






Edited by Jacques Lochard,
Thierry Schneider
and Noboru Takamura

The Co-Expertise Process

An Inclusive and Sustainable Risk Governance Approach for Post-Nuclear Accident Recovery

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This book, dedicated to the implementation of inclusive risk management processes involving citizens and experts in the post-nuclear accident reconstruction phase, is the result of extensive experience gained by researchers and practitioners in the areas contaminated by the Chernobyl accident in Belarus, Norway and the United Kingdom, and the Fukushima accident in Japan. Coming from diverse backgrounds, they enthusiastically shared their experiences, while adhering to rigorous scientific standards, to write thirteen essays that shed light on the challenges of restoring living conditions after a major nuclear event.

Building on the recommendations of the International Commission on Radiological Protection, a series of analyses and testimonies are offered to students and researchers, as well as to professionals in the social sciences and humanities committed to risk governance and cooperation with public and private sector stakeholders.

"In a time when expertise alone no longer guarantees legitimacy, this book shows how co-expertise — sustained dialogue and shared responsibility — can reshape post-accident recovery. A thoughtful and timely contribution to the future of risk governance".

Christopher Clement,
ICRP Scientific Secretary and IRPA President

"The co-expertise process offers profound insights and courage to all those who live in a risky society. It is a 'technology of humility' for safeguarding human values and for jointly building the future".

Toshimitsu Homma,
co-author of ICRP Publication 146

"Scientific rigor is essential in the co-expertise process, but it is the respect for human dignity that really makes a difference. Each chapter stands as a testament to this simple truth".

Nobuhiko Ban,
former Commissioner NRA Japan

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The 24 authors and co-authors
of the chapters of this book

Epigraphs

In memory of Gilles Hériard-Dubreuil (†) for his enlightened leadership.

To Henry Ollagnon for his strategic vision.

To Ohtsura Niwa for his commitment to promoting the human dimension of recovery after a nuclear accident.

To Shunichi Yamashita for his unwavering support.

Preface

Friedo Zölzer[1]

When radioactive contamination enters the environment following a nuclear accident, it does not merely create a technical problem to be solved by experts. It enters the intimate sphere of human life — the air we breathe, the food we eat, the soil we cultivate, the landscapes we cherish. It challenges our relationship with ourselves, with others, and with the territory we inhabit. The presence of radioactivity transforms familiar environments into sources of anxiety, turning an invisible hazard into a defining feature of daily life, and rendering people speechless in the face of dangers they cannot see, measure, or comprehend.

The history of responses to major nuclear accidents — from Chornobyl to Fukushima — has taught us a profound lesson: technical expertise alone, no matter how rigorous, cannot adequately address the multidimensional disruption that such disasters create. When experts measure radiation levels, establish safety standards, and prescribe protective actions without genuine engagement with affected populations, they risk deepening the very sense of exclusion and powerlessness that the disaster has already inflicted. The instrumentalization of protection — reducing complex human realities to physical measurements and regulatory thresholds — can become, as Jacques Lochard says, a "second catastrophe" for those whose lives have been upended.

This book presents a fundamentally different approach: the co-expertise process. Rather than positioning experts as the sole possessors of knowledge who dictate solutions to passive populations, co-expertise recognizes affected people as essential partners in understanding and managing their own situation. It is built on the understanding that expertise takes many forms — not only the scientific and technical knowledge of professionals, but also the practical wisdom and lived experience of those who must navigate daily life in contaminated territories.

The co-expertise process represents more than a methodological innovation; it embodies a shift in the ethical foundations of radiological protection in general, and post-accident recovery in particular. These foundations were explicitly articulated by the International Commission on Radiological Protection (ICRP)

[1] University of South Bohemia in České Budějovice, Czech Republic

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in its 2018 Publication 138 on "Ethical foundations of the system of radiological protection". The approach adopted is similar to that proposed by Beauchamp and Childress in their seminal "Principles of Biomedical Ethics", but its normative foundations have been identified through an analysis of several decades of ICRP recommendations and their practical application. At their heart lie four core values: beneficence and non-maleficence (doing good and avoiding harm, combined to emphasize the necessity of balancing benefits and risks), prudence (recognizing and following the most reasonable course of action even when full knowledge of consequences is unavailable), justice (distributing benefits and risks fairly), and dignity (treating individuals with unconditional respect and recognizing their capacity to deliberate, decide, and act without constraint). These core values are complemented by three procedural values essential to practical implementation: accountability (being answerable to all those possibly affected by one's actions), transparency (being open about decisions and activities that may affect others and communicating them clearly, accurately, and honestly), and inclusiveness (involving all relevant stakeholders in decision-making processes).

What makes this ethical framework particularly significant is its claim to cross-cultural validity. Rather than imposing an ethical stance based purely in Western philosophy, the ICRP document draws on religious and philosophical traditions from around the world — from the Vedas and Bhagavad-Gita to the teachings of Buddha, from the Torah and Gospels to the Qur'an, from the wisdom of Confucius to the oral traditions of indigenous peoples. This approach demonstrates that the values underlying radiological protection are not culturally relative but reflect a genuinely common morality that is widely shared across human societies.

Together, these values transform abstract principles into practical commitments — to work *with* people rather than *for* them, to share information openly, to respect individual autonomy while building collective resilience, and to act prudently in the face of scientific uncertainty. They provide the ethical compass that guides the co-expertise process, ensuring that technical expertise is at the service of human dignity and the common good rather than becoming an instrument of control or exclusion.

The chapters of this book document the remarkable evolution of this approach across multiple contexts and continents. From the pioneering ETHOS project in Belarus following Chornobyl, through various community experiences in Japan after Fukushima, to the Sami reindeer herders in Norway and upland sheep farmers in the United Kingdom, the book traces how co-expertise has been adapted and refined to meet diverse cultural contexts and local needs. Part I presents these experiences in their rich particularity — showing not abstract theory but lived practice. Part II offers practical guidance for those who would implement similar processes, addressing the essential roles of dialogue, radiation measurements, and local projects. Part III examines the deeper foundations, exploring the science of risk governance and the ethical dimensions that underpin the entire endeavour.

What makes co-expertise particularly valuable is its recognition of incommensurability — the reality that many of the values at stake in post-accident situations cannot be reduced to a common measure. How do we compare the psychological burden of evacuation with the long-term cancer risk of remaining? How do we weigh individual autonomy against collective well-being? How do we balance radiological protection with the preservation of cultural traditions and community identity? The temptation to translate all these considerations into the calculation of a monetary value for health impact or mortality has proved ethically questionable and challenging to implement in practice. Co-expertise offers an alternative: structured dialogue that makes value judgments explicit, involves diverse stakeholders, and maintains transparency about trade-offs without pretending they can be objectively calculated.

The process is not without challenges, of course. Experts must guard against trivializing radiological risk in their desire to reassure anxious populations. They must resist the temptation to progressively withdraw support, leaving people to manage alone. They must be vigilant not to manipulate outcomes under the guise of participation. And they must ensure that co-expertise opportunities are accessible to all affected communities, not merely those with existing social capital and leadership. Addressing these challenges requires what philosopher Paul Ricœur called "practical wisdom" — the ability to navigate between abstract principles and concrete situations, always oriented toward the fundamental aim of promoting well-being and the quality of living together.

For those who face the daunting task of managing the long-term consequences of nuclear accidents — whether as policymakers, practitioners, researchers, or community leaders — this book offers invaluable guidance. It demonstrates that recovery is fundamentally a social process, not merely a technical one. It shows that rebuilding trust requires sustained commitment, genuine dialogue, and respect for local knowledge and autonomy. Most importantly, it proves that affected people, when given appropriate support and partnership, can become active agents in their own recovery rather than passive recipients of externally imposed solutions.

The co-expertise process is, in the words of scholar Sheila Jasanoff, a "technology of humility" — an institutional framework that openly acknowledges uncertainty and addresses the normative dimensions of risk management head-on. In an age when public participation is often invoked but rarely implemented with genuine commitment, the experiences documented in this volume offer proof that meaningful engagement is both possible and essential.

This book arrives at a moment when the question of how societies prepare for and respond to nuclear accidents remains urgently relevant. As the epilogue suggests, "the path is built by walking" — co-expertise is not a fixed protocol but an evolving practice, continuously refined through experience and reflection. For all who share the commitment to putting ethical values at the service of human dignity and collective well-being in the face of nuclear disaster, these pages offer both inspiration and practical wisdom.

All the chapters of the present textbook represent a truly amazing and groundbreaking effort by all the authors that has greatly improved post-nuclear accident management for the whole of society, and affected local communities in particular.

Prologue
Living in contaminated areas after a nuclear accident

Jacques Lochard[1,2]

> “All human action, all knowledge, all experience has meaning only insofar as one can speak of it. [...] Men in the plural, that is to say men as “they live and move and act in this world, have the experience of the intelligible only because they speak, understand each other, understand themselves”.
>
> Hanah Arendt (1958) *The Human Conditions*, University of Chicago Press.

Faced with disasters of the magnitude of Chornobyl and Fukushima accidents, the questions that naturally come to mind for an expert is of a collective nature: How to protect the population? What actions can be implemented to reduce the impact of radioactive pollution? How to help victims? What organizations should be put in place to take charge of the management of the various consequences? Of course, this collective dimension is fundamental, but the focus on the collective response tends to pay limited attention to the fact that radioactivity, when it bursts into the environment, immediately reaches the private sphere and enters the privacy of each of the individuals caught up in the contamination. From this point of view, the catastrophe introduces a new reality of the human condition in the sense that Hannah Arendt gives to this expression.

Radioactivity in the environment is an invisible, impalpable, elusive presence. Moreover, it is unknown in the sense that man has no experience, no memory, of such a presence. The latter is therefore also unspeakable. It constitutes a danger

1 Nagasaki University, Japan
2 International Commission on Radiological Protection (ICRP)

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from the outset which is materialized by the scale of the initial response to the accident, but this danger is very difficult to identify. It is a potential danger, an insidious and lasting threat, because it also concerns future generations. All these characteristics explain why the presence of radioactivity in the environment following a nuclear accident is worrying and translates directly into a very high level of concern among the people affected and in particular among the mothers of young children.

This presence affects each individual in their relationship with themselves, to others and to their territory on all levels: health, economic, social, education, psychological, symbolic, aesthetic... First, this presence re-questions everyone's relationship to risk, and therefore to death. It updates the latter, which in normal times is postponed as an eventuality that first affects others, the severely sick, those who take risks. But in this face to face with death, man is speechless, he doesn't know how to express his fear of danger. The presence of radioactivity also challenges relationships with others, those who have been affected and those who have not. How to react in front of someone who is contaminated like me? How do the uncontaminated people perceive me? The children evacuated from the contaminated zones in Belarus after the Chornobyl accident were placed at the back of the class in the schools of the villages where they were rehoused. Young people living in uncontaminated territories often admit that they would not want to marry someone from contaminated territories. Being contaminated makes you different, almost like a pariah.

As for the relationship to the territory, it is also totally destabilized by its sudden loss of worth. Indeed, the territory is deskilled at the economic and social level (land losses, agricultural, fishery and industrial losses...), at the level of the common natural heritage (contamination of fauna and flora...), but also at the aesthetic level (there is a different vision of the environment, landscapes, before and after the accident). The familiar environment (the vegetable gardens, places of leisure, etc.) becomes hostile. In addition, this disqualification is administratively endorsed through the official "zoning" of the affected territories according to the level of contamination. The accidental contamination of an environment therefore affects life both at the individual and living together at the level of the community, and moreover it disqualifies the world in which everyone deploys and acts. And everyone is speechless in the face of this situation because they have neither personal nor family experience that could help them face it. Beyond the anxiety linked to the hostile presence, a deep feeling of loss of control of the situation sets in for everyone, which goes hand in hand with a loss of self-confidence. The action of man on his daily routines becomes severed. Deprived of the means of control over his own situation and of the capacity to act to improve it, man loses his dignity.

The irruption of contamination in the environment creates an unknown world. There is a lack of words to understand it in everyday language, so rumors circulate among the population on the effects of radioactivity and the means to protect themselves which are not based on any scientific evidence.

For mourning to take place, in relation to the "world before" the accident it is necessary for the population to accept the new situation in which some aspects of the "living together" are irretrievably lost and man's relationship with his environment, his territory, has become a hostile environment. For this work of mourning to be carried out, it is necessary for people to decide to protect themselves but also to develop a discourse on the accident and its consequences. They have to organize the memory through, for example, commemorative ceremonies to introduce symbols into society and also dialogue meetings in which everyone can testify about her or his experience and also express their views, concerns and expectations.

Another important dimension is that of exclusion, which gradually sets in. The individual finds themselves immersed in a new reality and at the same time they are excluded from it. This exclusion is reinforced. In two ways. Firstly, individuals do not know how to understand the new reality that surrounds them (lack of experience) and do not know how to react and act; they feel progressively isolated from this reality. Secondly, the management of the situation by authorities and experts reinforces this feeling of exclusion. To deal with these complex phenomena that are accidental pollution of technological origin, scientific and technical expertise is mobilized. It gradually takes hold of all affected dimensions of life and tends to confiscate them. The result is an "instrumentalization" of human action in the contaminated territories, which further reinforces the feeling of exclusion felt by individuals. Each of the steps that are traditionally found in risk assessment and management approaches, namely: measuring and evaluating the risk, introducing protection standards and finally implementing collective protective actions, participate in this process of exclusion. The measurement of radioactivity in the environment despite its technical dimension, is an activity that leads to a marked reduction in the complexity of the situation by reducing it to a single physical dimension: the quantity of energy released by the radioactive atoms present in a specific location, products or even in the human body. It is this indicator that serves as a guide to assess and manage the situation. Experts who take the measurements often exclude individuals from the process, thereby ignoring the human dimension of the situation.

The objective of this assessment for the authorities is to introduce standards to manage the post-accident situation which also reinforces the feeling of distancing from reality. These standards indeed tend to make a distinction between what is safe and what is not, whereas in reality, the situations are more nuanced. There is a very big difference between a sample of milk or rice whose level of contamination exceeds the marketing standard by a few percent and another whose level of contamination is two or three times higher than the standard. In practice, the application of norms erases the notion of quality which, on the contrary, makes it possible to differentiate the situations in a much finer way. Setting standards in a post-accident situation is therefore a delicate process because not only does it disqualify the environment and things, but indirectly also people.

A last point concerns the introduction of protective actions also called countermeasures, be they technical or administrative. Incidentally, the term countermeasure comes from military vocabulary: it means to render the enemy's action ineffective. This choice of term shows that a post-accident situation is comparable to a war situation, which is easily identifiable in the discourse of the inhabitants of the contaminated territories who easily use the vocabulary of war to talk about the accident and very often mention episodes of war that have happened in their living place throughout History. Having to confront death certainly explains this constant back and forth with the collective memory of episodes of war.

On the practical level, the protective actions are generally decided by experts, and introduced at the collective level based on emergency or recovery plans. In concrete terms, these various actions implemented aim at keeping people away from radioactivity or reducing the levels of radioactivity in the environment and food products. In this context where, due to the mere presence of radioactivity, individuals feel excluded, with no real possibility of controlling the situation, the introduction of collective protective actions further reinforces exclusion. The individual is seized and they become a cog in a mechanism that no longer depends on them. For many people, the implementation of protective actions, in particular those that profoundly modify ancestral relations with the environment and modes of production, is experienced as a second catastrophe. Overall, "the instrumentalization of action" to collectively respond to the problems posed by environmental contamination raises concern in the population, depersonalizes the individual and thus reinforces his exclusion and the world feels alien to the affected people. It also strongly contributes to the deterioration of social trust in authorities and experts.

The above developments allow us to better understand what is at stake for individuals who remain voluntarily or not in a contaminated territory. They also make it possible to better understand the different attitudes and strategies that are adopted by people to cope with the situation they face. A first attitude is that of risk denial. Some individuals repress the complexity, the feeling of worry and all the feelings that come to disturb the tranquility of everyday life. They refuse to see the situation as it is, and even convince themselves of the merits of their position by developing explanations tending to deny the risk. For example, many people say that after a certain number of years the radioactivity no longer affects their health because they are immune. Another attitude is that of resignation, of fatalism: people give up coping, they feel abandoned, they settle into a kind of apathy and the status of victim with often the denunciation of scapegoats. Denial and resignation generally lead to risky behavior for oneself and for others. For example, denial in families where there are small children can lead to the daily consumption of highly contaminated food without anyone worrying about the radiological quality of the food.

In reality, the inhabitants of contaminated areas face a constant dilemma: leave the area and abandon everything, or, conversely, stay, organize their lives, and prepare for the future of generations to come. Can we live here? This is the question that haunts most people. Those who think that there is no future for them and especially for their children on the territory leave. Those who stay often do so because they really have no other choice given their financial situation. Sometimes however, they stay because they have roots in the territory and by taking protective actions and by accepting the direct support of their community and the indirect support from national and international partners, they can build a future for their children. However, staying imposes people to remain in positions of awareness to cope with the situation. The price to pay for holding this position is high, as they must constantly monitor the quality of their environment and maintain unwavering vigilance. In this position, it is very easy to succumb to worry, even stress. Therefore, maintaining such an attitude requires considerable clarity of thought and determination. Remaining vigilant in the long term is only possible for the residents by sharing responsibility within the local community and progressively identifying the key points on which their vigilance is required while relaxing on the other facets of their daily life. In this perspective, implementing local projects in the community is crucial and contributes to build a possible future for the community.

The following chapters show how experts can accompany people affected by a nuclear accident along a sometimes long and winding path to a better life. This is achieved through the so-called co-expertise process, which helps individuals regain their autonomy and recover their dignity that was damaged by the accident. This process implicitly involves dialogue with experts, measurements of radioactivity, and the implementation of projects to protect people and improve their living conditions.

PART I
THE CO-EXPERTISE PROCESS IN PRACTICE: THE CHORNOBYL EXPERIENCE

1
The emergence of the co-expertise process in the ETHOS project in Belarus after the Chornobyl accident

Thierry Schneider[1,2,3], Jacques Lochard[2,3]

Abstract

The origin of the ETHOS Project arose in the early 1990s from the observation that populations residing in the areas contaminated by the Chornobyl accident had largely lost control of their daily lives. Led by a multidisciplinary team of French experts, the project started in July 1996 in the village of Olmany, and was extended later in 4 other villages of the Stolyn District in the South of Belarus, about 250 km West from Chornobyl. Based on the direct involvement of the population from the affected areas in the improvement of their protection and their living conditions, the project has seen the emergence of the co-expertise process now recommended by the International Commission on Radiological Protection (ICRP) in the management of post-nuclear accident situations. This article first presents the context of the ETHOS project's deployment, then the fundamental principles that guided its implementation over five years. It then describes its application by working groups composed of villagers and members of the ETHOS team, as well as the international seminar held in Stolyn which concluded the project.

Introduction

The history of the ETHOS project began in the early 1990s within the framework of the cooperation agreement between the European Economic Community and Russia, Belarus, and Ukraine: the so-called EC-CIS project (European Union, 2025). This project aimed to study the nature of the radioactive contamination resulting from the Chornobyl accident, to develop the technical skills necessary to manage such accidents in the future, and to improve emergency management

[1] Nuclear Protection Evaluation Centre (CEPN), France
[2] Nagasaki University, Japan
[3] International Commission on Radiological Protection (ICRP)

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procedures. It was during this five-year research program (1992-1996) that the idea of giving the populations of the affected territories back control of the situation emerged. Indeed, the researchers involved observed that the post-accident crisis persisted and affected all aspects of society. By studying the psychological and social consequences among the cleanup workers, those relocated, those living in contaminated areas and the general population, this work led to a rethinking of the role of experts and authorities. In fact, the authorities were confronted with a lack of trust among the general population and were unable to improve the radiological situation of the inhabitants, who were facing a serious economic crisis. In this context, the regulation and technical measures imposed by the authorities and experts were ineffective in ensuring that the people living in contaminated areas were adequately protected. Rather than deciding on, and implementing regulations and technical measures, in the hope of solving people's problems, the idea that experts should cooperate with people to make sense of the situation and help them regain control, gained traction. It was at the international conference, jointly organized by the European Commission and the Ministries of Health of Belarus, Russia, and Ukraine, held in Minsk in April 1996 and entitled "The Radiological Consequences of the Chernobyl Accident", that the psychological and social results of the research were presented (European Commission, 1996). At this time, a discussion with the Minister of Chernobyl of Belarus (the most affected Republic) led to the suggestion of developing a pilot project to explore how to directly involve the population of the affected areas in the improvement of their protection and their living conditions.

With the support of the European Commission and the close cooperation of the Belarus Chernobyl Committee, the ETHOS project started in July 1996 first in the village of Olmany, then in 4 other villages of the Stolyn District in the South of Belarus, about 250 km East from Chornobyl (Hériard-Dubreuil et al., 1999) It was implemented by a multidisciplinary team of 12 French experts in radiological protection, agronomy, local development, sociology, psychology and philosophy.

The first section describes the very specific strategic context in which the project was deployed. The second section presents the project's key principles. The third section presents the implementation of the local projects developed by working groups including villagers and the members of the ETHOS team, and the fourth section presents the extension of the project until 2001 and the Stolyn International seminar which concluded the ETHOS project.

1. The strategic context of the ETHOS project

In the weeks and months following the accident, the Soviet authorities initially managed the situation based solely on radiological exposure criteria and standards. The contaminated areas were vast, roughly a quarter the size of France affecting the three Republics — Belarus, Russia and Ukraine. In Belarus, the most affected republic, nearly 20% of the territory was contaminated. The authorities evaluated that, in roughly 80% of the affected territory, the level of contamination resulted in an average annual dose for the population of less than 5 mSv. In the late 1980s, this value corresponded to the annual individual dose limit recommended by the International Commission on Radiological Protection for members of the public for normal situations. The prevailing view was therefore that below 5 mSv/year, territories could be excluded from post-accident management, and that intervention was only necessary above that criterion. This approach was adopted to limit the scale of the problem and to address both economic and political concerns. However, as early as 1990, the international community adopted the new individual dose limit of 1 mSv per year for members of the public for normal situations. This provoked the population affected by the Chornobyl accident to strongly reject the standard imposed by the authorities. This reaction combined with a period of disturbances linked to the collapse of USSR, gave rise to similar demands by political movements during the first elections following the independence of the three Republics. Finally the value of 5 mSv per year was rejected in the 3 Republics and the value of 1 mSv per year became the basis for all post-accident legislation after 1991.

Despite all the measures adopted by the authorities, the presence of radioactivity remained a constant source of concern for the population. This phenomenon was termed "radiophobia", by the authorities, a concept introduced very soon after the accident to describe the anxiety of people affected by radioactivity. This terminology was also widely adopted by the international community of radiation protection professionals. Faced with this situation, the logical solution was to implement a program of "psychological rehabilitation' through the deployment of psychotherapeutic resources. UNESCO thus embarked on a strategy of establishing "psychological rehabilitation centres" to try to bring anxious and worried individuals back to a more peaceful state of mind. Field interviews conducted as part of the EC-CIS project with people supposedly suffering from radiophobia, revealed that they were just subject to fears, quite rational fears for people experiencing a loss of social confidence. There was a widespread fear of an invisible, omnipresent object, impossible to grasp except through fairly coherent technical means, impossible to assess without some background in radiation protection. After the accident, there was a general loss of confidence in the authorities, in the experts and in science. People were left alone confronted with a situation very difficult to understand. Their priority was their safety. Addressing the problem from a purely psychological perspective was completely inappropriate for their expectations. The psychotherapeutic approach, therefore, failed to address the problem and was gradually abandoned in favour of a more communication-focused approach.

The authorities eventually concluded that the root of the problem laid in the lack of information, and that by increasing the dissemination of information on protective measures, it would be sufficient to resolve the recurring concerns. Here too, this approach proved to be a dead end. First, because the dissemination of information is ineffective in the context of lost trust. Moreover, risk perception is a psychological trait that is unique to each person. Consider the example of people who had left certain areas and decided to return, knowing that the very act of living in those areas entailed risk. Fundamentally, the decision surrounding risk-taking involves the mobilization of the person taking the risk. It is not simply a matter of information.

Ultimately, the post-accident management of Chornobyl clearly demonstrated the limitations of a risk management approach focused solely on reducing risk and providing recommendations on radiation protection. This is primarily because the economic and social context clearly played a crucial role in the deterioration of living conditions for the affected populations. In the initial years following the accident, the strategies developed by the authorities enjoyed a period of relative success: evacuation of the most contaminated areas, implementation of various countermeasures in agriculture, cessation of private food production, and supplying stores with clean food.

Finally, despite all the above attempts to manage the situation, the ongoing concerns of people living in affected areas were not significantly addressed. Even though exposure levels were relatively low across a large part of Belarus a decade after the accident due to radioactive decay, the population still had to confront the persistent residual levels of radiation. The later also constituted a major obstacle to the long-term preservation of socio-economic infrastructure and the quality of life of the inhabitants.

It is within this context that the ETHOS project was launched in the village of Olmany in the Stolyn district (Figure 1), with the aim of actively and sustainably involving the villagers in their protection and in the overall rehabilitation of their living conditions. This was done thanks to the support from the European Commission and Belarussian authorities.

Figure 1. Olmany in the Stolyn district of Belarus
(from Google Maps with the authors having made some additions).

1.1. *The ETHOS project: a new approach to recovery*

The ETHOS approach in Belarus provided a change in direction from the previous post-accident management strategies (Hériard-Dubreuil et al., 2004). This approach not only considered risk reduction but also rehabilitation of living conditions. Furthermore, the population became actively involved in their own risk management. The term "rehabilitation of living conditions" was adopted to avoid the ambiguity that often arises in this type of situation, where the rehabilitation of territories is discussed as if it were possible to eliminate contamination. It cannot be eliminated and in the post-accident context, it is much more about rebuilding ways of life that allow populations to live safely in these areas. It was primarily a matter of a profound reorganization of lifestyles — economic, cultural, and social — in order to restore decent living conditions. This original approach thus simultaneously considered technical and social aspects. The idea was not to adopt a technical approach first and then focus on social issues. The decision was made to bring together different areas of expertise within a single team to avoid the lack of coordination often observed. The team therefore combined solid expertise in radiation protection, social risk management, agronomy, and more specifically in biodiversity management and heritage strategy, as cultural heritage had been profoundly affected by the post-accident crisis. In addition to this expertise, there was also expertise in building trust in the context of technological risks.

Talks with the Belarusian authorities had shown that they were approaching the issues rigorously, as they represented a political imperative for them: the inhabitants of the contaminated territories comprised 0.03% of the Russian population, approximately 4% of the Ukrainian population, and 20% of the Belarusian population. It was therefore a priority issue of national importance for the Belarusian authorities, who demonstrated a genuine interest in finding a site to implement the ETHOS project.

A small group of ETHOS team members visited all the districts of the contaminated territories in Belarus, where they presented the ETHOS project to the local authorities of various villages interested to cooperate. Ultimately, the village of Olmany, located in the Stolyn district in the southwest of the country, 200 km from Chernobyl, was chosen, in an area legally designated as a "voluntary resettlement zone". The Belarusian legal system divided territories into three main categories. When the average annual radiation dose received by the population was estimated at more than 5 mSv/year — a level considered intolerable — the territories should theoretically be completely evacuated. Between 1 and 5 mSv/year, the Belarusian authorities implemented an original concept regarding the risk of residing in these territories, through laws whose application relies on the voluntary participation of the population. Residents could choose to stay or leave — with partial reimbursement of their expenses — hence the name "voluntary resettlement zones". Below 1 mSv, these are "strict control zones": apart from a few checks, few measures were taken, and the population received only minimal support from the authorities. Figure 2 present a general view of the village surrounded by swamps and forest located at the end of a dead-end road. With a population of 1255 inhabitants including 370 children under 18 years old, the main activity was agriculture with a kolkhoz covering about 1800 ha. But inhabitants derived a significant portion of their incomes from berries picking and mushrooms from the forest. The village had a kindergarten, a primary school and an ambulatory hospital.

FIGURE 2. The characteristics of Olmany in 1996 (photo: J. Lochard).

Upon arriving in Olmany, the ETHOS team did not have the methodological framework presented in this chapter. This framework was built empirically and progressively through trial and error in the field during the ETHOS project. However, the team had clearly defined the contractual and ethical framework of the project from the outset, which aimed to build trust with the village population. How did they proceed? The first step consisted of establishing a basic level of trust between the team and the population by organizing a large public meeting attended by about one hundred villagers. During this meeting, the team was asked a number of questions. One of the anticipated and inevitable questions asked to the team was "can we live here"? It had been decided in advance not to answer this question directly, mainly because the decision to remain in the village belonged to the people directly affected; the area was legally designated as a voluntary resettlement zone. The members of the ETHOS team therefore clarified that they had not come to answer this question, but rather that they were willing to help the people who wished to live in the village and work with them to concretely improve their living conditions over three years. This commitment to come and work for three years to improve the situation constituted a strong ethical stance. To the question, "Would you have chosen to live here?", the team's responses were quite diverse and nuanced, but no member stated that they would actually want to permanently reside in Olmany!

Regarding the question of trust, the members of the ETHOS team quickly understood the importance of being committed for a three-year period and that they had to demonstrate their commitment. During the second mission, the team rented a house on a three-year lease, which they fitted out with offices and a meeting room, and which became the ETHOS house. This initiative definitively dispelled the lingering fears among some residents regarding the team's genuine commitment to working within the village to tangibly improve the situation.

2. The practical implementation of the ETHOS project

The first step of the co-expertise process essentially consisted of assessing and quantifying the radiological situation with the local population. It is important to note that this work was carried out collaboratively with the villagers. Radiation measurements were taken and certified to gradually paint a picture of the radiological situation in the village of Olmany. From this foundation, it was possible to begin a quantification process, moving from a completely unclear and gray picture to a much more nuanced and contrasting one. This sometimes yielded pleasant surprises—for example, some mothers noticed that the inside of their homes was "clean"—and sometimes, conversely, worrying things, such as those related to milk production. The team and the villagers then focused on identifying areas for improvement, taking into account available resources, in order to develop realistic solutions adapted to the situation. When it came to the step of making choices, the co-expertise was again based on dialogue and strong involvement of the villagers. Life in the contaminated areas inevitably involves dilemmas because protection resources are often limited. The villagers preferred, for example, that the available resources were dedicated to child protection. This was a choice no one could make for them. Similarly, choices had to be made between protection and income, between short-term and long-term goals. All these choices were extremely delicate, it was clearly a decision to be taken by the villagers themselves, as they are existential in nature.

The next step for the villagers was therefore to implement these choices with the ETHOS team and, if necessary, with the support of local authorities. Indeed, throughout the ETHOS project, the team maintained constant contact with local, regional, and national authorities. These authorities, moreover, shifted from a kind of benevolent neutrality to progressive involvement as the ETHOS project advanced, opening up new avenues for action and opportunities for intervention.

Six practical local projects were developed within the framework of the ETHOS approach: a project with mothers on children's radiological protection, a project with private farmers to improve milk quality, a project to rebuild the entire economic chain of meat production and marketing, an educational project to work with the Olmany school, a project on the management of contaminated ashes from village hearths, and finally, a video project with the village youth. It took more than a year to put in place the various projects. The process started first with the young mother's and the milk groups. They were then followed by the 4 other groups.

2.1. *The radiological protection of children*

This section outlines the action that gradually developed between the ETHOS team and the mothers of families in the village of Olmany, for the management of the radiological safety of children.

Listening to and talking with the villagers, it quickly became apparent that among those most interested in the presence of the French experts in the village were many mothers, particularly young mothers, deeply worried about their children's health, both in the short and long term.

What was the context of this concern? First, the official discourse of the doctors who regularly visited the school to examine the children and conduct basic tests indicated that their health was slowly deteriorating. Feeling powerless in the face of this situation, they tended to address the families, especially the mothers, during the parent-teacher meetings held after these consultations: "Your children are sick. What are you doing for their health? Stop giving them contaminated food". This situation ultimately generated a heavy sense of guilt among the mothers. They were aware that it was primarily their responsibility to intervene regarding their children's diet and that they were ultimately responsible for their health. And at the same time, they knew perfectly well that protection was very difficult to implement because, within the family, it essentially consisted of multiple prohibitions imposed on the children which, ultimately, prevented them from living as the village children had always done for generations: "Don't go to play in the garden, or in the forest. Don't eat blueberries or mushrooms. Don't swim in the river, it's contaminated"... Moreover, for these families living in very precarious economic circumstances, with a small plot of land where they grew vegetables and raised one or two cows, the room for maneuver was very limited. On the one hand, the produce was contaminated; on the other, village tradition dictated consuming local products. And, given the general economic situation, there wasn't really a choice. They had to give milk to the children. And besides, the children loved it... This situation, therefore, represented a major challenge for the mothers.

Another factor contributing to public concern was that, ten years after the accident, the population still had a complete lack of knowledge about the levels and mechanisms of how they were being exposed, and therefore no frame of reference for taking appropriate action. It is worth noting that the education system in Belarus was very effective. Belarusians are educated, articulate, quick learners, and read newspapers, even in rural areas. However, upon arriving in 1996, the ETHOS team found that the inhabitants had no idea about the levels of exposure and that even the simple distinction between "external exposure" and "internal contamination" was incomprehensible to them. Over the previous ten years, numerous measurements had been taken by the Belarusian authorities or by other scientific teams visiting the village, but no understandable feedback had been provided to the population.

The third important aspect in this context was that the children's health was ensured by the community through the school system. First, uncontaminated food was distributed to all schools in the affected areas. Whenever they were at school, the children were not ingesting radiation. The same was true when they visited sanatoriums. In fact, twice a year, the children spent a month in a sanatorium located in the uncontaminated regions of Belarus. In addition to these stays in Belarus, the school also organized trips abroad. For years, entire classes of children thus left their families during the summer holidays. The responsibility for protecting the children's health therefore fell to the school, which created an uncomfortable paradox for the young mothers: by perpetuating a traditional family lifestyle, they endangered their children, and it was only outside the family setting, when their children were cared for by the public system, that they found relative peace of mind. It is therefore understandable how maternal anxiety could develop in this situation where they felt powerless to act for their children.

Based on these observations, and through discussions with the mothers, the idea of creating a local group focused on child protection emerged. Initially, the ETHOS team tried to explain, from a theoretical perspective, the phenomena of external radiation and internal contamination, as well as the mechanisms by which children could be exposed, but this approach proved unsuccessful. The ETHOS team shifted its focus and, together with about ten mothers from the village, embarked on a measurement program to better understand and pinpoint the ambient contamination, and also to assess the amount of becquerels ingested by the children. In doing so, the team encountered significant challenges in finding user-friendly, robust measuring devices that could be integrated into everyday life. The mothers were then trained on how to use these devices, took measurements together, and to operate the equipment independently. A scaling-up process then began, spearheaded by the mothers, to measure ambient dose rates in homes and gardens. After taking some measurements in the houses, the ETHOS team and the group of mothers quickly realized that the most worrying problem lay in the ashes. In Olmany, traditional wood-burning stoves were used, and since the burned wood was highly contaminated, radioactivity accumulates in the stove fireboxes. Measurements were taken in the gardens where ashes were regularly spread.

Together, experts and mothers developed a protocol stipulating that for each house the ambient dose rate had to be measured in all the rooms, particularly around the stoves, and also in the gardens, to see if there were any significant differences. The first measurements were taken in the home of a young mother (see Figure 3). When the ETHOS team returned to Olmany three months later, it was pleasantly surprised to find 15 house plans. And, in the end, several dozen house plans spread throughout the village were done. The mothers also had the idea of organizing excursions with the school children to take measurements in the surrounding area. They drew their routes on paper, recording the measurements taken, which they then displayed at the school (see Figure 3).

Figure 3. Measurements of mothers (photos: J. Lochard).

In total, 298 measurements were taken inside the houses, 67 measurements near or inside wood-burning stoves, and 350 measurements in the gardens. The ETHOS team together with the group of mothers analyzed the data and tried several types of graphical representations. The problem of scale quickly arose: was it highly contaminated, or not at all? A point of comparison was needed. The mothers then asked, “And what about the radiation in your houses in France?” The ETHOS team engaged in a discussion on the issue of natural radiation, explaining that, independently of the Chornobyl contamination, when measuring ambient radioactivity in France, one can find varying levels. Measurements in the homes of ETHOS team members were performed and when back in Olmany, were compared with measurements from Olmany houses. The mothers were able to see that, ultimately, the radiation levels inside the village houses were quite similar to those found in France. This was, incidentally, good news that quickly spread throughout the village. Ultimately, the group chose the average natural radiation exposure in France as the reference level for assessing the situation in Olmany, namely an average ambient dose rate of around 0.15 microSv/h. From this, it was possible to construct a “management scale for external radiation”, allowing the development of precautionary measures to adopt in relation to ambient dose rates. This scale ranged from 0 to 2 microSv/h. Up to 0.2 microSv/h, the mothers considered there was no problem. Dose rates between 0.2 and 1 microSv/h — which were equivalent to a dose of approximately 10 mSv/year — the mothers decided that it was preferable to reduce the length of stay in these areas. Above 1 microSv/h, these were areas to avoid, except in exceptional circumstances. For example, if you had to cross the forest to collect firewood or pick blueberries, encountering dose rates ranging from 1.5 to 2 microSv/h, was not a problem. However, it was advisable to avoid spending entire days in the forest. The ETHOS team discussed the "prohibition" aspect, emphasizing the importance of time management: "If you don't have to go to a contaminated area, why then to go?" This was the philosophy behind the scale, built together between mothers and experts, a philosophy that was satisfying the villagers (Figure 4).

FIGURE 4. The external dose scale (photo: J. Lochard).

Alongside their work on external radiation, the ETHOS team encouraged the group of mothers to address the issue of internal contamination of children. Once it became clear to the mothers that the problem lay in the radiological quality of food, action had to focus on the diet. The mothers began by meticulously recording in notebooks what their children ate each day. When the first notebooks were analyzed, it became clear that the idea of an average ration, even for a small village in Belarus, was meaningless. Each family had its own eating habits, and within the same family, each child had their own preferences. There were staple foods like milk, potatoes, and berries, but also various other products whose consumption varied greatly from one child to another. The group of mothers then understood that, just as with external irradiation it had been necessary to work house by house. For internal contamination it was necessary to assess food rations child by child and, moreover, to measure the contamination of the different foods included in these rations, since the products themselves varied greatly in terms of contamination depending on their origin.

It should be noted that the Belarusian authorities had, for a number of years, implemented a system for monitoring the radiological quality of food. Thus, in the village of Olmany, a radiometrist regularly took samples of products, measured them, and sent the results to the authorities in Minsk. However, there was no feedback of this information to the villagers. This radiometrist had developed her own expertise in radiology and was quite cautious within her family, but in the absence of place for dialogue, results were not discussed within the community. Initially, the ETHOS team collected all the existing measurements — there were several hundred — and analyzed them together with the group of mothers. Then, the mothers were invited to actively participate in measuring food. The group took charge of collecting vegetables from the gardens and bringing them to the radiometrist. Very quickly, the number of measurements multiplied, and it became necessary to ask the authorities for help in setting up a second measurement station in the village. To eliminate any doubts about the quality of the food products and the performance of the device used by the radiometrist, the ETHOS team performed measurements in France on samples already measured in Olmany. The comparison of the measurements proved very satisfactory.

By compiling all the measurements, it was then possible to create a map of the radiological quality of food products in Olmany. With the mothers, it was decided to adopt a three-tiered approach: "clean" products — essentially all the food that came from the store — products "less susceptible" to contamination — mainly vegetables — and finally products "very susceptible" to contamination such as mushrooms (samples measured in the village vary between 400 and 16,000 Bq/kg of Cesium 137 (Cesium 134 being negligible) for fresh mushrooms and up to a maximum of 70,000 Bq/kg for dried mushrooms, cranberries, blueberries (between 100 and 3,600 Bq/kg), dairy products, and meat. The classification work simultaneously enabled mothers to grasp the meaning of regulatory standards regarding food contamination, and thus contributed to a clearer understanding of the authorities' actions in this area.

The group of villagers then moved on to analyzing the children's food rations. Several mothers compiled a list of all the products their children had eaten in a single day, along with the corresponding quantities. Based on this information, it was possible to calculate the amount of becquerels ingested through these rations, taking into account, for each product, the maximum and minimum contamination levels measured in the village. From these calculations, it immediately became clear that it was possible to take action to improve the radiological quality of the daily rations. The mothers realized that, depending on what they fed their children, the amount of becquerels ingested could vary between 50 and 800 becquerels per day. This presented them with a real opportunity for action. Experts and mothers then worked together to explore ways to manage the children's internal contamination on a daily basis, particularly with regard to the consumption of milk, berries, and mushrooms. Together, they established a new three-level scale: below 50 Bq/day (an annual individual dose of approximately 0.2 mSv), the situation was considered acceptable and the food could be consumed without any restrictions; between 50 and 300 Bq/day (a dose of approximately 1.3 mSv/year), it was necessary to try to reduce the consumption of the most contaminated products as much as possible; above 300 Bq/day, it was necessary, as far as possible, to avoid ingesting these products and to find substitutes (see Table 1).

TABLE 1. The Influence of the level of contamination of food products on the daily intake of children (From J. Lochard, 2013).

		Maximum contamination		Minimum contamination	
Foodstuff	**Grams**	**Bq/kg**	**Ingested (Bq)**	**Bq/kg**	**Ingested (Bq)**
Bread	250	60	15	10	2.5
Butter	10	400	4	30	0.3
Vegetable soup	300	100	30	10	3
Meat	200	300	60	10	2
Stewed apples	150	100	15	10	1.5
Sauerkraut	300	50	15	10	3
Potatoes	100	100	10	10	1
Stewed moorberries	200	2 000	400	100	20
Chocolate milk	100	2 000	200	10	1
		Total	**749**	**Total**	**34.3**

Once the mothers felt empowered to influence the level of internal contamination in their children, they asked how they could monitor the effectiveness of their actions. It was at this stage that the reconnection with the public health system and the district administration took place. Indeed, it became clear that, in order to verify the results of the actions undertaken by each mother on food consumption, it was necessary to utilize the whole-body internal contamination measurements carried out at the school. To achieve this, it was essential to engage the relevant doctors in the project. The ETHOS team and the mothers jointly presented the group's findings to the regional authorities. The medical officer for the Stolyn district immediately grasped the value of the approach. He expressed his desire to participate in the project and involve some local doctors. These doctors quickly realized the educational role they could play regarding the issue of internal contamination and the mothers' actions. They also understood that this presented them with an opportunity to take more effective action by relying on the mothers' active participation.

In practical terms, a doctor interested in the project joined the group of mothers and participated in the working meetings. A protocol for monitoring the children of the mothers in the group was established, including an initial in-depth medical examination, followed by regular whole-body internal contamination measurements, and an annual medical check-up. This fostered a dialogue between the doctor and the mothers. The long-term objective, beyond monitoring internal contamination and the children's health, was to disseminate the ETHOS approach beyond the village.

Once the group had individual data on the children's internal contamination, the mothers sought to understand the reasons for the significant differences observed from one family to another, as well as within the same family. Numerous questions arose, particularly concerning the benefits of sanatorium stays. To investigate this point, the ETHOS team developed a simple model to calculate the average daily becquerel intake per child between two whole-body internal contamination measurements. The team studied the case of a schoolgirl who spent 11 days in her village, 30 days in a sanatorium, and the rest of the time with her grandmother in an uncontaminated area. During the 61-day period between the two measurements of total internal body contamination, the model showed that the girl had ingested a total of 2750 becquerels. If, instead of going to the sanatorium, she had stayed in Olmany and ingested clean products, approximately 40 becquerels per day for 61 days, she would have ingested only 2440 becquerels. The calculations therefore showed that sending children to the sanatorium was of little benefit if they could ingest clean products in the village. This observation sparked a debate among mothers and authorities, which remained unresolved until the end of the ETHOS project.

Finally, the mothers involved in the local group worked to disseminate the ETHOS approach to other mothers in the village. At the same time, the doctors developed a strategy to try to replicate the experience gained in the village of Olmany throughout the district.

2.2. *The improvement of the milk quality*

The radioactive contamination of a territory where populations are strongly dependent on rural activities for their livelihoods, immediately raises numerous difficulties in relation to the radiological quality of agricultural products. This imposes a more or less profound re-organisation of the agricultural production system. These difficulties are very complex to resolve because they encompass many different and interrelated aspects affecting daily life: radiological risk, diet, management of private agriculture, recreational habits and family income.

Traditionally in Belarus, milk constitutes an essential part of the diet of the rural population, especially among young babies and children. After the Chornobyl accident, the contamination of pastures with ^{137}Cs led to milk becoming a major source of radiological exposure for the entire population. It was very difficult to guarantee the radiological quality of milk from private farms. Consequently, the authorities attempted to reduce the consumption of contaminated milk from these farms, by requisitioning all privately owned cows, urging families to buy non-contaminated milk in shops. However, the economic crisis following the break-up of the former USSR contributed to reduce family resources even further and they gradually began breeding cows again to meet their basic needs. But the remaining problem of contamination put the families in a vicious circle. On one hand, because of the collapse of the economy they had no money to buy uncontaminated milk in shops and therefore relied on private production to feed the family. On the other hand, many of them could not increase income by trading milk because of its poor radiological quality, which was well above the regulatory radiological standards.

The ETHOS project's approach highlighted a paradoxical situation (Lepicard and Hériard-Dubreuil, 2001). Most scientific knowledge was not truly integrated into practical know-how that could be used daily by the population.

For example, the mechanisms of radiocesium transfer from soil to grass, and then from grass to milk, are theoretically well understood by radioecology experts but were unknown to villagers. Similarly, the role of Ferrocyn as a feed additive to reduce the cesium transfer coefficient from forage to milk was ignored by farmers. This simple and practical information was nevertheless crucial for managing the day-to-day radiological quality of milk production, depending on forage contamination.

As already noted, discussions with the inhabitants of Olmany in summer 1996 revealed that mothers, particularly the younger ones, were extremely anxious about contamination of the milk which could reach up to 2,000 Bq per liter (^{137}Cs) for some families. Initial meetings with mothers and private farmers, who owned at least one cow for milk production, showed that the problem of milk contamination was of primary importance. The population felt deprived of any means to change the situation. As they put it: "Can we do something to improve the radiological quality of milk? Could we at least produce non-contaminated milk for our children?".

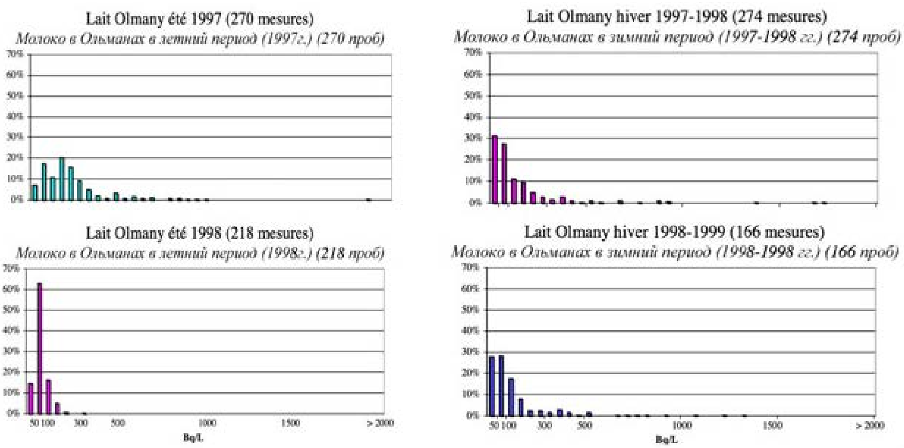
To answer these questions, the first step was the development of a common understanding of the organization of the milk production in the village by drawing up a clear picture of the situation (Figure 5). The ETHOS team together with the farmers analyzed the existing results of milk contamination obtained for the year 1995 gathered by working with the radiometrist of the village. The results were then discussed with the population, using graphs which showed that the milk produced in the village was not uniformly contaminated. Part of the milk was extremely contaminated, but in low proportions, while the majority of milk exhibited levels of contamination ranging from 200 to 400 Bq per liter (^{137}Cs). Finally, a proportion of milk was found to be below the marketing level of 100 Bq per liter. According to these findings, a group of volunteers, the "milk group" comprising a dozen peasant farmers breeding one or several cows for milk production, decided to focus on the improvement of the radiological quality of milk for children.

Figure 5. Understanding the grazing organisation (photo: J. Lochard).

One of the main aspects of the private milk production in the Olmany region was the contrast in practices between the summer and the winter periods. In summer, the milk production was organized collectively: the cows were assembled into herds. In Olmany there were 7 herds representing approximately 400 privately owned cows. Each herd was allocated a specific pasture on the outskirts of the village by the collective authorities (the kolkhoze). Each herd was led daily to its pasture, following the same itinerary through the village and the forest. In winter, the situation was completely different. The cows returned to their sheds next to the family homes and each producer managed his or her fodder on an individual basis. The resources of hay usually came from different sources: part of the hay can be provided by the kolkhoze, from its pastures, the rest being directly collected by the peasants in different places from the outskirts of the village (forest, private patches of arable land, etc.), or even bought in other villages. As a result, the contamination of the hay could vary enormously between different families.

In summer, herds had grazing patterns which crossed many different areas where grass contamination could vary significantly. Moreover, each farmer may feed his/her animal with additional foodstuffs produced at home. Taking into account this complex arrangement, it was decided by the group to adopt a pragmatic approach to assess the radiological quality of all the pastures allocated in summer to private herds, as a function of the levels of contamination in the milk produced by the cows put out to grazing. This was termed "milk mapping" elaborated by the "milk group", starting with a simple map of the village, representing the geographical location and name of each pasture and the corresponding herd number. Discussions with experts from the Institute of Terrestrial Ecology (Cumbria, United Kingdom) enabled the elaboration of a protocol for milk measurements, which ensured that the results were statistically robust/sound, giving a realistic appraisal of the radiological situation, reliable enough to identify possible practical means to improve the situation, but also taking account of local constraints. The milk group finally decided that the radiological quality of a given pasture could be assessed once for the summer period by measuring the contamination of the milk produced by a reasonable sample of 30-40 cows per herd grazing on this pasture. If the herd changes its pasture in the course of the summer, the operation must be repeated once again, making sure that measurements of milk are performed after at least 2-3 days of grazing in the new pasture waiting for the milk contamination to reach an equilibrium.

The follow-up study of milk contamination in winter was carried out on an individual and continuous basis throughout that season. Since the diet of animals could vary significantly, the radiological quality of the milk could also vary. A few farmers from the "milk group" were volunteers in an effort to find a way of optimising their resources in order to improve the quality of the milk. In the first stage, each farmer performed a radiological assessment of his/her available feeding reserves (could also say "fodder")? As they gathered and stored the hay in their sheds during the summer period, they measured its contamination and separated out hays of different origins and contamination levels, into different stacks, according to the quantity. Then, using a simplified optimisation model elaborated by the group, they planed the future winter production, managing the feeding of animals according to the hay contamination and other parameters and constraints such as: calving and milking periods; the availability of complementary feed or Ferrocyn to reduce the transfer of caesium to milk. A periodic follow-up of the milk allowed each farmer to check the radiological situation and to change the feeding regime of the animals during that period if the contamination of milk deviated from the forecasts. The assessment of the hay resources had to be performed before the winter started. The volunteers had to divide the hay originating from different locations into separated stacks. Next, they had to measure the contamination and to evaluate the quantity (mass) of each stack. Then, according to the calving period, they could plan animal feeding, giving the animals the most contaminated hay during the periods when milk was not consumed by the children, and keeping "clean" hay for the milking period. A monthly follow-up of the situation was organized, to measure the milk and, at the same time, to note the type of hay used to feed the animal, checking the contamination of this hay (see Figure 6).



Summer 1997 Winter 1997/1998

FIGURE 6. Improvement of the quality of the milk in summer (left) and in winter (right) (CEPN, 2002).

For the summer production, once the measurements of milk contamination had been carried out for all the herds, the results gathered by the radiometrist were evaluated using graphs which were displayed on posters in the village. This informed the population of the work that was being carried out and discussed in the "milk group". These results showed that the radiological quality of the milk from five herds was relatively good while the milk from two herds, which were partly grazing in forest areas, was highly contaminated. It was then a priority for both the population and the local authorities to find a solution for these two herds. The results also demonstrated for the other five herds, the positive effect of the improvement of pastures being performed by the authorities and about which the population had often expressed doubts in the past. The improvement of pastures was one of the agricultural countermeasures taken after the Chornobyl accident to reduce the amount of contamination transferred to the grass and, as a consequence, to the milk. It consisted of ploughing pastures, applying fertilisers (nitrogen, phosphorus and potassium) and sowing new grass.

The co-operation of local actors, peasant farmers, the radiometrist and the kolkhoze together with the ETHOS team in the evaluation process contributed to the re-establishment of a certain trust, especially between the peasants and the kolkhoze, as they could put more faith in the results and acknowledge the reality of improved pastures. Moreover, the results, obtained jointly and presented on clear graphs, provided the local stakeholders with a new bargaining power. In particular, it facilitated negotiations with regional and national authorities, and resulted in the allocation of specific resources to the kolkhoze to improve new pastures and re-organize the allocation of fields to villagers. Finally, the two herds showing problems could graze on improved pastures starting from mid-summer 1997, thus leading to a significant reduction in the contamination of privately produced milk in the summer period. Within the village, ^{137}Cs contamination in almost 80% of the privately produced milk dropped to less than 100 Bq per liter in summer 1998, compared with less than 10% in summer 1997. Parallel to the improvement of the quality of the privately produced milk in summer, the work carried out with the "milk group" on the optimisation of winter production, revealed that the farmers were progressively developing a practical know-how on the management of the radiological quality of milk at the individual level for the winter production, and at the collective scale for the summer production. For the peasants involved in the optimisation work, the radiological measurements started to be used as quality indicators, to explore real problems and to follow-up the production quality. Finally, certain families adapted their milk consumption habits throughout the year according to levels of contamination in milk as well as modifying the feeding regime of their animals. The cooperation between the milk group and the ETHOS team allowed the improvement in radiological quality of the privately produced milk and as a consequence the regional dairy for milk and its derivatives, based in Stolyn, decided to support the peasant farmers in Olmany by re-establishing the trading of their milk production. The dairy facilitated the process of collecting the milk in the villages and also offered better conditions of payment.

Finally, the integration of the dairy in the process, with its own means of measurement, was also a guarantee of the sustainability of the radiological quality of the milk.

Stimulated by the interest of the dairy in buying private milk again, the local authorities encouraged an increase in private production, and as a result the kolkhoze provided peasant farmers with a surplus of hay during winter 1997–1998. Consequently, at the end of this winter, about 56% of the private milk had a ^{137}Cs contamination of less than 100 Bq per liter compared to approximately 25% in winter 1996–1997. On the scale of the village, the potential for production of non-contaminated milk by peasant farmers was drastically increased between 1996 and 1999.

Beyond these tangible results, the improvement in the radiological quality of the milk has led to significant changes in the quality of life in the village. A good example includes a shift in the attitudes of the mothers involved in the project and a reduction in internal contamination among children as described previously. The results of the milk group also inspired new practical teaching methods to be implemented in schools, as well as the improvement in the radiological quality of pork.

2.3. *Summary of the other working groups set up in Olmany*

The villagers had a tradition of drying pork and selling it at the Stolyn market. After the disaster, the meat, contaminated because the animals were primarily fed milk produced in the village, could no longer be sold at the Stolyn market, resulting in a significant loss of income for the farmers. The ETHOS team, in collaboration with a group of farmers, worked on several solutions to reduce meat contamination. However, it was only after the milk problem was resolved through improvements in animal feed (see previous section) that meat sales could partially resume.

Several teachers at the Olmany school were involved in the young mothers' and milk working groups. As the results from the groups became clearer, they suggested using them to teach the school children. First, they taught the children how to use a dosimeter and they organized field trips in and around the village to measure ambient dose rates. Then they gradually introduced exercises during school classes relating to the radiological situation in Olmany (writing, mathematical calculations, historical research, etc.). The teachers noted a great interest from the children to better understand their own environment. They also noted that as the children acquired practical knowledge of the radiological situation in the village and how to deal with it, this knowledge eventually spread to the parents as well. The teachers reported on the communication that was established between school children and the inhabitants of the village in terms of collecting information on the history of the accident and its consequences on the daily life in Olmany (see Figure 7).

FIGURE 7. Excursion of school children (photo: J. Lochard).

When the people of the village embarked on the measurement of radiation, they quickly identified that the ambient dose rates in the wood stoves were much higher than the average in homes due to the presence of ash resulting from the combustion of wood from the forest. They were concerned by this, and raised the question of whether this posed a problem because the ashes were usually spread on the gardens to fertilize them. It was therefore decided to create a working group in which inhabitants and several forest guards got involved. The group sought to know whether the spreading of ashes posed a problem, and if it did, whether there was the option of using "clean" wood. The solution finally adopted by the villagers in order to avoid dissemination of radioactivity in the local environment, was to no longer spread the ashes but to collect them and bury them in holes dug in the vegetable gardens.

It is interesting to mention that during the first two years of the ETHOS project the young people of the village did not show any interest in the activities of the groups already formed. It was by chance that during a walk, while one of the French experts was filming a video of the village to show to his family, that a conversation began with a group of young people curious about the camera. The conversation led to the idea that the ETHOS team would bring the suitable equipment during its next mission so that the young people could make the film themselves. The result of the group of young people was the realization of the film with the help of the ETHOS team during which interviews of the villagers were performed, notably on the current activities of the working groups set up within the ETHOS project. This film was presented one evening in the village community hall and was a great success.

All these initiatives demonstrated that managing situations of persistent environmental contamination cannot be considered separate from the local way of life. It requires all stakeholders to establish new connections with their environment and with the local community, to understand radiological risk as one aspect among others in the complex process of improving living conditions, and to give new meaning to daily radiation protection activities. These aspects constitute a legacy to be passed on future generations.

3. The extension of the ETHOS project and the concluding International Seminar

In 1999, the Stolyn district authorities and national authorities requested the ETHOS team to implement the ETHOS approach with the local population in four other villages in the district: Belaoucha, Gorodnaya, Retchitsa, and Terebejov, which, like Olmany, were particularly affected by the contamination (Figure 8). This led to the extension of the ETHOS project for two consecutive years until autumn 2001.

In each village, the ETHOS team involved residents and local authorities like in Olmany but the role of the team was to train and support local professionals in implementing specific projects in the villages, based on the Olmany experience. While in the context of Olmany the members of the ETHOS team were heavily involved in local projects, in the second phase of the ETHOS project in the 4 villages, the involvement of the inhabitants was primarily overseen by local professionals — that is, individuals who were both village residents and representatives of a professional sector or who held an administrative position within the village. These individuals facilitated the development of the practical local projects involving the population focused on three main areas: improving the radiological burden of children, marketing and producing food products with good radiological quality — particularly potato production, developed especially by the Belarus Institute of Soil Science and Agrochemistry-BRISSA (Bogdevitch, 2003) — and finally, developing a practical understanding of radiological risk among young people through village school teachers. In total, approximately 80 professionals and specialists — collective farm managers, doctors, nurses, teachers, and radiometrists — volunteered in the five villages, including Olmany.

Finally, a seminar was organized in March 2000 in Stolyn for the initial training of these participants. The organization of this seminar was handled by the Stolyn district (CEPN, 2002). The ETHOS team was responsible for preparing the seminar content. The seminar took place on November 15th and 16th, 2001 at the Stolyn Agro-economic College, with 150 participants in attendance representing the local, national and international levels under the title "Rehabilitating living conditions in territories contaminated by the Chernobyl accident: the contribution of the ETHOS approach. The seminar had several objectives. Firstly, to present the results of the working groups in Olmany and the 4 other villages with input from the ETHOS team. Secondly, to debate with representatives from the International Community the ETHOS approach for developing sustainable rehabilitation of living conditions within the contaminated territories in Belarus.

FIGURE 8. Photos of the Stolyn seminar (photos: J. Lochard).

In his introductory address, the President of the Stolyn District said "*We can therefore say that we appreciate the approach developed by the ETHOS project because it is a new approach, whose goal is to change the situation by providing targeted information to well-defined groups within the population, rather than general information that affects no one. I must say that this project has achieved its objectives.*"

At the end of the seminar the participants adopted a text with the title "Conclusions and Recommendations of the International Conference held in Stolyn – Republic of Belarus" calling upon the departments of the Belarus administration concerned, as well as international organizations, to envisage a long-term cooperation in the area of the rehabilitation of living conditions in the territories of the Republic affected by the accident, particularly in relation to economic aspects with the overall objective to develop a new project that would take into account the experience of the ETHOS project and that would bring together sustainable economic development and radiological rehabilitation.

Conclusions and Recommendations of the Stolyn Seminar

Text adopted by all seminar participants on November 16, 2001.

The seminar brought together representatives of the Chernobyl Committee attached to the Soviet of Ministers of the Republic of Belarus, the Ministry of Education, the district and oblast authorities, managers and professionals from the collective farms (kolkhozes), residents of contaminated localities, scientists from the National Academy of Sciences, the Academy of Agrarian Sciences, representatives of the European Union, the European Commission, the UNDP, the World Bank, members of the European interdisciplinary group ETHOS, and other representatives of international NGOs.

The seminar participants reached the following conclusions:

1. Many health, environmental, economic, and social problems caused by the accident in Belarus are long-lasting and remain a focus of attention for the administration of the Republic, researchers, and the global community. A series of factors, in particular the deteriorating economic situation, the disintegration of the USSR, etc., have exacerbated the consequences of this disaster. A decisive factor is also the lack of knowledge among the population that would allow them to independently assess the veracity of information regarding the consequences of the disaster, which is often contradictory, and to take measures to reduce the radiological risks resulting from living in contaminated areas.
2. The large-scale initiatives undertaken by the State have significantly reduced the negative consequences of the disaster. Protective measures in the public agricultural sector ensure production meets standards and ultimately reduce the expected dose of exposure for the population. However, in the private sector, the rate of production exceeding standards remains very high. This is particularly true for forestry products. Addressing these problems requires close attention from local authorities. It is also necessary to consider improving existing approaches and

developing new methods in collaboration with the community. For the protection of children, measures adopted in the agricultural sector must ensure production meets the latest international standards for radiological exposure.

3. The complex problem of restoring living conditions in contaminated areas, which includes re-establishing economic and social activity while ensuring the safety of the population's living conditions, has become the top priority 15 years after the accident. This problem is unparalleled in history due to its complexity and scope. The current moment is characterized by an intense search for approaches to solving the problem of rehabilitation. Furthermore, it is important to continue research concerning the health of the inhabitants of contaminated areas.
4. In light of the above, the approach of the ETHOS project, funded by the European Community and implemented since 1996 in the Stolyn District, deserves to be studied, developed, and disseminated. This approach is complementary to the Belarusian State Program concerning the consequences of the accident. It is based on the involvement of the local population and specialists in managing the radiological situation, which requires the development of a specific radiological culture concerning life in the contaminated areas. The effectiveness of this approach has been confirmed in practice, as well as in this seminar, using the villages of Olmany, Gorodnaya, Belaousha, Terebejov, and Retchitsa as examples.
5. The seminar participants call upon the relevant agencies of the Belarusian administration, as well as international organizations, to consider long-term cooperation in rehabilitating living conditions in the areas of the Republic affected by the accident, particularly in the economic sphere. One direction would be the development of a new project that takes into account the experience of the ETHOS project and combines sustainable economic development with radiological rehabilitation.

Finally, The ETHOS project was a turning point in the rehabilitation policy of Belarus. It paved the way to the formalization of the "co-expertise process" that has been refined first during the development of the CORE Programme (2004-2009) (see Lochard et al., 2026), and later on in the affected areas of Fukushima (see EDP Sciences, 2026).

Concluding remarks

The ETHOS project officially ended in November 2001, but the ETHOS team continued its work in the Stolyn district, in the five villages concerned, within the framework of the CORE programme, both during the preparatory phase (two years) and during the implementation phase, until 2009. The residents of the villages of Belaoucha, Gorodnaya, Olmany, Retchitsa, and Terebejov, were involved in many projects, particularly in the priority areas of agricultural development, health, radiological quality, education and memory continuing the activities they initiated in the ETHOS project (see chapter 2). After the CORE programme, more sporadic missions were organized in the Stolyn district until the Fukushima accident in 2011. Several Belarusians, including local professionals from the district, participated in the ICRP Fukushima Dialogue between 2011 and 2014 to testify about how they went through the recovery process. Finally, several of the protagonists of the ETHOS project testified about their experiences in the documentary film "Chernobyl Fukushima: Vivre Avec" by Olivier Julien (Julien, 2016) presented in 2016 on the Franco-German TV channel ARTE on the occasion of the 30th anniversary of the disaster.

Towards the end of the documentary, Raissa Missoura, the female doctor and Head of Pediatrics at Stolyn Hospital who followed all the children in the district during the ETHOS project, states, "I remember the age when there were over 200 school children in Olmany with high radiation levels. But over the last 3 years, we have not detected a single person with a level above one millisievert. We are very happy about that".

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2
The CORE Programme in Belarus after the Chornobyl accident

Jacques Lochard[1,2], Pascal Croüail[3], Thierry Schneider[1,2,3]

Abstract

Building on the success of the co-expertise approach of the ETHOS project (1996-2001), the Chernobyl Committee of Belarus launched the Cooperation Programme for the Rehabilitation of Living Conditions in the Areas Affected by Chornobyl in Belarus (CORE Programme) in 2005. Based on an original governance framework designed to identify, evaluate, and monitor projects proposed by local stakeholders the programme aimed to sustainably improve radiological protection and living conditions in four Belarusian districts. The implementation of local projects was deployed in four priority areas: health, economic development, radiation protection, and education/memory. After a presentation of the governance framework, this article describes the key local projects developed in the four domains of action that were structuring the programme and finally draws a few key lessons. It is worth mentioning that the CORE programme, supported by numerous international organizations and NGOs, enabled partnerships and cooperation among local, national, and international stakeholders.

Introduction

The ETHOS approach led to three major observations (Hériard-Dubreuil et al., 2007; Lochard, 2004). Firstly, the radiological, health, ecological, economic, societal and ethical consequences of the Chornobyl accident are long-term in nature, requiring the development of new radiological protection methods that actively involve the affected populations. Secondly, the post-accident situation in Belarus — and the challenge of rehabilitating living conditions — encompasses local, national, and international dimensions, all of which must be

1 Nagasaki University, Japan
2 International Commission on Radiological Protection (ICRP)
3 Nuclear Protection Evaluation Centre (CEPN), France

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addressed within a framework that promotes interaction and complementarity among these different levels of action. Finally, the ETHOS project revealed that the various dimensions of rehabilitating living conditions mentioned above cannot be addressed in isolation. A sustainable approach to rehabilitation demands integrated strategies that consider the problem in its entirety.

The CORE programme — officially titled Cooperation for Rehabilitation of Living Conditions in Chernobyl-Affected Areas of Belarus — was initiated by the Chernobyl Committee of Belarus following the conclusions of the Stolyn International seminar held in November 2001 and the UNDP report (UNDP/UNICEF, 2002). It took more than two years to prepare the CORE Programme and in particular to gather the partners, including three United Nations agencies (UNDP, UNESCO, UNICEF), the Organization for Security and Cooperation in Europe (OSCE), the French Embassy in Belarus, the European TACIS programme, the Swiss Agency for Development and Cooperation (SDC), and the European Partnership Committee (CEP), which brought together several French organizations (ASN, IRSN, *Patrimoines sans Frontières*, Agro-Paris-Tech, FERT, *Médecins du Monde*, Mutadis Consultants, CEPN, ACRO). The CORE programme was officially launched in 2004 for a period of 5 years.

The primary objective of the programme, derived directly from the Stolyn declaration, was to make sustainable improvements to the living conditions in four of the affected Belarusian regions by facilitating the development of local projects in four key domains: health, economic development, radiological quality of food, feed, and the environment, and education/memory.

The programme supported by numerous international organizations and NGOs fostered partnerships and cooperation among local, national, and international stakeholders. It introduced an original governance framework designed to identify, evaluate, and monitor projects proposed by local stakeholders.

Between 2004 and 2008, 191 local projects were proposed, of which 146 were approved and implemented across the four priority areas. The total budget for the programme amounted to €4.3 million, with contributions from Belarusian organizations and eight international partners (Trafimchick, 2005).

1. The governance and operating principles

The governance framework and operating principles were directly inspired by the spirit of the ETHOS project and the lessons learned. Developed during numerous meetings, they culminated in the CORE programme's Declaration of Principles for Cooperation, signed by the participants on July 18, 2003 (see Annexe). According to this declaration, the programme aimed to *"improve the living conditions of the inhabitants of certain districts by engaging directly with them and helping them to formulate proposals for specific individual and collective projects".* For the inhabitants of the areas affected by the Chornobyl Accident, this represented a real innovative approach. The governance structure of the programme is presented in Box 1.

Box 1. The governance structure of the CORE programme

- The Preparation and Assessment Committee (PAC), responsible for evaluating and selecting local projects.
- The Approval Committee (AC), responsible for approving local project proposals.
- The Coordination Team (CT), responsible for assisting the PAC, and the AC by organizing workshops in the selected districts. It was also in charge of providing support to local project partners in the day-to-day management of their activities and identifying potential new partners at the local, national, and international levels.
- The Priority Area Liaison Committees, advisory bodies responsible for formulating recommendations and opinions regarding the implementation of various local projects in each priority area.

Annually, a workshop was organized in each district at which local projects were proposed by local people, evaluated by the Preparation and Assessment Committee and finally approved or not by the Approval Committee. Prior to these meetings, significant events were organized to commemorate the accident. For example, in Bragin, the district authorities, accompanied by the Minister of Chernobyl and the French Ambassador, laid a wreath at the foot of the statue representing the Bragin firefighter who died from radioactive burns while fighting the fire at the Chornobyl nuclear power plant (Figure 1). Figure 2 shows the participation of the local population in the workshop. Each workshop was an opportunity to review the activities undertaken in the program and also to spend time with the local population. About two months before each workshop, the coordination team visited the districts to invite residents to prepare project proposals and to give them guidance on the application process to increase their chances of acceptance. Figure 3 presents the meeting of the Preparation and Assessment Committee composed of local people and national and international experts including former members of the ETHOS team. Figure 4 shows the Approval Committee, chaired by the Minister of Chernobyl, in the presence of dignitaries, including representatives of the European Partnership Committee and, in this instance, former members of the ETHOS Team. Figure 5 shows the Priority Area Liaison Meeting on radiological quality, held two days later, in the presence of representatives from the other districts involved in radiological quality projects. Finally Figure 6 shows the coordination team at work in its headquarters in Minsk.

Figure 1. Ceremony at the Bragin monument (photo: J. Lochard).

Figure 2. The Bragin workshop (photos: J. Lochard).

FIGURE 3. The Meeting of the Preparation and Assessment Committee (photo: J. Lochard).

FIGURE 4. Meeting of the Approval Board (photo: J. Lochard).

FIGURE 5. Meeting of the Priority Area Liaison Committee on radiological quality (photo: J. Lochard).

FIGURE 6. The Coordination Team at work (photo: J. Lochard).

The CORE programme was implemented according to a set of fundamental principles. To ensure that the rehabilitation of living conditions in the contaminated territories was sustainable, all dimensions relating to the quality of life were integrated in the programme, and local people were involved in the design and implementation of activities. Participants joined the programme voluntarily by signing a declaration. New participants were approved by the Approval Board, and each participant retained the right to propose new projects or leave the programme at any time. The programme's primary objective was to coordinate and support the implementation of projects aimed at improving the living conditions of the population in contaminated territories. The programme was also based on non-profit activities, with the majority of funding allocated to strengthening the capacity of local actors to address issues identified in the priority areas. Furthermore no participant could dominate activities, based on territorial, financial, political, religious, or other characteristics, and each participant had the right to propose programme-related issues for fair and equitable discussion. All of these principles and provisions aimed at guaranteeing respect for strong ethical values such as the freedom for each individual to engage or withdraw, and the respect for the past and present local actions carried out by each participant in the CORE programme (in as much as they contributed to individual and collective well-being). Overall, these characteristics, beyond their contractual nature, ensured the smooth and successful implementation of the programme's activities which were also open to amendment in order for participants to be able to adapt to evolving conditions and make rapid collective decisions in the interests of the implementation of the CORE programme.

2. The commitment of local actors

As outlined in the objectives of the CORE programme (see *The Declaration of Principles* in Annexe), the activities undertaken were based on a participatory governance approach. This approach encouraged the active and voluntary cooperation of various stakeholders from both the public and private sectors, working together toward a comprehensive territorial rehabilitation project that took into account the specific contamination conditions in the areas where people were living.

The CORE programme relied on two main pillars. Firstly, financial, administrative, and organizational support for local initiatives aimed at improving living conditions adversely affected by the accident, through partnerships with local actors and other stakeholders, and donors at the national and international levels. Secondly, a multi-level mechanism of integration, coordination, and decision-making, which enabled a shared sense of ownership regarding the rehabilitation of living conditions among all those involved. These mechanisms also facilitated the progressive emergence of a common vision of the problem, a shared purpose, and a collective evaluation of results.

The key difference between the CORE programme and "classic" humanitarian projects was that the CORE programme was built on the results and experience of the ETHOS project, whereby the local population was not merely a beneficiary of the actions undertaken, but was also actively engaged in the design and implementation of small and medium-sized recovery projects.

3. The priority areas

The CORE programme focused on four districts — Bragin, Slavgorod, Chechersk, and Stolyn — out of the 21 contaminated districts in Belarus (Figure 7). Over a period of five years (2004–2009), it concentrated on four priority areas for actions: health of people including the health system, the radiological quality of food, feed, and the environment; the economic development of rural areas with a particular emphasis on agriculture, and the education of children and the preservation of the collective memory of the accident.

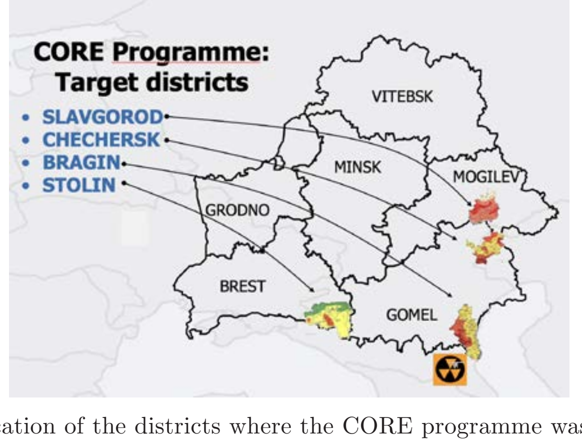

FIGURE 7. Location of the districts where the CORE programme was implemented (Drawing Zoia Trafimchik).

3.1. *Agriculture*

Within the framework of the CORE programme, a “microcredit scheme” for small agricultural producers (supplementary family farming) was developed and successfully implemented for the first time in Belarus. A guarantee fund was established at *Belarusbank* through funding provided by the *Foundation for the Development and Renewal of the Earth (FERT)*. As a result, more than 100 microcredits were granted between 2005 and 2007, with 100% of the financing repaid. Two agricultural development centres were also set up in Stolyn and Slavgorod to provide scientific, technical, informational, and administrative support for the economic initiatives of local stakeholders.

In several districts, modern technologies were introduced and traditional practices improved to increase both the volume and quality of agricultural production in the private sector, particularly in terms of radiological safety. These improvements involved a whole series of activities: vegetable production, including the introduction of drip irrigation systems; garlic production; beekeeping; utilizing modern equipment; pig breeding; milk production, including the use of feed additives in cattle rations; potato production; and poultry farming.

Building on the model of the ETHOS project, cooperation was developed between family-based initiatives for growing supplementary agricultural products and state-owned processing companies. Agronomists and radiation protection experts selected varieties and species of products that offered both attractive productivity levels and lower caesium transfer factors, making them suitable for cultivation on family plots in contaminated areas. For example, targeted cultivation and delivery of cucumbers to the Gorynsky canning factory in Stolyn and courgettes to the Bykhov canning factory were organized.

School fruit gardens, greenhouses, and mushroom-growing areas were created or rehabilitated to improve the diet of children in schools and kindergartens. Occasionally, surplus produce of the highest radiological and gustatory standards was sold for profit (e.g., the *“Dream Garden”* of the Mercoulovitchskaya School in the Chechersk district, the *vechenka* mushroom-growing area of the Nissimkovitchskaya School in the Chechersk district, and the greenhouse of the Stolyn Gymnasium).

Other activities were also developed, including garment-making and pottery in the Stolyn district, services for the elderly in the Chechersk district (such as ploughing land and sawing firewood) and agritourism in the village of Mikhailovo in the Slavgorod district. The information resources and organizational infrastructure were strengthened in educational and cultural institutions to support vocational guidance for children and young people (e.g., gardening at the Mercoulovitchskaya School in the Chechersk district; pottery in the village of Gorodnaya in the Stolyn district; sewing at the Children’s Creative House in Slavgorod).

3.2. *Health*

The health priority area of the CORE programme aimed to *“improve the health of the population by enhancing primary healthcare services, health education, and monitoring of pregnant women and children”*. More specifically, this component of the programme sought not only to improve existing healthcare services in contaminated territories but also to raise awareness among residents regarding the potential health effects associated with chronic exposure to ionizing radiation. Various activities focused on improving the information resources available to populations and disseminating a practical radiation protection culture.

Over a period of six years (2004-2009), more than 30 projects related to the *"Health priority area"* were proposed, of which 20 were funded and implemented. The CORE programme distinguished between "topical" projects — characterized by the involvement of partners from local, national, and international structures with substantial budgets — and "small" projects, which were primarily implemented by local actors. In total, 7 topical projects and 13 small projects were carried out.

In general, the projects conducted under the heath priority area focused on four distinct but complementary themes: (i) the provision of equipment, both for the diagnosis and treatment of pathologies as well as for the improvement of social and educational structures, (iii) the training of health professionals, (ii) the information and awareness of populations, and (iv) the health monitoring of the population.

The initiators and local professionals involved in these projects were primarily the staff of health establishments (hospitals, clinics) and educational structures (kindergartens, elementary schools, and colleges) in the districts participating in the CORE programme, as well as representatives of Belarusian universities, the Ministry of Education, and international partners. At the outset of the CORE programme, the inhabitants of the contaminated districts undertook relatively few individual initiatives to improve their health status, often due to economic difficulties and limited opportunities to enhance their living conditions. However, this situation gradually evolved toward a real and active commitment from local actors in the implementation of projects.

Medical records from the affected areas document numerous pathologies directly or indirectly linked to the aftermath of the Chornobyl accident. The connection between 1,800 cases of thyroid cancer in children and the radioactive consequences of the disaster has been recognized. The radiation-induced nature of the excessive incidence of thyroid cancer among individuals exposed to iodine radionuclides during childhood and adolescence has been substantiated as a result of the radiation monitoring system. Several CORE projects led to the strengthening of equipment and materials available for the screening and treatment of various pathologies, whether potentially induced by the presence of radioactivity or not.

For example, the project *"Improving the State of Health of Patients Suffering from Thyroid Cancer or Other Thyroid Pathologies"* enabled the Stolyn Hospital to acquire all the equipment necessary for the screening and treatment of thyroid pathologies (including hormonal assays). The hospital subsequently obtained a license in endocrinology and was able to provide care for patients. Similarly, the *"Say No to Cancer"* project modernized cancer diagnosis and treatment equipment in 16 dispensaries and hospitals in the Bragin district. The project *"Contribution to Improving the State of Health of Children in the Chechersk District"* resulted in the provision of devices for the Chechersk District Hospital to conduct clinical examinations of children (ultrasound devices, electrocardiographs, haematological analysers, etc.).

Several small projects focused on improving or creating reception facilities for sick or disabled children. One example is the *"Creation of Children's Health Centres"* project, implemented in the Stolyn district. Others concerned educational structures. For instance, the *"I Take Care of Myself, I Protect Myself"* project led to the construction of a new sports complex in the Stolyn district, which is now regularly used for sports sessions. The complex is equipped to facilitate exercises and games that strengthen the musculoskeletal system.

Nearly 25 years after the Chornobyl accident, the CORE programme partners observed that many health professionals lacked knowledge regarding the issues raised by a situation of long-lasting contamination. They also struggled to engage in dialogue with their patients on this topic. Most of the projects carried out within the health priority area therefore aimed to raise awareness, train health professionals in radiation protection, and improve the capacity of these professionals to support and inform their patients.

The *"Health and Family"* project was particularly effective in raising awareness among health professionals. Its main objectives were to increase their awareness of the problems posed by a situation of long-lasting contamination. The focus was on improving training of those involved in paediatric services, through continuing education. During this project, the Pinsk branch of the Radiology Research Institute (BB-RIR) developed educational modules that, after validation by the Belarusian Ministry of Health, were offered as optional courses in medical schools for general practitioners and nurses. Through theoretical lessons and practical work, this course pursued the dual objective of (i) providing students with in-depth knowledge of the practices and behaviour that enable families living in contaminated territories to better protect their health, and (ii) to teach them how to work effectively with the population.

Thanks to the provision of equipment and numerous awareness-raising initiatives for health professionals, the CORE programme enabled a significant improvement in the care services offered in the participating districts. Local health professionals demonstrated a remarkable capacity to assimilate new knowledge and operate modern medical equipment, thereby becoming the main contributors to the success of the projects. In many cases, they benefited from partnerships with national and international experts, who provided valuable technical support. Furthermore, these collaborations often led to exchanges that allowed for a mutual enrichment of practices and knowledge.

It should also be noted that certain professionals in the educational sector were also involved in awareness-raising and training initiatives. For example, through the provision of equipment in educational structures, they collaborated with health professionals and radiation protection experts. Examples of such cooperation include the project *"Establishment of Children's Health Homes"* and the project *"I Take Care of Myself, I Protect Myself"*, both implemented in the Stolyn district.

A limited number of projects focused on observing and monitoring the health status of inhabitants living in contaminated territories and on understanding the potential health effects associated with chronic low-dose exposure. The main project addressing this issue was the thematic project *"Contribution to Improving the Health Status of Children in the Chechersk District"*.

3.3. *Radiological Quality*

The institutional radiation monitoring and control system implemented in the territories in the years following the accident did little to help the population understand or regain control over their situation. Measurements — beyond their technical complexity — were often difficult to comprehend, and the fact that they were rarely shared or explained to the population tended to increase anxiety and concern rather than alleviate them. Surveys conducted in the early 1990s in Belarus, Ukraine, and Russia highlighted that the complexity of daily life in a contaminated environment led to a loss of control and a feeling of abandonment among residents (Lochard, 2013). Classical communication approaches proved ineffective in providing comprehensive and useful information to help people manage their situation. In practice, the absence of individual knowledge and adequate opportunity to control the radiological quality of food at the family level resulted in a significant increase in exposures, particularly among children, during the 1990s.

Building on the experience of the ETHOS project, the concept of an operational and "inclusive" monitoring system was developed and tested in several settlements and schools as part of the "*Radiological Quality*" priority areas of the CORE programme (Hériard-Dubreuil et al., 2007).

Commenced in the Bragin district, the project supported the creation of "Local Centers for the Promotion of a Practical Radiological Protection Culture" in the Chechersk, Slavgorod, and later on in the Khoiniki districts (Schneider and Lochard, 2026). From 2008, schools in Rovkavitchi, Voznesenskii, Polessie, Strelichevo, were equipped and the centres were modernized in the Bragin district, or reviltalized such as the one in the Communo-Leninskaya school of the Chechersk district, or in the educational and advisory centre for radioecology and radiation safety at the Vaskovitchskaya school in the Slavgorod district.

These Local Centers for the Promotion of a Practical Radiological Protection Culture were established during the 2000s with maintenance ensured by the Research Institute of Radiology in Gomel. Dosimetrists — or *"radiometrists"* — were trained to advise the population and provide practical recommendations regarding their behaviour and lifestyle that could reduce individual exposure at the family level. Their tasks initially included sampling and measurement of radiocaesium activity concentrations in food products (orchards, vegetable gardens, forest berries and mushrooms, game, and river fish) gathered by local inhabitants and private producers (hay, milk, etc.), as well as monitoring the surrounding environment and living spaces (ambient dose rates). The next step was to organize meetings to provide information and opportunities for dialogue, and for presenting pupils' activities in school projects, and conducting local workshops and radiation protection projects involving pupils, parents, and expert counsellors. Then, based on the interpretation of measurements from whole-body counters (WBC) *"critical groups"* (the most contaminated children) were identified. Dialogues with their families where organized to find ways to reduce individual doses, and, if necessary, recommended specific medical follow-up (involving local medical professionals). Finally, informational leaflets about the radiological situation in the territory were produced and disseminated, through local media (newspapers), public buildings, and the internet.

Among the projects implemented within the *"Radiological Quality"* priority area, the Bragin radiation monitoring project significantly deepened the experience and refined the co-expertise process initiated in the ETHOS project (Croüail and Bataille, 2005; Croüail et al., 2006; Bataille et al., 2008a). The project's objective was to develop a practical radiation protection culture among the population and encourage self-help protection actions to reduce contamination, particularly among children, based on the lessons of the project developed in Olmany in the Stolyn district. Using existing infrastructures to measure caesium-137 in food and in the body of inhabitants and with new equipment provided by project partners, the local professionals (medical doctors, nurses, teachers) were able, with the support of national and international experts, to significantly reduce the internal contamination of the 3,000 children living in the Bragin district, and 2,500 pupils living in the Chechersk district. Figure 8 presents the system implemented in the Bragin district to follow the internal contamination of school children and Table 1 presents the results obtained.

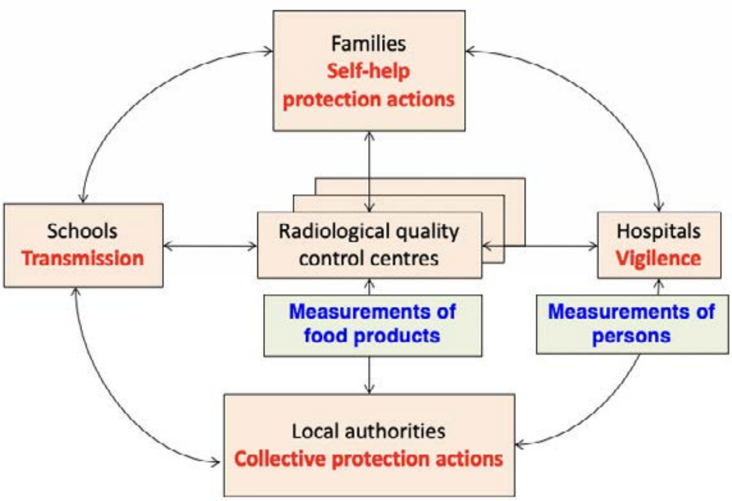

FIGURE 8. The radiation monitoring system implemented in the Bragin district (Bataille et al., 2008b).

Table 1. Results of the whole-body measurement campaigns in the Bragin district during the CORE Project (Bataille et al., 2008b).

	Number of measure-ments	**Mean value (Bq/kg)**	**Maximum value (Bq/kg)**	**Number of measure-ments >50 Bq/kg**	**Number of measure-ments > 100 Bq/kg**
Autumn 04	2 592	~32	2 660	249	64
Spring 05	2 526	~29	260	134	18
Autumn 05	2 612	~24	190	109	12
Spring 06	2 530	~25	168	50	4
Autumn 06	2 486	~31	980	242	43
Spring 07	2 438	~23	247	32	3
Autumn 07	1 705	~14	235	86	7

3.4. *Education and Memory*

Raising awareness and informing populations about the potential health effects associated with chronic exposure to radiation — and about lifestyles that reduce exposure levels — were major components of all CORE projects. For example, the *"Health and Maternity"* project, coordinated by the Brest branch of the Institute for Research on Radiology (BB-RIR), helped disseminate a practical radiation protection culture to pregnant women and nursing mothers living in the contaminated territories of the Stolyn district. By developing a radiation protection culture, the project aimed to minimize the risk of foetal exposure and reduce the level of contamination in breast milk.

Several other projects resulted in the production of new types of information. For instance, as part of the thematic project *"Improving the State of Health of Patients Suffering from Thyroid Cancer or Other Thyroid Pathologies"* (previously mentioned), an information brochure titled *"Primer for Patients Suffering from Thyroid Pathologies"* was created for patients. The small project *"Involving the Population in Improving Their Health"* also led to the publication of 2 books and 8 brochures. In most cases, health professionals chose to develop these documents in cooperation with local people to ensure they were tailored to their expectations and needs. It is worth noting that the literature available before the CORE programme was often too theoretical, providing generic and impersonal information, not targeted at specific audiences, for example different age groups, genders, professions, etc.

Public information was considerably reinforced during the 2000s, particularly to prevent the consumption of wild products (berries, mushrooms, river fish, and game) and to mitigate the consequences of the accident in areas that had not been decontaminated (through measures such as limiting free grazing, restricting or prohibiting the gathering or harvesting of forest products, and reconstruction of roads).

All of the above underscores the importance of preserving the memory of the accident and transmitting the lessons learned to younger generations still living in affected territories.

Within the framework of the CORE programme, many cultural projets — based on both scientific (e.g., the creation of practical radiation protection culture clubs in schools) and artistic foundations (e.g., the *"Tell Me, Cloud..."* and *"Lost Villages"* projects) — were conducted. These projects involved many inhabitants who had experienced the aftermath of the accident and enabled the collection of testimonies, objects, photos, literature, poems, paintings, and drawings. Several projects increased attention from both Belarusians and the international community regarding the affected territories (Ayrault et al., 2006). Most importantly, these initiatives allowed residents, and especially children, to reclaim the memory of places that had disappeared (such as buried villages) or those still contaminated, as well as the relentless efforts made by their parents or grandparents to rebuild and revitalize their communities.

Among these various projects, those developed in the Bragin district are particularly noteworthy. Thanks to the Bragin municipal librarian, a local working group initiated a reflection on the symbolic and cultural dimensions of the consequences of the Chornobyl accident. The group identified: a profound destabilization of the relationship with the homeland, a key element of culture and traditions, and an irreversible break between "before" and "after" Chornobyl. Furthermore, a generational break was apparent between those who lived through the disaster, and younger people, which highlighted the difficult question on "how to talk about the disaster and the contamination to young people"? The group also mentioned discrimination within the affected territories, and how their inhabitants were compared to the rest of Belarus and the World, which reinforced the feeling that the contamination was everywhere, every day but remained invisible. How to represent it and talk about it? Finally, the group noticed that traditionally, the memory of Chornobyl is evoked by commemorations and tributes to the victims (Figure 9) and it therefore decided to explore new ways of understanding the disaster and transmitting its memory effectively at the local, national, and international levels.

A key question was to identify the symbolic and commemorative dimensions that could contribute to the future of the affected areas. To this end, the group decided first to listen to and record what the population was saying. What emerged from this dialogue was mainly that the accident induced an irreplaceable loss. Sentences like the following were pronounced: "Here we have buried earth", or "We abandon everything, lost, everything, even the names of the villages were erased" and "They even buried Dostoyevsky and Shakespeare" (referring to buried libraries). But the group emphasised also the feeling of abandonment and oblivion from the general population of Belarus "They don't want us, the Chernobylians, elsewhere. We've been forgotten, it's easier".

Finally, based on the above reflections, the group embarked on a series of original activities in cooperation with French experts from the French Association "Patrimoine sans frontières" as well as Belarusian artists. At the newly renovated

Bragin Museum, four new projects on memory were implemented: an exhibition of works by painters native to the 30 km exclusion zone (Figure 10), a tribute to the young firefighter of Bragin victim of the accident, an exhibition of objects from the 30 km exclusion zone, and the creation of "The Lost Land" exhibition (Figure 11).

FIGURE 9. The Bragin monument in memory of the disappeared (razed) villages of the District (photo: J. Lochard).

FIGURE 10. Works from native painters (photos: J. Lochard).

This last project was developed through a collaborative effort between the residents of Bragin (six groups of adult volunteers), artists and museum professionals. During the preparation phase, the residents crafted a narrative of what they had seen and experienced. They expressed their suffering, but also the beauty of their land and the reasons for their desire to remain there ("This is our place"). They also gathered documents (testimonies, documents, photos, etc.). The exhibition, developed in an exemplary spirit of co-expertise, enabled the construction of a shared narrative (involving residents and local professionals) about the situation. The project offered a different way of approaching the accident and experiencing the situation that followed. It sought to establish a link between the past (the disaster), the present (life in the affected areas), and the future. It is also a tool for sharing, communication, and education for children, without relying on technology. It focuses on the meaning of the accident and life in the affected areas, rather than on its management (Figure 11).

FIGURE 11. The Lost Land Exhibition (photo: J. Lochard).

Concluding remarks

Before the implementation of the CORE programme, inhabitants of the contaminated districts took relatively few individual initiatives to improve their own health or radiological quality of their environment. This was largely due to economic difficulties and limited opportunities to enhance their living conditions. However, this situation gradually evolved as the CORE projects were implemented and advanced.

The objective of the programme, and of the associated local projects, was to help rehabilitate the living conditions of residents through an improvement in practical radiological protection. An inclusive radiation monitoring system (including self-monitoring) enabled inhabitants to assess the radiological situation in their own living areas. Direct access to monitoring equipment allowed them to regain control over the situation through a better understanding of the mechanisms by which humans are exposed (e.g., internal and external exposures, radioactivity in food, living spaces, and the environment).

The strengthening of medical and health surveillance, in accordance with the precautionary principle, aimed at detecting and treating pathologies and health problems that developed either as a consequence of chronic exposure to radioactivity or the strong disruption of the socio-economic fabric of the territory, caused by the radiological situation. The development, through the education system, of a strategy for the intergenerational transmission of a practical radiation protection culture was also a key focus. The resumption of the local economy, particularly small and medium-scale private farming, was another priority.

The co-expertise activities implemented in the CORE programme enhanced the post-accident recovery process in Belarus. Various projects were effective, thereby demonstrating how integrated measures and cooperation between all stakeholders can work on the ground, for example, local radiological monitoring centres, whole-body counting initiatives or micro-credit for small farmers. Moreover, the training of local dosimetrists, and the equipment of local centres able to run repeated whole-body counting campaigns improved the local technical capacity and created long-lasting local practices (individual monitoring, educational clubs, school projects). These capacities made it easier for local administrations and health services to continue the experience gained after the CORE funding ended.

Other beneficial outputs from the Core programme included:

- Establishment of multi-level governance mechanisms like the Approval Board, the Preparation & Assessment Committee, the Priority Area Liaison Committees and the Coordination Team, that modelled participatory decision-making and multi-stakeholder project selection. This mechanism was later referenced as an institutional model in UN/partner evaluations for best practice for community ownership. Finally, UNDP and CORE partners documented the programme as a promising model and influenced subsequent UN programming and donor priorities.
- Provision of valuable insights into the dynamics of co-expertise to address complex post-disaster challenges. The cooperation between the local populations, authorities, and external experts highlighted both the strengths of this approach and the challenges inherent in its long-term implementation.
- Demonstration that local projects are most effective when they foster individual control over the situation, enabling personal fulfilment and a sense of agency among affected populations. This was particularly reenforced because the programme created a cultural context that resonated with local values, traditions, and aspirations and also ensured

intergenerational continuity, embedding knowledge and practices within the community for the long term.

- Involvement of local authorities strongly supported by higher administrative levels (regional, national, and international) was crucial to ensure coordination, resources, and legitimacy. Foreign expertise played also a key role, particularly in contexts where confidence in national authorities was particularly eroded. External experts can provide technical knowledge, methodological support, and an objective perspective, helping to rebuild trust and capacity.

Finally, the CORE programme demonstrated on a larger scale than the ETHOS project the effectiveness of local rehabilitation projects when they are imagined, designed, and desired by the population itself. Projects imposed from the outside, without local buy-in, are far less likely to succeed or be sustainable. The CORE programme underscored the importance of listening to and engaging stakeholders in genuine dialogue, ensuring that their voices, concerns, and ideas shape the co-expertise process.

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Annexe: Declaration of principles on the CORE programme

"Co-operation for Rehabilitation of living conditions in Chernobyl affected areas in Belarus"

The undersigned, including national and regional authorities, international organisations, non-governmental organisations (NGOs), potential donors and others providing expertise (referred to hereunder as "Participants") agree to the following Declaration:

In appreciation of

- the efforts undertaken by the Republic of Belarus and the world community to mitigate the consequences of the Chernobyl Nuclear Power Plant (NPP) accident of 26 April 1986;
- the fact that the consequences of the Chernobyl accident for people have not gone away, at the same time as the level of national and international support to the contaminated areas has declined;
- the fact that the impact of Chernobyl on the contaminated areas is not only a local and national problem but a global concern for the world community;
- the urgent need of handling the long-term consequences of radioactive contamination for the mankind and its environment;
- several international assessments of the continuing impact of the Chernobyl disaster[11];
- the conviction that there is a need for a new sustainable rehabilitation and development-based approach. This should integrate health, economic and social development, environment, food, education and culture to address the actual and long-term needs of the affected populations and the civil society. Complementary to the above, donors should co-ordinate their activity so that their support efficiently reaches the people and communities most affected, and achieves the expected results.

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[1] United Nations Development Programme (UNDP) and United Nations Children's Fund (UNICEF) report on "The Human Consequences of the Chernobyl Nuclear Accident: a Strategy for Recovery" (25 January 2002): see www.un.minsk.by; the World Bank report "Belarus: Chernobyl Review" (15 July 2002): see www.worldbank.org.by; the reports of the Heads of Mission/Delegation of the European Union about their visits (April 2001 and May 2003) to the contaminated areas of Belarus sent to the Presidency and the Commission; Rehabilitation of the living conditions in territories contaminated by the Chernobyl nuclear accident – contribution of the ETHOS approach. Proceedings of the international seminar held in the city of Stolin, Brest oblast, Belarus (15-16 November 2001): see www.cepn.asso.fr/fr/ethos/seminaire.html

Declare that

– the CORE Programme is an adequate starting point for addressing the above, with a focus on the needs of people, and to improve their lives and living conditions through a framework which enables national and international support to the communities involved;
– the experience and results obtained during the implementation of the CORE Programme should become public knowledge;
– the CORE Programme is open to other participants. The undersigned appeal to international community for wider involvement in and support for the Programme.

SECTION I
THE PROGRAMME'S OBJECTIVE

The objective of the CORE Programme is to improve the living conditions of the inhabitants of selected districts by reaching out to the people themselves, helping them to contribute to formulating specific individual and common project proposals. While such participatory approaches, based on the involvement of the civil society in project activity, have been successfully used in other parts of the world, it is an innovative approach for those affected by the Chernobyl accident in Belarus to be considered as partners. This is to be achieved through the development and implementation of integrated projects in priority areas, involving local participation, as well as national and international partners, at the governmental and non-governmental level.

SECTION II
LOCATION AND TERM OF THE PROGRAMME

At first, the CORE Programme is implemented in the following four affected districts of Belarus: Bragin, Chechersk, Slavgorod and Stolin. Whenever possible, other contaminated districts will also be involved.

The CORE Programme is designed for an initial five-year period, effective after the adherence to the present Declaration by the participants. Thereafter, an independent international evaluation of the Programme will assess its results and consider further action.

SECTION III
PRIORITY AREAS

The CORE Programme integrates and co-ordinates the different dimensions of the rehabilitation of living conditions in the contaminated areas through a comprehensive set of activities focused on the following priority areas:

- *Health care and surveillance*: this part of the Programme aims to improve the health of the population through better primary health care services, health education and dynamic monitoring of the health of pregnant women and children in the radiological context. Efforts undertaken in this direction should contribute to increase the quality and the efficacy of care for affected people in the concerned areas.

- *Economic and social development in the rural contaminated areas*: this part of the Programme aims to increase incomes through sustainable economic development based on the local populations' initiatives, particularly private producers and some already existing economic actors in the area in a context of an economy in transition; and involves the provision of technical, agricultural, radiological, marketing and financial support (e.g. micro credits and grants).
- *Culture and education of children and youth, transmission of the memory of the Chernobyl disaster*: this part of the Programme aims to develop a practical radiological culture among children and youth, raising awareness and memory of the Chernobyl disaster and its consequences for the contaminated areas and for mankind.
- *Radiological quality*: this part of the Programme aims to develop an operational and pluralistic radiological measurement system in the four districts. This system will allow the assessment and the follow-up by the people themselves and by local professionals of the "radiological quality" of their environment and their food. The existence of such an operational measurement system is a prerequisite for the implementation of the three other priorities areas.

New priority areas can be proposed by any of the participants for consideration by the Approval Board (see SECTION V), and if agreed, they will be added through a special appendix to the present Declaration.

SECTION IV
BASIC PRINCIPLES OF THE PROGRAMME

The CORE Programme is implemented according to the following principles:

1. *Integrated approach***.** Sustainable rehabilitation of living conditions in the contaminated territories should be integrating all the dimensions of life quality and the participation of the local people in the design and implementation of activities. The Programme therefore implies an integrated approach, involving a set of projects in the fields of social and economic development, public health, education and culture.
2. *Voluntary participation and openness***.** The participants join the Programme voluntarily by signing this Declaration. New participants in the Programme will be agreed on by the Approval Board (see SECTION V). Agreement of new participants to the Declaration will be mentioned in a special appendix. Each participant has the right to present new projects according to the priority areas. Each participant has the right to leave the Programme at any time.
3. *Practical applicability***.** The main objective of the Programme is to coordinate projects and to support their implementation in order to improve the living conditions of the population of the contaminated territories.

4. *Non-profit approach.* The Programme is based on non-profit-making activities. The main portion of the funding will be allocated for strengthening the capacity of local actors to deal with the issues identified in the priority areas. This includes supporting technical and methodological partnerships of national and international institutions and NGOs.
5. *Collective decision-making.* None of the participants can play a dominant role based on territorial, financial, political, religious or other characteristics. Everyone has the right to propose a Programme-related issue for a fair and equitable discussion by the participants.
6. *Complementarity.* The Programme is complementary to the past and ongoing projects for improvement of living conditions in the contaminated areas, and by no means contradicts them.
7. *Flexibility.* The Programme activities are open to change, amendment, and expansion of their scope. The participants are ready to adjust themselves to changing conditions and to make fast collective decisions in the interests of the successful implementation of the Programme.

SECTION V
ORGANIZATIONAL STRUCTURES AND CO-ORDINATION

The CORE assessment, decision and coordination procedure is intended to provide the fundamental quality insurance needed for building and implementing integrated projects.

The objective is to ensure quality preparation of projects within the Programme Priority Areas; then to select the projects, and then to provide effective coordination and technical support for their implementation.

The CORE organisational structures and procedures for assessment, approval and coordination will be officially initiated within the three months following the signature of the Declaration.

The CORE organisational structures and procedures outlined in this section are without prejudice to specific rules applicable to relevant international aid programmes.

PREPARATION, ASSESSMENT, APPROVAL OF PROJECTS

Projects will be prepared, assessed and selected through a procedure involving a Co-ordination Team (CT), a Preparation and Assessment Committee (PAC) and an Approval Board (AB).

The Co-ordination Team (CT)

The CT, involving a Belarusian CORE coordinator, is supported by a representative team of national and international experts. It will:

- look for and provide support to potential local, national and international partners that could develop integrated "Topical Projects" in coordination with all participants;

- assist in identifying whether support is needed to help further develop the project, whether on technical questions, and/or in terms of facilitating the participatory process of project development;
- inform any new potential participants about the programme and deliver suitable information at a national, European, and international level.

Other functions of the CT (co-ordination) are outlined below.

The Preparation and Assessment Committee (PAC)

A formulation or preparation phase of projects will involve input from members of the PAC gathering the concerned actors (local, national and international participants of the CORE Programme) together with the Belarusian and international expertise. Once a draft project is defined, the PAC will:

- check if the proposed project fits within the priorities areas of the CORE Programme;
- check if the proposed project addresses actual local needs and concerns, and if there is a multi-stakeholder (local, national and international) approach;
- check if the necessary technical and process expertise is involved in the proposed project (according to its nature) in order to validate its viability and sustainability;
- check if the resources involved within the project will actually reach the target population and communities.

All this work will be conducted with the participant presenting the project on the basis of equal standing.

In case of positive assessment the project is proposed to the Approval Board (AB).

The Approval Board (AB)

The final decision on a project is taken by the AB, on the principle of consensus. The initial composition of the Approval Board is listed in annex 1. It can be amended by the AB, in particular, when new participants wish to join the CORE Programme. As soon as approved, a project is recognized as a part of the CORE Programme and will be suitable to integrate with the coordination structures of CORE.

Activities/projects selected and funded through a different programme (see SECTION VII) can, at any time, be submitted by sponsors to the CORE structures for assessment (PAC), approval (AB), coordination and integration (CT).

COORDINATION AND SUPPORT OF PROJECTS

The Co-ordination Team (CT) will:

- follow-up and co-ordinate the implementation of the CORE projects. Each project will involve a consortium of participants managed by a Project Co-ordinator (PC). This co-ordinator will be accountable for the implementation of the project, and reporting to the CT. If the project

is implemented within the UNDP Support Project (see below SECTION VI), the PC will also act as principal contractor;
- ensure geographical and cross-sectoral integration of the CORE projects;
- facilitate the PAC and the AB procedures (see SECTION V).

The financing and administrative support to the CORE co-ordination structures will be provided by the UNDP Programme Support Project (see SECTION VI).

SECTION VI
THE UNDP PROGRAMME SUPPORT PROJECT

Without prejudice to specific procedures applicable to relevant international aid programmes, such as the EU Cooperation Programmes, the UNDP Support Project will:

1. Provide financial, administrative and technical support to the CORE co-ordination structures for:
   - facilitating the preparation, assessment and selection of the projects (involving the PAC and AB);
   - co-ordinating the implementation of the integrated CORE Programme.
2. If so requested on a voluntary basis, administer donor resources for the Programme.
3. Support implementation of the Programme by bringing transparent, accountable and flexible procedures in the following fields: contract preparation with the operators of the projects; and follow-up of the implementation of the projects: schedules, financial management and results.
4. Help to create conditions for involvement of other affected areas of Belarus into the Programme, and linkages with similar work in other Chernobyl affected areas in Ukraine and Russian Federation.
5. Provide regular reporting as well as public information about the CORE Programme to Belarusians, Europeans and the international community.

The above is reflected in a UNDP project document, on which participants in the Programme will be consulted, and which is signed between the Government of Belarus and UNDP. If Programme participants chose, they can utilize the structure of the Support Project to delegate in a flexible, transparent and accountable way the day-to-day administrative and financial management of the project(s) to which they contribute.

Co-financers of the projects within the programme have the option of channelling their funds through the UNDP Support Project, or funding their Projects directly and using their own financial and administrative procedures.

SECTION VII
PROJECT FINANCING AND THE AUTONOMY OF CONTRIBUTING INSTITUTIONS

Each participant will consider the possibility of a contribution to the implementation of the CORE Programme. Each participant will determine and announce the level of its possible contribution to the Programme in due course. It will remain free to select (according to its priorities) the projects it wants to fund or to co-fund and/or to determine the sharing of its contribution.

The mechanisms of possible financing are determined by the participants, depending on their preferences and/or restrictions. The financial resources are channelled:

- directly to the organizations and the persons involved in implementation of the CORE Programme and/or projects; or
- through the UNDP Programme Support Project.

Any relevant information on project implementation and outcomes (except for confidential contract-related information) should be accessible to the participants.

The provisions included in this section are without prejudice to specific procedures applicable to relevant international aid programmes, such as the EU Cooperation Programmes. Each participant is, in particular, free to follow its own selection procedure for funding or co-funding activities.

SECTION VIII

OBLIGATIONS OF THE BELARUSIAN AUTHORITIES

The Belarusian authorities, represented by the Committee on the Problems of the Consequences of the Catastrophe at the Chernobyl NPP under Council of Ministers of the Republic of Belarus and the District Executive Committees, engage themselves to:

- assist foreign participants with free visa, customs and other procedures concerning their activity in Belarus within the framework of the Belarusian legislation;
- initiate, if necessary, the drafting and adoption of relevant legal acts of Belarus to facilitate favourable conditions for the Programme implementation (including tax exemption for cargoes and financial resources received from outside Belarus within the framework of the Programme);
- provide in-kind and financial contributions and other assistance as needed to support implementation of the Programme.

SECTION IX

EXPERT ASSESSMENT OF THE PROGRAMME

The participants commit themselves to an international independent review after the end of the five-year term of the CORE Programme, as well as a mid-term assessment after two and a half years. The review shall be based on the success criteria specified in SECTION X. The outcome shall be made public.

SECTION X
SUCCESS CRITERIA FOR THE PROGRAMME

The participants identify the following criteria to measure the success of the CORE Programme. Such criteria, as appropriate, will be integrated into the design of individual projects to help measure their success as well as that of the Programme:

- Increased living standards of the concerned populations measured in terms of progress in income, health, food quality, economic and social development, environment, education and culture;
- Entrepreneurship and social initiative developed in the concerned communities;
- A practical radiological culture developed to enable the concerned local population to better assess the radiological situation and to improve radiological quality, with respect to health, food, agriculture, and the environment;
- Access by the general public to effective, reliable, and pluralistic measures of radiological assessment;
- The level of involvement of local people, local communities and more generally Belarusian civil society in the Programme;
- An increased number and variety of projects in place meeting the objectives of the Programme in all priority areas, and reaching more people;
- An increase in the number of new participants in the Programme, whether governmental and non-governmental, and from all levels: local, national and international;
- An increase in international and national contributions to the Programme;
- An independent international review takes place within 5 years of the start of implementation assessing the need to continue the Programme and to modify or expand the priority areas;
- The CORE approach is disseminated to other contaminated districts of Belarus as well as to Ukraine and Russian Federation;
- Reliable, consistent and wide information about the Programme is made available at the local, national, European and international levels;
- The results achieved by the Programme are sustainable.

These criteria can be further refined as needed by the PAC and AB, with changes recorded in an appendix to the Declaration.

Done at Minsk this 15th day of October 2003

Mr. Vladimir G. Tsalko	Chairman of the Committee on the Problems of the Consequences of the Catastrophe at the Chernobyl NPP under the Council of Ministers of the Republic of Belarus
Mr. Kevin McGrath	Acting UN Resident Co-ordinator / UNDP Resident Representative in Belarus
Mr. John Daniel	Deputy Director General of the UNESCO
Amb. Eberhard Heyken	Ambassador, Head of the OSCE Office in Minsk
Mr. Matthias Weingart	Country Director, Swiss Development & Co-operation Agency
Mr. Gilles Hériard Dubreuil	Chairman of the CORE Partnership Committee[2]
Mr. Joseph Mc Grath	Executive Director, Students 10K for Chernobyl, Ireland
Mr. Alexander P. Yatchenko	Chairman of the Bragin District Executive Committee
Mr. Valery V. Berestov	Chairman of the Slavgorod District Executive Committee
Mr. Alexey A. Demko	Acting Chairman of the Stolin District Executive Committee
Mr. Vassily M. Maksimenko	Chairman of the Chechersk District Executive Committee

Done at Minsk this 2nd day of December 2003:

Amb. Jonas Paslauskas	Ambassador of Lithuania
Amb. Helmut Frick	Ambassador of Germany
Amb. Norbert Jousten	Ambassador, Head of Delegation of the European Commission to Belarus, Ukraine and Moldova

[2] Collective of European NGOs and institutions constituted during the preparatory phase of the CORE programme and including the « A Tous Vents du Monde » association, Nuclear Protection Evaluation Centre (CEPN), Fertilisation pour l'Epanouissement et le Renouveau de la Terre (FERT), National Paris-Grignon Agronomic Institute (INAP-G), French Radioprotection and Nuclear Safety Institute (IRSN), Médecins du Monde, French Ministry of Agriculture, Mutadis Consultants, Patrimoine Sans Frontière, Caen University.

Amb. Stéphane Chmelewsky	Ambassador of France
Amb. Tadeusz Pawlak	Ambassador of Poland
Amb. Brian Bennett	Ambassador of the United Kingdom
Amb. Guglielmo Ardizzone	Ambassador of Italy, also in his capacity as acting Presidency of the European Union
Mr. Ales Fojtik	Chargé d'Affaires of the Czech Republic
Mr. Jan Šadek	Counsellor, Head of Sweden office in Belarus
Dr. Edmund Lengfelder	Chairman of the Board, German Association "Tchernobyl-Hilfe" in Ottobrunn
Mr. Peter Junge-Wentrup	Head of the International Educational Centre, Dortmund, Germany

Done at Minsk this 3rd day of December 2003

Mr. Jozef Machishak	Chargé d'Affaires of Slovakia

Composition of the Approval Board

Mr. Vladimir G. Tsalko, Chairman of the **Committee on the Problems of the Consequences of the Catastrophe at the Chernobyl NPP under the Council of Ministers of the Republic of Belarus**

Ms. Cihan Sultanoglu, **UNDP** Resident Representative / **UN** Resident Coordinator in Belarus

Ms. Aicha Bah Diallo, Assistant Director-General for education of the **United Nations Educational, Scientific and Cultural Organization (UNESCO)**

Amb. Eberhard Heyken, Ambassador, Head of the **OSCE** Office in Minsk

Mr. Matthias Weingart, Country Director, **Development and Cooperation Agency of the Department of Foreign Affairs of the Swiss Confederation**

Mr. Gilles Hériard Dubreuil, Chairman of the **CORE Partnership Committee**

Mr. Joseph Mc Grath, Executive Director, **Students 10K for Chernobyl, Ireland**

Mr. Alexander P. Yatchenko, Chairman of the **Bragin District Executive Committee**

Mr. Vladimir P. Danilenko, Chairman of the **Slavgorod District Executive Committee**

Mr. Alexey A. Demko, Chairman of the **Stolin District Executive Committee**

Mr. Vassily M. Maksimenko, Chairman of the **Chechersk District Executive Committee**

Amb. Jonas Paslauskas, Ambassador of **Lithuania** in Belarus

Amb. Martin Hekker, Ambassador of **Germany** in Belarus

Amb. Steffen Skovmand, Charge d'Affaires and Interim, The Delegation of the **European Commission** to Belarus, Ukraine and Moldova

Amb. Stéphane Chmelewsky, Ambassador of **France** in Belarus

Amb. Tadeusz Pawlak, Ambassador of **Poland** in Belarus

Amb. Brian Bennett, Ambassador of **the United Kingdom** in Belarus

Amb. Guglielmo Ardizzone**,** Ambassador of **Italy** in Belarus, also in his capacity as acting Presidency of the European Union

Mr. Vladimir Ruml, Chargé d'Affaires of **the Czech Republic** in Belarus

Mr. Jan Šadek, Counsellor, Head of **Sweden** office in Belarus

Dr. Edmund Lengfelder, Chairman of the Board, **German Association "Tchernobyl-Hilfe"** in Ottobrunn

Mr. Peter Junge-Wentrup, Head of the **International Educational Centre**, Dortmund, Germany

Mr. Jozef Machishak, Chargé d'Affaires of **Slovakia** in Belarus

3
The co-expertise experience in Norway after the Chornobyl accident*

Yevgeniya Tomkiv[1], Deborah Oughton[1], Lavrans Skuterud[2]

Abstract

The 1986 Chornobyl accident severely impacted Norway, particularly South Sámi reindeer herders as their diet was heavily based on reindeer meat and wild products from their local environment. Specific countermeasures had to be adopted to allow for preservation of the Sámi lifestyle and culture without compromising their health and safety. This chapter details the impacts on reindeer herders including human and socio-economic consequences. It also describes how co-expertise developed as herders and scientists collaborated on countermeasures like clean feeding and live monitoring. Norway's experience highlights that managing nuclear disasters requires integrating local knowledge and involving affected communities in every decision.

Introduction

Among the countries outside the former Soviet Union, Norway has experienced the largest consequences of the radioactive fallout in the aftermath of the Chornobyl accident. The areas in Central and Southern Norway that suffered most from the fallout were areas where natural pastures are important for milk and meat production from sheep, cows, goats and reindeer (Liland and Skuterud, 2013). This resulted in significant and long-lasting contamination of foodstuffs above the permissible levels. In 1986, Norway had no operational

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[1] Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, Norway
[2] Orkland municipality, Norway

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nuclear emergency plans and preparedness, and few resources to manage such an emergency. Thus, monitoring and surveys to assess the impact were delayed and authorities struggled to fill people's information needs especially related to food safety and health concerns (Liland and Skuterud, 2013).

With no pre-established central plan for the management of radioactive fallout, the authorities' responses were ad-hoc and improvised. However, some scientists were available, with relevant knowledge from studies on the remnants of atmospheric nuclear weapons testing in the 1960s that were still ongoing. Various stakeholders including authorities, experts, producers and citizens had to work together to develop management strategies. It would be an exaggeration to call this a formal "co-expertise process" with a plan and structure as outlined in this book, although some later meetings were specifically designed to follow such a process. Cooperation and involvement of stakeholders were deemed necessary at an early stage because of the overwhelming situation but were also rooted in a social democratic and egalitarian society where unions and organizations had defined roles, responsibilities and expectations. And where inhabitants have relatively short routes to someone involved in decision-making processes. The post-Chornobyl management in Norway therefore contrasts with countries where strategies were more top-down.

The Chornobyl fallout had considerable consequences for many sectors in Norway (Tveten et al., 1998), with mitigating actions and extensive monitoring lasting for decades after the fallout occurred. The practical consequences were most long-lasting for sheep farmers and reindeer herders. The control schemes and regulations in sheep and reindeer production lasted for 38 years, until 2025[3], and some Sámi reindeer herders in the most contaminated areas are still advised to restrict their radionuclide intake. However, for cultural reasons the consequences have been largest for the Sámi reindeer herders, and this chapter will therefore focus on this situation.

1. Impacts on reindeer herding

1.1. *Who are the Sámi?*

The Sámi people are indigenous populations of Norway, Sweden, Finland and Russia, numbering in total some 80,000 — 100,000 persons — out of a total population of about 2 million in the area they cover. About 10-15% of the Sámi engage in reindeer husbandry, a traditional occupation tied closely to their culture and livelihood, primarily through reindeer meat production. Historically nomadic, many herders are now semi-nomadic, maintaining residences near both winter and summer grazing areas.

Despite being referred to as a single group, the Sámi consist of distinct groups with separate languages. In Norway, the Chornobyl fallout primarily affected the South Sámi, a population of around 2,000 (shared between Norway

[3] https://lovdata.no/artikkel/hva_er_nytt_fra_1__januar_oversikt_over_de_viktigste_regelendringene/4964

and Sweden), with most involved in reindeer herding. Approximately 350 South Sámi were directly impacted by the fallout in 1986 (Eikelmann, 1991).

1.2. *Early stages of post-accidental management*

Reindeer herding has already been known as particularly vulnerable to radioactive contamination from the time of nuclear weapons testing, and a monitoring programme of Sámi reindeer herders in northern Norway has been ongoing since 1965. Based on this understanding, meetings were arranged between authorities and herders in the most affected areas in June 1986. The herders were engaged in vegetation sampling in the grazing areas and sacrificed reindeer during the summer for the purpose of sampling and testing for contamination levels and time-trends before the start of the slaughter season in autumn and winter. In July, radiocaesium levels (sum of ^{134}Cs and ^{137}Cs) in reindeer reached up to 90,000 Bq/kg, which far exceeded the maximum permissible level of 600 Bq/kg for radiocaesium in basic foodstuffs. This prompted national concern and a ban on reindeer meat from central and southern Norway in autumn 1986 and winter 1986/87. Slaughtering was conducted as normal to avoid increases in sizes of herds, and related ecological consequences, but the carcasses were condemned and herders received financial compensation.

1.3. *The need for higher permissible levels*

As the 1986-87 winter and main reindeer slaughter season approached, it became clear that radiocaesium levels in reindeer meat would exceed the permissible 600 Bq/kg level even in northern Norway, which accounts for 70% of reindeer meat production. Given the very high contamination levels in central and southern Norway, and expected duration of the contamination problem based on experience from the 1960s (Figure 1), in November 1986, Norwegian health authorities chose to raise the permissible/intervention level for radiocaesium in marketed reindeer meat to 6,000 Bq/kg. One of the justifications for this decision was to avoid production for condemnation as well as to preserve Sámi lifestyle and culture (Directorate of Health and the Ministry of Agriculture, 1986). During winter 1986-87, radiocaesium levels in reindeer meat averaged 50,000 - 60,000 Bq/kg in central and southern Norway (Figure 1), peaking at 150,000 Bq/kg (Strand et al., 1992). Without raising the permissible level, 85% of national reindeer meat production would have been condemned. The increase was deemed acceptable due to low average consumption (0.5 kg/year) and minimal radiation exposure risk for the general population.

Since increasing the maximum permissible level in November 1986, the intention was always to lower it, as contamination in pastures declined. Due to the rapid decay of ^{134}Cs and reduced contamination in subsequent years, the level was reduced to 3,000 Bq/kg in 1994.

1.4. *Actions to protect Sámi reindeer herders*

The Chornobyl fallout in Norway was not large enough to make external doses to either Sámi or the general population a major concern. The main challenge was dietary intake of radionuclides. The Sámi reindeer herders were especially vulnerable due to their traditional diet, which relied heavily on reindeer meat and other local wild foods. Their diet shifted seasonally, with reindeer meat consumed in winter and fish and berries in summer and autumn, while mushrooms played only a minor role.

After the Chornobyl accident in spring 1986, the herders' diet rapidly shifted from being among the healthiest to one of the most contaminated. Families avoided local fish and berries, opting instead for canned food during the summer of 1986. When all reindeer slaughtered in autumn 1986 and winter 1986-87 were condemned and the maximum permissible radiocaesium level in reindeer meat was raised to 6,000 Bq/kg, herders received meat from less contaminated areas in Northern Norway as a substitute.

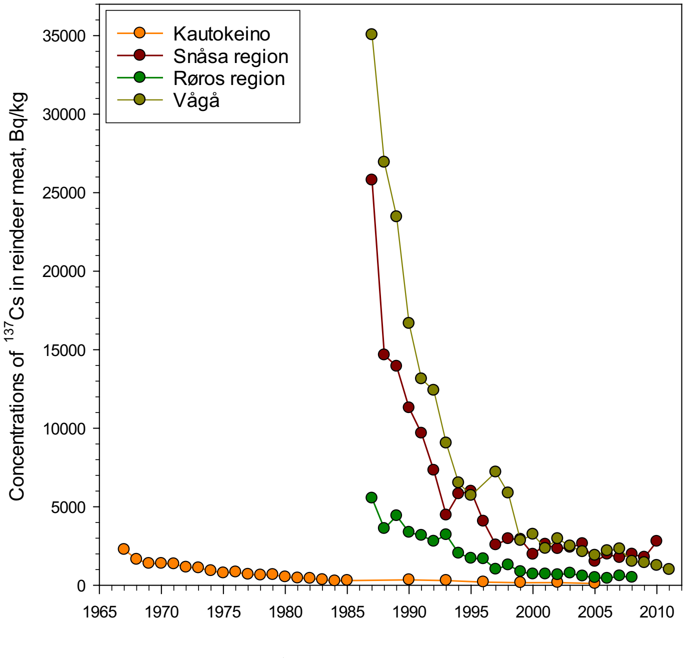

Figure 1. Concentrations of ^{137}Cs in reindeer meat since the mid-1960s[4]. (A compilation of data from Skuterud et al. (2005), Skuterud and Thørring (2012) and Skuterud and Thørring (2015)).

In addition to offering substitutes for the most contaminated products, the health authorities also published and distributed dietary advice to reindeer herders and other members of the population who had significant intakes of wild

4 Note that the graph does not include ^{134}Cs after Chornobyl; e.g., in Vågå the sum of the two isotopes reached the average level of 51,000 Bq/kg.

products (Directorate of Health, 1987). The aim of the advice was to limit radiocaesium intake to a maximum of 400,000 Bq the first year after Chornobyl, and 80,000 Bq in subsequent years (corresponding to about 5mSv/y and 1 mSv/y, respectively), with half these amounts recommended for pregnant/nursing women and infants (<2 years old). The distributed leaflet included recommendations on how much could be consumed depending on the contamination level, and what cooking and preparation methods could reduce the contamination levels of the finished product (e.g., salting, discarding broth when cooking meat). However, it also highlighted the nutritional value of reindeer meat and fish and cautioned against excessive salt intake.

Given the herders' self-sufficiency lifestyle, financial constraints could lead some to consume contaminated meat. To address this, a compensation scheme was created, providing annual payments to families whose reindeer meat exceeded 600 Bq/kg, allowing them to buy alternative foods or offset extra efforts to obtain less contaminated meat. This scheme, involving various countermeasures, operated until 2007, after which it was revised to focus on direct expenses related to safer meat acquisition.

1.5. *The whole-body monitoring programme*

Whole-body monitoring of the reindeer herders in the most contaminated areas in central Norway was initiated in spring 1987. The monitoring aimed to track ingestion doses and trends, and to let herders assess the effectiveness of their efforts to reduce intake. Results have also supported health studies and fuelled interest in further health-related research.

Initially, portable monitoring equipment was used with mobile labs being deployed from 1996 (Figure 2). Monitoring typically occurred at selected sites near herders' winter residences, and travel expenses for the herders participating were reimbursed. Participation was voluntary, with invitations sent by post. Measurement sessions lasted 15-20 minutes, allowing for discussion with each participant (e.g., comparison with their previous monitoring results and the concrete effects of the efforts they make to limit the radiocaesium intake). Waiting rooms provided space for informal discussion with staff and other herders.

FIGURE 2. A reindeer herder (left) being monitored in the whole-body monitor chair in a mobile laboratory. © Geir Tønset, Adresseavisen.

1.6. *Countermeasures and compensation in reindeer husbandry*

In 1986, the only planned countermeasure in reindeer husbandry was condemning contaminated meat. However, high contamination levels and the expected duration of the problem led herders, universities, and authorities to start developing additional strategies. Condemnation was costly and unsatisfactory for producers, even with compensation (Strand et al., 1990; Brynildsen et al., 1996).

The increase of the maximum permissible level for radiocaesium in reindeer meat to 6,000 Bq/kg in November 1986 was the first step in reducing the impact. In winter, live monitoring procedures were introduced (Figure 3) to sort animals by contamination level; less contaminated reindeer could be slaughtered, while others underwent countermeasures like clean feeding (Brynildsen and Strand, 1994).

FIGURE 3. Monitoring of radiocaesium in reindeer before slaughter (photo: Torild A. Østmo).

Clean feeding is the preferred countermeasure to reduce radioactive contamination in the livestock. However, for the reindeer herds this measure is associated with specific challenges like fencing of sufficiently large areas and provision of clean feed. The herders were reimbursed their expenses for erecting fences and for the costs of clean feed (either bought or collected in less contaminated areas). The herders also received a compensation for each reindeer undergoing clean feeding, depending on the contamination level of the reindeer and how long they would have to be fed. An alternative to clean feeding in fenced areas was to let the herds graze in areas known to be less contaminated (which also entitled the herders to some compensation).

Changing the slaughter season was the most widely used countermeasure in reindeer herding. Traditionally, reindeer were slaughtered in winter when contamination from grazing lichens was highest. In autumn, contamination levels were only 1/4 to 1/3 of winter levels (Åhman and Åhman 1994), allowing many animals to be slaughtered without extra measures being required. However, autumn slaughter meant animals were not fully grown, so herders received compensation for lost weight gain. Many Sámi herders also disliked autumn slaughter because strong bonds still existed between reindeer does and their calves.

Caesium binders, successful in other livestock, saw limited use in reindeer. Some non-Sámi herders used salt-licks or rumen boli with ammonium ferric hexacyanoferrate (AFCF), but technical difficulties and early animal deaths discouraged widespread adoption of the boli method among Sámi herders (Hove et al., 1991).

2. Cultural, psychosocial and socioeconomic aspects

Chornobyl fallout brought a range of human and socio-economic consequences for the Sámi reindeer herders. Although some of these consequences are specific to the Sámi's "Chornobyl history", others can serve as examples that resonate globally in terms of the human dimension. The South Sámi are a small minority, with their own language and culture, and even within Sámi society they are a minority. Before Chornobyl, Norwegian state policies aimed to modernize and consolidate Sámi herding, which, along with earlier assimilation efforts, created a tense relationship with authorities (Stephens, 1994). As a response, reindeer husbandry became even more central to Sámi identity and language use (Ms. Eira-Åhrén in Oughton et al., 2008; Paine, 1992).

2.1. *Independence and self-determination*

The Chornobyl fallout created a dramatic change for the reindeer herders: from having a life-style where they were the masters with their local know-how and experience, they suddenly became dependent on decisions and recommendations by authorities and scientists. Especially in the first months when everything was new. Some were afraid that the government would use the Chornobyl fallout as an opportunity for governmental interference into the Sami herding practices (Stephens, 1994). Instead of having reindeer husbandry and the culture as a boundary against "cultural and material encroachment by the surrounding non-Sami world", the herders suddenly needed the know-how of the scientists (Paine, 1992, p. 269). However, they realized that they could not surrender to them; that would be to deliver themselves into "delegitimizing dependence and to be sold short culturally" (Paine, 1992). They needed to reassert their practices and customs and make their culture visible vis-à-vis the experts: "We must *do*. We must be active, not passive" (Paine, 1992, p. 268). The herders started searching for practical solutions, and e.g. started experimenting with clean feeding during winter 1986/87. This cultural background could also result in competition between the knowledge of practitioners and that of “outside experts” (Paine, 1992). For example, the Sámi herders rejected the option to insert AFCF boli into the rumen of their reindeer on the grounds of animal cruelty (Oughton et al., 2008). By 1988, the reindeer herders had autonomy in terms of how things were done, and a memorandum was sent to the government ministry demanding that “individual solutions be accepted” (Paine, 1992).

2.2. *Raising the maximum permissible level*

Although the decision to raise the permissible level of radiocaesium in reindeer meat to 6,000 Bq/kg, “to save Sámi culture”, was supported by the reindeer herder association, it was received with considerable scepticism among several South Sámi.

Some viewed the decision as financially motivated, suspecting it was intended to reduce the government’s burden of compensating herders at market prices for animals that had to be slaughtered and condemned as unfit for human consumption (Paine, 1992). Others criticized the shifting risk management standards, questioning how a level of over 600 Bq/kg could suddenly be considered safe when it had previously been a health hazard, especially since Sweden maintained a much stricter permissible level of 300 Bq/kg. They also noted that pre-Chornobyl reindeer often exceeded even the stricter post-Chornobyl permissible level, raising doubts about the consistency and rationale of the regulations (Beach, 1990). Some felt it was more important to preserve public confidence in the quality of the meat (Stephens, 1994). Additionally, there was criticism that the larger and more politically influential North Sámi, who dominated the national herder association, were more interested in protecting their own market and easing consumer concerns than supporting the smaller South Sámi group and their cultural identity. It was argued that the North Sámi had pushed for the higher permissible level to avoid condemning their own meat, as reflected in the association’s statement that a lower permissible level would not ensure production clearance in Troms/Finnmark (Paine, 1992; Stephens, 1994; Directorate of Health and Ministry of Agriculture, 1986). Opinions of some of the reindeer owners were that these differences in consequences for the North and South Sámi added to the stigmatization of their meat (Paine, 1992).

2.3. *Meat substitution as cultural threat*

In traditional Sámi culture, reindeer are slaughtered and handled with great respect and care. Every part of the animal — blood, organs, antlers, hooves — is used for meals or traditional handicrafts. Although most reindeer are now slaughtered in modern facilities, many families still maintain traditional practices when slaughtering for domestic use.

The initial substitution of reindeer meat in the South Sámi areas with less contaminated meat from the north provided the herders with meat, but not with blood, organs or materials needed for traditional handicraft. This loss had strong cultural implications, as traditional foods and clothing made from reindeer are deeply tied to Sámi identity (Beach, 1990). Furthermore, as proud producers, the meat offered was not really appreciated: "It doesn't taste right; North Sámi don't know how to care for their reindeer as we do. This food does not nourish our bodies" (Stephens, 1994). It also disrupted the tradition of taking provision from one's herd, serving it to guests and sending dried meat to children, who studied far away, to keep the connection (Paine, 1992). Another consequence was that herding parents feared that their children would miss the opportunity to learn the customs (Beach, 1990).

2.4. *Dietary advice and risk management*

The permissible level for radiocaesium in reindeer meat was increased because the general population consumed little of it. Authorities issued dietary advice to herders and offered clean meat and compensation for reindeer exceeding 600 Bq/kg. According to Paine (1992), herders in the most affected areas followed these dietary restrictions for 16-18 months after the fallout. By 1987-88, encouraged by the success of clean feeding, they began returning to their traditional Sámi diet. However, even by 1996, one third of the population still ate less reindeer meat due to the concerns about the Chornobyl fallout (Mehli et al., 2000).

In Sweden, confusion over permissible levels led many herders to set their own limits for meat they would eat, based on consensus, expert advice, media, and personal comfort (Beach, 1990). Families with small children were especially cautious, preferring meat with the lowest contamination (Beach, 1990). This likely occurred in Norway as well. Beach (1990) also noted that most herders did not keep records of contamination values or meat quantities consumed, despite knowing this was important; many simply used the marketability limit as their personal safety threshold.

2.5. *Clean feeding*

As mentioned before, herders began experimenting with clean feeding even before it was officially accepted by the government (Paine, 1992). According to Paine (1992), some scientists warned against this practice due to concerns about animal welfare and potential losses of 10-20% of the animals. Clean feeding involved fencing small groups of reindeer selected for slaughter, gathering clean lichen from less contaminated areas, and purchasing special feed. This required significant labour, including building enclosures, and represented a new husbandry routine that reduced time for managing the main herd.

Clean feeding can only be done in winter to minimize disease risk, with restrictions on animal numbers per area and limited use of enclosures before they must be moved. Reindeer accustomed to a lichen dominated winter diet must gradually adapt to a more nutrient rich diet needed for longer periods of clean feeding. A special feed was developed by scientists, while the lichen needed in the transition feeding period had to be collected. The herder families have been collecting clean lichens in areas 300-500 km south of their ranges every autumn, creating a new tradition for herder families.

While clean feeding raised animal welfare concerns, some herders appreciated how it revived older, more intensive herding traditions and fostered closer relationships with their animals. However, they also found that parts of the clean-fed reindeer, such as hides and intestines, were of poor quality and unsuitable for traditional food and handicrafts (Oughton et al., 2008).

2.6. *Socioeconomic consequences*

The initial period, when all reindeer meat was condemned, put significant strain on the herders. There was deep concern about long-term economic prospects and uncertainty over whether state compensation would continue if it took decades for contamination levels to drop (Stephens, 1994). Many herders felt their livelihoods were threatened, describing themselves as "wards of the state" with meaningless work, as they produced "radioactive meat" (Beach, 1990; Oughton et al., 2008).

Compensation programs covered direct economic losses but did not account for extra labour required by the countermeasures. This led to complaints about inadequate compensation, such as the NOK 2,000 per person per year for "alternative diet", which was less than what households dependent on reindeer meat needed — and lower than the Swedish equivalent (Oughton et al., 2008). Clean feeding required additional work and costs for fencing, lichen collection, and animal care, while compensation rates often did not match the actual expenses, especially for shorter feeding periods involving fewer animals.

Other socioeconomic impacts included the inability to live off local resources like berries, mushrooms, and fish, the need to alter family diets, and the loss of materials for traditional handicrafts. For the herders, these challenges affected not just their economy, but their entire way of life and cultural identity: "not just a matter of economics, but of who we are, how we live, how we are connected to our deer and each other" (Stephens, 1994).

2.7. *Coping with Chornobyl — 30 years after*

In spring 2016, a study among South Sámi reindeer herders in Snåsa explored their experiences with radiation risk after Chornobyl and its impact on quality of life, culture, and daily routines, as well as their current concerns about radioactive contamination (Svenningsen, 2016). The findings revealed that herders generally had low levels of concern about radioactivity, but all reported that Chornobyl had caused significant psychological stress and extra work in the past. Initial fears included health consequences, the survival of reindeer husbandry, and the future of South Sámi culture, compounded by a lack of information and mistrust of authorities. One herder described the fallout as "an invisible enemy" and another expressed worries about cancer and the next generation. Nevertheless, community support and positive attitudes towards whole-body monitoring were highlighted.

Over time, the herders moved from a feeling of helplessness to a state of being better able to cope, gaining knowledge and control through involvement in the application of countermeasures and whole-body monitoring, with economic compensation helping to preserve reindeer husbandry. Social support from both local communities and national authorities played a crucial role in reducing stress. However, concerns about the loss of Sámi culture and traditions persist, particularly as countermeasures restrict the traditional use of reindeer materials in handicrafts, impacting future generations. The whole-body monitoring program was viewed positively, especially due to its voluntary nature.

3. Stakeholder engagement and co-expertise process

Early stakeholder engagement in the early phase after the Chornobyl accident extended to fallout monitoring, where reindeer herders were enlisted to collect samples for deposition mapping, as there was no nationwide system in 1986. Collaboration among authorities, unions, and the food industry established national working groups focused on research, development, and practical implementation of countermeasures. The authorities' principal aim to limit condemnation of food products led to intensive research and collaboration among national institutes and agencies. This unified approach produced a range of measures, such as live monitoring of animals, clean feeding schemes, and the use of caesium binders, which were developed through a combination of laboratory experiments and practical field testing. Scientists worked directly with farmers and reindeer herders, whose feedback was essential for successful real-world implementation. Over time, local adaptation of centrally developed routines occurred, reflecting local expertise and evolving practices.

Following the overwhelming initial period after the fallout occurred, the wide involvement of various stakeholders gradually decreased as the overall contamination challenges were solved and mitigation strategies decided upon. For some years, stakeholder engagement in Norway primarily centred on implementing countermeasures and negotiating the associated economic compensation (Skuterud, 2006). However, the long-lasting contamination situation revealed a constant need for information and involvement. Not only due to the turnover of persons affected and involved, but also because countermeasure regimes may need revision. One such example from Norway was the alterations of the permissible level of radiocaesium in reindeer meat. The main communication channel between national authorities and the affected population was through official written hearings and annual negotiations with unions. In retrospect, it might be argued that more engagement, with meeting points like in a planned co-expertise process, could have been an important supplement to the more formal processes. The feedback from regular meetings with reindeer herders during the whole-body monitoring campaigns showed that there were communication needs that were not properly taken care of in the formal processes.

In 2008, Norway participated in the EURANOS project, which aimed at improving post-accident rehabilitation strategies (Dubreuil et al., 2010). The EURANOS project promoted greater dialogue and shared responsibility among stakeholders using the IDPA co-expertise method (Lochard et al., 2023). In Norway, two stakeholder meetings were held in spring 2008, one in Steinkjer — a Chornobyl affected region, and one in Oslo. These meetings brought together representatives from local communities, agriculture, reindeer herding, fisheries, industry, outdoor groups, and authorities (Bay-Larsen et al., 2009; Liland et al., 2010; Oughton et al., 2008).

In accordance with the co-expertise process, at the first meeting, participants identified five key challenges for further discussion during the follow-up seminar in Oslo: lowering of the intervention level in reindeer meat; local organisation of emergency preparedness; psychosocial effects; information needs and strategies; and challenges for other socio-economic sectors than agriculture and reindeer herding (Bay-Larsen et al., 2009; Liland et al., 2010; Oughton et al., 2008). The Oslo meeting achieved an even wider participation with more representatives from national authorities and other economic sectors. Participants were encouraged to formulate recommendations for the radiation protection authorities.

A possible further lowering of the maximum permissible level in reindeer meat from 3,000 Bq/kg to 1,500 or even 600 Bq/kg had been considered by national authorities, but had not previously been discussed with other stakeholders. In 1994, the decision to reduce the maximum permissible level from 6,000 to 3,000 Bq/kg was taken without a wide stakeholder involvement. During the meetings in 2008 the reindeer herder representatives voiced several concerns about potential changes to the maximum permissible levels. They worried that renewed focus on radioactivity in reindeer meat could weaken consumer trust in the domestic market. Additionally, they were apprehensive about the increased controls and actions that stricter permissible levels would necessitate, arguing that such changes would effectively mean starting over. As one participant explained, “I don’t know where to find the motivation to go back twenty years; start clean-feeding, build fences and all the practical consequences that comes with it. This also has to be considered... A reduction in the permissible level would practically be comparable to a new Chornobyl” (Bay-Larsen et al., 2009, p. 33).

There were also concerns about the health messaging such a decision would send, with one herder noting, “One has also to think about health; which signals are given by lowering the permissible levels? People start thinking; has this been dangerous to us?” (Bay-Larsen et al., 2009, p. 34). The final recommendations emphasized that any assessment of changes to the permissible level must include psycho-social and cultural consequences, concluding that “at the present time, the benefits of such a reduction appear to be small compared to the disadvantages” (Oughton et al., 2008). The maximum permissible level of radiocaesium in reindeer meat in Norway remains at 3,000 kBq/kg.

4. Lessons learned for the co-expertise process

Post-accident management of the consequences of the Chornobyl fallout has been a challenging task in Norway. Although Norway had no preparedness procedures in place at the time of the accident, and lacked the necessary resources for monitoring, nevertheless authorities quickly enlisted the help of a wide range of stakeholders including farmers and reindeer herders. This created a starting point for the various co-expertise processes that developed and contributed to a number of lessons that are now built into the Norwegian nuclear emergency preparedness:

I. Involving various stakeholders in the development of practical countermeasures is crucial for the success of their implementation. A stakeholder in this context is anyone affected by the countermeasure: the animal owner, the slaughterhouse, the dairy, the local authority responsible for implementing the countermeasure, and the national authority carrying out inspections.

II. Developing measures that leave the affected inhabitants with a set of options, provides them some influence and control over their own situation, and independence. This is particularly important where there is a situation with a degree of scepticism between stakeholders and the authorities. Giving directives with no room for individual freedom of choice, is likely to cause frustration. Local knowledge will develop quickly, and individuals will make improvements to the centrally developed directives and guidelines.

III. Carrying out live monitoring is an effective measure to reduce condemnation of meat, and is widely accepted and appreciated by the stakeholders. Animal owners find production of meat for condemnation highly unsatisfactory when the reason is something beyond their influence, and money can only partly compensate for this. Furthermore, condemnation of food because of radioactivity can be considered especially unacceptable since permissible levels do not represent dangerous levels (as demonstrated when the authorities changed the maximum permissible levels). Live monitoring combined with other countermeasures is in most cases also considerably less expensive than condemnation.

IV. Developing and maintaining competence in post-accident management at the national level is necessary to build confidence and trust with those affected. Although the population wants to participate in the development of strategies and influence decisions, they expect authorities and experts to know definite answers to the problems. Much experimenting and testing creates a feeling of being “guinea pigs” among the population.

V. Engagement of stakeholders must consider potential for scepticism towards national authorities and experts. There may be general inherent scepticism among some rural populations towards the practical value of any regulation and advice coming from national authorities and experts. It’s also important to know and recognise the historical context that could contribute to this scepticism.

VI. Recognising that co-expertise is not a consensus exercise. Involving stakeholders in discussions on countermeasures and rehabilitation strategies does not imply that a common understanding of all decisions must or can be reached. Individuals from the same stakeholder group may have varying views, political interests as well as personal costs and these may change over time.

Conclusions

In conclusion, the Chornobyl accident had significant impacts on the minority Sámi populations. These effects extended beyond radiological and economic consequences, and include important social and cultural factors. To some extent, the actions taken by Norwegian authorities after the accident considered these aspects, since preservation of reindeer herder culture was cited as justification for the raising of permissible level and other countermeasures. Although it appears that the authorities' motivations and reasons for that increase are now largely appreciated[5], it is interesting that at the time there was a certain degree of scepticism that this was driven by purely economic concerns. Whilst health and economic concerns dominated immediately after the accident, the long-term impacts on culture and heritage due to changes in traditional practice were the main concern of the Sámi.

Overall, Norway's response to the Chornobyl fallout highlights the importance of stakeholder involvement at every stage — from research and fieldwork to compensation negotiations and ongoing policy revision — ensuring that local knowledge and practical experience are integrated into national strategies.

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4
The co-expertise experience of upland sheep farmers in the UK after the Chornobyl accident

Anne Nisbet[1]

Abstract

Deposition of radioactive caesium after the Chornobyl accident affected upland areas of the United Kingdom, where the practice of non-intensive sheep farming prevailed. Restrictions were placed on the marketing of sheep meat from these areas for 26 years, which severely impacted the traditional way of life of the affected farmers. The initial flawed response from the UK government took a top down, bureaucratic approach, which ignored the specialist local knowledge and expertise of the farmers, thereby undermining their autonomy. Over a period of many years, collaboration between farmers, local officials, independent scientists, and others enabled a co-expertise process to be developed. Measurements were a key element of this process that enabled consumer confidence to be maintained, whilst also bringing empowerment and dignity to the farmers by involving them in the taking of measurements and subsequent discussion of the results. This chapter discusses a range of approaches that were taken to facilitate stakeholder engagement, and how the adoption of a more holistic approach to risk was fundamental in removing the long-standing restrictions on sheep farming.

1. Historical context

In the late 1980s and early 1990s there was a crisis of confidence in the quality of food from the United Kingdom (UK) and a lack of credibility in the Ministry of Agriculture, Fisheries and Food (MAFF), following a wave of food scares including outbreaks of Bovine Spongiform Encephalopathy (BSE), Salmonella, and E-coli. BSE and its human equivalent, variant Creutzfeldt-Jakob disease (vCJD), was first identified in November 1986 and subsequently over four million head of cattle were slaughtered to contain the outbreak, and 178 people

[1] International Commission on Radiological Protection (ICRP)

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died after contracting vCJD through eating infected beef. It was during these challenging years that the Chornobyl accident impacted the UK.

Heavy thunderstorms on 2-4 May 1986 and again on 7 May, brought radioactive contamination from Chornobyl, located 4000 km away from the UK. Very high levels of deposition were found mainly on upland areas of the UK (Figure 1).

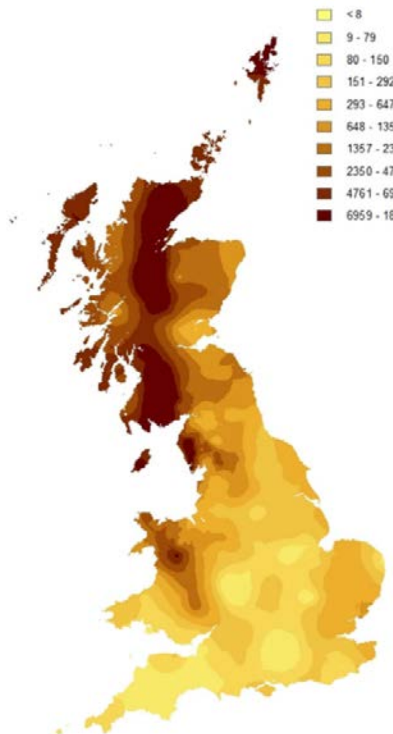

FIGURE 1. Chornobyl fallout over Great Britain in May 1986 (^{137}Cs activity concentrations in graminaceous vegetation, Bq/kg dry matter) (from J. Chaplow, N. Beresford and C. Barnett, 2015).

During the first few weeks, public confusion and anxiety were met with bland assurances from Government that there was no risk to health. On 13 May, MAFF found samples of lamb (sheep meat) from Cumbrian fells in Northwest England, had levels of radiocaesium of 1,500 Bq per kg, which was 50% greater than the UK (and European Commission) action level of 1000 Bq per kg (caesium-134 and caesium-137). On 20 June, under powers within the Food and Environment Protection Act (FEPA) 1985, MAFF announced an immediate 3-week ban on the movement and slaughter of sheep in parts of Cumbria and upland areas of North Wales. Similar restrictions were placed in Scotland on 24 June. The number of farms and sheep originally under restrictions is given in Table 1. More than 4 million sheep and ~9,000 farms were affected in the UK. This represented about one fifth of the UK sheep population.

TABLE 1. Initial numbers of farms and sheep under restriction in June 1986.

	England	Wales	Scotland	Northern Ireland
Farms	1,670	5,100	2,900	122
Sheep	867,000	2,000,000	1,358,000	53,000

Radiocaesium is excreted rapidly by lambs and every 12 days the concentrations decrease by ~50%. Therefore, it was assumed that it would take no longer than 3 weeks for activity concentrations to be less than the action level. The short-lived restrictions were based on the scientific belief that radiocaesium would become immobilised in soil and not incorporated into new grass. This was based on research on lowland clay mineral soils. However, the upland soils were mainly acidic, with a high organic matter content. As such, it was likely that the radiocaesium would remain chemically mobile and be available for uptake by pasture and grazing animals over many years (decades). On 24 July 1986, an indefinite ban was placed on the movement and sale of lamb from restricted areas in UK. This was serious as hill farmers potentially faced ruin, not only due to restrictions on lamb, but also breeding flocks faced starvation and wholesale slaughter, due to inadequate supplies of fresh pasture.

By August 1990, the number of restricted farms and sheep had fallen significantly with a reduction of around 90% in the number of farms in England and Wales subject to restrictions. Nevertheless, these data changed very little over the next 10 years with only a further 4% reduction in the number of restricted farms. The long duration of the restrictions impacted greatly on the affected farmers and their traditional way of life.

Upland lamb is highly prized for its distinctive, complex flavour and beneficial nutritional properties, which stem from the sheep's varied, natural diet, non-intensive farming methods and lifestyle in rugged environments (Figure 2). Upland lamb is a unique product that is irreplaceable, both in terms of quality and cultural significance, by sheep from other regions or other foods.

FIGURE 2. Upland sheep farming terrain (photo: Tony Richards).

2. The response by the authorities

On 18 August 1986, in response to the problem of overgrazing, the Government introduced a monitoring programme called Mark and Release, which permitted farmers to sell and move contaminated sheep from the restricted areas. This *in vivo* method for measuring radiocaesium was developed by experts over a period of around 6 weeks, for application on the farm (Figure 3). Sheep with measured concentrations of radiocaesium above the action level were classed as failures and were colour-marked with indelible paint: they could be moved or sold at any time but not slaughtered until they were remonitored. Sheep with activity concentrations less than the action level had to be kept on improved pasture, which had lower levels of radiocaesium, prior to sale. In addition to the routine Mark and Release monitoring programme, derestriction surveys were carried out on a few carefully selected farms to investigate whether farms could be permanently released from restrictions. These surveys were conducted in the summer months when activity concentrations of radiocaesium were known to be at their highest. Every sheep on the farm was monitored within 24 hours of coming off the upland pasture. Derestriction surveys provided a reliable means of identifying farms where activity concentrations of radiocaesium in lamb were less than action levels. The surveys were widely accepted by farmers as a way of returning to their normal farming practices, confident that the levels of radiocaesium in their flock were no longer of concern.

FIGURE 3. Mark and Release monitoring on restricted farms (© Crown copyright 2007. Source: Food Standards Agency. Licensed under the Open Government Licence v3.0.).

Slaughterhouse monitoring was used to complement the in vivo techniques that was carried out on live animals. The monitoring took place at ten slaughterhouses that received sheep from the restricted areas in Cumbria and North Wales. In 1989 more than 11,000 carcasses were monitored at these slaughterhouses. Similar numbers of carcasses were monitored in subsequent years. No meat with activity concentration greater than the action level was detected, thus providing reassurance to the authorities that the Mark and Release monitoring programme was effective and reliable. This also gave farmers the confidence that the Mark and Release programme was effective, and that no contaminated lamb was entering the food chain. Ultimately, this provided consumers with the confidence they needed, in the light of so many other food scares at that time.

The impact of the Chornobyl restrictions on hill farmers as well as the financial costs to MAFF, prompted MAFF to support various independent research projects to look for alternative ways to manage the radiological situation (e.g., Beresford et al., 1999; Nisbet and Woodman, 1999). These involved engagement with a wide range of stakeholders, including face-to-face meetings with the farming community, over an extended period. The evolution of this engagement (latterly known as co-expertise) process is described below (Section 4). However, despite numerous initiatives it was not until 1 June 2012, following a public consultation, that all Chornobyl restricted areas were released from restrictions.

3. The human dimensions of the situation

The initial response from the UK Government took a top-down approach, to inform the affected farming communities about what was happening and what they needed to do. The period between 1986-1990 was the most challenging due to the number of farms and sheep affected. The upland hill farming community has a distinctive traditional cultural identity. Farming upland areas is economically fragile as the land is marginal for cultivation due to poor soils and difficult terrain. Farmers have few if any alternatives to make a living, compared to lowland sheep farming. The normal practice on hill farms is for lambs to be brought off unimproved grazing to improved lowland pasture for a 3-week fattening period before being sold directly for slaughter. In 1986, when farmers were told by Government to keep sheep on the farm until levels of radiocaesium fell, their hill farm system couldn't easily be adapted to cope with this demand, as insufficient pasture was available. In interviews carried out by the BBC (BBC, 2011), one Welsh farmer said, "we were told, and presumed, that the whole issue would be over and done within a matter of weeks or months" and another remarked, "it was a huge battle to get the Government to realise the severity of the problem".

Farmers felt betrayed by bureaucrats and scientists because their own specialist local knowledge and expertise were ignored e.g., farmers were asked to hold on to their sheep which impacted their physical condition and market price (Wynne 1989). Pinpointing the optimum moment for marketing lambs is key to successful sheep farming. Complex craft judgments of trends in prices, rates of finishing of other lambs, pasture conditions, disease buildup, condition of breeding ewes for mating for next year's lambs, need for money (cash flow), and many other dynamic factors partly or fully beyond the control of the farmer, enter into these decisions. It is an informal but highly sophisticated process involving expert judgement, which runs counter to the bureaucratic advice to sell the lambs later. Furthermore, sale of spring lambs provides hill farmers with their only significant yearly income. One farmer from Cumbria remarked, “we were told we could not sell our lamb. This caused problems of cash flow”.

Farmers’ autonomy was undermined by how the restrictions were implemented, i.e., the restrictions required farmers to notify the local MAFF offices at least 5 days in advance of their intention to sell a certain number of sheep and to identify the market. The farmer had to give notice to allow the monitoring session to be scheduled and had to wait with the sheep on the appointed day. The farmers spent extra time gathering and handling sheep which worsened their condition and affected their value. The farmers reflected “It has been a real struggle. Our daily lives are much harder; I can’t just take my sheep to auction”.

In those initial few years after the accident the sheep farmers felt that their social identity as a specialist community with distinct traditions, skills and social relations was under fundamental threat, due to impractical interventions proposed by the authorities (Wynne, 1992). Scientists and MAFF officials were often seen as indistinguishable as one defended the other. Later claims from farmers for compensation encountered the inflexible bureaucratic demand for formal documentation, dates, details, proofs, and signatures that were alien to their own culture.

In the late 1980’s, Wynne (1992) and colleagues carried out in-depth interviews with hill sheep farmers in the restricted areas of Cumbria. From these interviews it became apparent that Government scientists expressed a certainty in their official statements that simply did not ring true with the farmers who were used to adapting to uncertain and unpredictable forces. The degree of certainty expressed in scientific statements, the unqualified reassuring assertions, and failure to admit mistakes led to a lack of trust and credibility amongst the hill farmers. Critical to the experts’ lack of credibility was their inability to recognise that farmers held extensive informal knowledge about sheep habits, the local physical environment, and farming practise and decision making, all of which needed to be integrated with more abstract and formal scientific knowledge to create an effective response framework to the Chornobyl deposition. Nor did the experts recognise the cultural and practical incompatibility of hill farming with the bureaucratic model in which everything is assumed to be subject to standard rules, control, deterministic planning, and formal evidence (Wynne, 1989).

The situation in Cumbria was further complicated by its close proximity to the former Windscale nuclear weapons factory and existing nuclear reprocessing facility at Sellafield, both located on the coast below the upland pastures affected by the Chornobyl accident. Both nuclear facilities were known to have released radioactivity into the environment due to a major fire at Windscale in 1957 (Garland and Wakeford, 2007), and routine discharges from Sellafield. Whilst historic measurements of radioactivity were available for the coastal strip, none had been made in the nearby uplands. It was therefore not surprising that Cumbrian farmers wondered whether the source of contamination affecting their farms was actually from Windscale or Sellafield, not Chornobyl. At this time, their level of trust in Government scientists was very low.

Evidence of a generational divide existed among the affected sheep farmers, primarily concerning differences in their perception of the risks, their trust in official scientific advice, and their views on the long-term impact on their way of life. While acknowledging the difficulties, some of the younger generation, who grew up with the restrictions as a "necessary evil," viewed the testing and monitoring as essential for bolstering consumer confidence in the long-term. Some also showed a greater acceptance of the low-level, long-term nature of the risk, often contrasting their minimal misfortunes with the severe impacts on Ukrainians closest to the disaster. Nevertheless, the prolonged uncertainty and economic fragility of hill sheep farming, partly exacerbated by the restrictions and fluctuating compensation payments, made the lifestyle less appealing to the younger generation. Many children of the original affected farmers chose different professions (e.g., joiner, electrician, chef). This reluctance to continue the family business points to a significant break in the multi-generational tradition of hill farming, driven by the difficulties faced by their parents' generation.

4. The co-expertise process

4.1. *Initial engagement*

It is within this challenging context that, farmers progressively engaged and cooperated with experts, first with monitoring teams through the Mark and Release scheme and then when derestriction surveys were carried out. The farmers appreciated the role and importance of measurements in supporting their farming practices and in maintaining consumer confidence in upland lamb, including several important brands. The farmers assisted the monitoring teams and discussed the measurement results with them, and what the numbers signified and any implications. In this way they felt empowered and that their dignity had been restored.

The farmers also connected with scientists who visited farms for monitoring, sampling, and research purposes. Some of these scientists stayed for several days and engaged in more informal dialogue/ conversations about their scientific research. These ad hoc interactions improved the credibility of these scientists and of their associated institutions, even though such encounters revealed scientific uncertainty. The Institute of Terrestrial Ecology (ITE), a locally based institution gained a reputation among the farmers as being plain speaking, open about uncertainty, independent, and trustworthy. Scientists from ITE lived in the area and understood the challenges faced by upland farming. In the first few years following the Chornobyl accident, a cooperation was progressively built between farmers, local farming union officials, local MAFF officials, local auctioneers and independent scientists from the nearby research establishment. Whilst the credibility of some scientists improved, and a certain level of trust was established with local officials, the opposite was true for MAFF, which was more centralised, hierarchical, geographically, and culturally remote.

Farmers quickly learned to distinguish and evaluate the different institutional affiliations. A deep mistrust remained of central Government which persisted throughout (Wynne, 1989).

Farmers also developed special relationships with representatives of the local farmers' union, local MAFF officials, and local auctioneers, all of whom they knew personally and trusted individually. These local representatives were invaluable in advising on how to manage the restrictions on marketing their lambs and on matters relating to compensation payments and related paperwork. The farmers' union successfully pushed the Government hard for compensation payments for price blight on marked sheep and inconvenience and time required for monitoring sheep.

4.2. *Dialogue on alternatives to the restrictions*

Some 10 years later, with the restrictions still in place, another dialogue with farmers took place, initiated by independent scientific experts from the National Radiological Protection Board (NRPB), a non-departmental public body. The main objective of this initiative was to identify alternatives to the monitoring controls (Nisbet and Woodman, 1999), that not only considered the views of the farming community, but also the wider impact on consumers, environment, and economy. These alternatives included the mandatory use of improved land, the improvement of upland pasture, the provision of clean feed to finishing lambs; the provision of boli containing Prussian Blue to reduce gut uptake of radiocaesium in sheep; and monitoring at the marketplace. This initiative took place in 1997, involving an extended dialogue and a series of face-to-face meetings with hill farmers and their farmers' union representatives, as well as phone calls, correspondence, and meetings with all other interested parties (including Countryside Council for Wales, National Parks Authority, Country Landowners Association, Tir Cymen, MAFF and Welsh Office Agriculture Department). At the end of the dialogue, it was concluded that many of the proposed alternatives were rejected either by the farmers themselves or other stakeholders, due to the environmentally sensitive nature of the areas, the negative impact on the image of upland lamb as an "organic product", low cost-effectiveness or limited applicability on a large scale (Nisbet and Woodman, 2000). Consequently, sheep restrictions remained in place.

4.3. *Revisiting the risks to consumers*

Questions on the duration of the restrictions continued to be raised by farmers, farming unions and the livestock trade. The Food Standard's Agency (FSA), that had taken over Government responsibility for food safety, reviewed its policy relating to the Chornobyl restrictions during its routine review cycle. As part of this review, the use of the current limit of 1,000 Bq per kg, as a measure of risk was reconsidered. Using a fixed limit of contamination in effect considers that sheep above 1,000 Bq per kg are unsafe and sheep below that level are safe to eat. International guidance published by the International Commission on

Radiological Protection (ICRP, 2007; ICRP, 2009) reinforced the view that protection from radioactivity should consider the actual risk to individuals (measured as the effective dose, expressed as milli Sieverts, mSv) rather than purely relying on a fixed limit of contamination. Therefore, the FSA with the help of independent consultants, carried out an updated risk assessment to consider the actual risk to consumers from eating lamb originating in the restricted areas (Wells, 2011; Field, 2011), noting that ingestion of lamb was the only exposure pathway of significance. During the summers of 2010 and 2011, extensive monitoring surveys were carried out in the restricted areas of Cumbria and North Wales, immediately that the sheep were taken off the upland pasture (this is when radiocaesium levels in lamb are at their peak). The data gathered were used to assess the risk to consumers. The risk assessment calculated the likely dose to the more highly exposed individuals (the so-called representative person). From these results it was concluded that the risk to consumers would be very low, following the lifting of all restrictions. The doses to the representative person range from <0.05 to 0.21 mSv per year with an average dose of less than 0.09 mSv per year. This is considerably below the 1 mSv per year reference level typically used in long-term exposure situations, and the 1 mSv per year limit for members of the public exposed to radiation from routine planned exposures (e.g., nuclear site discharges).

4.4. *Stakeholder workshop*

The findings from the dose assessment were widely disseminated among the farming community and in August 2010 were discussed at a stakeholder workshop attended by individual hill farmers, National Farmers' Union, Farmers' Union of Wales, Hybu Cig Cymru (Meat Promotion Wales), FSA, Department for Environment, Food and Rural Affairs, Rural Payments Agency, and independent radiological protection experts (Health Protection Agency, Centre for Ecology and Hydrology). The meeting was to gather information on which to base policy options. The format was a combination of presentations, plenary discussions and break out groups.

A range of alternative monitoring protocols were discussed at a stakeholder meeting. These were monitoring at the marketplace or slaughterhouse; monitoring sheep for sale or slaughter only; monitoring a representative sample of sheep (e.g., 10% of each movement). The conclusion, after discussion, was that all these alternative monitoring protocols were unsuitable for a variety of reasons (e.g., lack of control or opportunity to remedy the situation; reduced flexibility in marketing practice), as well as the very low risk to consumers of meat from the restricted areas.

Stakeholders identified the following factors that needed to be considered before the restrictions could be lifted: health risk; impact on consumer confidence; impact on the market value of sheep; cost; the decision-making process; and the method of communicating the decision. Overall, consumer's perception of health risk was the most important single factor. What consumers tolerate in terms of risk is down to the comfort they receive from the information presented to them. It was felt important that there should be robust evidence that lamb was safe to eat, that there was agreement among experts that this was the case. However, given that the topic is both complex and sensitive, the way this message needed to be communicated to consumers was very important, to prevent misunderstanding. Handled badly, there would be a risk that the product could be devalued, should media reports convey either the wrong information or misinterpretation of the facts. A clear and unified approach to communication was felt necessary to maintain confidence in the meat industry, that had developed several important brands which needed to be protected. There was a need for all stakeholders including the FSA, other Government and non-Government experts, farming unions and the meat industry to work together to produce a series of consistent messages.

4.5. *Public consultation*

The outcomes of the stakeholder workshop and informal discussions with farming unions, meat industry representatives and radiological experts, were used to inform a public consultation document that was launched by the FSA on 17 November 2011 (FSA, 2012). The FSA asked consultees for any evidence that would alter the assessment that the risk to consumers of lamb from the restricted areas was low. The overall objective was to ensure that the removal of restrictions was risk based, proportionate and that consumer safety was not compromised. In particular, FSA asked for feedback on the cost: benefit analysis that had been undertaken and whether any information on other costs or benefits had been missed. The FSA received 15 responses to its 12-week UK-wide public consultation from a variety of organisations, including the farming unions, meat industry, Health Protection Agency and Cumbria County Council. Individual farmers from the restricted areas also responded. The results of the public consultation are given below.

5. Evolution of the co-expertise process

In the years following the Chornobyl accident, the co-expertise process evolved, and relationships between almost all stakeholders were much improved, although a deep mistrust of central Government remained. The co-expertise was built between the upland hill farmers and their farmers' union representatives, local MAFF officials, local auctioneers, and a range of independent scientists who visited the restricted farms regularly. Involvement with local representatives, familiarization with the monitoring program and ability to discuss the results, all helped to regain the farmers' dignity and empowerment, slowly attitudes changed.

A wider network of stakeholders also became engaged in the process, as the affected farms were in areas of outstanding natural beauty, and some were within Snowdonia National Park in North Wales; some alternatives to the restrictions had the potential for adverse environmental impact. Furthermore, the reputation of upland lamb as a high quality, much sought after product, led to engagement with meat industry representatives such as Farm Assured Welsh Livestock and the National Sheep Association to voice concerns over some of the proposed interventions. Ultimately, the co-expertise process in the first 20 years after the Chornobyl accident, overwhelmingly favoured maintenance of the status quo, that is continuing the Mark and Release scheme, whereby every sheep from the restricted area was monitored prior to being sold or slaughtered. Publication of recommendations by ICRP in 2007 and 2009, challenged this approach.

Reference levels (in terms of annual effective dose) were considered to be the more appropriate radiological criteria to use when optimising consumer protection in the longer term. Previously, action levels (in terms of activity concentration in a foodstuff) had been correctly applied in the immediate aftermath of the Chornobyl accident and then retained without question, in the years that followed. Furthermore, new models to better understand risks to consumers based on measurement data were developed, supported by intensive monitoring surveys of sheep in restricted areas. The doses to the representative person were predicted to be well below the reference level recommended by ICRP (2009) for the long-term phase after a large nuclear accident. Consequently, FSA and other independent bodies with an interest in food safety, considered that (i) the restrictions were no longer proportionate to the very low risk, (ii) that they were ineffective at further minimising the already low doses and (iii) that by removing controls, consumer safety would not be compromised.

Responses from the public consultation were published on 20 March 2012 (FSA, 2012). FSA's final evidenced-led conclusion was that removing controls would not compromise consumer safety. The FSA Board supported the conclusion and all Chornobyl-based restrictions on sheep in the UK were removed on 1 June 2012. The responses were generally supportive of the risk assessment and agreed with the conclusions that there was a very low risk to consumers and that controls were no longer required to protect consumer safety. However, a few Welsh farmers were concerned that consumers may not understand the discussion about risk, and as a consequence, the reputation of Welsh lamb could be damaged. FSA officials attended meetings with farming union officials and farmers in North Wales, both before and during the consultation period. Feedback from these events stressed the need for a carefully constructed consumer engagement process to accompany the removal of controls, which was seen as vital to mitigate or respond to negative portrayals in the media.

The public consultation received coverage in both the local and national media, including prime-time national TV. The FSA received no adverse comment from consumers. In implementing the policy, FSA continued to reinforce the message that risk to consumers was very low and removing controls would not compromise consumer safety. FSA continued to work with the farming unions and meat industry on a joint platform and provided information and comment in their publications in order to provide context to explain the very low risk. Feedback indicated that more could still have been done to explain the relationship between activity concentrations (Bq per kg) and risk.

In the years after the Chornobyl accident, the UK Government became increasingly aware of the need to engage with stakeholders on all matters relating to food safety. In light of the farmers' experience following the post-Chornobyl sheep restrictions, scientists from NRPB recommended that a stakeholder group be established to develop strategies for managing agricultural land following a radiation emergency. In 1997, the Agriculture and Food Countermeasures Working Group (AFCWG) was established (Nisbet and Mondon, 2001), comprising a wide range of Government and Non-Government Organisations, the latter encompassing consumer and environmental groups, retail trade, producers and processors, and farming unions. Subsequently, based on the success of the AFCWG and with funding from the European Commission, the concept was extended through the FARMING project to other European Member States (Nisbet et al., 2005).

6. Main lessons learned for the co-expertise process

The experience of the UK sheep farmers affected by Chornobyl restrictions, was not, at the start, a co-expertise process. Over the years a co-expertise was developed between the farmers, local officials, and experts, and during this period many lessons were learned, which are further discussed below.

i. As soon as the upland areas of the UK were known to be affected by Chornobyl deposition, there needed to be recognition from central Government that the farming community in those areas had something valuable to contribute and were worthy of acting as co-experts with the authorities. There was a need for the authorities to engage sooner not only with the farming community but more widely as many stakeholders were affected by the restrictions. The considerable disruption and pain suffered by those affected in the first year would have benefited from a more empathetic approach from Government representatives. Regular engagement is key and unfortunately too many years were allowed to elapse between different initiatives. Nevertheless, through the involvement of local officials and independent scientists, relationships were progressively rebuilt, and a certain level of trust was established with the authorities.

ii. Government officials and scientists needed to admit uncertainty (e.g., on the timescales for when the restrictions could be lifted) and be humble and open to other sources of local information and knowledge. At the time of the Chornobyl accident, there was a deeply embedded assumption that lay people couldn't handle uncertainty and risk, which resulted in false reassurances from Government about the situation. Communication was perceived by farmers as an add-on to decisions that were made, providing post-hoc explanation and justification. A better approach might have been for officials to acknowledge that their backgrounds were not sufficient to address the complexity and challenges posed by radioactive contamination of upland sheep farms. The value of farmers' own expertise and local knowledge needed to be recognised and integrated into the response to the mutual benefit of all parties. Farmers' expertise is not written down but passed on orally and by apprenticeship from one generation to the next, as a craft tradition. This required experts to listen and learn from the farmers, to get to know them and their practices and to demonstrate commitment to improving their situation in the long term.

iii. The process that was used to assess, and then dismiss, a range of alternative approaches to the long-standing sheep restrictions, worked well. Dialogue with a range of stakeholders including the farming community, provided a broad spectrum of views that enabled a robust decision to be made, taking into account not only radiological concerns but also protection of the environment, and maintenance of economic and societal activities.

iv. The decision to take a more holistic approach to risk was fundamental in removing the sheep restrictions. In particular, moving from an initial approach based on activity concentrations in lamb to an approach based on estimating effective dose to consumers of lamb, provided a more reliable indication of risk in the longer term. Nevertheless, this new approach needed to be explained and communicated more clearly and perhaps more done in terms of education and training of a wider audience. The holistic approach to risk not only considered the impact of ingesting contaminated lamb but also took into account the social disruption caused to farmers by the restrictions, the economic cost to farmers and Government from enforcing the restrictions, and the environmental impact of the alternative protective actions that were proposed. This ensured doses were kept as low as reasonably achievable.

In conclusion, collaboration between farmers, local officials, independent scientists, and others over a period of many years enabled a co-expertise process to be developed. Measurements were a key element of this process that enabled consumer confidence to be maintained at a time when other food crises questioned the credibility of the Ministry of Agriculture, Fisheries and Food, and the quality of food in the UK. Involving farmers in the taking of measurements and in the subsequent discussion of the results brought empowerment and dignity. Furthermore, the co-expertise process was able to lessen the impact of the Chornobyl restrictions in the UK, maintain sheep farming in the affected areas, and after a period of 26 years, to enable farming practices to return to normal.

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PART II
THE CO-EXPERTISE PROCESS IN PRACTICE: THE FUKUSHIMA EXPERIENCE

5
The Kawauchi co-expertise experience in Japan after the Fukushima accident

Makiko Orita[1], Noboru Takamura[1], Hitomi Matsunaga[1], Yuya Kashiwazaki[1]

Abstract

How residents, local governments and specialists can work together to rebuild daily life and local communities after a nuclear disaster is a major challenge worldwide. In situations involving radiological risks, scientific knowledge is often complex and uncertain. This chapter describes the co-expertise process of the Kawauchi Village after the Fukushima Daiichi Nuclear Power Plant accident with the support of activities carried out by a team of professionals and researchers from Nagasaki University. These activities involved several interconnected processes, such as dialogues between experts and residents, sharing measurement data on radiation collected in the affected areas, support for residents and local authorities' decisions and actions to improve their protection and living conditions, and the provision of recovery assistance that respects local culture and ways of life. The aim of this chapter is to present practical examples of how co-expertise is formed and to help readers understand how experts, local governments, and residents can work together following a disaster.

Introduction

On March 11, 2011, the Great East Japan Earthquake struck eastern Japan with unprecedented force. Although Kawauchi Village is located in a mountainous area at mid-slopes of the Abukuma Highland, it suffered no direct damage from the earthquake itself (Figure 1). None of the approximately 3,000 residents of the community were injured, and no buildings collapsed, but the ensuing

[1] Department of Resilience and Disaster Science, Atomic Bomb Disease Institute; Nagasaki University, Japan

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accident at the Fukushima Daiichi Nuclear Power Plant located about 20-30 km from the village profoundly altered the life of the community. The situation at the nuclear power plant was not immediately clear after the earthquake and the tsunami. It was only on the following day that village authorities became indirectly aware of the severity of the accident, when the mayor of Tomioka Town — where the nuclear power plant is located — asked whether Kawauchi could temporarily accommodate evacuees from Tomioka.

FIGURE 1. Location of Kawauchi village in relation with the Fukushima Daiichi nuclear power plant (FDNPP) (photo: Makiko Orita).

Kawauchi Village opened all available facilities, including community centers, schools, and sports halls, to receive evacuees. Nevertheless, the sudden arrival of approximately 17,000 people quickly exceeded the village's capacity. On March 14, following the explosion of the third reactor and government instructions for residents living within a 20-30 km radius to remain indoors, severe supply shortages made it impossible for daily life to continue. As a result, all residents of Kawauchi Village and Tomioka town were evacuated by bus to the Big Palette Convention Center in Koriyama City, about 60 km away. This marked the beginning of a prolonged evacuation period and the initial phase of a recovery process that would later unfold.

For several months thereafter, the village remained almost completely silent. Daily life disappeared, houses were left unattended, and farmland became overgrown with weeds. Apart from occasional patrols by police, the Self-Defense Forces, and utility vehicles, there were few signs of human activity. As one resident later recalled, "No one came to Kawauchi other than cats and dogs". This prolonged absence symbolized not only physical devastation but also the uncertainty surrounding the village's future.

By early summer 2011, information gradually emerged indicating that radiation levels in Kawauchi Village were relatively low compared with those in other municipalities closer to the plant. At the same time, many evacuated residents expressed a strong desire to return to their homes as soon as possible. Faced with these voices, the Mayor of Kawauchi, Yuko Endo, convened village office staff to discuss whether and how a return might be organized. Key questions quickly arose what information should be provided to residents, how risks should be explained, and what conditions would be necessary to make return feasible. Discussions with the Ministry of the Environment regarding decontamination and waste management were also initiated.

From September 2011 onward, as government restrictions were gradually lifted in areas beyond 20 km from the nuclear power plant, the municipality organized a series of explanatory meetings for residents. Paradoxically, however, the more meetings were held, the more anxiety seemed to grow. Scientific explanations and numerical indicators alone did not necessarily reassure residents; instead, they sometimes intensified fears and confusion. Recognizing this dilemma, Mayor Endo began to question whether an early return should be postponed, despite initial intentions.

The return of Kawauchi Village was officially announced at a press conference on January, 2012. Importantly, the choice of whether to return was left to individual residents, and large-scale decontamination and mutual understanding were identified as prerequisites. At this critical juncture, support was sought from Nagasaki University to assist with evaluating radiological conditions and decontamination efforts. The experience of Kawauchi Village thus raises a fundamental question addressed in this chapter: how can residents, local authorities, and experts work together to make informed decisions and rebuild everyday life under conditions of uncertainty? The following sections describe how a co-expertise process gradually emerged in Kawauchi Village through dialogue, measurements of radioactivity, and sustained engagement, and how this experience later informed recovery efforts in neighboring municipalities.

1. Dialogue activities

In December 2011, following the government announcement that the Fukushima Daiichi Nuclear Power Plant accident had been brought under control, Kawauchi Village began preparing for the early return of its residents. As environmental monitoring progressed, it became evident that levels of radioactive cesium contamination in Kawauchi Village were relatively low compared with those in other municipalities within the restricted zone. Based on this information, Mayor Endo and the village administration began considering the possibility of organizing the residents' return. This decision was strongly influenced by lessons drawn from areas affected by the Chornobyl nuclear accident, where prolonged evacuation had led to long-term disruption and weakening of local communities. These experiences suggested that, when radiological conditions allow, delayed return itself can become a major obstacle to recovery. Against this background, the Fukushima Prefectural Government facilitated contact between Kawauchi Village and researchers from Nagasaki University, who had long-standing experience in radiation health risk management and post-Chornobyl studies (Takamura et al., 2021).

Rather than providing directives, Nagasaki University was asked to support the village by evaluating radiological conditions and assisting in communication with residents during an extremely uncertain period (Figure 2).

FIGURE 2. Meeting with residents of Kawauchi (photo: Makiko Orita).

As noted in the introduction, explanatory meetings held from late 2011 onward revealed a fundamental limitation of one-way communication. Scientifically sound data alone did not necessarily reduce anxiety, as many residents struggled to connect numerical indicators with their own living conditions. This realization marked a turning point, highlighting the need for dialogue grounded in residents' everyday experiences rather than abstract standards. While residents actively sought information, many were less concerned with abstract standards than with how radiation might affect their own homes, food, children, and daily routines. Questions increasingly shifted from general safety thresholds to highly specific concerns rooted in lived environments. Through this process, it became clear that effective recovery required more than the transmission of expert knowledge. Dialogue needed to evolve into a form of engagement that acknowledged residents' perspectives, uncertainties, and values. This recognition marked an important turning point in the relationship between Kawauchi Village authorities, its residents, and Nagasaki University. Dialogue was no longer understood merely as explanation, but as a mutual process of listening, contextualizing information, and building trust over time. This shift laid the foundation for subsequent activities, including individualized measurements and the introduction of a public health nurse who could engage directly with residents in their daily lives. Together, these efforts transformed dialogue from a preliminary step into a core component of the co-expertise process that would continue to develop throughout Kawauchi Village's recovery.

2. Measurement activities

Following these developments, decontamination work began in Kawauchi Village. In December 2011, Professor Takamura made his first visit to the village, accompanied by medical students from the university. They took soil samples, measured radioactive cesium concentrations, and estimated radiation doses for residents after their return (Taira et al., 2012). At that time, the village was quiet, even during the daytime, with few signs of daily life. Untended farmlands were covered with weeds, symbolizing the difficulty of reconstruction.

The soil samples they collected were later analyzed at Nagasaki University, and the results were reported to Kawauchi Village Office staff, who were still working from their evacuation premises in Koriyama City. The analysis showed that radioactive cesium concentrations had decreased significantly due to decontamination efforts. Based on these findings, it was concluded that external exposure to homes after residents' return would be extremely limited and that returning to the village was feasible. Discussions also took place regarding the safety of the groundwater used for drinking and appropriate methods for risk communication with residents concerning radiation exposure. Staff from the village office evaluated these findings, as the data needed to make a final decision on returning. In January 2012, Kawauchi Village officials declared their intention to return.

Professor Takamura also decided that he would hold explanatory meetings, both in the village and in other locations, in step with the residents' planned return in March 2012.

There was one more thing that he emphasized, in terms of measures for reconstruction support: providing information about radiation risk corresponding to each resident's personal circumstances by being closely involved in the life of the village. Around this time, many residents began to respond in ways that differed from their reactions during the initial phase following the disaster, particularly when the first crisis communication meetings were held. Now, they often referred to doses at the meetings, saying things such as, "This place showed a high dose", or "This place did not show a very high dose", based on measurements they themselves had taken inside and outside their homes using their personal dosimeters. The problem was that people referred to values without fully understanding what they really meant. The most typical example was one of "0.23 μSv per hour". Most of the residents in the Fukushima Prefecture had learned this value well since the accident, as it was the one the Minister for Reconstruction set as a goal for decontamination. So, what did these values mean? Professor Takamura presumed that, unlike today, when such information is ubiquitous, hardly anyone understood these notions correctly. It is said that 0.23 μSv per hour is an ambient dose equivalent rate, which equals an annual dose of 1 mSv under certain everyday conditions (Ministry of the Environment, 2013). Further, negative health effects do not always appear, even when a value exceeds this number. Nevertheless, a previous study revealed that many people believed a person living in a place with an ambient dose equivalent rate exceeding 0.23 μSv per hour for one year would certainly experience negative health effects. This confusion originated during the initial period after the accident, when the publicly announced, yet misleading, information set the radiation protection standard at 1 mSv for protecting the human body from radiation. People were treating exposure levels that cause health effects and the 0.23 μSv per hour value as if they were the same; this misunderstanding continues to cause confusion among people to this day (Orita et al., 2015).

3. Local project activities

Building on the dialogue-based approach described in the previous section, local project activities in Kawauchi Village focused on close engagement with residents' everyday living environments.

In response to residents' concerns, a public health nurse was dispatched to the village in collaboration with Nagasaki University. Makiko Orita, a newly qualified public health nurse who had graduated from Nagasaki University's School of Health Sciences and was working at a hospital while doing research in Professor Takamura's laboratory as a postgraduate in the Master of Nursing program, was chosen for the role. At the end of March 2012, Nagasaki University and Kawauchi village agreed that Ms. Orita would be stationed in the village for the month of May 2012 as a trial, in response to residents' concerns about radiation exposure and its health effects. They expected that having a young female public health nurse who could consult with residents while living in the village herself and eating the same food as the residents would inspire more confidence in these efforts than anything else could. Public health activities conducted by local public health nurses generally cover a wide range of fields, including maternal and child health, elderly and mental health care, community health promotion, and infectious disease control. Within this broad scope, Ms. Orita primarily took responsibility for radiation-related public health activities in Kawauchi Village, which pursued early return after the nuclear accident. In practice, much of her work involved visiting residents directly in their homes and responding to individual concerns (Figure 3). Residents frequently asked questions such as whether it was safe to drink local water or eat rice, and whether children could touch insects... In addition to home visits, she participated in various resident meetings organized by the village, including gatherings for evacuees and discussions on future land use, where she responded to questions related to radiation and health whenever they arose. When personal dosimeters were distributed to residents through a donation program, Ms. Orita also took the initiative to distribute the devices at community centers throughout the village and to provide explanations on their proper use. Through these activities, she supported residents in understanding radiation exposure in the context of their daily lives. Indeed, living in the same environment and responding directly to residents' concerns greatly contributed to building their sense of security.

FIGURE 3. Mrs Orita talking with a villager (photo: Makiko Orita).

In 2013, Nagasaki University established the Reconstruction Promotion Base (Satellite Office) in Kawauchi Village, creating a system for continuous support from the university. The same public health nurse was stationed in the village for three years and played an important role in developing a new community-based recovery model. For example, one of the most important aspects of radiation protection in Fukushima has been the reduction of internal exposure. Since the early phase of the accident, regulatory limits for food have been established, and a system has been developed to prevent contaminated food from entering the market. However, considering the aftermath of the 1986 Chornobyl accident, it was well-known that radiocesium tends to concentrate in wild mushrooms (Fesenko et al., 2001; UNSCEAR, 2000). At the same time, collecting wild mushrooms in autumn has long been an important cultural practice for many Kawauchi residents. After the accident, information about radiocesium accumulation in mushrooms spread among residents, and questions such as "When will it be possible to collect mushrooms again?" were repeatedly conveyed to the satellite office. In response to these concerns, the Nagasaki University team with the residents initiated the Mushroom Map Project in 2013. Radiocesium concentrations in mushrooms vary depending on factors such as species and collection sites, and many uncertainties remain. The university researchers discussed this with Kawauchi's residents and decided to implement a collaborative study, which they called the "Mushroom Map Project" (Figure 4). They asked the residents to collect mushrooms and indicate the spot of their collection on a map. They then measured the concentration of radiocesium in the mushrooms and prepared a map that included information on the types of mushrooms collected, collection spots, and radiocesium concentration levels (Nakashima et al., 2015; Orita et al., 2017; Cui et al., 2020). The project has been repeated every autumn since 2013. Through continued dialogue with residents, this project developed as a shared effort to better understand and manage internal exposure in everyday life. Through this project, residents' local knowledge and scientific measurements were brought together in a shared process of interpretation, enabling shared interpretation rather than one-sided risk communication.

FIGURE 4. Kawauchi residents collecting mushrooms (photo: Makiko Orita).

A particularly illustrative example of co-expertise can be found in the experience of Mr. Toshio Jindo, a resident of Kawauchi Village. Mr. Jindo worked for many years at a company in the Tokyo metropolitan area. After his retirement, he chose to relocate to Kawauchi Village, attracted by its rich natural environment. A few years later, however, he experienced the Great East Japan Earthquake and the subsequent nuclear accident as a resident of the village.

In 2013, when the area where Mr. Jindo lived was still designated as an evacuation zone, Kawauchi Village was preparing for the lifting of the evacuation order. During this transitional period, Mr. Jindo returned to his home earlier than most residents. At that time, staff from Nagasaki University met him and provided radiation dose measurements and individual health consultations for residents who were considering returning. This early return highlighted both the uncertainty surrounding radiation exposure and the difficulty of making decisions based solely on generalized information. Kawauchi Village is surrounded by forests, while decontamination efforts were largely limited to residential areas and land surrounding cultivated fields. As a result, a large part of the surrounding natural environment has not been decontaminated. Mr. Jindo questioned whether explanations based only on average or representative values could convincingly address the concerns of residents and visitors, especially in a landscape dominated by forests. He recognized that reassurance required objective, site-specific evaluation rather than abstract statements about safety.

Based on this understanding, Mr. Jindo began measuring radiation doses himself and actively emphasized the importance of objective evaluation grounded in actual living spaces. His activities were not driven by protest or political advocacy but by a desire to understand the environment in which he lived and to share that understanding to others in a credible way. In response to this local initiative, Nagasaki University began cooperating with him in radiation dose measurements, sharing methodologies and interpreting results together. This cooperation represents a concrete form of co-expertise, in which residents' lived experiences and questions guide scientific inquiry, while scientific expertise supports careful measurement and interpretation. Rather than experts unilaterally providing answers, knowledge was developed through shared practice. Mr. Jindo's experience demonstrates how radiation risk communication can evolve from one-way explanation to a process of joint evaluation, contributing to trust-building and informed dialogue within the community.

Approximately five years after the administrative return (around 2017), about 80% of Kawauchi Village's residents had returned. The rice paddies, which had once become overgrown with weeds as tall as an adult, are now filled with water in the spring and covered with ripe golden ears of rice every autumn. These developments suggest that the cooperation with and support from Nagasaki University has contributed to the region's revitalization. Whenever they see a golden carpet of ripe ears, the researchers report feeling very happy to have helped the villagers to return home in safe conditions.

4. Diffusion of the Kawauchi experience

Since 2016, Nagasaki University has also begun supporting the reconstruction of Tomioka Town, another municipality in the Futaba District. In April 2017, a Reconstruction Promotion Base was established in the town, with the aim of applying the experience gained in Kawauchi Village to a different area. Because Tomioka Town had historically played a central role in the Futaba region and maintained close ties with Kawauchi Village, advancing reconstruction efforts there was considered particularly important. Although Tomioka Town faced more complex challenges than Kawauchi Village — such as higher levels of contamination, longer evacuation periods, and greater damage to social infrastructure — Nagasaki University first focused on working with the town to reconstruct its living environment in a way that would support residents' eventual return.

In April 2019, the Tomioka Town Food Inspection Center was established on the premises of the Tomioka Town Office. At this center, radioactive cesium concentrations in food are measured, and residents can consult staff about radiation-related concerns and uncertainties. Food monitoring is conducted using non-destructive testing methods, allowing radioactive cesium concentrations to be measured within approximately ten minutes. The foods brought in by residents mainly consist of agricultural products from home gardens and ingredients collected from surrounding forests, with seasonal variations such as wild edible plants in spring, summer vegetables in summer, and mushrooms in autumn.

The Nagasaki University satellite office was also located within this facility and has continued its activities there. During the waiting period for measurement results, staff from the Nagasaki University satellite office and the town office engage in conversations with residents about radiation, food safety, and everyday life. These interactions do not focus solely on numerical results but provide opportunities to listen to residents' concerns and understand their perspectives in the context of daily living.

This approach — beginning with the measurement of radioactive cesium, identifying residents' needs through dialogue, and thinking together with residents about how to respond — reflects an important lesson derived from the Kawauchi Village experience. Similar activities have since been continuously implemented in other municipalities, including Okuma Town, where residents began returning in 2019, and Futaba Town, where residents began returning in 2022. These efforts demonstrate how the co-expertise approach developed in Kawauchi Village has been adapted and expanded to different local contexts, emphasizing that risk communication grounded in risk assessment is most effective when combined with sustained, place-based engagement.

5. Lessons Learnt

Through these activities, the engagement of Nagasaki University in Kawauchi Village demonstrated a concrete form of "being close to" affected communities. Rather than offering temporary support, this experience highlighted the importance of sustained involvement over time. Continuous presence allowed concerns to be addressed as they emerged and enabled relationships of trust to develop gradually—beyond what short-term interventions could achieve. The role of the public health nurse illustrated how human resources embedded in daily life can sustain trust and support co-expertise beyond technical data alone.

Through its support for Kawauchi Village, Nagasaki University also recognized the importance of developing human resources capable of implementing co-expertise following nuclear disasters, both in Japan and internationally (Takamura et al., 2018). Although standardized approaches to radiation communication exist (ICRP, 2009), the most essential aspect of disaster recovery is the ability to understand residents' concerns and everyday challenges and to respond to them appropriately. While deepening expert knowledge is indispensable, the manner in which professionals engage with residents should be considered a central theme in the training of future human resources.

Building on this experience, Nagasaki University later concluded collaboration agreements with other municipalities, including Okuma Town and Futaba Town, and has continued on-site activities. However, the university team does not assume that the Kawauchi Village model can be directly applied to all municipalities. Each community faces distinct historical backgrounds, social conditions, and future aspirations. While many municipalities encourage residents to return, decisions regarding return cannot be made on the basis of radiation levels alone. Looking ahead, an essential challenge lies in how municipalities and residents can envision their future together and how such visions can be shared and empathized with across the community. Recovery is strengthened when local people themselves can say that the place where they live is safe and acceptable, and when these voices are gradually shared within and beyond the community. In this context, co-expertise should not be regarded merely as a technical activity, but as a process that supports Fukushima's recovery and future-oriented community building. This role must not be overlooked as reconstruction efforts continue.

Conclusion

Many societies worldwide face complex technological and environmental risks characterized by scientific uncertainty, delayed health effects, and profound societal consequences. In such contexts, the Kawauchi case illustrates that recovery cannot be achieved through expert-driven approaches alone. The concept of co-expertise, as practiced in Kawauchi Village, provides a practical framework for integrating scientific knowledge with residents' lived experiences and local values. Through regular dialogue, shared measurements, and resident-participatory projects, expertise became something collectively developed rather than externally imposed. This process not only supported local decision-making, but also fostered resilience within the community.

The recovery support activities described in this chapter demonstrate several key elements of co-expertise, including decision-making regarding planned return based on decontamination data, support for residents in understanding radiation doses provided by a public health nurse, and resident-participatory initiatives such as the Mushroom Map Project. Throughout Kawauchi Village's recovery process, the local government, residents, and researchers from Nagasaki University brought together their knowledge, experiences, and values, forming a culture of shared expertise through regular dialogue. This case therefore represents a textbook example of the co-expertise process and clearly illustrates the dynamics of its implementation, which are often difficult to capture through theory alone.

From an international perspective, the Kawauchi experience underscores the importance of long-term, place-based engagement by academic institutions in post-disaster recovery. Universities can play a unique role by combining scientific rigor with continuity, neutrality, and a commitment to education and human resource development. The experience of Kawauchi Village suggests that such sustained engagement is essential for addressing the enduring challenges that remain long after the immediate phase of a nuclear accident has passed.

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6
The Suetsugi district co-expertise experience in Japan after the Fukushima accident

Ryoko Ando[1], Jacques Lochard[2,3], Thierry Schneider[2,3,4]

Abstract

The article presents the different stages of the co-expertise process, which took place in the community of Suetsugi located about 30 km South from the Fukushima nuclear power plant, to improve radiological protection and the living conditions of the residents. The originality of the process lies in the fact that it was initiated and led by residents of the community with the help of local leaders and volunteer experts. It was also followed regularly by some members of the ICRP. The first part presents the different stages of the process that took place in the community of Suetsugi. The second part draws some lessons from the experience, which has significantly contributed to enriching the formalisation of the co-expertise process in particular with regard to the recovery of social trust and the role and attitude of experts during the recovery phase after a nuclear accident.

Introduction

The Suetsugi community is located on the seashore 27-28 km away south from the Fukushima Daiichi Nuclear Power Plant (FDNPP) and 20 km north from the center of Iwaki City (Figure 1). The village covers only 7.4 km^2. It is made of a valley with rice paddies surrounded by sharp hills covered by forest. The population in March 2011 just before the accident was 479 residents in 127 households of local old families sharing their activities between farming and working

1 NPO Fukushima Dialogue, Iwaki, Japan
2 Nagasaki University, Japan
3 International Commission on Radiological Protection (ICRP)
4 Nuclear Protection Evaluation Centre (CEPN), France

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in the nearby cities of Iwaki and Futaba. Some of the residents were working for subcontracting companies from TEPCO. Some were retirees who came to settle there to enjoy the sea and the nearby mountains.

The tsunami that followed the Great East Coast Earthquake on March 11, 2011 hit Suetsugi, and killed seven persons. On March 13, the municipality of Iwaki City sent a bus to Suetsugi and asked residents to “voluntarily” evacuate the village because Suetsugi was not designated as a mandatory evacuation area by the government. Many residents decided to leave. The government ordered on March 15 people residing in the 20 to 30 km area around the FDNPP to stay confined to their homes. Most of the people followed the order in general but one elderly woman who stayed did not stop her farm work during this period. The government lifted the sheltering order for Suetsugi on April 22. By the end of that month, the government asked residents of the 20 to 30 km area to stop producing the agricultural products voluntarily. Residents started to return to the village about one month after being evacuated. However, most of the young families with young children did not come back.

The months that followed were a difficult period for residents who returned their homes, marked by growing concern due to the presence of radioactivity in their environment for which they had no information and felt completely disarmed. This feeling was largely reinforced by the numerous reports in the media, most often incomprehensible and, moreover, contradictory. It is in this context that a resident of Suetsugi, took the initiative in summer 2011 to undertake with the help of other residents a campaign to measure radioactivity in the village. This event marked the start of what has become over the years an exemplary experience of cooperation between the Suetsugi community and volunteer experts who put themselves at their service. The first part of this chapter describes the different stages of the co-expertise process, which took place in the Suetsugi community. The second part presents the various actions that contributed to disseminating the experience and ensuring its sustainability. The third draws lessons from Suetsugi’s experience, in particular with regard to the conditions and means for the practical implementation of the co-expertise process to address post-accident issues as well as in terms of the role and attitude of the experts involved and the restoration of social trust. It is to mention here that a large part of this chapter is a

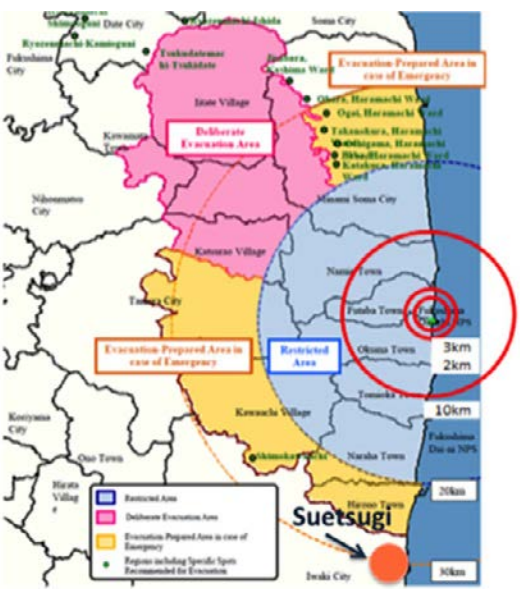

FIGURE 1. Location of the Suetsugi community (photo: Ethos in Fukushima).

revised version of an article originally published in the Radioprotection Journal (Lochard et al., 2020). It reiterates the main points of that article and presents recent developments in relation with the co-expertise process.

1. The initial steps of the co-expertise process

1.1. *The first citizen initiatives*

Very distressed by the deadlock in which he found himself after several months of forced inaction, Shinya Endo, a construction worker also farmer from Suetsugi, took the initiative to launch a measurement campaign to find out where and how much Suetsugi was contaminated. Beyond better understanding the local radiological situation, his objective was primarily to get an idea of the possibilities of resuming agricultural activities in the valley. During the autumn and winter of 2011 using materials borrowed free from Iwaki city hall and with financial support from the Suetsugi ward, he measured, with the help of a group of community volunteers, the ambient dose rates throughout the valley and in particular in the rice fields and around the dwellings. The group also took soil samples, which were measured by a private company. It is to note that at the very early stage of their measurements, several dozens of residents joined the measurement activity, then the number of volunteers had gradually declined. Finally, only 5 or 6 members continued until the end of March 2012.

An initial meeting with residents, organized in collaboration with Ethos in Fukushima (EIF), a civil society association in Iwaki, was held on March 30 and April 1, 2012, with the support of a radiologist from Fukushima Medical University (FMU) (Ando, 2012). The objective was to measure ambient dose rates and discuss the general situation in the village. This radiologist joined voluntarily the process initiated at Suetsugi following an invitation from the founder of the group Ethos in Fukushima. It is interesting to note in passing that they first met on Twitter on the occasion of a meeting concerning the radiological situation in September 2011 before the launch of the collaborative initiative in Suetsugi. It turned out that social media played an important role in the process that followed these first initiatives. The measurement of individual doses started in April 2012 with a dozen personal active dosimeters borrowed from a regional NGO involved in the post-accident activities of Fukushima. Six people initially wore the dosimeters for a period of three to four weeks.

1.2. *The dialogue with ICRP*

The founder of Ethos in Fukushima who had been involved since February 2012 in the ICRP Fukushima Dialogue Initiative, took advantage of the third Dialogue meeting held in Date City to invite an ICRP delegation to visit Suetsugi and meet the residents (Ban, 2016; Lochard et al., 2019). Several dozens of them and representatives of the media gathered at the Community House and they had the opportunity to express their concerns and ask many questions about the radiological situation in the village (Figure 2). What is the risk in Suetsugi? Can our children come to visit us with their children? Can we eat the products from our gardens? Will I ever be able to resume my farming activities? How effective is the decontamination? There was a perceptible tension in the audience and even anger by some participants at the start of the meeting. But a constructive dialogue was gradually established.

Concerning the many questions on the risk, ICRP members explained that ultimately it depends for each person on where they lived, their daily activities and their lifestyle. Without having precise information on the radiological situation of the village, it was difficult for them to answer those questions. They advised participants to take steps to better understand where, when and how they were exposed. They also suggested establishing contact with experts to help them carry out the measurements and interpret the results.

Figure 2. The July 2012 meeting with ICRP in Suetsugi (photo: Ethos in Fukushima).

Following this first visit, ICRP members regularly returned to Suetsugi. From July 2012 to Fall 2025 with an interruption due to COVID-19 pandemic, members of the Commission met with the community 16 times. Each meeting was an opportunity for fruitful exchanges for both parties. Building on Belarus' experience in co-expertise (Lochard, 2013; Lochard et al., 2026), the residents were able to benefit from some useful advice from the lCRP members particularly concerning the process to follow with the measurements of radiation. The latter also took advantage of these visits to enrich their understanding of the mechanisms at work in the process. Residents of Suetsugi participated at the 7th ICRP dialogue meeting held in Iwaki in November 2013. On this occasion, the round table discussion was organized between the community and the ICRP members.

1.3. *The decontamination and waste issues*

The decontamination of Suetsugi was carried out by Iwaki City with the support of the Ministry of Environment of Japan. It started at the end of December 2012 and finished in summer of 2013. Initially eagerly awaited by residents, this decontamination was complicated when it came to storing the contaminated waste on the territory of the community. Since the city of Iwaki owns a wastewater treatment plant in the Suetsugi ward away from the dwellings, it was decided after several meetings with the residents to store the waste near the plant temporarily. However, some residents were very concerned about the potential consequences of this decision on their health. Coincidentally, the ICRP's third visit in March 2013 took place when the decontamination work was already well advanced and the visit to a decontamination site as well as the storage site was organized by the EIF and some volunteers of Suetsugi. This was an opportunity for many residents to ask questions about the effectiveness of the decontamination works and the risks associated with the storage site. Explanations about the design and operation of the storage site as well as on-site measurements about ambient dose rates showing that a few meters away from the bags of waste stacked on the site the dose rate was similar to that of the village gradually reassured the inhabitants. During the debriefing session at the Community House, the ICRP members advised the participants to organize themselves the radiological monitoring of the site.

In autumn 2013, Iwaki City proposed to Suetsugi to also store the fly ashes from the city incinerator in the same storage site. In return, Suetsugi asked the city of Iwaki to provide it with the necessary services to carry out its measurement activities. The negotiation went for several months because Iwaki City was reluctant to specially support Suetsugi which were only a tiny fraction of Iwaki City. The standstill was broken when a member of the support team of the Cabinet Office of Japan for the Fukushima affairs who already knew the Suetsugi's activity through the ICRP Dialogue came to Iwaki City Hall to negotiate with the municipality. At the end of the meeting, the city of Iwaki agreed that the national budget intended for reconstruction projects in the area devastated by the nuclear disaster would be used for Suetsugi's activities. In exchange for the reception of the ashes of the incinerator, the Suetsugi community finally received the financial support for D-Shuttle personal cumulative dosimeters recording dose per hour (Chiyoda Technol, 2018; Naito et al., 2026) and the surveillance of the site by independent experts: Dr Miyazaki from FMU and Prof Yoshiyuki Mizuno, a professor of nuclear physics from Kyoto Women's University, who engaged in dissemination of information on radiation risk after the accident (Mizuno and Ando, 2012).

Later on, ICRP members visited several times the waste storage site together with residents and had the opportunity to discuss and analyse with them the measurement results for both the decontamination waste and the fly ashes. It is worth to note that the residents kept monitoring the ambient dose rate there twice per week for five years until the fly ashes were transferred. All this experience has shown that it is possible to involve residents concerned with the storage of low-level radioactive waste in the decision-making process concerning their future but also in their radiological monitoring. It is remarkable that after having assessed the risk associated with the storage of decontamination waste, the residents used their know-how to negotiate the reception of additional waste. Finally, all the decontamination waste had been transferred to the interim storage site in Futaba and Okuma and fly ashes to the final disposal site in Tomioka by the beginning of 2020.

1.4. *The whole body measurement campaigns and the food product measurements*

In April 2013, the first whole body measurement campaign was organized by the Suetsugi community and EIF with the help of Dr Makoto Miyazaki. 124 residents, young and old, men and women, took two chartered buses to go to Hirata central hospital in the Fukushima Prefecture about 60 km away from Suetsugi. At a meeting in May, they discussed the results of the campaign. Despite the wide variety of lifestyles and eating habits, radioactive caesium levels were below the detection limit in most people. It was a good surprise for the participants. In view of the results, many of them, reassured, decided not to continue the whole-body measurements.

The second campaign was organized in October 2013, with subsequent campaigns continuing about twice a year until the end of 2016. Results showed a drop in the number of detectable doses as well as the levels of contamination. Despite the implementation of the internal contamination measurement campaign and its first rather encouraging results, residents still remained concerned with local products, including products from the forest, which were very popular before the accident. Among other consequences, their quality of life had deteriorated, as they have had to give up offering their children, grandchildren or relatives the products they had grown themselves or picked in the forest, This persistent concern led the EIF and some volunteers of Suetsugi who were promoting the co-expertise process to organize a session of measurements of food products from the gardens at the occasion of the fourth visit of ICRP members in July 2013. It was an opportunity to discuss the radiological quality of the products according to their provenance: shops, vegetable gardens, forest. Participants to the meeting asked questions about the interpretation of the values observed for potassium 40 and caesium 134 and 137 and why most results of whole-body measurements were below the detection limit. They also inquired about the possible reasons for a few results being above the detection limit, the effectiveness of changing diet and the comparison with the results in Belarus provided by the ICRP members. The session ended in a heart-warming atmosphere with a meal prepared with the food products that had been measured.

A year later, at the occasion of their fifth visit in May 2014, ICRP members discussed once again the results of whole-body measurement and the impact of individual choices related to diet. A resident lady explained that her husband had recently returned to the forest to pick up bamboo shoots that were his favorite. After measuring them and despite a moderate contamination, he nevertheless decided to eat them thus balancing his anxiety about the radiation and his desire to taste the fresh bamboo shoots, which he is very fond of. The ICRP members advised the lady to ask her husband to participate in the next whole body measurement campaign to verify the impact of the bamboo shoot season on his internal contamination. This anecdote made it possible to highlight the importance of individual measurements of radiation to restore self-confidence in affected people. Incidentally some participants referred to families who had not returned to Suetsugi because of concerns about potential risks at the NPP.

1.5. *The D-Shuttle experience*

In April 2014, Chiyoda Technol Corporation loaned 30 D-Shuttle dosimeters to the Suetsugi community. Neither the city of Iwaki nor the government was involved in this initiative. Residents carried out measurements through the intermediary of Prof Hayano, a nuclear physicist from the University of Tokyo, who became involved with the population of Fukushima Prefecture after the nuclear accident (Hayano, 2015). In January 2015, Iwaki City and the Suetsugi community officially signed an agreement and decided to lease the D-Shuttle for a fee (see Section 3.7). The contract was to rent 100 units for a year. Therefore, for the period from January 2015 to April 2016, a total of 115 units distributed to almost every household were in operation in Suetsugi. The measurements revealed exposure levels lower or slightly higher than 1mSv per year.

This initiative had a considerable impact. Not only was each resident able to know her/his individual external exposure, but moreover thanks to the explanations of Dr Miyazaki she/he was able to understand on what occasions this exposure was received (Miyazaki, 2017). They discussed the results of the measurements together at meetings in the Community House, which allowed the community to gradually become aware of the role of lifestyles on the exposures and thus to establish a direct link with their daily actions (Ando, 2016). From there the atmosphere within the community evolved, and the residents became more self-confidence and serene as evidenced by the testimony below.

1.6. *Resumption of the full Suetsugi festival (spring 2014)*

The community of Suetsugi used to organise a festival every first weekend of April, the highlight of the ceremony taking place on the beach when a group of people supporting a portable shrine enters the sea. After the accident in March 2011, the annual festival was cancelled because Suetsugi was under the government sheltering order. However, already in spring 2012 the residents decided to resume the festival partly, skipping the beach ceremony because of the destruction caused by the tsunami. In April 2014, the residents were able to resume the full festival (Figure 3). with the final ceremony on the beach. This was an important step in rebuilding social ties in the community, although many of the young evacuees were not present. ICRP received an official invitation to participate to the April 2016 Suetsugi festival.

FIGURE 3. The Suetsugi Festival (photo: J. Lochard).

1.7. *The Suetugi project*

The idea of bringing together the various measurement activities developed so far in a coherent project has slowly taken shape over time. After a visit to Belarus organized in October 2011 on the sidelines of the ICRP dialogue initiative, it was realized that a key element in consolidating the involvement of residents would be the establishment of a food measurement centre along the lines of the radiological quality control centres which had been established within the framework of the CORE program in the district of Bragin in Belarus (Lochard, 2026). The challenge was to find a room and a person to take the measurements, but this remained difficult to implement without a sufficient budget. What started as voluntary activities got finally funding from January 2015 for a whole package, called the "Suetsugi Project" including:

- the distribution of D-Shuttle dosimeters to the community;
- a half-yearly whole body counter campaign;
- the support of a part-time counsellor in charge of measurements;
- weekly foodstuff measurement sessions at the community centre;
- the publication once every four months of a newsletter;
- the scientific and technical support from Fukushima Medical University (FMU) experts.

Thanks to this framework, residents could go once a week to the community centre to measure their food products and speak with Ms Maiko Momma, a resident of Yotsukura near Suetsugi, hired as a consultant by the project. Her role was not only to carry out the measurements of the samples brought by the residents, but also to provide them with information on the radiological quality of the local products and to answer questions related to the external and internal exposures in Suetsugi.

The newsletter, Suetsugi Dayori (Suetsugi News), was distributed to share the measurement results and general information on the life of the community with all residents. Also, it was to keep contact with those who had left the community after the accident and who started a new life elsewhere. 15 newsletters had been published from 2015 to 2020.

The project was able to receive financial support from Iwaki City between January 2015 to March 2017 and from FMU between April 2018, and March 2020. Finding these supports was not easy, which costed a lot of time and energy. It is thanks to their obstinacy and the quality of their activities, recognized by many national and international experts, that the inhabitants of Suetsugi were finally able to benefit from supports that met their wishes.

2. The diffusion and transmission of experience

2.1. *The "local radiation consultants"*

Suetsugi's experience, which was communicated at a very early stage through the ICRP dialogue initiative in Fukushima, had a direct influence on the Japanese policy regarding sustaining recovery of the affected people. Members of the Japanese Cabinet Office support team who attended an ICRP dialogue meeting in July 2012 visited Suetsugi on several occasions. The idea of the "local radiation consultants" system to support the residents in the affected areas, which appeared in the "Basic Policy on Measures Security and Safety upon Return", promulgated by the government in autumn 2013, was directly inspired by the activities undertaken by the community of Suetsugi (Arima, 2016). This system was intended to play a central role in informing and advising people on radiological protection matters in areas where evacuation orders were lifted. A major challenge encountered in the practical operation of the system concerned how to train and develop the consultants. When implemented as an administrative programme, it was difficult to adopt a trial-and-error approach of the kind used in Suetsugi. Moreover, administrative bodies tended to expect consultants to perform their roles perfectly well from the very beginning — an unrealistic demand in practice. In an effort to improve the competence of the consultants, meetings were held by the Ministry of the Environment which is responsible for the system on a continuous basis to promote exchanges among those engaged in the consultant system across the municipalities, which included practitioners in the field. From the Suetsugi community, the key local leaders participated in these meetings. However, despite similarities in approaches to radiation-related issues, the institutional challenges faced by the administratively led consultant systems differed in many respects from those encountered in Suetsugi, which had developed from a grassroots, non-governmental initiative. The ways in which these challenges were addressed also diverged accordingly.

2.2. *The Suetsugi video*

On two occasions — September 2016 and August 2017 — students from the Phoenix Leader Education Program for Renaissance from Radiation Disaster at Hiroshima University carried out fieldwork as a part of their course in Suetsugi. Welcomed at the Community House, the students listened to presentations on the events that followed the tsunami and the nuclear accident, as well as the radiological protection activities undertaken by the residents. Then, they visited the village, including the newly constructed breakwater to protect the village from tsunami risk, and the radioactive waste storage site. Back at the Community House, they attended a food contamination measurement session before taking part in a dialogue with residents, who shared their personal experiences of the accident and its aftermath. These exchanges were marked by detailed explanations and a strong willingness on the part of the residents to convey the experience that had been collectively emerged within the community.

It was on the occasion of one of the students' visits that the idea producing a video on the community's experience emerged. The video entitled "Regaining Confidence after the Fukushima Accident: the Story of the Suetsugi Community" was shot with members of the community and was uploaded to YouTube in 2018 in three versions: Japanese, English, and French (Miyai et al., 2018). It begins with a reminder of the triple disaster and then describes the stages of the co-expertise process. To this day, it remains the most precise testimony of what occurred in the community, concluding by highlighting how the community regained a certain sense of serenity and confidence (Figure 4).

As a resident expressed it very well, "After everything, I'm no longer in fear. I won't use the word 'security'... it's more like a peace of mind". Concerning confidence, a resident said in the video "That we are not forgotten, someone cares for us that makes a difference. I'm not alone, there's someone I can trust... An actual human being, not something you read in a book".

FIGURE 4. The Suetsugi video[5] (photo: Yu Miyai).

[5] English version: https://www.youtube.com/watch?v=L_ZhjixM6oM
Japanese version: https://www.youtube.com/watch?v=47sMGk87MuA
French version: https://www.youtube.com/watch?v=Yi5UDSJffEw

2.3. *The Suetsugi Atlas*

In time, participants in the co-expertise process felt the need to gather all the available information produced after the nuclear accident concerning the radiological situation as well as the testimony of residents on their paths towards the rehabilitation of their living conditions. Driven by the desire to transmit the experience of the community to present and future generations, the "Suetsugi Atlas project" launched in 2017, founded partly within the framework of the Suetsugi project. The project benefited from technical support of a professional editor and scientific advice from the experts involved in the co-expertise process. Through the interview process, residents were encouraged to look back once again on the period following the nuclear accident and to articulate their experiences as their own individual stories. Even before the creation of the Atlas, residents of the Suetsugi district had already had multiple opportunities to speak about their experiences through interviews for the Suetsugi Newsletter and through visits by observers. By repeatedly narrating their own experiences in this way, what had initially been a confusing and overwhelming series of events — difficult to grasp at the time — gradually came to be endowed with meaning as a lived narrative. Giving meaning to one's own experience, and thereby being able to perceive the world one inhabits as meaningful, occupies an important place in the process of recovery after a nuclear disaster. Only through this process, it can be said, is everyday life able to regain a sense of stability. At the same time, the interviews also revealed the limitations of the co-expertise process in Suetsugi. Feelings of unfairness experienced during decision-making in the recovery process, as well as dissatisfaction with administrative authorities stemming from the lack of opportunities to be involved in those decisions, persisted over a long period. Moreover, the restoration of trust toward experts in general — particularly those who were not directly involved in the co-expertise process — remained extremely limited. In addition, challenges that exceeded the community's own capacity to respond, such as population decline and regional revitalisation, continued to persist (Ando et al., 2026). Addressing the latter would likely require more integrated and strategic initiatives, such as the CORE program (Lochard et al., 2026).

FIGURE 5. The Suetsugi Atlas on Internet (photo: Ethos in Fukushima).

In late 2014, a meeting was held in Tokyo with various representatives of ministries and authorities from towns and villages of the Hamadori region, the most affected by the radiation in the Fukushima Prefecture. The experience of Suetsugi was presented which was unknown to the other communities and the importance of technical support from experts was emphasized. In the following days, representatives of a neighboring community visited Suetsugi to go deeper in the experience.

Suetsugi also has become over time a popular place for many delegations of both national and foreign experts concerned with better understanding the process of involvement and empowerment of the local population and the nature of its activities.

2.4. *Maintaining vigilance*

Beyond the concern of their individual exposures, the residents of Suetsugi also monitored the general evolution of the radiological situation of the whole community. This vigilance was first exercised following the storage of decontamination waste and the reception of fly ashes from the city of Iwaki. Small groups of villagers regularly visited the storage site to take measurements to ensure the stability of the situation. From the moment that the inhabitants were equipped with D-Shuttle dosimeters, these were used not only to assess the individual doses but also as a means of monitoring a possible rise in ambient radiation in the event of an incident perceived as always possible at the Fukushima power station. In fact, the residents had spontaneously supplemented the main function of the dosimeters for monitoring individual exposures with an alarm function.

Residents' commitment to exercising collective vigilance, combined with the monitoring of individual internal and external exposures and the radiological quality of the products, have gradually contributed to restoring social confidence within the community (Ando, 2018). Moreover, experts demonstrated their commitment to the community by making regular visit to Suetsugi. They confirmed the positive development of the local radiological situation, which also contributed to the restoration of social trust (Earle et al., 2007).

Over time the number of residents measuring their products has gradually decreased. Some started relying on those who continued the measurements to stay informed about the situation, which alleviated their burden. Others, seeing the results of the measurements, began to question whether or not it was necessary to continue the monitoring system. Finally, in January 2020, the decision was made to end the scheme at the meeting among those who were engaged in the co-expertise process including the residents because they now knew what to do and who to ask if something happens to them because food measurement is always available every day at the Iwaki City branch. It is undeniable that over time the residents of Suetsugi have acquired a practical radiological protection culture, which allows them not only to appreciate their radiological situation but also how to manage it for themselves and their love ones.

2.5. *The cooperation with the Fukushima Dialogue NPO*

In November 2023, during a follow-up meeting with residents — held on several occasions after completion of the Suetsugi Project, one of them expressed concerns about the discharge of treated water containing tritium from the Fukushima Daiichi nuclear power plant into the Pacific Ocean, which has been implemented since August 2023 after a long nationwide controversy. Although he acknowledged that the dilution of tritium offshore was significant, he nevertheless was questioning the possibility of reconcentration in the small bays along the coast near the village. During the discussions that preceded the first discharges into the sea, he had questioned experts in public meetings but had not received a clear answer. Since the NPOs delegation was also unable to provide an answer to his concern, it was decided to take action to measure the concentration of tritium areas likely to re-accumulate it.

Since measuring tritium required specialized equipment beyond the NPO's capacity, they sought professional laboratory support. This led to a collaboration with Professor Yuji Torikai at Ibaraki University, whose laboratory agreed to work alongside the residents and the NPO. A first measurement campaign took place in April 2024 with the participation of local residents, who selected sampling sites along the Suetsugi coast in consultation with university experts (Figure 6). The results of these measurements showed no significant difference before and after the releases. These results were confirmed over time, providing reassurance to the residents. This recent episode shows that the spirit of collaborative expertise remains alive within the population. Whenever the radiological situation is questioned, the measures are implemented to pinpoint the problem. This is a good illustration of the community's vigilance.

FIGURE 6. Suetsugi residents collecting samples (photo: R. Ando).

3. Some lessons from the Suetsugi experience

The co-expertise process described in this article is exemplary in more than one way. First, it was an initiative taken by the residents themselves. Suetsugi's experience shows that, in the context of an open society where large amounts of information circulate, affected people can gain the means of measurement and recruit experts and professionals through social media. They can take ownership of the situation they face and find ways to overcome it. It is certain that the past experience of Belarus, especially the ETHOS project, was a constant source of inspiration, as evidenced by the many questions posed to the members of the ICRP. From this point of view, all co-expertise processes must be documented and disseminated to help affected communities in the event of possible nuclear accidents in the future. Moreover, the residents of Suetsugi have shown a lot of creativity and independence in the way of implementing the co-expertise process. They have studied the measurement results together and decided on next steps sometimes with experts but also without them. In this approach, the role of local leaders was key to ensuring the continuity of the process.

Another lesson from Suetsugi's experience is that scientists, researchers and experts joined the process spontaneously and served the community over the long-term. Here again, the role of social media was decisive in "recruiting" goodwill. The process has also shown that, to be credible, experts should not only master the scientific basis of radiation protection and its practical implementation, and act in a transparent manner, but must also demonstrate empathy and, above all, respect people's freedom of choice while remaining faithful to their long-term commitment (Zoelzer, 2020). These are necessary conditions for gradually restoring confidence among the affected people.

By its very nature based on dialogue and the appropriation of the radiological situation with which the affected people are confronted, a co-expertise process is an approach which proceeds in stages, and which takes time. It is necessary to allow each participant time to assimilate the modalities and mechanisms by which he or she is exposed to the various radioactive sources present in the daily environment. Everyone has to gauge the importance of the exposures to which she/he is exposed and ultimately makes decisions about life choices. All this necessarily takes time.

The process of empowerment in which residents of Suetsugi acquired the practical culture of radiological protection was relatively similar in its development to that of the villages of Belarus (Lochard, 2013) in the late nineties. It was, however, more rapid because of the use of social media and the new generation of measurement means, in particular, individual dosimeters for external exposures allowing a direct link with the daily activity of those who wear them. Not only the deployment of the co-expertise process, but also the provisions to ensure its sustainability were put in place fairly quickly.

Most notable was the ability of the process leaders to negotiate and ultimately secure financial support. Although Suetsugi's experience served as a model for national authorities, as described above, it did not spread as might be expected. The deployment of local consultants in other affected communities certainly played a decisive role in engaging the population but did not foster a level of commitment comparable to that which emerged in Suetsugi. Beyond demonstrating the effectiveness of the approach, the Suetsugi experience also revealed the limits of the public authorities' willingness to trust the population to develop local projects aimed at improving both individual and collective protection, as well as living conditions.

Conclusion

During its 15th visit to Suetsugi in August 2019, the ICRP delegation held a Round-Table discussion with local residents involved in the experiment. During the discussions, they freely expressed their views and feelings. They emphasized that in the aftermath of the accident, there was a state of total chaos, and the local administration faced significant challenges in adapting their conventional procedures to the unprecedented situation. They noted that the measures undertaken within the framework of the co-expertise process effectively addressed residents' concerns. This process played a crucial role in enabling constructive negotiations regarding the acceptance of the Iwaki fly ash in their community. In conclusion, they stressed that the ability to express their concerns had always been vital, and that the Belarus experience provided essential insights. They observed that people's perspectives had evolved over time, and that ultimately, the experience had been a long and inspiring journey for the future.

At the end of the meeting, the Commission's scientific secretary presented the village chief and residents with a plaque in recognition of their invaluable contribution to the advancement of radiological protection (Figure 7). A few months later, this experience, along with others, was highlighted in ICRP Publication 146, entitled "Radiological protection of people and the environment in the event of a large nuclear accident: update of ICRP Publications 109 and 111."

FIGURE 7. The ICRP visit in August 2019 (photo: Ethos in Fukushima).

Beyond confirming the key role of dialogue and radiation measurements in involving and empowering residents to improve their protection and living conditions, Suetsugi's experience has highlighted the importance for experts of adopting a clear ethical position while respecting people's freedom of choice (Schneider et al., 2019). It has also shown that the co-expertise process — whether initiated by local actors or experts — can only unfold if authorities at all levels create the conditions necessary to facilitate the process and support local initiatives and projects.

The Japanese experience, like that of Chornobyl two decades earlier, has shown that the support of local initiatives and projects, which is essential for the rehabilitation of the living conditions, remains an unresolved issue. The challenge was to find a room and a person to take the measurements, but this remained difficult to implement without a sufficient budget. This difficulty was strongly highlighted by the co-expertise process conducted in Suetsugi. Past experience has clearly demonstrated that, in order to address high level of concern, lack of knowledge and experience concerning radiological risk, widespread mistrust towards authorities and experts, and the profound socio-economic complexity generated by the accident, a change in governance is unavoidable— one based on the decentralization of decision-making and on confidence in the capacity of those affected to address the problems of their own communities (Eikelmann and Hériard Dubreuil, 2016).

Despite inevitable obstacles and difficulties, the Suetsugi's experience has confirmed that, given the complexity and challenges arising from a nuclear accident, all public and private actors as well as all stakeholders, need to commit to cooperating in responding to the problems and challenges of affected areas. The co-expertise process, which can be considered a social innovation (Bodin, 2017), has proven effective in empowering those affected, supporting the restoration of their well-being, and improving the quality of "living together" within their communities, ultimately enabling them to regain their dignity.

Acknowledgements. The authors wish to express their thanks to all the residents of Suetsugi. This article is dedicated to them in recognition of their invaluable contribution to the deepening of the co-expertise process. They also thank ICRP members Ohtsura Niwa, Chris Clement, and Jean-François Lecomte who, on several occasions visited Suetsugi, and constantly supported the experience.

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7
The Yamakiya co-expertise experience in Japan after the Fukushima accident

Tetsuo Yasutaka[1], Yumiko Kanai[1], Momo Takada[1]

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).

[1] National Institute of Advanced Science and Technology (AIST), Ibaraki, Japan

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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.

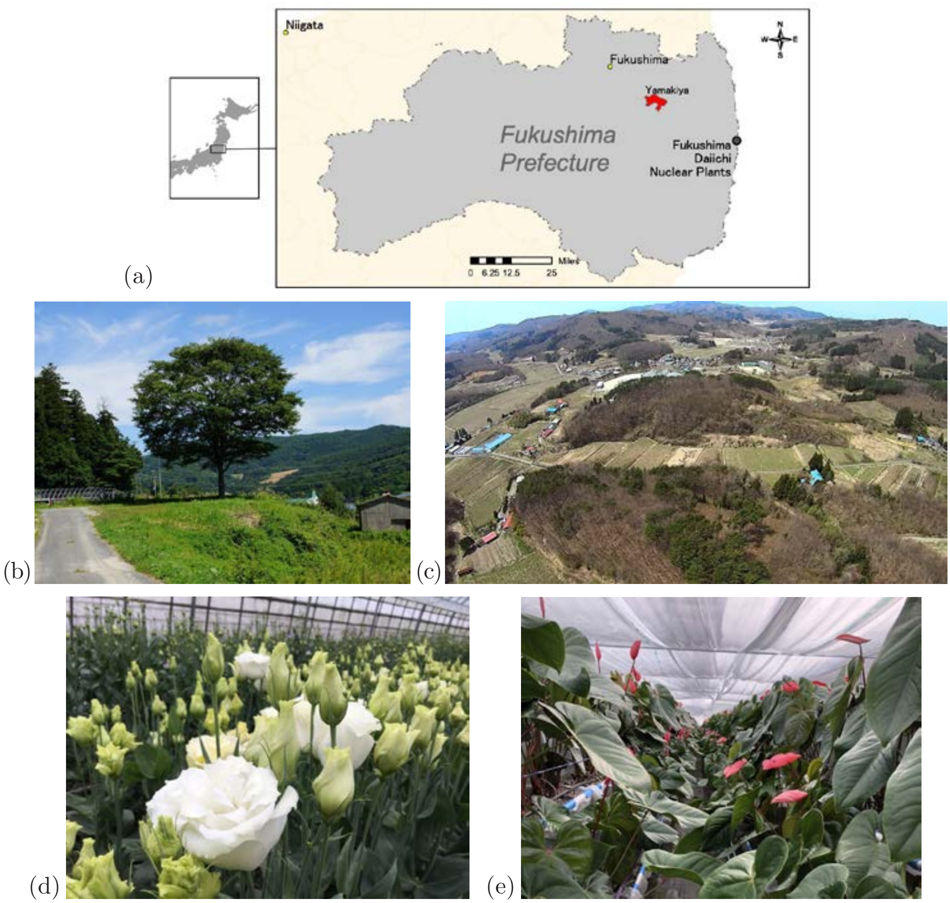

Figure 1. (a) The location of the Yamakiya distinct. (b) and (c) A general view of the Yamikiya distinct (The photo on the right was provided by Dr. Akihiko Kondo.). (d) and (e) Cultivation of *Eustoma* and *Anthurium* in Yamikiya distinct. From Yasutaka et al. (2020), © EDP Sciences.

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.

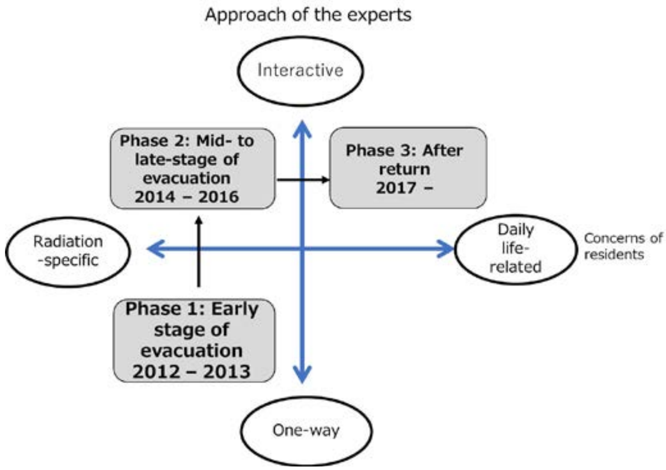

FIGURE 2. Changes in the concerns of participating residents in the Yamakiya district and in the approaches of the experts. From Yasutaka et al. (2020), © EDP Sciences.

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 (0.0003-0.0005 Bq.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 0.003-0.06 Bq.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 "Yamikiya 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 or 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 Yamikiya residents and the participants were encouraged in order to develop mutual understanding and continued interaction.

(a) (b) (c) (d)

FIGURE 3. (a) Visit of a temporally 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.

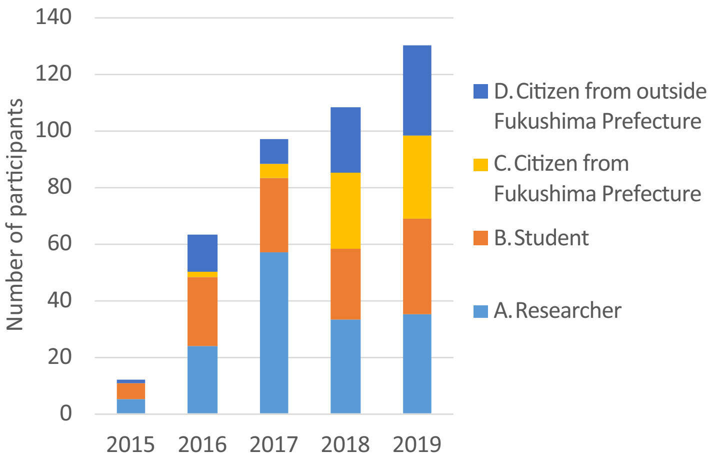

FIGURE 4. Number and quality of the participants from outside Yamakiya by year. From Yasutaka et al. (2020), © EDP Sciences.

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.

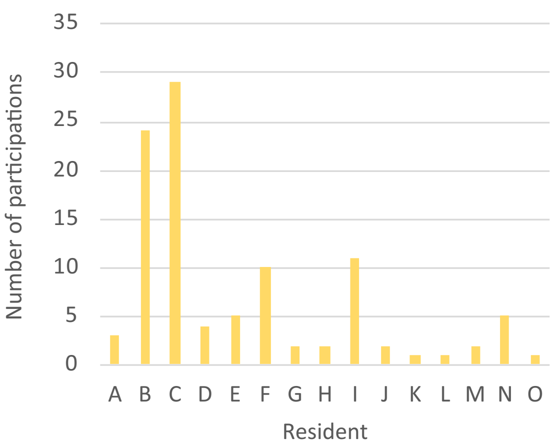

FIGURE 5. Number of participations by the residents of the Yamakiya district. From Yasutaka et al. (2020), © EDP Sciences.

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 retuned.

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
Issue (1) **Radiation effects** • Environmental safety • Safety of crops and forest products • Reputation	• Measurement of ^{137}Cs concentration in water • External exposure dose • Evaluation of behaviour of ^{137}Cs 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 ^{137}Cs in them.	• 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.
Issue (2) **Divided local communities and reduced local resources** • Disruption of cultural traditions • Division of the local community • Maintenance and management of the local infrastructure • Deterior-ation of the landscape	• 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	• 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.

Local issue	**Example of Yamakiya School and research activities**	**Details of interviews with Yamakiya residents participating in Yamakiya School**
Issue (3) Resuming agriculture • Insufficient manpower • Introduction of new crops and technologies • Animal damage • Decreased production motivation	• Volunteering in agriculture (about once a month) • Tea parties	• 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.

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 Yamikiya 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 Shimpo, 2018). This project, which gave rise to articles in the media, marked greatly the participants because of its symbolic dimension.

As the lesson after Chornobyl 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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8
The Kashiwa co-expertise experience in Japan after the Fukushima Accident

Yasumasa Igarashi[1]

Abstract

This chapter examines a co-expertise process in Kashiwa City, Chiba Prefecture, following the 2011 Fukushima Daiichi nuclear power plant accident. Despite being 200 km from the plant, Kashiwa became a radioactive hotspot, threatening local agriculture. A Round-Table project launched in July 2011 brought together local stakeholders, including farmers, consumers, retailers, restaurant chefs and a non-profit organisation responsible for measurements of radioactivity to address contamination concerns of the local population. Led by a sociologist, the project employed social science insights to overcome initial conflicts. A survey of kindergarten parents was carried out in autumn 2011. The results and interpretation of the survey provided an important perspective for farmers to positively reconsider the significance of the Round-Table and to actively participate in the dialogue. The farmers realized that consumers were not the "enemy," but rather potential good customers for local farmers, and that measurement by the citizens/consumers themselves was the way to proceed. As a consequence, the Round-Table developed an independent measurement protocol with a 20 Bq/kg standard for food products after several months of deliberative discussions between the various stakeholders. Radiological protection was integrated into everyday marketing of produce, directly sold to consumers. This case demonstrates how social science expertise can effectively address stakeholder conflicts in contaminated areas. By respecting consumer autonomy while restoring farmer dignity, the initiative avoided social fragmentation and enabled economic recovery for local agriculture, offering valuable lessons for post-disaster community reconstruction.

Introduction

One of the major social and economic challenges of a nuclear disaster, as illustrated after the Fukushima Daiichi Nuclear Power Plant accident (FDNPP), is the problem related to primary industries, e.g., agriculture and fishing (Schneider et al., 2021). Significant radiation protection measures have to be taken at all

[1] University of Tsukuba, Ibaraki Prefecture, Japan

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levels including the Nuclear Regulatory Authority (Nirasawa et al., 2021) and conflicts of interest may arise among stakeholders, such as consumers, retailers, and producers, over the radiological quality of agricultural, forestry, fishery, and other products from the land.

To address this problem, ICRP recommends implementing a co-expertise process, with a focus on Dialogue as the major means to confront and reconcile views of stakeholders in contaminated areas. ICRP also recommends that relevant stakeholders and representatives of the general population should be involved in the decision-making processes (ICRP, 2009, 2020). The experiences not only from the Fukushima accident, but also from the Chornobyl accident previously, have shown that foodstuff produced in contaminated areas may be perceived differently by the population living inside the affected areas than by those living outside, and therefore in-depth dialogues at national and local levels are needed. However, dialogues at the national level between residents with different interests and local identities were not adequately conducted in Japan after the nuclear accident. Nevertheless, some dialogue meetings with local residents and experts, as well as farmers and fishermen, did take place in various forms in Fukushima Prefecture between 2011 until now. The ICRP Dialogue Initiative and later on the Fukushima Dialogue are good examples (Lochard et al., 2019).

After the accident, many places were contaminated with serious consequences for local agriculture outside of Fukushima Prefecture, the center of the nuclear disaster. This was particularly the case in Kashiwa City, Chiba Prefecture, in the suburb of Tokyo. Farmers were confronted with radioactive "hotspots" and placed in the similar position as producers of the contaminated areas of Fukushima Prefecture. The residents of the city of Kashiwa, are a very mobile population with little attachment to the area. Moreover, because of their mobility and advanced commercial development, they have many options for buying foodstuffs, and therefore benefit from a situation similar to consumers in areas of Japan that escaped contamination. Therefore, dialogue with these consumers in the Tokyo suburban community required a different format to what was practiced in the farming community of Fukushima Prefecture.

In this chapter, the author describes how the practice of co-expertise with dialogue between consumers and farmers was organized in Kashiwa City (Figure 1) and discusses the implications for radiological protection resulting from this unique situation. Unlike many examples of co-expertise processes involving radiation protection experts, the Kashiwa project is remarkable and original because it was led by a sociologist — in this case, the author of this article. His insightful analysis of the situation of the various stakeholders, based on sociological theory, allowed them to shift their positions and break the deadlock they were experiencing. Overall, this endeavor demonstrates the value of involving experts from social sciences and the humanities in co-expertise processes.

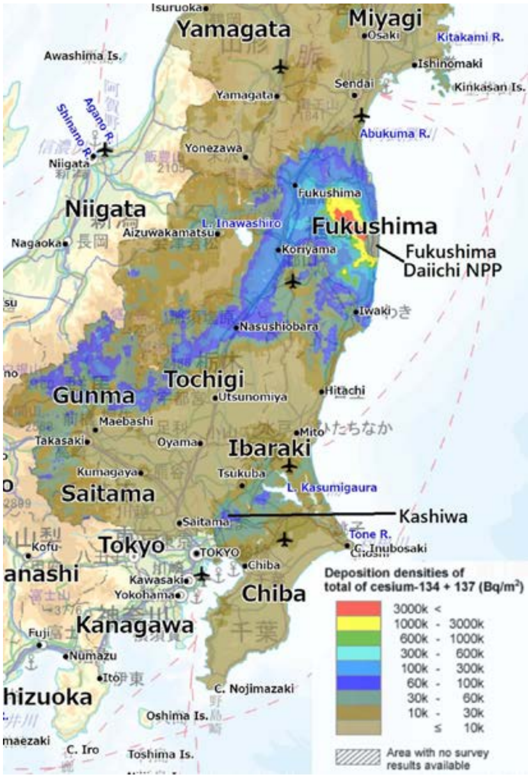

FIGURE 1. Geographical distribution of the fallout of Cs-134 + Cs-137 according to the results of airborne surveillance carried out by Ministry of Education, Culture, Sport, Science and Technology, Japan, September 2011. (From MEXT, with the author having made some additions).

1. The Round-Table project in Kashiwa city

Located only 30 km and 40 minutes by suburban train from central Tokyo, Kashiwa City in Chiba Prefecture is the largest commercial center in the north-eastern part of the Tokyo metropolitan area. It is a popular suburb for the young generation, with a population of approximately 400,000 residents that has more than quintupled during the past 50 years. In addition, it is a leading urban agricultural area focused on the production of vegetables for the Tokyo market, including the largest production of turnips in Japan. In Kashiwa City, the momentum for "local production for local consumption" began to develop among residents in the 2000s, and a citizens' group has been organizing a monthly local vegetable market since 2010. The author of this article, who is both a city dweller and a sociologist by profession, has been a core member of this group.

After the FDNPP accident due to the heavy rainfall on March 21st, 2011, the area around Kashiwa City became the worst radioactive hotspot in the Tokyo metropolitan area, despite being located approximately 200 km away from the damaged FDNPP (see Figure 1) (Fukuda et al., 2013; Ishida and Yamazaki, 2017).

Immediately after the FDNPP accident, having no equipment in widespread use to measure radioactive contamination of agricultural products, the citizen's group wondered if it was acceptable to organize a market to sell local vegetables without first confirming their safety. And around that time, heated Internet discussions over whether or not people should eat food from the nuclear disaster-affected area accelerated, and the author and colleagues realized that one of the worst aspects brought about by the nuclear accident was the fragmentation of the community. But it was also thought that in Kashiwa, where the distance between consumers and producers was close, it would be possible to avoid this fragmentation by having the consumers themselves communicate directly with producers and confirm the safety of agricultural products with their own eyes.

Based in this idea, a dialogue named the "Round-Table for Safe and Secure Kashiwan Products for the Kashiwan People" was launched in July 2011, with the aforementioned citizens' group serving as the organizer. Various local stakeholders were invited to become involved in this dialogue, which included four local farmers, two retailers, two restaurant chefs, three consumers, including women of childbearing age who had already been actively transmitting information about local radioactive contamination, as well as a local non-profit organization (NPO) in charge of radioactive measurements (Figure 2).

FIGURE 2. The author and citizen volunteers collecting soil samples for the Round-Table project (photo Y. Igarashi).

After months of discussion and deliberation, the Round-Table established the protocol of radioactive measurement as follows. First, using a battery-powered simple scintillation measuring system, five samples of soil taken from the four corners and center of every farm growing at least one vegetable, were collected to identify the most radioactivity contaminated spots on the farm. Using this soil data and some other soil characteristics, such as potassium concentration, soil type and texture, the vegetables with the highest contamination levels on each farm were identified. Then, these vegetables were picked and brought to the measurement institute managed by the NPO for more detailed examination by a NaI scintillation detector. In March 2012, only vegetables with a total Cs-134 and Cs-137 content below 20 Bq/kg, according to this testing protocol, began to be published on the Round-Table's webpage for each product and each farmer. This value was chosen at a meeting, based on measurement results and practical reasons concerning the detection performance of measuring instruments, as a compromise acceptable to stakeholders. The process was transparent, with the collaborative participation of various Round-Table members as well as volunteers recruited at public awareness events, including the buffet shown in Figure 3, which received media coverage.

FIGURE 3. The buffet event held in April 2012, featuring vegetables from farmers participating in the Round-Table's measurements (photo Y. Igarashi).

The Round-Table's project as a civic activity ended in December 2012 after the measurement of 15 farmers' farmlands and a total of 49 vegetable items were completed. At the end of this period, a farmer's market operator, who was a member of the Round-Table, decided to continue this project to measure farmland soils as his own business.

A preliminary report on the Round-Table was first published as a general book in Japanese (Igarashi et al., 2012) and then presented at several international conferences on sociology and radiological protection (Igarashi, 2014, 2016). In addition, a paper co-authored with Ryoko Ando on the contributions of social scientists in dialogue initiatives was published (Igarashi and Ando, 2021): this forms the basis of Section 2 below.

2. The role of dialogue between stakeholders and the contribution of sociology

The Round-Table project did not get off to a smooth start. During the first three or so monthly meetings, the atmosphere among the various stakeholders who had gathered was so gloomy that they were reluctant to openly express their point of view. What resulted from this deadlock was a dialogue among stakeholders, which is positioned as the first step in the co-expertise process (ICRP, 2020). This section describes two points where relying on sociological insights in the process facilitated dialogue.

First, it is important to note that the results and interpretation of the kindergarten parents' survey conducted in the autumn of 2011, provided a significant positive impact on the Round-Table participants, especially the farming members. Based on the assumption that the parents of kindergarten children were the most concerned about internal radiation exposure among the youngest children and the most sensitive about Kashiwa vegetables, a questionnaire survey was conducted with 439 parents of three kindergartens selected from the northern, central, and southern parts of Kashiwa City.

The results of this survey, which had a response rate of over 90%, were quite interesting. At the time, as many as 62% of respondents were reluctant to buy local produce after the nuclear accident. In fact, there was a significant tendency for respondents who were enthusiastic consumers of local produce before the accident to be reluctant to buy it after the accident. The reason for this observation is quite convincing: the original customer base for local vegetables is those who value freshness and safety, not the price. After the accident, the evaluation of safety has been reversed. In addition, there were several respondents who commented that they felt sorry for the farmers in Kashiwa, but that they were not willing to buy local vegetables at that time.

The most frequent answer to the question about the most reliable people for measuring agricultural products was "universities and specialized measuring institutions" (50%), followed by "citizens/consumers" (23%), and if "own measurement" (7%) is added to the above, the percentage reaches 30%. Conversely, trust in government (15%), producers (2%), and retailers (2%) was not as high (Igarashi et al., 2012).

When these results were presented and discussed with over 100 local farmers at a seminar at a direct sales office participating in the Round-Table, their attitude toward the Round-Table changed dramatically. In short, they realized that "noisy" consumers were not the "enemy," but rather potential good customers for local farmers, and that measurement by the citizens/consumers themselves was the way to proceed. Then, they had come to appreciate that the Round-Table and the four farmers participating in it were pioneers in this initiative.

For sociologists, designing and interpreting surveys that can generate valid findings from citizens' attitudes is a very basic skill. In the Kashiwa case, the involvement of a sociologist in the co-expertise process could have provided an important perspective for farmers to positively reconsider the significance of the Round-Table and to actively participate in the dialogue.

Secondly, it is important to note that insights and understanding through sociological theory about the nature behind the producer-consumer conflict structure played a decisive role in facilitating the dialogue. At the beginning of the Round-Table's launch, some producer members perceived "noisy" citizens as "the enemy" and consumers, including the organizers, were frustrated by producers' initial reluctance to conduct independent measurements with more scrutiny than the tests conducted by the authorities from the city of Kashiwa.

The reason why the producers were reluctant to take independent measurements was related to the concerns from the other producers. Even in suburban areas like Kashiwa, unlike most residents who commute to Tokyo, farmers live and farm in communities where residences and livelihood are integrated. If they were the first to conduct independent measurements and high levels of radioactivity were detected, it would have a negative impact on agriculture throughout the northern part of Chiba Prefecture. Kashiwa farmers were worried that, in the worst case, they might be blamed for their "thoughtless" behavior in the community and not even be able to farm and live on the land they had lived on for generations. It was only after hearing the words of one farmer, who had been measuring ambient dose rates late at night in secret with a borrowed Geiger Muller counter, that consumers and restaurant members understood what needed to be taken into consideration by the Round-Table.

What tormented farmer members at the time was not so much the malicious warning that flooded the Internet, such as "farmers don't sell poison!", but the easy advice from consumers who were superficially sympathetic to them: "You can stop farming in around Kashiwa, so why don't you go to some wasteland in Western Japan and farm?" The residents of suburbs like Kashiwa, who are a mobile population and loosely attached to their communities, did not understand the difficulties of leaving the land that farmers have inherited from generation to generation, nor the intricacies of an agriculture optimized for the microtopography and microclimate of each farm.

These episodes revealed that the perception gap between producers (farmers) and consumers in semi-urban areas regarding the feeling of belonging to the community was latent even before the nuclear accident and underpinned the conflict of interest between stakeholders. To understand this perception gap, it is helpful to recall a theoretical analysis by Zygmunt Bauman, one of the leading social theorists in the study of globalization, who argued that "the access to global mobility" was the main factor in creating stratification in contemporary society (Bauman, 1998). Based on this theory, we can understand that the essence of the conflict of interest on foods from contaminated areas lies in the gap between consumers, who are physically mobile and can easily move around to choose vegetables in supermarkets, and producers, who find it extremely difficult to farm and make a living apart from their land.

In this way, the pessimistic atmosphere at the beginning of the Round-Table gradually dissipated as all participants realized how differently their views were depending on their occupation and position, even though they lived in the same community. Then they reconciled their different perceptions of the community and shared the consideration they should have for each other. The members of the Round-Table, who had initially been in a pseudo-conflict due to "harmful rumors," gradually formed a shared vision of Kashiwa's situation and the actions the Round-Table should take by recognizing their differing societal positions through dialogue.

The fieldwork skills or interactive ability (Collins and Evans, 2007) of sociologists regarding the discourse of people from diverse backgrounds, considering their social contexts and interpreting them by adding information from theoretical frameworks, was widely used in the Kashiwa Round-Table project. This practice provides an important example of the contribution that sociologists can make to the stakeholder dialogue recommended by ICRP (ICRP, 2020). This contribution, which has been highlighted in the post-nuclear recovery of the community and in which the involvement of experts from various fields, including social scientists, is also recommended (Schneider et al., 2019).

3. Local project: understanding radiation protection as an everyday activity?

In November 2011, after the initial stalemate situation had improved, the Round-Table began to establish its vision and goals, and to discuss details about possible local projects to reconcile producers and consumers. To ensure the economic independence of farmers in the contaminated territory, a communication strategy towards consumers was necessary (ICRP, 2009).

(ICRP, 2009). One of the most promising methodologies was to appeal to the emotional support of people for the affected areas as well as to disseminate scientific facts. Indeed, it had been found that by reducing consumers' anxiety about radiation, their feeling of support for the affected areas increased, which promoted the purchase of foods produced in Fukushima Prefecture (Kudo and Nakayachi, 2014; Hori et al., 2017). In other words, the term "Eat and Support", widely known in Japan, is a very popular expression that encourages trade-offs on social risks by making consumers aware that their overly precautionary choices may hinder the recovery of the affected areas.

However, even though the Round-Table was often reported in the media as an "eat and support" activity, the vision of its members was not self-defined as a project to only support Kashiwa farmers. During the Round-Table, it was confirmed that the aim of this activity was for the various participating stakeholders to target their own interests: for the farmers, it was a question of "brand their own vegetables and gain consumers loyalty", while for the latter, it was about "regaining their civic pride in Kashiwa, where fresh, local vegetables are close at hand".

More importantly, the Round-Table was a very steady and low-key activity as part of local production for local consumers. Although often misunderstood by media, the Kashiwa Round-Table project did not aim to become a national benchmark for the safety of contaminated vegetables. A concrete goal of the Round-Table was set to connect consumers who originally wanted to buy local vegetables, whose existence was revealed by the results of the questionnaire survey described in Section 2, with producers who wanted to sell directly to the local market. At the same time, the project also took advantage of Kashiwa's geographical advantage of physical proximity between consumers and farmland, and established a policy of involving consumer volunteers in the measurement process, starting from the point where they check the production site of vegetables. The name of the project's web page: "Find Your Farmer", is precisely the articulation of this goal.

The Round-Table's policy did not adopt an approach aimed, on the one hand, at convincing consumers based on scientific arguments concerning the risks of radiation, and, on the other hand, at advocating support for farmers. In other words, the Round-Table decided to publish the list of products of individual farmers that had reached the independent standard value of 20 Bq/kg based on quality assured radiation measurements but without going further into scientific discussions. This position was important because it meant that the project was less likely to get caught up in the heated "safety/danger" debate on the Internet.

The realistic goal of the Round-Table was not to "educate the consumers with scientific accuracy", but to draw their attention to the results in order to recognize and sympathize with the farmers' efforts. In this approach, which aimed to locally widen the circle of conviction and empathy, if there were consumers who were not convinced by the measurement protocol and the results, it was not because they were "ignorant of science" but because they were just "customers who were not interested" at that point. That is, there was no need to convey a message that could be perceived as pressure to conform, thus avoiding the psychological reactance i.e., a negative emotional reaction of people generated by a threat or loss of freedom (Steindl et al., 2015).

Importantly, this policy was an approach that was easily understood as an extension of reasonable marketing very oriented towards direct sales to consumers by the small-scale farmers who participated in the Round-Table. First, for small- scale farmers, it was not necessary that all consumers accept and purchase the vegetables they produced. What mattered to them was that there were private customers and restaurateurs who sympathized with their approach to farming and appreciated the value of the vegetables they produced. Studying the mechanisms of radioactive material transfer, closely monitoring radioactive contamination of one's own farmland and vegetables, and communicating this information to customers, were not very different from their everyday marketing activities i.e., trying to gain loyal customers by cultivating high quality vegetables or reducing the use of agrochemicals. In this approach, while the quality and safety of their products and their way of farming, including radiological protection, was promoted as an attraction, the personal autonomy of consumers in making risk judgments was fully respected. At the same time, they regained their dignity as farmers by understanding that a nuclear accident is not an irreversible disaster, but as a difficult but solvable situation calling for personal efforts to understand its reality through measurements of the contamination and by applying a process of quality assurance and marketing, adapted to a context of radioactive contamination perceived as unfair.

After the Round-Table project ended in Kashiwa, the author of this article interviewed 17 people involved in the agriculture and fisheries industries in Fukushima Prefecture, many of whom had similar ideas and approaches (Igarashi, 2018). By incorporating radiological protection and communication as part of the current marketing strategy, this pragmatic approach addressed ethical issues. This avoided social fragmentation and psychological reactance, particularly significant in a society like Japan, where consumers have diverse values and many choices in a highly developed distribution system.

4. Radiation protection culture in a competitive market environment

The Kashiwa Round-Table, redefined radiation protection objectives and as part of its marketing efforts, agreed to adopt a unique approach that often deviated from scientifically recommended measurement protocols and benchmarks.

First, it is necessary to explain in detail once again how the independent standard of 20 Bq/kg, which is set extremely low in terms of international scientific recommendations, was determined. It needs to be emphasized that the very low independent standard was not adopted because the Japanese provisional regulatory value of 500 Bq/kg after the FDNPP accident or the standard of 100 Bq/kg applied to general foods since April 2012 were too high.

At the first meeting in July 2011, the Round-Table members confirmed and adopted the “as low as reasonably achievable” principle recommended by the ICRP, which is the cornerstone of the radiological protection system, and they came to fully understand that there should be different standards to aim for, depending on the contamination situation of the target area, the characteristics of the target products, and the social aspects such as the range of choices available to the local consumers.

In this context, for the vegetable farmers in Kashiwa, who had repeatedly conducted pilot measurements, 20 Bq/kg was a standard that would allow them to be confident that their farms would not produce vegetables contaminated above this level, even if it was an outlier result. On the other hand, for members from the consumer community, 20 Bq/kg was an acceptable standard even for their “zero-risk” oriented friends, and for supermarket owners and restaurant chefs, it was a standard they could explain to their customers as perfectly OK compared to other production areas.

In other words, the 20 Bq/kg was established as a compromise by the participating members of the Round-Table, based on the marketing perspective of how to get consumers to choose vegetables from low-level contaminated areas in competition with vegetables from other uncontaminated production areas. So, referring to the independent standard adopted by the Round-Table, it should be emphasized that the important aspect was not the value of 20 Bq/kg itself, but the process to reach agreement on this value after several months of deliberate discussions between the various stakeholders.

Another unique and essential aspect of the Round-Table's project is the measurement protocol for each individual farm, which combines soil and vegetable measurements, as described in Section 1. This is also quite different from the approach to food radioactivity measurement, which is usually done by sampling tests. This is because the Round-Table members agreed that the standard food radiation protection approach, which takes market dilution into account, is completely inadequate for the marketing they were aiming for.

In October 2011, there were sensational media reports that there was a "hot spot" in Kashiwa City. The fact that sales at the Round-Table members' farmers market had fallen the most after this media coverage indicated that many consumers in Kashiwa were not satisfied with sampling tests and wanted to be assured that the vegetables in front of them had really been grown in safe soil. And the producers participating in the Round-Table were farmers who wanted to sell their vegetables to local consumers on a face-to-face basis, without going through the market, and they considered it important to meet these needs in order to regain trust in the safety of local agricultural products and their competitiveness against other production areas.

Thus, with the goal of avoiding "outliers", the measurement protocol decided upon by consensus among the Round-Table members was to specify the spot in each farmland with the highest risk of contamination, and the basic principle of this specification was a quick soil measurement. However, it is not only soil contamination that determines the level of radioactive contamination of agricultural products, but also soil texture, pH, and potassium concentration in the soil. In particular, the deficiency of potassium in the soil, which results in the uptake of radioactive cesium as a chemical surrogate, is an important factor, and records of fertilizer application to their own farmland are important to determine this. Therefore, in addition to measuring the soil in the center and four corners of the farmland, the NaI scintillation detector was used to measure vegetables grown in spots that could be assumed to be high-risk based on information obtained from the farmers, such as where rainwater tends to accumulate in the farmland, which areas have sandy or acidic soil, and whether there was a history of failure to apply fertilizer in a particular area.

In this sense, the Round-Table's measurement protocols were continually updated by measuring their individual farms with farmers participating in the project who were fully aware of the conditions of their farmlands. The co-expertise process that determined the Round-Table's own measurement protocol can be evaluated as beginning with the basic policy agreed upon by the sociologist facilitation and then becoming more precise with the addition of the expertise of the farmers.

In addition, it should also be emphasized that Kashiwa was a slightly contaminated area that did not require long-term radiation protection measures for the health of its residents. Therefore, from the beginning, the Round-Table was considered to be a time-limited project until the residents' concerns about local vegetables were resolved to some extent, and it was not intended to embed a culture of radiation protection in the community over long periods of time.

The Round-Table in Kashiwa had reconciled the interests of many stakeholders and adopted a measurement protocol and standard appropriate to local situations. In these ways, the Kashiwa experience is an interesting case that demonstrates the feasibility of implementing a dialogue among stakeholders to realize the strategy recommended by the ICRP. While they were certainly far from typical scientific recommendations, they were nevertheless part of an optimization process (ICRP, 2009, 2020), with the goal of reestablishing residents' loyalty for locally grown vegetables in a competitive market environment, where vegetables from all over the world were available to consumers. And this case may also demonstrate the possibility of developing a co-expertise process that involves diverse professionals, including those from the social sciences, in order to achieve the goals required there in the light of the characteristics of each community.

Conclusion

This chapter has shown the effectiveness of the Round-Table project, launched immediately after the Fukushima Daiichi nuclear power plant accident, which took the form of a dialogue to reconcile consumers and farmers in the city of Kashiwa. They discussed at length the implications of the exceptional situation created by the accident and, in an atmosphere of trust, established appropriate local rules to empower all stakeholders and improve the situation.

There is no doubt that the Fukushima Daiichi nuclear power plant accident (FDNPP) severely undermined trust in the government, scientists, and food safety in Japan. Given the post-nuclear accident context and the structure of trust within Japanese society, where generally the level of trust is low (Yamagishi, 1998; Inoguchi, 2002), it seemed strategically appropriate to engage a dialogue between farmers and consumers based on measurements to ensure some objectivity in the process. This approach broadened the circle of belief and empathy for the visible products of "your farmer," based on personal trust. It also restored general trust in food produced in the areas affected by the nuclear disaster through the accumulation of this personal trust.

It is clearly necessary to aim for reconciliation involving consumers and producers after a nuclear accident, both in the areas seriously affected by contamination and beyond. Dialogue plays a crucial role in this reconciliation. An important lesson from the Kashiwa co-expertise process was that local and national governments, as well as international expert groups must recognize that their role in the post-nuclear accident reconstruction phase is not only to directly create large-scale dialogue opportunities, but also to support initiatives such as the Kashiwa Round Table, which expand small circles based on personal trust. While the Round-table approach did not resolve the entire agricultural problem in the area affected by the nuclear disaster, it demonstrated its effectiveness and success on a small scale.

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PART III
THE THREE PILLARS OF THE CO-EXPERTISE PROCESS AND THEIR SCIENTIFIC AND ETHICAL FOUNDATIONS


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9
The role of the dialogue in the co-expertise process after a nuclear accident: the power of narrative

Ryoko Ando[1], Jacques Lochard[2,3], Thierry Schneider[2,3,4]

Abstract

In the aftermath of major nuclear accidents, affected populations face profound disruptions to their everyday lives, sense of identity, and capacity for action. Recent evolutions in radiological protection, particularly those reflected in ICRP Publications 138 and 146, have emphasized approaches that place participatory dialogue, stakeholder engagement, and the sharing of knowledge at the center of the recovery process. Drawing on lessons from the Fukushima Dialogue meetings and on Paul Ricœur's philosophical theory of narrative framework and recognition, this chapter analyses the role of participatory dialogue as both a practical tool for radiological protection and an ethical space for the "reconstruction" of individual dignity and community cohesion. Dialogue functions not merely as information exchange, but as a narrative framework where autonomy, responsibility and dignity can be rebuilt.

Introduction

The practical implementation of radiation protection has undergone significant changes in recent decades, particularly under the growing influence of ethical reflection, social sciences, and post-accident feedback analysis. In particular, ICRP Publication 138, which defines the fundamental ethical principles underpinning the radiological protection system, such as beneficence, non-maleficence, prudence, justice, dignity, accountability, transparency, and inclusiveness, marked a decisive turning point towards taking into account the moral, social,

1 NPO-Fukushima Dialogue, Iwaki, Japan
2 Nagasaki University, Japan
3 International Commission on Radiological Protection (ICRP)
4 Nuclear Protection Evaluation Centre (CEPN), France

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and relational dimensions of radiation protection (ICRP, 2018). This approach recognizes that radiation protection cannot be reduced to a simple quantitative risk assessment or technical optimization; it must be understood as a practice rooted in individual and collective experience, influenced by values and science, and co-constructed with concerned individuals and radiation protection experts.

Building on this ethical framework, ICRP Publication 146 introduced and formalized the concept of a co-expertise process, designed to address the complexity of recovery after a nuclear accident and the need to actively involve relevant stakeholders (ICRP, 2020). This co-expertise is based on the fact that populations living in areas affected by an accident possess irreplaceable practical knowledge of their living spaces, the social relations within their community, and their daily living conditions.

The Fukushima Dialogue meetings, initiated in 2011 by the ICRP and continued with the support of local civil society organizations, are an exemplary application of this development (Figure 1). For more than a decade, the Fukushima Dialogue meetings have demonstrated how structured participatory dialogue between residents, experts, professionals, and authorities can help participants regain a degree of autonomy, develop self-confidence, and better understand the different perspectives of those affected by the accident. These meetings have also helped some participants to make informed decision about their future. The testimonies gathered during these meetings have highlighted not only the daily difficulties of living in a contaminated territory, but also the existential upheaval caused by uncertainty, displacement, and the loss of control over the situation. The dialogue meetings have thus emerged not simply as a communication tool, but as a shared space to give meaning back to the situation experienced by the residents and communities impacted, and also to restore their autonomy (Ando et al., 2023a,b).

FIGURE 1. 25th Dialogue Meeting organized by NPO Fukushima Dialogue. © Copyright FD Fukushima Dialogue.

About dialogue, the French philosopher Paul Ricœur developed a theory of narrative that offers a particularly valuable philosophical framework for understanding why participatory dialogue plays such a central role in the co-expertise process. Ricœur emphasizes that individuals and communities reconstruct their identity through narrative frameworks that allow them to interpret their experiences, that is, to understand how they lived the past and are living the present, and thus to recognize each other as moral actors. His conception of identity as a narrative framework highlights how fundamental telling one's story, listening to others, and constructing a shared narrative of events is for regaining dignity and agency (Ricœur, 2005). The narrative aspect of participatory dialogue brings an ethical dimension which plays a transformative role for participants. Ricœur's reflections help us to understand why participatory dialogue is not only a discussion which can lead to deliberations and decisions but also a framework for sharing views within which the meaning of the situation lived by the participants is recreated and their difficulty is recognized, thus allowing them to reconstruct their living conditions after a disturbing event such as an accident. In other words, this so-called reconstruction is, for Ricœur, the fruit of a personal reflection understood as a reappropriation of each individual's effort to exist.

1. The post-nuclear accident disruption

Major nuclear accidents destabilize the daily lives of many people, far beyond the immediate radiological damage. Individuals suddenly find themselves confronted with a profound loss of control over their environment and a destabilization of their daily lives. Everyday actions once taken for granted, such as preparing meals, letting children play outside, tending the garden, or maintaining family routines, become sources of uncertainty, hesitation, and anxiety.

The most innocuous decisions take on new importance, as they must incorporate the invisible presence of radiation and adapt to fluctuating information depending on the evolving situation. Families and communities can be fragmented due to evacuation orders or relocation policies. Tensions disrupt established relationships between family members or within communities. These tensions, based on differing perceptions of risks or choices regarding what to do about the radiation, weaken the bonds forged over time. Many residents also report forms of anxiety, fuelled not only by radiation exposure but also by fears related to long-term health effects, economic decline, the loss of cultural heritage and the stigmatization of their communities (Maeda et al., 2017; Takebayashi et al., 2017). Individuals face painful and morally complex dilemmas, such as whether to stay or leave, return home after an evacuation, or whether to let children play outside. This climate of uncertainty, combined with a perception of risk shaped by many factors can ultimately uproot residents from their familiar environment and social relationships (Ando, 2016). These disruptions threaten the material, symbolic, and existential dimensions of life. Materially, those people relying on agriculture, fishing, or forestry livelihoods may never fully return to pre-accident conditions. Symbolically, belonging to a place which is a key component of the sense of identity and intergenerational continuity can be profoundly damaged when the land, the home, and the community become associated with contamination or exclusion. Public spaces, local foods, and cherished landscapes may come to evoke fear rather than familiarity. Existentially, the sudden disruption to daily life produces a loss of coherence and continuity, challenging individuals' ability to project themselves into the future or maintain a stable sense of self.

The loss of control on living conditions reduces the ability to act and speak which are vital conditions that Ricœur identifies for maintaining the identity of people and their dignity. The erosion of these conditions can leave individuals feeling suspended between a past that no longer seems accessible and a future that remains uncertain. To counter this downward spiral, which can prove catastrophic for certain isolated or vulnerable individuals, participation in dialogues can become a lifeline.

2. Dialogue as a narrative framework

In the co-expertise process, as outlined in ICRP Publication 146, dialogue forms the central procedural mechanism through which stakeholders collectively, express concerns, interpret information, and discuss priorities. Rather than being merely a vehicle for information exchange, participatory dialogue creates a reflective and deliberative space where experts, authorities, and residents engage as partners. Through this mechanism, residents play no longer just passive recipients of expert decisions (Ando, 2021). This dynamic fosters a robust foundation for sharing information, negotiating decisions, acknowledging diverse experiences, and cultivating confidence both in scientific information and in the collective capacity of communities to shape their own recovery (Figure 2).

FIGURE 2. Spontaneous dialogue between residents at the occasion of a visit of the waste storage site in Suetsugi.

Evidence from the ETHOS project in Belarus and post-Fukushima initiatives indicates that this process functions as a "narrative" in the sense developed by Ricœur (Figure 3). His theory of narrative identity emphasizes that human beings understand themselves and others through the stories they tell, receive, and reinterpret over time. In this view, narrative frameworks are more than descriptive accounts of events; they are structures that give coherence to lived experience by linking the past, present, and future into a meaningful whole (Ricœur, 1983). This narrative framework allows individuals to integrate disruptions, contradictions, and crises into a renewed sense of self. Because nuclear accidents profoundly interrupt life trajectories, shattering daily routines, expectations, and symbolic frameworks, the capacity to reconstruct a coherent narrative becomes central to restoring sense of identity and agency for residents and communities.

FIGURE 3. Initial dialogue of the CORE Programme in the Bragin district in Belarus.

This is where participatory dialogue occupies a pivotal role: it becomes the social arena where individual narratives converge, are reconciled, and are collectively elaborated. It functions as a space of recognition — a sphere where the legitimacy of each person's experience is profoundly affirmed, and where the simple act of listening is elevated to a vital moral gesture. Ricœur insists that recognition is essential for ethical life: to recognize another is to affirm their dignity, to welcome their perspective, and to engage in the co-construction of shared meaning. Such recognition empowers participants to negotiate shared rules, revise their interpretations of events, and gradually rebuild a moral sense of identity that has been destabilized by a negative event like a death of a loved one or a disaster like a nuclear accident.

In post-accident contexts, where silence, uncertainty, and powerlessness may dominate, participatory dialogue meetings offer a crucial space for articulating what had previously remained unspoken. Participants recover their voice by recounting experiences of fear, displacement, stigma, or resilience. These testimonies enable emotional validation, helping individuals recognize their own reactions as legitimate and shared. They also foster mutual understanding, as residents, experts, and authorities hear one another's stories and grasp the diversity of lived realities. Studies following both Chornobyl and Fukushima have shown that such dialogical and narrative framework practices significantly contribute to regaining confidence, rebuilding social ties, and reconstructing meaning in disrupted lives (Barasch and Kelly, 2019). They enable isolated or fragmented narratives to be transformed into shared diagnoses and collective forms of understanding. When residents, experts, professionals, and decision-makers engage in structured participatory dialogue, the multiplicity of individual experiences and associated views, is brought together and gradually shaped into a more coherent representation of the situation. Through this process, the group involved in the dialogue develops a shared language, identifies common priorities, and clarifies points of divergence. This interpretive work done together, does not merely help participants understand the radiological situation and the many other challenges they face in their daily life, it also supports the co-design of local projects to protect people and to improve their living conditions by, for example, local monitoring surveillance networks, food-screening initiatives, community-based decontamination projects, or support systems for vulnerable groups (Schneider et al., 2026). As demonstrated in the ETHOS project and later in Fukushima, such co-constructed local actions tend to be more effective and better accepted than purely top-down interventions (Lochard et al., 2026; Ando et al., 2026).

For participatory dialogue to fulfil this ethical and practical function, however, it must adhere to rigorous standards. Ethical participatory dialogue requires transparency in the sharing of information, inclusiveness in the selection of participants, and a genuine respect for minority voices — including those who choose not to return, those who remain sceptical of official statements, or those whose economic activities are disproportionately affected. It also requires an acknowledgment of differing values and life projects, and a conscious avoidance of paternalism in expert behaviour. These elements ensure that participatory dialogue goes beyond a basic communication exercise to serve as a genuine space for deliberation and recognition. This ethical framework aligns with Ricœur's insistence that moral action be mediated through just institutions and fair procedures. By acknowledging a plurality of perspectives and upholding equity, the co-expertise process transforms dialogue into an embodiment of ethical life, where shared narrative frameworks serve as the essential foundation for collective action.

3. The role of testimonies in the dialogue

Testimonies also play a foundational role in the co-expertise process: they restore dignity to those who speak while simultaneously calling for a sense of responsibility in those who listen. In the aftermath of a nuclear accident, individuals often find their capacity to act and to speak diminished by fear, uncertainty, or simply social pressure. (Shigemura et al., 2012) When residents begin to share their stories describing their daily struggles, their doubts, their strategies for coping, or their hopes for the future, they progressively regain agency through the act of narrating. At the same time, these stories impose an ethical duty on experts and authorities, who must respond with empathy, respect, and accountability to realities described by the affected persons. Studies conducted after Chornobyl and Fukushima have shown that such testimonial practices strengthen mutual recognition and create the conditions necessary for more democratic and resilient forms of living together in a contaminated environment (Norris et al., 2008).

The ethical aspects of recovery following a nuclear accident encompass a broad set of principles to be embodied in the co-expertise process to guide decision-making and community rebuilding: transparency, autonomy, trust, accountability, intergenerational justice, equity, solidarity, and the protection of vulnerable groups. These values are not abstract aspirations but practical requirements for ensuring that recovery efforts are fair, participatory, and respectful of human dignity. Transparency, for example, allows residents to access reliable information about radiological conditions, while autonomy ensures their right to make informed choices about their lives and futures. Long-term engagement, and responsibility involve not only the duty to act prudently but also the obligation to repair past harms and prevent future ones (ICRP, 2020).

Dialogue provides the environment in which these ethical values are enacted and tested in practice. It is through participatory dialogue that inequities are revealed, contested, and addressed, allowing diverse stakeholders, for example residents, evacuees, workers and local leaders to articulate their specific concerns and vulnerabilities. This dialogical process also supports decisions that honour environmental stewardship, ensuring that recovery strategies are ecologically sound and attentive to the needs of future generations (Ando et al., 2024). Recent analyses of post-Fukushima recovery have emphasized that long-term sustainability depends on integrating environmental ethics with local knowledge and community participation (Murakami et al., 2025).

Figure 4. Dialogue at the Olmany kolkhoze.

Sharing narrative frameworks about land, work, and community life further strengthens ethical considerations of post-accident recovery by helping residents and local communities articulate the values they wish to preserve, the activities they hope to restore, and the responsibilities they feel toward their environment (Figure 4). These narrative frameworks inform decision-making processes that balance immediate needs with long-term responsibilities, reinforcing Ricœur's idea that ethical action emerges from the interplay of recognition, justice, and shared meaning. From this perspective, participatory dialogue is not simply a technical step in the co-expertise process, but a moral approach based on mutual respect.

4. Dialogue and the use of facilitation techniques

Experience from various post-accident initiatives — including the ETHOS project and CORE program, the ICRP Dialogue initiative, and subsequent efforts by local authorities and the Fukushima Dialogue NPO — demonstrates that structured facilitation within an appropriate ethical framework significantly enhances the effectiveness of these interactions (see Box 1). One such facilitation technique is the Identification, Diagnostic, Prospective and Action (IDPA) method. Originally used in the ETHOS project and CORE Program in Belarus, and later systematically applied in the Fukushima Dialogue meetings, this method is presented briefly in the following paragraphs.

Box 1. The Fukushima Dialogue (2011 - to present day)

Following a visit to Belarus during which Japanese members of the International Commission on Radiological Protection (ICRP) learned about the ETHOS team's dialogue experience, a first dialogue meeting was held in Fukushima Prefecture in November 2011 (Lochard, 2015). This meeting focused on improving living conditions after the Fukushima accident, and was held in the presence of representatives of regional and national authorities, as well as mayors and professionals from the affected localities, university researchers, national and international institutes, and NGOs. Building on the success of this first meeting, the ICRP subsequently organized 14 more dialogue meetings between 2011 and 2015. These meetings, which were held over 2 days at weekends, gathered invited participants including Belarusians and Norwegians, local, national, and international observers. They were facilitated by ICRP members, using a common language and the Identification, Diagnostic, Prospective and Actions (IDPA) dialogue technique, giving each participant the opportunity to express her/his view and to react to the views of the other participants. They were summarized by rapporteurs, after which there was a period for general discussion. All dialogue meetings were simultaneously translated and video recorded (Lochard et al., 2019). In early 2016, a group of regular participants to the dialogue meetings requested ICRP to hold further meetings. Entirely supported financially by the Nippon Foundation, facilitated by ICRP and logistically supported by Fukushima Medical University and the Ethos in Fukushima NPO, 8 meetings were held between February 2016 and the end of 2018. In June 2019 the NPO Fukushima Dialogue was officially established with the main objective to continue the Dialogue meetings (NPO Fukushima Dialogue, 2019). This date marks the start of the third series of dialogue meetings entirely organized by local residents, held annually in the autumn. The dialogues take place in person in the various municipalities affected by the accident but can also be followed online, always including a day for site visits and a day for facilitated dialogue. They are video-recorded and a summary is published online on the NPO's website in the following days, along with the full video of the discussions. The NPO Fukushima Dialogue organized the 27th dialogue meeting in December 2025!

FIGURE 5. General view of the Dialogue Meeting held in Date City in February 2012 (photo: Chris Clement).

The IDPA method, developed by Professor Ollagnon of the Paris Institute of Technology for Life, Food and Environmental Sciences in the 1980s, aims to facilitate dialogue between stakeholders facing complex or conflicting situations. Integrated into the "heritage audit" approach, it was designed to address emerging environmental challenges in France, such as groundwater pollution in Alsace or the reintroduction of bears in the Pyrenees. Later, this method was applied to various land-use planning projects involving stakeholders with divergent, even opposing, viewpoints.

The objective of IDPA is to bring together the expertise of all stakeholders, each considered a valuable expert in their own right. It seeks to determine the conditions and means to collectively support the resolution of the problems raised. Unlike traditional survey methods, IDPA does not simply gather opinions or measure attitudes, but aims to develop strategic thinking. Participants are not placed in a passive position, but play an active role as experts on the problem they are experiencing, thus contributing to a deeper understanding and effective solutions.

Participants are selected based on their ability to influence the situation, their representativeness (experts, authorities, professionals, NGOs, etc.), and sometimes randomly to diversify perspectives.

Their number depends on the complexity of the situation and the available resources. A facilitator, assisted by rapporteurs, guides the session. Participants first agree on a strategic question, formulated clearly and openly to avoid influencing responses. The IDPA method is based on a framework of four steps: Identification of the situation and the problem at stake, Diagnosis of the actions to manage the problem, Prospective on the evolution of the situation, and Actions proposed to respond to the problem. Each step is addressed in two discussion rounds. During the first step, each participant expresses their point of view on the aspects related to the step, and then responds to the comments of the other participants during the second step. To ensure a fair dialogue, strict procedural rules are applied: equal speaking time for everyone, and a ban on interrupting and debating. Each step is summarized and followed by a general discussion. If the situation is complex, the exercise may extend over several days. In short, IDPA promotes mutual listening and the reflection and convergence of views by structuring the exchanges for constructive collective (Lochard et al., 2023a).

Following the Fukushima nuclear accident in 2011, members of the International Commission on Radiological Protection (ICRP), inspired by the Chornobyl experience in Belarus and the IDPA methodology, organized a series of dialogue meetings in Fukushima Prefecture. The first meeting, in November 2011, brought together various local stakeholders, Japanese and international experts, as well as guests from Belarus and Norway, to address the challenges of long-term rehabilitation of the affected areas. To date, 24 meetings have been held in approximately ten municipalities, using a simplified and adapted version of the IDPA methodology combining the four steps because of the time constraint. These meetings, open to observers and the media, and recorded, took place in an innovative setting to ensure transparency and smooth communication, despite the presence of a large audience and the need for simultaneous Japanese/English translation. An experienced facilitator and a rapporteur ensured the fairness and transparency of the discussions. Ten to fifteen stakeholders, selected from among the participants, actively took part in the IDPA methodology, while the others attended as observers. Despite the loss of anonymity usually required, this did not disrupt the smooth flow of the discussions. Over time, the format of the meetings evolved, moving from two days to a single day indoors, with the other day dedicated to field visits.

Through the testimonies of the participants, these dialogues led to a better understanding of the societal consequences of the Fukushima accident such as the dilemmas whether to stay or leave the affected territories, the discrimination and stigmatization aspects as well as the crucial importance of radiation measurements and ethical considerations in the recovery process (Naito et al., 2026). These testimonies enriched the ICRP's recommendations for the protection of people and the environment in the event of a major nuclear accident, aiming to improve preparedness and support for communities in the event of a future nuclear accident (ICRP, 2020).

Conclusion

Experience has shown that dialogue rebuilds confidence in protection strategies, increases transparency in scientific reasoning, and trust in one's own capabilities, yet its transformative influence extends far beyond these immediate benefits. In the aftermath of a nuclear accident, people often face profound disruptions to their sense of agency, sense of identity, and belonging. Dialogue provides a social and ethical environment where these disruptions can be voiced, heard, and gradually reconstructed. By articulating their fears, uncertainties, and hopes, residents begin to reconnect with a shared humanity and a collective resilience (Aldrich DP, 2012).

Through participation in dialogue and co-expertise activities, individuals regain self-esteem, rediscover initiative, and reconstruct meaning in their disrupted lives. Dialogue helps residents see themselves not merely as passive recipients of expert guidance but as active contributors with valuable experiential knowledge. This shift in sense of identity enhances their capacity for personal initiatives —whether through citizen-based radiation monitoring, community-led evaluations of protective actions, or shared deliberation about the future of their life and environment. Dialogue also offers a space for emotional expression and validation, allowing fear, anger, uncertainty, and hope to be acknowledged without judgment. Studies following Fukushima have shown that such emotional processing, when embedded in a supportive dialogical structure, significantly strengthens long-term resilience and fosters a renewed sense of personal and collective agency (Schneider et al., 2025).

The French sociologist Edgar Morin said that culture means not feeling powerless in the face of problems (Morin, 1992). Dialogue helps restore precisely this cultural capacity by enabling individuals and communities to reconnect with their ability to interpret complex situations and respond with creativity and discernment. Through collective reflection and shared narrative framework, participatory dialogue cultivates a form of practical wisdom — an adaptive intelligence that emerges from the interplay of diverse experiences, values, and interpretations. As a result, people recover not only confidence in their own capabilities but also a sense of belonging to a community that can imagine and enact a shared future. Such recovery of confidence and belonging is not merely psychological but ethical. It reinforces dignity, autonomy, and solidarity, making participatory dialogue an indispensable element of the co-expertise process.

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10
The role of measurements in the co-expertise process after a nuclear accident: a contribution to mediating the reality

Wataru Naito[1], Ryoko Ando[2], Daiki Sasaki[3], Jean-Marc Bertho[4], Jacques Lochard[5,6], Thierry Schneider[5,6,7]

Abstract

This chapter explains how radiation measurements play an important role in the co-expertise process after a nuclear accident. Because people cannot feel radiation by their senses, measurements help them to see the invisible situation in their daily life. Through working together with experts, residents learn how to interpret numbers and understand their own exposure. This process also supports them to make decisions for protective actions and regain autonomy in their community. A turning point in terms of individual external dose measurements came with the development and roll-out of the D-Shuttle personal dosimeter after the Fukushima accident. The D-shuttle experience demonstrated how measurements reshape residents' perceptions and everyday decision-making, not only from a technical perspective but also by building dialogue and trust. The chapter closes with a discussion on ethical aspects of measurements and the importance of continuous vigilance in contaminated areas.

Introduction

Radiation cannot be felt by the five senses. Facing this elusive reality, imperceptible to the human senses, the only way to cope with the radiological situation is to appeal to science and deploy radioactivity measurements to translate it into

[1] National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan
[2] NPO-Fukushima Dialogue, Iwaki, Japan
[3] Tsukuba University, Ibaraki Prefecture, Japan
[4] Authority of Nuclear Safety and Radiation Protection (ASNR), France
[5] Nagasaki University, Japan
[6] International Commission on Radiological Protection (ICRP)
[7] Nuclear Protection Evaluation Centre (CEPN), France

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numbers. It takes some time for the people who decide to embark in radiological protection to master how radiation is measured, the meaning of units and how, more importantly, to interpret the results and finally to decide if there is a need for action or not. Needless to say, when a nuclear accident occurs and radioactivity invades the direct living environment of people, it is for them just an incomprehensible reality—one for which they have no experience, no words to describe it, and no knowledge how to grasp it or what meaning to give it (Lochard, 2026). What they generally know is that radioactivity is dangerous, because they have heard about the atomic bombs of Hiroshima and Nagasaki which killed instantaneously more than one hundred thousand people, not to mention the victims of cancer or other radiation-induced illnesses occurring later. In such dramatic and vague context what is the role of measurements in the co-expertise process?

Measuring radioactivity is one of the 3 pillars that structure the co-expertise process, in addition to dialogue and local projects. Measuring radioactivity is an effective way to engage residents living in affected areas to help them to understand when, where and how they are exposed in their day-to-day lives. By involving residents in the measurement of radioactivity it is possible to make visible what was invisible to them. Measurements raise awareness of the ways in which an individual is exposed and allow possible protective actions to be sought, at the individual or collective level, to reduce those exposures, which are avoidable. Engaging residents in measurements should be progressively developed based on a comprehensive approach performed by residents themselves (self-monitoring) and/or by the authorities and experts together with the residents living in affected areas. By doing so residents regain progressively control over the radiological situation they are confronted with.

The act of measuring one's environment transforms a difficult-to-understand situation into understandable, actionable information, that reduces anxiety and enables residents to make choices aligned with their own values, desires and life projects and to be able to express their views on the recovery strategy established by the authorities. The measurement activities demonstrate to those involved that scientific and technical knowledge, when shared and explained and rooted in lived experience, can support individuals in reconstructing meaning and regaining control in the aftermath of a nuclear accident. It is through this interaction between measurement, interpretation and development of the narrative framework, that is to say the linguistic process by which individuals make sense of their experiences, that communities begin to regain control of their present situation and to imagine possible futures (Ando, 2016).

1. The measurement process: making the invisible visible

1.1. *Before Measurement: Establishing the Conditions for Dialogue*

When an expert meets a resident of contaminated land in the weeks, months, or even years following a nuclear accident, and when residents' prior knowledge is limited to information circulating in the mass media, the expert is very likely to be confronted with a recurrent initial question: "Is it dangerous to live here?" — asked in the presence of others — or, in a more private setting, "Tell me, you are an expert, can I live here?"

At this stage, residents' images of radioactivity are often extremely vague. Most people have never carried out any form of measurement, nor can they readily imagine what measurement entails or what purpose it might serve. As a result, residents are not necessarily inclined to engage in measurement at the outset and may even be sceptical of it. Some residents even refuse to engage in measurements because they are apprehensive about the result! At the same time, in the absence of measurement, their concerns and questions remain so indistinct that it is difficult to grasp how they might be addressed.

In responding to such questions, experts may be tempted to draw on their technical knowledge of radioactivity and to provide more or less precise explanations based on available data on the radiological situation. However, this approach often serves only to reinforce residents' distrust of anything perceived as "official."

An alternative response is for the expert to suspend premature explanation and instead return the question to the resident's living context: "I do not know because it depends on where and how you live. Tell me about your home, your occupation, your eating habits, and other aspects of your daily life that I do not yet know." Such a response may initially unsettle residents, but it often arouses curiosity. It is at this point that a dialogue can begin. By asking a few seemingly innocuous questions — such as "Where do you live?" or "What do you do for a living?" — the expert invites the residents to speak about their everyday life. Such an alternative asks for a radical change in the expert standpoint, from a top-down, scientific and technical discourse about the situation, which represents sometimes a working life-long experience, to an open-minded, language-adapted posture, respectful of residents' concerns and opinions. In these conditions, gradually, a narrative begins to emerge.

Within this informal dialogue, residents start to hint at the concern that motivated their initial question. This concern may relate, for example, to a daughter who left the village with her children at the time of the accident and no longer wishes to return, leaving the resident fearing that they may never see their grandchildren again. It may also concern something quite different, such as whether it will ever be possible to resume gathering bamboo shoots or blueberries in the forest bordering the village.

Importantly, the concerns that residents articulate at first are not always those that most directly shape their daily struggles. When confronted with an unprecedented situation, only a small minority of people are able immediately to recognize what they are struggling with and to communicate it clearly to others. Vague anxieties and mistrust are therefore often expressed through episodes drawn from personal memories or second-hand accounts — for example, stories heard about long-term health effects among atomic bomb survivors. While such narratives are meaningful, they do not necessarily correspond to the underlying source of concern. As a result, no definite response can be found, no matter how extensively they are discussed.

For this reason, attentive listening is essential. Dialogue prepares the conditions under which residents can, through conversation, arrive by themselves at the issue that motivates their concern. Only once this concern has been identified does it become possible to consider how to address it. If the concern is related to radioactive contamination, the carrying out of measurements can then be proposed. From this point onward, dialogue continues, in which the expert shares knowledge in everyday language, while the residents describe their daily life in greater detail, articulating questions, fears, and hopes.

This scenario is necessarily simplified and somewhat artificial. Nevertheless, it illustrates a central point: When grounded in dialogue, measurement can become a meaningful contribution to address residents' concerns and set the co-expertise process in motion.

1.2. *Implementation of measurements in the field*

Technically, measurements should involve ambient dose rates, external/internal exposures, and foodstuff contamination. For measurements to be meaningful, they should be conducted step-by-step from sources of exposure to the exposures received by individuals through the various exposure pathways. At the same time, interviewed experts mentioned that, when performing measurements, the most important aspect to pay attention is to listen and understand the concerns expressed by affected people (Thu Zar et al., 2022). By grasping resident's concerns and expectations, it becomes possible to provide measurement instruments adapted to the stakeholders' need, to accompany them in the definition of the monitoring programme, and to support them in interpreting the results. It is also the responsibility of the expert to provide advice on instruments to be used that must be adapted to the situation, reliable, robust, easy to use, and if possible, include the possibility to share the results in an easy way as illustrated by the D-Shuttle and OpenRadiation in the next sections. The aim is for the residents to be able to think about what the measurement results mean for their own lives. The involvement of residents in analysing the results of measurement, and in sharing them with members of their community, is crucial for understanding their meanings (Ando, 2016).

In most cases, particularly at the initial stage, simply looking at numerical measurement results does not allow residents to judge whether the values are high or low. One reason is their limited knowledge of radiation risks. Another is that low-dose exposure inherently lies in a grey zone in which judgment is difficult. As a first step, many people therefore seek reference points that allow them to assess their own situation through comparison. In this context, comparing their exposure levels with those of neighbours or other members of the community can be a powerful means of helping residents understand the factors that shape their own exposures. In addition, placing radiation exposure alongside more familiar exposure, such as those associated with daily life activities, can help residents to put in perspective the risk associated with the exposure they receive.

With regard to the basic concepts and units of radiological protection — which at first glance are often incomprehensible to non-specialists — the experiences of Chornobyl and Fukushima have shown that the most effective way for residents to learn how to use them is through individual measurements in which residents are directly involved and interact with experts to interpret the results (Lochard, 2013;

Ando, 2016). During the measurements, experts can progressively introduce concept and notions on radiation exposure. These experiences have also shown that sharing measurement results in order to discuss the situation of the community is a powerful means of enabling residents to understand their own situations and to identify opportunities to improve their protection. Measurements implemented within a co-expertise process can thus support the adoption of self-help protective actions adapted to each individual and if necessary to require additional collective protective actions, as well as the organization of radiological monitoring within the community to ensure collective vigilance.

What is important here is to develop expert discussion on the properties of radioactivity starting from concrete, individual measurement results. Abstract, textbook-style explanations, or knowledge about radioactivity presented in the form of general statements, often lack clarity as to whom they are meant to be meaningful for. As a result, such discussions rarely lead to self-help–oriented action and instead tend to degenerate into inconclusive debates. By contrast, when concrete measurements are carried out in the environment of the community, numerical values and related concepts acquire meaning in relation to one's own life or that of one's family. From this starting point, understanding of radioactivity and its properties and the way residents are exposed can progress substantially.

As far as the implementation of the measurements is concerned, it requires the use of appropriate measurement instruments, and it is the role of experts and authorities to support residents to get these instruments. Conducting individual measurements requires both the competence to perform measurements and access to suitable instruments. Public and/or private support to residents is therefore necessary to acquire these instruments, and their use by residents inevitably mobilises technical and human resources (Figure 1).

When the process is not supported from the outset by a specific organization, those leading the co-expertise process must seek the necessary support from local or national authorities, experts or academic institutions. This can be a demanding and time-consuming task, requiring tenacity, as illustrated by the experience of the Suetsugi district (Ando et al., 2026).

FIGURE 1. The food measuring station in the Suetsugç community house (Ando et al., 2026).

2. Taming the rays: the D-Shuttle experience in Japan

2.1. *Early limitations in post-accident co-expertise*

In the co-expertise initiatives after Chornobyl, such as ETHOS and related projects, residents did not have easy-to-use portable devices to measure individual external dose in their daily life. Measurements focused mainly on ambient dose rates and on internal exposure using whole-body counters. Therefore, individual external exposures had to be inferred indirectly from ambient data and time individuals spent in different locations and activities, rather than being measured directly for each person's routine. This imposed additional calculations and modelling within the co-expertise team to turn people's questions into practical, self-help actions based on their real activities.

2.2. *A turning point: individual external dose measurement with D-Shuttle*

The gradual use of D-Shuttle in Fukushima created new opportunities. D-Shuttle is a small silicon personal dosimeter that records hourly personal dose (Figure 2). It shows when and how much exposure happens during the day. Combined with GPS logs and time-activity diaries, residents and experts could interpret the numbers together and link directly dose patterns to places and actions. Large campaigns from 2013 to 2019, including several hundred participants in both non-evacuation areas and former evacuation zones, produced realistic distributions of individual external doses and their variation across jobs, locations, and routines (Naito et al., 2016, 2017).

Figure 2. The left side shows the D-shuttle device. The upper right shows the management unit and an example of hourly dose display, while the lower right shows the daily dose (photos: W. Naito).

Across studies, average additional individual external doses measured with the D-Shuttle were often lower than estimates provided by the authorities and expert bodies based on airborne monitoring and conservative assumptions concerning the times of exposure indoors and outdoors of the residents. At the same time, differences between people from the same community were meaningful and reflected their time — activity patterns (for example, outdoor work, commuting routes, or time at specific indoor/outdoor sites). This combination — lower population averages but useful variation between individuals — shifted attention from abstract debates about "areas" to concrete, person-specific factors that people can manage.

Importantly, D-Shuttle was not used by one team only. Beyond the series of studies by Naito and colleagues, D-Shuttle was also used in school-based projects and other resident-led or researcher-supported efforts. For example, a high-school project compared students' individual doses inside and outside Fukushima, including students from Belarus, France and Poland, and helped them communicate their findings in simple terms (Adachi et al., 2016). Such cases broadened participation and showed that non-experts can collect and discuss personal dose data, if the process is well guided.

2.3. *What residents actually learned: from numbers to everyday choices*

Beyond the scientific characterization of individual doses, the D-Shuttle experience revealed how measurement reshapes residents' perceptions and everyday decision-making. For many residents, wearing a dosimeter did more than give a total number. It changed how they looked at daily life. Hour-by-hour profiles discussed with experts showed that dose depends not only on where one lives, but also on how one moves and spends time. In some cases, commuting by car through certain road segments or working outdoors at particular sites contributed most; in other cases, time at home mattered more, depending on house conditions and routine schedules. These insights helped residents separate what was unavoidable from what was avoidable. Small adjustments — changing a route, shifting the timing of an activity, or re-balancing indoor and outdoor time — were often significant to improve individual external exposure, without disrupting family or work plans.

Interviews done when returning results showed different reactions to similar numbers. (Naito and Uesaka, 2018). Some residents felt reassured once they saw that their usual habits led to doses below familiar reference values. Others focused on short peaks and asked for concrete options to reduce them. The lesson is clear: measurement alone is not enough. What matters is the shared interpretation — the dialogue that connects numbers to places, routines, and personal goals — so that residents can choose and act with confidence, and if necessary, call for additional actions from the authorities.

The studies in Fukushima also showed a double-edged sword of personal dose measurements. If results were sent without proper explanation, or if short-term peaks were compared directly with annual radiological criteria, anxiety could increase. In addition, because D-Shuttle clearly shows differences by lifestyle and location, residents may be tempted to avoid "higher" spots even when the differences are small and not practically important. And, as noted in the previous section, residents naturally compare their results with those of neighbours to understand their own situation. When D-Shuttle reveals distinct living-pattern differences, those with higher readings may feel they are at a disadvantage, which can harm well-being at both individual and community levels. Co-expertise therefore needs reliable devices and prepared support for explaining, comparing, and following up on results, so that numbers build capability rather than worry. Experience in Fukushima suggests a practical way to reduce these negative effects: present doses as ranges rather than isolated values. By showing where a person's exposure sits between familiar reference levels—such as natural background radiation, a commonly used guideline for additional dose—attention shifts away from small numerical differences. This banded presentation helps residents focus on the overall exposure level and supports calmer, more balanced decisions.

2.4. *What D-Shuttle changed in the co-expertise process*

Bringing easy-to-use individual dosimetry into co-expertise shifted the focus from places to lives. Instead of speaking only about contaminated "areas", residents and experts could see how exposure changes hour by hour within real daily routines. This helped residents make protective choices based on their own values and practical needs, rather than on abstract maps.

It also shifted the focus from averages to distributions. Community-level averages often hid important differences. Personal dose data showed who was more exposed and for what reasons, making it easier to support fair and proportionate actions for those who needed them most.

Finally, it shifted the focus from one-way explanation to co-interpretation. Numbers gained meaning through dialogue. Residents were able to act more autonomously in everyday protection and to discuss recovery options with authorities in a concrete and constructive way. At the same time, the Fukushima experience highlighted the importance of ensuring that participation in individual measurements is voluntary, and that people clearly understand how their data will be used. Particular care is needed to protect individual privacy, especially when results reflect personal lifestyles or places of living. When measurement data are shared beyond the individual level, explicit consent is essential, together with safeguards to prevent identification and misuse.

In short, the D-Shuttle experience in Fukushima did not simply add another device to the measurement toolbox. It changed measurement into a mediating practice that makes the invisible visible for someone, in a specific place, at a specific time. Through this process, co-expertise supports understanding and enables residents to act with greater autonomy.

3. The main ethical aspects of measurements

While measurement plays an essential practical and cognitive role, it also brings forward fundamental ethical issues within a co-expertise process. Three main ethical aspects of the measurements in the co-expertise process can be highlighted: contributing to the autonomy of residents, identifying and addressing inequities, and ensuring vigilance.

3.1. *Contributing to autonomy*

Engaging a community in measurement campaigns aims first of all to characterize the local radiological situation and the specific exposure features. As mentioned above, participating to this characterization, residents gain progressively, with the help of the experts, a capacity to better understand the local radiological situation and the way they are exposed. This step allows them to acquire the radiological protection culture and contribute recovering their autonomy on their day-to-day life.

This autonomy gives them the capacity to identify specific self-protective actions to reduce their exposure and to take informed decision on their implementation. It also contributes to their capacity to evaluate and judge the recovery program developed and implemented by authorities. Gaining in autonomy, they can engage a dialogue with experts and authorities to identify the relevant actions to be implemented for improving the situation of their community and envisage the future.

In this perspective, the promotion of autonomy through co-expertise is not aiming at residents fend for themselves and therefore isolate themselves but rather to promote this autonomy in the context of the community together with the support of experts as necessary. In addition, the role of measurements is not aimed at explaining to the residents that there is no significant radioactivity in their surroundings but rather to provide them the capacity to judge by themselves on the situation, to take relevant protective actions and to request specific support from authorities when necessary.

3.2. *Identifying and addressing inequities*

Most of the time, when residents of a community ask an expert about the level of exposure where they live, they are completely unaware that their exposures depend on their location within the community, their daily activities, and their dietary habits. They have a vague belief that the situation is identical for everyone in the community and that the expert will be able to easily answer the question. In fact, if the expert, as described in the first section, engages in dialogue and implements measurements to consider each person's situation, the collaborative assessment process will inevitably reveal radiologically disparate situations on an individual level. Few residents are aware of this fact because, living in the middle of a community, everyone thinks they share the same situation as their neighbours, and this thought is supported by the implementation of protective actions by the authorities established on potential large geographical scales, far beyond the local community. In practice, each radiological situation is characterized by a distribution of exposures, which translates into a distribution of doses received by each individual. This phenomenon is not limited to differences between neighbours in terms of the distribution of contamination, but can also exist within the same family depending, for example, on significant differences in each person's diet. Measurements carried out in Belarusian villages participating in the ETHOS project have shown very significant differences concerning internal contamination of children within the same family consuming highly contaminated milk for example when one of the children disliked milk and never drank it, while their brother or sister was very fond of it (Lepicard and Hériard-Dubreuil, 2001). This example shows that without individual measurements grounded in daily practices, such disparities remain invisible and therefore unaddressed.

In this perspective, engaging residents in measurements is useful both for the residents to identify their own radiological situation and for the experts to identify the dose distribution due to the specific local characteristics and habits of the community. Without this detailed assessment of the situation provided by the co-expertise process, it is not manageable to engage a more individualized approach to cope with the inequity in the distribution of exposures.

Regarding the distribution of individual exposures, the International Commission on Radiological Protection (ICRP) has long recommended aiming for equity, that is limiting individual exposures to correct any disparities in the distribution of individual radiation doses within exposed populations (ICRP, 1977). Thus, the Commission recognizes that any exposure situation, whether natural or man-made, can lead to a wide distribution of individual exposures. Furthermore, the implementation of protective measures can also introduce potential distortions in this distribution, which could exacerbate inequities. In this context, the protection criteria of the radiation protection system play a dual role. First, these criteria aim to reduce inequities in the distribution of individual exposures in situations where some people might be subjected to significantly greater exposure than others. Secondly, they aim to ensure that exposures do not exceed the values beyond which the associated risk is considered not tolerable in a particular context (ICRP, 2018). These "ethical" principles can only be verified through measurements.

Moreover, to make such figures meaningful, experts must put them into perspective by relating them to exposure situations that are familiar to residents. At the same time, the use of comparison requires particular caution. It is important to distinguish between the characteristics of the exposure situations which are compared such as imposed exposure vs. voluntary exposure. Without such distinctions, comparisons may have adverse effects, especially in terms of general trust. Only when reasonable comparisons are provided, together with the necessary caveats regarding the exposure situations, are people more likely to be able to assess satisfactorily the situations they face (Murakami, 2018; Covello et al., 1988). If risk comparisons are not conducted carefully, they can be even counterproductive. For example, when differences in exposure levels within a community are substantial, comparisons among community members may foster a sense of inequity and, in some cases, lead to stigmatisation. For this reason, comparisons with neighbours are generally more appropriate in communities where differences in exposure levels are in the same range.

3.3. *Ensuring vigilance*

Although the combined action of decontamination efforts by public authorities and the natural decay of radioactivity significantly reduced the ambient dose rate in the areas affected by nuclear accidents, allowing for the gradual lifting of protective actions, many residents still wish to take measurements to better characterize the radiological situation of their living areas as well as its evolution. In fact, radioactivity is distributed heterogeneously in the environment and moreover it is not fixed in the environment and can migrate and accumulate due to erosion, rain, flood and other natural phenomenon or anthropic activities. In this context, vigilance is defined as a protection behaviour against the danger represented by the presence of radioactivity in the living environment and its evolution (Figure 3).

FIGURE 3. A school teacher checking the ambient exposure rate during a forest excursion with her students during the ETHOS project in Belarus (1996-2001) (photo: J. Lochard).

In this context, the NPO Fukushima Dialogue (NPOFD), an NGO dedicated to promoting dialogue on radioactivity in the Hamadori region of the Fukushima Prefecture, recently received several requests from some residents of Fukushima Prefecture to take measurements. Building on the collaboration with OpenRadiation, a French citizen initiative for radioactivity measurement (Bottollier-Depois et al., 2019), the NPOFD provided radioactivity detectors to residents wishing to perform ambient dose rate measurements in their environment. In fact, the objective is not anymore to assess individual exposure, as it was made by using D-shuttle, but rather to implement environmental monitoring able to answer questions from land users or customers about the presence of radioactivity. Interviews were also conducted with the residents who performed these measurements in Japan to identify their motivations and interests. Results indicated that the main motivation was to answer questions about radioactivity from potential users. Most of them were not surprised by the results, globally low. However, some specific points gave unexpected results, which highlighted the variability of results according to both the place of measurement and measurement protocols and the need for vigilance.

Despite the motivation of reassurance, the participants shared some doubts about the usefulness of sharing the results on a local scale. Reasons including avoiding risks of stigmatization of places in which evacuation orders were lifted and avoiding risks of conflict with local authorities. However, they all agree on two points. The first point is making measurement results available on-demand, and the second point is the agreement to publish these results at an international level. This later reason seems to be linked to the wish to show that the situation is comparable to other places in the world (the objective being reducing stigmatization).

From a radiation protection perspective, the main motivation remains concern about the presence of radioactivity in the environment or in foodstuffs and clearly relies on the vigilance principle. For instance, measurements made along the Fukushima Hamakaido Trail showed some places where ambient dose rates were surprisingly elevated. This was due to the proximity with a forest. These measurements, as well as those carried out as part of the "Kobito no Mori" project or along the Pacific coast at Suetsugi, clearly demonstrate that even 14 years after the Fukushima accident, citizen-led measurements are still relevant (Ando et al., 2026), even if the underlying questions are different from those arising in the first two years after the accident (Ando, 2016). This observation was also previously highlighted in a study carried out near the Chornobyl region in the late 2010s (Bertho et al., 2019), where citizen-led measurements in a Belarus village close to the exclusion zone highlighted three hotspots, due to ashes remaining from fireplaces. This study also highlighted the need for individuals to be vigilant, both as a means to evaluate radiological quality of the environment and also to reduce further environmental contamination if necessary.

4. Measurement as mediation to reality

Although Paul Ricœur, a well-known French philosopher of the 20th century, was more interested in the study of human behaviour than in the direct study of physical phenomena, his reflections on the concept of "mediation" provide an interesting perspective on the role of measurements in the co-expertise process. For Ricœur, our access to reality is always mediated by language, symbols, or instruments. Measurements implemented in the physical sciences, such as those of radiation in the radiological protection domain, are technical mediations that allow us to objectify the presence of radioactivity and communicate this reality of the world. Like narratives, measurements allow us to explain the reality that surrounds us. Generally, measurements transform subjective observations into objective ones, shareable, and verifiable, making phenomena understandable and open to debate. Indeed, Ricœur is comparing reality as a text to be interpreted and our access to reality is always mediated by language, symbols, or instruments. The measurements of radioactivity are technical mediations that allow us to objectify the presence of radioactivity and to communicate this reality of the world. In his work "The Conflict of Interpretations: Essays in Hermeneutics" (Ricœur, 1969), he distinguishes scientific objectification and practical judgment. Measurements serve the objectification of reality. They are legitimate and indispensable for explaining facts using a theoretical framework and models, but they say nothing about the views of the people involved and the meaning they attribute to these facts. Thus, in the field of science, they allow us to structure reality so that it can be interpreted according to common rules shared by scientists in a given field.

It is also important to remember that, for Ricœur, objectivity results from a collective process that makes it possible. This shared process is a constitutive element of confidence in the results and contributes to fostering confidence among the participants (Figure 4).

FIGURE 4. The midwife and the dosimetrist from the village of Olmany checking the quality of the milk in the presence of an interpreter from the ETHOS team during the ETHOS project (1996-2001) (photo J. Lochard).

However, regarding radiation protection, an additional dimension has to be taken into account — that the objective reality of the world is represented by a measurement of radioactivity (with a result in Becquerel, the unit for measuring this physical phenomenon). The presence of radioactivity in the environment can be judged as illegitimate on an individual basis, but is a representation of the physical, objective reality of the world to the whole community. This is in accordance with the concept of interpretation of reality. For Ricœur, objective reality is clearly a social construct, but it is also important to bear in mind that while measurements allow us to interpret a part of objective reality, they indicate absolutely nothing about what the people involved in the measurement evaluate as an acceptable risk for themselves.

The expert thinks about comparing the results with the applicable standards, and the resident wonders about the presence of radioactivity and its impact on their grandchildren. These intimate personal experiences are only accessible through the social sciences. In short, for Ricœur, measurements are mediations that make reality accessible and require interpretation through collective conventions within the rationality of society. In conclusion, one could say that measurements of radioactivity allow us to objectify a part of reality. They are a very useful medium for acting on this reality and also for talking about it, embarking other dimensions to grasp their full meaning (see box 1).

Box 1. Belarus farmer and his potatoes

During a visit to a potato field belonging to a Belarusian farmer, who had come to check if they were ready for harvest, he pulled on a stem to retrieve one. He first cleaned it by hand to remove the soil, then took out a folding penknife that he never left behind and, with a steady hand, cut the vegetables in half. He then brought one half to his nose to smell it and, turning towards the field, declared with conviction: "it's perfect. I'll come back tomorrow for the harvest with the whole family". Then, looking around him, he added a little later, somewhat sadly, "and to think the potatoes might be 90 becquerels like last time"!

It was once he returned to the village, after measuring the potatoes, which turn out to be only 30 becquerels per kilo, and after a dialogue with the family and a radiation protection professional, that the farmer was able to combine the quality of his potatoes with the measurement result. He finally decided that part of the harvest would be for the family's own consumption and the rest would be sold at the market.

Concluding remarks

Since the Fukushima accident, the ICRP has reaffirmed its recommendation to support citizen initiatives aimed at regaining control of the radiological situation after a nuclear accident, by promoting the implementation of an inclusive co-expertise process involving radiation protection authorities, experts, NGOs, and local communities (ICRP, 2020). This approach has already been implemented after the Chornobyl accident, notably during the ETHOS project. The availability of user-friendly sensors after the Fukushima accident enabled the rapid development of citizen-led environmental radioactivity monitoring around the world. As a result, the amount of publicly accessible data has increased considerably and now feeds into ambient dose rate monitoring networks. These measures can be used to inform the general public about radioactivity, but also to strengthen preparedness for nuclear accidents. For younger generations, this is a way to confront the memory of the Chornobyl and Fukushima accidents and to understand that radioactivity measurements taken by residents of contaminated areas are essential for fostering dialogue between the public, experts, and government representatives in order to manage the radiological, social, economic, and environmental consequences of such accidents. By learning that these measurements are indispensable for enabling residents to develop a culture of radiation protection and to participate in radiation protection strategies, they will certainly be better prepared should they one day encounter radioactivity in their daily environment.

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11
The role of local projects in the co-expertise process after a nuclear accident: fostering self-confidence and building the future together

Thierry Schneider[1,2,3], Jacques Lochard[1,2], Ryoko Ando[4], Win Thu Zar[1]

Abstract

After engaging residents in dialogue and performing radiological measurements, the third pilar of the co-expertise process focuses on the selection and implementation of local projects. These projects aim to improve the radiological protection of people and the environment, and to contribute to an improvement in their quality of life by maintaining and supporting the dynamic of the socio-economic activities. This chapter describes first the variety of local projects implemented after the Chornobyl and Fukushima accidents in four priority areas, namely health, radiological quality, economic development and education/memory as well as the level of partnership: individuals themselves, community level, regional level, national level and international cooperation. Secondly, the chapter discusses the key contributions of these projects relating to fostering self-confidence, restoring community life, contributing to well-being and ensuring vigilance and sustainability. In conclusion, ethical considerations and governance mechanisms to support local projects are highlighted.

Introduction

The rehabilitation of living and working conditions in affected areas after a nuclear accident presents a double challenge. First, it is to provide adequate protection for the people and the environment, and secondly, it is to maintain

1 Nagasaki University, Japan
2 International Commission on Radiological Protection (ICRP)
3 Nuclear Protection Evaluation Centre (CEPN), France
4 NPO Fukushima Dialogue, Iwaki, Japan

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and support the dynamic of socio-economic activities (ICRP, 2020). The feedback from Chornobyl and Fukushima has shown the importance of the direct involvement of the affected people and local communities, through the adoption of the co-expertise process fostering the cooperation between local residents and the experts (Thu Zar, 2022). In addition, it also highlighted the need to adopt governance mechanisms respecting ethical and social values, aiming to favour and support local initiatives within the recovery process (Lochard, 2016).

Radiological protection, although essential to protect people from radiation (i.e., those who have stayed, those who return, and those who settle for the first time) is not adapted to ensure socio-economic development. Experience has shown that the implementation of radiological standards in the deployment of a recovery strategy defined by national authorities are not enough to restore people's confidence in the recovery process, and that without the active involvement of all the stakeholders it is difficult to create a favorable dynamic (Lochard, 2013).

There are two major challenges in the recovery process. The first challenge is to ensure that radiological protection promotes individual well-being and the quality of living as a community. The second challenge is to ensure that local and national projects dedicated to socio-economic development take into account their radiological context, by contributing to the protection of people and the environment and by maintaining vigilance to ensure a sustainable future for the local population (Schneider et al., 2021).

Local projects constitute the third pillar of the co-expertise process. This pillar is essential for the completeness of the co-expertise process. It could be considered as the achievement of the co-expertise process: after engaging residents in dialogue and performing measurements to better characterize the local radiological situation, it is crucial to consider which actions could be undertaken to improve the radiological protection of people and the environment, and to contribute to an improvement in their quality of life. In this perspective, setting up local projects plays a key role and complements the two other pillars of the co-expertise process.

This chapter describes the variety of local projects implemented after the Chornobyl and Fukushima accidents, and then goes on to discuss the key contributions of these projects relating to self-confidence, living together, well-being and sustainability. In conclusion, ethical considerations and governance mechanisms to support local projects are highlighted.

1. The variety of local projects implemented after Chornobyl and Fukushima

1.1. *The domains of implementation*

Past experience has shown that the communities involved in co-expertise experiences after a nuclear accident are eager to develop local projects in all domains of daily life (Baudé et al., 2016; Lochard et al., 2026). Given the presence of radioactivity, projects in the field of radiation protection are obviously the most numerous, at least during the first years after the accident. Progressively residents involved in co-expertise processes also invest time and effort in all areas relating to their quality of life, as well as the quality of life of their community. In fact, all aspects of life can be the subject of local projects. Making an exhaustive list would be of little interest, and it is preferable to rely on existing typologies. In this regard, the projects developed within the framework of the CORE Programme relied on four priority areas, namely health, radiological quality, economic development and education/memory. These four areas ultimately served as an operational framework to evaluate, select and monitor about 150 local projects, including: the decontamination and renovation of a playground for small children not used since the accident; establishment of a cooperative for the sale of cucumbers; the renovation of a pottery workshop to create a training center for young people to perpetuate the local tradition; the renovation of a local museum; and the development of a loan system for private farmers (Lochard et al., 2026). The following sections briefly present the main characteristics that not only provided a structure for the priority areas, but also underpinned the local projects.

1.1.1. Health

In the health domain, which is a topic of concern shared by all residents, it is interesting to note that the local projects are generally supported by the health system, traditionally focused on monitoring the health of the population. Local initiatives are therefore limited in number and generally focused on local events organized by medical professionals to promote healthy living and to conduct screening campaigns for example at schools. Thus, within the health care in Belarus, local projects were generally focused on the renovation of healthcare centers or the training of healthcare personnel. In Fukushima, local projects consisted of the construction of new hospitals in the municipalities that were long abandoned due to the evacuation orders, the commitment of nurses within local communities, notably in Kawauchi, and the involvement of medical doctors to accompany the whole-body measurements (Ando, 2016; Ando et al., 2026; Goto et al., 2018; Orita et al., 2014, 2026; Tsubokura et al., 2013).

1.1.2. Radiological quality

In the domain of radiological quality as mentioned above, the control of the level of radiation in the environment and in food products to protect the residents, gives rise to numerous private or collective initiatives at the local level. In this context, the most numerous local projects focused on measurements. Measurements showed that the initially high levels of radiation progressively decreased over time, and as this happened, the objectives changed to ensure vigilance, in other projects, so that they did not contribute to an increase in exposures for those involved and for the local population (Lepicard and Hériard-Dubreuil, 2001; Lochard, 2007; Ando et al., 2026). For example, during the installation of the exhibition in the Bragin Museum, the exhibited material from the restricted zone was carefully decontaminated to protect future visitors (Lochard et al., 2026). Those involved in the decontamination work were properly protected and used appropriate personal protective equipment.

1.1.3. Economic development

Over time, driven by the desire of residents who voluntarily chose to remain in the affected territories, to improve their quality of life, the local projects dedicated to economic development tend to proliferate. Indeed, given the economic context of the 1990s and 2000s in Belarus, in the territories affected by the Chornobyl accident, development projects primarily focused on agricultural production, aiming to improve yields, organize cooperatives to ensure product marketing, and provide access to appropriate financing mechanisms (Lochard et al., 2026). In Japan, the situation was quite different in the affected territories, even though agriculture and fishery were important traditional activities. Over time, in the non-evacuated part of the affected territories, the challenge has been to maintain activities and to address this, local projects have developed across the whole spectrum of economic activities from agriculture, fishery and food services to small, medium and large industries (Schneider et al., 2021; Igarachi et al., 2026; Yasutaka et al., 2026). In the municipalities that were long abandoned following the evacuation orders, it became necessary to rebuild local services such as public facilities, businesses, crafts, and small and medium-sized industries and in some cases, to establish new facilities for industry, but also for trade and leisure. It is evident at this level, that initiatives are mainly taken by local or even national public authorities, but for them to meet the expectations of the population, they must be discussed and developed in a participatory manner (Schneider et al., 2021; Tomkiv et al., 2026).

Box 1 succinctly presents how a large industry in the Iwaki region of Japan, located in a low-contamination area, had to cope with the post-accident situation in terms of radiation protection, in order to protect its staff and also ensure the continuity of its operations, which were largely focused on international trade (Orita et al., 2014; Schneider et al., 2021).

Box 1. Iwaki manufacturing industry

Although located outside the zone affected by evacuation orders and more than 40 km from the Fukushima-Daiichi NPP, an international company of Iwaki city specializing in the manufacture of car navigation systems, suffered from the consequences of the nuclear accident. The activities of the factory ceased in the first days following the accident and did not resume until 2 weeks later. About ten employees decided to leave the company between April and September 2011 in order to avoid exposure to radiation. Around thirty additional resignations were recorded until March 2014 (Yoshioka, 2020). While the majority of employees decided to continue working at the factory, many of them expressed concerns about the lack of information regarding the presence of radioactivity in their environment (Orita et al., 2014; Takeda et al., 2016). This led the company to implement various actions to provide answers to employees' questions and to help them to make their own judgment on the radiological situation. A series of lectures on radioactivity and its potential effects on health was organized until the fall of 2011, with the assistance of experts from Nagasaki University. Following these conferences, private consultations with health professionals having an expertise in radiological protection were offered to the employees and their families so that they could express their concerns and questions about radioactivity and receive the appropriate information. The factory nurse was trained by Nagasaki University to resume and continue private consultations with employees and their families, as well as to ensure their long-term health follow-up. At the same time, ambient dose rate measurements were made using dosimeters installed in the plant. The results of these measurements as well as those of the contamination of the food served in the canteens were continuously displayed in the factory hall and on the company intranet. Partnership with Nagasaki University also organised access to whole body counting (WBC) measurements for the employees and their families. The 2012 and 2013 WBC campaigns showed that the estimated annual effective dose corresponding to the internal contamination measurements was between 0.01-0.06 mSv for the first screening and between 0.01-0.02 mSv for the second screening (Orita et al., 2014).

1.1.4. Education and memory

In the process of recovery, memory not only plays a role in remembrance but also serves as a living reminder to raise awareness, maintain vigilance, transmit the experience. It thus contributes to building the future. Capitalizing on the accumulated experience and making it accessible to all affected people, as well as sharing it internationally, is a moral duty. In this perspective, the involvement of the education system (schools and universities) is an essential means of transmitting the experience to the next generation.

Box 2. The Bragin Museum

FIGURE 1. The Bragin Museum after renovation (photo: J. Lochard).

Within the education and memory priority areas of the CORE Programme, a group of residents, led by a librarian of Bragin, developed a project to refurbish the museum with the help of a French association specializing in heritage preservation and the financial support of CORE. The project was ambitious, involving the renovation of the museum's four sections, including a permanent exhibition of works by painters native to the 30 km evacuation zone, an exhibition of objects from the same area, a room dedicated to the tribute of the young firefighter from Bragin who died in the accident, and finally, a space for temporary exhibitions, the first of which — entitled "The Lost Land" — remained in place for several years due to its success. It attracted numerous visitors, both local and from across Belarus and also foreign countries. This local project was developed in close cooperation with artists and museum professionals, most of whom were visiting the area for the first time since the accident. Discussions and meetings allowed for the development of a highly original narrative about the experience of local residents and the group gathered testimonies, documents, and photos to enrich the museum's collection.

Traditionally, the memory of Chornobyl is evoked by commemorations and tributes to the victims. This local project which focused on the meaning of the accident and the lives of those who live in the affected areas is an original approach to celebrate the memory of the accident, offering visitors another way to discuss the accident and experience the local situation. It also allowed for connections to be made between the past, the present, and the future.

1.2. *The levels of partnership and cooperation*

The local projects presented above show that the initiatives are taken by a large variety of stakeholders from individuals to international stakeholders. The origin of the local projects can come from different levels:

- individuals themselves in cooperation with a group of stakeholders at the community level, or by partners within an economic sector;
- at the community level by the authorities of the municipality on their own initiative or within the framework of the recovery policy set up at the national level;
- at the regional level, involving a group of local communities/municipalities, again on their own initiatives or under the leadership of the regional authorities;
- at the national level to create the conditions for the redeployment of social and economic activities in the affected region;
- in the framework of international cooperation by international organisations, government, authorities, research institutes or NGOs from foreign countries.

As illustrated by the governance framework set up within the CORE Programme, the multi-level partnership is important to ensure a fair and sustainable cooperation between all stakeholders, providing financial and technical support as well as contributing to the robustness and trustworthiness of the cooperation. Although such a framework is not easy to implement, the experience of the local projects after Chornobyl and Fukushima has highlighted that the deployment of co-expertise process relies on the interaction between stakeholders from different levels to address the concerns and expectations of residents.

Whatever the type of partnership established, the focus should be on promoting and supporting local projects, where local citizens play a key role. Ensuring fair participation of local stakeholders and empowering them in these partnerships are crucial for the deployment of local projects within the co-expertise process. In this perspective, there is a need to promote a shared diagnosis of the situation in the affected territories and to elaborate a shared vision for the future. Furthermore, providing technical and financial support for the participation of local stakeholders is necessary for ensuring their sustainable empowerment (Thu Zar, 2022).

Box 3. The Great East Japan Earthquake and Nuclear Disaster Memorial Museum

The Great East Japan Earthquake and Nuclear Disaster Memorial Museum is located in Futaba, in the coastal area of the Fukushima Prefecture, very close to the Fukushima Daiichi Nuclear Power Plant currently undergoing decommissioning (Figure 2). It is a remarkable example of a large-scale State infrastructure project developed in the framework of the recovery process of Fukushima Prefecture in 2021, ten years after the accident. Its construction was completed as planned for the Tokyo Olympics in 2020, but the COVID-19 pandemic somewhat disrupted the opening festivities. This state-of-the-art museum offers a rich and immersive experience. Through exhibits, personal accounts, research, and interactive presentations, visitors can learn about the history of the region before, during, and after the disaster, deepen their understanding of Fukushima's revitalization and the decommissioning of the Fukushima Daiichi Nuclear Power Plant (TEPCO), and hear the stories of local residents.

The museum welcomes many visitors not only from the Fukushima Prefecture and Japan, but also from overseas. It regularly offers temporary exhibitions on various aspects of the accident. The museum director is a professor at Nagasaki University, and the museum regularly welcomes students from this university, as well as from other higher or secondary education institutions. It also offers seminars and symposia during which students and experts explore the museum together, as well as visiting the municipalities of the Hamadori region, which were the most affected by the accident.

Open to all, the museum offers numerous activities that promote civic engagement, involving Fukushima residents as well as a wider public, many of whom are learning about the situation in the prefecture for the first time. The museum is located near other museums, such as the Namie Town Ukedo Elementary School museum or the TEPCO Decommissioning Archive Center which together demonstrate the prefecture's commitment to preserving the memory of the past and preparing for the future.

FIGURE 2. Inside the Great East Japan Earthquake and Nuclear Disaster Memorial Museum (photo: J. Lochard).

2. Contribution of local projects

Beyond their practical objectives (protecting individuals and the community, improving living and working conditions, etc.), local projects are a means for actors to build self-confidence, which was seriously impaired after the accident, and to look again positively at the future. To effectively implement these local projects, cooperation with the competent authorities, public and private organizations, experts and professionals is essential. Support for local projects requires the establishment of appropriate decision-making mechanisms to ensure the legitimacy, transparency and equity of their implementation.

The rehabilitation of decent and sustainable living and working conditions in the affected areas must necessarily be based on a "long-term vision of their development" co-negotiated between all the concerned actors: national, regional and local authorities, experts, scientists, professionals and of course the people directly affected by the accident (Baudé, 2016). The challenge is to create the conditions for the restart of social and economic activities damaged by the accident, to rely on the emergence of new and innovative activities in line with the local context and to favour and support local projects led by individuals and / or local communities, which must also aim to constantly ensure the radiological protection of people and the environment.

2.1. *Fostering self-confidence*

Confronting the presence of radioactivity caused by the accident deeply affects the self-confidence of the residents living in contaminated areas because it leads to a disruption to their daily life experiences and their ability to speak, understand, decide, act and also to project themselves into the future. An accident is a traumatic event for individuals who, from one day to the next, struggle to express their feelings beyond the fact that they have great difficulty objectifying the situation they are facing. When self-confidence is impaired, self-esteem, which depends on the moral dignity of individuals — even if threatened — nevertheless persists and never completely collapses. This distinction between self-esteem and self-confidence, developed by Paul Ricœur in his book "Oneself as Another" (Ricœur, 1992) is very illuminating for understanding what is at stake in the dynamics of what he calls the "reconstruction" after a traumatic event (such as the death of a loved one or an accident) and which fully supports the co-expertise process.

For Ricœur, self-esteem is the capacity of each individual to recognize her/himself as a worthy subject who can act and be accountable for her/his actions. Self-esteem is a relatively stable existential given, even if it is sometimes threatened and silenced. As for self-confidence, it refers to what Ricœur calls the "capable subject", that is to say, individuals who can speak and enter into relationships with others in order to decide and act. Self-confidence when severely weakened, as it is the case after a nuclear accident, can never be rebuilt alone because it needs recognition from others. We never rebuild ourselves alone. This is why the co-expertise process with the deployment of local projects is fundamental. It allows affected individuals to rebuild their self-confidence and thus reintegrate into life. Through dialogue, residents regain self-confidence, through measurements of radioactivity, they objectify reality with others, and then through their involvement in local projects they can decide, act, and project themselves with their community into the future.

The dialogue and objectification of reality through multiple viewpoints, trigger the formulation of a local project and associated actions, which can be at the individual or the community level. Dialogue, measurements, and the local project are in constant interaction, each one feeding the other two. According to Ricœur, the co-expertise process does not aim to lead to a shared interpretation of reality. In this process, measurements provide a common ground for discussing and sharing visions that eliminate erroneous viewpoints on reality. That said, it only allows for an interpretation of reality and does not provide the truth. The development of a local project and its implementation then guide the continuation of co-expertise through dialogue and measurements that allow for the evaluation of project progress and the provision of support in case of difficulty. Thus, each project, whether individual or collective, translates, by the very nature of the co-expertise process, into a shared responsibility among all stakeholders involved and significantly contributes to restore self-confidence of residents.

2.2. *Restoring community life*

Rebuilding communities after a nuclear accident is a complex challenge encompassing all the health, social, and economic dimensions impacted by radioactivity. The experiences of Chornobyl and Fukushima provide valuable lessons on the crucial role that local projects can play in the process of rebuilding the social fabric. To be effective, these projects must, as previously mentioned, address the specific needs of residents while contributing to their radiation protection and improving their living and working conditions in order to restore their trust in experts and authorities and give them back a sense of control over their future.

For example, the projects developed under the CORE programme in Belarus in the 2000s demonstrated that, economically, they could contribute to job creation and to the revitalization of local activities in agriculture, crafts, small-scale industry, and tourism (Lochard et al., 2026). In Fukushima, projects in the fields of agriculture, energy, and advanced technology (medicine, information technology, dismantling technics), gradually emerged in the years following the accident. In agriculture, while traditional farming has declined significantly, organic farming is steadily progressing with the arrival of young farmers attracted by the fact that the soils have remained free of chemical inputs for a decade (Yasutaka et al., 2026).

In the fields of education, heritage, and culture, the organization of festivals, exhibitions, and artistic events naturally fosters encounters and strengthens social cohesion. The gradual resurgence of festivals in the areas affected by the Fukushima accident, for example, illustrates how they have allowed families scattered during the disaster to reunite (Ando et al., 2026). The creation of memorial museums also contributes to maintaining intergenerational ties and encouraging visits to the areas by non-residents.

Some initiatives are taken by local communities while others are promoted through national programmes to support the resurgence of the local communities in areas affected by the accident. This clearly highlights the importance of promoting an integrated approach and in this respect the existence of co-expertise process within local communities clearly favours the involvement of residents and local communities in local projects. This has been observed in the ETHOS project and CORE programme as well as in several communities after the Fukushima accident such as Kawauchi, Suetsugi or Yamakiya (Ando et al., 2026; Lochard et al., 2026; Orita et al., 2026; Schneider et al., 2026; Yasutaka et al., 2026).

It is also interesting to mention the projects in the fields of research. They are generally decided and supported financially by the State. For example, after the Chornobyl accident, a research center was established in the 30 km exclusion zone around the power plant to study how animals and plants were evolving in a radioactive environment. In Fukushima, the Fukushima Institute for Research, Education and Innovation (F-REI) was recently created with the objective of conducting research in Fukushima to solve local issues and revitalize the region through value creation and to build next-generation human capacity for science, technology, and regional growth. F-REI will undoubtedly contribute to local economic, social and cultural initiatives with the arrival of researchers.

The local projects dedicated to the preservation of memory through workshops and field visits and the organization of archives of testimonies are also important to connect the different generations within the local communities. Furthermore, the organization of joint activities and exchanges between schools from contaminated and uncontaminated areas, as well as with other countries has demonstrated how they are effective at creating interpersonal connections, and above all foster self-confidence among participants (Lochard et al., 2026; Schneider et al., 2026). There are also potential activities in the field of sports, such as the Kawauchi marathon, which attract thousands of athletes in the Kawauchi village every year who thus discover the affected areas and their inhabitants (Orita et al., 2026).

It is the accumulation of all the local projects, and their blending and interconnection, that ensures a favorable evolution in the quality of individual and community life in the affected territories, that eventually restores community life. This type of ambition needs time (it could be a matter of decades) and significant investment coming from state and regional funds, utilizing crowdfunding, and establishing public-private partnerships. Experience showed that, it is also essential to involve residents from the earliest stages in the decision-making processes, so they can propose local projects and express their views concerning their priorities and expectations, for example, for urban planning, infrastructure and industry projects contributing to the economic development, as well as the shaping of the territory for decades.

Clear communication is indispensable as well as regular updates on project progress. Notably, it is important to provide easy access to radioactivity monitoring results to ensure vigilance. Projects must be adapted to the evolving needs of the community, and all groups must be represented to ensure inclusion, including women, young generation, elderly and vulnerable people. Therefore, a governance structure tailored to the situation should be implemented with significant involvement of the local community.

2.3. *Contributing to well-being*

Well-being is generally defined as the state in which a person feels in harmony with her/himself and her/his environment, experiencing a sense of fulfillment, health, and quality of life. The World Health Organization defines well-being as a complete state, a state of physical, mental, and social well-being, and not just the absence of disease. According to Seligman, well-being includes elements such as engagement, positive relationships, meaning, accomplishment, and positive emotions (Selignman, 2002). These definitions emphasize that well-being is subjective and dynamic: what is important to one person at a certain moment may differ for another and also may evolve with life's circumstances.

For Ricœur, well-being is a necessary foundation which allows individuals to project themselves toward higher goals but is not a sufficient condition for ensuring good living conditions what he calls "the Good Life" (Ricœur, 1992; Verhoef, 2023). Good living involves self-esteem, being accountable for her/his actions but also concern for others, justice and participation in institutions. Ricœur does not reject well-being but for him a life reduced to just well-being ignores the ethical dimensions of living together. For Ricœur, who draws his inspiration from Aristotle and Kant good living is a tension between her/himself and others that allows one to transcend an individualistic vision of well-being in order to access a responsible life, open to others.

Nuclear accidents deeply impact individuals, communities, and territories. In this context, local projects involving communities become essential for restoring not only the quality of the environment but also the well-being/living conditions of residents. Fostering cooperation with others plays a central role, as no one can face the challenges of such catastrophes alone.

Following a nuclear accident, reconstruction projects — whether environmental, health-related, societal or economic — allow residents, workers, experts, professionals and authorities to come together around common objectives and projects. Examples are numerous (see Section 2) and include: citizen initiatives for measuring radioactivity in order to make choices about the economic or social activities; and dialogue meetings to discuss the future of the territory and to identify local projects addressing the priorities for the future. These projects restore self-confidence and the dignity to those affected while strengthening community life.

Nuclear accidents generate lasting trauma, fear of health consequences, stigmatization, and loss of bearings. Local projects that incorporate psychological support, such as discussion groups, resilience workshops, and educational programs, help break isolation and restore confidence and well-being. This also involves acknowledging suffering and creating spaces where everyone can express their fears and hopes. After a nuclear accident local projects such as community gardens on contaminated land, training programs for decontamination, and cultural projects such as exhibitions help residents of affected territories to transform the traumatic experience into a collective narrative as it was demonstrated in the CORE Programme in Belarus (Lochard et al., 2026). These actions demonstrate that reconstruction is possible, even if it takes time. They also remind us that well-being is not limited to radiological protection but includes rebuilding the social fabric and the quality of life.

Engaging local projects in the co-expertise process, whether individual or collective are a source of motivation and fulfillment for those involved. They not only strengthen self-confidence, but also the well-being of residents and the quality of living conditions of affected communities. Embarking on local projects can become an essential pillar of recovery, offering motivating objectives to the residents. Ultimately, post-accident projects are not only a way to regain autonomy of residents and improve the living conditions in the affected territories but also a way to overcome the loss of bearings where people live, and thus become more resilient and aware of one's own strengths.

2.4. *A key feature for ensuring vigilance and sustainability*

Cooperation between local residents, associations, scientists, and public authorities is essential for designing appropriate and transparent projects. Experts contribute their technical know-how, while locals contribute their day-to-day and intimate knowledge of the territory and of their needs and expectations. This cooperation is important to avoid imposed decisions from outside, which are a source of mistrust and sometimes of anxiety. Examples from Chornobyl and Fukushima clearly demonstrate that the involvement of all stakeholders fosters more sustainable and widely accepted solutions.

After a nuclear accident, cooperation is not an option but a necessity. It allows for the sharing of responsibilities, the pooling of resources, and the restoration of living conditions through working together. Affected communities have not only to overcome the immediate consequences of the accident but also to build a more resilient and united future. Past experience has shown that trying to return to the pre-accident situation is a dead end. It has also shown that the support of professionals, experts, and authorities is absolutely necessary to move local projects forward and thus improve well-being.

The management of the recovery process must be linked to the "long-term vision of the territory" taking into account the health, social, environmental, economic, cultural, memorial dimensions, etc. As mentioned above, the objective is to restore individual well-being and the quality of community life in the affected areas where people are allowed to reside. This implies the development of a sustainable socio-economic framework articulating the redeployment of infrastructures and socio-economic activities including innovative projects, the support of local projects initiated by individuals and local communities, and the dissemination and transmission of the experience gained in managing the situation. In this perspective, cooperation between the residents and local, regional and national authorities aims to develop and adopt a common project endorsed by the local communities to ensure their future including the different facets of sustainable development (WCED, 1987; Hammer and Pivo, 2017). In practice, such a common project relies notably on the selection of areas in which to re-establish social life and economic activities and the organization of the relevant support for their implementation, ensuring that they are mainly driven by local communities.

Resilience is generally defined in the literature as the return to an "equilibrium" after an event (Norris et al., 2008; Paton, 2009). However, the experience of the Chornobyl and Fukushima post-accidental situations reveals that a return to the previous situation is generally not achievable. Complete removal of radioactivity from contaminated areas is not feasible and whatever efforts are made, there is always residual contamination, especially in forest areas (Takada et al., 2020). In addition, many human and societal consequences are irreversible and the destabilization of communities leads to disruption and complex dilemmas. To cope with this situation as Norris points out in his article, resilience has to be seen as a "process" rather than a "result" and has to refer to "adaptability" rather than "stability". From this perspective, community resilience after a disturbance is described as: "a process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations" whose final results aim at the well-being of individuals and communities (Norris et al., 2008). Favoring and supporting the emergence of local projects within the co-expertise process are essential to reconnect the people to a dynamic of socio-economic development while ensuring the protection of people and the environment against radiation.

As the cohesion of the local/regional communities has been significantly affected by the consequences of the accident, it is necessary for the local communities to elaborate and promote a common project to support the socioeconomic development in a harmonized and fair dynamic. In this context, as Norris emphasizes, the main objectives of the community resilience process are to reduce risks and resource inequities, involve the local people in mitigating the consequences, create organizational links between all actors, as well as stimulate and maintain social support. Such a process requires relying on reliable sources of information but also on flexible decision-making skills with the participation of the affected citizens (Norris et al., 2008; ICRP, 2021).

Conclusion

Community resilience in affected areas requires the deployment of a socio-economic programme with governance mechanisms that respect ethical values. This approach will ensure that people and the environment are protected against the risks of ionizing radiation and will contribute to decent living and working conditions to communities affected by a nuclear accident. It is of primary importance to rely on the involvement of local communities in the elaboration and deployment of the socio-economic activities with due considerations for ensuring the integrity of the communities, and respecting their choices.

From a radiological protection point of view, the primary objective of the framework for recovery is to contribute to protecting people and the environment and to ensure the "well-being"/"wellness" of affected individuals (Oughton, 2016). Therefore, it is essential to ensure that the local projects are clearly articulated with these objectives and not only driven by economic considerations. The decision-making process put in place for promoting and selecting these local projects should take due considerations of the impacts and contributions that decisions may have on living and working conditions, life expectancy, mental health and well-being and livelihoods of the affected people. Environmental protection and more globally the quality of the environment have also to be considered in this process. In addition, the adoption of local projects should necessarily be accompanied by measures dedicated to the organization of vigilance on health and environmental issues.

The deployment of local projects contributing to the socio-economic development should aim at ensuring equitable and fair contribution to the protection and well-being of the different affected communities, and the different categories of stakeholders. In this perspective, it is essential to put in place governance mechanisms including representatives of the different stakeholders at local/regional and national levels in order to identify the main priorities to achieve this goal. In addition, during the implementation of the socio-economic programme, it is necessary to regularly evaluate whether its implementation ensures a good and fair balance in the allocation of human and financial resources and to identify whether additional efforts should be granted for certain local communities. In practice, individuals and local communities are affected differently by the residual contamination, their exposures depending on their habits, their environment and their socio-economic situation. Furthermore, the benefits and drawbacks of implementing protective actions are not always distributed evenly among the people concerned. In this context, special attention should be paid to the protection of vulnerable groups and future generations.

The post-accident situations of Chornobyl and Fukushima emphasized the imperative need to restore and preserve the dignity of the residents and communities affected by the accident in the recovery process. In this perspective, the establishment of a socio-economic programme should first be based on the voluntary commitment of residents and communities to live and/ or work in the affected areas. Therefore, for the implementation of local projects, it is necessary to ensure that resources (human, technical, financial...) are available to preserve the autonomy of residents and local communities (Thu Zar, 2022). The socio-economic programme should therefore include specific measures to support citizens' initiatives aimed at regaining control on their daily life, where experts, through the co-expertise process, are at the service of the residents and communities. This requires the support of the authorities and the respect of individual autonomy.

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12
The scientific foundations of the co-expertise process: from risk assessment and management to risk governance

Michio Murakami[1,2], Jacques Lochard[3,4], Thierry Schneider[3,4,5]

Abstract

This chapter examines the scientific foundations of the co-expertise process from the perspective of risk analysis theories, focusing on the theoretical and methodological developments related to radiation risk. It highlights how the evolution of modern societies, and particularly the major technological disasters of Chornobyl and Fukushima, have contributed to redefining the concept of radiological risk and its management, emphasizing the importance of the psychological, sociological, and ethical dimensions that shape the notion of risk.

Introduction

The idea of managing risk is multi-millennial. Managing risk historically includes the edging system in case of losing their goods among the Babylonians, or the guild system in ancient Greece and Rome to support craftsmen in the event of an accident or damage. Modern risk management was first associated with the use of market insurance invented by Lloyd's of London in 1688 to protect individuals and companies from various losses associated with accidents (Bernstein, 1998).

[1] Center for Infectious Disease Education and Research, University of Osaka, Suita, Japan
[2] EIPM Center, University of Osaka, Suita, Japan
[3] Atomic Bomb Disease Institute, Nagasaki University, Japan
[4] International Commission on Radiological Protection (ICRP)
[5] Nuclear Protection Evaluation Centre (CEPN), France

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Risk assessment and management as scientific disciplines emerged after the early 20th century when market insurance was perceived as too costly and incomplete for protection against risks. Over the past fifty years, risk research has undergone profound transformations reflecting a broader evolution in how modern societies understand, assess, and manage technological risks.

In the 1960s - 1970s, there was rapid development in the field of risk assessment that was dominated by deterministic and technocratic approaches, based on quantitative assessments carried out exclusively by scientific and technical experts. In conjunction with the quantification of risk, new risk management methods also arose during the 1970s. Initially, the focus was on the development of risk assessment techniques that grounded the management of risks on a scientific basis (the technocratic model).

The succession of major industrial and nuclear disasters in the late 1970s and 1980s — such as Mexico, Bhopal, Three Mile Island, Chornobyl, exposed the limitations of these traditional approaches. These events revealed that populations confronted with hazards do not react solely on the basis of numerical data or expert judgments. Rather, their interpretations of risk are filtered through cultural worldviews, social dynamics, psychological processes, historical experiences, and political contexts. The discrepancy between expert assessments of radiation-related dangers and the lived experience of affected communities highlighted a critical gap between technical rationality and social reality. This gap became especially evident in situations marked by uncertainty, invisibility of contaminants, disruption of daily life, erosion of institutional trust.

In response to these challenges, research in the domain of risk focused during the 1980s and 1990s on the development of risk perception and risk communication as distinct scientific fields emphasizing first that risk is subjectively defined by individuals who may be influenced by a wide range of psychological, social, institutional and cultural factors, and then how to better explain risk data based on risk assessment in order to find ways of bridging the public/expert risk perception gap related to activities raising concerns in the society (nuclear energy, chemical industry...).

These developments led to the refinement of the risk assessment and management techniques by integrating societal, environmental and economic considerations into the decision-making process to control the risks with public participation becoming integral part of the risk management process (the inclusive governance model). This evolution is best illustrated by the series of reports developed by the US National Research Council to foster risk assessment and risk management in the Federal Agencies (National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health, 1983; National Research Council, 1989; National Research Council, 2009).

Figure 1 schematically illustrates the evolution mentioned above. The progressive thickening of the arrow reflects how risk assessment and management, risk perception, risk communication, and risk governance are deeply interconnected, each step building upon and enriching the previous ones.

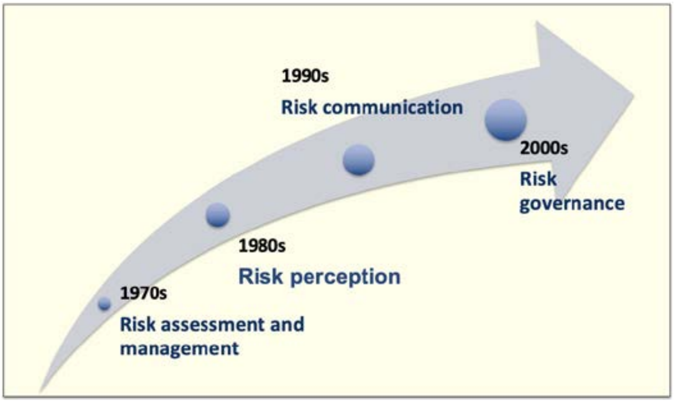

FIGURE 1. From risk assessment and risk management to risk governance (© J. Lochard).

The following sections describe in more detail how the evolution of risk research, briefly mentioned above, has been reflected in the field of radiological risk, from the 1970s to the recent integration of the co-expertise process into the radiological risk management system in 2020.

1. The basis of radiation protection

1.1. *Risk assessment and management*

The International Commission on Radiological Protection (ICRP) is an independent international body with responsibility for developing the system of radiological protection system for the public benefit. In particular, ICRP provides recommendations and guidance on all aspects of protection against ionising radiation. The first set of post Second World War recommendations were published in Publication 1 (1959). In this publication it is recognized that some effects may not have thresholds: "The most conservative approach would be to assume that there is no threshold and no recovery... and the incidence might be proportional to the accumulated dose" (ICRP, 1959).

Since then, health effects from radiation exposure are divided into deterministic and stochastic effects. A deterministic effect is a health effect that can occur in a short period of time following exposure, with exposure doses exceeding a certain dose (i.e., threshold dose). For example, the threshold dose for primary infertility in males is 100 mGy (ICRP, 2007). On the other hand, with regard to stochastic effects, health effects are considered to occur with a certain probability even in the presence of low doses. Typical stochastic effects include cancer and genetic effects. Dose-response relationships for stochastic effects are investigated by epidemiological studies in exposed individuals. The largest and most reliable epidemiological study is a survey of atomic bomb survivors in Hiroshima and Nagasaki and their second generations (United Nations

Scientific Committee on the Effects of Atomic Radiation, 2011). Among the survivors of the atomic bombings in Hiroshima and Nagasaki, no genetic effects from radiation exposure have been observed; however, the ICRP takes genetic effects into account as part of a prudent risk management framework.

As far as the management of the risk is concerned, logically ICRP (1959) recommended that exposure be kept below the threshold levels for deterministic effects and for stochastic stated "Any departure from the environmental conditions in which man has evolved may entail a risk of deleterious effects... However, man cannot entirely dispense with the use of ionizing radiation, and therefore the problem in practice is to limit the radiation dose to that which involves a risk that is not unacceptable to the individual... This is called a "permissible dose" (§ 29).

During the 1960's, based on information from Hiroshima and Nagasaki, ICRP prudently adopted the Linear No Threshold (LNT) model, that assumes that even low levels of radiation carry some risk. This approach was chosen because a linear extrapolation from higher-dose data was considered the most protective in the absence of clear low-dose evidence, as described above.

In 1977, ICRP published new General Recommendations (Publication 26) that introduced the important concept of detriment, which combines the probability and severity of stochastic effects to provide an overall measure of radiation risk. The total stochastic risk from uniform whole-body irradiation was set at about 2% per sievert, as an average for both sexes and all ages. Furthermore, from the radiation risk management perspective, ICRP introduced the three key principles that shape the current system of protection; justification, optimisation of protection and dose limitation. It should be noted that the dose limit values have been progressively adopted by all national authorities in the world. The 1977 Recommendations supported an effective dose equivalent limit of 50 mSv/year for occupational exposure based on the risk of cancer mortality level (ICRP, 1977a; ICRP, 1977b). Here, the annual cancer mortality risk for the whole population corresponding to a dose limit of 50 mSv/year was calculated from the LNT model and the cancer mortality to dose ratio, based on epidemiological studies among the atomic bomb survivors of Hiroshima and Nagasaki. Acceptable risk levels, on the other hand, were calculated from annual mortality rates associated with other occupations by comparing these data, it was confirmed that the average risk of occupations involving radiation was comparable to that of other safe occupations.

Thus, by the end of the 1970s, radiation risk was conceptualized as an objective entity that could be measured, controlled, and communicated using numerical indicators, with the recommendation that all exposure be kept as low as reasonably achievable economic and social factors being taken into account (known as ALARA), assuming implicitly that rational decision-makers and the general public would react predictably to scientific evidence and behave prudently. This approach was widely disseminated in the World within government agencies responsible for assessing and managing occupational and environmental radiological risks.

1.2. *Risk perception*

As described above, risk management involves complex societal value judgments, such as how to assess risk in a conservative manner, whether to protect the population as a whole or vulnerable individuals (e.g., most exposed individuals), what indicators to use, and what risk levels to accept. Despite refinements in the assessment and management of radiological risk, the acceptability to the population of situations involving radiation risk has become increasingly challenging over time, which pushed a group of US researchers in the 1980s–90s to explore the factors explaining the perception of risk to understand why the public tended to over-estimate the risk.

Risk perception research transformed understanding of how individuals interpret, evaluate, and emotionally respond to risk. This was done by building on a pioneering contribution by Chauncey Starr (1969) demonstrating that people are willing to tolerate significantly higher levels of risk when they associate the activity with substantial benefits, illustrating a fundamental asymmetry between voluntary and involuntary exposures. Slovic, Fischhoff, and colleagues clarified that factors such as dread, catastrophic potential, unfamiliarity, voluntariness, controllability, and trust play essential roles in shaping perceived risk (Slovic, 1987). These elements helped explain why risks with low statistical probability — such as radiation accidents — may nonetheless generate profound public concern. This foundational insight challenged the prevailing assumption that risk tolerances were primarily determined by objective probabilities, highlighting the importance of considering value judgments of the public.

A major conceptual shift in risk tolerability/acceptability and risk management was introduced in the next ICRP general recommendations, the publication 60 (ICRP, 1991). The dose-response equation allowing risk to be calculated was updated by epidemiological studies from the atomic bomb survivors. Progress was also made in social science research on acceptable levels of risk. Following work carried out by the UK Royal Society (1983), ICRP introduced the tolerability of risk model. The publication was also adding to the understanding of population-based risk management (i.e., average exposure) and the consideration about individual risk management (i.e., maximum exposure). Various outcomes including lifetime mortality risk, loss of life expectancy, age-specific mortality risk, and age-specific mortality increase, were used as risk indicators.

In ICRP Publication 60, the tolerability of risk is described using three qualitative terms — unacceptable, tolerable, and acceptable — to support normative judgments on radiation exposure. Within this framework, dose limits are positioned as a selected boundary between unacceptable and tolerable exposures for the control of practices, while exposures below this boundary remain subject to optimisation of protection.

2. Stakeholder involvement and the ethical foundations of the system of protection

In its most recent General Recommendation Publication 103 (ICRP, 2007), the Commission introduced stakeholder involvement as a key dimension associated with the principle of optimisation of protection.

Concretely stakeholder involvement emerged in the field of radiation protection in the late 1980s and early 1990s in the context of the management of exposures in areas contaminated by the Chornobyl accident and sites contaminated by past military activities in the US. These experiences demonstrated that engaging stakeholders was an effective way to take into account the concerns and expectations of those affected and also the prevailing circumstances of the exposure situations. It was also a way to adopt more effective and fairer protective actions, to disseminate radiation protection culture, and to favour the empowerment and autonomy of affected people i.e. to promote their dignity.

Despite these experiences had clearly demonstrated the value of stakeholder involvement, it took more than 20 years for ICRP to incorporate it into its general recommendations. Many professionals believed that seeking input from those affected by a radiological situation who were unfamiliar with radiation science could only lead to unrealistic and ineffective solutions, and would also unnecessarily slow down decision-making processes.

Regarding ethical values, although long recognized and regularly discussed by prominent members of the Commission (Lochard, 2016) it was not until the beginning of the 21st century that the Commission asked its Committee on the Application of Recommendations to clearly formulate the ethical values underpinning the principles of justification, optimization of protection, and dose limitation. The concrete involvement of several members of the working group responsible for this formulation in the experience of the Suetsugi community affected by the Fukushima accident (Ando et al., 2026) and in the ICRP dialogue initiative in Fukushima (Lochard et al., 2019) was crucial in finalizing the reflection that led to ICRP Publication No. 138 (ICRP, 2018), entitled "Ethical Foundations of the Radiation Protection System". This publication highlights four core ethical values: beneficence and non-maleficence, prudence, justice and dignity, as well as three procedural values considered fundamental to facilitate the practical implementation of the radiation protection system: accountability, transparency and inclusiveness (Takahashi et al., 2026). By disseminating the values and ethical principles that underpin the radiation protection system, not only professionals but also the public can have a clearer idea of the societal implications of the Commission's recommendations.

3. Risk communication

As research progressed, it became increasingly clear that risk perception cannot be fully explained by cognitive evaluations alone. Socio-psychological components were shown to exert powerful influence on risk judgments. Kahneman's dual-system theory, which distinguishes between fast, intuitive thinking (System 1) and slow, analytical reasoning (System 2), provided a conceptual framework for understanding why intuitive, emotionally driven reactions often dominate public responses to technological hazards, particularly under conditions of uncertainty, threat, or stress (Kahneman, 2011). Studies across psychology, sociology, and anthropology revealed that cultural worldviews, gender differences, social norms, and broader political contexts further shape how risks are interpreted, communicated, and acted upon. These insights highlight the importance of integrating psychological, emotional, and cultural dimensions into effective risk communication, emphasizing that technical expertise alone cannot address the complex human realities inherent in radiological emergencies.

In the field of radiological protection, this research on risk perception has particular significance. Populations affected by nuclear accidents face chronic uncertainty, invisible contaminants, and disruptions to daily life that profoundly shape their psychological and emotional well-being. Under such conditions, institutional trust often becomes fragile, and intuitive reactions may override analytical assessments — even when authorities provide accurate technical information. Experiences from Chornobyl and Fukushima illustrate how fear, stigma, and social fragmentation can escalate when risk communication does not adequately account for cultural sensitivities, emotional experiences, and historical memories.

Radiation-related risk communication has a central role both in supporting the mental health of affected people and in discussion of post-disaster recovery. As academic fields, risk communication has both psychological and social psychological aspects. Several representative case studies on the psychiatric aspect have shown the relationship between radiation risk perception and mental health. For example, after the Chornobyl disaster, it was reported that people with strong anxiety about radiation had worse mental health (Bromet, 2012), and many similar cases have been reported after the Fukushima disaster (Ito et al., 2018; Suzuki et al., 2015). In addition to mental health, perceived radiation risk has been linked to a wide range of outcomes, including attitudes toward sightseeing in Fukushima, perceptions of environmental safety, intentions to relocate or return to one's hometown after the lifting of evacuation orders, intentions to leave one's job or not return to work in Fukushima, health-related behaviours such as drinking, experiences of discrimination or social division, food avoidance, pregnancy intentions, and self-esteem or self-efficacy (Murakami et al., 2022).

The debate on the socio-psychological dimension was deepened by the question of how to communicate about radiation risk. Importantly, regardless of nationality, radiation-related risks are perceived as highly dreaded (Kleinhesselink and Rosa, 1991; Slovic, 1987). Furthermore, it was argued that acceptance of nuclear power plants is influenced by perceived risk and perceived benefits, which were governed by trust (Visschers and Siegrist, 2013). Similarly, acceptance of radiation-related facilities varies greatly depending on whether distributive or procedural fairness is ensured (Takada et al., 2022). These findings suggest that authorities and experts must look not only at people's knowledge of radiation risks, but also at the broader social aspects.

Indeed, it has been shown that affected people's views on radiation risk after the Fukushima disaster was only minimally governed by knowledge but also strongly influenced by demographic factors, trust, and other disaster experiences (Murakami et al., 2016).

In view of the above, it is important to carefully examine the results of communication on radiation-related risks. Risk communication was never addressed directly by ICRP. Nevertheless, many ICRP publications contain recommendations on informing stakeholders about the issues addressed in these publications; for example, it is clearly recommended to inform nuclear workers about the radiological conditions of their interventions; patients undergoing radiological examinations about the exposure they receive; or travellers by plane about the enhanced levels of natural radiation they receive in altitude.

The significance of providing information can be organized into two dimensions: (1) an obligatory aspect from authorities and experts, and a human rights aspect from citizens (e.g., the right to know and to be involved in decision-making), and (2) an effective aspect through a collaborative process. The former is the value represented by President Kennedy's "consumer rights" (i.e., consumers have the right to safety, to be informed, to choose, and to be heard) (Kennedy, 1962). For example, it is a natural right of people to express their opinions and be involved in decision-making regarding measures after a nuclear disaster. The latter is that dialogue and collaboration can function effectively in identifying values to be assessed and risks to be managed, and in promoting such measures. For example, the wisdom and collaboration among stakeholders including residents within a community lead to the introduction of measures that truly meet their needs. In fact, other examples are presented in previous chapters of this book how stakeholder involvement has actually moved measures forward and led to the resolution of issues.

This is a way to ensure equity while building trust and encouraging updates on the experiences of affected people and other stakeholders. This approach is based on the experience after the Chornobyl disaster, as stated in ICRP Publication 111: "For management of the radiological quality of foodstuffs in a country with a contaminated territory, relevant stakeholders (authorities, farmers' unions, food industry, food distribution, consumer non-governmental organisations, etc.) and representatives of the general population should be involved in deciding whether individual preferences of the consumers should outweigh the need to maintain agricultural production, rehabilitation of rural areas, and a decent living for the affected local community" (ICRP, 2009). Furthermore, ICRP Publication 146 also recommends that "the authorities, experts, and stakeholders should co-operate in the so-called 'co-expertise process' to share experience and information, promote involvement in local communities, and develop a practical radiological protection culture to enable people to make informed decisions" (ICRP, 2020).

In light of the above considerations, it is important to carefully examine the results of communication by experts on radiation-related risks. The Chornobyl and Fukushima disasters amply demonstrated that communication is not simply a matter of numbers; and that knowing whether safety is being sought, but also whether trust exists, and whether we are progressing towards "a world where life is good" (Select Committee on Science and Technology, 2000) is essential to understanding how individuals interact with radiation and society (Murakami, 2016).

Risk communication initially focused on improving public understanding of numerical risk information, operating under the assumption that clearer data and more effective explanations would narrow the gap between expert analysis and public perception. This so-called expert-to-public "deficit model" presumed that misunderstandings and public resistance to risks stemmed primarily from a lack of knowledge, and that education alone would correct these deficits. However, experience rapidly showed that this model was insufficient, particularly in contexts of high uncertainty and emotional distress such as nuclear emergencies. During crises, people do not process information in a purely rational or linear manner. Instead, they interpret messages through personal values, fears, memories, and levels of trust. Research by Fischhoff, Slovic, Covello, and others demonstrated vividly that effective communication requires far more than accurate data—it requires empathy, transparency, openness to dialogue, and genuine engagement with the concerns and experiences of affected populations (Slovic et al., 1979; Covello et al., 1988).

The cardinal rules of risk communication emphasize listening, honesty, respect, and collaboration with trusted community voices. These rules highlight that communication is not simply an act of transmission but a relational and ethical practice. Siegrist, Earle, and Gutscher's distinction between trust and confidence (Siegrist et al., 2010) further clarified why communication strategies often fail in contexts where institutional trust is weakened. Confidence may depend on technical performance and past reliability, but trust is rooted in shared values, perceived fairness, and social relationships. When people are stressed or afraid, they experience a phenomenon known as "mental noise," which significantly reduces their ability to hear, remember, or interpret information. Under such conditions, emotional reassurance, acknowledgment of suffering, and respect for people's lived experience become essential components of effective communication. In nuclear accidents, where risks are invisible, complex, and long-lasting, such elements are indispensable for preventing social amplification of fear and restoring a sense of control.

As a result, narrative approaches, storytelling, and dialogical communication have emerged as critical tools in radiological protection. These approaches recognize that people make sense of their experiences through stories and that dialogue creates spaces for shared meaning, mutual recognition, and collective problem-solving. After the Chornobyl and Fukushima accidents, personal testimonies, shared measurements, community meetings, and dialogue circles proved powerful in rebuilding trust and empowering affected citizens. Through these communication processes, individuals were able to voice their fears, confront uncertainty collectively, and regain agency in their daily lives. Today, risk communication is widely understood as inseparable from trust-building, stakeholder participation, and inclusive governance. It serves not only to convey information but to strengthen resilience, foster cooperation, and support ethical decision-making in complex radiological contexts (ICRP, 2018).

4. Risk governance

Risk governance is the way that societies make collective decisions about technologies and activities that are complex and have uncertain consequences. Risk governance goes beyond traditional risk assessment and management analysis to include the involvement and participation of the concerned stakeholders in the assessment and management of the risk. Research on risk governance also highlighted the fundamental role of trust in the decision-making processes related to risk management.

It has long been argued that risk assessment and management should be functionally separated (National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health, 1983). However, as described above, the public plays an important role in risk-related decision making, highlighting the importance of addressing risk through a risk governance approach that deals with risk assessment, management, and communication in an integrated manner (Renn, 2008). This has also led to a solution-focused risk assessment (Finkel, 2011), i.e. an assessment in which the effectiveness of protective actions and other activities are evaluated by assuming in advance what kind of measures will lead to the solution of the issues. In the case of the Fukushima disaster, measuring radiation doses to individuals and in residences highlighted what actions and measurement options were available. This led to risk management including decision-making, through dialogue among stakeholders. This kind of integrated approach has its own beneficial implications for affected residents, experts, and governments.

Risk governance expands traditional risk management by recognizing the multiplicity of actors involved in decisions about hazardous technologies and the broad range of factors that shape these decisions. Unlike classical risk management, which relies heavily on expert judgment and quantitative assessments, risk governance acknowledges that societal expectations, ethical constraints, cultural worldviews, political systems, and institutional arrangements profoundly influence how risks are defined, evaluated, and addressed. According to Ortwin Renn, governance frameworks must integrate legal, social, economic, and technical dimensions, reflecting the complex interplay between scientific knowledge, public perception, and societal values (Renn, 2008). This makes risk governance particularly relevant for ambiguous, long-term, or uncertain risks — such as those associated with radiological contamination after a nuclear accident — where no single actor holds all necessary competencies or legitimacy.

Beyond recognizing multiple dimensions of risk, risk governance emphasizes inclusiveness, transparency, and the active involvement of diverse stakeholders. Governments, regulatory authorities, scientific experts, industry representatives, civil society, and local communities all contribute to the processes through which risks are assessed and managed. This plurality of perspectives is not a limitation but a strength: it ensures that decisions are informed by technical expertise while also reflecting lived experiences, moral considerations, and social priorities. Such an approach is particularly important when dealing with radiological risks, where uncertainty, invisibility of hazards, and potential long-term consequences challenge traditional expert-driven decision-making and heighten public sensitivity.

The co-expertise process exemplifies inclusive risk governance in practice. Originating from the ETHOS project in Belarus and later refined following the Fukushima Daiichi nuclear accident, the co-expertise model provides a structured way for experts and affected communities to work collaboratively. Ethical principles such as transparency, equity, prudence, autonomy, and loyalty underpin the co-expertise model. Transparency ensures that information is openly shared and that uncertainties are acknowledged. Equity reinforces fairness in participation and decision-making, ensuring that all voices — including the most vulnerable — are heard. Prudence guides protective measures by balancing scientific, social, economic and environmental considerations. Autonomy respects each individual's right to make informed decisions about their own life, while loyalty reflects the long-term commitment of experts and authorities to support affected communities. By engaging populations directly in the decision-making process, the co-expertise approach shifts the paradigm from top-down management to participatory governance. It enables individuals and communities to regain control over their lives, rebuild their social fabric, and develop practical radiological protection culture. As such, it represents one of the most significant evolutions in modern radiological protection, illustrating the essential role of shared responsibility and collective learning in addressing complex risks.

Figure 2 illustrates the integrated approach to risk governance using dose measurements as an example.

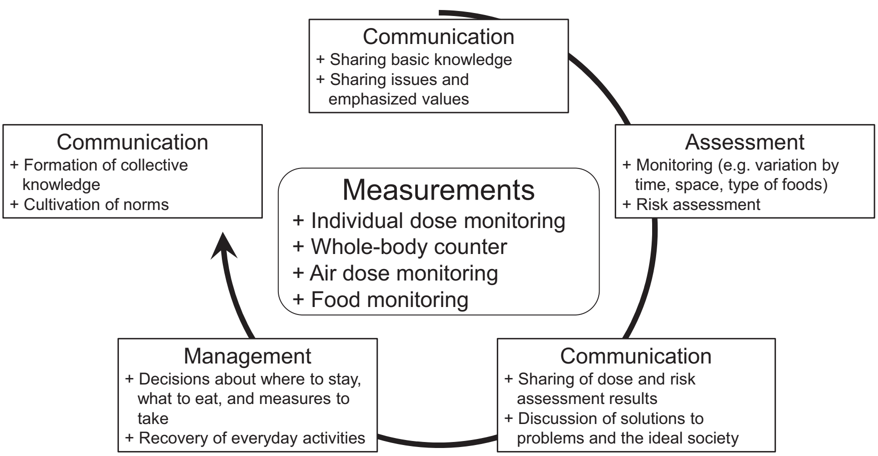

FIGURE 2. The integrated approach to risk governance using dose measurements as an example (© M. Murakami).

For residents, this approach means a process that allows their opinions to be reflected in decision-making and to restore their everyday lives. The measurement of radionuclides in foods and ambient dose rates at residences, and individual internal and external exposures, together with discussions of the results among stakeholders including experts, are useful for the residents in facilitating their decision-making, such as what they can eat and where they can go (Ando, 2016). It should be noted here, however, that when measurements indicate a level perceived by residents as high risk, but additional protective measures (e.g., decontamination or relocation) are not possible or difficult to implement, such information may not effectively support decision-making for some actions. This highlights the importance of "integration of radiological protection into municipal systems," such as local public health, environmental monitoring, and community support frameworks, and "liaising officers" to bridge affected residents and radiological experts (Miyazaki, 2016). It was reported that after the Fukushima disaster, people who engaged in risk communication with their family, friends, and acquaintances were more likely to show improvements in self-efficacy and health-related behavioural changes. Furthermore, participation in everyday individual, social, interpersonal, and economic activities, such as hobbies, social participation, relationships, and work aided recovery (Kobayashi et al., 2021). This implies that it is important for affected residents to engage in routine communication with their families and friends that addresses the overall post-disaster situation, including radiation-related risks, in the aftermath of a nuclear disaster. The formation of collective knowledge about radiation within a community through a co-expertise process will be a cornerstone of such dialogue among affected residents.

Conclusion

The shift from risk assessment to risk governance reflects a profound transformation in the field of risk research. This transformation is also evident in radiation protection. While scientific data and information remain essential, on their own they are not sufficient. Psychological aspects, communication strategies, cultural aspects, ethical considerations, and stakeholder involvement are now recognized as indispensable components of effective management of exposure situations. This change underscores the growing awareness over recent decades that risk is not simply a technical variable to be quantified, but a multidimensional social construct influenced by trust, values and lived experience. In practical terms, this translates into the need for interdisciplinary collaboration, combining expertise from the natural sciences, social sciences, ethics, and the knowledges and wisdom of the public.

The co-expertise process represents one of the most advanced implementations of inclusive risk governance. It illustrates how scientific knowledge can be integrated with local experience, shared responsibility, and community-driven actions. By fostering dialogue, joint measurements, and collaborative problem-solving, the co-expertise approach helps empower affected populations, rebuild confidence and trust and bridge the gap between expert assessments and public concerns. These elements are particularly vital in post-accident contexts, where uncertainty, loss of control, and disruption of daily life challenge traditional communication and management strategies.

As future technological and environmental challenges emerge, this holistic approach will be crucial for sustaining resilience and social cohesion. Climate change, energy transitions, and evolving technological risks will likely intensify societal demands for transparency, participation, and fairness in decision-making. Radiological protection must therefore continue to expand beyond narrow regulatory frameworks and invest in inclusive, adaptive, and ethically grounded governance models. Such an evolution reinforces the idea that effective risk management is ultimately a shared endeavour—one that depends not only on scientific accuracy, but also on meaningful engagement, mutual respect, and the collective capacity to navigate uncertainty together.

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13 The ethical dimensions of the co-expertise process after a nuclear accident

Makoto Takahashi[1,2], Thierry Schneider[3,4,5], Jean-François Lecomte[4], Jean-Christophe Gariel[6]

Abstract

Following the Chornobyl and Fukushima disasters, decision-making processes have been largely challenged leading the experts to revise their role and to favour participatory processes and to rebuild trust. In this context, ethical considerations are crucial to ensure a fair implementation of the co-expertise process to address the future of the local communities and allow people to live well with each other while facing a complex situation in areas affected by the accident. This chapter discusses different ethical issues relating to the role of experts, and situations to be avoided such as: experts trivialising the radiological risk in contaminated areas, co-expertise as a progressive trend to leave people managing their situation alone, co-expertise as a justification of decision already taken by the experts and co-expertise only accessible for few local communities. To overcome the complexity of the post-accident situation, the deployment of co-expertise processes must promote and expand the empowerment of citizens, implement fair and inclusive decision-making processes, ensure institutional commitment and address the conditions for long-term sustainability of community life as well as organising the vigilance.

Introduction

Calls for more open and democratic modes of governance have long been a feature of the social sciences, achieving great success from the 1990's onwards. Ours is an age in which calls for more citizen science and public participation

1 McQuillan Institute for Science, Technology and the Human Future, Harvard University, USA
2 Harvard Kennedy School of Government, Harvard University, USA
3 Nagasaki University, Japan
4 International Commission on Radiological Protection (ICRP)
5 Nuclear Protection Evaluation Centre (CEPN), France
6 Nuclear Safety and Radiation Protection Authority (ASNR), France

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are commonplace, and many imagine them to be a remedy for political disaffection. The OECD has framed public participation as the "missing link" in modern societies, for example. The field of nuclear disaster management is no exception to this trend. Faced with public suspicion following the Chornobyl and Fukushima Daiichi disasters, experts have pioneered governance approaches aiming at both favoring participatory processes and rebuilding public trust. In addition, to be efficient, it emerges that the management of the long-term consequences had to better consider the characteristics of the local situation and the practical knowledge of the local citizens. The co-expertise process outlined in this book has emerged as one of the most prominent of these mechanisms. Much of this textbook is dedicated to making the case for a co-expertise approach and how to implement it in practice. The aim of this chapter, however, is to reflect critically on the *ethics* of the co-expertise process. What values have shaped it? How has the experience of implement it spurred ethical reflection in radiological protection specialists? And what ethical challenges does the implementation of the co-expertise process pose?

1. Co-expertise as a site of ethical reflection

Broadly speaking, it can be said that the co-expertise process has been a catalyst for ethical reflection on the values structuring the condition of intervention of the experts in the process, in particular in the field of radiological protection (Lochard, 2021; Schneider et al., 2019). For experts of the domain, who were members of the International Commission on Radiological Protection (ICRP), the opportunity to work with the people most affected by the Fukushima disaster was an important prism through which they could reflect on the ethical principles that guide their profession. Though the ICRP had long recognized that radiological protection is a matter of both facts and values, between 1928 and 2016 it had only rarely made explicit statements about the values that guided its work. On the heels of the 2011 Fukushima Daiichi disaster, however, the ICRP resolved to rectify this state of affairs and at a meeting in Fukushima, Japan in October 2012, the Commission decided to set up a working group on the ethical foundations of the system of radiological protection including professionals with experience in the co-expertise process. This culminated in ICRP Publication 138 five years later which highlighted four fundamental ethical values and 3 procedural values considered fundamental to the radiation protection system namely: beneficence and non-malevolence, prudence, justice and dignity with respect to core values and accountability, transparency and inclusiveness to aid their implementation in practice (ICRP, 2018):

- **Beneficence/no-maleficence:** promoting or doing good and avoiding doing harm. This is reflected, for example, in the primary aim of the system of radiological protection which is to achieve an appropriate level of protection without unduly limiting desirable human actions;
- **Prudence:** making informed and carefully considered choices without full knowledge of the scope and consequences of an action. Prudence is

reflected, for example, in the fact that in all decisions aimed at protecting people or the environment, the uncertainties of radiation science are taken into account by acting in a judicious and reasonable manner, in particular with regard to low exposures;
- **Justice:** fairness in the distribution of advantages and disadvantages. Justice is a key value underlying, for example, individual dose restrictions that aim to prevent any individual from receiving an unfair burden of risk;
- **Dignity:** the unconditional respect that every person deserves, irrespective of personal attributes or circumstances. Personal autonomy is a corollary of human dignity. This underlies, for example, the importance placed on stakeholder participation and the empowerment of individuals to make their own informed decisions.

Publication 138 further outlines three procedural values, which are highlighted to aid the practical implementation of radiological protection:
- **Accountability:** to be responsible for one's own action. This requires to report on the activities and decisions, endorse the responsibility of the actions and decision, and account for the consequences, if necessary;
- **Transparency:** to share available information and favour the accessibility of information about the deliberations and decisions concerning potential or ongoing activities. It relies on the honesty with which this information is transmitted;
- **Inclusiveness:** to involve relevant stakeholders in the decision-making processes by establishing the conditions for their participation and promoting their empowerment.

1.1. *The co-expertise and the good life with others*

How the parameters of a problem are defined is inseparable from the success in solving it. Frame the issue too narrowly and the policy solutions will fail to address the real-world issue; frame it too broadly and the interventions may prove too diffuse. In practice, most complex real-world issues can be framed in innumerable ways and defining the nature of the problem is an essential political choice. Nonetheless, experts, politicians, and members of the public often frame the problems they face in highly specific ways, without recognizing how they are (inadvertently) defining the scope of action. Dialogue between actors can serve to catalyse reflection and create an opportunity to develop shared policy frames. The notion of "normalcy" is illustrative of the objective of nuclear disaster management, which is often framed as a return to normalcy. Many understand "normal" as indexing their pre-disaster living and working conditions, in which radiation was of no consequence to their daily life. This is an entirely legitimate expectation but is unlikely to be satisfied, due to lingering contamination as well as the social and economic effects of nuclear disasters. In this context, the establishment of a "new normal" will necessarily have to reflect these post-accident realities. Explicitly framing the goals of disaster management in these terms and engaging in an open dialogue with the relevant stakeholders about the contours of this "decent living and working conditions" in the new context is essential to avoiding disappointment and disaffection and creating opportunities for affected people to meaningfully shape the response to the disaster, fostering the autonomy upon which *dignity* rests.

Radiological protection is not an end in itself. The objective of post-nuclear accident recovery is, beyond protection, to ensure decent and sustainable living conditions in the affected communities. Rebuilding living together requires implementing local projects that help improve the well-being of individuals and the quality of living together. This is why experience has shown that the communities having participated in co-expertise experiments are keen to develop projects in the fields of radiological protection but also education, memory and culture (Schneider et al., 2021). To effectively implement these local projects, cooperation with the competent authorities, public and private organizations, experts and professionals is essential

The co-expertise approach aims to integrate technical expertise and the values carried by the people concerned in compliance with regulatory requirements. The philosophy behind the process is that experts and stakeholders can jointly solve the challenges facing the community through their respective expertise — that of scientific and technical experts and that of daily human experience made up of traditions, culture and aspiration to live well with and for others. Local actors are a valuable resource for understanding the concerns of the community but also for deciding what actions to implement, because their interests are at stake. Experts are a valuable support to help gather technical data and assess rational options and their impacts. Affected people live with the consequences of decisions and are therefore the best judges to decide which options to adopt.

1.2. *The co-expertise at the service of people*

At its core, co-expertise is an exercise in the values of *prudence* and *modesty*. Foundational to the practice is the recognition that we must act in an uncertain world. Though the effects of ionizing radiation on human health are well-studied, claims about the effects of exposure to low doses (i.e. <100mSv/y) continue to be contentious: some suggesting harm, others suggesting that no effect should be assumed, still others contending that low doses of radiation may be beneficial to human health (*radiation hormesis hypothesis*). The basis for ICRP recommendations, in general, and the co-expertise process, in particular, is that because of the uncertainties in the estimation of the risk at low dose, it is *prudent* to adopt the precautionary principle and assume that the risk is proportional to the dose, whatever the level of the dose (*linear non-threshold (LNT) hypothesis*). Contemporary radiological protection is thus framed as a matter of *optimisation*, whose implementation consists in acting to ensure that exposure to radiation is *as low as reasonably achievable*. (This dictum is often abbreviated to ALARA.)

But who should determine what is reasonably achievable? The co-expertise approach advocates having the humility to recognize that experts do not have a monopoly on reason, so cannot claim the sole right to define what exposures are (un)acceptable. Risk management is always a matter of facts and values, in which actors must define when the optimization process can cease. Far from being a purely technical determination, this is inherently a matter of judgement. Modesty might help experts to recognize a simple means of addressing a complex problem. Namely, that if the object of risk management is to promote the well-being of affected people, then these very people have something valuable to contribute. This observation undergirds the invitation to work with people as "co-experts" in order to develop among them the "practical radiological protection culture" necessary to protect themselves in daily activities.

A post-accident situation differs in many aspects from a normal situation. It is particularly disturbing for those affected. Therefore, the success of a co-expertise process requires the experts to adopt an appropriate attitude vis-à-vis the other concerned parties, taking into account their actual situation. From an ethical point of view, it is a duty for the experts involved in a co-expertise process to demonstrate commitment and accountability, often over the long term. For instance, it is important that they come on the spot several times, that they get to know the members of the various parties concerned, that they engage with them in a two-way dialogue.

After a nuclear accident, it is possible and even likely that trust in radiological protection experts will be impaired. In order to regain trustworthiness, it is crucial that experts involved in the recovery process adopt an attitude marked by: modesty by avoiding overly academic postures; openness by being attentive to the questions and concerns of the affected people but also to their knowledge and experiences that they wish to share; transparency by providing the information and explanations in an understandable manner; empathy by taking due account of the disruption and pain suffered by those affected; and inclusiveness by helping to organise a balanced dialogue between all concerned parties.

It is essential that the experts involved in post-accident management engage with the populations in order to improve their protection and restore their living and working conditions. The aim is to be committed at the service of the society and to work with the local people rather than for them, in order to improve the well-being of the population.

In radiological protection and more specifically to address exposure at low doses, prudence is a key ethical value to which the experts should refer, both to estimate the risk and to manage it. It is necessary for the radiological protection experts to recognize the assumption behind the radiological risk, the limits of their own knowledge with regard to the complexity of the post-accidental situation as well as the uncertainties associated with the management of the post-accident situation. Experts have to provide the good science and relevant scientific and practical knowledge to address the situation together with due consideration of other issues to be embarked in the context of post-accident situation. Experts have also to show modesty by acknowledging the fact that they will not be able to fully understand the impact that may have a nuclear accident on the daily life.

Thus, it is never easy and not the role for the experts to conclude that a situation is safe or not and, more generally, to discuss the effects and risks associated with exposure to ionizing radiation with those affected. Putting the exposure due to the accident into perspective with other radiological exposures or even other risks is generally a sensitive issue. The first ethical position for the experts is to acknowledge that in any case the contamination due to the accident of the local areas is not at all legitimate. The experts should remain both consistent with the scientific knowledge relating to the radiological risk and the basic principles of radiological protection, as well as attentive to the perception of this risk by the affected population as well as the consequences of this contamination for the daily life of the residents. They notably have to recognise that acceptability of the exposure situation is not only a matter of level of risk and cannot be decided by the experts solely with scientific arguments but needs to be addressed by the affected people themselves, with due consideration of all the facets of the daily life affected by the presence of radioactivity in their own environment.

1.3. *The fairness of the co-expertise process*

It is common for risk management strategies to subdivide the population into different groups, identifying specific populations as particularly "at risk". In radiological protection, the basis for this classification is often biological. Women and children are framed as particularly vulnerable, while the elderly are deemed less "at risk". In addition, specific attention should also be devoted to future generations. This diagnosis usefully captures one dimension of the post-disaster scenario but can disguise the social dimensions of vulnerability. How might the elderly, though less sensitive to radiation exposure, be particularly adversely affected by both the experience of evacuation and the subsequent collapse of community infrastructure, for example? (In Fukushima, numerous studies have reported that evacuation led to excess mortality in the institutionalized elderly (Nomura et al., 2013; Yasumura, 2014) and the social isolation of the elderly is of real concern (Yoshida et al., 2021). When evacuation orders have been lifted, it is overwhelmingly older residents who have chosen to return to the affected territories, often leading to a separation from the younger generations of their family. However, the media's celebration of the elderly's tenacity and dedication to rebuilding Fukushima — epitomized by news coverage of seniors in the so-called "Fukushima 50" and later "suicide corps" which volunteered to replace younger cleanup workers — has often led the needs of the elderly to be neglected.) And how might women's experience of the disaster be distinct, not only due to factors of biology, but due to uneven distributions of household activities (in societies in which childcare, cooking, and cleaning remain gendered, so too do daily encounters with radiation risk) (Ando, 2025). Or indeed, how might women's experiences of a nuclear disaster be shaped by misogyny? Women disproportionately face forms of discrimination and social policing in post-disaster situations. Marriage discrimination is more acutely experienced by women from Fukushima, for example (Heath, 2013); while stereotypes of "hysterical women" can make it more difficult for women to express their concerns. The prominence of the phrase "radiation brain mom" (*hōshanō mama*) in Japanese popular discourse is indicative of the stigmatization that concerned women face (Kimura, 2016). Factors such as class and indigeneity may also be important concerns. The dignity of indigenous peoples may be tied to specific lands or forms of life, which would be violated by broad policies aimed at optimizing the general population's health (consider, for example, the centrality of reindeer herding to Sami culture (Stephens, 2021)). To act with humility is to recognize that one's schema for categorizing the affected public is inevitably partial. When seeking to engage stakeholders, it is therefore important not to assume that we know what "the stakes" — and therefore who "the stakeholders" — are, in advance. Rather, it is through dialogue with affected people that experts can learn how the disaster is being experienced. Put plainly, affected people should ideally act as co-experts in defining who the stakeholders in the process are. In a post-accident situation, experts will face competing accounts of *justice*, where justice is conceived in the ICRP's terms as the fair distribution of advantages and disadvantages. Actors on the ground will likely have different accounts of what is "fair" but also subdivide the population into different groups, who may identify different conditions as necessary for human dignity. Sensitivity to these competing worldviews is a core precept of the co-expertise process.

1.4. *The co-expertise and the empowerment of affected people*

Despite the rise of participatory practices across the policy landscape, public engagement is often conducted "downstream" as a means of legitimizing predetermined policy decisions. This leads to a failure of the promises to "empower" participants, as the scope of decision making is already heavily constrained. This is a key criticism that has been levelled at the co-expertise process. Rather than take seriously the view of affected people, the argument goes, experts could engage in discussion only to persuade affected people that it is safe to live in the affected areas and that they should return. As a point of principle, participants in the Dialogue avoid answering questions on whether specific actions are safe, recognizing that this is a judgement that affected people are best placed to make for themselves. The criticism nonetheless correctly identifies that many activities occur "downstream" from national (and even regional) decision-making. Ensuring that affected people are given opportunities to shape "upstream" framing of radiological protection policies is therefore essential for co-expertise to achieve its full potential.

The foundation of co-expertise is mutual respect and learning between citizens and experts. One test of the extent to which dialogue is genuinely two-way is to ask, what have the expert participants learned from the experience? In the course of the Fukushima Dialogues, for example, expert participants have come to develop a great appreciation for the role of community rituals and traditions as a source of comfort and meaning for affected people, worthy of prioritizing.[7] Yet experts can often face institutional barriers to learning. By nature, most institutions are committed to framing policy issues in specific ways. Consequently, learning is constrained to working more effectively within this frame, rather than questioning its assumptions. Factors such as cultural practices, crucially important to the affected peoples, may nonetheless be deemed to fall outside the proper purview of the experts by their parent organisation, leading to efforts to dissuade action on these issues. For co-expertise to be most effective, the commitment to humility must be cultivated at an institutional, as well as a personal level.

However, the mandate of the experts engaged in the process may limit the scope of this empowerment. Individual experts can only invite local people to participate in decisions that they themselves have the authority to make. Experts have broadly two (overlapping) options for overcoming this obstacle. The first is to advocate for the co-expertise process, both within their institution and across different policy institutions. The second, parallel strategy is for experts to shift their attention from "invited" forms of participation to what social scientists have variously called "uninvited" (Wynne, 2007), "bottom-up" or "spontaneous" (Bucchi and Nereseni, 2007) participation: civil society initiatives and interventions, organized independently of established policy institutions. Rather than feeling the need to lead the co-expertise process, by creating new spaces for dialogue between stakeholders, experts can also volunteer their support to "bottom up" projects and organisations, lending these existing endeavors their expertise, social capital, and support (NPO Fukushima Dialogue, 2026). In the wake of the

[7] Talk of recovering community traditions and cultural heritage can seem a little abstract, so we'd like to offer two examples of volunteer projects undertaken in the village of Iitate, prefecture of Fukushima, which was evacuated between 2011 and 2017. When a small fire broke out in 2013, no one was close enough to prevent the 11th Century Yamatsumi Shrine from being burned to the ground. The nuclear disaster had (indirectly) claimed another piece of Fukushima's cultural heritage. Luckily, researchers from Wakayama University had been studying the shrine and carefully photographed the ceiling, on which 242 wolf deities had been painted. Together with 20 of his graduate students, Tokyo University of the Arts Professor Kei Arai went about carefully reproducing the prints, which were installed into the rebuilt shrine in 2016 – ready for the shrine to host its first festival since March 2011 and for the return of villagers in the spring of 2017, when the evacuation orders were lifted.

Another site of citizens' efforts to recover their cultural heritage is Yasaka Shrine, Iitate. For more than 300 years, the dance of three lions was performed at the Shrine every October. This tradition, which came to a halt in 2011, was resumed on 17 October 2017. However, while the dance is traditionally performed by young boys, it is now performed by adults because few children have returned to the village. Nonetheless, keeping this intangible cultural heritage has become a focal point of some local people' efforts.

Initiatives such as these were unlikely to be prioritized under traditional radiological protection approaches, which focused more on public health (narrowly defined) and economic activity. A co-expertise approach advocates that practitioners allow affected people to frame the task of reconstruction for themselves, acknowledging that there is more to "living" than (biological) health, and support local citizens' efforts to build a "new normal".

Fukushima Daiichi disaster, for example, numerous citizens groups were independently organized to monitor radiation levels (e.g. SAFECAST) and exposure (e.g. D-Shuttle), as well as promoting dialogue (e.g. NPO Fukushima Dialogue). Experts should have the humility to place themselves at the service of such local initiatives, rather than feeling the need to lead or manage the interaction.

By empowering those involved, the co-expertise process develops a practical radiological protection culture which allows members of the community to interpret the results of radiation measurements, to build their own benchmarks in relation to the radioactivity present in their daily life, to make their own decisions to protect themselves and their loved ones and finally to assess the effectiveness of protective actions implemented by themselves or by authorities and organizations (ICRP, 2020).

2. The ethics of the co-expertise process in practice

2.1. *Ethical challenges of implementing the co-expertise process*

Four main ethical issues have been identified in the post-accidental context: experts trivialising the radiological risk in contaminated areas, co-expertise as a progressive trend to leave people managing their situation alone, co-expertise as a justification of decision already taken by the experts and co-expertise only accessible for few local communities.

2.1.1. Experts trivialising radiological risk

One of the major issues for affected people in a post-accident situation is to know if it is safe or not to live or work in a contaminated area, if it is safe or not to eat food produced in affected areas and what is the health risk for them and their relatives, with a main concern for the health of their children. People are expecting that the experts could provide unambiguous answers on the possible health effects for the current and future generations. At the same time, different points of view are expressed including false rumours about the nature or the magnitude of the risk arising from radioactivity, and even with manipulation of scientific knowledge.

On the other side, experts generally consider and observe that the doses for most of the people living in authorised affected areas in a post-accident situation are expected to be low or even very low from a radiological protection point of view. In this context, experts can be tempted to respond with scientific arguments and relying on risk calculation without providing enough nuance in the sense of low risk and uncertainties associated with radiation-induced risk at low level of exposures.

Due to the fact that the linear non-threshold dose-effect relationship is an assumption and the lack of evidence about radiation-induced heritable effects for human, experts may argue that the risk associated with radiation exposure for people living in affected areas is trivial. Such a position has been observed following the Chornobyl and Fukushima accidents clearly emphasizing the lack of due consideration of the perception of the risk as well as the various non-radiological factors affecting the exposure situation and missing to recognize that the radioactivity should not have been there.

In the prolongation of this issue of risk at low doses, some formulations should be used with caution, such as the concept of normality. The primary aim for local citizens is to come back to the ante situation as soon and as much as possible. In this perspective they generally rely on the cleaning of affected areas and radioactive decay to reduce and even delete exposures due to the fallout of the accident. There is a legitimate expectation to come back to "normal" living and working conditions (i.e. referring to decent living and working conditions) where the radioactivity has no more consequences on their daily life.

In fact, this "return to normality" is generally not achievable due to the long-lasting presence of radioactivity in the environment and due to the complexity of the consequences of the accident not only on radiological exposure but more broadly on the societal and economic activities. In this context, the concept of normality only makes sense if it incorporates the new living and working conditions, which is not explicit. In this regard, the focus on radiological criteria is a pitfall for experts to address the complexity of the situation in its many dimensions and to justify the difference with ante situation. Anyway, the ardent desire to turn the page should not overshadow the necessary long-term vigilance on health and environmental issues, and more generally the prolonged commitment of affected communities.

2.1.2. Leaving people alone

The empowerment of local populations in the co-expertise process, in particular with the aim to favour their involvement in the management of their own protection, could be considered as a disengagement of the experts. It could even be viewed as a strategy to progressively let people manage their situation alone, in the perspective of reducing the support from the public bodies. This concern is understandable as ideas of localism and volunteerism have historically been used to justify cuts to the size of the state.[8] It is therefore important to stress that co-expertise is intended to reinforce the partnership between residents, experts and authorities and could lead to *shape* and *augment* the state's support for affected people, not to *substitute* for it. It cannot replace compensation, provision of healthcare, or decontamination, to name just a few

[8] Famously, David Cameron's UK Conservative party promoted the idea of *The Big Society*: a package of policies with the stated aim of "creat[ing] a climate that empowered local people and communities, building a "big society" that would take power away from the politicians and give it to the people". In practice, this Conservative party platform aimed to *devolve* more powers to local administrative units and encourage citizens to *volunteer* in their local community, whilst also imposing *austerity*. The promised "empowerment" thus took the form of local governments and citizens assuming more responsibility for governance, while also receiving reduced resources. Given that *The Big Society* (2009-2013) was contemporaneous to ICRP's adoption of a "co-expert" approach, suspicion about the language of "empowerment" is understandable.

vital state functions. These forms of material support are *necessary* to citizens' empowerment. Yet it is also true that they may not prove *sufficient*. Citizens who feel their material needs are adequately met may nonetheless feel isolated or overwhelmed by the enormity of a nuclear disaster. The co-expertise process offers such citizens a community in which to make sense of the disaster and take (individual or collective) decisions. (Some have noted that the format shares important features with group therapy (Takahashi, 2021).) Moreover, it aspires to be a space in which citizens can articulate their material needs, thereby shaping both local initiatives and the state's allocation of resources. However, the extent to which co-expertise is able to accomplish this latter goal depends upon the authority of the convening body. (Note that neither the ETHOS Project nor the ICRP had the authority to determine compensation policy in Belarus or Japan, respectively.)

Beyond the first step when experts help citizens to characterise the radiological local situation, there is a temptation to progressively leave them to make additional measurements and to interpret the results. In the same spirit, the dissemination of individual monitoring devices may contribute to this challenge and progressively transfer the responsibility of dealing with the radiological situation to the affected people. In this context, one of the difficulties for the experts is to ensure the articulation and complementarity of protective actions to be handled by the local people themselves with the protective measures implemented by national and local authorities. Depending on the available resources (financial, human, material), this articulation may evolve rapidly and may put experts in a difficult position with regard to leaving people alone, or not.

2.1.3. Deciding for people

Co-expertise processes require a close relationship between experts and local populations. Progressively, this could be seen as a potential manipulation by experts, forcing people to stay in contaminated territories. At least, the experts could be suspected of influencing the decisions of those affected, notably by trivialising the risk. By taking refuge behind their knowledge and experience, experts may take decisions on behalf of the individuals or community concerned or initiate protective actions without involving them. On this basis, the experts should wish to protect people even without them or despite them.

Involved in co-expertise process, it is not so trivial for the experts to put aside their own convictions to accompany people and help them to make their own opinion by giving access to meaningful technical and scientific knowledge, without influencing them. Due to the complexity of the post-accidental situation and the demanding process for experts involved in co-expertise, they may overstep their role and wish consciously or not to become involved in the choices based on scientific arguments or even personal considerations while these choices should be made by the citizens themselves. For the experts, finding a good position to favour the autonomy of local people without leaving them in isolation is not easy to address.

2.1.4. Only accessible for few local communities

The development of co-expertise process generally relies on interaction between experts and local leaders. In this regard, the contact that experts have to establish with local stakeholders, in particular those from civil society, can also constitute a key challenge. Some are harder to reach than others. The pitfalls in this area are numerous, for example: involving only the elite or those who come forward while forgetting the most deprived or those who remain in a waiting position, working with certain communities and not others, neglecting the evacuees who have not returned, etc.

On the other hand, the number of radiological protection experts is limited and they cannot be everywhere. An important challenge is to guarantee the access to participation and empowerment process of the communities willing to implement it. It is also challenging to share and disseminate the results with communities which do not implement it.

2.2. *The way forward*

2.2.1. Expanding the empowerment

In order to contribute to the autonomy of affected people, the role of the experts is not to make decisions for individuals on their future, nor even to convince that a path is the right one. As a matter of dignity of affected people, experts have to respect everyone's values and choices in the co-expertise process without imposing their views. They also have to provide adequate means and support to allow them to recover their autonomy. A fair balance has to be found in the process between scientific knowledge and experience, local knowledge of the situation, values and habits of local citizens, societal, environmental and economic considerations. In addition to the restoration and development of the capacity for each individual to take informed decisions in the new post-accidental context, the experts should support communities in their self-assessment, in accordance with the values of justice and equity.

A fair engagement from the experts includes contributing to the development of a practical radiological protection culture for citizens involved in co-expertise processes, helping them to characterize the radiological situation and the potential impacts on their day-to-day life while preserving their autonomy. Such a contribution encompasses many ways, several of which have already been mentioned in other chapters, for instance: allow the access to pluralistic scientific information and multidisciplinary expertise, support people to make their own measurements without imposing it to all individuals, help them to interpret the results, share the results with everyone, help to understand and use the radiological protection criteria and possibly assist people to build their own reference system. It has to be considered with a sustainable implication of experts to avoid the pitfall of leaving people alone.

Any protective action can have advantages and disadvantages for those for whom they are intended or for other people: disruption of daily life, loss of goods or values, separation from loved ones, transfer of risk, appearance of new risks, etc. In order to contribute to doing more good than harm, i.e. to respect the values of beneficence and non-maleficence, the experts should favour a joint assessment of the advantages and disadvantages of decisions with affected people within the co-expertise process. This should be considered by assessing protective actions or combination of actions, taking into account the prevailing circumstances for the individuals and the communities as well as their own values.

2.2.2. Promoting fair decision-making processes

Decisions involve consideration of many dimensions and the radiological issue is just one of them. In post-accident situation, the radiological experts need to acknowledge that their background is not sufficient to address the complexity of the local situation. There is a need to promote a pluralistic approach and a multidisciplinary view by involving experts from different origins and from different disciplines. In such a context, it is not easy to address the non-radiological factors in the assessment and management of the situation and to set up the rules of cooperation between these experts themselves and with local citizens, notably with the distrust of public experts and authorities after a nuclear accident.

However, the interdisciplinary cooperation is essential to properly balance the different components in the decision-making process and to prioritize the decisions considering as much as possible the diverse dimensions of the situation: preservation of health, protection of environment, maintenance of economic and societal activities. Promoting such a process for the co-expertise could reinforce the robustness of the decision-making process with due consideration of the value of non-maleficence and the autonomy of decision of affected people.

At the local level, it is essential for the experts to consider carefully the equity between all concerned parties, ensuring that no individual or group of individuals is discriminated compared to others. Adopting a global and average approach is generally not adapted to the post-accidental situation in the long-term. Addressing equity is a concern in particular with regard to vulnerable groups such as children, pregnant women or the elderly, or people who are constrained by protective actions without benefiting from them.

Special attention should also be paid to the protection of future generations who are not involved in the co-expertise process but who will bear the consequences of the decisions to be made. Addressing the issue of transmission of the situation to the next generation is therefore a necessity. Compliance with the values of justice and equity will also help to find compromises between the inevitable conflicts of interest generated by the complexity of the situation. Experience shows situations and expectations can vary from one community to another, and radiological protection issues can be quite different.

Thus, in this context, experts have to adapt their expertise to each local specificity and individual's need, without any preference or special privilege. For instance, experience shown a lack of support from experts to communities of evacuees not returned to their homes. It was generally not considered as a priority while in fact those people were left alone with their concerns and expectation, even suffering discrimination. Testimonies reflected that those who left suffer as much if not more than those who stayed or returned. These evacuees need support, in compliance with the values of beneficence, justice and equity. In that perspective, some questions should be dealt with, such that the obstacles to reach these communities, the difficulty for the experts to be committed outside the contaminated areas and even how radiological protection experts can help them.

Ensuring the dissemination of the experience achieved in a specific local community to others are key elements to promote justice and equity. Despite the limitation of available resources, promoting the networking among affected communities and sharing experiences is a way to stimulate the development of co-expertise processes and to favour the implication of experts with a larger number of affected communities. All concerned parties should cooperate in such a dissemination, with the support of the local and national authorities, by being attentive to the needs and expectations from communities that are not yet engaged in a co-expertise process. It should be done respecting the autonomy of each local community facing common but also different issues. Transparency, including notably the traceability of local experiences, would help to organise the access to information and to share these experiences with other communities.

The contribution of experts should be organised not only at local and national levels but also at international level. Indeed, thanks to their networking with their peers around the world, the experts are able to relay information from the local to the international and vice versa. It could help sharing information, contribute to a better understanding of the actual situation and mitigate misinterpretation, false rumours and discrimination. This information can take the form of reports or publications intended to ensure the traceability of data and actions and to facilitate subsequent research. In doing so, experts will need to exercise restraint so that local citizens do not feel like “guinea pigs”. Globally speaking, the experts can play the role of “The Ferryman” illustrated by both paintings made by the Japanese and French artists Utagawa Hiroshige and Jean-Baptiste Corot, which bear this title. To be fair and efficient, such role should be played in accordance with ethical values such as transparency, equity, prudence and dignity.

Experience from Chornobyl and Fukushima has shown that to be credible, experts must not only master the scientific basis of radiological protection and its practical implementation (Accountability), but must share openly all information they own and recognize their limitations (Transparency) and deliberate and decide together with stakeholders (Inclusiveness). Here we find in action the procedural values highlighted by the radiological protection system.

2.2.3. Mandate and institutional commitment

While the disruption of administrative, economic and social practices after a large nuclear accident leads to a change in the political governance of the affected areas, notably by further involving the relevant parties at local level, the co-expertise process also creates a change in the governance of expertise. The experts should be prepared to take and/or support initiatives as soon as possible in the recovery phase, i.e. to establish dialogues with the population, its representatives and notably those who invest themselves as citizen-experts, in order to share experience and knowledge, to engage affected people in measurements and sharing results, to identify and implement protective actions and to organise citizen vigilance as well as the implementation of local socio-economic projects. Such initiatives should be carried out in a multidisciplinary mode taking into account the multidimensional feature of the situation. Further, the experts should stimulate and support initiatives of the same nature from local parties. They also should respect local projects even when they are not in line with the institutional approach. These initiatives, in accordance with the procedural values as identified in ICRP Publication 138, will greatly contribute to the increase of the resilience of the affected people. The experts who commit themselves in this way should be as much as possible prepared, supported and benefit from appropriate resources as well as a certain autonomy in their approach.

2.2.4. Addressing long-term sustainability and vigilance

In the long-term perspective, while there is a need to recognize that radiological protection is not necessarily the major issue for the local communities, the co-expertise process has to cope with the implementation of the optimisation principle in order to reach a level of exposure considered as low as reasonably achievable. This has to be done in a broader perspective, including the various components of the local situation in order to contribute to the well-being of the affected population in reference to the ethical values of beneficence and non-maleficence.

The evaluation of this achievement and the corresponding criteria should be agreed with the concerned parties. The restoration of the living and working conditions includes due considerations of health and environmentally sustainable protection with the long-term vision of the socio-economic development of the territory. From a radiological protection point of view, this long-term perspective needs to be accompanied with the organisation of the overall vigilance on the radiological situation comprising sustainable and adequate radiation monitoring and health surveillance of the affected population.

Considering ethical values may also guide the allocation of resources and the choice of priorities for deploying co-expertise processes. Commitment to co-expertise is time-consuming and resource-demanding for all concerned parties, particularly to ensure long-term commitment. For instance, it is difficult for the experts to be committed with a large number of local communities for a long time. While it is a duty for the national and local authorities to provide appropriate resources to address the situation, these are not unlimited and priorities must be defined.

The selection of the priorities should be made in consultation, in accordance with the values of inclusiveness, transparency, beneficence and justice. For example, in the long-term, during the implementation of a socio-economic programme aiming at a sustainable development of the territory, it is necessary to regularly evaluate whether its implementation ensures an adequate level of protection as well as a good and fair balance in the allocation of human and financial resources. On this basis, it is necessary to identify whether additional efforts should be granted for certain local communities, if the support programme is still equitable and proportionate as well as if it addresses the expectation of affected communities.

Conclusion

The situation after a nuclear accident is very complex, including many dimensions among them the radiological protection may not be the major issue. All ethical values underpinning the radiological protection system provided by ICRP, both core values (beneficence/no-maleficence, prudence, justice and dignity) and procedural values (transparency, accountability, inclusiveness), are at stake in addressing such a situation on the long term.

The co-expertise process refers directly to ethical values. The difficulty is that in a context of plurality of points of view there is no value which is a priori dominating. What is preferable can only be a matter of democratic debate between the stakeholders. Finally, the co-expertise process is based on the recognition that to make sense for people confronted with radiation, knowledge about radiological protection must be anchored to their daily reality to allow them to act to improve their future living conditions. This is only possible if they are directly involved in the process and it requires putting ethical values at the service of the overall ethical objective of promoting individual well-being and the quality of living together in order to satisfy the desire for accomplishment to which every human being aspires (Ricœur, 1992).

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Epilogue
"The path is built by walking"*: the co-expertise process as a technology of humility

Jacques Lochard[1,2], Makoto Takahashi[3,4], Anne Nisbet[2]

In the introduction of her seminal 2003 article entitled "Technologies of humility: citizen participation governing science" Sheila Jasanoff stated that it is time to seriously reassess existing models and approaches that structure the relationships between expertise and public policy. She also raises a series of overarching questions including the following two: *"Can we imagine new institutions, processes, and methods for restoring to the playing field of governance some of the normative questions that were sidelined in celebrating the benefits of technological progress? And are there structured means for deliberating and reflecting on technical matters, much as the expert analysis of risks has been cultivated for many decades?" (Jasanoff, 2007)* Acting as a synthesis, this Epilogue is an

* *The path is made by walking.* This quote is from the poem "Traveler, there is no path", by the Spanish poet Antonio Machado, published in 1917 in the collection of poems "Campos de Castilla".

Traveler, your footprints	By walking, the path is made
Are the path and nothing more	And when you look back
Traveler, there is no path	You'll see a road
The path is made by walking	Never to be trodden again

"This is the experience of many of us nowadays. There is no pre-existing path for us to follow, no recipe or best practice. We are in a discombobulating world filled with new opportunities and threats. So we need to become Wayfinders, Explorers who are unafraid to walk into the unknown and make new paths." (Sonja Blignaut – LinkedIn)

[1] Nagasaki University, Japan
[2] International Commission on Radiological Protection (ICRP)
[3] McQuillan Institute for Science, Technology and the Human Future, USA
[4] Harvard Kennedy School of Government, USA

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attempt to partly answer these questions based on the experience acquired in the implementation of the co-expertise process after the Chornobyl and Fukushima nuclear accidents.

1. Historical perspective

The co-expertise process was built progressively in the context of the Chornobyl post-accident situation in the late 20th and early 21st centuries from an empirical trial and error approach. However, experts involved in the process were influenced by work carried out in the previous two decades on the development of risk assessment and risk management and its prolongation into risk perception and risk communication.

Despite advances in risk management during the 1990s, decision-making processes and regulatory approaches related to hazardous activities, continued to face growing opposition from stakeholders at local and national levels. This situation led researchers and experts in the field of risk assessment and risk management to carry out a detailed analysis of the underlying problems so that obstructions could be identified. It was found that whilst a technical approach to risk management is necessary, this in itself is not sufficient for making effective decisions on risk.

As a result of these investigations the new interdisciplinary perspective called risk governance emerged in the late nineties allowing a better understanding of the factors, criteria, processes and mechanisms by which decisions about complex situations with uncertain risks are taken, thereby contributing to social cohesion in technological societies. Thus, risk governance goes beyond traditional risk assessment and risk management analysis to include considerations of the legal, political, economic, societal and environmental contexts in which a given risk is evaluated and managed. Risk governance can be seen as an analytical framework aimed at integrating all previous theoretical and methodological developments relating to the understanding of risks: risk assessment and management, risk perception and risk communication.

But the innovation of risk governance lies partly in the importance given to the involvement and participation of stakeholders, and partly on the fundamental role of trust in the decision-making processes. Researchers who developed risk governance identified that the approach to risk that had prevailed until the nineties was often deadlocked because it did not sufficiently take into account the perception of risk and the aspirations of the public directly concerned. As Ortwin Renn, one of the leading contributors to risk governance, has pointed out, *"The concept of inclusive risk governance is based on a normative belief that the integration of knowledge and values can best be achieved by involving those actors in the decision-making process that are able to bring all the respective knowledge as well as the variability of values necessary to make effective, efficient, just and morally acceptable decisions in terms of risk."* (Renn, 2009).

In addition to the key role of inclusiveness, risk governance researchers have also identified that the perception of risk depends not only on the knowledge that a person has of the risk but also on the values that she/he shares with the person(s) or institution(s) who talks about the risk. This has led to a distinction in the risk management process, between trust (based on morality information) and confidence (based on performance information). This distinction between trust and confidence theorized in the Trust, Confidence and Cooperation (TCC) model is powerful in furthering an understanding of how individuals perceive the risk, and cooperate (Earle et al., 2007). In particular, it provides an explanation of why dialogue, citizens' measurements of radiation, and participation in local projects with the support of professionals, are the way to restore trust after a nuclear accident. As underlined by Earle *"As long as the social system is stable, shared confidence in the system can supply the necessary foundation for daily life. When the system becomes unstable, however, confidence is lost, and trust is required to provide a transition to a new, stable state*".

The ETHOS project and CORE programme taught us that cooperation with experts, personal experience of sharing views with other affected people and performing radiation measurement gradually change the perception of the risk, which in the first instance can be fuzzy and disturbing, even frightening, and which over time is transformed into real knowledge on which to base decisions and action in everyday life. By combining dialogue, measurements and projects, the co-expertise process is an effective mechanism to restore self-confidence among the affected people and trust in the experts cooperating with them. (see Box 1).

Box 1. The short story presented below provides an illustration of how self-confidence and trust are shaped by dialogues, measurements and projects — A 30-becquerel hot chocolate

I had just arrived in Olmany for a new week-long ETHOS mission in early autumn 1997. I was walking in the main street of the village with Nina my faithful Ukrainian interpreter and we met by chance Anna — a farmer, mother of four children and a dedicated member of the young mothers' working group who, for more than a year, had been working to improve the protection of her children and those of the village (Figure 1a). After a warm greeting, Anna invited me to her home to drink a hot chocolate. It was 2 p.m., it was hot, and I didn't feel like drinking a hot chocolate. I excused myself and offered to visit Anna one evening during the week. Seeing her deep disappointment, I dared to ask the reason for this unforeseen invitation. "But it's a 30-becquerel hot chocolate!" she replied, almost in a whisper. This completely unexpected answer filled me with so much joy and satisfaction that I immediately changed my mind and said to Anna "I finally accept your kind invitation! Let's go to your home now".

What a delight to learn that the milk her family drank no longer contained more than 2,000 becquerels per litre, as was the case three months earlier when we measured it together as part of the "milk project" (Schneider et al., 2026). On the way to her house, I remembered my visit in July, when I had to tell Anna that her children were the most contaminated in the village. I had just learned the news from the school nurse who had informed me of the results of the last internal contamination measurements campaign of the school children. That day, I was not feeling at all at ease when I entered Anna's house to explain the situation to her. After a moment of despair, she asked me determinedly, "What can we do?" I explained to her, "We have to find the source of the contamination in the children's food. At school, they consume products from outside the contaminated areas. So we have to examine the products they consume at home." Anna then replied immediately, "It cannot be the milk because Kazoula (her cow), grazes in the same meadow as my neighbour's cow, who measured the milk last week and it was clean!" After exploring several possibilities, but without identifying a potential source of contamination, I was a bit lost. However, I had discovered in passing that Anna had adopted a very cautious attitude with regard the diet of her children, particularly for Aliocha and Maria, the youngest ones. Then, changing the subject to regain some composure, Anna started talking to me about her family, her father and grandfather, and casually mentioned, "I loved going with my grandfather in the evenings when he went to the riverbank to cut grass for his cow. He would tell me little stories..." Continuing the conversation, I then learned that it was a family tradition of giving the cow a supplement of fresh grass every evening, cut daily, at the edge of the marsh, to give a particular taste to the milk! She said that she had learned about this special place from her father, who had learned about it from his grandfather! So by chance, during a dialogue about family memories, we discovered the origin of Kazoula's highly contaminated milk, which was far above the average level of contamination of the herd that she was grazing with, in the summer.

Sitting at the kitchen table while sharing with Anna and Nina the 30 becquerel cocoa, Anna proudly explained to me how she managed the situation on her own. First by reducing the quantity of milk drunk by her children, and secondly in parallel, by reducing the contamination of Kazoula's milk by giving her access to Prussian blue salt lick (Figure 1b), which she obtained from the village's collective farm. Anna was using terms like "Becquerel" and "internal contamination," which had burst into her daily life after the disaster, and which for years, had seemed to her an incomprehensible jargon. She later confided that hearing these terms had made her cry.

(a) (b)

FIGURE 1. (a) Anna and her family; (b) Kazoula licking Prussian blue (Photos: J. Lochard)

As I was closing the blue gate at Anna's house to return to the ETHOS house with Nina, I reflected on my visit, and how, by sharing a hot chocolate she was offering me a truly wonderful gift in gratitude for our successful cooperation.

Many years later, I realized that this episode perfectly illustrated how self-confidence and trust in others are gradually rebuilt when we work closely together in the co-expertise process.

2. About the technology of humility

As Jasanoff aptly points out, the technology of humility *"calls for different expert capabilities and different forms of engagement between experts, decision-makers, and the public"*. This approach goes beyond what was considered necessary in the classical governance structures.

A shift in perspective is needed. Jasanoff was already advocating more than 20 years ago for research to focus *"on what people value and why they attach importance to it."* She believes that this type of research is neglected in favour of "*the expansion of scientific knowledge and technological capabilities.*" She thus called on research to focus on "*the analysis of aspects of the human condition that science cannot easily illuminate*" and she asked analysts and decision-makers to "*reconnect with the moral foundations of action in the face of inevitable scientific uncertainty*" (Jasanoff, 2007). It is interesting to note that the enormous research effort mobilized after Fukushima, while initially focusing primarily on scientific and technical dimensions, has recently shifted towards the social sciences and humanities in relation to the challenges of post-accident reconstruction in Japan (Murakami et al., 2025).

But this shift will only bear fruit if the experts and decision-makers who implement the results of this research trust the public. As the experience of the United Kingdom sheep farmers has demonstrated trust on both side is essential to engage in fruitful dialogues. After Chornobyl and Fukushima, much has been written about the loss of public trust in experts and politicians (Takahashi 2020). Many analysts and decision-makers have questioned how to regain this lost trust, but beyond acknowledging the loss and even quantifying it, little has changed in practice.

From this perspective, implementing the co-expertise process represents a learning opportunity. The experiences of Chornobyl and Fukushima demonstrated that the loss of trust is not permanent and that a combination of circumstances can foster a change in attitude. Among these circumstances, the trust shown to affected individuals by all those cooperating with them in the process is undoubtedly a key element. This point, which still requires further analysis, has been little studied. It is not enough to merely involve individuals on a formal basis; it is also essential to create an environment that encourages affected individuals to share their knowledge and expertise to solve the problems they face. The experience of the Sami people in Norway, or that of the residents of the village of Kawauchi, or the inhabitants of Kashiwa, Suetsugi and Yamakiya in

Japan, have clearly shown that the exchange of views in dialogue, the sharing of radiation measures, and the engagement in individual and community projects, strengthen self-esteem and that of others and are all favourable elements for the establishment of mutual trust between the affected people, the experts and the decision-makers. In a certain way, one can argue that the co-expertise process is nothing other than a learning process about living together in the presence of radioactivity within a community of stakeholders.

In conclusion, it is worth recalling that the root of the problem is linked to the unwanted presence of radioactivity in the environment, and that, among the first to become involved in managing the situation were radiation protection specialists. Subsequently, they were joined by a multitude of researchers, experts, decision-makers, and well-intentioned citizens. In this context, it is important to remember Lauriston Tylor's remarks in 1956 concerning radiation protection: *"Radiation protection is not only a matter for **science**. It is a problem of **philosophy,** and **morality**, and the utmost **wisdom!"*** (Taylor, 1957). Drawing on his long experience in serving the public interest, this visionary clarified 24 years later: *"Aside from our experienced scientists, trained in radiation protection, where do we look further for our supply of wisdom? Personally, I feel strongly that we must turn to the much larger group of citizens generally, most of whom have to be regarded as well-meaning and sincere, but rarely well-informed about the radiation problems that they have to deal with"* (Taylor, 1980). Recognizing that the wisdom necessary for specialists to serve the public interest is found among the citizens, also suggests to the specialists that they must rely on the testimonies and accounts of those who have lived through the ordeal of the accident. If after a nuclear accident, the recovery of self-esteem is crucial for affected people to regain dignity, then empathy is key for experts and decision makers to provide decent living conditions for these people (Lochard, 2021). In this regard the most important lesson from the Chornobyl and Fukushima experiences undoubtedly lies in the fact that experts who support the co-expertise process, beyond practicing their sciences with pride, sincerity, and transparency, must also cultivate empathy with humility and solicitude.

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Biographies

About the preface writer

Friedo Zölzer is a biophysicist by training and currently Professor of Environmental Sciences at the Institute of Radiology, Toxicology and Civil Protection, Faculty of Health and Social Sciences, University of South Bohemia in České Budějovice, Czech Republic. His work has involved both basic and applied research in radiobiology, through which he has developed a strong interest in the ethical aspects of radiological protection. He has been a member of several ICRP task groups working in this area, has contributed to a number of European research projects, and organised a series of International Symposia on the Ethics of Environmental Health.

About the editors

Jacques Lochard, Thierry Schneider and Noboru Takamura, co-editors of this volume, have been instrumental in developing and championing the co-expertise approach over decades. Their engagement with the management of the consequences of the Chornobyl accident beginning in 1990, followed by their sustained involvement with affected communities in Japan after Fukushima, reflect careers dedicated to bridging the gap between radiological protection expertise and the needs of affected populations. This book therefore brings together 3 unique journeys serving the victims of the two severe nuclear accidents in History, with large consequences for the inhabitants.

Jacques Lochard has a background in economics. He joined the Nuclear Protection Evaluation Centre (CEPN), a non-profit research and study organization in radiation protection, in 1977 and served as its director from 1989 to 2016. His main contribution in radiological protection has been first in the development of methodologies for the implementation of the optimisation principle. From 1990 onward, he dedicated himself to protecting populations affected by the Chornobyl and Fukushima nuclear accidents. He was full Professor at Nagasaki University from 2017 to 2024. Throughout his career, he was a member of several international radiation protection organizations, including ICRP, which he joined in 1993. He served as Vice-Chair of the Main Commission from 2013 to 2021 and is currently an emeritus member.

Jacques Lochard, the book's principal author, was ideally positioned as Vice-President of the International Commission on Radiological Protection (ICRP) from 2013 to 2021 to influence the introduction of the fundamental and procedural values of radiation protection, as well as the co-expertise process in ICRP publications 138 and 146. This stemmed directly from his extensive experience in Belarus and the reflections arising from the Fukushima Dialogues, initiated in 2011, which he facilitated during eight years. The synergy between practice and principle, between lived experience and ethical reflection, is evident throughout his career.

Thierry Schneider is the Director of Nuclear Protection Evaluation Centre (CEPN), France since 2017. He has a PhD in economics from Paris-Dauphine University, in the field of health and insurance. He is member of the International Commission on Radiological Protection (ICRP) since 2017. Since April 2025, he is also Professor of radiological protection and risk communication at Department of Disaster Resilience and Science, Atomic Bomb Disease Institute of Nagasaki University. He has been involved in research projects related to the assessment and management of radiological risk, including social and ethical issues. He has been involved in post-accident management projects since 1990 at the national, European and international levels.

Thierry Schneider, the second editor, is Member of the Main Commission of the International Commission on Radiological Protection (ICRP) and Chair of ICRP Committee 4 on the application of the system since 2021. Building on his practical experience with the populations in the affected areas around Chornobyl and Fukushima nuclear power plants he is now continuing, among other things, to bring matters, such as resilience, sustainability, tolerability and reasonableness, concerning developments related to the Fukushima accident, in the context of reviewing and revising the general recommendations for the system of radiological protection.

Noboru Takamura is a full Professor in the Department of Disaster Resilience and Science, Atomic Bomb Disease Institute of Nagasaki University since 2008. He graduated from Nagasaki University School of Medicine in 1993, and got a PhD at the same university in 1997. Immediately after the Fukushima accident, he was appointed advisor to the Fukushima Prefecture on radiation-related health risk management. He contributed to the recovery of affected communities and participated to the establishment of Nagasaki

University branches in several municipalities. In April 2020, he was appointed as the first director of the Great East Japan Earthquake and Nuclear Disaster Memorial Museum in the town of Futaba close to the Fukushima nuclear power plant established to share the lessons learned from the complex disaster that occurred in Japan.

Noboru Takamura, the third editor, worked as a young medical doctor around the Chornobyl Nuclear Power Plant from the mid-1990s, mainly doing thyroid screening, to support the affected residents in Ukraine, Belarus, and Russia. Just after the accident at the Fukushima Daiichi Nuclear Power Station in March 2011, he implemented crisis communication with regard to radiation exposure and its associated health effects with residents of the Prefecture. He has also contributed to the establishment of satellite offices of Nagasaki University in Kawauchi village, and the towns of Tomioka, Okuma, and Futaba in Fukushima Prefecture.

About the authors

Pascal Croüail is a senior nuclear physicist and project manager at the French Nuclear Protection Evaluation Centre (CEPN) since 1990. Specializing in the application of ALARA optimization principles during the design, operation, and decommissioning of nuclear facilities. Since the 2000s, he has contributed to the ETHOS and CORE projects in Belarus. As a member of the NERIS research platform on preparedness for nuclear and radiological emergencies, he has participated in many European post-nuclear accident management projects. Following the Fukushima accident, he undertook several missions to Japan, focusing on food and property management, as well as health and environmental monitoring.

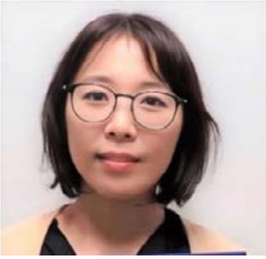
Yevgeniya Tomkiv is a researcher at the Norwegian University of Life Sciences (NMBU). She has a PhD in Environmental Sciences with her thesis focused on improving risk communication and stakeholder involvement in nuclear emergency preparedness. She has spent over 10 years researching risk communication about ionising radiation and has been involved in multiple EU projects dealing with the societal aspects of radiological emergencies, societal aspects of radon and naturally occurring radioactive material, and stakeholder involvement in environmental remediation and natural resource management. She is the president of the European Platform for Social Sciences and Humanities in Ionizing Radiation Research (SHARE).

Deborah Oughton is a professor in Nuclear/Environmental Chemistry at the Norwegian University of Life Sciences (NMBU) and deputy director of the Norwegian Nuclear Research Centre (NNRC). She has worked on the human, environmental and societal impacts of ionising radiation for 40 years, including the Chornobyl and Fukushima accidents, and taught research ethics to PhD students for 25 years (adjunct professor at the University of Oslo). She was a member of UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology from 2014 to 2022, and is currently a member of the ALLEA Permanent Working Group on Science and Ethics.

Lavrans Skuterud holds an MSc in Biophysics and a PhD in Environmental Chemistry. He served as a Senior Scientist at the Norwegian Radiation Protection and Nuclear Safety Authority (DSA) until 2021, when he became Head of Municipal Affairs in Orkland Municipality. He has over 30 years of experience working on environmental, food-chain and societal consequences of nuclear accidents and management. While primarily focusing on issues in Norway, he also participated in international projects related to both the Chornobyl and Fukushima accidents, the ICRP dialogue seminars in Japan, and served as expert for FAO, IAEA, WHO and WTO.

Anne Nisbet (PhD) is an environmental geochemist by training. She joined the UK National Radiological Protection Board (NRPB) in 1986 to carry out studies on the consequences of the Chornobyl accident. She established a European stakeholder network to address technical, economic and societal aspects of radiation emergencies. She also initiated and developed a series of European Radiation Recovery Handbooks. She was a member of ICRP Committee 4 (2013-2025). As a consultant to various international organizations, she had opportunities to work in regions affected by the Fukushima accident. She currently chairs an ICRP task group on radiological accidents and malicious events.

Makiko Orita (PhD) is originally from Nagasaki City and holds graduate degrees from Nagasaki University, where she specialized in radiation health sciences. Following the Fukushima Daiichi Nuclear Power Plant accident, she began working in Kawauchi Village in 2013 as a researcher at the "Nagasaki University-Kawauchi Village Reconstruction Promotion Base," which had been newly established at that time. She is licensed as both a nurse and a public health nurse, and has been dedicated to supporting residents in areas affected by the Fukushima accident through accurate communication of radiation-related information, health management, and efforts to alleviate anxieties associated with radiation.



Hitomi Matsunaga is a public health nurse. She is an associate professor in the Department of Resilience and Disaster Science, Nagasaki University. She participated in radiological risk communication projects for residents of the villages of Kawauchi, Tomioka, Ōkuma, and Futaba during the reconstruction period following the Fukushima accident. In recent years, her research focused on the perception of radiological risks by local populations and municipal staff in these areas. She also conducts studies on the challenges related to the decommissioning of the Fukushima plant and soil decontamination, and leads training sessions for students, researchers, and professionals in Japan and abroad.

Yuya KashiwazakI (PhD) is an Assistant Professor and Clinical Psychologist at Atomic Bomb Disease Institute of Nagasaki University. Actively involved since 2012 in the Fukushima Health Management Survey, he conducted surveys and provided mental health support to residents affected by the triple disasters. Currently, he is based at Nagasaki University's Reconstruction Promotion Base in the Hamadori region of Fukushima. In this role, he engages in radiation environmental monitoring and coordinates educational training programs. His core research focuses on enhancing the mental health and well-being of residents as a fundamental contribution to the ongoing Fukushima community recovery.

Ryoko Ando was born in Hiroshima and currently lives in Fukushima. After experiencing the Fukushima nuclear disaster in 2011, she founded the Ethos Fukushima association and led a co-expertise process in the village of Suetsugi. She also participated in organizing the ICRP's Fukushima Dialogues. In 2019, she established the non-profit Fukushima Dialogue association, which she currently chairs. She is also a writer, author of works including "Shooting at the Sea" and "Steve & Bonnie," and writes a bi-monthly column for the daily newspaper Asahi Shimbun. She is currently pursuing a doctorate at the Open University of Japan.

Tetsuo Yasutaka is currently Deputy Director of Integrated Research Center for Nature Positive Technology at the National Institute of Advanced Industrial Science and Technology (AIST) and Visiting Professor of Hokkaido University in Japan. He graduated in School of Agriculture, Kyoto University in 2002 and School of Environment and Information Sciences, Yokohama National University in 2007. His research focuses on environmental risk assessment, as well as stakeholder engagement for nuclear accidents, heavy metal-contaminated soils and mine waste, mine waste/onwards. Since 2011 he has been involved in the recovery process after the Fukushima nuclear accident.

Yumiko Kanai participated in the Yamakiya School project as a research fellow attached to a Hiroshima University's graduate programme until March 2018, and subsequently as technical staff at the National Institute of Advanced Industrial Science and Technology (AIST) from July 2018 onwards. She was primarily responsible for communication with residents, including liaison and conducting interviews. Since 2019, she has supported collaboration between Yamakiya residents and external specialists and citizens as coordinator of a volunteer network spun off from Yamakiya School. She settled in Yamakiya in June 2025.

Momo Takada received her PhD from Hiroshima University in September 2016 through its graduate program on radiation disaster recovery. Her PhD research examined the dynamics of radiocesium in forests in Fukushima following the nuclear accident. Since 2017, she has conducted research on relationships between contaminated forests and local communities, with a particular focus on Yamakiya, as well as on the public acceptance of the final disposal of decontamination waste. She has been a researcher at the National Institute of Advanced Industrial Science and Technology (AIST) since 2021.

Yasumasa Igarashi is an urban sociologist specializing in community building and a professor at the University of Tsukuba. His involvement in radiation protection began when Kashiwa City, where he had been engaged in community development since 2005, became a low-level radiation-contaminated area following the FDPP accident. He launched a Round-Table in 2011 in Kashiwa, to conduct radiation measurements and disseminate the results. In addition, he is serving as a committee member for the MAFF and the Reconstruction Agency, acting as an expert on the market for agricultural and fishery products after the nuclear disaster.

Wataru Naito (PhD) is a team leader at AIST's Integrated Research Center for Nature Positive Technology. His work focuses on environmental risk assessment, including methods for missing data, microplastics, and contaminants of emerging concern. He has also been involved in studies on external radiation dose evaluation in Fukushima and assessed COVID-19 risk management strategies. He serves on advisory committees for central and local governments and has been a member of OECD's Working Party on Exposure Assessment since the 2000s. He holds a BS from Virginia Tech and MA/PhD in Materials Science and Chemical Engineering from Yokohama National University.

Jean-Marc Bertho (PhD) is an immunologist by training, accredited for research in radiobiology. He joined the French Institute for Radiological Protection and Nuclear Safety (IRSN) in 1991, where he developed research in radiobiology, treatment of radiation-induced injuries, and radiotoxicology. Since 2017, he participated in field studies on the radiation protection of people affected by nuclear accidents, as well as on emergency preparedness and long-term recovery. Since 2024, he has coordinated the OpenRadiation project, which aims to raise public awareness of radiometry and radiation protection. He is editor-in-chief of Radioprotection, the international journal of the French Society for Radiation Protection.

Win Thu Zar is originally from Myanmar and completed her PhD in Advanced Preventive Medical Science at Nagasaki University, Japan. She recently joined the OECD Nuclear Energy Agency (NEA) in the Division dealing with Radiological Protection. She holds a background in Nuclear Engineering and in Disaster and Radiation Medical Science. Her research focuses on the human aspects of radiological protection during the recovery phase following nuclear accidents. In particular, she investigated post-Fukushima Daiichi Nuclear Power Plant accident recovery efforts through surveys of affected residents. Her work aims to support the development of radiological protection culture in affected territories.

Michio Murakami received his Ph.D. (Doctor in Engineering) from the Department of Urban Engineering, Graduate School of Engineering, the University of Tokyo, in 2006. He is currently a Professor at the University of Osaka. His research focuses on risk science, including multi-risk assessment, management, and communication. He previously served as an Associate Professor at Fukushima Medical University School of Medicine, where he contributed to research, education, and social implementation on radiation risk assessment and risk communication following the Fukushima nuclear accident.

Makoto Takahashi is the Executive Director of the McQuillan Institute for Science, Technology and the Human Future and a Fellow at the Harvard Kennedy School of Government. Trained in the field of Science and Technology Studies (STS), Makoto works on crises of trust in experts and is particularly interested in the aftermath of the Fukushima nuclear disaster. He received his BA, MPhil and PhD from Cambridge University, and previously worked as an Assistant Professor at Vrije Universiteit Amsterdam. He is the curator of the travelling exhibition, Picturing the Invisible, which explores the legacy of the Fukushima Daiichi disaster.

Jean-François Lecomte, now retired, was a radiation protection expert at the French Institute for Radiological Protection and Nuclear Safety (IRSN). His work focused primarily on managing radiological risks related to existing exposure situations, such as natural radioactivity (radon, naturally occurring radioactive materials), contaminated sites and post-accident exposure situations. He gained particular experience in this last domain during missions in Belarus and Japan, in areas affected by the Chornobyl and Fukushima nuclear accidents. He participated actively to the series of Dialogue meetings in Fukushima. He is currently an emeritus member of the International Commission on Radiological Protection (ICRP).

Jean-Christophe Gariel is currently Deputy Director General of the French Authority for Nuclear Safety and Radiation Protection Authority (ASNR). After obtaining a PhD in physics from the University of Grenoble (France), he worked as a researcher in the field of seismic risk, successively at Columbia University (New York, USA), and at Kyoto University (Japan). In 1990, he joined IRSN, where he successively held positions in seismic risk assessment and environmental radioactivity. More recently, he was successively Director of Environment and Director of Health at IRSN. His area of expertise is focused on radiation protection, covering both environmental and human protection.