to the public based on an assumption that almost no radioactive material will be released in any accident, and disaster prevention plans and resident briefing sessions have been built on this assumption.[46]

(3) Nuclear disaster prevention and "regulation"

The third point is that offsite nuclear disaster prevention was not subject to "regulatory requirements" or "examination", but rather was closely linked to "promoting".Based on the lessons learned from the Fukushima nuclear accident, NISA was abolished and the Nuclear Regulation Authority (NRA) was established as a regulatory body independent of the Ministry of Economy, Trade and Industry, in order to separate "promoting" and "regulating".

However, the NRA neither includes evacuation plans in its regulatory requirements like in the United States, nor does it make requests about the evacuation plans of the Cabinet Office (Disaster Prevention) and each prefecture as the U.S. NRC submits to the FEMA. It is said that it commented that the reasons for this were "1) legally, the new regulatory standard is a standard for operators and cannot be used to impose obligations/burdens on local governments; 2) it is almost impossible for

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[46] Interview with former staff in charge of nuclear disaster prevention, Cabinet Office, November 29, 2019.

local governments to handle tasks such as assessing conformity to new regulatory standards as current operators do; and 3) there is no zero risk, and as long as there is no end to disaster prevention measures, it is impossible to assess 'effective evacuation plans' that evaluate regulatory compliance."[47]

Regarding these, the stance on the regulatory agency side was to explain only that "the evacuation plans are effective in light of the nuclear disaster prevention guidelines". Verification is insufficient (currently, only Niigata Prefecture is verifying evacuation).

At present, nuclear disasters and natural disasters come under the jurisdiction of different bodies at the government level: the Cabinet Office (Nuclear Disaster Prevention) and the Cabinet Office (Disaster Prevention). The core of the Cabinet Office (Nuclear Disaster Prevention) comprises mainly co-assigned staff and officers seconded from the Agency for Natural Resources and Energy at the Ministry of Economy, Trade and Industry, and has a strong relationship between "promoting" and "regulating".

In addition, the relationship with the Cabinet Office (Disaster Prevention) is weak, and there is no mechanism for utilizing natural disaster response expertise for nuclear disaster response. This is not only a question of a vertical structure in the government's crisis management organization, but also creates a mismatch between nuclear disaster prevention and natural disaster prevention.

As for nuclear disaster prevention at the government level, the Cabinet Office (Nuclear Disaster Prevention) has prepared an "emergency response" for each nuclear power plant location. Consistent with that, disaster prevention plans for each prefecture and each municipality are made, and the government's involvement is more direct than with natural disasters. In the case of nuclear disaster prevention, it is assumed that the prefectures and local governments will match up 100% the areas being evacuation from and to without making individual judgments, and that all the people requiring assistance will be listed up and transferred.

However, at TEPCO's Fukushima Daiichi Nuclear Power Plant, more than half of the people were evacuated to direct relatives and relatives' homes over a wide area nationwide, rather than as directed by the government.[48] In the first place, there are almost no cases of 100% evacuation due to natural disasters, not just nuclear accidents.[49] The plans are such that have never taken place in the past, not only for nuclear accidents, but also natural disasters. Of course, efforts to realize policies (ideals) where no one is left behind can be appreciated, but, at the very least, the fact is that they are trying to realize impossible plans that are not implemented in natural disasters.

Also, assumptions and scenarios are emphasized in training drills, and in natural disasters, blind-type drills where natural assumptions and scenarios are hidden from the implementers are not often performed.[50] Additionally, most of the radiation measurement personnel for exit inspections at each site rely on personnel dispatched from the various electric power companies (support from other electric power companies via the electric power company actually), there being many areas where electric power companies provide welfare vehicles for the evacuation of people.

Of course, it is natural for operators to take a central role and great responsibility in nuclear disaster

[47] Ibid.
[48] Sekiya, 2019c.
[49] An exception is damage from a volcanic eruption. However, eruptions have mostly occurred in the past on remote islands or other areas with small populations, avoiding the unprecedented scale of damage that a nuclear power plant accident can cause.
[50] Only Hokkaido and Niigata did blind nuclear power plant disaster prevention exercises in the fiscal year 2019.

prevention, but in reality nuclear disaster prevention and training appear to be premised on the condition that nuclear power plants will restart and the promotion of nuclear power. In fact, this nuclear disaster prevention has a structure that is dependent on the electric power companies as being part of a set with the restart and promotion of nuclear power.

Taking into account lessons learned after the Great East Japan Earthquake, the Nuclear Regulatory Agency was established by differentiating between nuclear “promotion” and “regulation”, but harmful effects have been brought about by the fact that nuclear disaster prevention was excluded from the regulatory requirements (under the jurisdiction of the Cabinet Office not the Nuclear Regulation Authority).It can be seen that the “purpose” of nuclear disaster prevention, such as accident response and minimizing exposure risk to residents, has been replaced by the “means” for restarting nuclear power plants, thus rebuilding a “safety myth” triggered by nuclear disaster preparedness.

This is because it does not assume economic damage. The amount of damage from the Fukushima nuclear accident was estimated to be 21.5 trillion yen in 2016. Emergency response after a nuclear accident and disaster prevention plans have been prepared for each area of a nuclear power plant, but economic damage has not been calculated. This is in sharp contrast to the assumption of economic damage in the case of an earthquake in Metropolitan Tokyo or a giant earthquake in the Nankai Trough. In other words, before one can even start minimizing economic risk in a nuclear accident, it is treated as if it does not exist. The “safety myth” of not “assuming” economic damage is being incorporated into the nuclear disaster preparedness system once again.

The lessons pointed out by the three Accident Investigations, and many people, were response to the unexpected, compound disaster response and coordinating compound disaster response with natural disaster response. That has not materialized, however. At the very least, the current situation must be said to be one where “assumptions” for disaster response in the case of a nuclear accident, multi-faceted studies on off-site response including evacuation of residents bearing in mind compound disasters and based on knowledge of natural disasters, and an organizational framework to realize these are all inadequate.

Basically, the issue in nuclear disaster prevention can be said to be the conflict between “minimizing harm to health as a radiation exposure risk” and “minimizing feelings of anxiety as a subjective risk”, which remain unresolved.

**Summary: Re-emergence of the safety myth**

Nine years have passed since the earthquake, and the following three issues have emerged.

First, the loss in credibility of the scientific community and the government has caused long-term communication deficits, and an absolute standard of 1 mSv/year has been established in the turmoil of the immediate aftermath. This has had very important policy implications that have resulted in prolonging decontamination, intermediate storage facilities, soil waste, and evacuation. Additionally, Japan has failed to switch from crisis communication to risk communication in normal times, and has been unable to switch from the crisis stage of taking preventive measures in an emergency to the stage of sharing risk in normal times.

The second is grasping the trilemma. In order to recover from radiation disasters, “minimizing health damage as a radiation exposure risk for the general public”, “minimizing feelings of anxiety as a subjective risk”, and “minimizing economic damage as an industrial risk” must be achieved. However, bureaucrats and scientists assert that "minimizing health damage as a radiation exposure risk for the general public" is enough, and they continue to ignore "minimizing feelings of anxiety as a subjective risk" and "minimizing economic damage as an industrial risk" as the concern of a mere few. The trilemma goes unsolved, each solution being deemed good enough as a science-based "setting of reference values", "risk communication" by the Ministry of Health, Labor and Welfare and the Consumer Affairs Agency to explain the health effects of radiation, and "promotion" of agriculture, forestry and marine products by the Ministry of Agriculture, Forestry and Fisheries and local governments, and we are about to reach ten years on in the absence of real risk communication.

However, explanations of radiation did not directly lead to "minimizing feelings of anxiety as a subjective risk," and without being incorporated into the distribution structure at the root of reputational damage, promotion did not lead to "minimizing economic damage as an industrial risk." Soon ten years will have passed without solving this trilemma.

Thirdly, the strengthening of regulations after the Fukushima nuclear accident, and the separation of regulations and nuclear disaster prevention, has replaced the "goals" of nuclear disaster prevention such as accident response and minimizing the exposure of residents, with the "means" for promoting and restarting nuclear power. "Minimizing economic damage as an industrial risk" is ignored because ultimately accidents do not occur, and the stringency of regulations and standards force accident assumptions into a Fukushima nuclear power plant template for nuclear disasters and creates the paradox of underestimating the scale of release. This creates a structure where greater priority is given to achieving "small peace of mind" by eliminating fears that might hinder restarting nuclear power rather than achieving the "great safety" of evacuation in the event of a nuclear power plant accident.

In other words, a new "safety myth" is being rebuilt.

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