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The Yamakiya co-expertise experience in Japan after the Fukushima accident

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Abstract

This chapter summarises the co-expertise process developed in the Yamakiya district, a former evacuation area in the Fukushima Prefecture. It shows how collaboration between residents and researchers improved understanding of radiological conditions and supported daily decision-making. Initially, communication was one-way, from researchers to residents, but this evolved over time into an interactive approach that incorporated residents' concerns, particularly regarding the behaviour of 137Cs in water, soil, forests and agricultural products. Additionally, the Yamakiya School — launched as a collaborative programme in which residents, researchers and visitors worked together through farming activities, environmental surveys and cultural exchanges — further strengthened residents' sense of security and helped shape a vision for the future.

Introduction

The following paper describes the involvement process of local stakeholder in the authors' research activities on the behaviour of radioactive caesium in the environment in the Yamakiya district of Kawamata town in the Fukushima Prefecture, a rural area located in the Abukuma Highlands. It also attempts to illustrate the process of co-operation between experts, professionals and local stakeholders — the so-called “co-expertise process” — which aims to help people living in affected areas to understand the radiological situation they face daily in order to make informed decisions to protect themselves and their loved ones. Residents' collective learning and assessment of the local situation with appropriate help of experts allow passing from a fuzzy and negative appreciation of the radiological situation to more contrasted and reliable picture (Lochard, 2013).

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Drawing on past experience in implementing the co-expertise process, the authors have modified their practices step by step, favouring dialogue with locals to share the results of their research (Rollinger et al., 2016).

In addition, the authors initiated the “Yamakiya School” to conduct a program of interactive learning based on active exchanges between the residents and participants outside the region to understand the changing needs of the residents before and after returning. The program has been conducted 29 times so far with the participation of over 500 researchers, students, and residents of the Yamakiya district but also from all of Fukushima prefecture and other prefectures. This paper also discusses the effects of the Yamakiya School’s activities on local issues in the former evacuation zone based on the information obtained from the interviews with the residents. The content of this chapter is a revised version of an article originally published in the journal Radioprotection by Yasutaka et al. (2020). It reiterates the main points of that article and presents recent developments and the current situation in Yamakiya from the perspective of the co-expertise process.

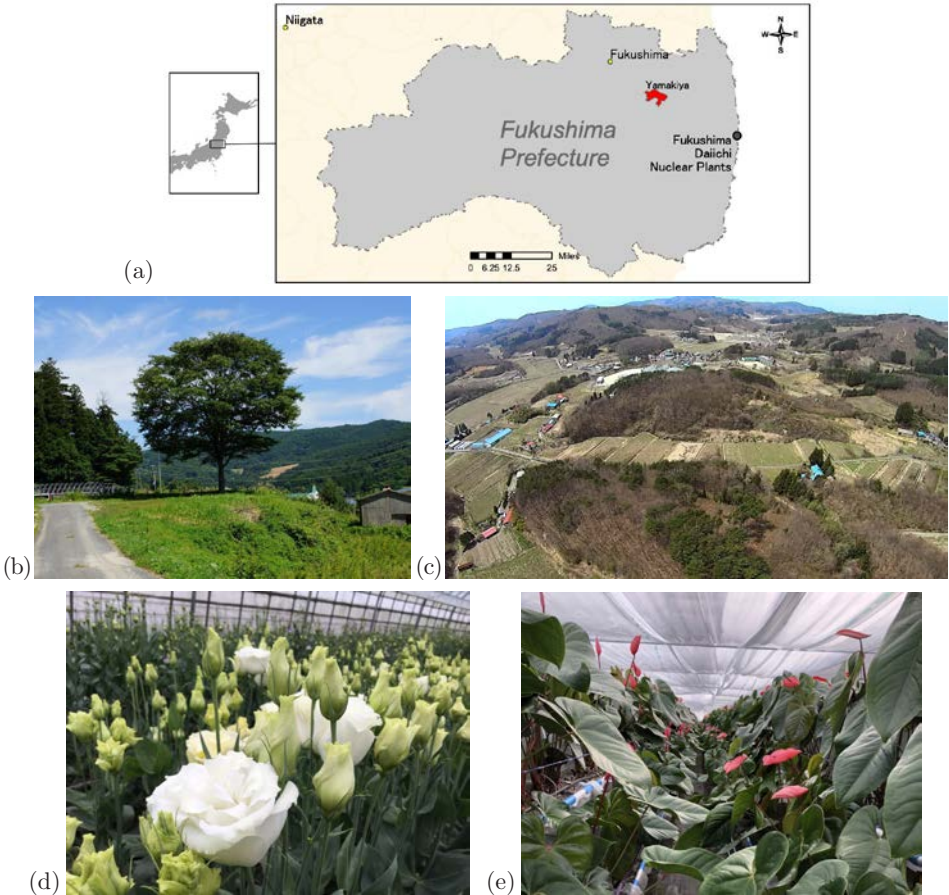


FIGURE 1. (a) The location of the Yamakiya district. (b) and (c) A general view of the Yamakiya district (The photo on the right was provided by Dr. Akihiko Kondo).

(d) and (e) Cultivation of *Eustoma* and *Anthurium* in Yamakiya district.

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1. Environmental surveys and dialogue in the Yamakiya district of Kawamata

Yamakiya district is located approximately 40 km in the northwest of the Fukushima Daichii Nuclear Power Plant (Figure 1). In April 2011, only the Yamakiya district was designated as a “planned evacuation” area in the Kawamata town and it was evacuated. It is notable that, unlike the neighbouring Iitate village, only a part of Kawamata town was designated as an area to be evacuated. Yamakiya district had a population of 1,252 before the 2011 accident. The evacuation order was lifted on March 31, 2017, and as of January 1, 2019, 330 people had returned, most of them being elderly (Kawamata Town, 2019). The elementary and junior high schools were reopened in 2018, but the elementary school closed in 2019 owing to a lack of students.

The main economic activities of Yamakiya district include those of flower and rice cultivation. Cultivation of *Eustoma* was widely practiced before the accident. Cultivation trials started from 2014 and full-scale shipments re-started in 2017 when the evacuation order was lifted. There was almost no damage to the reputation of the product and shipments resumed at the same level as before the accident. Radioactive contamination of the rice was also tested before the order to lift the evacuation and the results were found to comply with the marketing criteria. Full-scale shipments of chrysanthemums and vegetables were also resumed. In addition, the cultivation of *Anthurium* was newly started through a collaboration project between Kinki University and Kawamata town. Although the traditional production activities were actively resumed, they have not returned to the levels before the accident.

From 2012, the general environmental monitoring of the radiological local situation and specific surveys were conducted in collaboration with members of the local agricultural promotion association and various farmers, and the results were discussed together about once or twice a year. In the last seven years, public concerns and the approach of AIST experts have changed. In the early stages of evacuation, a one-sided approach toward residents was taken by the experts with respect to radiation issues. From the middle to the late stage of the evacuation, a shift was made toward a more interactive approach, but it is only when the evacuation order was lifted that a true interactive approach was developed on the daily-life-related concerns of the residents in addition to those related to the presence of radiation (see Figure 2). The following sections describe the evolution of this process and the main factors that influenced it.

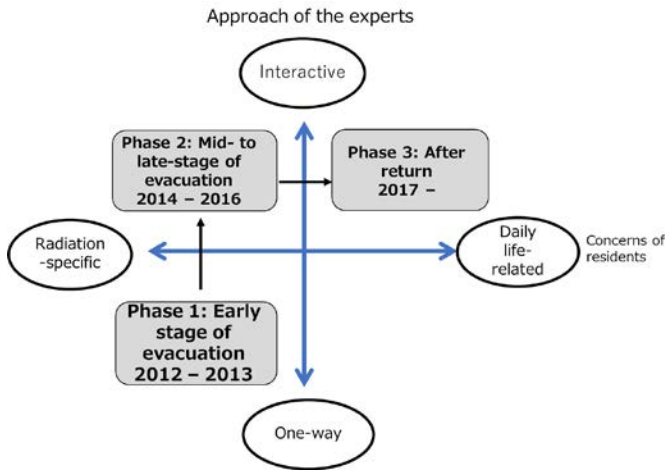


FIGURE 2. Changes in the concerns of participating residents in the Yamakiya district and in the approaches of the experts. From Yasutaka et al. (2020), © EDP Sciences.

1.1. *The approach before the evacuation order was lifted*

Before the evacuation order was lifted a series of environmental studies were conducted in the Yamakiya district mainly on the measurement and behaviour of ^{137}Cs in water (Tsuji et al., 2014), soil and forestes (Kurihara et al., 2018a,b). During this first phase, the studies were carried out on the sole initiative of the researchers, and their results were reported. There was a gap in communication between the researchers' academic reports and presentations and the residents' desire to be informed. The approach was one-way, from the experts to the residents, and the topics of the studies were focused on radiation. As a result, there were few questions from the residents and sometimes some of them slept during the briefing sessions!

In order to improve this situation, the resident's requests concerning the results of the studies collected during surveys or individual interviews were gradually integrated into the process. During this second phase, although the study themes remained specific to radioactivity, a two-way communication approach was established through a dialogue between the experts and the residents. To illustrate this dialogue here are some of the questions asked by residents regarding ^{137}Cs in water.

1. "In most national monitoring surveys of ^{137}Cs in water, the lower limit of detection is around 1 Bq.L^{-1} . As a result, almost all data are below this limit. But what is the actual concentration level? I would like to know the concentration of ^{137}Cs in groundwater from the newly installed wells".
2. "The topsoil of rice fields is to be decontaminated. Will the rice field be contaminated again by irrigation water used when rice cultivation is resumed?"
3. "Only a part of the forest is to be decontaminated. However, is ^{137}Cs not flowing out of the mountain forests through stream water?"

In order to respond to these questions, a series of measurements campaign were initiated. The concentration in ^{137}Cs was measured in different wells. Results showed extremely low concentrations ($0.0003\text{--}0.0005\text{ Bq}\cdot\text{L}^{-1}$). Dissolved ^{137}Cs (in a form easily absorbed by plants) was also measured at eight locations in the rivers of Yamakiya district between 2013 and 2015. Here again results showed extremely low concentrations (between $0.003\text{--}0.06\text{ Bq}\cdot\text{L}^{-1}$) with a confirmed tendency to gradually decrease. Based on the measurement results of dissolved ^{137}Cs and suspended ^{137}Cs in river and stream water and the amount of water generally used in the rice fields it was estimated that the contribution of irrigation water, when cultivation of rice fields is resumed after decontamination, was very small (Tsuji et al., 2014; Nakamura et al., 2012). Furthermore, monitoring results at the outlet of the small watershed toward Yamakiya indicated that the concentration of suspended ^{137}Cs increased during heavy rainfall due to sediment runoff, but it is a temporary phenomenon, and the amount of ^{137}Cs released was estimated at 0.1–0.3% annually with respect to the amount of deposition in the area (Nakamura and Yasutaka, 2012).

These results were shared and discussed with the residents of Yamakiya district to improve their understanding of the local radiological situation. The researchers' efforts to answer the questions were appreciated by the residents. During the dialogues, the residents expressed their satisfaction. So, they mentioned among other comments that “researchers measure the concentration of water according to our needs, which allows us to know the situation we are facing” or that “some researchers just send their papers, when they have completed their studies and suddenly appear on TV talking about the radiological effects without explanation to local people. Sharing the results of the research together in advance and reporting to us face-to-face beforehand led to a sense of trust”.

By adapting to the residents' questions, the research brought results closer to their daily lives. By sharing these results directly, the confidence in the figures and also in those who produced them has increased accordingly. The dialogue is a basis for co-expertise.

1.2. The approach after the lifting of the evacuation order

Discussion in the issues raised by residents became increasingly rich and serious as the lifting of the evacuation order was getting closer, and a change in their interests and concerns emerged. Before the evacuation order was lifted, attention was mainly focused on the levels of radioactivity in air, water, and soil. After the evacuation order was lifted, concerns related to daily life became more prevalent. The questions related to the restrictions of activities in non-decontaminated forests in particular concerning the gathering of mushrooms and wild vegetables or those related to the levels of radioactivity in the various crops became more frequent. Residents' concern over negative rumours regarding the radiological quality of agricultural products also grown. In addition to the aspects linked to the presence of radioactivity in the environment,

after the residents' return there was an increased interest in social and economic issues, in particular those related to the resumption of agriculture, the rehabilitation of infrastructures and the maintenance of local communities. Past experience had shown that after natural disasters when residents return from a prolonged evacuation, social and economic problems are at the heart of people's concerns (Hashimoto et al., 2013). Thus, the questions raised by the reduction of the population and its aging due to the low number of active people among the returnees as well as the problems related to the management of agricultural facilities and agricultural land due to a decrease in the number of farmers and the lack of labour became frequently raised issues in the dialogue meetings.

In the third phase, research related to radiation was conducted taking into account these changes in the interest of residents. Thus, studies have been carried out on the contamination of wild vegetables and other forest products, on the effects of the presence of uncontaminated forests in the vicinity of living areas, and also on the individual doses received by residents during their daily activities. The implementation of these studies, in which the residents were closely associated, made it possible to deepen the exchanges between experts and residents and to progressively develop among them a practical culture of radiological protection.

2. The Yamakiya School interactive learning and exchange program

Considering that in the past, the Yamakiya district had a good experience in welcoming people from urban areas for field trainings, the authors after consulting with volunteers from the district, launched the "Yamakiya School". This interactive learning and exchange program for local and other district residents aims to strengthen the ties within the local community, to find solutions to overcome the lack of local resources and to encourage the resumption of agriculture. The program includes activities promoting the discovery of the district and the support of local agriculture. These activities make it possible to initiate a dialogue between the local residents, the visitors from other districts and the experts not only on questions relating to the radiological situation but also to all aspects of living in the district and other places.

2.1. Yamakiya School activity details

The “Yamakiya School” was launched in March 2015 by the local residents and the researchers. It operated without interruptions until 2019. Table 1 presents an overview of the activities carried out each year.

TABLE 1. Activities of the Yamakiya School: multiple contents are included in a single event.

Activity details \ Year	2015	2016	2017	2018	2019
Farm work and dialogue	1	7	8	7	5
Exchange meetings	1	7	6	5	3
Lectures and seminars	1	5	2	0	2
Local tours	1	5	5	2	2
Surveys	0	0	0	2	2
Others	0	1	4	3	3
Number of “schools” in the year	1	7	8	7	6
Number of the participants	14	88	130	136	154

The “School” carried out numerous activities including farm work and dialogue, exchange meetings, tours of the Yamakiya district and field surveys.

Work on farms growing vegetables or flowers, such as *Eustoma* and *Dahlia*, were carried out by participants on a voluntary basis. This work was followed by dialogues between participants and the farmers on the local challenges of agriculture. The exchange meetings included lectures by experts on the situation in Yamakiya after the accident, the levels of contamination by ^{137}Cs in the district or the removal of soil and the management of the radioactive waste. On the occasion of these meetings, the participants could taste the local specialties. During the district visits, participants were able to attend local socio-cultural activities, visit the local shrines and also the border of the “difficult-to-return” area. The surveys carried out included sampling wild vegetables and mushrooms and measuring their ^{137}Cs concentration. Other activities such as flower arrangement using *Eustoma* and making miso were also conducted. During each of these activities, dialogues between the Yamakiya residents and the participants were encouraged in order to develop mutual understanding and continued interaction.

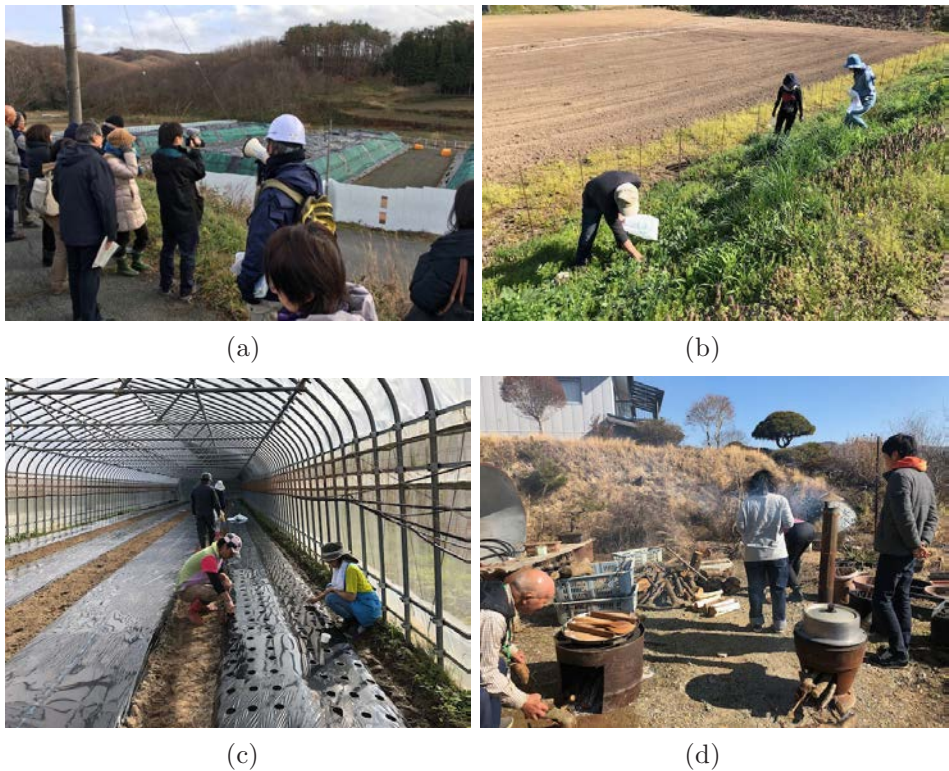


FIGURE 3. (a) Visit of a temporarily storage site of the decontamination waste in Yamakiya. (b) Gathering the wild plant with residents and visitors. (c) Work on farms growing *Eustoma* with visitors. (d) Making miso activity. From Yasutaka et al. (2020), © EDP Sciences.

2.2. Characteristics of the participants

Figure 4 shows the year-wise number and attributes of participants at the Yamakiya School by year, excluding residents. The number of participants is based on registration records and is approximate as partial participation was also encouraged.

Figure 4 shows that the number of participants increased each year. Researchers and students accounted for more than 80% of the total from 2015 to 2017. They were initially from fields related to the environmental dynamics of radioactive materials, such as pedology, ecology, hydrology, and environmental radioactivity. Through networking, researchers from various fields such as architecture, civil engineering, agriculture, and psychology became progressively involved. Furthermore, cooperation with social science researchers was promoted to meet the diversifying needs of the residents of the Yamakiya district. However, the number of researchers after 2017 declined because environmental radiation research gradually subsided. Meanwhile, the number of residents from the Fukushima Prefecture and outside increased to 40% in 2019.

This may be because the evacuation order was lifted in March 2017, which reduced concerns about radiation among residents and the spread of information from participants to friends and acquaintances and an increase in the number of repeating visitors.

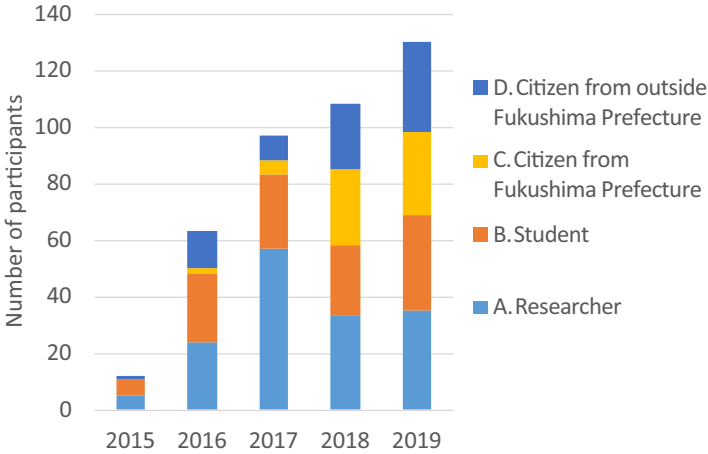


FIGURE 4. Number and quality of the participants from outside Yamakiya by year. From Yasutaka et al. (2020), © EDP Sciences.

Figure 5 shows the number of times residents in the Yamakiya district participated in the program. Fifteen residents (about 5% of returnees) have participated, but of those six people have participated five times or more confirming that some residents are more actively involved.

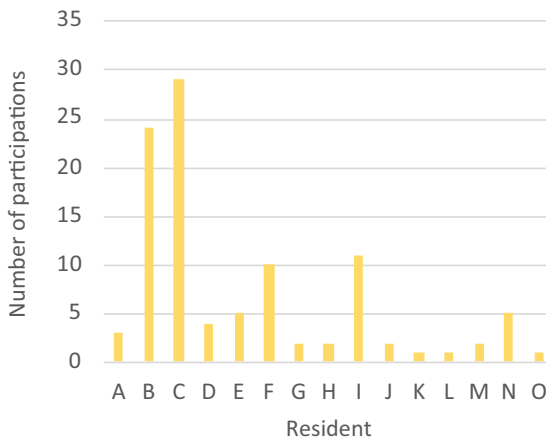


FIGURE 5. Number of participations by the residents of the Yamakiya district. From Yasutaka et al. (2020), © EDP Sciences.

3. Effectiveness of the Yamakiya School

3.1. *Interview method*

After the evacuation order was lifted in March 2017, returning residents resumed farming, including *Eustoma* and rice, and festivals at the shrine resumed for the first time in seven years, but many issues remain in the Yamakiya district, as well as areas that were evacuated around the same time. In terms of the radiological situation, the anxiety about the effects of radiation, the use of the non-decontaminated forests, the methods of using former temporary storage sites for the waste were major concerns for some residents. In terms of society and economy, the low return rate to Yamakiya, which is about 30%, led to the high aging society, the shortage of farmers and manpower, the reduction of joint work as for example the cleaning of the irrigation canals, the dilution of local communities, a weakening of the social fabric with less close neighborly relations than before, increase of the abandonment of agricultural lands, and the maintenance of social infrastructure such as grocery stores, restaurants, public halls, and clinics. The authors interviewed five residents who participated in the “School” activities to evaluate their impacts concerning the above issues. A survey was conducted in March and April 2020 on four residents who had returned to the Yamakiya district and who had frequently participated in the School. Oral and written explanations about the participation in the survey were given to them and their consents were obtained. Interviews were conducted through telephone or E-mail because of the effect of the COVID-19 pandemic.

3.2. *Effect of the Yamakiya School program on the community*

Table 2 presents the main issues of the Yamakiya district, examples of activities at the School and in research, and the contents of the interviews with residents who participated in the survey. Based on these results, we tried to ascertain the effects of the School on local issues.

As part of the Yamakiya School activities, Caesium 137 was measured in the environment (water, soil, forests, etc.) as well as in the crops and forest products and the results were shared with the residents. In addition, the School prepared meals with foods whose safety was confirmed and which was eaten together with the participants. Residents indicated the importance of measuring radiation according to their needs and providing face-to-face the results in return. They suggested that eating the radiation-measured foods together with the researchers increased their sense of security. It is also interesting to note that students, researchers, and residents from outside, including children, visiting Yamakiya through the School, gave the residents confidence in terms of safety.

The second issue is the division of local communities and the reduction of local resources. The aging of the population, the disruption of cultural traditions, the division within the community, the decline in maintenance and management of the local infrastructure, and the deterioration of the landscape due to the presence of decontaminated soil and waste flexible container, are realities that residents are confronted with and which are of great concern to them even if the almost all flexible containers have been taken to an interim storage facility by March 2022. To address these issues, the School conducted activities such as volunteers' participation in farming, meetings on utilizing local specialty products (flower arrangement, miso-making, etc.), exchange meetings between the Yamakiya residents and the visitors using local ingredients, and tours for traditional performing arts at local festivals. Participants to the survey (local resident) indicated that the benefits of these activities included rediscovering the good aspects of living in Yamakiya through the feedback of the visiting participants, contribution of participants' voluntary work to the local economy, and obtaining information about the situation in other affected communities thanks to the numerous exchanges on other areas through new networks and exchanges. Although, these activities were considered beneficial, nevertheless the interviewees highlighted the difficulty to reach out the non-participating residents of Yamakiya and to disseminate the experience of the School outside.

Although the regular increase in the number of outside participants does not resolve at all the question of the depopulation of the community, the interviewees underlined that their continued participation, especially from young people, increased the sense of security and confidence of the residents. They however mentioned that these positive effects do not spread to the whole region because of the low participation of residents perceived as mainly due to the advanced age of the population who returned.

Regarding the issue of the lack of manpower and the decline in motivation to resume agriculture in the district, the School organized work on the farm with volunteers followed by tea parties to promote dialogue between local farmers and participants after volunteering activities. The interviewees confirmed that volunteers are an important source of manpower in the early stages of resuming agriculture, but volunteering once a month after agriculture is fully resumed does not make much of an impact. The residents suggested that the exchange through agricultural volunteering has increased their motivation in terms of production activities but also for improving their living conditions.

TABLE 2. Residents' views on the effects of the Yamakiya School on local issues.

Local issue	Example of Yamakiya School and research activities	Details of interviews with Yamakiya residents participating in Yamakiya School
<p>Issue (1) Radiation effects</p> <ul style="list-style-type: none"> • Environmental safety • Safety of crops and forest products • Reputation 	<ul style="list-style-type: none"> • Measurement of ¹³⁷Cs concentration in water • External exposure dose • Evaluation of behaviour of ¹³⁷Cs in forests • Agricultural work and crop surveys • Wild vegetable surveys • Sharing of survey results • Lectures on radioactive materials • Eat wild vegetables together after measuring the concentration of ¹³⁷Cs in them. 	<ul style="list-style-type: none"> • It was significant that the university brought in students. The students probably also had concerns about whether the location was safe. If students can be reassured about safety, then we (residents) can also feel safe. Students do their research and report to the teacher. • I am confident that it is really safe because the researchers brought their children. • We and the participants can feel safe by collecting and measuring agricultural products and wild vegetables, and based on the results eat them together, and use them for flower arrangements. • These exchanges can be made and awareness shared by having fun together. Yamakiya is believed to be high in radioactive material, but in small individual steps, we have gradually gained confidence.
<p>Issue (2) Divided local communities and reduced local resources</p> <ul style="list-style-type: none"> • Disruption of cultural traditions • Division of the local community • Maintenance and management of the local infrastructure • Deterioration of the landscape 	<ul style="list-style-type: none"> • Tours of Yamakiya • Events utilizing local specialties (flower arrangement, miso-making, etc.) • Exchange events for residents of Yamakiya and elsewhere using local ingredients • Agricultural experiences 	<ul style="list-style-type: none"> • I think that the School contributes to the community. I think that it contributes economically because it buys ingredients. • The things people from elsewhere notice help us reconfirm the appeal of Yamakiya that we take for granted. • Speaking with people from outside the area allows you to get various new information. For example, when discussing dried daikon, we talk about how delicious the navel daikon in Marumori is, and how the dried daikon in Nagasaki is. This makes us think about what we could do in Yamakiya. Although we will not make money right away, we might want to imitate them or try a different approach. • Yamakiya people who do not participate are still very cautious and critical about the outside world. I want such people to participate. • Events such as the School may be temporary, but if we continue to nurture connections, we may find something of value. • Some local people have given up or lost motivation; I think it would be good to let the locals know what is happening at the School. • We want to share the idea of making the whole area a place where people want to come to and that feels comfortable. I want to share this intention, but it is difficult. • The areas along the national road are managed, but places that are not convenient and rough have reverted to nature. Even if they are to revert to nature, it would be good to manage the whole area as a landscape.

<p>Local issue</p> <ul style="list-style-type: none"> • Insufficient manpower • Introduction of new crops and technologies • Animal damage • Decreased production motivation 	<p>Example of Yamakiya School and research activities</p> <ul style="list-style-type: none"> • Volunteering in agriculture (about once a month) • Tea parties 	<p>Details of interviews with Yamakiya residents participating in Yamakiya School</p> <ul style="list-style-type: none"> • Agricultural volunteers were effective to some extent in the early stage of resuming agriculture. However, once full-scale agriculture was resumed, agricultural volunteers who came about once a month had no significant effect. • Training people from urban areas and students from outside Yamakiya in farm work is troublesome and can reduce work efficiency, but having them getting to know Yamakiya and working together is stimulating, and therefore, attractive. • We are thinking of creating a volunteer system by expanding the network from the School. I think we need a system, such as recruitment, giving vegetables as an expression of gratitude, or the like. • There are limits to compensation and assistance, so we must consider what we can do to continue. Both product and tourism resource perspectives are needed.
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4. The Fukushima Dialogue in Yamakiya

As part of its general activities, the Yamakiya school organized a Dialogue meeting on 25 and 26 November 2017 in the framework of the cooperation with the International Commission on Radiological Protection entitled “Dialogue with residents of Yamakiya to share current situations”. The participants in the dialogue, including several foreign experts, were welcomed by the mayor of the city of Kawamata who on this occasion presented the problems of the region and met with the participants. On the first day, the participants visited a shrine, a flower production farm, one of the decontamination waste storage sites located in the district, as well as a farmer who chose to return to Yamakiya after the lifting of the evacuation order. They also shared a meal prepared with local products. The second day took place in the form of a seminar. In the morning a series of presentations on the history and culture in Yamakiya, the restart of the agriculture in the area, the testimonies of several farmers, and the management of the radioactive waste from the soil decontamination, allowed participants to better understand the challenges faced by the residents. In the afternoon, a panel discussion on the theme of sharing the current situation and its problems and the future of Yamakiya allowed a small group of residents to share their experience and express their concerns and expectations (Ethos in Fukushima, 2018).



FIGURE 6. The Fukushima Dialogue in Yamakiya district in November 2017 (photo: Yumiko Kanai).

The Yamakiya dialogue meeting was a catalyst for new developments and prospects in the district by starting some citizen-led projects involving local residents and former residents of Futaba Town located in the “difficult-to-return” area. One of them, was the transplantation of flowers from Futaba Town to Yamakiya, with the support of the government which organized

the radiation measurements of the soil and the flowers and their transport (The Kahoku Shimpō, 2018). This project, which gave rise to articles in the media, marked greatly the participants because of its symbolic dimension.

As the lesson after Chernobyl already suggested, the “direct involvement of residents and authorities and professionals” in a key factor for the rehabilitation of the living conditions in the affected areas after a nuclear accident. This involvement implies the “shifting from a centralized, top-down, prescriptive and normative approach to a more decentralized bottom up, and quality-driven approach” (Lochard, 2013). Despite the fact that many issues remain in the Yamakiya district, the School experience has established the possibility of the birth of a new form of cooperation between the residents, the experts, and the authorities, which is promising for the future of the region.

5. Epilogue

Finally, this chapter concludes with a brief overview of the current situation in Yamakiya as of January 2026. Prior to the disaster, the district had a population of 1,252. As of January 2026, 280 residents have returned, representing approximately 22% of the pre-disaster population. Of the remaining population, 277 individuals have passed away, while 695 have either evacuated or relocated outside Yamakiya. Among those who have returned, 177 people (approximately 63%) are aged 70 or over. Conversely, since the lifting of the evacuation order, the number of new residents moving into Yamakiya has gradually increased. As of December 2025, 35 new residents had settled in the district, most of whom were aged 69 or younger.

Agricultural production continues in Yamakiya, particularly in flower cultivation (e.g., *Eustoma* and *anthuriums*) and rice paddy farming. However, many farmers who owned land following decontamination had withdrawn from agricultural activities due to ageing and technical constraints, including the deterioration of farming equipment. As a result, much of this land has been leased to younger farmers, enabling more intensive forms of cultivation. Rice planting, which constitutes the most labour-intensive phase of rice production, has been sustained through the support of volunteers from outside the region, including participants in the Yamakiya School programmes, throughout successive planting seasons up to 2025. Nevertheless, securing stable labour remains a continuing challenge for new agricultural entrants. In response, plans are currently being developed to incorporate the agricultural business as a legal entity, thereby providing an institutional platform for prospective farmers. Meanwhile, shipping restrictions on wild vegetables and mushrooms remain in place, as certain varieties continue to exceed food safety standards.

The Yamakiya School initiatives described above have faced difficulties in sustaining organised activities since 2020 due to the spread of the COVID-19 pandemic. Despite these disruptions, some participants have maintained informal networks through social media and continue to engage in agricultural practices and in aspects of the Yamakiya lifestyle.

With regard to everyday life, the commercial complex *Tonya no Sato* — including a supermarket — has opened, and local cultural events such as the Three-Lion Dance festival have resumed. *Tonya no Sato* also hosts a wide range of events, including markets, which attract many visitors. At the same time, only six residents aged 20 or under currently live in the district.

Though the population has dwindled and the community's character has shifted somewhat, Yamakiya's new form of daily life persists there. Even when we visit the Yamakiya district, residents rarely discuss radioactive substances or radiation.

This, however, is not a restoration of Yamakiya as it existed prior to the disaster. It must not be forgotten that the district experienced severe consequences as a result of the nuclear accident: six years of evacuation orders, large-scale decontamination activities, and the establishment of temporary storage sites caused substantial damage and contributed to many unnecessary conflicts.

Conclusion

Environmental research and interactive learning and exchange programs in the affected areas implemented with the cooperation of local residents help in resolving environmental issues related to the presence of the radioactivity in their daily life, provide a sense of security for residents, and lead to a vision for the future. Researchers and their activities must consider the questions and concerns of the affected people and should involve them in their work. They must utilize research results to infuse positive effects on residents and society and contribute to improve their living conditions. As shown in the results of the interviews, studies with only academic interest and without providing appropriate feedback to the community result in distrust by residents. Contrarily, practical collaborative research between the researchers and residents closely linked to the local problems the residents are facing contributes in the residents regaining a sense of control over their lives.

In addition, the local knowledge of the residents is often essential for researcher to interpret their measurement results and carry out their studies. Experience has shown that this knowledge has often proven to be very useful in solving difficult questions. The independent involvement of stakeholders, such as local residents and authorities is key to solving the local challenges related to the consequences of the accident. As described in the concept of the Partnership of Sustainable Development Goals, dialogue is needed for the continued involvement of experts in boosting the efforts of the residents. Close collaboration between researchers and residents will continue to be important for future studies in the affected area at the service of improving the situation.

The needs and concerns of the residents with respect to their daily lives changed when the evacuation order was lifted. The role of experts also changed to respond to the interests of the residents. As the level of exposure is progressively decreasing, the focus of the researchers in the Yamakiya district has to adapt and to focus the fields of interest described in this article. It is important to build a flexible system in which researchers and specialists in various

fields can respond to changes in the needs and concerns of residents. In order to achieve this, building a network with comprehensive cooperation between research institutes, universities, and specific regions is crucial.

The authors would like to deepen their understanding on the current state of radiation exposure in the disaster-affected areas and to work with the residents and local governments in accumulating scientific knowledge to contribute to the reconstruction of these areas and to improve the living conditions of the residents.

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