Commentary

Looking Back Five Years of Fukushima

−Progress of Environment Decontamination and Radiation Risk Communication−

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Five years have passed since the Great East Japan Earthquake of 2011. This commentary on decontamination work and radiation risk communication reflects on the activities that the author has actively engaged in during these years and identifies some of the challenges ahead. In particular, this work has been a battle against the mistaken belief that comes from an impatient demand to reach the long-term decontamination target of 1 mSv/y. The achievements secured through the more rational approach adopted by the city of Date suggest that the target should have been set at 5 mSv/y. This commentary further considers how to enable evacuees to return to their homes and dispel the lingering and harmful rumors.

KEYWORDS: Fukushima, decontamination, radiation risk communication, radiation exposure, spatial dose rate, 1 mSv/y, natural radiation

I. Introduction

Five years have passed since the Great East Japan Earthquake. This is the final year of the decontamination work being conducted in Fukushima Prefecture. Immediately after the nuclear plant accident, Fukushima-shi and another centrally located major city, Koriyama, recorded a dose rate of over 10 μSv/h due to radiation from iodine-131 (I-131), which has a half-life of 8.0252 days. The long-term target of reducing the annual additional exposure dose in living environments to 1 mSv/y has been achieved in these cities and other areas, with the exception of restricted residence zones and difficult-to-return zones. Personal dosimeters registered a substantive annual cumulative dose of less than 1 mSv even in the highly contaminated parts of Tamura, Kawauchi, and Naraha, where evacuation orders have been lifted. Decontamination work in the remaining areas will be completed so that evacuation orders can be lifted.

Nevertheless, there are still roughly 100,000 evacuees from Fukushima Prefecture (55,000 living inside the prefecture and 43,000 living outside the prefecture) [1]. Responses from evacuees to a questionnaire on their intention to return home suggest that it is hard for evacuees from communities where evacuation orders have been lifted to return home. What

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should be done now and what measures will it be possible to take if a similar emergency happens again in the future? To answer these questions, the author mainly discusses decontamination work and radiation risk communication by reflecting on activities carried out in the past five years.

In the immediate aftermath of the disaster, the author participated in volunteer decontamination work in Date and Minamisouma in fiscal 2011, where he gained some of the hands-on skills involved in the performance of decontamination work. He specializes in radiation technologies (particularly neutron-related ones) and learned radiation risk communication by himself. In fiscal 2012 and 2013, he was in charge of public relations at the Fukushima Office for Environmental Restoration, which was established by the Ministry of the Environment. He engaged in public relations activities related to decontamination projects, supervised the operation of the Decontamination Information Plaza, and was involved in radiation risk communication. He sometimes participated in discussions and site visits with experts from the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA). He has also attended dialogue forums, etc., with local residents on behalf of the office.

The author's summary of a Community Dialog Forum for Residents of Fukushima Prefecture with International Experts that was held in Fukushima in November 2012 has been published in this journal [2]. At this forum, which was moderated by ICRP experts, residents of Fukushima Prefecture shared their experiences of being forced to evacuate without any knowledge of radiation or any adequate information. They also talked about the issues that they faced later. The Fukushima Office for Environmental Restoration provided explanations of the decontamination projects, while ICRP experts provided advice on how to deal with radiation. They explained that radiation doses in Fukushima should not be considered problematic because the doses in Fukushima are comparable to those caused by natural radiation in other countries. They stressed the importance of radiation risk communication to ease concerns over radiation and dispel harmful rumors about food products from Fukushima Prefecture. Full-scale decontamination work began that year (2012), and many rounds of briefing sessions were held to acquire consent from local residents for the decontamination work and the construction of temporary storage yards for the resultant waste. The work was initiated after the necessary consent had been obtained.

Unfortunately, decontamination work reduces the dose rate by only about 50% on average. Naturally, the long-term goal of reducing the dose rate to below 1 mSv/y could not be achieved in highly contaminated areas, a fact that was widely criticized in the media. Evacuees were also discouraged by the fact that they were unable to return home even after the evacuation orders had been lifted. With respect to this issue, an IAEA investigation team that was invited to evaluate decontamination projects in 2013 made the encouraging claim that those involved in decontamination work should not be obsessed with this long-term target of 1 mSv/y [3]. Substantive dose measurements were later conducted using personal dosimeters in Nihonmatsu and Date. The resultant measured dose rates were found to be about half the levels estimated based on air dose rates. To verify claims made by experts from the ICRP, the author evaluated the country-averaged annual exposure dose rates caused by natural radiation throughout the world and summarized the results in a graph. This graph was welcomed by residents of Fukushima Prefecture, who said, "We feel very relieved." When it was presented at the dialogue forum, though, this same graph was referred to as an excuse for not having achieved the long-term target [4]. This claim made the author realize the limitations of his earlier activities, which prompted him to leave the Ministry of the Environment. Since then, he has engaged in discussions focused on the issue of reconstructing Fukushima with students

by joining dialogue forums organized by a Senior Network of the Atomic Energy Society of Japan (AESJ). Through these activities, the author was able to learn how people outside Fukushima view the problems there. Based on the above experience, the following sections discuss problems related to decontamination and radiation.

II. Decontamination

1. Decontamination Technologies and Procedures

Initially, pilot decontamination projects were conducted by the Japan Atomic Energy Agency (JAEA) and Japan's Self-Defense Forces to confirm the decontamination technologies alongside the volunteer decontamination work conducted in Date and Fukushima. The Ministry of the Environment developed decontamination guidelines based on the outcomes of these pilot decontamination projects [5] to standardize measures for later decontamination projects. More details on the decontamination technologies and procedures can be found on the website of the Decontamination Information Plaza (current name: Environmental Regeneration Plaza; http://josen.env.go.jp/plaza/).

It is worth mentioning the trouble that experts experienced when dealing with uninvited guests at the Decontamination Information Plaza and lecture meetings who insisted that the decontamination work was unacceptable as the radioactive materials were simply relocated as a means of transferring the contamination rather than being completely removed. Furthermore, residents and contractors complained about the decision of the Ministry of the Environment to suspend the pressure washing of roofs when the dose rates were reduced by rain washing away radioactive materials over time. The ministry revised [6] the guidelines to incorporate new findings and better methods that had been devised based on the experience gained from earlier decontamination work. A comprehensive review of the decontamination projects was also conducted.

2. Decontamination Targets

According to the ICRP guidelines, decontamination work is conducted with the aim of achieving the long-term target for the exposure dose rate of 1 mSv/y, which is the dose limit for ordinary people. However, it is recommended that an actual operating target be assigned at an appropriate level of between 1 and 20 mSv/y [7].

The volunteer decontamination work in Date that the author participated in was conducted with the aim of achieving the upper limit for the annual additional exposure dose rate of 5 mSv/y in accordance with the instructions issued by Mr. Shunichi Tanaka, who headed the Nuclear Regulation Authority from 2012 to 2017. Around October 2011, many spots with a dose rate that exceeded 5 μSv/h were found around Ryozen, a town in Date where the accumulated dose was estimated to be 20 mSv for one year after the accident and was designated as a recommended evacuation point on June 30. The decontamination work was conducted by selecting areas with a measured dose rate of more than 1 μSv/h at a height of 1 m above the ground. The grass was mown, and topsoil in places with a dose rate of more than 3 μSv/h was scraped off. Around a hut without a front-covered gutter, the rain fell directly from the roof to the ground, making deep holes. As a result, hot spots with a dose of 10 μSv/h formed around the holes. The doses at these spots could be reduced by digging down about 30 cm. Finally, the scraping of topsoil was limited to a thickness of 5 to 10 cm since digging deeper would

only increase the amount of soil waste. Uncontaminated soil was used to provide a shield against radiation. Of course, the decontamination work for houses and trees that needed to be carried out at elevated locations was outsourced.

With respect to the target areas for full-scale decontamination, the Ministry of the Environment initially offered to cover the decontamination expenses for areas with an annual dose of over 5 mSv/y. On April 30, 2011, Mr. Toshisou Kosako resigned from his post as Special Advisor to the Cabinet over the issue of restoring school environments [8]. At that time, he did not clearly indicate the reference level for the decontamination of living environments. This led to surging support for a long-term goal of limiting the dose rate to 1 mSv/y. Accordingly, Mr. Yuhei Sato, Governor of Fukushima Prefecture, requested that the Japanese government provide a budget that would also cover the decontamination of areas with a dose rate of between 1 and 5 mSv/y. His request was approved by the former Minister of the Environment, Mr. Goshi Hosono [9]. The selection of decontamination targets was left to the judgment of the municipalities. As mentioned earlier, Date maintained a target of 5 mSv/y for its volunteer decontamination work in consideration of the natural decay of cesium and with the intention of reducing the amount of waste, which was clearly described in their decontamination plan. In contrast, most municipalities conducted decontamination work in areas with a dose rate of more than 1 mSv/y. In practice, they conducted radiation monitoring and selectively decontaminated places with a dose rate of 0.23 μSv/h or more. Extensive area decontamination work was performed in the special decontamination area where the government conducted decontamination work directly, but selective decontamination work is generally being performed in a similar manner to that adopted by the municipalities.

3. Impact of the Budget Allowance for the Decontamination of Areas with a Dose Rate of Between 1 and 5 mSv/y

The policy shift to cover the costs of decontaminating areas with a dose rate of between 1 and 5 mSv/y inevitably increased the budget by a few trillion yen. Efforts to achieve this lower dose limit resulted in the increased amount of decontamination waste being left on site due to the difficulty involved in securing enough space for its temporary storage.

Concerns over a higher dose rate than the long-term target of 1 mSv/y increased the number of refugees from Fukushima Prefecture. Furthermore, people who tried to achieve the target of 5 mSv/y have lost a sense of accomplishment. The air dose rate target of 1 μSv/h was very easy to understand for measurements, but the target of 0.23 μSv/h is quite complicated and baffling. Moreover, when 1 μSv/h was the target, places where it was only necessary to sweep away fallen leaves and remove weeds, for example, needed the further removal of topsoil in order to achieve 0.23 μSv/h. Consequently, people felt that they could not do it by themselves, so they asked the national government or local government to handle it. The feelings of residents who thought that they could do it themselves and wanted to complete the decontamination work in a hurry also cooled, and the progress made in the decontamination work suffered as a result.

People who initially considered returning to their homes began to feel that they must wait until the dose level has dropped below 1 mSv/y. Even some local leaders began to insist that they were unable to lift the evacuation orders because a return is impossible until the dose level falls below 1 mSv/y.

It is quite reasonable that Ms. Marukawa, Minister of the Environment, objected to the policy change made by former Minister Hosono, taking into account issues such as the enlargement of the budget. In the discussion held in the Diet, however, the essential issue was

not discussed and her incidental comment that the "change to the decontamination target was made without scientific basis" was attacked as being wrong, forcing her to withdraw her statement. Given that the radiation dose in Date City, which was decontaminated with a target of more than 5 mSv/y, has now almost reached the long-term target of 1 mSv/y, it can be said that the ministry's original policy was not wrong.

4. Decontamination Results and Post-Decontamination air Dose Rates in Major Cities

Table 1 shows the progress in decontamination work that municipalities made in September and October 2015 [10]. It has almost been finished outside Fukushima Prefecture, and 70% of all residential areas in Fukushima Prefecture have been completed. The decontamination work led by the national government was completed for the residential areas in Tamura, Kawauchi, Naraha, and Okuma, followed by those in Katsurao, Kawamata, and Iitate. The remaining work will be completed by the end of this fiscal year.

Thanks to this decontamination work, the air dose rates caused by radioactivity have dropped. According to airborne monitoring [11] conducted on September 29, 2015 (the results can be viewed by accessing https://radioactivity.nsr.go.jp/ja/list/362/list-1.html), the air dose rate 1 m above the ground surface has been reduced to 1 mSv/y extensively throughout Fukushima Prefecture.

Table 2 shows the air dose rates measured at some of the monitoring posts in Fukushima Prefecture [12] (https://www.pref.fukushima.lg.jp/sec/16025d/kukan-monitoring.html). In around 2012 to 2014, fears were raised that the target air dose rate of 0.23 μSv/h would not be achieved. Today, the target of 0.23 μSv/h, which corresponds to 1 mSv/y, has been achieved in most parts of the Nakadori region of Fukushima Prefecture. The air dose rates in most parts of Date are close to 0.1 μSv/h, except for the Shimooguni Assembly Hall (Ryozen), which has a dose rate of 0.24 μSv/h. The same trend can be observed in Iwaki, Hirono, Soma, and other nearby municipalities in Hamadori. In addition, almost all of the decontamination special areas under the direct control of national government, Tamura, Kawauchi, Naraha, and Kawamata have dose rates of less than 0.23 μSv/h. Currently, about 90% of Katsurao, where decontamination work is underway, about 75% of Minamisoma City, and about 25% of Tomioka and Iitate have dose rates of less than 0.23 μSv/h. Futaba, Namie, and Okuma, which have many difficult-to-return areas, have also cut their dose rates to 0.23 μSv/h, as is the case in the Okawara area, where decontamination work has been completed. However, although most of the monitoring posts are located at public facilities, their values are representative values. Other than that, there are places with high doses, but they do not significantly exceed 0.23

Table 1 Progress made in municipality-led decontamination work [1]

	Inside Fukushima Prefecture (as of the end of October 2015)	Outside Fukushima Prefecture (as of the end of September 2015)
Public facilities	Approx. 90%	Almost completed
Houses	Approx. 70%	Almost completed
Roads	Approx. 40%	Approx. 90%
Farmland, pastures, etc.	Approx. 80%	Completed
Forests around houses	Approx. 50%	Completed

Table 2 Changes in air dose rates at the main monitoring posts

Post location		Apr. 29, 2011	Nov. 7, 2014	Feb. 3, 2016
Date	City Office	1.25, 1.23	0.23, 0.21	0.17
Fukushima	Health and Welfare Office for North Fukushima	1.58	0.24	0.19
Kawamata	Town Office	0.73, 0.75	0.16, 0.16	0.09
	Yamakiya Fire Service Center	(～3.0)	0.68, 0.68	0.24
Nihonmatsu	City Office	1.39, 1.44	0.25, 0.26	0.20
Tamura	Tokiwa Administrative Office	0.26	0.10, 0.09	0.08
Koriyama	Government Office Complex	1.53	0.13	0.11
Shirakawa	Government Office Complex	0.64	0.09	0.07
Aizuwakamatsu	Government Office Complex	0.18	0.06	0.06
Minamisoma	Government Office Complex	0.54	0.11	0.08
Hirono	Shimokitaba Assembly Hall	(～0.8)	0.11, 0.11	0.07
Iwaki	Government Office Complex	0.27	0.07	0.07

Note: Air dose rates in units of μSv/h

μSv/h.

The numerical value obtained by multiplying these air dose rates by five provides an estimate of the annual amount of exposure per mSv/y. Not only the Nakadori district, but also most of the residential areas in the area where municipal decontamination work is being carried out in the Hamadori district have dose rates of less than 1 mSv/y. With respect to the decontamination results for the special decontamination areas [12], more than half areas in Tamura, Naraha, and Kawauchi, where decontamination work was completed at an early stage, also have dose rates of less than 1 mSv/y, and even at their highest, the actual amount of exposure as measured with a personal dosimeter should be less than 1 mSv/y. The Okawara area, where the decontamination of Okuma was carried out, has a dose rate of around 1 mSv/y. The decontamination of residential areas in Katsurao, Kawamata, and Iitate has also been completed, and the post-mortem monitoring of each area is being carried out.

Of course, high doses exceeding 20 mSv/y of additional exposure can be seen in difficult-to-return areas. Decontamination plans have not yet been formulated for these difficult-to-return areas. In addition, the results of airborne monitoring show that some parts of forest area of Nakadori has a dose rate of several mSv/y. These are future issues for environmental recovery.

III. Radiation Risk Communication

1. Purpose and Intended Targets

In Japan, about 40 years ago, the description of radiation education disappeared from the course guidelines produced by the then Ministry of Education, Science and Culture, and radiation education was no longer conducted. As a result, anxiety about radiation, which people were no longer familiar with, spread immediately when the nuclear accident happened. In

addition, discriminatory remarks were made concerning the genetic effects of the accident due to a failure to understand the effects of radiation exposure, and the reputation of food from the affected areas has increasingly suffered. Furthermore, there has, for example, been opposition to the final disposal facility for designated waste containing more than 8,000 Bq/kg from the wide-area treatment of rubble and radioactive materials. This opposition stems from anxiety about radioactive materials as well as concerns about the harmful rumors.

In order to solve these problems, it is important to communicate the basic nature of radiation, its effects and remedies, and the current state of radiation to the public, not to mention people from the affected prefectures. This is known as radiation risk communication. For this reason, after the accident, various academic societies specializing in radiation, mainly in the disaster-affected areas, and the decontamination information plaza, which is jointly operated by Fukushima Prefecture and the Ministry of the Environment, dispatched radiation specialists to support radiation education in schools and to conduct lectures and deal with questions about radiation and decontamination for volunteers such as kindergarten teachers, public health nurses, and community associations. As a result, knowledge of radiation in Fukushima Prefecture's citizens has improved considerably.

Meanwhile, the author noted that university students tended to have an inadequate understanding of radiation and the realities in Fukushima during the various dialogues that he has conducted with them regarding nuclear energy and radiation since fiscal 2014. For instance, they expressed surprise when the author mentioned that local newspapers in Fukushima and neighboring prefectures still report the local radiation doses and that Fukushima Prefecture keeps contaminated food products away from the marketplace by reporting the results of radiation inspections of food products on the market. This perception gap is presumably a source of harmful rumors and concerns over the stigma associated with them.

To dispel harmful rumors, radiation risk communication is vital not only for the affected communities themselves, but also for people from other areas.

The education provided to pupils at elementary and junior high schools is quite effective as younger people can generally absorb information about radiation more flexibly. Kindergarten students at a preschool in Fukushima gave the author an eye-opening experience when he discovered that they understand that our world is made up of many substances and that it has been bombarded by radiation ever since the beginning of the universe. Therefore, the benefit of using learning aids about radiation that are based on the target age group is questionable. Such learning aids should be organized according to levels of understanding.

2. Health Impact of Low-Dose Exposure

In radiation risk communication, the impact of low-dose exposure and the risks posed by the additional exposure to 1 mSv/y of radiation are matters of the greatest concern. The author and his colleagues have studied the latter and compiled relevant materials [13]. People generally have an annual exposure limit of 1 mSv. The corresponding risk coefficient is estimated to be 4.5×10^{-7} based on the epidemiological findings regarding atomic bomb survivors from Hiroshima and Nagasaki that cancer mortality increases by 0.5% for every 100 mSv if we assume that the radiological impact is proportional to the exposure dose. This figure is two orders of magnitude lower than the risk coefficient of 5.9×10^{-5} for deaths from motor vehicle accidents. In fact, it is comparable to the risks normally associated with the use of railways.

Meanwhile, ICRP experts proposed a comparison of the exposure dose rates from naturally occurring radiation. The author tried to present figures for parts of China, India, and Brazil

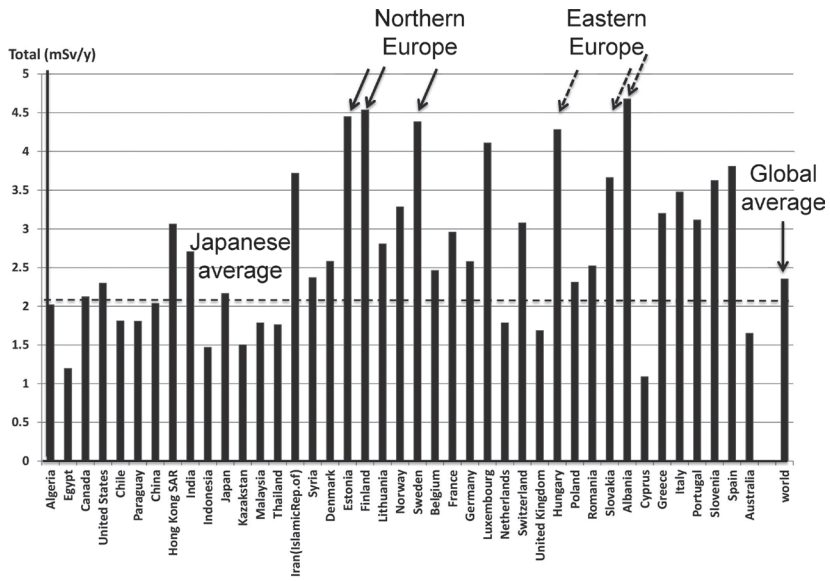

Figure 1 Annual exposure dose rate from naturally occurring radiation in different countries

that Japanese researchers had yet to explore, but the presentation of this information at the Decontamination Information Plaza did not gain much understanding. Changing his approach, the author compared the exposure dose rates from naturally occurring radiation in different countries based on data from the UNSCEAR 2000 Report [4, 13]. The results presented in **Figure 1** show that, due to greater exposure to radon, the dose rate levels for Northern and Eastern Europe (4–4.5 mSv/y) were about double that for Japan (2.1 mSv/y).

This finding is based on the average value for each country. An exposure of 5 mSv/y is quite likely considering the statistical variance of these values. A comparison with data obtained from the International Agency for Research on Cancer demonstrated that there is no correlation between the exposure dose and cancer incidence [14]. It was thus concluded that exposure to anything comparable to naturally occurring radiation does not affect cancer incidence or that the impact is statistically inconclusive.

3. Exposure in Fukushima

What people in Fukushima worry most about is their exposure immediately after the accident. According to a basic survey of about 450,000 people in Fukushima Prefecture [15], only 2% of people had an external exposure that exceeded 5 mSv in the four months after the accident, and 94% of them had one of 2 mSv. In addition, only 12 people had an external exposure that exceeded 15 mSv, and the maximum was 25 mSv.

Hirosaki University measured thyroid doses from exposure to iodine-131, which has a half-life of 8 days. The estimated maximum dose was no more than 100 mSv [16]. In the Belarusian city of Gomel, however, 3,400 children aged under seven were reported to have been exposed to a high-level dose of between 2,000 and 40,000 mSv [17]. Thyroid exposure in Fukushima was lower than that in Belarus by two orders of magnitude. Hence, cancer incidence is considered much less likely.

The radiation dose received by people in Fukushima is equal to the average natural radiation exposure in Japan plus an additional exposure caused by cesium. For example, the

reported value for Kawauchi village in June 2014 immediately after decontamination was 4.1 mSv/y, even if the natural radiation exposure is added to the average value of 2.0 mSv/y. (Of course, the majority now have a dose rate of less than 1 mSv/y.) Figure 1 shows that this is almost the same as receiving it in Northern Europe and Eastern Europe.

4. Radiation Exposure from Food Intake and Food Standards

In terms of internal radiation exposure from food intake, it is important to note that the average Japanese male has 7,000 Bq of radioactive material, potassium-40, from food intake and that fish consumption results in an exposure of 0.98 mSv from polonium-210 and other radioactive materials.

Fortunately, food contamination of food products from Fukushima by radioactive cesium is rare thanks to the decontamination of and improvements to farmland. Measurements conducted using whole-body counters recorded a dose of no more than 1 mSv among 99.99% of roughly 250,000 residents in Fukushima Prefecture. The highest dose of 3 mSv was noted for two individuals [15]. International rumors about food products from Fukushima and Japan in general could be largely dismissed if the Japanese government communicated this fact to the world more decisively.

Importantly, other countries have imposed import restrictions based on the misunderstanding that many Japanese food products have been contaminated. This misunderstanding was caused by the assumption of a food contamination rate of 50% by the Food Safety Commission in an attempt to limit the lifelong exposure of the public to 100 mSv at their own discretion if they set rigorous standards such as a limit of 100 Bq/kg. In reality, only 2.5% of the food was contaminated with a dose that exceeded the provisional threshold by the time Ms. Komiyama, the Minister of Health, Labour and Welfare, advised that a new standard should be set to reduce the limit for the annual internal exposure dose from 5 mSv to 1 mSv. An assessment of internal exposure demonstrated an annual dose of 0.019 mSv [18] in Fukushima Prefecture, which is two orders of magnitude lower than the advised level of 1 mSv/y. This provisional standard was considered adequate. However, the new standard led to demands for an even more stringent standard due to the damage caused to the reputation of food products from Fukushima Prefecture and drove residents with small children to evacuate from the prefecture. Meanwhile, the European Commission adopted the following three-pronged standards: 1,000 Bq/kg for food from member countries as recommended by the Codex Alimentarius Commission; 600 Bq/kg for food products from areas affected by the Chernobyl Accident; and the new Japanese standard for food from Japan.

Recently, a proposal has been made to move away from such a fragmented set of standards and establish a unified international standard instead. Japan should take this opportunity.

IV. Conclusions

In this commentary, we discussed decontamination with the aim of recovering from the environmental pollution caused by the nuclear plant accident, which was triggered by the tsunami that occurred following the Great East Japan Earthquake, and the radiation risk communication necessary to facilitate a return of residents in the future.

In terms of decontamination work, we discussed what the decontamination target areas and values were, and most of the work was conducted for a dose rate of 1 mSv/y or more. As a

result, it was found that the long-term target of 1 mSv/y was achieved in many areas of Fukushima Prefecture, except for residential restricted areas and difficult-to-return areas. On the other hand, it should be noted when determining the decontamination policy in the future that Date, which is targeting the decontamination of areas with a dose rate of 5 mSv/y, was able to achieve a dose rate of 1 mSv/y, including the specified evacuation recommendation point of 20 mSv/y.

Radiation risk communication described 1 mSv/y as a level that could be accepted by the public with respect to radiation risk, and revealed that exposure to natural radiation in Northern Europe and other countries is 5 mSv/y. This matter seems to provide a measure for judging radiation exposure. In addition, the public seems to have developed a good understanding through communication in the form of public relations magazines and the lectures that have been held for the people of Fukushima Prefecture so far. However, given that there are still about 100,000 evacuees in Fukushima Prefecture and that their return is not progressing, the author cannot help thinking that there is still a lack of communication. The problem is that the cancellation of evacuation orders has been delayed. This is because there are only two types of conditions for the cancellation of evacuation orders: 20 mSv/y as the evacuation order condition and 1 mSv/y as the long-term target. Of course, the cancellation of evacuation orders is applied taking into account improvements to the living environment, such as improvements to infrastructure and shops, but the importance of radiation is high. The author would like to propose that the level accepted by residents be a reference level for considering the cancellation of evacuation orders and that this level should be set to 5 mSv/y, which is what the exposure to natural radiation is in Europe. In addition, if a special guest in an evacuation order release preparation area can measure in advance the amount of exposure to be considered by using an individual dosimeter, the real dose measured using this individual dosimeter is desirable. However, if this is not possible, an evaluation value based on the air dose rate can be used. It is also expected that this reference level of 5 mSv/y will be considered in the decontamination work scheduled for forests and difficult-to-return areas going forward.

With regard to the disposal of decontamination waste, which is not mentioned in this commentary, the author proposes efforts and concrete plans to gain the understanding of residents because the burden on the final disposal site can be reduced in the future by using the waste as the foundation for roads and seawalls, taking into account the fact that the radiation dose decreases and cesium is strongly adsorbed into the clay crystals contained in the soil and does not dissolve in water. With regard to the construction of a final disposal site for designated waste, the author proposes that we aim to reach an agreement at a stakeholder dialogue meeting, which has been successful in Europe and the United States, in order to realize this kind of policy, rather than a briefing session between government offices and residents as before.

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