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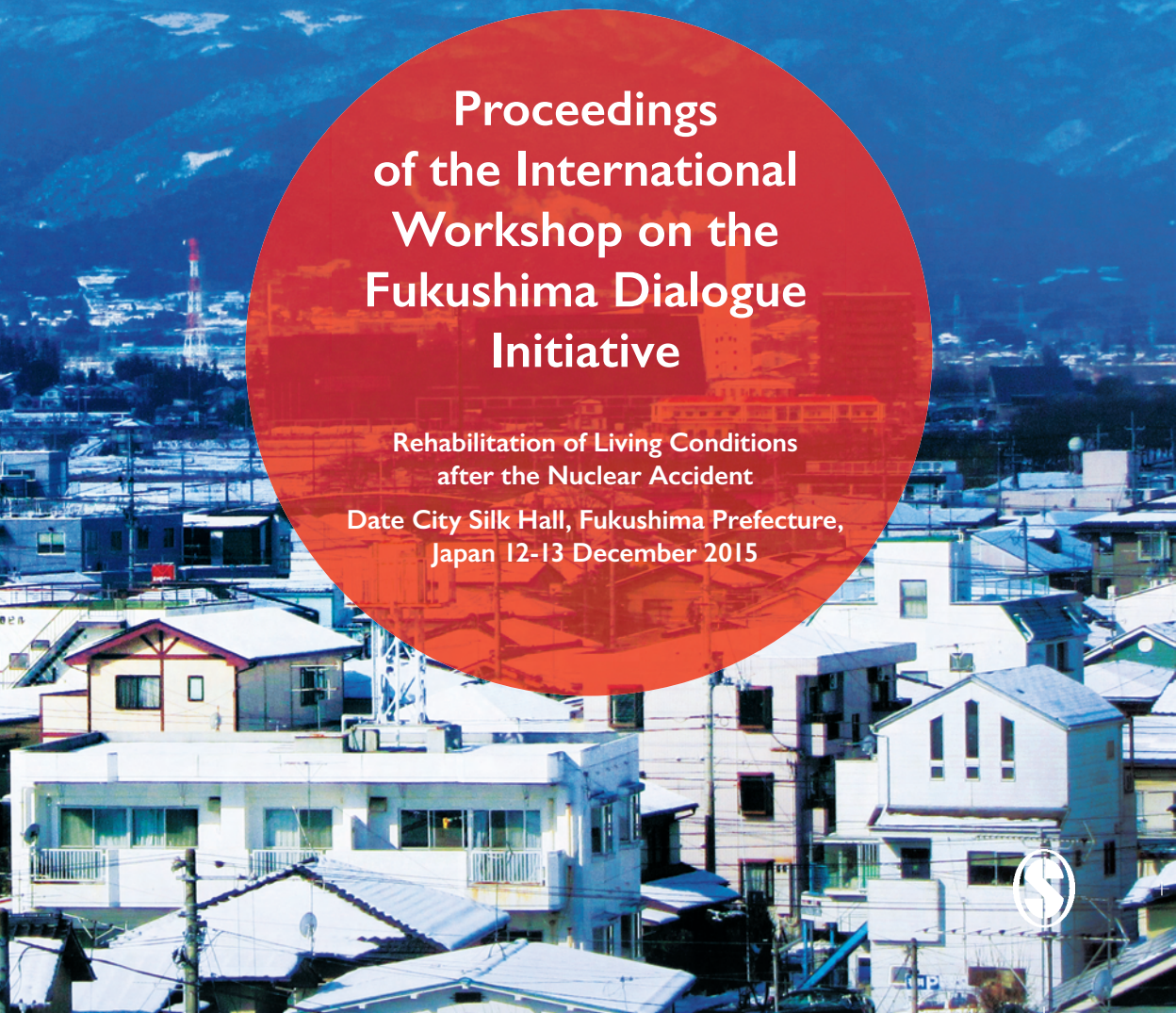
Rehabilitation of Living Conditions after the Nuclear Accident

Date City Silk Hall, Fukushima Prefecture, Japan 12-13 December 2015



On the cover

Fukushima City in February 2012, with Mount Azuma-kofuji and its surrounding mountain range in the background

Photo by Christopher Clement

Annals of the ICRP

Proceedings of the International Workshop on the Fukushima Dialogue Initiative

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Editorial

EXPERIENCES OF FUKUSHIMA

In 2011, the International Commission on Radiological Protection (ICRP) began a series of symposia focused on the system of radiological protection to increase engagement with professionals, policy makers, and the public. An international symposium on the system of radiological protection is now held once every 2 years; the next will be in Paris in October 2017. A key feature of these symposia is the publication of proceedings as special issues of the Annals of the ICRP, so that the messages from the symposia can be shared as widely as possible. Importantly, other than for the first ICRP symposium in 2011, we have been fortunate enough to receive the financial support needed to make these proceedings downloadable at no cost to readers, further broadening the audience.

In recent years, ICRP has also been organising smaller, more focused workshops, seminars, etc., on topics within radiological protection such as ethics, dosimetry, environmental protection, radiation risk, and medicine.

The current publication extends the idea of producing freely available proceedings to the International Workshop on the Fukushima Dialogue Initiative held in December 2015 in Date City, Fukushima Prefecture, Japan.

The workshop was organised by ICRP, hosted by Date City, and held in co-operation with a large and diverse set of organisations: Ethos in Fukushima, French Institute of Radiation Protection and Nuclear Safety*, French Nuclear Safety Authority*, Fukushima Medical University, Fukushima Prefecture, Japan Health Physics Society, Japanese Cabinet Office (Support Team for Residents Affected by Nuclear Incidents), Japanese Nuclear Regulation Authority, Ministry of the Environment of Japan, The Nippon Foundation*, Norwegian Radiation Protection Authority*, OECD Nuclear Energy Agency*, and Radiation Safety Forum Japan (those marked with an asterisk also provided the financial support necessary to make this event a reality, and the resulting proceedings freely available).

The objective of the workshop was to share the experiences and main lessons of the ICRP Fukushima dialogue initiative, focusing on the 12 main dialogue meetings held between November 2011 and September 2015 at various locations in Fukushima Prefecture.

Over 4 years, the dialogue initiative succeeded in transferring experience from communities affected by Chernobyl, facilitating discussions between stakeholders, and helping ICRP to understand the challenges being faced in order to improve future recommendations. It brought together: local residents and professionals; representatives of villages, towns, Fukushima Prefecture, national agencies, non-Government organisations, and other Japanese organisations; representatives of Belarusian, Norwegian, and French organisations with direct experience in managing long-term consequences of the Chernobyl accident; and representatives of international agencies.

Led by ICRP Vice-Chair Jacques Lochard and closely supported by ICRP Main Commission member Ohtsura Niwa and ICRP Scientific Secretary Christopher Clement, the dialogue initiative and the international workshop that capped it off were novel approaches to fulfilling the ICRP mission of promoting radiological protection, with the additional benefit of supporting aspects of the ongoing recovery work in Japan following the accident at Fukushima Daiichi nuclear power plant. This approach allowed ICRP members to gain a depth of understanding that would not have been possible without dedicating significant personal effort over a long period of time. The results are clearly seen in the work of ICRP Task Group 93, chaired by Michiaki Kai, established to update ICRP recommendations on radiological protection in nuclear emergencies and post-accident recovery. The work of ICRP Task Group 94, examining the ethics of radiological protection, has also benefitted greatly, as following the post-accident recovery closely has revealed many key ethical aspects that are more difficult to discern in easier times.

In all, approximately 1000 people participated directly in the Fukushima dialogue initiative; many were local citizens, but many others were from elsewhere in Japan and the rest of the world. This included several ICRP members, including the key players mentioned above, members of Task Groups 93 and 94, and ICRP Chair Claire Cousins, who supported the initiative throughout and participated personally in the final dialogue meeting of this initiative. Many more have been able to learn from the initiative through social media, local media reporting, and information available through the ICRP and Ethos in Fukushima websites.

The hope is that these proceedings will give an even wider audience an insight into some of the experiences and lessons of the initiative, from the perspective of those who participated actively.

Although the formal, multi-stakeholder dialogue initiative has ended, ICRP continues to engage in dialogues related to the accident at Fukushima Daiichi nuclear power plant. These are now led by local organisations, with ICRP playing a strong supporting role. This shift is natural and healthy, both for ICRP and those

who are still dealing with the accident more than 5 years later. There is still much more to learn, and much more to share, to help with recovery from this accident, and to provide the best possible recommendations in case another accident occurs in the future.

Finally, some readers may have been surprised (and hopefully delighted) to see the particularly colourful cover of this issue. The artwork was inspired by the opening image of a web documentary that tells the story of 'Four years of dialogue for the rehabilitation of living conditions in the areas contaminated by the Fukushima accident'. The documentary uses the dialogue as a thread, but the stories are primarily those of people for whom the accident and recovery have been an ever-present and enormous part of their lives in recent years. It was commissioned by the French Institute of Radiation Protection and Nuclear Safety, not by or for ICRP, and so although we cannot endorse it, interested readers are encouraged to navigate to www.fukushima-dialogues.com to see it for themselves.

Christopher H. Clement
ICRP Scientific Secretary
Editor-in-Chief

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Guest Editorial

THE GENESIS OF THE ICRP DIALOGUE INITIATIVE

The Spring 2011 meeting of the Main Commission of the International Commission on Radiological Protection (ICRP) was scheduled for mid-April 2011 in Seoul, Korea. It goes without saying that the Fukushima accident, which had occurred just a month before, affected the agenda for this meeting. Many discussions were devoted to trying to understand the implications of the accident in terms of radiation protection, to reflect on actions which the Commission could undertake to help the ongoing situation in Fukushima, and to learn lessons from the accident vis-à-vis the ICRP system of radiological protection. This was greatly facilitated by the initiative, taken by Main Commission member Ohtsura Niwa a few days before the meeting, to organise a special session with Japanese colleagues invited to Seoul in view of the geographical proximity, and a videoconference with officials of Tokyo Electric Power Company.

The atmosphere of the meeting contrasted sharply with the relaxed ambience that usually characterises gatherings of the Main Commission members. We were all deeply concerned about the extremely complex situation that was facing the population, the professionals, and the authorities. I will never forget the arrival of the Japanese delegation to the meeting room where the special session was held. Their faces were serious and tense. One could feel the weight on their shoulders. Among them was Dr Kazuko Ohno from Kyoto College of Medical Science, the only woman in the delegation, dressed in an impressive pink kimono. With her choice of clothing, and the dignity and pride she displayed, she revealed how the accident had shaken the deepest roots of her country.

On the sidelines of the Main Commission meeting, discussions on the consequences of the accident continued during lunches generally taken together as a group, and during the evenings in small groups in local restaurants. On several evenings, Niwa, ICRP Scientific Secretary Christopher Clement, and I continued the day's discussions late into the night. Niwa, aware of my long involvement in the Belarusian territories affected by the Chernobyl accident in the context of the Ethos Project and the Core Programme in the late 1900s and the 2000s, questioned me constantly about the measures taken at the time to reduce the consequences of the accident. He was also very interested to know how the people had reacted at the time of the

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

accident and what is the situation today in the affected territories. Despite my efforts to answer his questions, he admitted that he found it difficult to fully understand the situation. Once again, I realised the difficulty of transmitting the experience of living in a contaminated environment to radiological protection colleagues who had never been confronted with residents from such areas. Finally, I suggested to Niwa and Clement that a mission to Belarus should be organised so that they could see first-hand the living conditions in the affected areas.

Due to various constraints on all sides, the Belarus trip could not be scheduled until the end of September 2011. During the summer, there were many exchanges between the three of us. Niwa visited Fukushima Prefecture on several occasions and informed us of developments in the affected areas. He also kept us informed of the actions of the public authorities, and of the many debates that marked this delicate period following the initial phase of the emergency.

In June 2011, many members of the Commission received invitations to participate in the International Expert Symposium in Fukushima on Radiation and Health Risks, organised and supported by the Nippon Foundation and Fukushima Medical University, on 11 and 12 September, the 6-month anniversary of the earthquake and tsunami. Thirty-one international experts were invited to Fukushima City, including 16 members of ICRP, including Niwa, Clement, and I. The meeting was also attended by many Japanese experts already working in Fukushima, including Shunichi Yamashita of Nagasaki University, who had been appointed as the Fukushima Prefectural Radiation Health Management Adviser just after the accident, and who became the Vice-President of Fukushima Medical University the following summer; Toshimitsu Homma of Japan Atomic Energy Agency, who had been very involved in the management of the emergency phase of the accident; and several experts from Fukushima Medical University. Beyond the scientific and technical considerations presented and discussed during the various sessions, and the visit to the devastated Fukushima power station that followed, this symposium was a welcome opportunity to meet with many Japanese colleagues involved in managing the consequences of the accident. However, regrettably, it was not possible for Clement and I to meet residents from the most affected areas on this occasion.

Returning to Tokyo, Niwa arranged a meeting in the lobby of a hotel with Jun Ichiro Tada, a member of the non-goverment organisation (NGO) Radiation Safety Forum Japan, chaired by Shunichi Tanaka who was engaged in decontamination works in Date City. Tada introduced me to the decontamination work of individual homes that he was undertaking with the assistance of the residents. He showed me many pictures to illustrate his point, and I noted the presence of people, including youngsters, taking measurements or helping the decontamination team. Referring to my experience with Chernobyl, I underlined the importance of involving the inhabitants of the affected areas in the rehabilitation of their living conditions, and encouraged Tada to continue the efforts of his NGO in this direction. Tada told me about the

administrative constraints and the difficulties he experienced cooperating with the various stakeholders whom he had to face to carry out his work. I underlined the fact that we had encountered the same obstacles in Belarus, and that this state of affairs was not specific to the Japanese situation. The Chernobyl experience in Belarus, and in Norway where the Sami people had been severely affected, had shown that dialogue among all stakeholders was the only realistic way to overcome misunderstandings and antagonisms, and to gradually encourage the involvement of the affected population in actions to improve the situation. I noted in passing that this was clearly emphasised in the Commission's recommendations on the protection of people living in long-term contaminated areas after a nuclear accident (ICRP, 2009). This led to a discussion on how the dialogues in the villages of Belarus had been organised and conducted more than a decade ago.

In hindsight, this impromptu exchange with Tada appears to me to be the starting point of the process, which led us to organise the first ICRP dialogue meeting in Fukushima only a few weeks later. Meanwhile, Niwa, Clement, ICRP Committee 4 member Michiaki Kai, and I ended up in Minsk at the end of September 2011 to start a week-long visit to the contaminated areas of Belarus. We first met with national authorities and experts in the capital, and then went to Bragin District, adjacent to the 30-km exclusion zone around the Chernobyl plant, to meet local authorities and professionals as well as the residents with whom I had worked for 5 years in the framework of the Core Programme in the second half of the 2000s. The mission ended with a visit to the Research Institute of Radiology Research in Gomel, where we were presented with a detailed overview of the protective actions implemented in the contaminated territories.

The narrative of the residents of Bragin District on the dialogues organised by the French experts, and their involvement in the rehabilitation of their living conditions with the cooperation and support of local authorities and professionals, finally convinced my colleagues to try a similar approach in Fukushima Prefecture. Back in Japan, Niwa, with the help of Tada and Yamashita, contacted various representatives of local communities, as well as experts and professionals involved in actions to improve the radiological situation in Fukushima Prefecture, to find out if they would be interested in participating in a meeting to present their actions and to interact with other participants. Several responded positively, and gradually a programme took shape. From the outset, we thought it would be important to involve representatives from Belarus and Norway to testify about their actions in their own countries following the Chernobyl accident, as well as national and local media to ensure the transparency of the process. One important element for the success of the meeting with foreign participants and local residents was simultaneous interpretation, so two highly capable interpreters, Kanae Hirano and Kimiyo Machida, were recruited to perform this task. A key point was the title of the meeting. The term 'dialogue' was obvious but it was also necessary to determine its object. After several e-mail exchanges, we adopted the title 'Dialogue on the rehabilitation of living conditions

after the Fukushima accident' to make it clear that the issue at stake was the well-being of the inhabitants of Fukushima Prefecture, and not only their fight against radiation.

Obviously, one important point related to the financial aspects of the meeting. It was necessary to quickly find funding to support the travel expenses of some participants, and the simultaneous translation of the presentations and discussions. After we had each explored a few possible avenues, I ended up asking the organisations that had supported projects in Belarus in the past: the French Institute of Radiation Protection and Nuclear Safety; the Norwegian Radiation Protection Authority; the French Nuclear Safety Authority; and the Committee of Radiation Protection and Public Health of the OECD Nuclear Energy Agency. All responded positively without hesitation, and it is important to underline that they continued their unfailing support for 4 years, covering all 12 of the ICRP dialogue meetings. Fukushima Prefecture, Radiation Safety Forum Japan, and Fukushima Medical University also contributed.

The first ICRP dialogue meeting took place in a meeting room in Fukushima Prefecture on 26 and 27 November 2011 in the presence of 40 participants. Among them were the mayors of the villages of Iitate and Kawauchi, representatives from Date City, the NGOs Radiation Safety Forum Japan and Greenpeace, several local health and education professionals, and experts from national organisations and universities. Foreign participants came from Belarus, Norway, and France. Chaired and moderated by ICRP, this first dialogue meeting was classically structured around presentations followed by discussions in the form of round tables. Although the exchanges took place in a rather warm atmosphere with an attentive audience, a high level of tension was perceptible among the Japanese participants. They were clearly divided between incredulity and disarray on the one hand, and hope on the other, depending on whether the complexity of the situation in Fukushima or the progress made in Chernobyl was mentioned. The testimony of the Belarusians and the Norwegians undoubtedly played a decisive role in the dynamics of the meeting, certainly not unrelated to the desire to continue exchanges beyond this first ICRP dialogue meeting, which gradually emerged during the discussions. Quite naturally, the participants agreed with the idea suggested by ICRP to prepare a final declaration, with the proposal to pursue and broaden the dialogue adopted unanimously with a few abstentions.

It turned out that the day after the first ICRP dialogue meeting, the Ministry of the Environment was organising a public hearing as part of a series of sessions on the management policy of the Fukushima accident. Clement and I made presentations of the ICRP recommendations and the Belarussian experience. The presentations were well received by the Minister and others present, and raised quite a few questions. The meeting with Minister Hosono was also an opportunity to inform him about the dialogue meeting that had been held on the preceding day, and to transmit the final declaration.

Participation in the public hearing had unexpected consequences for the continuation of the dialogue. Back in France, in early December 2011, I received a message from a Japanese man I did not know named Kota Nakahira, stating that he was translating my presentation and asking me for an explanation about a particular point. I responded immediately as best I could, and received a thank you message in return, which also indicated that the efforts of the Commission to convey the experience of the past were very helpful in overcoming the present situation. In response to this second message, I expressed my feelings about the evolution of this situation, but also asked him who he was and what his involvement was with Fukushima. I learned that he was an engineer in the automotive sector, residing near Tokyo, and that he was not directly involved with the accident but was helping friends living in Fukushima who had to face many 'discordant voices'.

Our exchanges, which continued at a steady pace, allowed me to send Nakahira several comments on the ICRP recommendations, as well as material concerning the Ethos Project and the Core Programme. I understood that he was part of a group of volunteers from different regions of Japan and abroad translating documents and exchanging them via Twitter to support the actions of Mrs Ryoko Ando, a resident of Iwaki City who was particularly interested to know more about the Chernobyl experience. The announcement on 9 December 2011 of the launch of the site 'Ethos in Fukushima' by Mrs Ando's group, and the request to post my messages there, was not only a huge surprise for me but also a moment of great emotion. The Ethos Project had sometimes experienced severe criticism; the fact that it had served as a source of inspiration for citizens of Fukushima was an unexpected, symbolic recognition of the co-expertise approach undertaken 15 years earlier with the villagers of Belarus.

In the wake of these exchanges, it was clearly logical to invite Mrs Ando and her contacts to participate in the second ICRP dialogue meeting, then in preparation. On 26 December 2011, Niwa announced that Date City had agreed to host the second ICRP dialogue meeting by the end of February 2012. A few days later, he informed Clement and I that members of Ethos in Fukushima had contacted him to express their wish to participate. January 2012 was devoted to building the dialogue programme. With the help of Tada, Niwa made contacts with many people from Fukushima. He also went to Fukushima Prefecture to visit some of them personally. Progressively, a series of interventions was established, including many testimonies of citizens, particularly farmers of the village of Iitate, badly affected by the contamination.

Finally, the second ICRP dialogue meeting was held on 25 and 26 February 2012. On the first day of the meeting, it snowed abundantly in Fukushima Prefecture and many participants were delayed. This was the case for Mrs Ando, who appeared in the meeting room after a car journey delayed by 6 h! As with the previous dialogue meeting, the atmosphere was warm. However, this did not prevent several

participants from expressing their anger at the complex situation with which they were confronted, and even their disapproval of the actions undertaken by the authorities. Farmers were particularly upset about the Japanese Government's decisions regarding the marketing of products from Fukushima. That said, it was perceptible that the objective of the exchanges was to seek ways to progress, encouraged by the new testimonies of the Belarusian and Norwegian participants. This was reflected in the concluding session calling for better protection of children, and to further mutual understanding and cooperation among all stakeholders. Finally, it should be noted that all sessions of the dialogue meeting were videotaped by Ethos in Fukushima, and many observers used Twitter extensively over the 2-day meeting to communicate with the outside world.

With the success of the second ICRP dialogue meeting, a dynamic was established, and the idea to deepen the dialogue between the agricultural producers of the prefectures and the consumers of the region and beyond quickly took shape. It was then decided to hold the third ICRP dialogue meeting by the end of July 2012, again in Date City. In March 2012, Ethos in Fukushima proposed to post all the presentations and debates of the previous dialogue meeting on its website, and to ensure the video recording of future dialogue meetings to promote their dissemination with full transparency. This type of approach was quite unusual for the Commission, and it took some time and several exchanges of e-mails to finally conclude that this proposal was acceptable as long as the information was also relayed on its own website. For the third ICRP dialogue meeting, Ethos in Fukushima also suggested organising an invitation via Twitter for consumers living outside Fukushima Prefecture to talk about their apprehensions and attitudes towards food products from Fukushima, and engage in a dialogue with local producers.

In view of the forthcoming confrontation between producers, consumers, and retailers on the issue of food products, which was a hot topic in Japan at that time, I proposed a structured approach to the discussions. Drawing on a technique we used widely in Belarus to facilitate discussions on complex and conflicting subjects, I suggested that two sessions should be organised during the dialogue meeting when participants selected in advance would have the opportunity to express their own views and to react to those of others in a fair way. This approach had previously been shown to be effective for developing common understanding between different stakeholders, and identifying processes and actions satisfactory to all involved participants to improve the situation at stake.

The third ICRP dialogue meeting was held on 7 and 8 July 2012 in the presence of several participants from Tokyo, Yokohama, and Kyoto, who came as expected to share their testimonies. The structured discussions were very lively, and many issues emerged which were not foreseen in the programme. These included, for example, the tradition of picking mountain vegetables (the so-called 'sansai'), and the very sensitive question of discrimination against the inhabitants of Fukushima, especially the

girls. This topic led the Mayor of Date City, Shoji Nishida, who was among the participants, to engage in a relevant intervention that captured the spirit of the dialogue, and was reported in the newspapers the following day. With this third ICRP dialogue meeting, the dialogue had reached maturity in terms of organisation. Many issues related to the rehabilitation of living conditions in the affected territories had been identified, and the process could be pursued in different municipalities as was suggested by Mayor Nishida when Niwa, Clement, and I met him the day after the meeting to thank him for his support. On this occasion, the Mayor assured us that the doors of Date city hall would always be open to welcome the ICRP dialogue meetings. Moreover, during the summer, Niwa moved to Fukushima Prefecture and devoted a large part of his activities to visiting stakeholders and building the programmes for the next meetings. This support obviously played a key role in the success of the nine dialogue meetings that followed.

In retrospect, when the decision was taken to organise the first ICRP dialogue meeting, we had no idea that this initiative would last for 4 years. Although it benefited from a series of unexpected positive events, it clearly responded to a latent expectation of many stakeholders: that of opening a space for the plurality of points of view concerning the Fukushima accident and its material and human consequences to be expressed, and for stimulating the willingness to act to overcome them. However, without the foresight and determination of all those who contributed directly or indirectly to the organisation and the conduct of the ICRP dialogue meetings, this expectation would have remained wishful thinking. To conclude, I would like to thank all these people from the bottom of my heart.

Jacques Lochard
ICRP vice-chair

REFERENCE

ICRP, 2009. Application of the Commission's recommendations to the protection of people living in long-term contaminated areas after a nuclear accident or a radiation emergency. ICRP Publication 111. Ann. ICRP 39(3).

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Measurement and communication: what worked and what did not in Fukushima

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Abstract–The accident at Fukushima Daiichi nuclear power plant contaminated the soil of densely populated regions in Fukushima Prefecture with radiocaesium, which poses risks of internal and external exposure to the residents. However, extensive whole-body-count surveys have shown that internal exposure levels of residents are negligible. In addition, data from personal dosimeters have shown that external exposure levels have decreased, so the estimated annual external dose of the majority of people is <1 mSv in most areas of Fukushima. Despite these reassuring data, many problems remain in Fukushima, many of which are psychosocial rather than radiological. This article will discuss the roles of measurement and communication in the postaccident phase based on 5 years of experience.

Keywords: FDNPP accident; Internal exposures; External exposures; ICRP *Publication 111*

1. INTERNAL EXPOSURES

After the accident at Fukushima Daiichi nuclear power plant (FDNPP), there was considerable confusion in the assessment of internal radiation exposures of Fukushima residents. Nowadays, it is known that the internal exposure risks of Fukushima residents are negligible (Hayano et al., 2013; Sato et al., 2013; Miyazaki et al., 2014; Hayano, 2015a). However, this does not mean that the problems are over; in particular, families with children remain unconvinced.

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

1.1. Initial confusion: are the numbers correct?

The author started to collaborate with medical doctors in Fukushima in Summer 2011, when Dr Tsubokura of Minamisoma Municipal General Hospital (MMGH) and Dr Miyazaki of Fukushima Medical University made contact on Twitter (@hayano), and asked for help with the evaluation of data they had obtained using a chair-type whole-body counter (WBC) in July 2011. This WBC was brought to MMGH, located 23 km north of FDNPP, at the end of June 2011. This was the first WBC unit installed in Fukushima Prefecture after the accident, and was provided on loan for 3 months from Ningyo-toge Environmental Engineering Centre of the Japan Atomic Energy Agency.

Fig. 1 (left) compares gamma-ray spectra obtained with no one sitting on the WBC chair (black) and with a high-risk subject sitting on the WBC chair (red). The radiocaesium peaks are lower when a subject is sitting in the chair compared with background radiation alone. This is because this type of WBC does not have sufficient shielding, and the human body partially shields the environmental background radiation. In 2011, it was very difficult to assess the degree of internal contamination of Minamisoma residents correctly using such data. Later, the data were analysed successfully, and the committed effective dose to adult high-risk residents of Minamisoma was estimated to be 0.35 mSv at most (Hayano et al., 2014b; UNSCEAR, 2015).

Fig. 1 (right) also shows a problem with a chair-type WBC encountered in Fukushima city in late 2011. A non-governmental organisation measured approximately 1000 residents of Fukushima city, and data suggested an average body burden of approximately 20 Bq kg^{-1}. However, this was due to improper subtraction of background radiation.

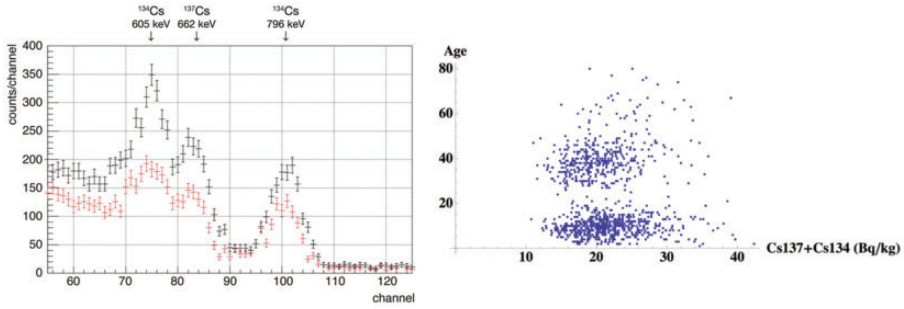

Fig. 1. (left) Typical gamma-ray spectra measured at Minamisoma Municipal General Hospital in July 2011. Black points represent the background spectrum, and red points represent the data for subjects. Source: Hayano et al. (2014b). (right) Distribution of radiocaesium body burden (Bq kg^{-1}) vs age among residents of Fukushima city in December 2011. The average appears to be approximately 20 Bq kg^{-1}, but this was subsequently found to be due to incorrect background calibration.

As these examples show, when the whole environment is contaminated, chair-type WBCs with insufficient shielding are difficult to operate. This situation was much improved using the FASTSCAN (Canberra Industries Inc., Meriden, CT, USA) with 4 tons of shielding. The FASTSCAN measures a subject in a standing position in 2 min and became a de-facto standard; the first unit was installed at MMGH in September 2011, the second was installed at Hirata Central Hospital (45 km south-west of FDNPP) in October 2011, and there are now more than 50 units throughout Fukushima.

However, the data shown in Fig. 2 from the FASTSCAN at Hirata Central Hospital reveal a further problem. There was a sharp decrease in the percentage of radiocaesium detected in March 2012, when all subjects were asked to change into hospital gowns for scanning; this suggests that the radiocaesium detected before March 2012 must have been mainly due to contamination on clothing.

1.2. Body burdens of Fukushima residents are lower now than in the 1960s

After correcting for this (and other minor problems), more than 30,000 people were scanned at Hirata Central Hospital in 2012; 100% of children and 99% of adults were below FASTSCAN's detection limit of 300 Bq per body (Hayano et al., 2013). For comparison, the body burden of an adult male in Japan in 1964 was 535 Bq per body (Uchiyama et al., 1996).

When measuring a large number of people for internal contamination, data show a log-normal-like distribution, i.e. a long tail (Hayano, 2015a). However, the percentage of people with a body burden exceeding a few thousand Bq per body in 2012

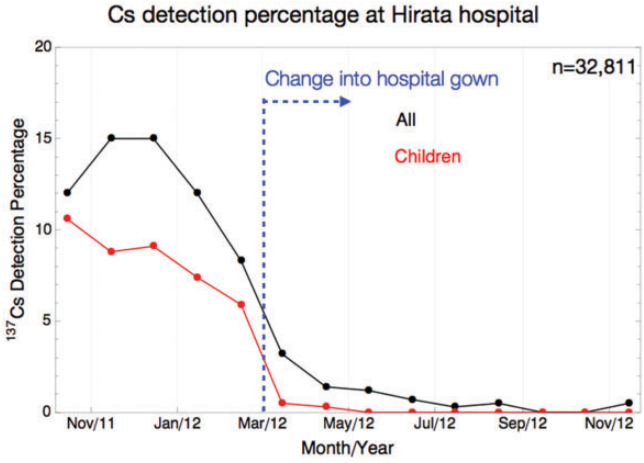

Fig. 2. Percentage of radiocaesium detected at Hirata Central Hospital. After March 2012, when all subjects changed into hospital gowns, the percentage decreased considerably. Source: Hayano et al. (2013).

was very small (approximately 0.01%) at Hirata Central Hospital. In these cases, a germanium semiconductor detector was used to measure the foodstuffs they consumed, and these individuals reported that they regularly ate items for which contamination advisories have been issued (e.g. wild mushrooms, wild boar, freshwater fish, etc.). They were advised to avoid consuming such foodstuffs, whereupon their body burdens decreased at rates consistent with the biological half-life. In this sense, measurement and communication did reduce the internal radiation exposures of those people. However, in retrospect, as the committed effective doses of these individuals were below $1\,\mathrm{mSv\,year^{-1}}$, strict control may not have been necessary.

1.3. The BABYSCAN story

Data show that internal doses have always been lower than external doses in Fukushima since the FDNPP accident. However, this does not match the risk perceptions of a large proportion of Fukushima residents, especially parents raising children. The geometry of FASTSCAN is not suitable for measuring small children, who cannot stand for 2 min, and this made the situation more difficult as parents wished to have their children (babies) scanned directly.

This situation prevailed until early 2013, when the author decided to develop a WBC that was optimised for measuring small children (BABYSCAN). This was designed not just as a high-sensitivity WBC for small children, but also as a communication device; it was expected to play an important role as a communication tool to facilitate interactions between medical staff and residents.

When using the BABYSCAN, the baby lies on a bed for the 4-min scanning time. The whole unit is heavily shielded with 6 tons of iron, but its exterior is covered with an ergonomically designed plastic cover, giving it a friendly, reassuring look. The detection limit is <50 Bq per body, making it possible to quantify the amount of naturally-occurring potassium-40 in the body of a newborn baby (Hayano et al., 2014a).

The first BABYSCAN was introduced at Hirata Central Hospital in December 2013, the second was introduced at Tokiwakai Hospital in Iwaki city in May 2014, and the third was introduced at MMGH in July 2014. In 2014, more than 2700 children were scanned using these three units, none of whom were found to exceed the detection limit (Hayano et al., 2015b).

This was not at all surprising to the author. However, the large difference in risk perceptions among parents living in different regions of Fukushima, revealed by analysing the pre-scan questionnaire completed by parents, was unexpected. For example, in Minamisoma, 57% of families avoid consumption of tap water, local rice, and local vegetables. In contrast, in Miharu town, some 50 km west of FDNPP, the corresponding figure is 4%, indicating that most families have resumed 'normal' life (Hayano et al., 2015b). The protective measures taken by parents in Minamisoma do not visibly contribute to lowering the risks, as all children are below the detection limit. These findings illustrate that the current problems are psychosocial rather than radiological.

2. EXTERNAL EXPOSURES

From Summer 2011, many Fukushima municipalities commenced individual external dose monitoring for members of the public living in existing exposure situations, although such large-scale measurements of the general public have not been considered mandatory in conventional radiation protection schemes. The measurements typically used individual dosimeters (radiophotoluminescence glass dosimeters), and targeted pregnant women and children in most cases. For example, in Fukushima city, the percentage of survey participants whose estimated additional dose was below 1 mSv year^{-1} (i.e. after subtracting the pre-accident natural background of 0.54 mSv year^{-1}) was 51% in Autumn 2011, 89% in 2012, 93% in 2013, and 96% in 2014. Correspondingly, the estimated average additional exposure for children aged $\leq$15 years also decreased; 1.04 mSv year^{-1} in 2011, 0.56 mSv year^{-1} in 2012, 0.44 mSv year^{-1} in 2013, and 0.32 mSv year^{-1} in 2014.[1]

The results in other municipalities are similar. External exposure doses are lower than expected by most people, but are slightly higher than internal doses as the latter are almost negligible.

2.1. 'D-shuttle' for measurement and communication

These measurements are useful in assessing the overall situation, but are less informative when using the results at individual level. For individual measurements, a badge is typically worn for 3 months to determine the estimated 'additional' dose per 3 months. This is not useful when relating the dose received to behaviour.

In Spring 2013, the author, together with Dr Miyazaki, started to use a low-cost electronic personal dosimeter, the 'D-shuttle',[2] to measure individual external doses and to communicate the results with the survey participants. This device records integrated hourly $H_p(10)$ dose, and records the data with time stamps. The results can be read out using a computer interface.

2.2. D-shuttle data of French high school students

Fig. 3 shows the D-shuttle data of eight students and four teachers who visited Fukushima from France in Summer 2015. The dosimeters were sent to France before the visit commenced. Time-stamped data from the 12 dosimeters were read out, and are plotted overlaid in Fig. 3. The abscissa range covers 7 days of their visit. The D-shuttle uses a small (2.7 mm $\times$ 2.7 mm) silicone sensor for gamma-ray detection; as such, sensitivity is not particularly high (10 counts per 0.1 μSv h^{-1}). This explains the relatively large fluctuations seen in the graphs, but the results of all dosimeters were consistent within statistical errors.

The first peak on 2 August 2015 was due to x-ray screening of hand baggage at Charles de Gaulle airport. During the flight from Paris to Tokyo, the exposure level remained very

[1]Data from Fukushima city home page (in Japanese): http://www.city.fukushima.fukushima.jp/soshiki/71/hkenkou-kanri14022601.html (last accessed 20 July 2016).
[2]Codeveloped by the National Institute of Advanced Industrial Science and Technology and Chiyoda Technol Corporation.

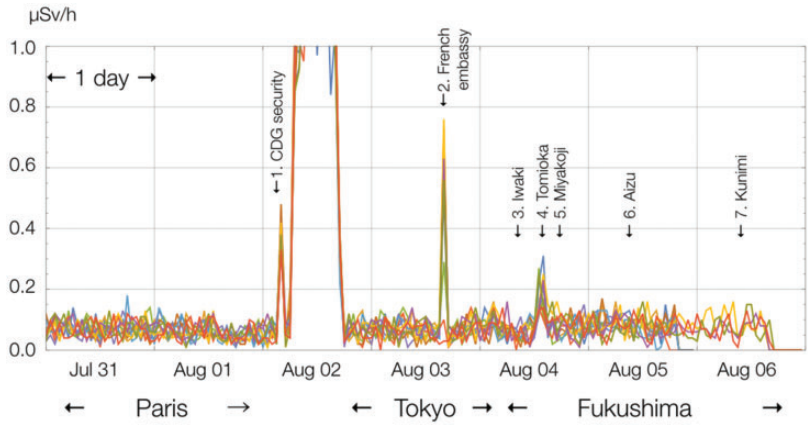

Fig. 3. D-shuttle data of eight students and four teachers who visited Fukushima from France in Summer 2015.

high due to cosmic rays. On 3 August 2015, the party was invited to the French Embassy in downtown Tokyo, and the dosimeters were x-rayed again (Peak No. 2).

On 4 August 2015, the party drove towards Fukushima along the Pacific coastline, through Iwaki city, and went to the railway station in Tomioka, 10 km south of FDNPP, which was washed away completely by the tsunami (Peak No. 4; note that the evacuation order has not yet been lifted in Tomioka town). Next, they visited the Miyakoji district of Tamura city, within the 20-km zone, which is the first district for which the evacuation order was lifted (April 2014). As shown, there was no visible peak in Miyakoji (Peak. No. 5).

The French students stayed in the homes of students of Fukushima high school on the nights of 4 and 5 August 2015, and visited Aizu on 5 August 2015 (Aizu is distant from FDNPP and is known to be less contaminated than Fukushima city). On 6 August 2015, they visited a peach farmer in Kunimi town, in the northern part of Fukushima Prefecture.

The data clearly show that the individual dose rates were similar in Paris, Tokyo, and various parts of Fukushima (excluding the evacuation zone).

2.3. The D-shuttle project: comparison of individual doses of high school students

The students of Fukushima high school were interested in the capabilities of the D-shuttle, and were motivated to use it to compare the individual doses of high school students living in various parts of Fukushima Prefecture in order to better understand their own exposure situation. This project, termed the 'D-shuttle project', was later expanded to include high schools in Japan outside of Fukushima Prefecture, and high schools in France, Poland, and Belarus.

Each participant, 206 in all, wore the D-shuttle for 2 weeks in 2014, and kept a journal of their behaviour (school, home, etc.). Based on the 2-week measurements, the annual exposure of each participant was estimated, and the resultant

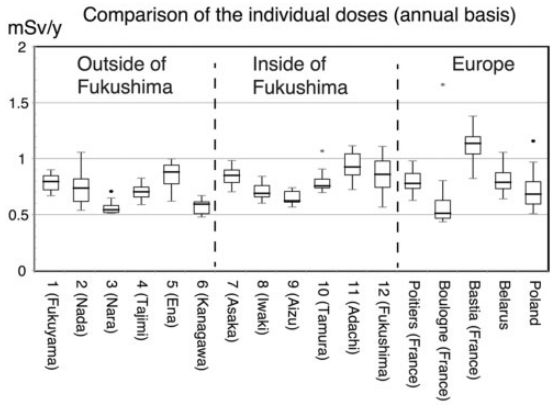

Fig. 4. The 2-week integrated individual dose was converted to annual dose (mSv year^{-1}), presented in box-and-whisker diagrams. Source: Adachi et al. (2016).

distributions are compared in Fig. 4 in the form of box-and-whisker diagrams (Adachi et al., 2016). Fig. 4 confirms the results shown in Fig. 3 (i.e. the external doses in Fukushima, including natural background radiations, are not very different from those in other parts of Japan or in Europe).

Adachi et al. (2016) published these findings online at the end of November 2015, and attracted considerable media attention in Japan and worldwide; the article had been downloaded more than 65,000 times by Summer 2016.

2.4. 'Reference level' in the case of external exposures

When, as in Adachi et al. (2016), the measured dose is low (e.g. additional dose < 1 mSv year^{-1}), measurement and communication work as for internal exposure measurement. Repeated measurements and discussion can result in reassurance, although this may take a long time. However, if the measured external dose is high, the situation is different and more difficult.

In the spirit of ICRP's reference level (ICRP, 2009), if the measured dose is high, countermeasures need to be taken to reduce the dose below the reference level [within the 'as low as reasonably achievable' (ALARA) principle]. In the case of internal exposure, this can be done by advising/deciding not to eat a certain contaminated food, as discussed previously. This can be done at the individual level.

In the case of external exposure, there is little that an individual can do to reduce the dose level. For example, asking for additional decontamination may not be easily granted, as massive decontamination works have already been undertaken according to government-defined instructions in most parts of Fukushima. If the dominant contributor to the integrated dose is work undertaken in an orchard, should the individual stop working in the orchard? This would deprive him/her of a source of income and makes little sense.

As such, the concept of reference level does not work in practice when the dominant exposure is external. This is the case in Fukushima.

3. CONCLUSIONS

Despite initial confusion, dose measurements in Fukushima, both internal and external, are now well under control. Huge amounts of data have been collected, and have been disseminated one way or the other[3] (sometimes not easy to find, particularly for those who do not read Japanese). It has been well established that internal radiation exposures due to radiocaesium are negligible, and external exposures (other than in the evacuation zone) are not very different from those in other parts of Japan or other countries. Unfortunately, awareness of these results is poor within Japan, let alone worldwide.

Face-to-face communication of the results is important to regain the trust of residents living in contaminated areas. This is a slow process but seems to be the best way to achieve this goal. When, in rare cases, internal dose is found to be high, this can be lowered by avoiding consumption of the particular contaminated foodstuff.

However, when external exposure is dominant and measurements show that the dose is relatively high, there is little that the stakeholders can do. In this case, communication is of little benefit, unless there is a clear way to reduce the dose without sacrificing the individual's quality of life. Over the past 5 years, ALAP (as low as possible) has become the norm in Fukushima, and it appears to be difficult to make decisions according to the ALARA principle, both at the level of the individual or at the level of authorities.

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Four and a half years of experience of a clinician born and raised in Fukushima: discrepancy found through dialogues and practices

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Abstract–Many initiatives to measure the internal and external exposures of the residents of Fukushima have been undertaken since the accident at Fukushima Daiichi nuclear power plant. However, residents have had few, if any, opportunities for face-to-face explanations to understand the meaning of such measurements. Although the personal data of tens of thousands of residents were collected, these data were not analysed adequately, and were therefore not used to implement large-scale programmes to manage/reduce exposures. One of the lessons learned from the Fukushima accident is that it is imperative for the government to implement these measures for radiation protection, and to build an effective functioning service for the residents. The author, as a physician from the region, has worked as an explainer/interpreter of exposure dose measurements to individual residents. Another lesson learned from this experience is that local medical and health professionals can contribute to building a public system for radiation protection, by acting as 'liaising officers' to connect residents, the authorities, and experts from outside the region. This paper describes the author's experience and lessons learned in the hope that this information will be useful in the event of a future accident.

Keywords: Existing exposure situation; Whole-body counter; Liaisons; Individual dosimetry; Radiation health management

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

1. LOOKING BACK ON PAST EXPERIENCES AROUND PRESENTATIONS AT THE ICRP DIALOGUE SEMINARS

The author was a professional diagnostic radiologist before the Great East Japan Earthquake and the accident at Fukushima Daiichi nuclear power plant (FDNPP) caused by the tsunami in the immediate aftermath of the earthquake. After assisting in radiation emergency medicine in response to the accident at FDNPP, the author began to engage actively in the multiple-site sharing of information regarding management of the accuracy of whole-body counters (WBCs), which began to be introduced into Fukushima Prefecture in large numbers in the latter half of 2011, and providing information to local governments that were contemplating introducing WBCs. In 2013, the author started to measure and explain individual external exposure doses to residents, particularly those living in areas adjoining the evacuation zones. This was made possible using new features of a new generation of electronic personal dosimeters developed after the Great East Japan Earthquake. One of the themes that emerged through these activities was the issue of how government authorities, which possess vast amounts of data on individual exposure doses, should use such data.

During this early stage, the author was given the opportunity to present at the first ICRP dialogue seminar, held in Fukushima on 26 and 27 November 2011 (although this presentation was not part of the initial agenda). The author reported on the efforts made by Fukushima Medical University in radiation emergency medicine as part of the early-stage response to the accident at FDNPP, and on how he began sharing knowledge about radiation and the state of contamination with the residents of Fukushima. The author's conclusion at the time, less than 1 year after the accident at FDNPP, was that there was an urgent need to build a platform on which the residents and government could co-operate to devise appropriate measures, based on accurately measured and assessed data (i.e. set up a community-based infrastructure to share and use such data). In his presentation, the author also noted that merely communicating the accurately measured radiation doses (i.e. measurements) to residents is insufficient. As the concepts of exposure dose and radiation are unfamiliar to the general public, each community needed someone to explain what the measured doses, such as Bq $body^{-1}$, meant to residents. From the onset, it was clear that there was no process in place to properly interpret and communicate the results to individual residents to enable them to use the data in their lives. In other words, although there was a need for a process of 'explaining/interpreting' the data, such a process was missing. The serious lack of explainers and interpreters of measured radiation doses, particularly individual dose measurements, continues today.

At the third ICRP dialogue seminar, held in July 2012, the author gave a presentation entitled 'Whole-body counting of Fukushima inhabitants'; this summarised the results of WBC screening tests that had been conducted for approximately 15 months after the accident at FDNPP (Miyazaki, 2012). The WBC screenings continue to be implemented in Fukushima to this day. However, Fukushima Prefecture has only published the number of recipients and their respective committed effective doses of radiocaesium by millisievert (mSv) bracket. Therefore, almost all subjects

are classified as '<1 mSv'. It is known that approximately 30,000 Bq of radiocaesium has to be detected from a person's body in WBC screening to assume that internal exposure of radiocaesium through chronic ingestion during the immediately preceding year exceeds a committed effective dose of 1 mSv (equivalent to annual ingestion exceeding 75,000 Bq). In Fukushima Prefecture, however, very few subjects exceeded the WBC's lower detection limit (approximately 200–300 Bq body^{-1}), even at the time of the presentation, and for most of those who exceeded the detection limit, their levels of exposure were a few thousand Bq at most. Furthermore, their exposure levels decreased in accordance with the effective half-life of radiocaesium upon further testing. Given the state of radioactive contamination of food distributed in Fukushima at the time, and interviews on the dietary composition of those who exceeded the lower WBC detection limit, it is likely that many of those who exceeded the detection limit regularly consumed certain types of foods found in the wild that were not distributed in the market. Thus, the risk of internal exposure for the residents of Fukushima who consumed food purchased from regular distribution channels was considered to be extremely small. However, it was understood that the economic and cultural effect on farmers and residents who enjoyed wild produce as part of their traditional lifestyle was significant.

At the seventh ICRP dialogue seminar in November 2013, the author reported his experience acting as an interpreter of measured individual exposure doses from WBC screening tests, conducted at residents' own initiative with the results shared within the community; an effort that remains rare in Fukushima today (Miyazaki, 2013b). This effort is still being conducted in Suetsugi district, Iwaki. This programme began when one resident voluntarily started measuring radiation levels of soil in the district without any support from the public sector. This led to measurement of radiation levels of foods, use of personal electronics, and sharing of results within the community (Ando, 2016). In this district, the author's role was limited to that of an 'explainer'. Through this involvement, he effectively resolved the lack of 'explainer/interpreter' of the results of individual measured doses that he highlighted in his presentation at the first ICRP dialogue seminar. Even before the author's involvement, the people concerned about radiation in this district had 'brought about a situation where data could be shared and used within the community'. Through participating in WBC screening and sharing the results within their community, the residents of this community succeeded in acquiring the means to understand the radioactive contamination in their district in realistic terms, and to make decisions about their future diets. As an explainer/interpreter, the author focused on how to explain the results of WBC screening – which only shows how many Bq body^{-1}, a value alien to the residents – in relevant and understandable ways so the residents could use the test results in their daily lives. It is important to understand that the objective of sharing the results of WBC screening within the community is not merely to dispel the residents' health concerns nor to reduce internal exposure levels. What is crucial is to provide information so that each resident may make objective and informed decisions about whether they can resume their lifestyle (from before the accident at FDNPP) in the current environment, including eating home-grown

vegetables and seasonal delicacies from the forest, etc. Experiences gained through involvement with this district were eye-opening and valuable for the author, as he witnessed how the whole community co-operated in considering their post-FDNPP accident lifestyles based on the WBC screening results.

The author's presentations at the 11th and 12th ICRP dialogue seminars, held in May and September 2015, respectively, focused on how the results of individual dose measurements, which are only shown as numbers, may be explained in ways that could be used effectively by the residents in their daily lives (Miyazaki, 2015a,b). From the author's viewpoint, the individual doses measured in WBC screening or using electronic personal dosimeters reflect the individual's lifestyle. Behind the WBC screening test result is the story of 'what he/she had been eating on preceding days'; behind the result from the personal electronic dosimeter is the story of 'where he/she has spent time'. As such, it is extremely important to respect the privacy of the individual when handling such data. The author reported that his focus had been to think about each resident's lifestyle and life setting when explaining the data, and to give concrete, easy-to-understand advice so that residents could make their own decisions about what to eat and where to spend time. The author also explained that, as the local government (municipal) staff met the residents on a daily basis, it was crucial that these people linked the residents and the interpreters for the municipal services to provide a new service to 'explain radiation', established after the unprecedented accident at FDNPP, in order to reach the outreach objective/target effectively (i.e. the residents of affected communities).

Needless to say, a system for linking the local government to interpreters or experts on radiation does not exist in times of normalcy. In the face of this reality, the situation after the accident at FDNPP called for someone who could fulfil a new role of an intermediary (a 'liaising officer') to link residents who needed information about radiation, the local government that had to provide municipal services to provide residents with such information, and experts who had the knowledge/capacity to provide such information. The author's experience is proof that a local physician (such as himself) could fulfil both the 'interpreter' and 'liaising officer' roles. The lesson learned from this experience following the accident at FDNPP is that local physicians, nurses, and public health nurses involved in the health management of residents, as well as local professionals including school teachers, may act as 'liaising officers' when there is a need to quickly establish a new radiation-related service for residents of affected areas in the early stage after an accident. Additionally, there is a need to provide measures to prepare such professionals to fulfil said roles as part of emergency preparedness and response for radiation accidents.

2. THE GAP BETWEEN ICRP RECOMMENDATIONS AND THE REALITIES AFTER THE ACCIDENT AT FDNPP

The above summarises the author's personal activities after the accident at FDNPP in chronological order, based on his presentations at ICRP dialogue seminars. Most of the presentations at these seminars were related to internal exposures,

especially individual feedback of WBC screening results to individuals. In addition, the author also presented on activities (general health consultation services) carried out from the public health and preventive medicine perspectives to prevent the deterioration of health among evacuees at the sixth dialogue seminar (Miyazaki, 2013a). Outside the programme, the author gave updates on the progress of WBC screening to experts from both Japan and abroad. Details on and approaches to the measurement of individual external exposure doses using the electronic personal dosimeter, or D-shuttle, as well as explanation of D-shuttle results to individuals that were conducted in parallel with interpreting the results of WBC screening tests, were also shared through the ICRP dialogue seminars. In other words, the seminars provided valuable opportunities to communicate and share information with many experts as well as the residents who participated. The seminars also enabled real-time communication of the actual problems being faced by medical and health professionals in the field to experts from outside Fukushima. It was a valuable opportunity as the former tackled unforeseen situations after the nuclear accident. Conversely, dialogues with said experts clarified the deficiencies in existing manuals and/or recommendations on radiation accidents drafted prior to the accident at FDNPP.

There were no manuals available for the author's activities. The author made use of his prior training and experience on radiation in his field in acting as an 'explainer/interpreter'. In other words, ways to explain exposure doses to individual residents, and ways to analyse and share the measured exposure doses with related government departments were developed through trial and error. During this process, the author first learned of *Publication 111* (ICRP, 2009) in September 2011. *Publication 111* is based on the experiences of people living in long-term contaminated areas after the Chernobyl accident. Although *Publication 111* is not a manual per se, it became the most reliable source of reference in the author's subsequent activities. Especially in the early phase, there were many cases where *Publication 111* provided suggestions to actual problems.

As the activities in Fukushima continued, the author identified gaps between *Publication 111* (ICRP, 2009) and the actual situation on the ground. These can be summarised as follows:

1. *Publication 111* does not refer to the role of the 'interpreter' or 'liaising officer'.
2. Integrating the optimisation process into the municipal system was actually difficult and did not function.
3. In reality, most radiation protection measures adopted after the accident at FDNPP were based on the ALAP (as low as possible) principle rather than the ALARA (as low as reasonably achievable) principle recommended in *Publication 111*.
4. When external exposure is the predominant source of exposure, there are limited means available to reduce radiation doses after measuring individuals' exposure doses.

The above shows that 'integration of radiological protection into municipal systems' is crucial to induce residents to participate in opportunities where the results

of individual dose measurements are explained. It is also necessary for the authorities to use the statistically-processed results from large-scale measurement activities in the next policy step. Although the concept is not surprising, it was not included in *Publication 111* (ICRP, 2009).

Another problem that emerged after the accident at FDNPP was severe restrictions imposed on the collection and use of information on individual exposure doses. This was because such data were considered as 'personal information,' subject to requirements of the Act on Protection of Personal Information. This response, however, may have been unique to Japan in the wake of a large-scale nuclear power plant accident, and may not apply to other countries.

Given the conditions after the accident at FDNPP, interpreters and liaising officers linked the policies of the authorities – especially those of the central government – with the understanding and needs of individuals and communities, thereby functioning as key instrumental players in integrating radiation protection measures in relevant municipal systems.

3. DUAL MEANING OF INDIVIDUAL EXPOSURE DOSE MEASUREMENTS

It may be difficult to visualise an administrative system that can measure individual exposure levels effectively and use the data for policy purpose. To illustrate this point, the author will depart from the context of radiation protection, and use the viewpoint of public health.

Let us envisiage Municipality A. Municipality A has many patients with hypertension, which has caused significantly higher health insurance costs (and resulting reimbursement) for hypertension compared with other municipalities. By carrying out a disease incidence rate survey, it became evident that the incidence of cerebral stroke in Municipality A was also clearly higher than the national average. Considering the gravity of the situation, Municipality A decided to add spot urine tests in the community's health check-up programme to track the residents' sodium intake. In addition, Municipality A implemented two measures, based on the high-risk approach and the population approach. Through Measure 1 (high-risk approach), the municipality's public health nurses used the estimated level of sodium intake in individual counselling with those diagnosed as hypertensive, as such individuals tended to have higher levels of estimated sodium intake. The test was also used to continue following-up on the effectiveness of measures to reduce sodium intake. Through Measure 2 (population approach), Municipality A decided to make reduced sodium consumption one of the top priority health issues in the municipality, and invested in conducting health seminars to disseminate knowledge and campaigns aimed to encourage the residents to reduce the level of sodium in their diet. This was based on the finding that, looking at the distribution of sodium intake of the entire population of Municipality A, the average sodium intake in Municipality A was substantially higher than the level of sodium intake recommended by the national government.

The short-term goal of these efforts was to reduce the level of sodium intake, and the long-term goal was to reduce the number of patients with hypertension (and the associated health costs), and the number of patients with cerebral stroke (for which hypertension is a risk factor). As a result of these efforts, health insurance reimbursement for hypertension to Municipality A declined 10 years later, and the number of patients with onset of cerebral stroke decreased 15 years later.

The key 'value' for this fictitious Municipality A was 'estimated sodium intake'. Although this is expressed as a simple value from a test result, it can be used for different purposes, in both the high-risk approach for specific individuals, and the population approach for the entire community. As an individual value, it is used to identify high-risk individuals from the group with high intake. Subsequently, it is used for 'explanation' by the public health nurses to explain the meaning/implication of said value and provide guidance on future diet through individual health consultation. Such individual consultations will not be conducted for the residents who did not belong to the high-sodium-intake group. However, based on the latter measure, the general implications of high sodium intake in Municipality A and a campaign to encourage a low-sodium diet will be promoted continuously through the municipality's magazines and health seminars, etc.

To recap, the goal of the former approach is to reduce the level of risk for individuals who are at risk of suffering from hypertension or experience aggravation of hypertensive conditions. Similarly, the goal of the latter approach is to lower potential risk for the population, so as to reduce the number of cases of cerebral stroke among said population in the future (Law et al., 1991).

In Japan, local government authorities invariably have a section responsible for public health that is staffed with experts who understand the above-mentioned duality of these measurements. Most residents are familiar with this municipal system. Using this system, the municipality sets annual health check-ups, notifies the results to residents, provides health guidance, and draws up municipal health policies based on the analysis of the collective results. Many clerical and professional staff are involved in this process. When necessary, the municipality seeks advice from public health experts, and their advice is used in future health policies. Many residents are also aware of the meaning of test results, and the measures that need to be adopted based on the results. Such residents also help to disseminate the contents of campaign messages to other residents that the municipality may not be able to reach through official campaigns, etc. (e.g. if a member of a family attends any campaign activity, the information will be shared in the household). In daily health administration, the municipal system functions naturally and as a matter of course.

In stark contrast to the above, a municipal system to use the results of individual exposure dose measurements has not been established, even in the chronic phase after the accident at FDNPP. As explained above, one cause was the exceptionally limited number of interpreters. In addition, the authorities did not consider establishing a system to link the residents who received their test results with the interpreters. Further troubling is the fact that, even today, efforts to analyse vast amounts

of data on individual measurements as tools for future policy making or to seek advice based on said analyses from experts remain inadequate.

Medical professionals are well aware that individual measurements in health check-ups, etc. are not only useful for individuals at high risk, but also for the population as a whole, through analyses of the measurement results of the entire population. This makes it all the more exasperating that individual exposure dose measurements obtained after the accident at FDNPP have not been adequately used for 'optimisation' measures for the entire population, which is conceptually parallel to the population approach in radiation protection.

4. CONCLUSION

This report looks back on the author's four and a half years of activities in Fukushima, drawing on his presentations at ICRP dialogue seminars. As someone who has lived in Fukushima throughout his life, both as a student and a physician, the author could not pretend not to notice the impact of the accident at FDNPP on the region. Nor could he regard the activities as something temporary, as was the case among experts from outside the region who had the option to move away. In this context, the author had to question the roles to be fulfilled by local professionals in the wake of a nuclear accident.

Who has to respond to various problems that arise in the region on a continuous basis? The answer has to be those who are in immediate proximity to the residents. At the forefront are staff members of the municipalities and various local professionals. They enabled large-scale screening of individual exposure doses, agonised over the difficult task of radiation protection, and engaged in various tasks that did not exist before the accident. However, in most cases, they did not have experts by their side with whom they could consult on the basics of radiation or the most appropriate response to residents in a specific situation. As someone who grew up in Fukushima and as a professional committed to the region over the long term, the author was able to contribute to this region, although in a limited locale, by responding to their questions as quickly as possible and, where necessary, by linking them to high-level experts; in other words, he acted as a 'liaising officer' linking residents, the government, and experts.

In reality, there were few professionals who fulfilled such a role after the accident at FDNPP (obviously many of them were too busy performing their regular duties). These professionals, however, had received training that equipped them with the capacity to use measured data for both high-risk and population approaches. The author believes that their knowledge/capability could be used effectively in the chronic phase of a large-scale radiation accident such as the accident at FDNPP. Some radiation protection experts whom the author met firmly believed that individual dose measurements were personal information. The author experienced cases where such thinking prevented the use of vast amounts of data from measurements when drawing up measures for the entire population or large-scale policies.

There is a need to balance the requirements of the Protection of Personal Information Act and the emergency circumstance following a nuclear accident, and this must be addressed as a policy issue.

The author proposes that training should be provided to physicians, public health nurses, and school teachers in regions where nuclear facilities are located, so that they can fulfil the role of liaising officer as part of preparedness for large-scale radiation accidents similar to the accident at FDNPP. By increasing the number of professionals who have advance knowledge/awareness of their responsibility to fulfil the role of liaising officer in times of emergencies, it is expected that gaps between residents and the authorities/experts would be closed more quickly, community-level understanding/approach would be promoted more widely, and a radiation protection culture would be enhanced. Although said professionals may not be directly involved in radiation in their regular line of duties, they are likely to understand the importance of acting as a 'liaising officer' in the early stage after an accident, through sharing the concept with other experts, including radiation expert professionals, in order to provide better service to the affected residents. In this context, the concept of 'liaising officers' is important in the aftermath of a nuclear accident. In giving a detailed description of his role as a 'liaising officer' for more than four and half years, the author hopes that his experience will be useful in the event of a future accident.

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Looking back on media reports on the nuclear accident

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Abstract–The accident at Fukushima Daiichi nuclear power plant in the wake of the Great East Japan Earthquake received considerable media coverage. However, a leaning towards sensationalism and a proclivity for denouncing those in power resulted in articles that were, in several instances, scientifically inaccurate, causing anxiety among disaster victims and delaying recovery efforts. Individuals working for the local media in Fukushima had the task of reporting the disaster while being victims of the disaster at the same time. Therefore, many individuals studied and deepened their knowledge about radiation and its effects, and were pained to see inaccurate media coverage of the disaster. Should they have been more forthright in opposing such false media coverage?

Keywords: Media coverage; Media; Mass communication

1. GAP BETWEEN NATIONAL TELEVISION NETWORKS AND LOCAL STATIONS

As a journalist covering the accident at Fukushima Daiichi nuclear power plant for a local television station in Fukushima, one of the most compelling things experienced by the author was the gap in how news about Fukushima was presented by key national television networks and by local stations. For example, 1 year after the incident, a national television network broadcast a special programme on the discovery of mutant butterflies in Fukushima. At around the same time, a local station

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aired a programme showing progress in the recovery efforts undertaken in Fukushima.

The people of Fukushima were regularly measuring radioactivity with whole-body counters and taking thyroid screening tests, and were sensitive to radiation exposure levels. By 2012, the general feeling among the people of Fukushima was that radiation risk was less than anticipated immediately after the incident. The two television programmes with widely divergent views of the situation in Fukushima were broadcast at around this time, which would have deeply confused the viewers in Fukushima. This gap is expanding even today.

2. DISCUSSION OF AN ARTICLE

Fig. 1 shows the logic used in an article in a national newspaper on the reasoning for government policy.

The problem with this article is complete misrepresentation of the concept of radiation dose assessment. The actual ambient dose differs from the effective dose. The ratio of ambient dose equivalent to effective dose is 1:0.7. As shown in a graph prepared by Associate Professor Tomohiro Endo of Nagoya University based on a study conducted at the High Energy Accelerator Research Organization (Hirayama et al., 2013), the amount of radiation that passes through a person from all directions, as in Fukushima, is the amount of radiation indicated on a personal dosimeter, and is equivalent to the effective dose. The environmental dose measured at a monitoring post differs from the personal dose due to people's daily activities. Instead of being fixed at a monitoring post all day, people sleep in their homes, commute to work by car, work in an office, and return home. A person's dose will differ depending on the physical shields encountered in their lifestyle. Therefore, a personal dosimeter will show a different reading from the ambient dose measured at a monitoring post.

What motivated this article? Although it is not clear whether the journalist lacked knowledge or was being arbitrary, it appears that the journalist intentionally chose to obliterate information that was true. Such articles are sometimes motivated by competition for a better audience rating or a larger circulation, or a tendency within the

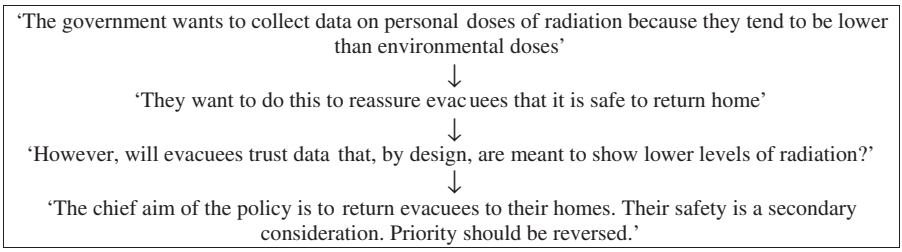

Fig. 1. Logic used in an article in a national newspaper to criticise government policy.

media to shirk responsibility by reporting on both sides of an argument. More essentially, the belief in the role of the media to 'warn, enlighten, and guide the public' has often led it to gain satisfaction from denouncing the Government and others in power. When this tendency is carried too far, it could result in articles such as the one mentioned above. This is not to say that the media should become a mouthpiece for the Government. The media should criticise where criticism is due and draw attention to errors. For example, the Ministry of the Environment originally set $0.23\,\mu Sv\,h^{-1}$, or $1\,mSv\,year^{-1}$, as a reference level for evacuation. Now that the Government has set $20\,mSv\,year^{-1}$ as a reference level for lifting evacuation orders, the Fukushima residents would be anxious about returning home unless the original reference level was explained as a 'provisional guide'. The Government needs to explain the rationale for the new reference dose for lifting evacuation orders, and promote discussion with returnees. The media could pick up this issue to promote discussion and constructive criticism within the Government and in Fukushima.

However, an article such as the one mentioned above solves no problems and only serves to perpetuate residents' distrust in the Government.

A reporter from a national media outlet told reporters from Fukushima, 'We make our living by stirring up the public.' Another journalist, also from a national media outlet, who had disparaged a person in power on the subject of radiation exposure dose in a television programme and who had written signed articles about radiation exposure dose for a national newspaper, apparently said, 'I have little interest in radiation exposure.' These cases, however, were relayed by one journalist who heard it through a third person.

3. PROVIDING ACCURATE DATA IS NOT ENOUGH TO DISPEL FALSE REPORTS

In hindsight, the media was not able to sufficiently communicate information and data about environmental radiation, exposure, and radiation dose to Fukushima residents. Whereas experts and others in communities succeeded in establishing

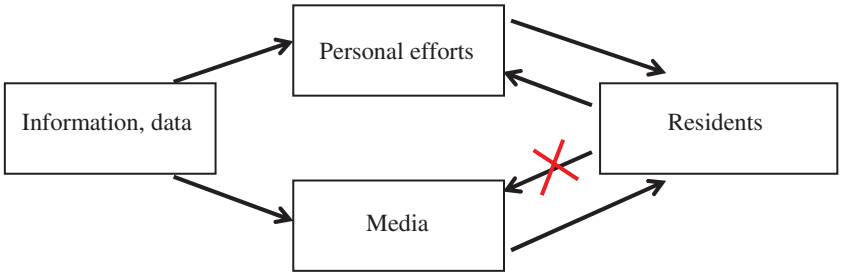

Fig. 2. Information transmitted by the media.

good communication with residents, the media, as shown in Fig. 2, engaged in one-way communication that did not fully meet the needs of residents.

On the question of whether the media should have countered false reports, it had been considered that if residents were provided with detailed scientific data, they would make the right judgement; however, this assumption proved too optimistic. In the face of possible threats that residents felt to their lives and health in the wake of the accident at Fukushima Daiichi nuclear power plant, the value system and approaches in the media that have persisted since after the war could have been discarded. Frankly, the author has no clear answer regarding media coverage in the future, but hopes to advise young journalists to adopt new ways of reporting in the face of unprecedented events.

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Thinking, talking, and working with professional community workers after the Fukushima nuclear accident

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Abstract–This article examines postdisaster public health activities (focusing primarily on parenting support) through collaboration between universities and local government, and reports on the support provided to public health nurses, who are the gatekeepers of community health. For a year after the Fukushima disaster, discussions were held on the short- and long-term measures for responding to the concerns of parents, who face difficulty interpreting risks. Child health checkup data and mothers' counselling sessions with public health nurses were analysed to gather evidence to reinforce the health system over the long term. As the results of the analysis showed a need for the development of a system for communicating health information in ways that are accessible to residents, a health literacy training programme was developed and implemented for public health nurses in Fukushima Prefecture.

Keywords: Health system; Evidence; Health literacy

1. THREE PERSPECTIVES

The postdisaster activities undertaken by the author, a specialist living in Fukushima Prefecture, can be summarised from three perspectives. The first perspective is that of a mother living in Fukushima with a child. In academic terms, this may be described as participatory observation of a qualitative study. The second perspective is that of an epidemiologist. The author has been involved in the analysis of data from the Fukushima Health Management Survey (a prefecture-wide cohort study) and

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the provision of parental support services based on the obtained results. The third perspective is that of a public health physician working with public health nurses in the region. In this area, in particular, the author is promoting health literacy for improving access to health information. This paper will focus primarily on the third perspective.

2. START OF ACTIVITIES

Fukushima city, which is home to Fukushima Medical University, lies within the 50-mile evacuation zone recommended by the US Government in the immediate aftermath of the accident at Fukushima Daiichi nuclear power plant. Mothers living in the city were naturally concerned about the health risks of radiation, and some decided to evacuate. Partly for this reason, the population of children aged <5 years in Fukushima city declined by nearly 15% during the 2 years following the disaster. A report by the Fukushima Nuclear Accident Independent Investigation Commission recommended disclosing information 'for use by individual residents to make informed decisions' (NAIIC, 2012) to assuage the concerns of residents. However, it was not at all clear, especially in the immediate aftermath of the accident, what specific actions were needed to address those concerns.

Approximately 1 month after the accident, the author received a telephone call from a public health nurse with whom she had worked on maternal and child health in Fukushima city. She wanted advice regarding how public health nurses could help mothers with concerns about radiation. Details about the author's response have been published previously (Goto et al., 2014a). In short, the author asked the nurse to list the major concerns of mothers and the difficulties faced by nurses. She subsequently consulted with specialists in respective fields for their advice regarding the concerns and problems listed, and organised meetings with the nurses. The first meeting with the nurses, approximately 2 months after the accident, focused on responding to parents' immediate anxiety. The second meeting, organised 6 months after the accident, addressed issues related to parents' persistent anxiety, and the third meeting, held 8 months after the accident, examined ways to strengthen the long-term system for responding to parents' concerns. Proposals were made on the topics discussed at each meeting: systematic information provision and setting up indoor play spaces at the first meeting; expansion of counselling services at the second meeting; and an early parenting support system and regular training sessions for public health nurses at the third meeting. The role of the author at these meetings was to listen to nurses report on the state of affairs as an adviser, collect information from specialists as needed, and assist nurses to make their own proposals regarding the steps needed. This experience, and discussion with Mr Jacques Lochard of the International Commission on Radiological Protection, suggested that it was important to take each of the following steps in turn when building trust through dialogue in health risk situations:

(1) when responding to a person seeking advice, make it clear that you cannot tell the person what to do;

(2) ask the person to describe his/her concerns and situation; and
(3) think together with the person about what measures could be deployed.

3. FINDING EVIDENCE

With regard to the proposal for strengthening the health system made at the third meeting with nurses, there was a need for detailed analysis of municipal data to draw evidence that could be used to plan measures. A database was created from health checkup files of 18-month-old children. This included written records of mothers' counselling sessions with public health nurses. The detailed results of the analysis have been published previously (Goto et al., 2014b,c). In short, interpersonal problems at home were significantly associated with lower maternal confidence in parenting, and mothers who were concerned about differences in risk perception about radiation among family members tended to be depressed (Goto et al., 2014b). In addition, public health nurses reported difficulties in communicating information about health risks to residents (Goto et al., 2014c). This implied the need for public health nurses to improve their skills in mediating health information to mothers.

4. FROM DATA TO ACTION

This led to the launch of training workshops on health literacy for public health nurses in Fukushima Prefecture in 2013 (Goto et al., 2015). Health literacy is both knowledge and skills that residents need in order to gain access to, understand, and use information for promoting and maintaining good health, as well as knowledge and skills that healthcare professionals need for communicating health information. The training programme consists of two training sessions, followed by 1 month of application of the learned skills in practice. In the first session, the public health nurses are given an overview of health literacy skills, after which they learn the processes for assessing health information materials for ease of understanding. In the second session, they learn how to improve the understandability of the materials they assessed. They apply the learned skills to their work for the next month, at the end of which they are given a questionnaire sheet for reviewing the application of skills and additional materials.

As health information needs to be communicated in ways that are easily understandable by those receiving the information, the training programme places emphasis on two-way communication between those who disseminate information and those who receive information. Specifically, the author has introduced the 'marker method' to assess health information materials for ease of understanding. In this method, a person is given printed health information material and a marker, and is asked to 'mark any words or sentences that might be difficult for another reader to understand'. It is often the case that the marked words are technical words that are familiar to the expert who created the material. The marker method not only creates opportunities to involve residents in the process of writing health information, but also helps public health nurses to take pride in the use of a new approach in improving communication with residents.

Fig. 1. Reinforcing the health system from a health literacy perspective.

The long-term effects of the training programme that encourages healthcare professionals to embrace a health literacy perspective include improvement in accessibility to health information and improvement of the health system (Fig. 1) (Lai et al., 2015). This stems from the fact that, first of all, it promotes communication with residents as mentioned above. Second, it requires the communication to be relevant and to the point, which in turn requires the communicator to clarify the goals of the communication and hence the goals of the health promotion activities of which the communication is a part. Further, the training programme also stresses the importance of teamwork in creating the health information materials. As four eyes see more than two, working in a group means that the material can be revised from different angles to make the final product easy to understand.

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Lifting of evacuation orders and subsequent efforts in Japan

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Abstract–With confirmation of the cold shutdown conditions of the nuclear reactors after the accident at Fukushima Daiichi nuclear power plant, the Japanese Government reclassified the areas under evacuation orders as follows: (1) difficult-to-return zones ($>50\,\mathrm{mSv\,y^{-1}}$), (2) restricted residence zones ($20–50\,\mathrm{mSv\,y^{-1}}$), and (3) zones in preparation for lifting of the evacuation order ($<20\,\mathrm{mSv\,y^{-1}}$). The Government continued its initiatives towards reconstruction of Fukushima, and has lifted evacuation orders in Zones 2 and 3. In terms of radiological protection, the Government emphasised its policy of placing importance on individual dose, and promoted the assignment of consultants in each municipality.

Keywords: Evacuation order; Individual dose; Consultant system

1. INTRODUCTION

The Support Team for Residents Affected by Nuclear Incidents, Cabinet Office of Japan has been involved in setting and lifting evacuation orders, and in various other matters in the affected areas. This report will introduce the changes made when reviewing the areas under evacuation orders, and the efforts of the Japanese Government.

This paper does not necessarily reflect the views of the International Commission on Radiological Protection. Also this paper is based on the author's personal experience and views, and does not necessarily reflect the official opinion of organisations the author belonged to.

2. TRANSITIONS OF THE AREAS UNDER EVACUATION ORDERS

After the accident at Fukushima Daiichi nuclear power plant, of Tokyo Electric Power Co., Inc. (TEPCO), the Japanese Government expanded the areas under evacuation orders concentrically and took a measure to set areas within a 20 km radius as 'restricted zones', in which people were, in principle, prohibited to enter and to stay overnight. In addition, the Government classified areas where the annual cumulative radiation dose was >20 mSv as 'planned evacuation zones', in which people could enter but were prohibited to stay overnight.

An annual cumulative radiation dose of 20 mSv is considered to be equivalent to 3.8 $\mu Sv\,h^{-1}$, calculated under the assumed condition of being indoors for 8 h and being outdoors for 16 h each day. The Government designated areas within 30 km of Fukushima Daiichi nuclear power plant as 'zones in preparation for evacuation in case of emergency', so that people would be prepared to shelter indoors in case of an emergency. In September 2011, the evacuation order of 'zones in preparation for evacuation in case of emergency' was lifted. With confirmation of the cold shutdown conditions of the nuclear reactors at Fukushima Daiichi nuclear power plant, the Government started to review the areas under evacuation orders.

In the process of the review, the Government held approximately 200 briefing sessions for inhabitants in each area. In these meetings, the inhabitants showed their

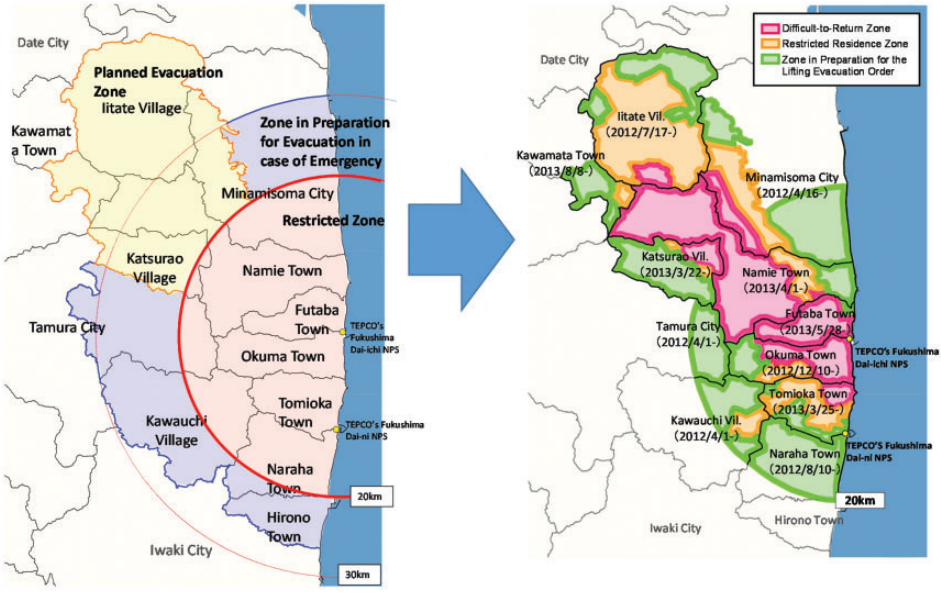

Fig. 1. Designated zones in April 2011, and zones as of August 2013 following the review process (This figure is assembled by the author based on materials published by the Japanese government.).

criticism and anger towards the Government, as well as anxiety and disbelief towards the health impacts of radiation. After the Government completed their review of the areas, they classified them into three zones according to different prevailing radiation doses. First, they designated the areas where the annual cumulative radiation dose exceeded 50 mSv (9.5 $\mu Sv\,h^{-1}$) and would not fall below 20 mSv (3.8 $\mu Sv\,h^{-1}$) even 6 years after the accident as 'difficult-to-return zones', in which people were basically prohibited to enter and to stay overnight. Next, they designated the areas which had annual cumulative radiation dose between 20 and 50 mSv (3.8–9.5 $\mu Sv\,h^{-1}$) as 'restricted residence zones', in which people were basically prohibited to stay overnight but were allowed to enter and operate business activities in part. Additionally, they designated the areas where the annual radiation dose was <20 mSv (3.8 $\mu Sv\,h^{-1}$) as 'zones in preparation for lifting of the evacuation order', in which people were basically prohibited to stay overnight but were allowed to enter and operate business activities.

3. EFFORTS FOR LIFTING EVACUATION ORDERS

Lifting of evacuation orders is an indication that reconstruction is proceeding at full pace. First of all, the evacuation orders are measures to force inhabitants, including those who want to remain at home, to evacuate compulsorily without exception. When the evacuation orders are lifted, it makes it possible for inhabitants who want to return home to do so, but people are not forced to return.

When the Government started to review the areas under evacuation orders in December 2011, they determined three conditions for lifting orders, as follows:

- The annual cumulative radiation dose estimated from the air dose rate must be <20 mSv.
- Infrastructure that is essential for daily life such as electricity, gas, water, sewerage, main transport network and communications, as well as services such as medical service, nursing service, and mail service needed for daily life must be, for the most part, recovered. In addition, decontamination work must progress, focusing particularly on the living environment of children.
- Active dialogue must be carried out between the prefectural government, the local municipalities, and the inhabitants.

In December 2013, the Cabinet decided to implement a policy 'For Accelerating the Reconstruction of Fukushima from the Nuclear Disaster'. The Government set up three main pillars for this initiative as follows:

- support for early return and for establishing the residents' new living environment;
- to strengthen countermeasures for decommissioning of reactors and contaminated water; and
- to clarify the division of roles between the national government and TEPCO.

Regarding support for early return, the Government decided to have comprehensive and stratified safeguards not only for proceeding with decontamination works, but also knowing and managing individual doses, promoting measures to mitigate health concerns, and establishing a consultant system to support returning inhabitants closely, based on 'Practical Measures for Evacuees to Return Their Homes' recommended by the Nuclear Regulation Authority in November 2013. Moreover, the Government decided to set annual individual additional exposure dose <1 mSv as a long-term goal as inhabitants return and start their new lives.

In June 2015, the Government revised the above policy, taking into account the situation as evacuation orders were being lifted and reconstruction work was progressing. The revision was to establish a goal of improving the environment in order that the evacuation orders for 'zones in preparation for lifting of the evacuation order' and 'restricted residence zones' would be lifted within 6 years of the accident (by March 2017). In addition, it was decided that compensation for mental damages would be paid, regardless of when the evacuation order was lifted, as an amount equivalent to the compensation paid 6 years after the accident. However, regarding compensation for property, there was no option but to pay the amount at the time of lifting of the evacuation order because of the nature of the matter. Another initiative concerning issues related to reconstruction and self-reliance, businesses, and livelihood, was the establishment of a joint public–private team as a major provider of assistance.

Through these efforts, the evacuation order for Miyakoji district, a part of Tamura city, that was designated as a 'zone in preparation for lifting of the evacuation order' was lifted on 1 April 2014. Six months later, a part of Kawauchi village that was designated as a 'zone in preparation for lifting of the evacuation order' was lifted (October 2014), and another area that was designated as a 'restricted residence zone' was redesignated as a 'zone in preparation for lifting of the evacuation order'. On 5 September 2015, the evacuation order for the whole of Naraha town, that had been designated as a 'zone in preparation for lifting of the evacuation order', was lifted. This was the first evacuation order to be lifted in a municipality where all of the inhabitants had been evacuated in the wake of the accident.

4. CURRENT STATUS OF AREAS UNDER EVACUATION ORDERS

According to a report from Fukushima Prefectural Government, in December 2015, there were approximately 102,000 evacuees in Fukushima Prefecture as a result of the Great East Japan Earthquake. Approximately 70,000 evacuees were from areas under evacuation orders in nine municipalities. The breakdown was approximately 24,000 evacuees from 'difficult-to-return zones', approximately 23,000 from 'restricted residence zones' and approximately 24,000 from 'zones in preparation for lifting of the evacuation order.'

Taking a look at the status of evacuees returning after the lifting of evacuation orders, 198 people (58% of the entire population) had returned to Tamura city (Miyakoji town) by the end of 2015. Over the same period, 1735 people (63% of

the entire population) had returned to Kawauchi village, but the percentage of returnees from the initially designated evacuation zone would be much lower. For example, 388 people (approximately 5% of the entire population) had returned to Naraha town by 1 December 2015. The reason for this low percentage could be attributed to the fact that the evacuation order was only lifted recently, and classes at schools had not yet resumed.

As of now, in order to prepare for returning home, 'temporary stays at home to prepare for returning home (preparatory stays)[1]' for a period limited to 3 months started from 31 August 2015 in Katsurao village, Kawamata town, and Minamisoma city, and from 1 November in the remaining areas under evacuation orders in Kawauchi village. As for Katsurao village, Kawamata town, and Minamisoma city, the period for preparatory stays was extended by an additional 3 months from 1 December 2015 to 29 February 2016.[2]

With the government revision of the policy 'For Accelerating the Reconstruction of Fukushima from the Nuclear Disaster' in June 2015, the Joint Public–Private Fukushima Soso Reconstruction Team was established in order to reconstruct businesses and individual operations on 24 August 2015. This team was formed of over 100 members from the national and prefectural governments and the private sector. The team is visiting the affected business operators individually. As of 9 December 2015, the team had contacted 4824 business operators by telephone and visited 2419 operators individually. They continue to visit, consult, and support the operators, and also consider the promotion of new support plans based on the results of listening to the actual voices of operators during visits.

5. RADIATION PROTECTION AND CHALLENGES

It was recommended in the above-mentioned 'Practical Measures for Evacuees to Return Their Homes' (Nuclear Regulation Authority, 2013) that, for radiological protection purposes, focus should be placed on the dose to which the individual is exposed, and that appropriate measures of support should be put into place. Until then, the focus was on air dose rate and reduction of dose through decontamination. Consequently, it became necessary to measure individual exposure dose, taking into consideration the living conditions of each individual, and to establish a mechanism to explain the results of the measurements so that they would become aware of their own individual dose and thereby be able to discuss/consult any issues. In order to

[1]'Preparatory stays' make it possible to stay at home, as an exception, in areas under evacuation orders, where it was originally prohibited to stay, so that inhabitants can resume their life at home smoothly after the evacuation order is lifted.

[2]Subsequently, evacuation orders for 'zones in preparation for lifting of the evacuation order' and 'restricted residence zones' in Katsurao village were lifted on 12 June 2016, and evacuation orders for 'zones in preparation for lifting of the evacuation order' (former 'restricted residence zones') were lifted on 14 June 2016. Evacuation orders for 'zones in preparation for lifting of the evacuation order' and 'restricted residence zones' in Minamisoma city were lifted on 12 July 2016, and evacuation orders for 'zones in preparation for lifting of the evacuation order' and 'restricted residence zones' in Iitate village will be lifted on 31 March 2017.

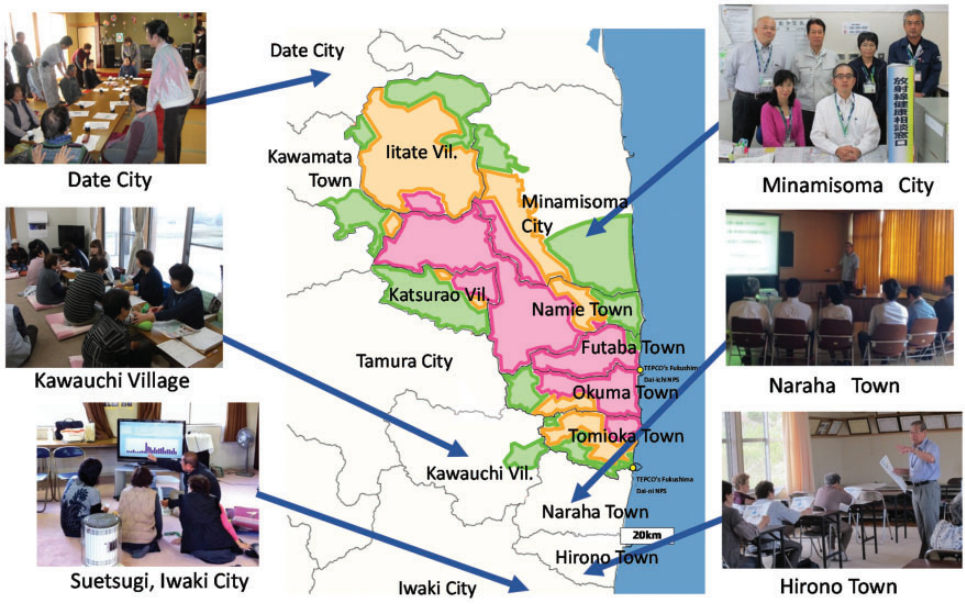

Fig. 2. Examples of the activities implemented by consultants in each area. (This figure is assembled by the author based on materials published by the Japanese government.)

achieve this, it was recommended that consultants would work closely with the inhabitants who had chosen to return home. These consultants would play a broad role in supporting their daily life, and rebuilding and planning their future.

The actual consultation system is not implemented uniformly but is 'tailor-made' in each municipality in accordance with the actual circumstances of each region. One typical example was the implementation of support for measuring individual dose using D-shuttle dosimeters, and explanation of the results (hourly exposure dose) individually to those inhabitants who were interested. Through these initiatives, the inhabitants could visualise the relationship between personal activities and behaviour and exposure dose, and create awareness of radiation that they could neither see nor feel. Naraha town is another example of a place where new consultants were not introduced, but the employees of the municipal office who had been undertaking door-to-door visits and patrol activities, liaison officers for temporary housing, and life support consultants had responsibility for understanding the concerns of the inhabitants, including their concerns about radiation. These people also work with a strong network of experts and health workers to provide detailed support for the inhabitants.

Through these activities of the consultants, it is expected that anxieties and doubts, mainly related to radiation, of those inhabitants who have returned home will be covered. Nevertheless, in areas where evacuation orders have been lifted, the individual dose of the inhabitants measured approximately 1 mSv y^{-1} in many cases. However, as evacuation orders will be lifted in more areas in future, this will include

areas with relatively high air dose rates. In that case, following the decontamination of wide surface areas, we will face the problem of whether there are any specific effective measures to decrease exposure dose further. In order for returning inhabitants to regain their lives at home, the Government must continue to deepen discussions to study what countermeasures are feasible.

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Involvement through photography

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Abstract–As a photographer living in Tokyo, I have been visiting Suetsugi village regularly to take photographs and show the printed photographs to the residents. What is the role of photography? What does it mean to be involved in the life of Suetsugi through photography? This article discusses some of the answers to these questions 5 years after the accident at Fukushima Daiichi nuclear power plant.

Keywords: Photography; Involvement; Outsider; Invisible; Mind; Living

1. MAKING STEPS TO RECOVERY VISIBLE

I work as a photographer in Tokyo. At the time of the accident at Fukushima Daiichi nuclear power plant, my daughter was just 1 year old, and I was looking for reliable information on which to base my actions. Among a wide array of information on the Internet, I found the International Commission on Radiological Protection's (ICRP) *Publication 111* (ICRP, 2009). Using social media, I worked with experts to interpret the document. Eventually, I began to acquaint myself with residents of Fukushima Prefecture on social media sites.

Motivated by my interest in the real situation of those residents, I decided to attend a local workshop on radiation that was organised in Hisanohama district in Iwaki city in December 2011. The residents were taking notes and listening intently to the lecturers as they thought seriously about how they should deal with the issue of radiation. When the time came to share information about their own situation, they were no longer smiling as they had been at the beginning of the workshop. They spoke, some in tears, of their concerns about and anger towards

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the situation that appeared to be unfairly and undeservedly forced on them. A resident, who was subject to discrimination as a victim of the disaster, made a comment that struck me particularly: 'We cannot see radioactivity, but we cannot see through what other people think either.' I realised that those of us living in Tokyo knew very little about the hardship that these residents were facing. At the same time, I began to explore how I could help them as a photographer.

I next met Mr. Shinya Endo of the Society for Protecting Suetsugi and other residents of Suetsugi village, which represents the northernmost part of Hisanohama. Having decided to rebuild their lives by themselves, and mistrustful of the Japanese Government and Tokyo Electric Power Company, the Society for Protecting Suetsugi has produced a radiation map of their village by measuring radiation doses of their houses and fields, and radioactive materials in the soil. Their activity was why I began to visit Suetsugi regularly to take photographs of the lives of the residents and to show them the photographs.

Radiation and what is in people's minds are invisible. I thought I could make visible the lives of people who live in Fukushima and their paths towards restoration.

2. PHOTOGRAPHS

Fig. 1. October 2012: Mr. Shinya Endo smiles in front of his rice field nearing harvest. He continued to plant rice even after the Great East Japan Earthquake. Surrounding the field are weeds that have grown yellow flowers in a fallow field. As most residents stayed away from farming this year, the yellow flowers were everywhere in Suetsugi. On the way to the rice field, Mr. Endo said, 'This sea of yellow flowers looks pretty.' When we arrived at the field of rice shining in gold, he said, 'My field looks beautiful, doesn't it?' In the year of the earthquake, the radiation from the rice in his field measured 200 Bq kg^{-1} at most. In 2012, the radiation from the rice shown in the photograph declined to <7 Bq kg^{-1} for a bagful of rice. Although the radiation levels were not known at the time of the shoot, he told me the radiation measurement results when I visited to hand him the printed photographs. By shooting and handing him the printed photographs, I was able to support him in making visible his perseverance, efforts, and the positive outcomes.

Fig. 2. July 2013: Mr. and Mrs. Endo smile as they stand side by side in front of hydrangea flowers. Hydrangea blossom can be seen as one drives north from Iwaki station, and on a hill to the left as one enters the village of Suetsugi. Mr. Yutaka Endo and his wife Masako look after the hydrangeas. They began planting the hydrangeas a few decades ago when Mr. Endo came up with the idea to please visitors to Suetsugi. Now, the hydrangea flowers almost cover an entire hillside. Mrs. Endo has a dosimeter for integral dose measurement in her shirt pocket. After returning from evacuation, she felt desperate and argued with Mr. Endo that she did not want to live in Suetsugi. Nearly 1 year after returning to Suetsugi, she regained confidence when she realised that radiation exposure could be reduced by cutting down on the time spent outside looking after the hydrangeas. She said, 'It gave me knowledge that we could live in Suetsugi and look after the plants.' The dosimeter, the people supporting them, and, above all, their own efforts contributed to putting smiles on their faces at the time of the shoot.

Fig. 3. April 2015: Mr. Mamoru Niitsuma sits on top of shiitake mushroom logs. He is a past recipient of the Minister of Agriculture Prize. 'That has been my pride,' said Mr. Niitsuma. Last year, the radiation levels of his shiitake mushrooms finally fell below 70 Bq kg^{-1}, which is the level considered fit for market distribution. However, his mushrooms did not make it to the market. The local government instructed him to discard his mushroom logs. The life of the logs is 5 years at most. Mr. Niitsuma continues to grow mushrooms, in small amounts, that are a source of pride.

Fig. 4. New Year's Eve 2014: Mr. Motoyoshi Niitsuma shows his daughter how to use the iPad, in the small amount of time she had to spend with her father before leaving Suetsugi before the New Year, returning to Onahama city, 30km south of Suetsugi, where she was, and remains, evacuated. The room is decorated with the traditional straw festoons for the New Year. 'We are probably the only household in Suetsugi that still hangs the straw festoons for the New Year,' says Mr. Niitsuma. He decided to stay in the house and continues to live in Suetsugi.

Fig. 5. April 2013: A small truck makes its way across the village in drizzle, carrying the sacred *mikoshi* palanquin and carriers. There is clear sky ahead. They are participating in the spring festival at Miwatashi shrine. The festival had been held every year, even during the Second World War, until it had to be suspended in 2011 following the Great East Japan Earthquake. It resumed last year in a somewhat modified format, and this will be the second festival since the earthquake. The festival is a cultural symbol of the village.

Fig. 6. April 2013: Residents from three local districts gather to make *hanagasa* flower umbrellas for the festival. Each district makes their own flower umbrellas, but due to depopulation in the wake of the earthquake, the three districts had to join forces to preserve the festival. Each district has their own tradition in the making of the flower umbrellas. 'That's how you make your flowers.' 'Our umbrella looks more impressive.' The participants find joy in exchanging information about flower umbrellas, which would have been rare before the earthquake. Although affected by the earthquake, the local culture is preserved.

3. SHOWING THE PHOTOGRAPHS AT AN EXHIBITION

I printed the photographs I took in Suetsugi and showed them to the residents when I visited the village. After I began taking photographs of the festival, the number of people who were shot in the photographs increased dramatically, which created a need to organise an exhibition. I gathered the photographs I had taken and exhibited them in May 2014 at the village hall and at the village railway station. At the exhibition, I saw the residents happily explaining each photograph to the visitors.

Fig. 7. April 2014: A father and daughter put down the flower umbrella for a rest. The girl's grandfather, who lived in a newly developed residential area in Suetsugi before the Great East Japan Earthquake, had never been a carrier of the flower umbrella. He volunteered after the earthquake because the earthquake had 'brought home the importance of maintaining community ties'. Despite the difficulty, the festival has created new ties.

Fig. 8. April 2014: The carriers toss the *mikoshi* palanquin up and down and to and fro in the sea for the first time in 4 years since before the Great East Japan Earthquake. The tradition of carrying the palanquin in the sea dates back to the Second World War. 'Let's enter the sea, shall we?' 'I'd rather not.' 'It's damn cold.' 'Go, go, here we go!' The tones of the carriers were partly happy and partly scared, but when they brought the Mikoshi back to the shore, they were proud of their little achievement.

4. ROLES

Based on my activities to date, I see my role in Suetsugi as follows.

- An outsider observing the people, their lives, and culture with respect

Through photography from an outsider's perspective, I want to make visible the scenes that are often difficult for insiders to appreciate.

- Continued involvement as an outsider

I want to continue to involve myself not only as a photographer, but also as a friend from the outside. I think there is meaning in having an outsider who does not live in Suetsugi paying regular visits simply because of his fondness for the village.

- Disseminating information

I felt that disseminating information about Suetsugi through the exhibition contributed to increasing the confidence of the people of Suetsugi. I believe I have a role to play in disseminating information about Suetsugi, not just within the community but also outside the community.

5. FINALLY

Fig. 9. April 2016: The *mikoshi* palanquin departs under the cherry blossom. Only approximately half of the carriers now live in Suetsugi. Some live in cities to attend college. Others have been displaced by the disaster. However, all have returned to preserve the festival. 'It's the first time we have the cherry blossom coincide with the festival!' 'What a beautiful day for a festival!' The joyful voices of the residents resound far and wide.

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For the day when I can return: the future is one step away

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Abstract–Iitate, a village in Fukushima Prefecture, suffered little damage from the Great East Japan Earthquake that struck on 11 March 2011. However, all village residents were belatedly ordered to evacuate 1 month after the accident at Fukushima Daiichi nuclear power plant. My family and I had to evacuate to the city of Fukushima, located 40 km from our home in Iitate. This came at a time when my husband and I were planning to start research on Natsuhaze (a type of blueberry grown in Japan) after his retirement. There were conflicting reports. On one hand, the media reported that it was not possible to live in Fukushima. The village of Iitate organised a lecture by an expert to assuage the fear of the residents. The evacuation order 1 month after the disaster contradicted what the expert was saying, and appeared to amplify distrust among the residents. I tried to arrive at my own judgement by measuring the ambient radiation dose in and around my house. Participating in the International Commission on Radiological Protection dialogue seminars provided accurate understanding of the situation. Measurement of radiation doses of wild plants that my husband's father had been cultivating for over 30 years has given me many insights, and I had no concerns about returning to Iitate.

Keywords: Evacuation; Assessment of the situation; Measurement; Wild plants; Family

1. SIX MONTHS AFTER THE DISASTER

I live with my husband and his parents. At the time of the accident at Fukushima Daiichi nuclear power plant, my husband was a principal at a prefectural senior high school. He was due to retire at the end of March 2011, but his retirement was postponed for 4 months in the wake of the disaster. Besides working as a high school

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Fig. 1. Wildflowers near home.

teacher, my husband breeds and registers new varieties of potatoes and pumpkins. He had a field for breeding experiments. In late March 2011, before the evacuation order was issued, my son sent us an e-mail saying, 'Soil in Iitate is badly contaminated. Father should stop experimenting. He shouldn't produce anything in the field.' My husband and I discussed this and decided to look for a potato field outside Iitate. After we learned that an evacuation order was about to be issued, we asked an acquaintance to look for a field for seed potatoes with a house nearby for evacuation. We felt that my husband's parents, who made a living as farmers in Iitate, needed a house as well as a field to enable them to live a meaningful life.

My father-in-law, who was 85 years old at the time, had been cultivating wild plants and wildflowers (Fig. 1) for more than 30 years, developing new methods for cultivation and propagation. Some of the wild plants he grew were popular items in supermarkets in Tokyo. It must have been frustrating to leave home and leave his crops untended, just at a time when he was planning to start full-scale cultivation of his wild plants. As looking after his wild plants and wildflowers kept him going, we encouraged him to return home every weekend to look after the plants after we had evacuated. For safety precautions, we measured the ambient radiation dose in the field and knew that radiation levels were not a concern for short stays. NHK, Japan's national public broadcaster, made a documentary about my father-in-law, which was titled, 'For the day when I will eventually return home.' The title of this programme inspired me to prepare for our return to Iitate while we were displaced.

2. SIX MONTHS TO 1 YEAR AFTER THE DISASTER (OCTOBER 2011–MARCH 2012)

For me, the nuclear accident occurred at a time when my husband and I were planning to start research on Natsuhaze (*Vaccinium oldhamii – Miq.*, a type of blueberry grown in Japan, Fig. 2) in April 2011 after his retirement. We had transplanted more than 100 Natsuhaze trees that grew on our premises in the mountains to the fields in November and December of the previous year. Although we could no longer look after the trees after evacuation, we met a farmer who grew Natsuhaze near the house we evacuated to. We bought some Natsuhaze berries from the farmer, made jam from them, and sent the jam to acquaintances. This led to development of an agricultural business model for Natsuhaze.

Fig. 2. Natsuhaze.

3. ONE YEAR AFTER THE DISASTER (APRIL 2012–MARCH 2013)

As it became possible to measure the radiation dose of foods in Iitate's municipal hall at the end of 2011, we asked for measurements of three types of wild plants in May 2012. The results were 3422 Bq kg^{-1} for ostrich fern, 805.2 Bq kg^{-1} for victory onion, and radiation was not detected for hosta. These results showed that the radiation dose was not as high as expected, and that it differed between types of wild plants. Some wild plants had radiation doses <100 Bq kg^{-1}, the level that was considered safe for distribution. Contrary to the widely held notion that 'wild plants have a high radiation dose' and 'consumption of wild plants should be avoided', the results showed that some wild plants were edible; this gave us hope for the future. My husband's parents were delighted when I put some edible wild plants on the table. They smiled and said, 'It's as if we are back in Iitate.' It struck me that there was no reason to cause them unnecessary anxiety and deprive them of their joy.

I joined a gathering of other people thinking about returning to Iitate for exchange of information. It was at this gathering that I was asked to participate in the third International Commission on Radiological Protection (ICRP) dialogue seminar. I spoke on the theme of 'dialogue on food', reporting on my experience of measuring the radiation doses of wild plants in Iitate municipal office, and expressing my hope of using the technology to measure radiation levels of foods when I returned to Iitate. I also met Professor Ohtsura Niwa, who showed me how to measure radiation doses. The following year, I was able to measure radiation levels of foods.

As for Natsuhaze, I was advised to apply for the Cabinet Office's project for regional employment creation through restoration assistance. My application was accepted and we established Nikoniko Sugano Nouen, Limited Liability Company in February 2013. This allowed us to start preparing for processing of Natsuhaze berries in Iitate.

4. TWO YEARS AFTER THE DISASTER (APRIL 2013–DECEMBER 2015)

With the support of Professor Ohtsura Niwa, I was able to borrow a radiation dosimeter from Co-op Fukushima, which had purchased dosimeters for Co-op members to learn about radiation. I could use the dosimeter, which was made in Belarus, to measure radiation doses of foods from April 2013. The results are shown in

Table 1. The results show that persistence pays off: (1) radiation doses are clearly falling and more wild plants are fit for eating; and (2) radiation doses depend on the location and could even differ for the same crop. This meant that choosing crops growing in low-dose locations increased safety.

In September 2013, I accompanied an organisation that was going to Belarus to deliver electrocardiographs in an effort to assist Belarus with supply of medical

Table 1. Study on radiation doses of wild plants (unit: Bq kg^{-1}; location: Azashichiro, Kusano, Iitate).

Food	Isotope	2012	2013	2014	2015
Victory onion, fore mountain	Cs-137	557	15.6	19.6	–
	Cs-134	248.2	11	ND	–
	Total	805.2	26.6	19.6	ND
Victory onion, back mountain	Cs-137		63.6	86.3	21.2
	Cs-134		37.5	33	16.6
	Total		101.1	119.3	37.8
Victory onion, entry	Cs-137		47.8	21.1	12.6
	Cs-134		22.2	7.44	–
	Total		70	28.54	12.6
Hosta	Cs-137	ND	16.7	19.4	12.4
	Cs-134	ND	8.02	ND	–
	Total		24.72	19.4	12.4
Ostrich fern	Cs-137	2251.3	326	195	92.9
	Cs-134	1171.3	191	97.5	34.5
	Total	3422.6	517	292.5	127.4
Japanese horseradish leaves	Cs-137		27.9	13.8	22
	Cs-134		14.8	ND	ND
	Total		42.7	13.8	22
Shidoke (*Parasenecio delphiniifolius*), woods	Cs-137	70.2	135.0	152	125
	Cs-134	51.2	65.7	57.3	35
	Total	121.4	200.7	209.3	160
Shidoke, back mountain	Cs-137		85.8	44.1	19.4
	Cs-134		60.2	21.9	12.8
	Total		146	66	32.2
Natsuhaze	Cs-137	268		50.4	20.7
	Cs-134	167	Measured in Fukushima city	22.2	6.06
	Total	435	157	72.6	26.8

Blank spaces indicate that no measurements are available.

equipment. In Belarus, a woman in her thirties who had returned to her hometown after being relocated after the Chernobyl disaster, and an elderly couple who refused to move out of the forced relocation zone told me about their experiences. A local hospital director told me that thyroid cancer among children was the only disease that showed a clear increase after the nuclear accident. He said that the introduction of heart examinations increased the number of patients diagnosed and treated for heart conditions, but the increase was unrelated to the nuclear disaster. In September 2014, the Norwegian Radiation Protection Authority invited me to visit a mountainous region in Norway. The Norwegian Government and local residents told me that the livestock are inspected for radiation dose before shipment, and shipped if the dose is below the reference value. If the dose is not below the reference level, the livestock are clean fed for 3 months before they are re-inspected for shipment. I thought this was rational. The Japanese livestock farmer Mr. Takeshi Yamada, who was also on the trip to Norway, said that because the radiation dose of feed must be $<100\,\mathrm{Bq\,kg^{-1}}$ in Japan, he was having to import the feed he used on his farm. It appeared to me that this type of a barrier might discourage livestock farmers from resuming their businesses. I was told that, unlike in Japan, the farmers in Norway generally trusted the Government, but things could have been different if the Chernobyl disaster had occurred in today's information society. A female dairy farmer in her early thirties, who was at primary school at the time of the disaster, said, 'I wasn't worried because my parents stayed calm and we studied about nuclear accidents and radiation at school. I wasn't worried about going into dairy farming, or about getting married, or about getting pregnant.' This made me realise the importance of education. I felt the need to help the children of Iitate acquire knowledge so that they would not become unnecessarily worried, and would have the resources to counter prejudice and discrimination that they might face in the future.

5. TOWARDS THE DAY OF RETURNING TO IITATE IN MARCH 2017

There is a Japanese cedar forest outside the premises of our home in Iitate that acts as a windbreak. In the autumn of 2014, the trees were cut down for decontamination. The trees were planted by ancestors more than 60 years ago when my husband was born, so that their children could use the trees to build a house if necessary. It was regrettable to simply let the trees rot. When I spoke to the president of a construction company about this, he proposed building a house using the cedar trees as a symbol of the restoration of Iitate, and it was decided that most of the trees would be used for building our house (Fig. 3). The radiation dose of the trees was measured with the support of Mr. Junichiro Tada (Fig. 4). Trees are part of our family history. I thought that if people in other villages learned that they could build houses using trees felled for decontamination, this could lead to revival of local forestry and encourage more people to return to their villages. I also wanted to set the narrative about the situation in Iitate for communicating to the rest of the world. For me, building a house using the trees felled for decontamination is one of the outcomes of the ICRP dialogue seminars.

Fig. 3. The heartwood is placed side by side to form a wall.

Fig. 4. Cutting the tree to measure the radiation dose.

As a member of the education board of Iitate, the most difficult issue is how to re-open the schools in the village. Kindergartens, primary schools, and a junior high school in Iitate have temporary school buildings outside the village, and approximately half the number of students originally enrolled in the schools go to these schools on school buses from where they have evacuated. The plan is to re-open the schools in Iitate in April 2018. On this issue, the village authorities and parents will need to promote dialogue in the spirit of 'Madei', which means 'with sincerity' in Iitate.

6. CONCLUSION

The experiences that I have gained from more than 5 years in displacement may prove to be useful in the face of a future event, although I obviously hope that an event such as the Fukushima nuclear disaster will never happen again. The Great East Japan Earthquake of 11 March 2011, the tsunami, and living in displacement following the nuclear disaster have taught me that: (1) anything can happen in life; (2) measurement and data are important to have an accurate grasp of the situation; (3) networking with people through the ICRP dialogue seminars enabled me to take measurements; and (4) my family spurred me to action. It was important to have an accurate grasp of the situation so that my family could live in peace, and taking measurements was necessary to understand the situation. These measurements also provided hope. The data became a 'shield' from inaccurate information and false rumours, and protected my family and I from unnecessary anxiety.

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Raising children in Fukushima

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Abstract–Before the accident at Fukushima Daiichi nuclear power plant in March 2011, I never thought about radiation. After the accident, I originally evacuated with my two sons, but we returned home a few weeks later to be with my husband and parents-in-law as I felt that life with my family was what mattered and the very basis of my happiness. Today, 5 years after the accident, some people are able to think positively about the situation, and some remain uncertain. This article offers my experience and thoughts as a mother to help enable others to feel less stressed about eating food produced in Fukushima, and suggests ideas to help lift their spirits.

Keywords: Raising children; Evacuation; Contamination; Radiation measurement; Dialogue

1. OUR DAILY LIFE BEFORE THE EARTHQUAKE

I live, with my family, at the foot of Ryozen, a small mountain (825 m above sea level), in Date city, Fukushima Prefecture. I moved here 9 years ago when I got married. We are a family of six consisting of myself, two small boys, my husband, and his parents. Before the accident at Fukushima Daiichi nuclear power plant, our sons loved to play outside (Fig. 1), picking and eating fruit from our blueberry trees and strawberry fields, running around in the fields, stepping on the growing vegetables, and picking beautiful flowers. My parents-in-law used to laugh at them saying, 'Well, what can we do (with these little ones)?' When I prepared supper for my family, I harvested onions and carrots from our fields and felt grateful that we were so blessed.

Between our house and the foot of the mountain, there is a large (10,000 m^2) area of grass and flowers that has been maintained and protected by previous generations.

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Although it is not unusual to have plenty of open space in rural areas, I occasionally think that this land is excessively spacious.

2. AFTER THE DISASTER

The Great East Japan Earthquake took place on 11 March 2011 followed by the tsunami. Radioactive fall out covered our rich green natural surroundings and our house.

Our sons were aged 3 years and 1 year at the time of the disaster. Despite the power outage immediately after the earthquake, we used our own power generator to try to gather information from the television and radio. When I saw the images of the tsunami on the television, I was shocked and could not believe that what I was seeing was real. I just kept staring at those images, petrified. As the damage from the tsunami became more severe, news of the accident at Fukushima Daiichi nuclear power plant was reported. The situation became worse as time passed, and I was panic stricken. I wanted to just run away but I could not. I believe many people felt the same. On 14 March 2011, when we heard of the hydrogen explosion at Fukushima Daiichi, we decided to evacuate to my parents' home in Aomori Prefecture, 350 km north of our home in Fukushima. At that time, everyone in Fukushima wanted to run away as far away as possible; however, many people had nowhere to go and had run out of fuel, so had no option other than to remain in Fukushima. We were fortunate to have sufficient fuel and a place to stay in Aomori.

Our house is 46 km from Fukushima Daiichi nuclear power plant. It is located next to Iitate village, which was designated as an evacuation zone because the annual radiation dose exceeded 20 mSv. Although evacuation was not mandatory, 46 people, representing 14 of the 44 families in the village, many of them with children, evacuated following the Government's evacuation order. This was the start of our life of repeated evacuations.[1]

3. EVACUATION TO AOMORI

On 14 March 2011, our family left home in Fukushima and headed for Aomori at 9 pm. While driving along in the dark, we passed a red emergency vehicle heading to rescue the tsunami victims along the coast. In the uncomfortably heavy atmosphere, we were listening to repeated warnings on the car radio not to go outside unnecessarily, to wear masks and nylon jackets when going outside, and to remove mud from shoes before entering the house. Over the few days since the accident, this was the only information and advice provided by the Government. No information was given regarding how far the radioactive material would reach. As we drove through Fukushima, Miyagi, and Iwate Prefectures, everywhere was dark due to complete power outage as we drove along the bumpy roads damaged by the earthquake.

[1]Evacuation record: March 15–April 3: evacuation from Fukkushima to Aomori; April 3–July 7: temporary return to Fukushima; July 7–June 2012: evacuation to municipal housing prepared by Date city, as well as five more two-week periods spent in Aomori.

I remember driving slowly and carefully, seeing long queues of cars waiting for petrol stations to open, even though it was the middle of the night.

Early in the morning of 15 March 2011, as we entered Akita Prefecture, the radio reported the second explosion at Fukushima Daiichi nuclear power plant. I remember feeling desperate, with a sense of having to protect our children at all cost. My husband's parents had remained at home in Fukushima, despite our pleas for them to evacuate with us. They said that all their siblings and relatives were in Fukushima, and they could not leave them and run away. They said, 'You go ahead and escape with the children'. I could not understand why they would not come with us, but I finally came to understand, through their words, how they were feeling. I still remember very clearly when they saw us off. I was speechless and torn, thinking that I would never be able to return to our home.

4. EVACUATION LIFE IN AOMORI

As days went by, the magnitude and severity of the situation placed the entire country in a state of fear. On arrival in Aomori, I knew that we would have to live with radiation for a long time, so I ordered a dosimeter immediately. It was delivered, if I remember correctly, in April 2011. The people in Aomori welcomed us warmly when they heard that we had evacuated from Fukushima. However, my husband had to return to Fukushima for work. He did not have sufficient fuel to drive back to Fukushima, but the owner of the closed petrol station generously offered him a full tank of fuel when he noticed, from the license plate, that my husband was from Fukushima, saying 'We must help each other in times of need'. At that time, Aomori was also suffering from a shortage of fuel and poor logistics. My husband was fortunate – I heard some terrible stories through the media and local rumours that some people refused to fill cars with Fukushima license plates with petrol, and that children from Fukushima were being bullied. I felt that our family would fall apart if we continued to live separately from my husband and parents-in-law. I felt a sense of crisis that we might not be able to return to our old life. Although I did not want to breathe the air in Fukushima, I thought it was best to talk everything over with my family to determine if Fukushima was really so bad that we were unable to live there. I thought it would never be too late to make a final decision about evacuating to Aomori with my children, so I decided to return to Fukushima to view the situation for myself.

5. OUR FAMILY LIFE IN FUKUSHIMA

On 3 April 2011, we made a temporary return home to Fukushima after 3 weeks in Aomori. This marked the start of my daily work of measuring radiation dose. The measurement read $3\,\mu Sv\,h^{-1}$ inside the house and in higher places, and $>5\,\mu Sv\,h^{-1}$ outside. Radiation dose was particularly high in the gutters and under the roof, measuring $20–40\,\mu Sv\,h^{-1}$. Unable to wait any longer, we started decontamination measures ourselves. We scraped 5 cm of surface soil from around the house and from the vast meadows using heavy machinery. We had the gutters cleaned and replaced.

We cut down two of the four rows of cedar trees, which served as a windbreak. We tried many things, such as covering the surface soil with concrete and getting our drinking water inspected at the inspection agency. To our disappointment, some of the measures that we tried, such as high-pressure washing of the roof, and planting amaranthus which is said to absorb caesium in the fields, were not effective. My parents-in-law did much of the manual work, using scoops to decontaminate the area around our home. We started in April 2011 and had almost completed our work by November. The municipal office in our area finally started decontamination measures in December 2011, nearly 1 year after the disaster; this was relatively early compared with other areas of Fukushima. We tried to decontaminate every possible area that we could think of by collecting any information available. This extensive decontamination was not easy for an ordinary household. However, fortunately, we were operating a construction business and therefore owned heavy machinery and dump trucks. I felt very fortunate that I had married into this family.

Most of the people in my neighbourhood are elderly. Fourteen families have children of kindergarten age or school age; we were the only family who had preschool children at home during the day. Therefore, we had a deluge of television and newspaper reporters from the mass media every day for over a month, asking questions such as, 'Is it safe for the children to live here?' 'Aren't you going to evacuate?' It made me feel uneasy and my heart was shaken. I almost went crazy and was really stressed. My 3-year-old son started to soil his underwear, maybe due to the terrifying experience of the earthquake or maybe because he picked up on my own feelings of insecurity. I was obsessed with thoughts of iodine and caesium, and I felt desperate when I heard that strontium had also been detected. I was anxious, I was stressed, and even my sweet-natured mother-in-law who never complained said, 'Who can live in such a place...?' My entire family was pushed to the edge.

At a conference on radiation, a doctor told us that, following the accident in Chernobyl, citizens in the contaminated area felt insecure for a long time and many became sick due to anxiety and stress. The doctor told us to make sure we had the correct information and to be afraid for the right reasons. That particular phrase caught my attention. I have subsequently attended various conferences to gather information regarding how to live with radioactive materials. As a result, ironically, I found it difficult to distinguish between who was telling the truth and who was not. Gradually, I settled down.

What was most important was protecting the children from internal exposure by being very attentive to what they ate. I learned that radioactive material is discharged from the body. The only way to fight against it was to build up immunity and boost metabolism by building a strong, healthy body. I was once again reminded of my responsibility as a mother. From very early after the disaster, I told my children that it was safe to play outside as long as decontamination had been completed. Of course, there were still many places within our property and in our neighbourhood that were untouched and remained contaminated. After decontamination, I measured the radiation dose and found levels of 0.08–0.19 $\mu Sv\,h^{-1}$ inside the house and 0.14–1 $\mu Sv\,h^{-1}$ outside, including areas that were untouched. I was happy to discover that the

radiation had reduced over time. I used to stare at the dosimeter all the time in the beginning, but 18 months after the accident, I stopped using it. Having gone through many internal struggles, I was finally sure of what it meant to raise my children in Fukushima, and I was freed from feelings of insecurity and fear. Although I thought I knew how to deal with radiation, I was so afraid of feeling insecure and depressed again that I stopped using the dosimeter or measuring radiation dose.

6. EXPERIENCING THE DISASTER

I needed a strong sense of determination to stay in Fukushima with my children. Some of my friends evacuated as far away as Okinawa Prefecture. I almost gave up many times, but each time I told myself that there was nothing better and happier than keeping our family, a family of six, together. I am not sure how this life will affect my children's future, but when I think of the many other things that affect our health, such as smoking, food additives, agrochemicals, electromagnetic waves, etc., I can remain positive and consider radiation as just another evil on the list.

Looking back, I have learned many lessons, and gained a great deal, from this event. My mother-in-law tells me that she feels happy when she is making 'Daifuku' rice cakes with me. She also tells me that she feels happy that we can all live together as a family. I have come to find happiness and gratitude in things that I previously took for granted. I am happy that I was given the opportunity to take a fresh look at my life and to make new discoveries. There were extremely tough and difficult decisions, but happy surprises too. I certainly never dreamed that I would start running marathons.

7. FUTURE OF FUKUSHIMA

Despite the severity of the accident at Fukushima Daiichio nuclear power plant, I was very fortunate. It was a painful experience for everyone, regardless of whether they remained, left, or returned to Fukushima. Five years after the accident, some people are able to think positively about the situation, and some remain uncertain. Many mothers are still not convinced that is it safe to live in Fukushima. I think it is totally understandable that there are people 'who are still afraid to buy vegetables produced in Fukushima' or 'who do not want to learn about radiation because nuclear power plant related information from television news and newspapers only makes them cry'. I think this is a normal reaction by mothers who care deeply about their children.

In order to be physically and mentally healthy, it is best to have a good balance of nutritious food and exercise. It is often said that one needs to be with other people or involved in the community in order to be mentally healthy and to reduce anxiety and stress. In Japanese rural culture, there is an old custom called 'Ochanomi' (tea drinking), and we enjoy this in our family. At 6 am, our neighbours come round without letting us know in advance. When the weather is good, we all sit on our porch with our tea cups and tell each other stories, such as having seen wild boars

Fig. 1. Our home environment where children play outside.

and snakes. It is important to create more opportunities like this, where people can talk their hearts out. I would also love to listen to the voices of mothers if that could be of help.

In Fukushima, what we need in the future is not decontamination (with the exception of some areas), but dialogue and to be with and listen to people who need to be heard. Education and human development are very important, and experts who can speak the same 'language', with simple and comprehensible words, are indispensable.

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A farmhouse son-in-law and radiation

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Abstract–The residents of Suetsugi in Fukushima Prefecture measured ambient dose rates and radiocaesium concentrations in the soil after the accident at Fukushima Daiichi nuclear power plant in an attempt to maintain living conditions in the region. The measurements were colour plotted into maps to visualise the contamination. Through the receipt of external support, a number of radioactivity-related initiatives were implemented for the residents. Studies were also undertaken regarding the impact of radiocaesium contamination on rice farming in Suetsugi following the Great East Japan Earthquake and the accident at Fukushima Daiichi nuclear power plant.

Keywords: Ambient dose rate; Radiation concentration in soil; Rice farm

1. INTRODUCTION

1.1. Suetsugi

Suetsugi is in Hisanohama-machi district on the northern side of Iwaki city, at the southern tip of Hamadori. It is a small hamlet facing the sea and surrounded by mountains, next to Hirono-machi in Futaba-gun. Before the Great East Japan Earthquake in 2011, there were 120 households and approximately 500 people living in Suetsugi. At this time, Suetsugi was similar to any other hamlet, with residents growing vegetables in their fields for their own consumption. Following the disaster, the ocean side of Suetsugi was devastated by the tsunami, and many people left the hamlet as a result. Today, 5 years after the disaster, restoration of the embankment is still not complete. Azaleas have been planted at Suetsugi station

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Fig. 1. Suetsugi [azaleas (left), hydrangeas (right)].

and along the rail tracks, and hydrangeas grow in the area surrounding the station and the national highway. These flowers are in full bloom in spring and summer every year (Fig. 1).

1.2. The accident at Fukushima Daiichi nuclear power plant

Suetsugi is situated 27 km from Fukushima Daiichi nuclear power plant, and was therefore included in the 30-km radius zone, designated the 'indoor evaculation zone'. We evacuated to a relative's house in Saitama Prefecture immediately after the accident on 11 March 2011 that followed the Great East Japan Earthquake and tsunami. I subsequently learned that all the residents who did not evacuate in the immediate wake of the accident were evacuated on order of the city government on 13 March 2011. Some of the residents returned when the indoor evacuation order was lifted on 22 April 2011. Approximately 100 households have now returned to Suetsugi, but 30–40% of those of my generation with small children have not returned.

2. CONFRONTING RADIOCAESIUM

2.1. Measuring ambient dose rates in Suetsugi

As residents of Suetsugi, we wanted to know the situation we were facing in terms of radioactivity, so we decided to measure ambient dose rates for every house in the hamlet. In January 2012, approximately 10 months after the disaster, a total of 40 residents participated in this task for 2 days. Groups of two to three people were formed, and each group read the measurements on the dosimeters, recorded the measured results on data sheets, and recorded the date of measurement. Five measurements were taken at points 10 cm and 1 m above the ground. All four sides of buildings were measured, as were areas considered to have high ambient dose rates, such as where rainwater might accumulate (Fig. 2).

2.2. Measuring radiocaesium concentration in rice paddy fields

After measuring the ambient dose rate, the radiocaesium concentration in soil was also measured to determine whether or not rice farming could be resumed.

Fig. 2. Measuring ambient dose rates around the residences.

Fig. 3. Collecting soil samples and measuring ambient dose.

The ambient dose rate was also measured while soil samples were collected (Fig. 3). Soil samples were collected from depths of 0–5 cm and 5–10 cm from each of the 440 rice paddy fields in the region. Soil samples were also collected from a few fields and forest areas. In total, 1000 soil samples were collected and taken to a local company for analysis. It was agreed that we would collect the soil samples, allocate numbers to them, and indicate their origin on a map, and that the company would perform the analysis at a cost of 100 Japanese yen per sample. The total cost was approximately one million yen, paid for by Tokyo Electric Power Company (TEPCO).

2.3. Drawing radiation maps

Maps were drawn to show ambient dose rates and radiocaesium concentrations in the soil, using colours to clearly illustrate the radiological situation in the region (Figs 4 and 5). An expert who visited Suetsugi told us that ‘radioactivity is an invisible ghost’, but we made the measurement results visible so that everyone in the region was able to understand the situation. The maps were located in the local assembly hall so that everyone was able to see the data from the environmental measurements as well as their personal dose rates whenever they wished. Although

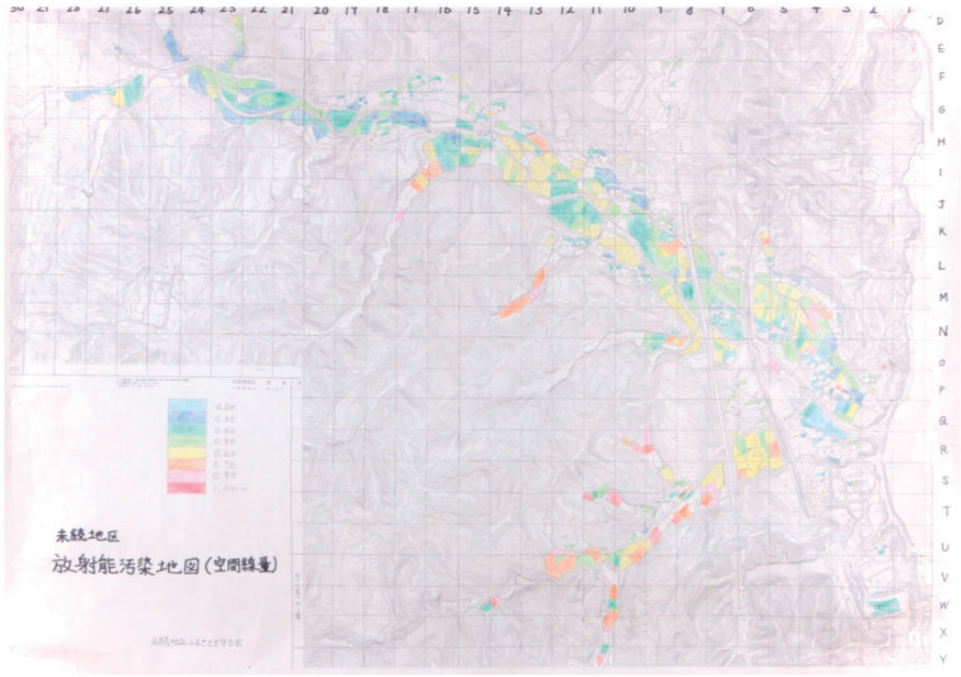

Fig. 4. Map of ambient dose rate in Suetsugi.

it took time for the local authorities to take action, we, as residents, were able to achieve our initial goal by taking charge of our own living environment.

2.4. Support given to Suetsugi

In the wake of the accident at Fukushima Daiichi nuclear power plant, we initially worked with the so-called 'anti-nuclear people'. However, as time went on, we started to realise that these people only talked and took no action. At this point, I consulted one of my acquaintances in Suetsugi, and I was introduced to Ms. Ryoko Ando of Ethos in Fukushima who was providing support in the region through a study group that she had founded after the disaster. Subsequently, with the support of Ethos in Fukushima, we were able to hold study sessions and dialogues to measure internal exposure with whole-body counters, and measure radiocaesium concentrations in foodstuffs with the experts (Fig. 6). We also measured cumulative external exposure with dosimeters that we borrowed from other volunteer organisations. However, the batteries of these dosimeters needed to be changed every day, and it was not easy to keep records of daily activities. These factors made it difficult to communicate and explain the measurement results to the residents. Later, we were able to acquire dosimeters with a longer battery life that could record hourly cumulative doses. One hundred residents carried these improved dosimeters, and we were able to share the data and the opinions of experts regarding the measurement results.

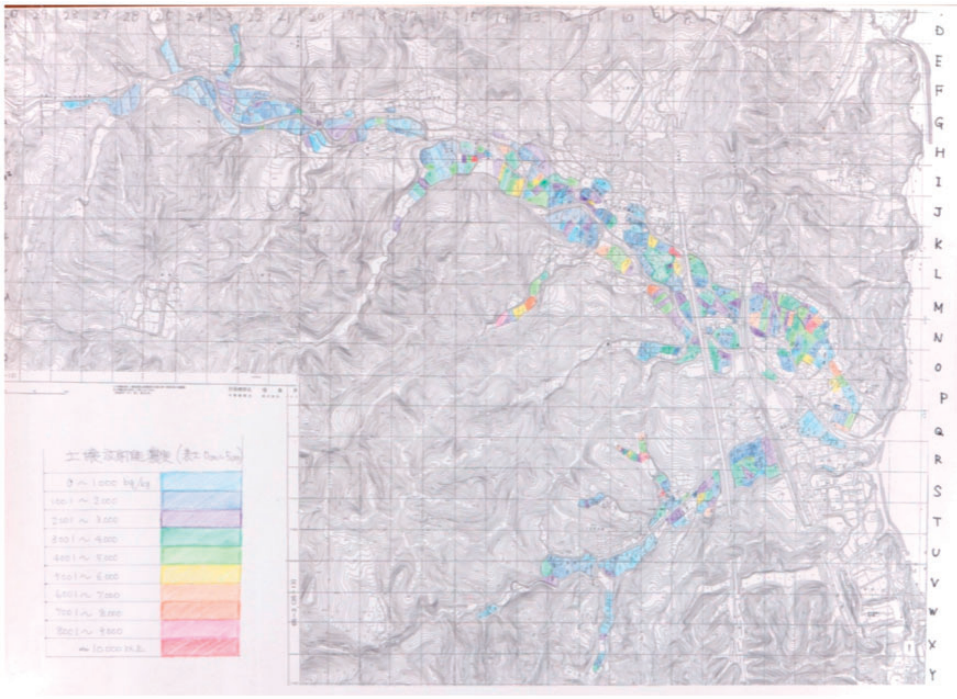

Fig. 5. Map of radiocaesium concentration in rice paddy fields in Suetsugi.

Although the number of dosimeters in use is now declining, I feel that people should continue to do so if this helps to put their minds at rest. Having drawn up our maps, I realised the importance and the effectiveness of our experience of recording and visualising the data. We received a great deal of external support, and I feel that the opportunities to meet with many experts and volunteers were very valuable encounters for Suetsugi and for myself.

3. RICE FARMING AFTER THE DISASTER

After the accident at Fukushima Daiichi nuclear power plant, we were told not to grow rice. However, as I wanted to confirm the reality of the situation, I planted rice in a single paddy field in 2011, knowing that I would not be able to sell the rice. The first harvest after the accident was analysed by a local company.

The unpolished rice was found to have a radiocaesium concentration of $232\,\mathrm{Bq\,kg^{-1}}$. Another bag of rice from the same harvest from the same paddy field on my farm was sent to Iwate Agriculture and Forestry Office, and found to have a radiocaesium concentration of 76 $\mathrm{Bqkg^{-1}}$ (Table 1). I cross-checked to see if there were any differences in the environments in which the rice was measured, but no


Fig. 6. Briefing sessions by experts (left). Dialogue sessions (right).

Table 1. Results of the measurements of radiocaesium concentrations of rice harvested in 2011.

	1. Tested personally	2. Stored rice	3. Iwaki Agriculture and Forestry Office re-tested rice	4. Defective rice
	4 October	30 December		
Cs-137	118	35.6	39.6	126
Cs-134	114	40.4	37.2	104
Total	232	76.0	76.8	230

1. Harvested rice tested by the author – 232 $Bqkg^{-1}$ total radiocaesium.
2. Iwaki Agriculture and Forestry Office testing of stored rice detected 76 $Bqkg^{-1}$ total radiocaesium. The stored rice means the abortive kernel which does not satisfy the size for delivery.
3. Re-testing of the stored rice (different bag of rice).
4. Defective rice tested to highlight the difference in results for 1, 2, and 3.
Amount of harvested rice = on average eight straw bags from a 1 tan field [10 a (31.5 m x 31.5 m)]: about 300 tsubos

major differences were evident. It is difficult to imagine that shaking the rice during threshing, transportation, and drying processes after harvest could have caused differences in contamination between bags. As the radiocaesium concentration decreased over time, it may be that contamination of the machines used for packaging could explain the differences in contamination between bags. The second year harvest from the same paddy field had a radiocaesium concentration of 10 $Bq\,kg^{-1}$, and the level was undetectable by the third year. We are now consuming the rice produced in our paddy field ourselves at home. I am committed to continue to reduce the radiocaesium concentration as low as possible in our rice. I believe it is the responsibility of us, the producers, to produce safe and secure products.

4. MOTIVATION FOR OUR ACTIVITIES

Drawing maps and continuing to grow rice stem from my own curiosity to know the truth. After the disaster in 2011, there were days and days of nothing but complaining. If I had been asked at the time what I wanted to do, the truth is that I did not feel like doing anything. After the disaster, the municipal government and TEPCO did nothing to restore the living environment in this small hamlet. I felt that it was unjustifiable that people who were in responsible positions to take leadership were doing nothing. Therefore, I decided that we ourselves would do whatever we could until the authorities and TEPCO started to act. The motivation was that unless we took action ourselves, we would lose everything that we treasured. With this determination to take the first step, my feelings also changed. My strongest motivation was that I did not wish my son, aged 3 years at the time of the accident, to grow up seeing a cowardly father. I wanted him to grow up ready to face any difficulties, with the attitude that he would never give up. Meeting Mr. Jacques Lochard at the International Commission on Radiological Protection dialogue seminars was another motivation. In one of the seminars, I remember being very strongly impressed by his words. To the question from a resident, 'Can we return home in the future?' Mr. Lochard answered, 'It's you, not I, who make that decision.' He was different from all the other experts I had met before. Other experts gave answers that sounded good and tried to make people feel better, but Mr. Lochard was different. He was sincere. Even today, Mr. Lochard never forgets to visit us, as he promised then, every time he is in Japan. I am grateful to all the people I have met and who have supported us, whom I would never have met if the disaster had not taken place. I would be happy to return their kindness, however and whenever I can. Suetsugi is what it is today thanks to all those who have contributed. It is what we wished for and is what we have achieved.

5. CONCLUSION

Suetsugi has settled down considerably since the disaster. I feel so grateful that there are still opportunities to talk and discuss the results of our work, which we have continued since the accident at Fukushima Daiichi nuclear power plant. I would be more than happy to share my experiences with other regions if this would be of assistance.

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Eyes to the unseen, ears to the unheard

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Abstract–I have learned a great deal by participating in the ICRP dialogue seminars. I will summarise what I have observed and felt regarding the thoughts of the inhabitants of Fukushima over the last four and a half years, and what the ICRP dialogue seminars meant to them.

Keywords: Unseen; Unheard; Thoughts; Will; Listen closely

1. MY ENGAGEMENT WITH FUKUSHIMA

I myself was hardly impacted by the Great East Japan Earthquake. I spent that unforgettable day, 11 March 2011, in Oita city in Kyushu where not a single tremor was felt. After moving to Tokyo with my family, there was hardly any change to our daily life except for the recommendation to save power. The affected territories were, for me, a world within the screens of computers and television sets.

My first encounter with Fukushima was in August 2012 when I was in my first year at university. I participated in the support programme, the 'Mura juku' project, in Iitate village. This was an educational initiative that Iitate village had entrusted to a cram school in Fukushima city in order to improve the scholastic aptitude of junior high school students from the village. I participated in 2012 and 2013 as a volunteer tutor.

I also participated in the fifth ICRP dialogue seminar in March 2013, and subsequently attended a further seven dialogue seminars up to the last one in December 2015.

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2. MY IMPRESSIONS AND THOUGHTS ON FUKUSHIMA PRIOR TO PARTICIPATION IN THE DIALOGUE SEMINARS

I was in Tokyo preparing for my university entrance examination the year after the nuclear accident. The people who had suffered unspeakable losses of their loved ones and their cherished belongings were always on my mind while I concentrated on my studies. I even felt apologetic, close to a sense of guilt that I was studying for my entrance examinations, unaffected by the disaster.

During all this, I was thinking that I would search for what I could possibly contribute once I started university. This determination led me to participate in the 'Mura juku' project in Iitate village. I had always had an interest in the affected area, feeling sympathy for the people, as I heard about it from my father who went to Fukushima regularly.

3. MY THOUGHTS ON THE DIALOGUE SEMINARS

Looking back at the eight ICRP dialogue seminars I attended, there were many different aspects of the post-accident situation. I would like to summarise my thoughts and impressions, dividing them chronologically into the following three phases – first phase: awareness and shock (fifth to seventh ICRP dialogue seminars); second phase: sense of helplessness and doubt (eighth and ninth ICRP dialogue seminars); and third phase: a feeble light ahead (10^{th} to 12^{th} ICRP dialogue seminars).

3.1. First phase: awareness and shock (fifth dialogue seminar 'Homecoming', sixth dialogue seminar 'Iitate', seventh dialogue seminar 'Iwaki and Hamadori')

In the first phase, I came directly into contact with the mixed feelings and emotional turmoil of people who had to evacuate from their beloved hometowns. I could not listen to the words of the affected people without pain in my heart; they spoke in a matter-of-fact yet desperate tone, and at times in a choking voice as they talked about the agony of being separated from their families and friends, the excruciating pain of leaving the land handed down from their ancestors and letting the fields be desolate, fear of radiation, and the hardships in their daily lives. I was embarrassed to have thought I already knew enough about Fukushima by imagining the situation from what the media reported. In reality, I knew so little.

At the same time, I was to learn that only a few of the affected community members were participating in the ICRP dialogue seminars, and so many affected people had lost all hope and energy and were not able to raise their voices. The 'voices of the voiceless' were muffled up and buried away. Also, Fukushima is always referred to as an area affected by the nuclear power plant accident in the context of the Great East Japan Earthquake, but I was reminded that the initial damage was brought upon Fukushima by the tsunami. It made me realise how limited my mental horizon was, and that I had nothing more than an image of the situation.

The first phase jolted me with 'awareness and shock' that I knew nothing.

3.2. Second phase: sense of helplessness and doubt (eighth dialogue seminar 'Minamisoma', ninth dialogue seminar 'Child rearing')

In the second phase, I felt strongly that the affected people were beset with doubts and suspicion towards the authorities and experts, and I was tormented with a deep feeling of paralysis and my own helplessness of not being able to do anything. Mothers with small children were tormented constantly with anxiety and stress, thinking that they had to bring up their children in as safe an environment as possible, and had to protect them at all costs in a situation that was full of things beyond their understanding. Suspicion accumulated as they struggled in solitude. Were they able to continue to live under the influence of radiation? Where should they bring up their children? Was it safe to go outside? What was safe to eat and not safe to eat? What was the Government doing? Were the experts talking irresponsibly? Was information hidden or manoeuvered? Their anxiety and doubts seemed to be so deep-rooted and desperate that nothing could erase them, and a solution was nowhere to be found.

Initially, I hoped that the ICRP dialogue seminars would provide an opportunity to make people look forwards. However, my expectations were crumbling as time went on, with a feeling of stagnation and helplessness. I was even starting to feel doubts towards the ICRP dialogue seminars themself.

3.3. Third phase: a feeble light ahead (10th dialogue seminar 'Tradition and culture', 11th dialogue seminar 'Life and measuring', 12th dialogue seminar 'Past and future')

As the dialogue seminars entered their third phase, topics selected for discussion changed to those that gave us feelings of hope. Many activities were introduced, such as reviving local festivals and arts; reviving little by little the food culture of Fukushima, including wild vegetables ('sansais'); and re-examining the residents' lives through measuring radiation dose. These activities could be the basis of their lives tomorrow and in the future. Determined, future-oriented action programmes were suggested to revive the human bonds that had been severed by the accident and to recreate damaged lives. No one was free from injury and trauma, but even when confronted by diverse problems, they spoke of reviving their lives through what each could contribute.

It was the third phase that raised hopes in positive attitudes and ways to look at the real life of the participants in the ICRP dialogue seminars.

4. WHAT I LEARNED FROM THE DIALOGUE SEMINARS

The struggle and activities of the affected inhabitants after the accident were reported at the ICRP dialogue seminars. However, what struck my heart most was not the actual reports but each person's own pain, sadness, and determination. Gradually, society began to free itself from the impact of the accident, forgot it, and continued to change. Nevertheless, it was terrible to see the sadness and pain of those

who were trapped and abandoned in the 'aftermath of the accident', feeling like time had stood still. 'How can we live in this environment?' This phrase touched me as an expression of bewilderment, anxiety, and strong fear rather than a presentation of the actual problem. However, the participants of the ICRP dialogue seminars have strong willpower to face and overcome their wounds and sadness. I believe that their power to rise above pessimism is the underlying basis of the 12 ICRP dialogue seminars.

5. WHAT THE DIALOGUE SEMINARS EMPHASISED

Generally speaking, society places emphasis on efficient, public, universal, logical, and objective approachs. However, focusing on those aspects alone can lead to neglect of the human heart. In quite a few cases, objective and convincing solutions ignore the voices of scattered minorities who remain unconvinced and are left alone to suffer.

The ICRP dialogue seminars took an alternative approach, focusing on different aspects to those valued in society. They made a consistent, inefficient approach to find solutions, listening to personal/individual and emotional/subjective voices. At times, this process also uncovered people's emotions that had been buried intentionally and rationally to move forwards. Participants spoke of their thoughts and feelings, listened to individual sufferings, and there were no voices that denied or criticised the opinions of others. I believe that the essential point of the ICRP dialogue seminars was getting close to and supporting affected people, and this enabled them to move forwards.

6. HOW TO CONFRONT PROBLEMS

Society tends to place emphasis on what can be seen and what can be heard when trying to face problems. It aims to have productive discussions based on correct information to find solutions or make decisions. However, the ICRP dialogue seminars focused on what is unseen and what is unheard. In other words, people's feelings and their determination, which can only be revealed through human relationships. Sometimes, just being at one's side in silence makes it possible for people to open their hearts and build trust between each other. It is the 'unseen' that inspires people into action. The ICRP dialogue seminars have promoted human relationships in this way. It is not that they neglected what can be 'seen' and 'heard', but they paid more attention to the 'unseen' and the 'unheard'.

It goes without saying that a rational approach to what is visible is indispensable. However, society is a gathering of living human beings burdened with emotional conflict and individual past history, and it would be inhumane to try to move forwards ignoring individual feelings. I think the ICRP dialogue seminars showed us the power and importance of the inefficient but humane approach.

I conclude with two quotes that represent my thoughts on the stance of the ICRP dialogue seminars and what I have learned:

Give every man thy ear, but few thy voice;
Take each man's censure, but reserve thy judgment.
Hamlet Act 1 Scene 3 (words of Polonius)

The reality of the other person is not in what he reveals to you but in what he cannot reveal to you. Therefore, if you would understand him listen not to what he says but rather to what he does not say.
Khalil Gibran

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Report of decontamination at Tominari Elementary School

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Abstract–On 19 April 2011, the Ministry of Education, Culture, Sports, Science, and Technology designated 13 elementary schools, including Tominari Elementary School in Date city, as high-dose schools that needed to restrict outdoor activities due to the effects of the accident at Fukushima Daiichi nuclear power plant. Approximately 1 week later, the municipal government took action to remove the topsoil from the school grounds, and the prohibition of outdoor activities at Tominari Elementary School was lifted. The school staff continued to work on decontaminating the surrounding areas using high-pressure washers and brushes. There were certain positive outcomes, but a more effective decontamination method was required. In July 2011, the municipal government started an environmental remediation project, both inside and outside the school buildings, with researchers and decontamination workers at Tominari Elementary School, involving members of the Parent–Teacher Association (PTA), local communities, and volunteers using various effective and specialised forms of decontamination. As a result, Tominari Elementary School was able to recommence swimming lessons at the end of the first semester, which had been thought to be impossible. This article will provide information about the importance of 'dialogue' for decontamination, how engagement of the experts gave members of the PTA and the local community a feeling of 'security and safety', and how the decontamination work was an ever-expanding collaborative work of a large number of people.

Keywords: Schools after the accident; Restriction of outdoor activities; Safety and security; Decontamination project; Collaborative decontamination; Dialogue; Demonstration experiment; Scientific understanding

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

1. INTRODUCTION

Tominari Elementary School is located approximately 60 km northwest of Fukushima Daiichi nuclear power plant in beautiful natural surroundings. Initially, it was thought that the school would not be affected a great deal by the accident, and an entrance ceremony was held with all the pupils in April. However, in mid-April, Tominari Elementary School was designated as a high-dose school and outdoor activities were restricted. This came as a great shock to the staff, the members of the Parent–Teacher Association (PTA), and particularly to the entire community.

Contaminated soil was removed from the school grounds by the municipal government, and buried in the ground; there were concerns about whether or not the local community would accept the decontamination project at the school. However, what was a large-scale professional-standard decontamination process at that time was carried out. This decontamination process was subsequently used in other parts of the city. The decontamination work was an example of true collaborative work, involving members of the PTA, local inhabitants, and volunteers from across Japan who answered the calls of the project leaders.

This article will report how a safe and secure environment was created around Tominari Elementary School by describing the processes of this collaborative decontamination project involving municipal authorities, experts (radiation researchers and professional decontamination specialists), and school staff.

2. THE FIRST DECONTAMINATION

In mid-April 2011, Tominari Elementary School was designated as a school with an ambient dose $> 3.8\,\mu Sv\,h^{-1}$, and outdoor activities were restricted. At this time, most schools in Fukushima Prefecture were limiting outdoor activities due to fear of radioactivity. Therefore, the official designation notice led to no changes in the school activities. However, following the announcement that Tominari Elementary School was one of the high-dose schools, the school started to receive telephone calls with invitations to evacuate from other prefectures, reporters from the media requested interviews, and anxiety levels increased in the community. Briefing sessions and workshops were held for members of the PTA and school staff, which helped them to understand the overall situation, units of measure, and calculation of safety criteria. However, a greater concern was how to deal with the existing situation and the possibility of changes to the reference value. The school staff did everything possible to continue with 'ordinary school life', believing this to be the best way to reduce anxiety among children and their parents.

The municipal government decided to start decontamination work, giving high priority to children's daily life, by reducing radiation dose in the grounds of those schools with prohibition of outdoor activities. At the end of April 2011, scraping of the topsoil in the school grounds commenced (Fig. 1). This involved scraping 15 cm of topsoil, removing the scraped soil, and replacing it with non-contaminated soil.

The work was undertaken over the weekend when the children were not at school. Originally, waste soil was planned to be stored temporarily in the community area, but it had to be buried on the school grounds due to opposition from local residents. The soil from digging the hole for burying the topsoil was taken outside the community area. Although the issue of how to treat waste soil remained, the average dose in the school grounds was $< 0.37\,\mu Sv\,h^{-1}$ after decontamination; this was the second lowest dose at the school, with the lowest dose found in the gymnasium, built of reinforced concrete.

Following decontamination of the school grounds, the restriction on outdoor activities was lifted. However, the next step was to think about decontamination of high-dose areas in the surroundings, as there were more and more demands from parents that decontamination was not progressing around the wooden school buildings, or to lower the dose of the children as much as possible. By this time, many parents had dosimeters and were able to access dose information in the area, including at school.

Soon after, the city authorities distributed washers for decontamination, and the PTA agreed to take part in the decontamination work. At Tominari Elementary School, the staff spent 3 days measuring 12 different places in the school premises to create a dose distribution map and perform test decontamination. After measuring with the dosimeters provided (maximum measurement $10\,\mu Sv\,h^{-1}$), high-pressure washers and brushes were used for decontamination.

As a result, it was found that certain places, such as drain ditches, had ambient dose rates $> 10\,\mu Sv\,h^{-1}$, and that the dose rates at rainwater pipes (>8–$10\,\mu Sv\,h^{-1}$) and catch basins (3–$12\,\mu Sv\,h^{-1}$) could be reduced by a factor > 2 by washing decontamination. On the other hand, the dose at brick walls and the surface of paved

Fig. 1. Decontamination of school grounds ($3\,\mu Sv\,h^{-1} \Rightarrow <0.37\,\mu Sv\,h^{-1}$).

asphalt roads in front of the school building, decreased by $< 0.1\ \mu Sv\ h^{-1}$ following decontamination.

Doses differed with location and building materials. There were also hotspots scattered here and there. A more efficient decontamination method was needed for places such as outer walls, as walls tend to peel from washing. High-dose areas were marked with signs showing 'No entry zone'. The municipal authorities were asked to measure the dose in areas that could not be measured with dosimeters, and these areas were excluded from the decontamination areas under the responsibility of the PTA. How to decontaminate the areas that did not improve following the initial decontamination measures remained a challenge.

3. DECONTAMINATION PROJECT STARTS

3.1. Briefing sessions for decontamination around the school premises

In June 2011, as decontamination progressed in all the school grounds in the city, the decision was made to install air conditioners in all classrooms as summers in Fukushima are very hot. It was also at this time that the timeline for environmental decontamination around the school buildings and the surroundings was decided. However, it was not known whether or not the remaining issues facing the inhabitants would be solved by decontamination.

Two weeks prior to the PTA-led decontamination, the municipal government appointed an advisor for effective decontamination, and the decontamination project was ready to start. It was proposed that this project would be carried out jointly with the PTA members. This proposal was discussed, and implementation of the project was decided after reaching a consensus regarding the objective and timing of the decontamination.

Initially, a meeting was held with the PTA members, the principal (the author) and assistant principal of the school, representatives of the municipal government, and the advisor to report the results of the experimental decontamination carried out to date, as well as the remaining issues. The representatives of the municipal government and the advisor explained the most recent decontamination methods that were to be used and the anticipated numerical results. The school members asked various questions about radiation and the decontamination methods, and received clear answers from the government team. Following the meeting with the representatives of the municipal government, the school members asked for a briefing session prior to starting the decontamination work. This was to inform each member of the PTA, in plain language, about the issues that arose in the decontamination of the school grounds, such as 'explanation of radiation/radioactivity', in order to carry out this project successfully.

A briefing meeting led by the advisors and decontamination specialists took place on Sunday (Fig. 2). The large-scale decontamination had been announced through the media and on the internet, and many participants from kindergartens and other areas came along. The same instructions were given, each with specific reasons, as those given for the previous decontamination efforts, such as how to wipe windows

Fig. 2. Briefing session to parents (3 July 2011).

and shelves effectively, and the most up-to-date methods for decontaminating slopes, walls, and the ground with minimum exposure were also explained. Explanations were given in easy-to-understand language, and each question was answered carefully. One of the welcome yet surprising revelations was that masks, long-sleeved shirts, and long trousers were no longer required.

At first, the atmosphere was tense, but a peaceful and friendly atmosphere prevailed in the room as people started to talk to each other. The PTA members suggested that everyone could start by weeding the school ground slopes, which was not included in the plan, but local residents and parents of children stood up to get the weed whackers. As time went on, in July 2011, the meetings turned into dialogue-style discussions and lasted for four times as long. The main reason why the local residents and volunteers were able to carry out this collaborative decontamination work was due to the very thoughtful and scrupulous explanations given by the professionals, which removed the doubts and anxiety of the local residents.

3.2. Three decontamination projects

Decontamination projects were divided into three areas: interior of school buildings (classroom, windows, berms, gutters, veranda); outside the school buildings (plants, garage, outer stairways, approach, embankment, playground equipment); and the swimming pool (pool water, facilities around the pool, building). These were carefully planned, explained, and implemented.

Decontamination inside the school buildings was performed by members of the PTA after the following thorough instructions: clean floors and windows carefully using mainly chemical and water rags, which should be folded after each wipe; and smooth surfaces should be dusted with diluted kitchen detergent or chemical rags. The same decontamination method was used in homes and local buildings.

With this decontamination, the air dose was reduced from 0.11 $\mu Sv\,h^{-1}$ to 0.06 $\mu Sv\,h^{-1}$ at 50-cm height in the classroom, and from 10 $\mu Sv\,h^{-1}$ to $< 1\ \mu Sv\,h^{-1}$ in the gutters.

Decontamination outside the school buildings involved scraping the ground and walls around the school buildings using machines. This work was undertaken by professionals, except for the slopes. Asphalt surfaces and other small holes that had been filtrated by radiation were decontaminated using the sandblast method (Fig. 3). This method involves scraping the area with a fine abrasive media of sand, which is then sprayed using equipment with filters attached. If there were cracks in the surface to be decontaminated, weeds were removed, and the cracks were filled with asphalt. Plastics such as playground equipment were cleaned using chemicals or just wiped.

Weeds were cut from the slopes and the roots were removed by scraping. Planted areas were pruned with electric cutters fitted with a vacuum cleaner bag (Fig. 3).

The effects of this decontamination test work showed results that could be confirmed both visually and numerically.

School staff struggled with decontamination of the asphalt surfaces, yet the air dose decreased from 8 $\mu Sv\,h^{-1}$ to 0.7 $\mu Sv\,h^{-1}$, the school ground dose decreased from 3–5 $\mu Sv\,h^{-1}$ to 1–1.5 $\mu Sv\,h^{-1}$, and the dose around the planted areas decreased from 3.7 $\mu Sv\,h^{-1}$ to 0.7 $\mu Sv\,h^{-1}$.

Decontamination of the swimming pool involved a highly technical method. After the accident, it was thought that it would not be possible to use the pool for some time as the drainage would be directly connected to waterways used for newly planted paddy fields. It was felt that the inhabitants would not agree to this drainage method as it had been difficult to persuade them to accept surface soil from the school grounds.

Decontamination of the swimming pool was performed in three phases, confirming the effectiveness after each phase. Similar work was performed simultaneously in the fish pond.

Professionals purified and drained the water in the 200-ton swimming pool, followed by decontamination in and around the swimming pool by professionals together with members of the PTA. The last phase was to supply water to the pool through a filter.

The pool water was purified to reduce the contaminated water to the reference value for drinking water (tap water standard $< 50\ Bq\,l^{-1}$). Zeolite was used to absorb radioactive caesium, coagulating sedimentation with blue-green algae, and collected as sludge. It was dried, put into plastic bags, and left in temporary storage as waste material.

A briefing session was held on the first day of decontamination of the swimming pool. The project team explained about water purification and performed a demonstration experiment for the officials of the waterway union who had come to the school. The murky contaminated pool water (650 $Bq\,l^{-1}$) went through the decontamination device, and came out clear and measuring $< 50\ Bq\,l^{-1}$. The members of the union who saw this result agreed immediately that it was acceptable to drain the water, and left. It was considered that visible proof of numerical facts had proved most convincing.

Work to decontaminate the swimming pool continued for 10 days, involving water purification and thorough decontamination inside and in the peripherals of the swimming pool. Clear pool water measuring $< 50\ \mathrm{Bq\,l^{-1}}$ was drained out of the swimming pool, the air dose was $0.7\ \mu\mathrm{Sv\,h^{-1}}$ in the surroundings, and the dose at the surface of the pool was $0.39\ \mu\mathrm{Sv\,h^{-1}}$. The children wanted to start swimming in the pool again, and the school principal conveyed their words to the advisor. He demonstrated the actual dose that the children would receive while swimming, and stated that the effect of water shielding made the dose lower than that in the classrooms. Despite this, there was much resistance from many PTA members who said that there was considerable anxiety regarding letting the children swim in swimming costumes when decontamination of their homes had not yet commenced. As such, it was decided that there would be a presentation on the results of decontamination, and a briefing (dialogue) about opening the swimming pool.

The most convincing explanation at the meeting was the experiment performed by the experts. This showed that the dose hardly changed with or without a heavy thick towel around them, and that the shielding effect of water was proven to lower the dose still further.

Three days after the meeting, the swimming pool was opened. Children with parental agreement became the first children to enjoy swimming lessons in Date city. Physical education classes were held in the gymnasium for those children whose parents remained undecided about letting their children swim. After the summer holiday, all children were able to enjoy physical education classes in the swimming pool.

4. DECONTAMINATION PROJECT AND BEYOND

The decontamination project, a collaborative project involving the local community, school, volunteers, and experts, came to an end in late July 2011. The day that the team was due to leave the school, a teacher brought a letter to the principal's

Fig. 3. (Left) Sandblast method ($8\ \mu\mathrm{Sv\,h^{-1}} \Rightarrow < 0.7\ \mu\mathrm{Sv\,h^{-1}}$). (Right) Electric cutter method ($3.5\ \mu\mathrm{Sv\,h^{-1}} \Rightarrow 1\ \mu\mathrm{Sv\,h^{-1}}$)

office with beautiful drawings, written by a number of the children who wanted to hand their letter of gratitude to the team. The letter was given to the team leader in the afternoon, and he looked very pleased, saying 'the team members will be very happy'. However, the principal still felt a sense of regret that the children had not received a full explanation about decontamination.

Subsequently, the city authorities continued their decontamination work in various ways, focusing on the unity within the community and communication. At Tominari Elementary School, an environment has been established whereby each parent is confident of the safety of their child/children.

Today, there are 24-h monitoring dosimeters set up in all the public facilities in Fukushima Prefecture. The ambient dose at Tominari Elementary School was $3.9\,\mu Sv\,h^{-1}$ at a spot 1-m high in April 2011. It was reduced to $0.17\,\mu Sv\,h^{-1}$ on 7 December 2015, indicating a safe environment. Following completion of the project, decontamination measures continued behind the school buildings with the Forestry Cooperative, and on the slopes around the school with volunteers (Fig. 4). Numerous discussions were held with parents, community members, and city authorities, and a map of dose distribution at the locations related to school activities was drawn up.

5. ACHIEVEMENTS AND CHALLENGES OF THE DECONTAMINATION PROJECT

5.1. Achievements

Having implemented this project, members of the PTA and school staff came to understand what it was to 'fear correctly by understanding radiation'. They learned

Fig. 4. Decontamination of the slopes by volunteers from around the country (16 July 2011).

the methodology of decontamination, and worked in close contact with the children to maintain a safe and secure environment at school. The school was considered to be the safest place in the community due to the collaborative and effective decontamination with the participation of professionals, community members, volunteers, and many more. This achievement provided a huge boost to subsequent reconstruction activities at the school.

5.2. Remaining challenges

The author would like to maintain a mechanism for sharing information with the school and local residents, with a goal of mutual understanding. Something that the author was unable to, but would have liked to included in this project, was find a way of involving the children and pass on the spirit of cooperation and solidarity displayed by the local residents throughout the decontamination process.

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ICRP Fukushima dialogue seminars: joint learning at many levels

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Abstract–The Norwegian Radiation Protection Authority and representatives from the CERAD Centre of Excellence participated at the majority of the International Commission on Radiological Protection dialogue seminars in Fukushima between 2011 and 2015. The open and sharing structure of the seminars contributed to an unprecedented understanding of the challenges faced by the general public affected by radioactive contamination due to an accident at a nuclear power plant. Most importantly by presentations from people in Fukushima, but also by presentations from lay people in Norway and Belarus who shared their experiences from the Chernobyl accident at several seminars. The seminars created new friendships and connections, which inter alia led to several exchange visits between affected people in Norway and Japan where worries and experiences could be shared in an open and reflective manner. The mix of actors (various experts, authorities, local populations) created joint learning across sectors and levels, representing an invaluable source of knowledge for organisations involved in nuclear and radiological emergency preparedness and planning.

Keywords: ICRP dialogue seminars; Fukushima; Societal challenges; Exchange visits; Joint learning

1. WHY NORWAY?

Norway does not have any nuclear power plants, only two small research reactors. However, many neighbouring countries have nuclear installations and nuclear-powered vessels close to Norwegian territory. Further, Norway was the country

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outside of the former Soviet Union that experienced the greatest consequences from the Chernobyl accident in 1986 (Liland et al., 2009). Mitigating actions are still necessary in Norwegian agriculture and reindeer herding due to the radioactive fallout 30 years ago. A strong national nuclear and radiological emergency preparedness organisation is thus in place to deal with any incident or accident involving nuclear or radiological material affecting Norwegian territory, citizens, and interests abroad. In a changing world, we need to learn from both the past and the present to evolve concurrently with societal changes. The accident at Fukushima Daiichi nuclear power plant was an important learning point for Norway, as for most other countries in the world. The invitation from the International Commission on Radiological Protection (ICRP) for Norway to participate in the Fukushima dialogue seminars was thus most welcome. It provided the opportunity to learn, in-depth, about the challenges faced by officials and inhabitants in Fukushima Prefecture, representing an invaluable source of knowledge for organisations involved in nuclear and radiological emergency preparedness and recovery planning.

2. IMPRESSIONS FROM THE ICRP FUKUSHIMA DIALOGUE SEMINARS

The first seminar revealed a great deal of anger and frustration among the participants. There was a serious lack of trust in national authorities and a general feeling among people that they were not receiving correct or sufficient information. The Japanese public was not educated regarding radiation protection issues, and faced a difficult time trying to learn and understand what it was all about. Media representatives presented the dilemma of highly contradictory messages from different experts on the health risk of radiation – how could the general public know which experts to trust? Given the lack of sufficient governmental actions, some local professionals and volunteers started their own measurement campaigns and decontamination actions. Co-operation between the authorities and various other organisations was clearly not working satisfactorily in the beginning. Experience from Norway and Belarus on the handling of the Chernobyl accident was presented and much appreciated by the participants. They also appreciated the opportunity to meet and express their views in a wider group facilitated by an international organisation, where they all participated at an equal level. Japan does not have a tradition for open public debates, and the value of dialogues, such as this, was appreciated more and more over the years.

The seminars covered different topics and the experiences of different people over time, providing an excellent way to learn about the wider consequences of radioactive fallout and the diversity of views within a population. The experience shared by participants from Belarus and Norway added to that diversity, highlighting both similarities and differences in people's perceptions of the situation across countries, and that there are several ways to recovery.

Over time, the understanding of this complex issue and possible solutions increased among the participants. The anger and frustration decreased gradually, and a more positive attitude developed over the years as knowledge increased,

areas were cleaned, culture and traditions were resumed, and experience was shared with others. Some people have been important driving forces for this recovery, such as Ryoko Ando (the founder of the non-governmental organisation Ethos in Fukushima), Dr. Makoto Miyazaki from Fukushima Medical University (who performs measurements on people and discusses the results with them), Takahiro Hanzawa from Date city (involved in decontamination actions locally), and Prof. Ryugo Hayano from the University of Tokyo (who developed BABYSCAN for measuring babies). These individuals have been instrumental (in several ways other than those mentioned) in helping people in Fukushima to understand the situation and their own exposure to radiation, and regaining confidence that there is a future for towns and villages in Fukushima Prefecture. Many other private individuals have been driving forces, too, for local initiatives that have also contributed to empowerment of the citizens.

Even if the situation has improved over the years, challenges remain and will remain for many years. It seems, however, that people are regaining control of their lives and taking back their futures. It has been said that the positive development was more pronounced in the towns that took part in the dialogue seminars than in other areas. One participant said that after moving in and out of Fukushima Prefecture for the last 5 years, it was time to make a decision and settle down for good. Some people have already settled elsewhere and do not want to return to Fukushima Prefecture. Others are eager to move back to their hometown and cannot wait to be granted access by the authorities. A large majority of people have still not decided if they will move back or not. The very strict decontamination level set by the authorities ($<0.23\ \mu Sv\ h^{-1}$ external dose rate) to allow people to move back has resulted in very slow recovery of the territory. Personal dosimeters, such as D-shuttle dosimeters, worn by the inhabitants show that the doses received are much lower than the calculated 1 mSv y^{-1} based on external dose rates of $0.23\ \mu Sv\ h^{-1}$. The legal implementation of this limit leaves very little room for optimisation, which is one of the fundamental principles in radiation protection. It also impairs the possibilities of the local people to participate in recovery actions and make their own informed choices.

The compensation scheme for evacuees, although necessary, creates suspicion and frustration among people and adds to the burden they already feel every day. Some participants reported that they feel stretched to their limit every day. Worries about the future, especially that of the health of children, remain. More than 2700 babies and small children have been measured using the BABYSCAN, and none showed detectable levels of radiocaesium (Hayano et al., 2015). Measurements of children and adults are helpful for people to regain control of the situation and trust in a future for Fukushima Prefecture. A misconception that lingers on, unfortunately, in Japanese society is that women from Fukushima who give birth in the future will have children with genetic disorders. There is no scientific evidence to support such a belief, yet people from Fukushima experience stigma and discrimination. One can only speculate why the Japanese authorities have not taken necessary actions to counteract such a misconception.

Fig. 1. Discussions between Japanese and Norwegians on measurements of live animals prior to slaughtering (photo: Astrid Liland).

3. EXCHANGE VISITS BETWEEN JAPAN AND NORWAY

Through participation at the ICRP Fukushima dialogue seminars, new contacts were established between Japan and Norway. The presentations on post-Chernobyl management in Norway created interest among the affected people in Japan. A first visit by local Japanese inhabitants to Norway took place in September 2012. The Norwegian Radiation Protection Authority (NRPA) facilitated visits to the contaminated territories where they met farmers and employees at local food monitoring and control offices. They learned about the history after Chernobyl, and talked to farmers who are still implementing mitigating actions to produce meat and milk below the food intervention levels. They were shown measurements of foodstuffs and live animals (Fig. 1). NRPA acted solely as a facilitator, and did not interfere with the questions and answers exchanged between the participants. Instead, NRPA listened carefully and learned a lot from both the questions asked and the answers given. In addition, NRPA explained about the management of radioactivity in Norway and answered any related questions.

Through financial support from the Norwegian Ministry of Foreign Affairs/ Norwegian Embassy in Tokyo, the exchange visits continued. In May 2014, three farmers, one cheese producer, and a reindeer herder took part in the eighth ICRP dialogue seminar and presented their post-Chernobyl experiences (Fig. 2). They later visited Fukushima farmers and a waste disposal facility.

A return visit was arranged in September 2014 when farmers and local people from Fukushima Prefecture visited Norway. They talked to a reindeer herder and several farmers, as well as food safety officials in the contaminated territories, and experienced live monitoring of sheep and reindeer (Fig. 3).

Exchange visits between affected people in different countries are valuable as they show solidarity with each other and can learn from each other's experiences. When authorities arrange meetings, they usually have a strict agenda for specific topics and only those topics are discussed. For exchange visits, there is an open agenda where any topics can be raised by the participants. This gives a broader view of the challenges

Fig. 2. Norwegian participants (in the middle) together with the other participants at the eighth dialogue seminar in Minamisoma (photo: NRPA).

Fig. 3. People from Fukushima Prefecture observing the live monitoring of reindeer prior to slaughtering (photo: Astrid Liland).

faced by local inhabitants, as all questions and comments are welcome. A listening regulator can learn a lot from the questions and answers given, and can investigate in more detail with the inhabitants when something is unclear or puzzling. Taking part in exchange visits has been rewarding both professionally and personally.

4. WHAT DID WE LEARN?

Experiences from the dialogue seminars have strengthened the view of NRPA as a regulator that nuclear emergency preparedness planning must include plans for the late phase and the implementation of mitigating actions other than evacuation and

iodine prophylaxis. Failure to plan beyond the evacuation phase was one of the reasons why recovery following the accident at Fukushima Daiichi nuclear power plant has been so slow. The testimonies from the Japanese people clearly show how the radioactive fallout affects everything in their life, and how the unpreparedness/lack of knowledge has added to their struggle. Reports were given on increased mortality among elderly people in Fukushima Prefecture due to evacuation (Yasumura et al., 2012), and increased frequency of diabetes, hyperlipidaemia, and hypertension in evacuated citizens (Nomura et al., 2016). This questions the justification of evacuation in less contaminated areas. On the other hand, people from the most contaminated areas face permanent relocation as they have been told that they will probably not be allowed to move back in their life time.

When comparing the actions taken in Norway (Liland and Skuterud, 2013) and Belarus after Chernobyl and in Japan after Fukushima, it is clear that there are different ways to recovery. There are similarities and differences in the societal consequences of the accidents; the reasons for these require further investigation. It seems clear, however, that the active involvement of inhabitants in mitigating actions leads to faster recovery with a greater degree of trust than setting the people aside while authorities take actions on their own. The solutions to a situation that challenges the whole society lies in the involvement of a wide variety of stakeholders. It is also necessary to educate people about radiation issues and risk management so that they can make their own informed choices. This should be supported by opportunities for personal radiation measurements, where the results can be discussed with trusted health personnel in their hometowns. Organising venues where people can meet and share their worries has been very important in Japan, as they have no tradition for open debates. Sharing the worries lessens the individual burden.

Fig. 4. New friendships – Jacques Lochard, Ryoko Ando, and Prof. Ryugo Hayano. Prof. Ohtsura Niwa in the background (photo: Astrid Liland).

The ICRP dialogue seminars have certainly created new contacts and friendships of value on both a professional and personal level within Japan and between Japan and other countries (Fig. 4). I am personally most grateful for being invited to the seminars where I could listen to all the brave people of Fukushima, and where Norway and Japan could share their experiences with long-lasting radioactive contamination. The Norwegian participants have learned so much on many levels that inspire us to continue, and evolve, our work in nuclear emergency preparedness and radiation science.

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Lessons learnt by IRSN about the involvement of experts towards the population in contaminated areas in Fukushima Prefecture

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Abstract–Since November 2011, Institut de radioprotection et de sûreté nucléaire (IRSN) experts have participated in the International Commission on Radiological Protection's (ICRP) dialogue initiative for the rehabilitation of living conditions after the Fukushima accident. In 2013, IRSN and Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire (CEPN) launched a study to identify the main lessons that can be learned from these dialogues, and benefit French IRSN experts in the event of a postaccident situation. The main lesson is that in order to protect the inhabitants of contaminated areas efficiently, experts must work in cooperation with local actors to develop a co-expertise process. The availability of measurement devices for inhabitants is crucial to allow them to assess their own radiological situation. Measuring radioactivity makes it visible, and allows individuals to discuss the results in their communities and develop local projects to improve their daily life. Eventually, inhabitants create a practical radiological protection culture to manage their situation. However, helping people to protect themselves does not mean that authorities and experts have no responsibilities, and this calls for strong ethical principles such as not making decisions for people about their future. To be helpful, scientists need to understand that, as necessary as radiation protection is, it is not the only problem that inhabitants are facing and it cannot control people's lives. Radiation protection experts must commit themselves to be at the service of individuals and the community, and the issues they want to address.

Keywords: Stakeholder empowerment; Co-expertise; Practical radiological protection culture; Ethics

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

1. INTRODUCTION

In November 2011, when the International Commission on Radiological Protection (ICRP) and the Japan Radiation Safety Forum initiated the first seminar of the dialogue initiative for the rehabilitation of living conditions after the Fukushima accident, they asked various international organisations to participate and support the independence of the dialogue.

The French Institute for Radiation Protection and Nuclear Safety (Institut de radioprotection et de sûreté nucléaire, IRSN) and the Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire (CEPN) agreed to be involved in this initiative for the following reasons:

- IRSN and CEPN have been involved in the ETHOS and CORE projects in Belarus in the aftermath of the Chernobyl accident. They learned the importance of involving the population with the support of national and local authorities and experts to ensure the effectiveness and sustainability of protective actions.
- They wanted to bring their testimony to the inhabitants of Fukushima, and learn from the experience of Japanese people living in the contaminated areas.

It is a considerable challenge for IRSN to understand what is at stake in the contaminated areas, and to learn and transmit this information to colleagues in France and worldwide.

2. ANALYSIS PERFORMED BY IRSN AND CEPN

2.1. Introduction

Beyond supporting the dialogue initiative and reporting on their experience in Belarus, IRSN and CEPN launched an analysis in 2013 to identify lessons to be learned that could benefit French experts if such a situation should occur in France.

This work has been undertaken in cooperation with Japanese stakeholders and experts involved in the dialogues in Fukushima Prefecture.

The main lessons can be summarised into four topics:

- the human dimension of the postaccident situation;
- stakeholder engagement: authorities, the public, and experts;
- the co-expertise process; and
- development of a practical radiological protection culture.

2.2. The human dimension of the postaccident situation

The potential health consequences of the contamination of vast territories raises strong concerns among the inhabitants about health, particularly that of children. However, this is not the only problem that inhabitants face. The appearance of radioactivity in their daily lives is a disruption that creates an unprecedented

situation, and deeply upsets the relationship of humans with themselves, others and their environment.

Living in a contaminated environment is a complex situation that generates numerous questions among the affected population, even for the most trivial elements of everyday life (e.g. going out, coming home, opening windows to air the house, drinking, eating, sending children to school), at a time when they have lost confidence in the authorities and experts.

That leads to a complete loss of control over everybody's daily life, a feeling of helplessness and neglect, and a general feeling of discrimination and exclusion.

Furthermore, the technical answers to improve the radiological situation (i.e. decontamination, travel bans and other restrictions, food controls) have indirect effects that isolate affected people from their day-to-day environment.

Contamination has a tremendous emotional and social impact that challenges the inhabitants' lifestyles and relationships with others (i.e. neighbours, family). Ultimately, each individual is confronted with the following dilemma:

- to stay in the contaminated territories or leave;
- once evacuated, to return home or not.

All inhabitants need to evaluate the possibility of working and living in contaminated areas, and have to find a way to reconstruct their lives.

2.3. Stakeholder's engagement: Inhabitants, local authorities, and supporting experts

In the months following the accident at Fukushima Daiichi nuclear power plant, different types of stakeholders committed themselves to face the situation and its complexity.

Local authorities had to take charge of the situation and rely on local administration (e.g. Date city and Iitate village). Some local communities mobilised themselves to initiate actions (e.g. Suetsugi and Hippo). Both addressed the practical concerns of the inhabitants, but needed the help of experts to develop solutions.

The experts who supported the affected people were of very different backgrounds and committed themselves personally. A key challenge for them was the lack of connection of their engagement with the institutional framework, as the national authorities remained distant from these local initiatives for a long period of time. Only in the last year has the Japanese Government started to show an interest.

From their experience close to the inhabitants, Japanese experts identified the following lessons.

- People urgently need reliable and accessible information, but it is extremely difficult to talk about the effects and risks associated with exposure to ionising radiation. Inhabitants want the experts to be modest, given the uncertainties and limits of knowledge. They want them to distinguish science from judgements and, above all, to respect everyone's values and choices.

- Consequently, experts must not conclude that the situation is safe and promote dialogues rather than lectures. Japanese experts highlighted the importance of cooperation with local professionals involved in management of the situation (i.e. education, health, and administration).
- Scientists need to understand that, as necessary as radiation protection is, it cannot control people's lives. They must commit themselves to the service of individuals and the community.
- The values and choices of individuals must be respected, whatever they are.

2.4. The co-expertise process

A co-expertise process needs to be developed to address problems faced by the inhabitants in their daily lives. This co-expertise relies on the following:

- places for dialogue should be established to allow experts to listen to questions, concerns, challenges, and expectations of those affected, and to discuss them together;
- in order to be relevant and efficient, assessment of the situation of the people and their community must be conducted jointly by locals and experts;
- projects need to be implemented to address the problems identified as the most important at individual and community levels, with the support of local professionals, experts, and authorities; and
- the results of these co-expertise processes must be evaluated and disseminated.

In Fukushima Prefecture, a few communities gradually engaged themselves in the implementation of practical projects in a similar way to that of Belarus; however, there were large differences regarding the means for measurement to characterise the radiological situation and the role of social media to share the information.

From their experience, Japanese experts highlighted some key points.

- Measurement and dialogue are important to restore confidence. However, scientific explanations alone cannot create confidence in experts; returning regularly to interact with people and share experiences and feelings is crucial.
- Reaching out to the population, using a common language, and undertaking action in the long term are key elements to working with the population.
- Furthermore, lessons learned must be shared in order to foster emulation among communities. Financial support from the administration is needed to generalise these types of actions and ensure their sustainability.

2.5. Development of a practical radiological protection culture

Step by step, the co-expertise process promotes the development of practical radiological protection culture within the affected communities.

This culture gradually allows people to interpret the results of measurements: ambient levels, external and internal doses, contamination of products, and development of his/her own benchmarks against radioactivity in day-to-day life.

With this approach, people need to be able to take measurements themselves with suitable devices in order to make their own decisions and protect themselves at an individual level or at other levels (e.g. family, local community) by discussing the results among themselves with the help of experts. This practical radiological protection culture makes it possible to improve living conditions.

The appropriation process of the practical radiological protection culture in some communities, such as Suetsugi, is very similar to that of Belarus, but seems faster and is now complementary to the actions of the authorities. These communities seem to have regained control of their life and started to consider their future in their beautiful country.

However, the empowerment of inhabitants raises an important question: does helping people to protect themselves mean that authorities have no responsibilities?

3. WHICH ROLES FOR PUBLIC BODIES?

This process of stakeholders' empowerment raises important questions: what are the roles and responsibilities of public bodies, experts, and authorities? What could be the ethical principles for public bodies to take actions?

3.1. Responsibilities for authorities after a nuclear accident

One key responsibility of authorities is to quickly implement a dose level above which it is not authorised to reside permanently, and the adoption of different criteria to guide actions, taking into account the prevailing circumstances (e.g. food contamination levels).

In addition, authorities and experts must ensure radiation monitoring and health surveillance of the population over time.

Besides these responsibilities at global level, authorities and experts are also responsible for accompanying and supporting all affected people in their local projects to restore decent spiritual, moral, and material living conditions:

- the establishment of places for dialogue is crucial and must be supported by public bodies;
- experts must contribute to joint assessment of the radiological situation; and
- the help of authorities and experts is crucial for the development of a radiation protection culture.

In short, it is crucial for authorities to take responsibility for implementing conditions allowing respect of freedom and justice.

3.2. Some ethical principles

The empowerment of people also carries risks, and these have to be considered carefully by experts and authorities in their relationships with inhabitants. These include:

- trivialising the radiological risk or manipulating people in some way to make them stay in contaminated areas;
- leaving people alone and abandoning them to face the risk without help, or trying to protect people against their will.

To prevent these risks, the following ethical principles have to be adopted:

- not to make decisions for people about their future – whatever their decisions, their autonomy and freedom must be respected;
- experts and authorities must commit themselves to be at the service of improving protection against radiological risk, and, more generally, the living conditions of the population in a global manner; and
- experts must always keep a prudent attitude towards radiological risk.

3.3. Perspectives and challenges

Should such a situation happen in France or Europe, people's trust in authorities and experts will certainly be lost at first. However, the Japanese experience demonstrates that it has been possible in some places to regain this trust by working with local actors and helping them to develop solutions matched to their concerns.

But what would be the place of a national expert such as IRSN at local level? How can we prepare ourselves for this work with the population? This major challenge is faced by experts collectively in France, Europe, and worldwide.

To record and share the memories of this experience, a web documentary has been created and is freely available, in Japanese, French, and English, at www.fukushima-dialogues.com, and on the IRSN and ICRP websites.

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Involving stakeholders in radiological protection decision making: recovery history and lessons from the people of Fukushima

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Abstract–Between September 2011 and August 2015, the International Commission on Radiological Protection (ICRP) organised a series of 12 stakeholder dialogue workshops with residents of Fukushima Prefecture. Discussions focused on recovery, addressing topics such as protection of children, management of contaminated food, monitoring, and self-help measures. The OECD Nuclear Energy Agency (NEA) supported, and the Committee on Radiation Protection and Public Health (CRPPH) Secretariat attended, all 12 meetings to listen directly to the concerns of affected individuals and draw lessons for CRPPH. To summarise the dialogue results, ICRP organised a final meeting in Date, Japan with the support of NEA and other organisations. The lessons from and utility of the dialogue meetings were praised by dialogue participants and sponsors, and ICRP agreed that some form of dialogue would continue, although with ICRP participation and support rather than leadership. This paper summarises the internationally relevant lessons learned by CRPPH from this important process.

Keywords: Recovery; Post-accident; Lessons learned; Radiological Protection

1. INTRODUCTION

The significance and complexity of post-accident recovery have emerged increasingly over the months and years since the accident at Fukushima Daiichi nuclear power plant. These recovery issues have strong culture-specific aspects, yet also have a certain universality. Based on its previous work on stakeholder involvement in radiological

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

protection decision making, the Nuclear Energy Agency's (NEA) Committee on Radiation Protection and Public Health (CRPPH) began to support a series of dialogue symposia organised by the International Commission on Radiological Protection (ICRP) starting in November 2011. After participating in 12 such symposia, the last being held in September 2015, CRPPH developed this article to assess the lessons of international relevance based on the experience of the people of Fukushima.

2. BACKGROUND

For some time, CRPPH has been interested in the processes of radiological protection decision making, in stakeholder involvement in such processes, and in the role of the radiological protection expert. This focus began approximately 5 years after the Chernobyl accident, as its radiological impacts on NEA member countries became more apparent, and has since been incorporated into the Committee's work programme in several different manifestations. CRPPH's work in this area has been extensive and pioneering for the radiological protection community. Through the CRPPH Villigen workshops, work on post-Chernobyl recovery, and focus on understanding how science and social values support and drive radiological protection decisions, CRPPH has built an evolving understanding of the roles of stakeholders and radiological protection experts in decision-making processes. This understanding can be characterised simplistically as follows:

- Villigen workshops (NEA, 1998, 2001, 2003)
  - Integrate radiological protection aspects into societal decisions, rather than integrating societal values into radiological protection decisions.
- Chernobyl work from 1987 to 2011 (NEA, 2011a)
  - The radiological protection expert should be at the service of stakeholders.
- Science and values workshops in 2008, 2009, 2012, and 2015 (NEA, 2011b)
  - Decisions are informed by science, but are driven by social values.

From this level of understanding and experience, CRPPH was invited by ICRP in 2011, 6 months after the accident at Fukushima Daiichi nuclear power plant, to participate in a stakeholder dialogue symposium, where affected individuals from Fukushima Prefecture came to discuss their situations, and to hear from individuals who had lived through the Chernobyl accident. From this first symposium experience, ICRP, along with the Nippon Foundation (http://www.nippon-foundation.or.jp/en/), organised 11 further symposia, each gathering affected individuals and organisations, and each addressing a topic of relevance to participants. Table 1 lists the topics and dates of these gatherings.

3. LESSONS LEARNED

Post-accident situations can be very difficult in terms of stakeholder interactions, because affected populations will generally be angry, will probably be overwhelmed

Table 1. List of the topics and dates of the 12 stakeholder dialogue symposia.

	Dialogue focus	Date
1	Initiation of a new process of discussion among affected stakeholders	November 2011
2	Understand what has been accomplished in Date	February 2012
3	Food production, distribution, and marketing	July 2012
4	Education and memory	November 2012
5	The difficult decision to stay/return or go/not return	March 2013
6	The situation and challenges faced by the citizens of Iitate	July 2013
7	Self-help actions taken by local people in cooperation with experts	December 2013
8	The situation and challenges faced by the citizens of Minamisoma	May 2014
9	The challenges of raising children in a contaminated area	August 2014
10	The importance of tradition and culture for recovery	December 2014
11	The importance of measurements for recovery	May 2015
12	The future, in particular the future of the Suetsugi region	September 2015

with the complexity of the situation, and will generally have lost trust in any governmental and 'accident source' experts. However, as described above, the dialogues built trust relatively quickly, which fostered the expression of open and heart-felt opinions by stakeholders.

The dialogues resulted in many lessons and suggestions. Much of this was in the context of Japanese culture, yet much of this experience is very relevant beyond Japanese culture and the specifics of the Fukushima accident. The experience gained from the ICRP dialogues has all been in the context of post-accident recovery, although much of this experience is applicable to almost any stakeholder dialogue situation. The following aspects are key examples of what has been learned to assist other NEA member countries to be better prepared so as to recover more efficiently from a nuclear or radiological event.

The lessons and observations presented here represent those of CRPPH over the past 25 years, and more specifically, those drawn from post-accident recovery in Fukushima. The overall conclusions from these two elements, while coming from a patchwork of very different circumstances in many different cultures and countries, are felt to be relatively universal. The following simplified global recovery lessons thus represent the broad aspects that will be extremely important to address should another large-scale nuclear accident occur:

- the radiological protection focus of stakeholder involvement in a post-accident recovery situation should be on long-term technical support;
- trust is a necessary and central component of successful stakeholder involvement, successful being understood as providing information and support so that stakeholders can make informed decisions and so that they feel that their concerns have been addressed;

- as a result of stakeholder involvement, individuals can develop a positive vision of their future, which will help them to make an informed choice to stay or to go;
- individual decisions whether to stay or to go, are all valid and it is essential that this be clearly expressed; and
- the level of support needed to achieve the goals listed here can be very resource intensive.

More generally, CRPPH has been through a learning process over the past 25 years with respect to radiological protection decisions. It has taken time to recognise the role of the radiological protection specialist in decision processes, and that the skills needed for embarking on stakeholder interactions are not 'normally' addressed in radiological protection education programmes. Considering that the 'most effective' stakeholder interactions are undertaken by radiological protection experts trained in public interactions rather than by communications experts trained in radiological protection, it will be important to review and most probably revise university and on-the-job training approaches for radiological protection experts to include stakeholder interaction training.

4. CONCLUSIONS

Years of CRPPH experience in the field of radiological protection, particularly following the Chernobyl and Fukushima Daiichi nuclear power plant accidents, have strongly suggested that the role of the radiological protection expert in post-accident recovery situations is principally one of support to affected stakeholders, both in terms of 'affected stakeholders' and 'stakeholders' in the broader sense of the term. Trust is required to achieve effective support, and this trust will depend on pre-accident engagement and post-accident responsiveness, clarity, and transparency in addressing stakeholder concerns. The resources needed for this will be significant, and processes for such engagement will need to be established pre-accident. In implementing protective measures during an emergency situation, it will be important to communicate recovery processes to affected populations (e.g. how decisions to end protective measures will be made and how stakeholders will be involved). Thus, while recovery from an accident will present unique challenges, flexible and resilient processes for 'moving forward together' will be central pillars to restoring individual's lives and society's structure in the framework of post-accident conditions.

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The recommendations of ICRP *Publication 111* in the light of the ICRP dialogue initiative in Fukushima

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Abstract–*Publication 111*, published by the International Commission on Radiological Protection (ICRP) in 2009, provided the first recommendations for dealing with the long-term recovery phase after a nuclear accident. Its focus is on the protection of people living in long-term contaminated areas after a nuclear accident, drawing on the experience of the Belarus population, Cumbrian sheep farmers in the UK, and Sami reindeer herders in Norway affected by the fallout from Chernobyl. The ICRP dialogue initiative in Fukushima confirmed what had been identified after Chernobyl, namely the very strong concern for health, particularly that of children, loss of control over everyday life, apprehension about the future, disintegration of family life and of the social and economic fabric, and the threat to the autonomy and dignity of affected people. Through their testimonies and reflections, the participants of the 12 dialogue meetings shed light on this complex situation. The ICRP dialogue initiative also confirmed that the wellbeing of the affected people is at stake, and radiological protection must focus on rehabilitation of their living conditions. The challenge is to incorporate the important clarifications resulting from the ICRP dialogue initiative into the updated version of *Publication 111* that is currently in development.

Keywords: Nuclear accident; Long-term recovery; Practical radiological protection culture; Self-help protection; Fukushima dialogue initiative

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1. BACKGROUND OF *PUBLICATION 111*

Publication 111 (ICRP, 2009) provided the first recommendations for dealing with the long-term recovery phase after a nuclear accident. All previous recommendations of the International Commission on Radiological Protection (ICRP) concerning nuclear accidents had been confined to short- and medium-term actions of the emergency phase. The focus of *Publication 111* is on the protection of the general population living in long-term contaminated areas after a nuclear accident. As such, there are no recommendations concerning the protection of the so-called 'responders' (on-site and off-site), which is the subject of much discussion in Fukushima and certainly deserves to be taken into account in the future by the Commission. It is also important to emphasise that *Publication 111* relies mainly on the personal experience of the experts who developed it on the basis of their long engagement with the Belarus population, the Sami reindeer herders in Norway, and Cumbrian sheep farmers in the UK affected by the fallout from Chernobyl.

Publication 111 (ICRP, 2009) was adopted in 2008 and published in 2009, shortly before the Fukushima accident. It was clear that in most countries, including Japan, there was insufficient time to digest this publication before the accident. *Publication 111* was translated into Japanese by the Japan Radioisotope Association, and was published about 1 year after the Fukushima accident in 2012. An interesting document prepared by a group of Japanese stakeholders, entitled 'Introduction to ICRP *Publication 111*', was circulated on the web from 2012 (available, in Japanese, at: https://www59.atwiki.jp/birdtaka/pages/23.html), and in 2015, another publication to introduce *Publication 111* was prepared by the Japanese ICRP members in cooperation with Japanese experts personally involved in the management of the accident (Niwa et al., 2015).

2. MAIN POINTS OF *PUBLICATION 111*

Basically, *Publication 111* (ICRP, 2009) recognises that living in contaminated areas after a large nuclear accident is a very complex situation affecting all dimensions of life, and all stakeholders of society that cannot be managed solely through radiological protection considerations. This position calls for the modesty of radiological protection professionals, who must admit that protective actions are insufficient on their own to solve all of the problems faced by the affected people.

Regarding the protection of people, *Publication 111* (ICRP, 2009) is based on experience which shows that the average level of exposure globally is dependent on the level of contamination, but individual exposures are mainly driven by the behaviour and lifestyles of each affected person. This means that it is not possible to adopt an average approach to manage postaccident situations, and it is necessary to consider the particular circumstances in which the affected communities live, which can differ widely in terms of level of contamination, activities, and lifestyle.

With regard to the basic principles of radiological protection, *Publication 111* (ICRP, 2009) refers to those set out in the general recommendations of the

Commission. The justification principle states that all decisions concerning radiological protection must do more good than harm. Justification applies to the decision to allow people who wish to live permanently in the contaminated areas to do so. The accident results in a radiological situation in which authorities have to make a decision about where to draw a line between places where people can stay and live if they wish, and places where it is not possible to live because the level of exposure is high and is likely to induce health impacts or it is difficult to maintain the social and economic fabric.This is by far the most difficult decision to be taken after a nuclear accident given the enormous human and material consequences it can potentially cause. In addition, it is also necessary to justify all decisions taken on protective measures to improve the radiological situation, such as decontamination, management of foodstuffs, radiation monitoring, health surveillance, etc. Numerous decisions have to be taken, each of which has advantages and disadvantages (e.g. the impact on decontamination on the environment and the generation of huge quantities of waste that will need to be managed). It can be difficult to balance these advantages and disadvantages, and the process requires experience and wisdom.

The optimisation principle states that the exposure of people should be kept as low as reasonably achievable, given the prevailing circumstances. This principle, which is considered as the cornerstone of the radiological protection system, derives directly from the cautious approach adopted by the Commission since the late 1950s, that regardless of the level of exposure, there is a proportional risk. The optimisation principle should be implemented using a reference level. For the management of the long-term recovery phase after a nuclear accident, *Publication 111* (ICRP, 2009) recommends that the reference level should be selected from the lower part of the 1–20 mSv $year^{-1}$ band, with the long-term objective of keeping residual individual doses caused by the accident around 1 mSv $year^{-1}$ or lower. Since its publication, this recommendation has been the subject of much debate. This is mainly due to the fact that the Commission has remained deliberately qualitative as regards the fixing of values and their timing, giving only a general framework and leaving the authorities concerned to select the values best suited to the circumstances. As for the value of 1 mSv, it is more a question of equity than of risk. Indeed in the long term, when the situation in the affected territories is considered to be 'normal' again from the radiological protection point of view, it would not be fair to apply a different criterion than that used for managing normal situations in areas not affected by the contamination.

The process of selecting the reference value should take into account the prevailing circumstances by weighting the different dimensions that characterise them. Furthermore, as clearly stated in *Publication 111* (ICRP, 2009), this process should include all relevant stakeholders. This means that the radiological situation, as well as the economic, social, and psychological situations, must be analysed carefully, particularly characterisation of the contamination, in order to understand where, when, and how people are exposed. This also explains why the Commission does not recommend precise values in advance, but leaves authorities to decide these in consultation with experts and relevant stakeholders. It is important to keep in mind that

the reference level has nothing to do with a limit. It is not a regulatory instrument, but a tool to identify which groups of affected people should be prioritised for protection (i.e. the most exposed individuals) and to guide the selection of the protective actions that aim to reduce exposure to a level as low as reasonably achievable.

The experience of Chernobyl in Belarus and Norway has shown that stakeholder engagement is a powerful means of providing affected persons with the necessary knowledge, skills, and 'know-how' required to make informed decisions about their own protection (Lochard, 2013). The notions of 'practical culture of radiological protection' and 'self-help protection' introduced in *Publication 111* (ICRP, 2009) are a direct result of this experience, and the actions undertaken by certain communities in Fukushima over recent years in relation to the ICRP dialogue initiative (e.g. in the village of Suetsugi) confirmed their relevance as well as their operational character. Of course, in order to engage stakeholders, it is essential to set up places for dialogue (termed 'local forums' in *Publication 111*) in order to share information between experts, local authorities and professionals, and citizens. The purpose of dialogue meetings is not only to pass information on to participants, but also to engage in a genuine dialogue on the basis of mutual listening and joint analysis to assess the situation and possible actions, and to prepare decisions.

It is the responsibility of the authorities to implement an inclusive monitoring system and a health surveillance programme in the affected areas. From this perspective, the role of the authorities is to establish the conditions and implement the means to facilitate engagement of the affected population in the rehabilitation process. Particularly important is the setting of an inclusive exposure monitoring system and a health surveillance programme in the affected areas. Measurement of individual exposure is key for effective implementation of the optimisation principle by the authorities, and also to allow individuals to make informed decisions about their protection. The importance of individual monitoring was underlined by the participants many times at the ICRP dialogue meetings. Medical surveillance is certainly one of the aspects not yet fully mastered in postaccident management. Despite the experience from Chernobyl, many questions remain about the role and ways to organise this surveillance. This point should be developed further based on the Fukushima experience.

3. HOW *PUBLICATION 111* WAS RECEIVED

The Commission's objective with *Publication 111* (ICRP, 2009) was not to add an a new technical document to the long list of reports already in existence concerning the implementation of protective actions, but to draw the lessons from Chernobyl's experience in particular regarding the population's involvement in the recovery process. As mentioned earlier, there were some criticisms about *Publication 111*, particularly concerning the virtual absence of dose criteria to manage the situation, and the lack of detailed information on the practical implementation of the optimisation process. These criticisms emerged soon after *Publication 111* was published, and were obviously reiterated at the time of the Fukushima accident. There were also

misunderstandings about the objectives of the long-term recovery phase, which may reflect difficulties for experts unfamiliar with a postaccident situation to grasp the complexity of the human dimension at stake. In terms of radiological protection, the objective was clearly to reduce exposure to a level as low as reasonably achievable through the implementation of appropriate protective measures. However, experience from Chernobyl showed that this objective only made sense if it is at the service of rehabilitating the living conditions of the affected people. The reduction of exposure is not an end in itself, it is only a means. What ultimately matters is the wellbeing and dignity of people. Achievement of this objective is a complex process that mobilises resources and presupposes particular conditions that depend largely on the circumstances. The Commission did not intend to make recommendations on this approach, and *Publication 111* merely acknowledged the problem and indicated a general term for the route to be pursued in general terms.

That said, the confrontation of *Publication 111* (ICRP, 2009) with the situation in Fukushima was instructive. Despite criticisms, it is undeniable that *Publication 111* has served as a landmark for many experts and non-experts, and has gained some support. This was achieved gradually as stakeholders took measure of the difficulties and challenges posed by the accident situation. It is also noteworthy that, for many people affected directly by the accident, *Publication 111* provided real support, as evidenced by the following personal message received in Spring 2012:

After the nuclear accident, raging voices over Fukushima left behind those of us who live in Fukushima. Everybody wanted to have his say, disregarding what we think and feel. I could not accept that. I even felt angry. The reason why I started Ethos in Fukushima comes from the conviction that it is we who should narrate our life. In the midst of the turmoil, Publication 111 was the only support for our mind (Ryoko Ando – Ethos in Fukushima).

This message was, of course, important for all those who had contributed to *Publication 111* (ICRP, 2009), because Ando confirmed that it was difficult to understand the spirit of this publication if one had not experienced living in a contaminated area among the affected people, and that in spite of all the criticisms, ICRP had fulfilled their work properly.

4. CONTRIBUTION OF THE ICRP DIALOGUE INITIATIVE

The ICRP dialogue initiative confirmed what had been identified after Chernobyl, namely the very strong concen about health, particularly that of children; loss of control over everyday life; apprehension about the future; disintegration of family life, and of the social and economic fabric; and the threat to the autonomy and dignity of affected people. However, through their testimonies and reflections, the ICRP dialogue participants shed light on the complexity of the situation. Together they told a story, and gave rise to the emergence of a narrative on this complexity. Although the experience from Chernobyl allowed the identification of key issues characterising the postaccident situation, the ICRP dialogue initiative has clarified what is at stake in terms of human, social, and economic dimensions.

As stated previously, *Publication 111* (ICRP, 2009) purposely adopted a minimalist approach to the use of dose criteria. Thus, no dose value is proposed for allowing people to stay permanently in contaminated areas, because it is considered that the value to be adopted will differ for each accident based on the characteristics of its consequences. Similarly, only a range of values is recommended to select the reference level, with the qualitative indication that it should be in the lower part of the 1–20 mSv year^{-1} band (i.e. $\leq$10 mSv year^{-1}). This also depends on the prevailing circumstances. The only recommended value is the long-term objective to keep residual individual doses caused by the accident around 1 mSv year^{-1} or lower.

On the issue of dose criteria, it is interesting to note that participants in the ICRP dialogue meetings occasionally mentioned the existence of dose criteria, particularly the reference level, but never discussed their rationale. Discussion at the ICRP dialogue meetings confirmed that people affected by the contamination were primarily motivated by what they can do to improve their situation from the radiological point of view. When they have acquired the practical radiological protection culture, they are able to make their own decisions according to the radiological situation and to act according to their desires (what is called self-help protection). Dose criteria are for them only benchmarks to guide their actions. In turn, the ICRP dialogue participants discussed and analysed the impact of dose criteria on daily life, and particularly the fact that they may be a blocking factor for action and a source of division between people, with negative consequences for communities (Ando, 2016).

The ICRP dialogue initiative highlighted the need to implement as soon as possible in the emergency phase a radiation monitoring system to characterise the radiological situation. This is obviously important to guide the action of the public authorities, but even more for the affected people themselves. However, access to information on ambient dose rates and contamination of food products is not sufficient for individuals to make decisions about their behaviours and activities in order to control their exposures. On the contrary, experience has shown that this information tends to paralyse individuals' actions. Only access to external and internal individual exposures allows people to link the radiological situation that characterises their familiar environment and their lifestyle. In this perspective, the distribution in some affected communities of the Fukushima Prefecture of high-performance personal dosimeters has proved to be a powerful way to help people regain control of the situation and thus confidence. It is obviously the responsibility of the public authorities to rapidly set up in the affected territories a system of individual monitoring of radiological exposures so that everyone can understand not only the level of her/his exposure, but also of the reasons that lead to it. The importance of a rapid characterisation of the radiological situation adapted both to the needs of the public authorities and affected people is certainly one of the key lessons of the ICRP dialogue initiative.

The latter also confirmed the importance of establishing meeting places at local community level between the experts and affected people in order to develop a practical radiological protection culture and favour self-help protection. For the experts, these places are the means, through listening to the affected people, to understand their concerns, their questions, and their expectations. For the affected

people, it is not only a matter of receiving general information about the situation of their community, but of understanding how they personally are exposed, and what the issues are for them and the community. This exchange process is what the Commission calls 'co-expertise'. On the one hand, the experts bring their knowledge on radiation, and on the other hand, the affected people bring their knowledge on their behaviour and local living conditions. Experience has shown that it is only by crossing these two knowledge fields that it is possible to develop a practical radiological culture, which in turn favours self-help protection. The Commission has sometimes been criticised for promoting self-help protection, with the accusation that this is transferring the burden of protection to the affected persons, and is faciltating the disengagement of public authorities. However, the Commissison would argue that self-help protection does not mean a transfer of responsibility from authorities and experts to affected persons, but empowers the latter so that they regain autonomy for decision making and thus their dignity.

In *Publication 111* (ICRP, 2009), the role of the authorities and affected people is described as complementary: on the one hand, authorities have the responsibility to put in place the conditions and means for effective and fair management of the radiological situation, and on the other hand, affected people can implement self-help protective measures individually if they have the means, and if they wish, to do so. It is also the responsibility of the authorities to ensure that self-help protection can develop. There is a division between what must be done collectively and what can be done individually to ensure the best possible protection. The ICRP dialogue initiative revealed the importance of the specific characteristics of the affected communities in terms of the rehabilitation of living conditions. The same level of contamination can have different consequences depending on economic and social specificities, but also on the traditions, culture, and history of each community. This aspect calls for further reflection on the articulation of action at local, regional, and national levels in order to identify what types of governance mechanisms would be most suitable to consider this diversity.

Among the many contributions of the ICRP dialogue initiative, it is worth mentioning the protection of children. This is a major concern for many parents in Fukushima, especially mothers, as it has been and remains in the territories affected by the accident in Chernobyl. It is no coincidence that this was the subject of two dialogue meetings: the first in November 2012, dealing with the education of children and young people; and the second in August 2014, devoted to all issues related to raising children. The experience of Fukushima and Chernobyl shows that the practical modalities of this protection depend not only on circumstances but also on mentalities, and cover a wide spectrum of actions. Beyond differences, what is common is the desire not to keep children, and particularly teenagers, away from problems concerning life in a contaminated territory. At the final ICRP dialogue meeting, several adolescents testified about their activities, and made it clear that they intended to be involved in the future in the rehabilitation of living conditions in the Prefecture. This raises the question of the role of parents and educators in the

dissemination and transmission of a practical radiological culture among young people, which goes well beyond the acquisition of scientific bases about radiation at school.

The ICRP dialogue initiative also found that family members were often divided regarding how to deal with the protection of children, particularly young children, and the question of whether or not to develop specific advice for them was debated. On this point, the Commission merely emphasises the fact that children deserve special attention, and relies on common sense regarding the most appropriate measures to ensure their protection. This was implicit in *Publication 111* (ICRP, 2009). The ICRP dialogue initiative clearly highlighted that, in Fukushima, overprotection of children from the potential effects of contamination, particularly by restricting their outdoor activities, has led to indirect effects that can be very detrimental to their health, their social life, and their psychomotor development. What is the right balance? It is a complex issue that appeals to many ethical values and remains largely open. The ICRP dialogue meetings provided valuable insight into all the issues facing children and adolescents living in a contaminated territory. It was also stressed that, despite appearances, children are often stronger than adults believe, and it is important to provide a forum for children to speak as they have a lot of interesting things to say about the situation. These considerations, which are completely absent from *Publication 111*, will undoubtedly be included in the future recommendations of the Commission.

5. CONCLUSIONS

The ICRP dialogue initiative confirmed that radiological protection following a nuclear accident must focus on the rehabilitation of living conditions; in other words, restoration of the dignity and wellbeing of people. The ICRP dialogue meetings did not raise new issues concerning the protection of people living in long-term contaminated areas, calling for a significant change to the principles, criteria, and advice of *Publication 111* (ICRP, 2009). However, the ICRP dialogue initiative brought several important clarifications and complements concerning the human and organisational dimensions of the rehabilitation process, and the challenge is now to incorporate these elements into the updated version of *Publication 111* that is currently in development. These clarifications represent a unique and invaluable contribution of the ICRP dialogue participants to the management of future postaccident situations.

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Considerations and challenges in the ICRP dialogues

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Abstract–'Yes I tried to explain, but residents couldn't understand...' This was the title of my presentation at the first International Commission on Radiological Protection (ICRP) dialogue seminar in November 2011 held at the Fukushima Prefectural Government office. The accident at Fukushima Daiichi nuclear power plant was triggered by the tsunami caused by the Great East Japan Earthquake of March 2011. Initially, it was thought that Date city, 50–60 km away from the accident, would be safe, but unfortunately this was not the case due to the direction of the wind at the time of the accident. I reported on decontamination in the aftermath of the accident at the ICRP dialogue seminar, following an invitation from Dr. Niwa of the University of Kyoto and a member of ICRP. There were many participants from overseas, and it was the first time that I had attended a meeting with simultaneous interpretation. I still remember that I was slightly bewildered.

Keywords: Visualisation of radiation; Lessons learned and feedback; Perseverance; 'To connect' diverse opinion

1. REPORT ON DECONTAMINATION IN DATE CITY

I reported on decontamination in Date city at the first International Commission on Radiological Protection (ICRP) dialogue seminar. I commenced my presentation by saying, 'It is important to decontaminate as soon as possible for radiation protection' and 'It is important to remove radioactive materials scientifically from the surroundings', thinking that anyone worried about radiation exposure would start decontamination right away.

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However, to my surprise, local residents were not starting to decontaminate. I realised that it was not sufficient to say 'scientifically avoid radiation exposure . . .'. In addition, it was important to address the mental and moral aspects that resided within the minds of the local residents, and I realised that oral scientific explanation was of limited value. As such, I reverted to a totally unscientific approach, using beads to depict caesium, and an analogy of lions to explain the dangers (Figs 1 and 2). In other words, I made the situation 'visible'. Gradually, the local residents started to understand what decontamination was all about, and started to decontaminate.

Fig. 1. Use of beads for visualisation of invisible caesium.

Fig. 2. Lions were used to represent radiation: 'Be afraid if lions are loose!'

2. THE 12 ICRP DIALOGUE SEMINARS

I thought that this seminar was a one-off meeting, but Dr. Niwa approached me and suggested that a second seminar should be held in Date city. I accepted, believing that they were going to hold another one-off seminar. It never crossed my mind that there would be 12 dialogue seminars, or that seven of them would be held in Date city!

The themes chosen for each seminar were diverse, including food, education, and whether or not to return. There were new discoveries at every seminar. The ICRP dialogue model of roundtable discussion was introduced into briefing sessions with the local residents, which had traditionally been classroom-style meetings. This was found to improve understanding among the residents.

When I thought they had exhausted all the topics for discussion, 'Festival and culture' was suggested as the theme for the next dialogue seminar. 'What has that got to do with radiation?' was my reaction. However, under Jacques Lochard's impeccable chairmanship, we learned that tradition and culture play an important role in reconnecting communities disconnected by radiation.

3. LESSONS LEARNED FROM THE ICRP DIALOGUE SEMINARS

Many lessons have been learned ('YESs') from the ICRP dialogue seminars. Administrative organisations tend to take a 'top-down' approach, and risk communication could be a way to convey information for the sake of making the people 'understand what is correct'. However, this is not the case with dialogue with local residents. We have learned the importance of building trust among the stakeholders, that there is a gap between what the Government wants to convey and what the residents want to hear, and that the Japanese people want 'uniformity'. Drawing from overseas experience, we have learned that local residents are not solely concerned with the risk of radiation from a scientific point of view, and their relationship with radiation in the long term, in terms of everyday living, is of greater importance to them. There was a limit to what the Government and municipal authorities could do; the involvement of the local residents will become more and more crucial now, 6 years since the accident.

Needless to say, the participation of high school students in the latter stages of the ICRP dialogue seminars was all the more meaningful. The significance of their involvement is that they will surely be the forerunners in fostering radiation protection culture in Japan.

4. FUTURE CHALLENGES

The future challenge is whether a meaningful dialogue will take root in Japan, which is a country with low awareness of risk. As the country is not used to 'dialoguing', discussions tend to create 'binary oppositions' where constructive opinions are difficult to obtain. What makes the situation worse is amplification of the

mentality of being victimised. Furthermore, it would be difficult to continue effective dialogue should these discussions have a political dimension.

We need to transmit information in a timely manner to continue making steady efforts to support the positive attitudes of the residents and to recover the lost trust. It is on the foundation of this trust that our efforts towards genuine reconstruction of Fukushima must continue with the local residents.

Even before the accident at Fukushima Daiichi, Japan was facing the challenge of population aging and a low birth rate. These challenges have been highlighted further since the accident. However, I worry that if we continue to blame the nuclear accident and depend on the municipal government for everything, reconstruction will be delayed physically and the residents will never be able to recover their lost pride and self-confidence. I feel that it is important for the local residents to take upon themselves the work of genuine reconstruction of 'damaged Fukushima', not that of 'Fukushima', as we enter the sixth year since the accident.

I believe that continuation of the ICRP dialogue remains a necessity in helping this reconstruction process. The seminar format will finish, but I believe the spirit and achievements of the ICRP dialogue must continue in various other forms.

5. CONCLUSION

There have been many 'YESs' from the ICRP dialogue seminars. As mentioned above, briefing sessions to local residents have changed from classroom-style to dialogue-style meetings. Another important lesson was the establishment of an environment for residents to come together to talk. It is this form of communication that allows differences of opinion and feelings to be discussed openly, so no views are ignored and discarded.

There have been many valuable encounters with people we would never have met had it not been for the ICRP dialogue seminars. This is indeed one of the great achievements of the seminars, without which we would never have been able to listen to diverse opinions and experiences from so many people.

There were many, many 'YESs' but there were also some 'BUTs', which were surprising at times. Maybe that is because I was responsible for providing the venue in Date city at many dialogue seminars. This is the last of the dialogue seminars, but should there be more 'BUTs', I am determined not to be surprised again.

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Increase in disaster-related deaths: risks and social impacts of evacuation

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Abstract–In Fukushima Prefecture, disaster-related death is a social problem for individuals who were forced to leave their hometowns as a result of the Great East Japan Earthquake and the accident at Fukushima Daiichi nuclear power plant. Disaster-related death is caused by stress, exhaustion, and worsening of pre-existing illnesses due to evacuation. The number of disaster-related deaths has reached almost 2000, and continues to rise. Prolonged uncertainty and deteriorating living conditions suggest no end to such deaths, although response measures have been taken to improve the situation. It is said that insufficient response measures were taken, in particular, during the transitional period between the emergency phase and the reconstruction phase. There is a need to apply the lessons learned in planning for evacuation after a nuclear hazard, considering radiological protection as well as risks associated with evacuation.

Keywords: Disaster-related death; Prolonged life in evacuation; Increase of stress factors; Lack of transitional measures

1. INTRODUCTION

In response to the Great East Japan Earthquake and the accident at Fukushima Daiichi nuclear power plant on 11 March 2011, evacuation zones were established around the plant, affecting 12 municipal districts in Fukushima Prefecture. Evacuation peaked at >164,000 residents. Even today, 5 years after the accident, >100,000 people are still forced to live in temporary accommodation. The number of disaster-related deaths has reached almost 2000, which exceeds the number of

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Fukushima residents who were killed directly by the Great East Japan Earthquake and tsunami. Disaster-related deaths are undeniably an element of man-made disaster, as these individuals were saved by emergency evacuation and subsequently lost their lives due to insufficient measures to support them. Although this topic has not been discussed in detail during the ICRP dialogue that started in November 2011, this article will address the issue of effective radiological protection and evacuation planning.

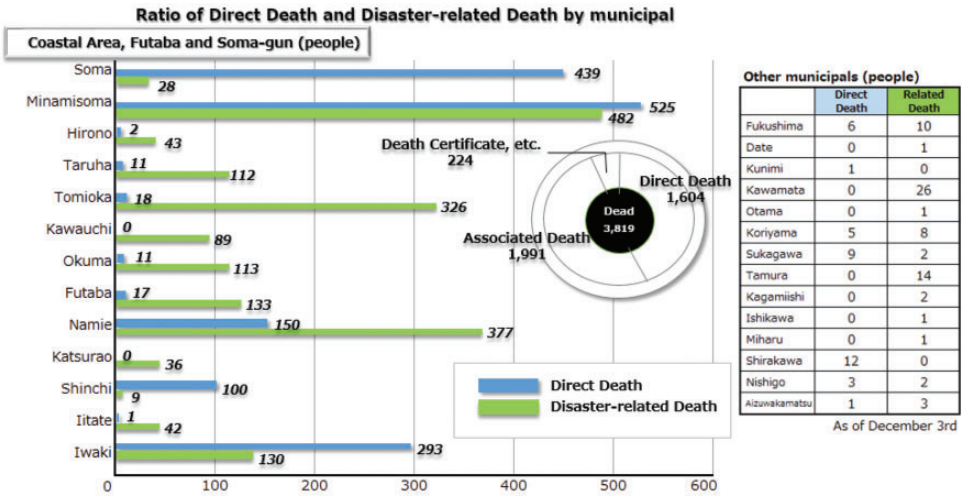
2. WHAT IS DISASTER-RELATED DEATH?

In contrast to direct death (e.g. being crushed by a collapsing building or drowned by a tsunami), disaster-related death is characterised as indirect death resulting from poor health and exhaustion experienced during evacuation. Disaster-related death is covered by the Government's condolence money policy, paid in the case of natural disasters. The condolence money policy works as follows. Once the examination committee, formed of a group of intellectuals, recognises that the cause of death is due to indirect factors, municipal governments treat it in the same way as a direct death and pay condolence money to the bereaved. This policy has been applied mutatis mutandis to the disaster in Fukushima that was a combination of an earthquake, tsunami, and nuclear accident, and disaster-related deaths have been included in the statistics. The data show that disaster-related deaths are much more common in Fukushima Prefecture than in other affected prefectures (e.g. Iwate and Miyagi Prefectures). This situation is an ongoing issue that is unique to nuclear disasters, and campaigns are being run to advocate for the improvement of evacuees' lives and prevent disaster-related deaths.

3. REALITY OF DISASTER-RELATED DEATH

According to the survey of the Reconstruction Agency, by March 2015, there had been 1914 disaster-related deaths in Fukushima Prefecture; corresponding figures for Miyagi Prefecture and Iwate Prefecture were 910 and 452, respectively. The number of disaster-related deaths in Fukushima Prefecture was equivalent to 60% of the total count for the three prefectures. Compared with a survey undertaken 6 months earlier, the total number increased by 121. Ninety percent ($n = 1728$) of all disaster-related deaths were among people aged >66 years. This trend continues today, and the number of disaster-related deaths reached 1991 by 3 December 2015. The percentage of disaster-related deaths within the total death toll is >50% in Fukushima Prefecture, compared with 8–9% in Iwate and Miyagi Prefectures. The number of disaster-related deaths now exceeds the number of direct deaths related to the disaster.

While most deaths occurred in the first 6 months after the disaster in all three prefectures, the number of people who died <1 year or >1 year after the disaster was strikingly high in Fukushima Prefecture, showing a difference from Iwate and Miyagi Prefectures. As such, disaster-related death is said to be an ongoing issue in Fukushima Prefecture.



	Direct Death	Related Death
Fukushima	6	10
Date	0	1
Kunimi	1	0
Kawamata	0	26
Otama	0	1
Koriyama	5	8
Sukagawa	9	2
Tamura	0	14
Kagamiishi	0	2
Ishikawa	0	1
Miharu	0	1
Shirakawa	12	0
Nishigo	3	2
Aizuwakamatsu	1	3

Fig. 1. Ratio between direct deaths and disaster-related deaths by municipal district.

As shown in the breakdown by municipal district (Fig. 1), disaster-related deaths were concentrated around the coastal area of Fukushima Prefecture (Hama-Dori area). Among the municipal districts designated as 'restricted zones', both direct deaths and disaster-related deaths were high in the towns of Minamisoma and Namie, which were heavily damaged by the tsunami. The disaster-related death rate was much higher in areas such as the towns of Naraha, Tomioka, and Okuma, and the villages of Futaba and Iitate, and the number of direct deaths was relatively low.

According to the report by the Reconstruction Agency issued in the early postaccident period (Table 1), the main causes of disaster-related death were 'physical and mental exhaustion due to evacuation', 'physical and psychological exhaustion through travelling to evacuation areas', and 'worsening of pre-existing illnesses due to hospitals not being able to operate'. These situations imply that disaster-related death is derived from nuclear accidents, and that emergency evacuation and subsequent life in evacuation have a substantial impact on individuals, both physically and mentally.

The bereaved families of four people who have committed suicide since the accident raised a lawsuit against Tokyo Electric Power Company Inc. (TEPCO), the owners of Fukushima Daiichi nuclear power plant, for damage compensation. For two of these four cases, the court recognised the relationship between suicide and the nuclear accident, and the company was required to pay damages. The causal link between disaster-related death and nuclear accidents has also come to be acknowledged by the judiciary.

4. INCREASE IN DISASTER-RELATED DEATHS

Given the situation, the Reconstruction Agency compiled a report on considerations to prevent disaster-related deaths in Fukushima Prefecture in March 2013.

Table 1. Major causes of disaster-related death.

Major causes of disaster-related death	All three prefectures	Fukushima Prefecture	Ratio
Physical and psychological exhaustion through evacuation life	683	433	63.3
Physical and psychological exhaustion through travelling to evacuation area	401	380	94.8
Worsening of pre-existing illnesses due to dysfunction of hospitals or hospital transfers	283	186	65.7
Physical and psychological stress due to earthquake and tsunami	150	38	25.3
Delay in initial treatment due to dysfunction of hospitals	90	51	56.7
Physical and psychological stress due to nuclear accident	34	33	97.1
Delay in initial treatment due to traffic conditions	17	4	23.5

The report states different support measures, such as supporting restoration of evacuees' living conditions, prevention of isolation, and mental care. Nevertheless, as mentioned above, the disaster-related death rate is increasing and one of the reasons for this is prolonged life in evacuation.

In June 2014, the number of evacuees peaked at 164,218; this number has been decreasing since 2012, a year after the nuclear accident (Fig. 2). However, >100,000 people are still unable to return to their hometowns. Among municipalities designated as evacuation zones, the evacuation order has not been lifted in some areas. Some municipalities aim to lift the evacuation order and enable the inhabitants to return home by March 2016, other municipalities plan to do so in 2–3 years, and other municipalities have no plans at all.

Fukushima Centre for Disaster Mental Health supports disaster victims, and 20,000 people attended the Centre between 2012 and 2014. Among them, most patients ($n = 4900$) attended due to physical symptoms caused by mental instability, followed by irritation and emotional issues, and difficulty sleeping. Not all symptoms have shown an increasing trend; some have actually decreased, which shows that the nature of evacuees' suffering has been changing and growing more complex over time.

5. INCREASING STRESS FACTORS

Living conditions are becoming worse as life in evacuation is prolonged. In Fukushima Prefecture, there are still 16,400 temporary residences, housing 19,800 people. Many residents, such as the elderly and vulnerable, have lost vitality and the will to earn their own living. The Disaster Relief Act limits the duration for living in temporary accommodation to 2 years. However, this has been extended due to delay

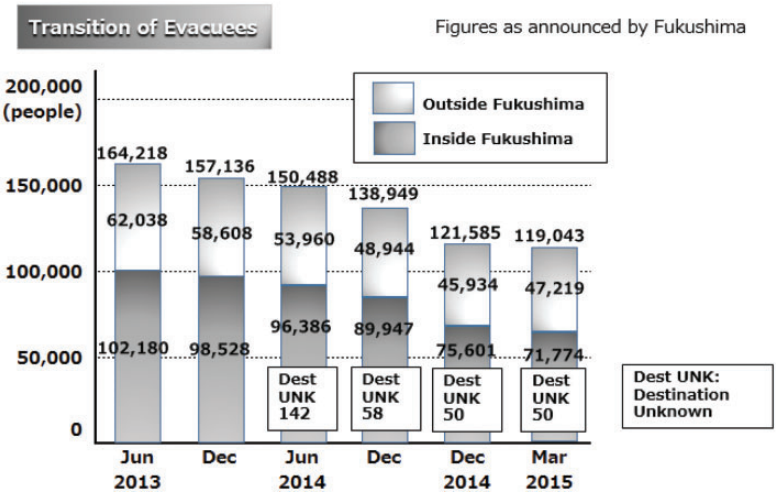


Fig. 2. Transition of number of evacuees.

in the construction of temporary public housing. Extended use of temporary accommodation is naturally leading to damage, such as corrosion of the base pile and slopes, termite damage, blocked gutters, and damage to external television antennae, doors, and woodwork. The physical and mental impacts on evacuees are immeasurable. These people are full of resentment about being forced to leave their home towns, being deprived of work, splitting up of families, separation from friends, and being forced to live in poor-condition temporary housing in an unfamiliar place. It is now 5 years since the nuclear accident, and although many victims are restoring their lives successfully, one must not forget that stress factors lead to feelings of isolation in vulnerable people that often go unnoticed.

6. RESPONSE MEASURES AND CHALLENGES

In order to prevent disaster-related deaths, including suicide, the Government and relevant institutions and groups are taking pro-active action by providing consultation and keeping watch over the evacuees. As mentioned earlier, the nature of evacuees' suffering is changing and growing more complex over time. It is doubtful that supportive care, such as keeping watch, can improve the situation. As the number of disaster-related deaths keeps increasing, it is questionable if simple treatment of symptoms can improve the situation. The suffering of evacuees will not be eliminated unless national and prefectural governments, municipalities, and TEPCO work together to solve the issue of temporary housing, prevent isolation of the inhabitants, clearly indicate the possibility and timing of returning home, support rebuilding individual lives, and solve the issue of compensation.

7. FOR THE FUTURE

Some may wonder how the above is relevant to radiological protection. After all, the cause of disaster-related death is concerned with how affected people are evacuated in the case of a nuclear disaster, and how they are treated after evacuation. Following the accident in Fukushima, the emergency evacuation was successful insofar as direct fatalities. However, when viewed in hindsight, risks during the evacuation were not considered thoroughly. There is no denying the element of man-made disaster in disaster-related death, as those lives that were saved by evacuation were subsequently lost. The author believes that insufficient measures were put in place to implement seamless support during the transitional period between the emergency phase and the reconstruction phase.

Dr Tsubokura of Minamisoma City General Hospital has presented findings that show a large difference in mortality rate between those who evacuated from care homes for the elderly and those who did not following the nuclear accident. This type of research achievement should be used for future evacuation planning so that the rest of the world can learn lessons from Fukushima. In addition, the author believes that public authorities need to review the effectiveness of treatment of inhabitants following evacuation, together with experts from different domains.

The Nuclear Regulatory Authority has compiled guidelines for response measures concerning nuclear emergency on the basis of the accident at Fukushima Daiichi nuclear power plant. Municipal governments with nuclear power stations in Japan are reviewing their own disaster plans in accordance with these guidelines. Some nuclear power plants have resumed operations; however, their evacuation plans are not sufficient when viewed by individuals who have actually experienced the accident. The residents of Fukushima were thrown into this disastrous event, and are now making extraordinary sacrifices in the form of disaster-related deaths. This experience cannot be wasted. It is the author's strong hope that this experience is disseminated to the rest of the world, and that better disaster prevention schemes are established.

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Exposure and current health issues in Minamisoma

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Abstract–Various reports have shown that internal and external exposure levels of local residents after the accident at Fukushima Daiichi nuclear power plant were very low. However, there are serious postdisaster health effects in the form of increased prevalence of diabetes and other chronic conditions. Stress, changes in the social environment and in living arrangements, and disruption in healthcare support provided by a network of people have resulted in increasing the cost of care and changing patients' behaviour, such as delay in visiting a hospital. In addition to radiation protection, it is necessary, when looking after the health of Fukushima residents, to focus on human networking, social infrastructure, and protection of culture and history that are intangible, and not to overlook their roles in health.

Keywords: Radiation exposure; Diabetes; Chronic conditions; Informal care; Breast cancer

1. INTRODUCTION

The city of Minamisoma is located in Hamadori in Fukushima Prefecture. After the accident at Fukushima Daiichi nuclear power plant, three evacuation zones were set within the city: one within a 20-km radius of the plant, another between 20- and 30-km radiuses of the plant, and the third outside the 30-km radius. As vertical radioactive contamination differed between locations within the city, the evacuation zone demarcation was not consistent with the degree of contamination and became

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one of the causes of inequality, conflict, and other issues. Minamisoma Municipal General Hospital, located near the coast within the 30-km radius of Fukushima Daiichi nuclear power plant (approximately 23 km from the plant), was the only hospital in the 30-km radius evacuation zone to maintain outpatient services in the immediate aftermath of the Great East Japan Earthquake. It played a central role not only in postdisaster health care but also in radiation response. This article reports on the current radiation exposure levels in the Soso region, and provides an overview of the health effects of the nuclear disaster.

2. RADIATION SCREENING TESTS AND RADIATION EXPOSURE TO DATE

Various reports have shown that internal and external exposure levels of local residents after the Fukushima nuclear accident were very low. In particular, there has been successful containment of internal exposure, which became a long-term issue in the case of the nuclear incident at Chernobyl.

In Minamisoma, Minamisoma Municipal General Hospital led an effort to commence internal exposure screening tests for residents in July 2011 (Hayano et al., 2014), and external exposure screening tests using integrated dosimeters in October 2011 (Nomura et al., 2015). Both tests are currently ongoing. At Minamisoma Municipal General Hospital, difficulties were encountered in measuring internal exposure using an on-vehicle whole-body counter when the screening was introduced in July 2011 because the vehicle did not provide sufficient radiation shielding. In September 2011, whole-body counters were installed in the hospital and have since been used for screening. In total, some 100,000 people have been screened. For approximately 99% of all children, including elementary and middle school students, in the city, internal exposure levels were below the minimum level for detection (Tsubokura et al., 2015a). Similar results have been observed in other municipalities.

More than 5 years since the disaster, internal exposure levels on the order of several thousand or several tens of thousands of becquerels are still being detected in those who regularly consume wild boar, wild birds, wild vegetables, or mushrooms that are highly contaminated, with a frequency of about several persons per 10,000 people (Tsubokura et al., 2014). However, internal exposure levels are not likely to increase for those who consume foods distributed through regular channels.

External exposure levels have also been maintained at low levels. The total exposure dose for elementary and middle school children in Minamisoma who underwent external and internal exposure screening tests in 2012 was between 0.025 and 3.49 mSv $year^{-1}$ (median 0.70 mSv $year^{-1}$). Results showed that the annual exposure dose was <1 mSv $year^{-1}$ for 77.9% of the children (Tsubokura et al., 2015b).

3. INCREASED PREVALENCE OF CHRONIC CONDITIONS

As described above, radiation exposure levels of local residents have been maintained at low levels, and it is unlikely that radiation will affect their health directly,

such as by damaging cells in their bodies. However, there are serious postdisaster health effects in the form of increased prevalence of chronic conditions.

The increased prevalence of diabetes is particularly serious. The number of patients with diabetes has been increasing every year, and in some age groups, the prevalence rate has increased by approximately 5% since the earthquake. Nomura et al. reported that higher risk of diabetes, compared with the predisaster level, has persisted for several years (Nomura et al., 2016). While similar results were observed in the Fukushima Health Management Survey, it is noteworthy that similar trends can be observed among residents living outside the evacuation zones. It is well known that diabetes is a risk factor for myocardial infarction and cerebral infarction. It has been reported that the number of patients with cerebral infarction admitted to Minamisoma Municipal General Hospital has more than doubled since the nuclear disaster (Gilmour et al., 2015).

In addition, diabetes has been associated with increased risk of cancer. It has been reported that the hazard ratio for cancer incidence among patients with diabetes is approximately 1.2, and that the risk of liver and pancreatic cancers, in particular, is approximately twice as high for patients with diabetes. It is anticipated that the risk of cancer from diabetes and other lifestyle-related diseases is greater than that from radiation exposure.

4. WHY IS THE PREVALENCE OF CHRONIC CONDITIONS INCREASING AND WHICH GROUPS ARE AFFECTED?

Why is the prevalence of diabetes increasing? Stress, changes in the social environment, and changes in living arrangements may be some of the factors, but the answer is not known conclusively. Results of the Fukushima Health Management Survey showed that the prevalence of diabetes increased more among residents from evacuation zones than among residents from outside evacuation zones. On the other hand, a study on residents of the cities of Minamisoma and Soma found no difference in the prevalence of diabetes based on whether or not residents had evacuated (Nomura et al., 2016). Results of research conducted at Minamisoma Municipal General Hospital, published in July 2016, showed that among the patients with diabetes who continued to receive treatment at the hospital after the disaster, deterioration was greater among patients living in urban centres compared with patients living in suburbs (Leppold et al., 2016). It is essential that further research is conducted and interventions undertaken for selected target groups.

In terms of intervention, it is important not to link onset of diabetes or deterioration in diabetic condition to the patient's behaviour or character traits. Physical exercise, healthy eating, and diet therapy are basic to controlling diabetes. However, although fast food, for instance, may be bad for the body, one should not forget that there are many people, due to financial difficulties, who have few other economically viable options. The only thing that can be done is to inform people about such circumstances, and to engage repeatedly in outreach to patients through health seminars, frequent visits, and other educational activities.

5. SOCIAL FACTORS OF HEALTH CARE

If diabetes is the most significant health problem, the most serious social problem is the loss of informal care since the disaster. Informal care can be described as regular care and assistance to the person requiring support that is made possible through a network of people. For example, consider an elderly person admitted to hospital for pneumonia. Before the disaster, he could have been discharged after a few days' stay and returned home. However, this can no longer happen because there is no younger generation who can look after him at home. He cannot go and live in a cramped temporary housing unit because it is not barrier-free. As a result, the hospital stay becomes longer and he grows physically weaker. He may have to look for a residential care home, otherwise he cannot be discharged. As a result, he becomes physically weaker and becomes ill again. The cure rate declines. The birth rate in Fukushima Prefecture has rebounded sharply since the disaster. There is a shortage of kindergarten teachers, and many advertisements for them. On the other hand, the postdisaster evacuation, the issue of radiation, and changes in the social structure have been harmful to health, which was formerly protected by a network comprising the local community, neighbours, and family members. A study by Dr Morita of Soma Central Hospital showed that nursing care costs per elderly person in Minamisoma have increased 1.3 fold since the disaster (Morita et al., 2016).

Health problems in temporary housing are becoming long-term problems. A study by Dr Shimada of Minamisoma Municipal General Hospital found that the prevalence of diabetes and other chronic conditions was high even in Summer 2015. Many of those who have secured a new home in the last 5 years, and have a network that allows them to live with their families, have already left temporary housing units. On the other hand, those whose family ties have been disrupted and who have difficulty managing their own health tend to remain in temporary housing. For patients with diabetes who find themselves in such circumstances, it is important that measures are implemented at the individual level, and dietary control and exercise are promoted. There is no point in arguing that stress is the underlying problem for such patients.

Dr Ozaki of Minamisoma Municipal General Hospital reported that the time taken from a patient with breast cancer finding a lump in the breast for the first time to visiting a hospital has increased since the disaster (Ozaki et al., 2016, submitted). The delay in visiting a hospital may contribute to discovery of breast cancer at more advanced stages. Although the cause is not known, it was found that there was a strong tendency for those not living with their children to visit a hospital less frequently. Some readers may have the experience of visiting a hospital only at the insistence of their children. The absence of members of the younger generation in patients' homes tends to keep patients away from hospitals, even when they feel something is wrong with their health. Changes in familial relations bring about changes in behaviour related to hospital visits.

6. CONCLUSION

The accident at Fukushima Daiichi nuclear power plant caused serious radioactive contamination, second only to the Chernobyl nuclear disaster which was rated level 7 on the International Nuclear Events Scale. Health effects of radiation exposure are normally at the core of various effects of radiation disasters. Fortunately, the radiation exposure levels for Fukushima residents were shown not to be significant. On the other hand, a significant health risk has resulted from changes in the social environment and life arrangements, increased prevalence of diabetes and other chronic conditions, and loss of interpersonal relations.

Future measures should focus not only on radiation protection, but also on human networking, social infrastructure, and protection of culture and history that are intangible. The disaster has raised issues that had been embedded in this region since before the disaster, for which there are no quick solutions. There is a need to recognise that the effect of a nuclear disaster is not limited to radiation, and that other effects of the disaster have an even greater impact on health. It is time that society as a whole came to consider what could be done to solve these problems.

Healthcare professionals are not necessarily required to take extraordinary actions. What would be required can be summed up as maintaining the existing healthcare system, working together with other professionals, and engaging in daily practice. There is a shortage of healthcare professionals in the region, particularly nurses and young healthcare staff members. There is a need to create a mechanism for providing incentives for young healthcare professionals to work in Fukushima, so that they can see their jobs in Fukushima in a positive light. Fukushima is drawing national attention because of the radiation issue. As time passes and attention wanes, the community will have to think how it can differentiate itself from other regions in order to survive. Presentations at scientific conferences, publication of articles, and close inter-regional and international exchange are important components of such efforts.

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Ethos in Fukushima and the ICRP dialogue seminars

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Abstract–Ethos in Fukushima, a non-profit organisation, participated in 10 of the 12 International Commission on Radiological Protection (ICRP) dialogue seminars over the past 4 years. The slides and videos that were shown at the seminars are recorded on the Ethos in Fukushima website (http://ethos-fukushima.blogspot.jp/p/icrp-dialogue.html). I would like to introduce the activities of Ethos in Fukushima to date, and explain why the ICRP dialogue materials have come to be published on its website.

Keywords: Ethos in Fukushima; ICRP dialogue; Suetsugi; Non-profit organisation

1. INTRODUCTION

The relationship between Suetsugi and the International Commission on Radiological Protection (ICRP) dialogue seminars started from my participation in the second ICRP dialogue seminar, held in February 2012. I continued to participate in the dialogue seminars, uploading almost all ICRP dialogue videos and slides on to the Ethos in Fukushima website (http://ethos-fukushima.blogspot.jp/p/icrp-dialogue.html). I have never had a chance to explain why we are publishing the ICRP dialogue materials, so I would like to take this opportunity to introduce our activities and explain why the materials are published on our website.

2. THE BEGINNING OF ETHOS IN FUKUSHIMA

In Autumn 2011, soon after the accident at Fukushima Daiichi nuclear power plant, we started to take action, recognising the need to know what this accident

This paper does not necessarily reflect the views of the International Commission on Radiological Protection.

meant for us residents of Fukushima. At this time, information (from the media and all other sources) was causing great confusion in the minds of residents as well as the public at large. In particular, the Internet was overflowing with all types of information of variable quality and credibility. I thought I had been collecting good-quality information from the early stages in the wake of the accident, and that I was able to understand the situation that I was facing to make my own judgements, but looking around at the reality in the daily lives of the people in Fukushima, there was nothing but aggravation of this chaotic state which seemed unlikely to ever return to normal. It occurred to me that communicating solely through Twitter would not be the answer to improving the situation. It was necessary to take action, and this led me to start our study group. I was strongly aware that we would need to work simultaneously like two wheels of a motorcycle; the Internet and local activities. My plan from the beginning was that although we could obtain information and human resources through the Internet, our local activities would have to depend on face-to-face contact. This plan of action enabled effective use of the massive amount of data on the Internet. Information is only useful when it is understood by its users, hence the need for face-to-face discussion. Needless to say, we recognised the effectiveness of the Internet and its power to disseminate information, but we hoped that our small group activities would cross all local boundaries to spread information to the wider group of people with the same concerns, and be of some use in providing them with useful suggestions. My intention was two-fold: to collect and transmit information.

Our first study group involved 15 local residents, and was held on 24 September 2011 in Tabito Village, Iwaki city, where I lived. We invited Prof. Yoshiyuki Mizuno of the Department of Nuclear Physics, Kyoto Women's University. We were able to obtain the manpower needed to carry out our activities, including Prof. Mizuno, via the Internet. I feel that this study group was a success because, although the number of participants was small, there were active and focused discussions with many questions and answers. However, this meeting highlighted the fact that many things could not be solved by supplying information about radiation. The participants were local residents and the questions raised were related to their daily lives, such as, 'Is it safe to eat spinach grown here?', 'What will be done to decontaminate the forest area?', and 'Is it safe for children to play in the sand?' These were questions that Prof. Mizuno, even with his expertise, was not able to answer fully. It became clear that our own practical initiatives, including measuring radiation dose, were absolutely necessary.

Video recordings of these study group meetings were compiled and later distributed to those who wanted them via the Internet. We tried to connect the people and share information on the Internet by transmitting what we had learned and how our awareness of the situation had been nurtured through these meetings. The reaction to our activities was very positive, and subsequently contributed greatly to gathering much-needed support.

3. ACTIVITIES ON THE INTERNET

The study group meetings gave rise to increased information exchange on the Internet. 'What can we do to acquire practical knowledge and not just general knowledge?' was a challenge with which the group was always confronted. As we searched for the answer, we came across ICRP *Publication 111* (ICRP, 2009). What was written in this ICRP publication, especially the experience of Olmany village, seemed to overlap with my own awareness of our problem and attracted my strong interest. At the same time, I learned of the English presentation entitled 'Rehabilitation of living conditions after nuclear accident: lessons from Chernobyl' by a member of the ICRP Main Commission, Jacques Lochard, on the Cabinet website (Lochard, 2011) (http://www.cas.go.jp/jp/genpatsujiko/info/twg/dai5/siryou2.pdf). The presentation was made at the Fifth Low Dose Exposure Risk Management Working Group at the Cabinet Office on 28 November 2011. I tried to find someone who could translate this presentation into Japanese, and, to my surprise, an unexpectedly high number of people came forward to cooperate. This was the start of our translation project. The Lochard presentation was translated with the cooperation of a team of 16 composed of people of diverse professions such as researchers, translators, businessmen, and editors. It was a truly collaborative work carried on solely on the Internet.

Thereafter, many volunteers have continued to translate a number of documented materials. Ethos in Fukushima is the website that we established to collect all these translated documents. The name 'Ethos' is a name taken from the name of the project started by Jacques Lochard in Belarus for rehabilitation of the living environment in 1995. We decided to use the name in respect and as a show of our feeling of solidarity with the people who undertook the Ethos project in Belarus, and, above all, the people of Belarus who have continued their long, bitter struggle in the affected areas. The name 'Ethos' will always stay with us.

4. PARTICIPATION IN THE ICRP DIALOGUE SEMINARS

Our participation in the ICRP dialogue seminars began because one of the volunteer translators had contacted Jacques Lochard for clarification of his original text. At that time, our activities in Suetsugi had not yet started and the name of our group was not finalised, but in preparation for attending the dialogue seminar, we translated our original logo for Ethos in Fukushima into Japanese.

The presentation I made at the second ICRP dialogue seminar was made possible because of the contribution of many people via the Internet. The last few sentences of my presentation went as follows:

> *This is a reality that we can handle. It is a reality that we can overcome to build a better future with our own hands. We believe we have all the power and potential to make this happen.*

These words reflected the situation at the beginning of 2012 when there was still no prospect of reconstruction after the accident.

5. COLLECTING AND DISCLOSING DOCUMENTS OF THE ICRP DIALOGUE SEMINARS

After participating in the second ICRP dialogue seminar, it was decided that Ethos in Fukushima should film the dialogue sessions and upload them, together with the presentation slides, on the Ethos in Fukushima website. This was a proposal that we had made to Dr. Ohtsura Niwa, ICRP dialogue facilitator and member of the ICRP Main Commission. I knew, via the Internet, about the first ICRP dialogue seminar that took place in November 2011, but despite the dialogue seminar being a place to discuss the post-accident situation in Fukushima, the materials from the meeting were not available anywhere. I was not satisfied that the citizens of Fukushima were not able to access information that was related to them. So, as I was going to participate in the next seminar, I proposed to the organisers that the information from the seminar should be released on the Internet. The organisers felt that they did not have the capacity to collect data and publish it on the Internet. As such, with the permission of the organisers, we agreed to take on this responsibility. This was the start of our current activity, whereby (mainly) volunteers connected on the Internet undertook video recording, editing, and publishing.

6. ACTIVITIES ON THE INTERNET, ACTIVITIES IN THE FIELD

From March 2012, we started to work in collaboration with the Association for the Protection of Suetsugi Hometown in Hisanohama-machi district in Suetsugi. Our main activities were measuring and discussing the results. We solicited donations for our operating expenses, on the Internet, to pay for the majority of the cost of our local activities. We received a total of 1,794,602 JPY from 126 people over the period when donations were collected (12 June 2012 to 31 March 2015). We had no other source of income and this represented our total operating expenses.

Since January 2015, our activities in Suetsugi have been consigned to play a role in the Japanese Government's 'consultant system'. We are officially recognised by the Government to operate under government funding. Our activities of 'measure and discuss' remain unchanged and we do not require many additional funds. As such, we stopped accepting donations.

7. ETHOS IN FUKUSHIMA TODAY

The number of members of Ethos in Fukushima peaked at 13 at the start of the activities. The members were all residents of Fukushima prefecture, and no one was a full-time dedicated member. As the majority of our activities moved from the Internet to the field, the number of members decreased and there are just two

members as I write this report. In the first place, our heavily community-based activities of practical radiation protection cannot be continued on a long-term basis other than by dedicated people who are fully committed to the cause, or by people who find it indispensable for their daily living. Our main activities have now moved to Suetsugi district, where they are focused on helping the residents in their daily lives. At the same time, the people assigned to work for the 'consultant system' now support our activities. Apart from our local activities, the activities of Ethos in Fukushima have many supporters who are not actual members, but it is because of all these supporters that we are able to continue our activities with a greater number of non-members.

8. ETHOS IN FUKUSHIMA AND THE ICRP DIALOGUE SEMINARS

As stated above, the activities of Ethos in Fukushima are two-fold: small local activities and activities through the Internet that often involve global participation. As you can guess from the number of members, we hardly exist as an entity. I, myself, do not consider Ethos in Fukushima as an organisation, but I think that it is a catalyst that binds the local areas with the Internet and, furthermore, Fukushima with the outside world. We can connect the people who have an interest in Fukushima and who want to help with the residents of Fukushima. I believe that this is the value of the existence of Ethos in Fukushima.

The bond that we have created on the Internet, where we have a large presence, can be said to be a tenuous relationship when compared with the real visible relationship. ICRP dialogue seminars are functional in that they bring the people connected on the Internet together to meet and to talk amongst each other. The value of the ICRP dialogue seminars, as I see it, is their contribution in bringing together the people who have the will and the aspiration to reconstruct Fukushima to speak, listen, and build human relationships.

9. THE FUTURE

Almost 5 years have passed since the turmoil of the 2011 accident. The situation has now settled down to a certain extent, but there are still areas where evacuation orders have not been lifted, or even if lifted, there are many regions where reconstruction is only half complete.

Here is a citation from the opening paragraph of the Ethos in Fukushima website:

> *We are small but we continue to search for the meaning of living in Fukushima after the nuclear disaster; living here is wonderful and we have a bright future that we can pass onto the future generations; we measure, we acquire knowledge, we think and search for a common language that connects us. We are small but we continue with persistence.'*

What I can continue to do as we move forward, as a person living in Fukushima, is simply to continue to measure, to know, to think, and to dialogue to search for a

common language, as mentioned above. The ICRP dialogue seminars were also an attempt to try to find a common language through dialogue.

When we turn our attention from the local areas to focus our thoughts on the social environment in the aftermath of the accident at Fukushima Daiichi nuclear power plant, I feel very strongly that the search for a common language is required not only in Fukushima but also in Japanese society at large.

One example would be with the experts. In May 2011, the then Special Advisor to the Cabinet on radiation protection issues resigned in objection to the Government's policy. His resignation had enormous implications in Fukushima prefecture, and created a state of panic, especially among families with children. The impact of this statement made by a person in an official position of the then Government and as an expert caused a far wider effect in society. Therefore, I feel strongly, seeing the confusion within Fukushima prefecture, that it is necessary to verify the appropriateness of the statement.

However, despite the fact that this incident had such a social impact, it did not serve to create momentum for discussion among the experts. It is recognised that, in the case of an emergency event of such a specialised nature as a nuclear accident, experts, either individually or as a group, have the ethical obligation to think and discuss how they are to contribute or to engage themselves in society, and not only to discuss the right and wrong of the statement made. I cannot but be totally dissatisfied with the experts as there has not been any sign to discuss these matters.

In the wake of the accident, we, in Fukushima prefecture, have continued our efforts to communicate amongst ourselves. The results of our endeavours are nothing glorious or conspicuous, but I feel that they have definitely contributed to the improvement of people's living environments. I would like to conclude my article with a recommendation that the efforts of dialoguing are not only for the people of affected areas, but also for relevant groups such as experts and administrators.

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D-Shuttle project: measurement and comparison of individual doses of high school students

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Abstract–In 2014, a team of high school students and teachers measured individual exposure doses using D-Shuttle dosimeters. In total, 216 students and teachers participated in the project, with the cooperation of 12 high schools in Japan (six from Fukushima Prefecture), four from France, eight from Poland, and two from Belarus. The participants wore the dosimeters for 2 weeks and recorded their locations in diary charts. The distribution of annual exposure doses for each school and region, estimated from the measured results, overlapped. It was concluded that the external exposure of high school students in Fukushima Prefecture was not markedly higher compared with that of students from other regions.

Keywords: Fukushima Daiichi nuclear power plant accident; Individual dose; International comparison; Radiation education

1. INTRODUCTION

The accident at Fukushima Daiichi nuclear power plant, triggered by the Great East Japan Earthquake, has given rise to concerns of contamination caused by radioactive material fallout. In Fukushima City, glass badges were rented to all school children and pregnant women from Autumn 2011 to measure individual exposure doses. However, this survey only provided data on cumulative doses over a certain period of time (3 months), and the sources of the cumulative doses were unknown.

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Fig. 1. D-Shuttle dosimeter.

The D-Shuttle dosimeter (Fig. 1) is able to record integrated exposure doses from natural background radiation and additional doses on an hourly basis. Its efficacy has been confirmed previously in other studies, and Professor Hayano of the University of Tokyo has highlighted the effectiveness of using D-Shuttle dosimeters to communicate the state of exposure to residents. Coop Fukushima has undertaken a comparison of individual doses inside and outside Fukushima Prefecture with the cooperation of its members, but to date, no surveys of individual exposure doses for high school students have been reported. As such, this article reports an individual dose study undertaken by members of the Super Science Club of Fukushima High School, with the cooperation of high schools in Fukushima Prefecture and elsewhere, using D-Shuttle dosimeters to record individual dose among high school students and teachers.

2. METHODOLOGY

In total, 216 high school students and teachers participated in this study, wearing individual dosimeters for 2 weeks. All participants were asked to record their behaviour patterns in everyday life. Details of the participating schools are shown in Table 1. Japanese high schools outside Fukushima Prefecture were selected by referring to the Geological Map of Japan, published by the Geological Association of Japan. Schools from Fukuyama (Hiroshima Prefecture), Tajimi (Gifu Prefecture), and Ena (Gifu Prefecture) were chosen to represent regions with high natural background radiation, and schools from Yamato Koriyama (Nara Prefecture) and Yokohama (Kanagawa Prefecture) were chosen to represent regions with low natural background radiation. For Fukushima Prefecture, high schools were selected using the map from the 'Results of Airborne Monitoring in Fukushima and Neighboring Prefectures' of the Nuclear Regulation Authority. Schools from Fukushima, Nihonmatsu, and Koriyama were chosen to represent regions with a relatively high postaccident dose, and a school from

Table 1. Schools participating in the individual dose study.

Region	Name of school	No. participants	No. of data points	Median ($\mu Sv\ h^{-1}$)
Fukuyama	Hiroshima University Jr. & Sr. High Schools	11	3696	0.09
Kobe	Nada High School	11	3696	0.08
YamatoKoriyama	Nara Gakuen Jr. & Sr. High Schools	10	3360	0.06
Tajimi	Gifu Prefectural Tajimi North High School	10	3360	0.08
Ena	Gifu Prefectural Ena High School	10	3360	0.09
Yokohama	Kanagawa University High School	11	3696	0.06
Koriyama	Fukushima Prefectural Asaka High School	11	3696	0.09
Iwaki	Fukushima Prefectural Iwaki High School	11	3696	0.08
Aizu	Fukushima Prefectural Aizu Gakuho High School	11	3696	0.07
Miharu	Fukushima Prefectural Tamura High School	11	3696	0.09
Nihonmatsu	Fukushima Prefectural Adachi High School	11	3696	0.1
Fukushima	Fukushima Prefectural High School	14	4704	0.09
Poitiers (Fr)	Bois d'Amour High School	16	5168	0.09
Paris (Fr)	Notre Dame High School	11	3278	0.06
Bastia (Fr)	Giocante de Casabianca High School	13	4276	0.11
Belarus	Bragin High School	12	4032	0.09
Poland	CZE · OST · OTW · PTO · WAW · ZABKI · ZABRZE	33	9773	0.08
Total		217	70,879	

Fr, France.

Aizu Wakamatsu was chosen to represent regions with a low postaccident dose. Overseas high schools were selected through cooperation with Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire (CEPN, France).

The high schools were asked to select students from diverse environments. Diversity of lifestyle was considered to be important so that, for example, the students would not all live in apartment complexes or in the same neighbourhood, and the students would not all be members of field sports clubs. The study was conducted from 18 June to 1 July 2014 for the 12 high schools in Japan; the specific study

periods differed for overseas countries but were implemented for a 2-week period between October and December 2014.

This study used D-Shuttle dosimeters. These semi-conductor-type individual dosimeters were jointly developed by the National Institute of Advanced Industrial and Science and Technology and Chiyoda Technol Corporation. D-Shuttle dosimeters can lodge hourly cumulative dose (dose rate) with the date and time, so the data can be viewed against the record of daily life and thereby show when and where a person was exposed to radiation. Each participant was asked to wear a D-Shuttle dosimeter around their neck during the day, and to leave it next to their pillow while sleeping.

For each participant, there were 24 data points/day × 14 days = 336 data points. This equated to approximately 3600 data points per school, and totalled 70,879 data points for the 216 participants.

3. RESULTS

3.1 Comparison of dose rates for each school

Fig. 2 compares the average dose rates measured over the 2-week period for each school in Japan. Individual doses were higher in Fukushima, Nihonmatsu (Adachi High School), and Koriyama (Asaka High School) compared with Aizu Wakamatsu and Iwaki. It should be noted that these values include the natural background radiation dose counts. However, when comparing the individual doses of students from Fukushima, Nihonmatsu (Adachi High School), and Koriyama (Asaka High School) with those of students from schools outside Fukushima Prefecture, they were equal to the values found at high schools in Ena (Gifu Ena High Schoo), Fukuyama (Fukuyama Univ. Jr. & Sr. High School), and Kobe (Nada High School). The dose counts from outside Fukushima Prefecture represent those of natural background

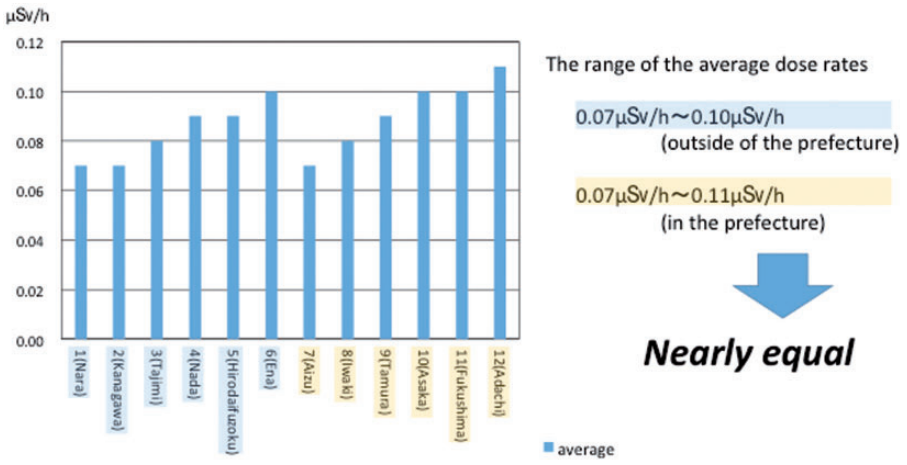

Fig. 2. Comparison of average dose rates in Japan.

radiation dose alone. These comparisons show that although the impact of the accident at Fukushima Daiichi nuclear power plant can be seen on the individual doses of the students in Fukushima Prefecture, the gap is not huge compared with individual doses received from natural background radiation.

Fig. 3 shows a box-and-whisker graph of data from each school. The x axis indicates the names and regions of the schools, and the y axis indicates the dose rates (unit: μSv h^{-1}) with a logarithmic scale. The bottom line of the box for each school represents the first quartile value (25th percentile), the vertical line represents the median, and the top line represents the third quartile value (75th percentile). The lengths of the whiskers are 1.5 times the lengths of the boxes, and X indicates outliers. The total value of the outliers is 1059, or 1.5% of the data.

The red lines indicate the minimum value of the first quartile and the maximum value of the third quartile. The positions of these red lines and the boxes for each school show that the ranges of boxes with 50% of school dose rates are almost equal; as such, it can be concluded that exposure of high school students in Fukushima Prefecture is not much higher compared with that of high school students in other regions.

The outliers need to be examined separately. However, it should be noted that outliers are not only seen in Fukushima Prefecture, but also in regions outside Fukushima Prefecture and in France, where radiocaesium contamination seems unthinkable.

The records of everyday life were used for the analysis of outliers. For example, there is an outlier for Fukushima High School which is very high at 5 μSv h^{-1}. The reason for this high value is due to one of the participants undertaking a survey in a high-dose area, Okuma in Fukushima Prefecture, during the study. In addition, there

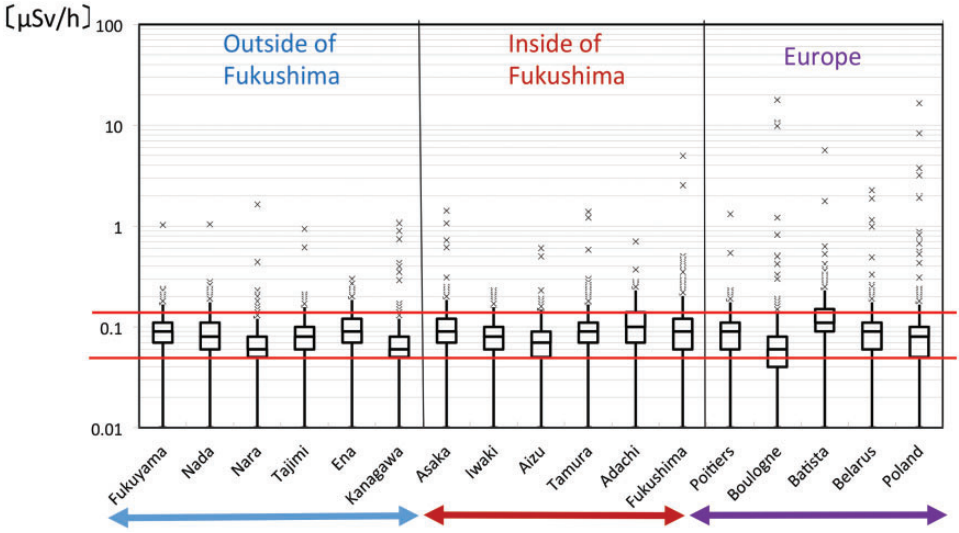

Fig. 3. Comparison of dose distribution by school.

are three outliers in Boulogne that are higher than 10 μSv h^{-1}. They were detected when the participant was in a library, so it is difficult to imagine that the individual was actually exposed to such a high dose. Considering that there are places outside Fukushima Prefecture with outliers >1 μSv h^{-1}, it can be concluded that not all outliers are due to high dose, but may be due to the influence of communication devices such as mobile phones, or from noise transmitted if a dosimeter hits something. As stated above, the ratio of outliers in the total data was approximately 1.5%. The impact of these outliers on individual participants' total exposure dose will be covered in the following section.

3.2 Comparison of annual individual doses

Fig. 3 is a box-and-whisker graph that depicts the total measured values of the participants over the study period, converted into annual individual doses. The y axis indicates the annual individual doses in mSv $years^{-1}$. The bottom of the box, the horizontal line in the box, and the top of the box indicate, as in Fig. 2, the first quartile, the median value, and the third quartile for each school and region, respectively. The tip of the whiskers indicates the maximum and minimum values for each school and region.

It should be noted that the outliers plotted in Fig. 2 were not excluded from the calculations of annual individual dose. Therefore, a participant in Boulogne shows a value as high as 1.8 mSv $year^{-1}$. If the three outliers mentioned above for this participant were excluded, the annual value would be 0.04 mSv $year^{-1}$, equivalent to the minimum value for Boulogne.

Furthermore, the measured values include natural background radiation dose. The additional exposure dose of the general public is expressed by the International Commission for Radiological Protection as <1 mSv $year^{-1}$. However, the values measured for most of the participants, as shown in Fig. 4, are inclusive of a natural background radiation dose of approximately 1 mSv $year^{-1}$. In other words, although there are slight differences in the distribution, even when the outliers in Fig. 3 are taken into consideration, it can be concluded that the high school students in Fukushima Prefecture are not exposed to much higher levels of radiation compared with students at high schools in other regions.

4. NATURAL BACKGROUND RADIATION DOSE AND INDIVIDUAL EXPOSURE DOSE

Fig. 5 shows that the individual doses received by high school students in radiocaesium-contaminated Fukushima were not particularly different from those received by students in other regions. The bar graph in Fig. 5 was taken from data released by the Japan Geology Association to plot natural background radiation dose in the neighbourhoods of participating schools in Japan. The unit for the y axis is μGy h^{-1}. The boxes at the top of the graph indicate the values with whiskers and outliers excluded from the box-and-whisker graph (Fig. 2), and the horizontal lines in the boxes represent the median for each school (μSv h^{-1}).

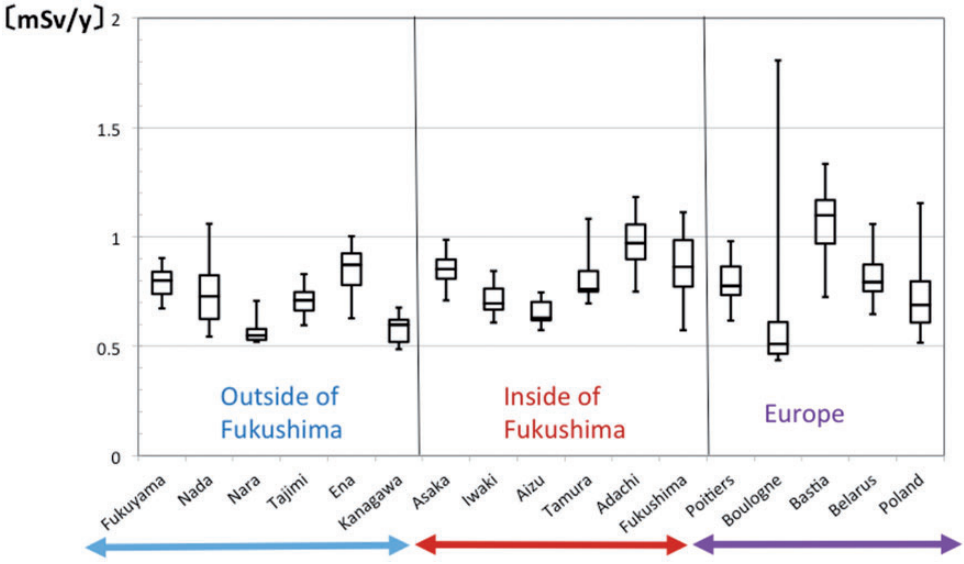

Fig. 4. Distribution of annual individual dose by school.

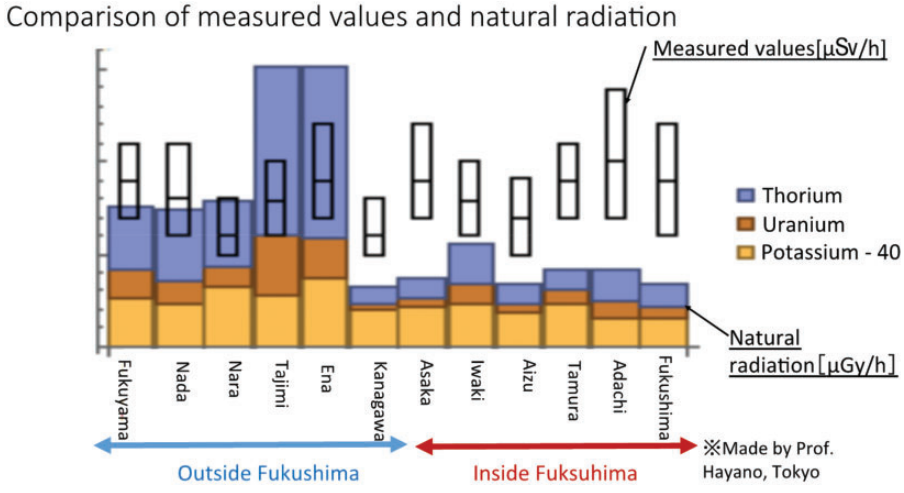

Fig. 5. Comparison of natural background radiation and individual exposure dose.

Fig. 5 shows that natural background radiation dose in Fukushima Prefecture is lower compared with other regions. Again, the positions of the boxes and bars tend to overlap in regions outside Fukushima Prefecture, while the bars are higher than the boxes for Fukushima Prefecture. From these results, it can be concluded that if

there was no contamination due to radioactive substances, the positions of the boxes and bars would have overlapped. However, due to contamination, individual exposure doses are slightly higher than those from natural background radiation, placing the boxes higher than the bars. However, natural background radiation in Fukushima Prefecture has always been low; therefore, even if exposure doses due to contamination were added, it is considered that the results would be of the same level as those for other regions.

5. CONCLUSION

Individual external exposure doses were measured using D-Shuttle dosimeters by students and teachers from 12 high schools in Japan (six from Fukushima Prefecture), four from France, eight from Poland, and two from Belarus. Median dose rates were 0.06–0.09 $\mu Sv\,h^{-1}$ outside Fukushima Prefecture, 0.07–0.10 $\mu Sv\,h^{-1}$ inside Fukushima Prefecture, and 0.06–0.11 $\mu Sv\,h^{-1}$ in Europe. The annual median individual doses calculated from the total exposure doses measured over the study period were 0.55–0.87 $mSv\,year^{-1}$, 0.63–0.97 $mSv\,year^{-1}$, and 0.51–1.0 $mSv\ year^{-1}$, respectively. It can be concluded that students in Fukushima Prefecture are not exposed to much higher doses of radiation compared with students in other regions.

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