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ARTICLE

Risk communication in the recovery phase after a nuclear accident: the contribution of the "co-expertise process"

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Abstract – Risk communication in post-nuclear accident situations faces many challenges related to the limited knowledge of experts about the actual situation in the affected communities, as well as of the affected people about radiological risk combined with their distrust of authorities and experts. In such an anxiety-provoking context, the co-expertise approach recommended by the ICRP combining technical expertise, citizen participation and two-way communication has shown that it was an effective approach for restoring trust between the experts and the people concerned and developing, among the latter, a practical radiological protection culture. In essence, technical-oriented risk communication is not sufficient alone. A dialogue with affected people is necessary in combination with measurements of radiation associated with their daily life in order to gain their participation in the co-expertise process and to progressively restore confidence in them and trust in authorities and experts. The article highlights the salient features of the co-expertise process in relation to risk communication.

Keywords: risk communication / nuclear accident / co-expertise process / Chernobyl / Fukushima

1 Introduction

Communication on radiological risk in the context of a nuclear post-accident faces three major obstacles beyond the great complexity of the situation: (1) the high level of concerns among affected people particularly about health, and more specifically of young children; (2) the deficit of their basic knowledge and experience about radiological risk and; (3) their widespread mistrust of authorities and experts as a result of the accident. Experience of Chernobyl and Fukushima nuclear accidents has confirmed that in such context, the diffusion of scientific and technical information plays a limited role in helping people to understand the situation, regain their trust, and to make informed decisions.

The International Commission on Radiological Protection (ICRP) has recently published new recommendations for the protection of people and the environment in the event of a large nuclear accident (ICRP, 2020). In this publication, the Commission is recommending to use the so-called "co-expertise process" to engage and empower affected people in post-nuclear accident situations in order to help them to regain control of their day-to-day life. This process has proven to be effective to communicate about radiation and developing a practical radiological protection culture among them.

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The co-expertise process was built progressively in the context of the Chernobyl post-accident situation in the late 1900s and early 2000s from an empirical and error learning approach (Lochard, 2021). However, experts involved in the process were influenced by the previous two decades in the development of risk assessment and management and their prolongation in risk perception and risk communication, and were also prompted by late 1900s reflections on risk governance in complex and controversial situations involving risks. Consequently, the co-expertise process includes the main advances in these different fields and in particular their practical applications as far as risk communication is concerned.

After a reminder of advances in risk communication over the past decades, the present article then presents the characteristics of the co-expertise process in relation to these advances. The following section examines the conditions and means to be implemented to ensure effective risk communication in the co-expertise process. The discussion and the conclusion highlight the salient features of the co-expertise process.

2 About risk communication

Since the early 1980s, researchers in the field of social sciences have provided a major contribution to the foundations of risk communication theory. The term "risk communication"

was first introduced in the mid-1980s, as an interdisciplinary field bringing together different disciplines: psychology, sociology, and communication research. In the 1990s, the focus was on ways of bridging the public/experts' risk perception gap associated with activities that raise concerns in society. Risk communication research explored among other issues how it is possible to address the general public's concerns regarding controversies related to risk situations characterized by uncertainties with potential health, societal and environmental consequences. The presence of artificial radiation in the daily life of people after a nuclear accident is typical of such a complex and controversial risk situation.

There are two main steps to the development of the history of risk communications: first explaining the risk to the public (one-way communication); then exchanging information and opinions with the public (two-way communication). The first step has been to try to explain to people the risk information more clearly based on the results of risk assessment studies (Fischhoff, 1995). Recognizing the inefficiency of explaining the risk by numbers, risk communication progressively shifted to sharing information and interacting with interested stakeholders. This evolution has recognized that the problem is not only that people do not understand numbers, but rather that they are also frustrated, worried, discontented, and even angry, and that they have doubts or do not trust authorities and experts (Slovic, 2012).

Despite all the efforts in communication during the nineties, the regulatory frameworks and decision-making processes related to hazardous activities continued to be faced with growing opposition from the stakeholders at local and national levels. This led to further investigations in the early 2000s to better understand the main challenges associated with the management of these activities. As a result, a new interdisciplinary perspective, describing the available approaches to risk management, called risk governance emerged allowing to better understand the factors, criteria, processes, and mechanisms by which decisions, about complex situations with uncertain risks, are taken contributing to the social cohesion in technological societies.

Generally, different stakeholders are involved in making collective decisions: the government or the agencies that are working within the government, the corporate or industrial sector represented by economic actors, the civil society represented by NGOs and other actors as well as experts and scientists bringing state-of-the-art knowledge in risk assessment and risk management. All of these stakeholders have something to say and some power to play and the main issue is finding a middle ground/understanding regarding the collective decisions to make respecting the concerns of the stakeholders as well as considerations of the legal, political, economic and social contexts in which the considered risk is evaluated and managed. Research on risk governance highlighted particularly the fundamental role of social trust in the decision-making processes related to risk management.

The research and studies on risk governance had shown that analytical thinking and deliberative exchange of arguments are indistinguishable in decision-making processes. They also underlined that the involvement of stakeholders including those affected by the risk was a productive way of ensuring the efficiency of the decisions. However, "*organizing and structuring discourses on risk go beyond the good intention to have the public involved in risk decision-making. A willingness to listen to public concerns and practice of a two-way communication process is not enough*" (Renn, 1999).

In the case of a nuclear accident, the risk communication in the early phase of the emergency response is faced with a complex situation. The affected people are in stress and full of emotions. Facing this unprecedented situation, they have difficulties to understand the radiological situation and the scientific and technical issues raised by experts, they are scared and have no vision of their future. Furthermore, trust in authorities and experts is greatly affected, and some people are full of anger (Takamura, 2019). The risk communication activities by many institutions and the media during the early phase also contribute to the social amplification of the perception of the risk and increase the general confusion among the public (Kasperson *et al.*, 1988). In such a context, the ability of people to process information is severely impaired and as a consequence sharing information is a real challenge (Covello, 2011).

The recovery phase begins when radiological conditions in affected areas are sufficiently characterized to support decisions by the authorities about the future of these areas, and also when long-term protective actions have been implemented to accompany the rehabilitation of living conditions in areas where people are allowed to stay or expected to return (ICRP, 2020). In this phase, affected people are confronted with various challenges in the process of rebuilding their lives. This includes unemployment with declining occupational options, adjustment to unfamiliar environments, changing working conditions and lifestyles of people, dislocation of families, social networks, and community lives, and above all uncertainties about the future (Mosneaga, 2015). The affected people's daily lives are very depressing and to be effective, post-accident risk communication needs to take into consideration all these aspects and not only those related to the risk of radiation. Since decisions to improve the living conditions of affected people may induce uncertain outcomes that affect different parts of the population to different degrees, as a consequence a major requirement for effective, efficient, and fair risk communication is for authorities and experts to be responsive and to integrate the knowledge, values, and interests of all stakeholders into the risk decision-making process.

3 The co-expertise process

The co-expertise process, an abbreviation of cooperation between experts and stakeholders, emerged in the late 1990s and early 2000s in the context of projects aimed at involving affected people in the rehabilitation of their living conditions in areas of Belarus contaminated by the Chernobyl nuclear accident (Dubreuil *et al.*, 1999). The process was then refined through the experience of different Japanese communities affected by the Fukushima nuclear accident (see Box 1). The process is combining the scientific foundations of the radiological protection system recommended by ICRP and the experience and knowledge of affected people about the local situations with the objective to protect people against the harmful effects of radiation and restore their well-being profoundly affected by the accident.

Box 1. Projects and experiences that have contributed to the emergence and consolidation of the co-expertise process

The ETHOS project (1996–2001): a pilot project in 5 villages of the Stolyn District in the South of Belarus to demonstrate the feasibility of involving local, regional and national stakeholders in the recovery process after a nuclear accident (Dubreuil *et al.*, 1999).

The CORE programme (2004–2008): accompaniment and support of 146 local projects aiming at protecting people against radiation and improving their living conditions in 5 districts of Belarus based on the ETHOS project results (Trafimchik, 2005).

The Kawauchi initiative (2011–until now): a cooperation between local authorities and university experts to improve the radiological protection and revitalize the social and economic conditions in the village of Kawauchi affected by the Fukushima nuclear accident (Takamura *et al.*, 2018).

The Suetsugi experience (2011–2021): an initiative of the local residents of the community Suetsugi in the Fukushima Prefecture to improve their radiological protection and living conditions supported by local leaders (Lochard *et al.*, 2020).

The Yamakiya experience (2015–until now): a cooperation between local residents and experts to develop a practical radiological protection culture among the affected people and local projects to accompany the recovery process after the Fukushima accident (Yasutaka *et al.*, 2020).

The Round-Table Project in Kashiwa (2011–2012): a dialogue to reconcile consumers and farmers in the Tokyo suburbs after the Fukushima accident (Igarashi, 2022).

Figure 1 illustrates the main steps and driving elements of the process, which is described in detail in ICRP Publication 146 (ICRP, 2020). Dialogue, measurements of radiation, and local projects are the three pillars of the co-expertise process. The following paragraphs focus on those aspects of the process that shed more light on the risk communication aspects, *i.e.*, the dialogue and the measurements of radiation. For other aspects, readers are invited to refer to the ICRP Publication, but also to recent contributions (Schneider and Lochard, 2021; Lochard, 2021).

3.1 About dialogue between affected people and experts

The first step of the process aims at establishing a dialogue between experts and stakeholders in affected areas to identify the problems and the challenges they are confronted with. Through this dialogue affected people can have a fair opportunity to express their concerns, challenges, and expectations on the situation at stake, share their experiences about their living conditions, and ask questions about the situation.

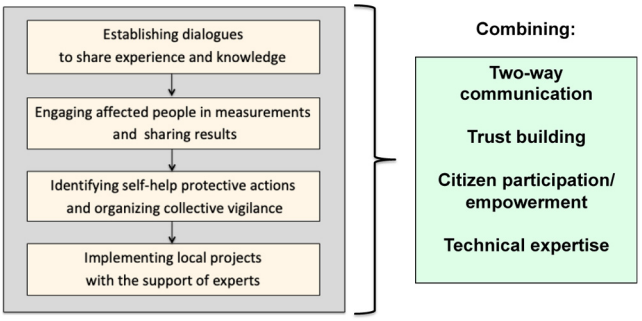

Fig. 1. The main steps and driving elements of the co-expertise process.

Dialoguing goes beyond exchanging information, and ideas and knowing what the other thinks. Both affected people and experts come to truly understand one another's views concerning the situation. Dialogue is a form of two-way communication adapted to complex situations in which experts have difficulties effectively dealing with people's concerns and anxiety. Its goal is not to impose a particular view. Dialogue gives participants the opportunity to be transformed into their being, in freedom, and also to empower themselves in order to make informed decisions.

Effective dialogue brings together various skills and sensibilities and helps to identify the real concerns and expectations of people. It abolishes the duality between the experts and the laymen, *i.e.*, those who know and those who do not know. It is a space to share freely and openly experiences and for everyone to listen to different points of view and opinions on the situation and to put her/himself in the shoes of the others participants. The use of common language and narrative facilitates the sharing of each person's intimate experience, the revelation of the richness of sense of the situation, and also allows each one to revisit their values and aspirations and affirm their identity. The close relationships between the participants facilitate understanding the complexity of the situations they face and facilitate the search for solutions to the individual and collective problems identified together. As underlined by experts, dialogue plays a key role to rebuild trust between stakeholders after the accident (Fig. 2).

In practice, dialogue must develop based on all the questions from affected people to experts related to their concerns whether it is the radiological situation or its consequences on their daily life beyond the level of exposure. When starting a dialogue, experts must avoid giving explanations of what radioactivity and radiation risks are. The scientific discourse is not sufficient to allow affected people to gain an understanding of the relations that exist between the exposure situation they are confronted with and their own exposure. It is only after having listened carefully to the affected people's concerns, that experts can share information based on knowledge about the science of radiation and practical implementation of radiological protection (Kashiwazaki *et al.*, 2022). When experts give this information, they must make it simple, avoid the technical terms as much as possible, and favor narrative. In the dialogue, people inevitably ask questions about the radiation risk and this is an

Fig. 2. Dialogue between a Nagasaki University expert and residents in Kawauchi village, Fukushima Prefecture.

opportunity for experts to explain that the risk is depending on actions taken by authorities but also on individual habits and activities and the local pattern of the radiological contamination. This is also the best way for experts to emphasize the importance of performing measurements to characterize the local exposure situation and the individual exposures as a prerequisite for being able to talk about radiation risk.

3.2 About measurements of radiation

The second step is to engage affected people in measurements with the aim to help them to understand when, where, and how they are exposed in their day-to-day lives and the effectiveness of the actions implemented by authorities. By involving affected people in the measurement of radioactivity, it is possible to make visible what is invisible to them. Measurements made together with experts allow affected people to become aware of where individual' exposures are coming from and to look for possible protective actions to reduce those, which are avoidable. Engaging people in measurements should be progressively developed based on a comprehensive monitoring approach performed by the authorities and/or by affected people themselves (self-monitoring). By doing so, people regain progressively control over the radiological situation they are confronted with.

Measurements should involve ambient dose rates, external/internal exposures, and foodstuff contamination. To be meaningful, measurements should be done step-by-step from sources of exposure to the exposures received by individuals through the various exposure pathways. Interviewed experts mentioned that when performing measurements, the most important aspect to pay attention was to listen and understand the concerns expressed by the affected people. This allows to provide adapted measurement instruments to the stakeholders and to accompany them in the definition of the monitoring programme as well as in the interpretation of the results. The aim is for affected people to be able to think about the meaning of the results of the measurements for their lives. The involvement of affected people in the analysis of the results of measurement and their sharing with the people of the community they live in is crucial to understand their meanings (Ando, 2016).

Fig. 3. Sharing results of contaminated foodstuff measurements in Suetsugi, Fukushima Prefecture (Photo Lochard).

When sharing information about measurement results, the comparison with the behaviors of their neighbors and the other people of the community is a powerful means to help individuals to understand the factors driving their own exposures (Murakami, 2018) and the importance of the latter with regard to the risk for their health. Although risk comparison is important for people to allow them to decide whether the risk they face is important or not for them and their loved ones, if not conducted properly by experts it can be very counterproductive. After a nuclear accident information about the impact of radiation is generally provided in terms of exposures expressed in unfamiliar units (milli-sieverts) and it is difficult for people to evaluate the risk associated with the figures announced by the experts. In order to make these figures meaningful, experts must put them in perspective with familiar risks to people. However, the use of risk comparison must be done carefully. Past experience has shown that comparing radiation risk with risks from day-to-day life (e.g., driving a car, smoking cigarettes...) can be very counterproductive as these risks refer to situations that are perceived completely differently by people who consider them as irrelevant if not meaningless. To avoid such difficulty, it is therefore important to limit the comparison of the radiation risk due to the accident with other radiation exposure situations mainly background radiation or medical exposure (Fig. 3).

Despite these rules, it is important for those using risk comparison to always mention the key differences that may exist between the different exposure situations they use for the comparison. Without such explanations, people may have a wrong perception of the messages of the experts and this may affect the general trust. By giving reasonable risk comparison, with the necessary caveats concerning the exposure situations, people are more prone to judge satisfactorily the radiological situation they are facing and the risk attached to it.

Experience with the implementation of the co-expertise process has confirmed that the most effective way to familiarize people with the basic concepts and units of radiological protection is on the occasion of individual measurements in which people are directly involved and interact with experts to interpret the results. It has also shown

that sharing measurement results to discuss the situation of the community is a powerful means to allow each individual to understand her/his own situation and the one of his/her community. It also allows to identify opportunities to improve protection at the individual and collective levels. The measurements implemented in the co-expertise process favor the implementation of self-help protective actions adapted to each individual as well as the organization of radiological monitoring within the community to identify collective protection actions benefiting to all and to ensure collective vigilance.

4 Conditions and means to implement the process

Chernobyl and Fukushima nuclear accidents have shown that the proper behavior of experts and adequate human, technical and financial resources are crucial to ensure the success of the co-expertise process.

4.1 Behavior of the experts

Beyond mastering the radiological situation, the challenge of experts in the co-expertise process is to understand the concerns and worries of the population, but also its expectations for the present and for the future. They need to listen carefully to affected people (Openness) and be attentive to their worries (Solicitude). In other words, they must put themselves in the place of others (Empathy) when communicating with individuals. They must also follow the ethical principles and values of radiological protection *i.e.*, doing more good than harm, being prudent and fair, and respecting the dignity of people (ICRP, 2018). Measurements made in the co-expertise process together by experts and affected people are a very effective way to help the latter regain confidence in the information provided by experts on radiological situations because the measurements they make, allow them to see the local and individual situations, such as the situation of food products from the garden and also the situation of their community. This is a powerful factor for restoring progressively the trust in experts. Another important factor in this restoration is the fact that experts involved in the co-expertise process are necessarily visiting regularly affected people and inevitably are brought to participate in social events of their communities (Loyalty).

When communicating about radiological risk in the co-expertise process, experts need to not only adopt a prudent approach for managing risk by implementing the optimization process, but additionally promote protective actions improving the well-being of individuals and the quality of the living together of the community to which they belong. Experts must respect the individual decisions of the affected people while preserving their autonomy of choice and keep in mind that the issue at stake is not to make people accept the risk but to allow them to make informed decisions about their protection and their life choices (Orita, 2015). It is also important not to impose standards on the affected people. Therefore, experts must master not only the scientific and ethical basis of radiological protection and its practical implementation (Accountability) but also work with the local population to obtain accurate information about their environment and their habits (Inclusiveness). Experts must listen carefully to the stakeholders to understand their individual situations and act in accordance with the ethics of radiological protection, that is to say prudently and equitably. Sharing openly all information they own to the members of the community they work with but also recognizing the limits of their knowledge concerning the local radiological situation (Schneider *et al.*, 2019). In their involvement with affected populations, experts must show empathy and humility.

4.2 Human, technical and financial resources

Having a place for dialogue where affected people and experts can meet and share their views and experience is a prerequisite for initiating the co-expertise process. Experience has shown the importance to use a convivial place where community people used to gather to facilitate dialogue and also involve local leaders to serve as a transmission between experts and affected people.

Beyond institutional experts who engage themselves in the co-expertise process either at the request of their organizations or voluntarily, local authorities and professionals, local leaders, and sometimes international experts may also play an active role in the development of the process. The number and characteristics of these persons is depending upon the local circumstances but also to the dimensions at stake calling for a multidisciplinary approach and there is no ideal model. However, the experience of Belarus and Japan has shown that the engagement of local authorities and local leaders is crucial for the success of the co-expertise process because institutional experts cannot stay permanently in the affected communities and there is a need of establishing relays to ensure the continuity of the process.

As far as measurements are concerned, they require the use of adapted measurement instruments and this is the role of experts to provide these instruments to the affected people. To implement individual measurements, there is a need to have competence for doing measurements and adequate instruments for this. Public and/or private support is necessary to buy the instruments and using them inevitably mobilizes technical and human resources. In case the process is not supported from the beginning by a given organization, those leading the process have to find the necessary support from local or national authorities, experts, or academic organizations. This is sometimes a difficult task that takes time and requires tenacity as it was illustrated by the Suetsugi District experience (Lochard *et al.*, 2020).

As far as the support of local projects emerging during the co-expertise processes is concerned, the cooperation between all involved stakeholders (local people, experts, local authorities and professionals, and private organizations...) is essential. Experience has shown that it is sometimes difficult to raise the necessary resources because local and national authorities and organizations have no tradition to support such types of initiatives, especially if they come from local stakeholders. For the success of local projects, it is necessary to establish appropriate governance structures involving all concerned parties to ensure legitimacy, transparency, and fairness of the decision-making process related to their design and implementation (Baudé *et al.*, 2016).

Finally, the implementation of the co-expertise process mobilizes human and financial resources that can help to identify problems and contribute to their resolutions. Experience shows that the success of the process depends largely on the personal commitment of the experts over time. Whether they work on behalf of an organization such as the case of Kawauchi village with the support of Nagasaki University (Takamura *et al.*, 2018) or the case of Yamakiya District case with the support of the National Institute of Advanced Science and Technology (Yasutaka *et al.*, 2020) or on a voluntary basis as illustrated in Suetsugi community (Lochard *et al.*, 2020) or Kashiwa (Igarashi, 2022) in all cases the interpersonal relationships between residents and experts play an essential role both for initiating the process and also building trust during its implementation.

5 Discussion

Facing the deficit of knowledge and experience about radiological risk among the affected people, the high level of their concern, and their widespread mistrust of experts, risk communication in post-nuclear accident situations is a real challenge. Fukushima nuclear accident has highlighted that in such a context the "co-expertise process" is an effective approach to communicating with stakeholders. The process, which is now recommended by ICRP (2020), is also a powerful approach to empower affected people in order that they regain control on their day-to-day life. Without dialogue and measurements concerning the radiological situation they are confronted with, the slightest level of radiation is a concern for them. By going through the co-expertise process, people progressively understand where, when, and how they are exposed to radiation, and make informed decisions to protect themselves and their loved ones. Finally, they also understand what is trivial or important for their health.

Research has shown that in the absence of trust, risk communication has a limited impact (Slovic, 2012). Over time, the cooperation between the experts and the affected people involved in the co-expertise process helps them to verify that they share many values, despite their different roles and positions in the recovery process, and also that the measurements made by the experts are of good quality and relevant. This, together with the long-term commitment of the latter are strong factors to progressively rebuilding the confidence of the affected people in the information concerning the radiological situation they are facing and trust in the experts, professionals, and local authorities who implement them.

Finally, the co-expertise process, driven by an effective risk assessment and management approach and combined with a thorough two-way communication process, is creating an environment where the affected people can understand the important meaning of radiation measurement results for their lives. Experience in Belarus and Japan has shown that this process is a powerful tool to engage affected people in measurements to characterize their individual radiological situation in relation to their daily concerns and to help them interpret the results together with people in their community. This allows them identifying individual protection actions but also establishing radiological monitoring program within their communities to promote the development of a "citizen vigilance" on the radiological situation. These actions should follow the optimization process with the objective to reduce exposures as low as reasonably achievable taking into account the societal environmental and economic factors characterizing the local situations (ICRP, 2006).

Experience of the Chernobyl and Fukushima nuclear accidents showed that dialogue and radiation measurements are essential to restoring positive connections and fostering cooperation between authorities, experts, and affected people. By allowing the latter to interpret the results of the 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 to assess the relevance and effectiveness of the protective actions implemented by authorities or by themselves, the co-expertise process is an effective way to acquire the alphabet, the units and the basic rules that underpin practical radiological protection culture (Lochard, 2017).

As underlined by ICRP, preparedness planning is an important process in preparing the strategy for the protection of people and the environment in case of a nuclear accident including provisions for the deployment of the co-expertise process (ICRP, 2020). In this perspective, the training of the actors in the process is a real challenge given the fact that the skills required in practice are still very limited at the level of the education and training courses received by the various experts likely to be involved in particularly radiation protection professionals. This situation calls for the development of academic courses but also of practical guides for the use of experts and professionals (Schneider *et al.*, 2018). Recent experience has also shown the importance of combining the transmission of experience acquired in terms of co-expertise through practical exercises in areas contaminated by past nuclear accidents. The International Advanced Training Course on Stakeholder Engagement for Recovery after Nuclear Disasters organized by Nagasaki University is a good example of this type of training course, which allows participants (students, young professionals, experts, local authorities and professionals, ...) to familiarize themselves with the process of co-expertise by having a direct dialogue with affected people and experienced experts (Nagasaki University, 2021).

Finally, nuclear post-accident management doctrines should be updated and harmonized (Bertho *et al.*, 2022) taking into account the evolution of the system of radiological protection including the co-expertise process (Clement *et al.*, 2021; Clement *et al.*, 2022; Bourguignon, 2022).

6 Conclusion

The challenge of risk communication in the post-accident situation is to support the co-expertise process with the objective to empower affected people about the radiation risk so that they make informed decisions to protect themselves and their loved ones. Experience has shown that technical-oriented risk communication is not sufficient to address this challenge. Engaging affected people in a dialogue combined with measurements of radiation associated with their daily life allows them to establish a concrete link between the radiological situation and their activities and behavior.

Through their participation in the co-expertise process, affected people regain progressively confidence in them and trust in authorities and experts.

This process takes time, is resource demanding, and implies the involvement of local leaders and experts/professionals who are committed to cooperating with affected people in the long term. It also requires experts and professionals to strengthen their theoretical and practical skills in the field of risk communication by including in their training the know-how on two-way communication, building trust, stakeholder participation, and particularly conducting dialogue. For authorities, it requires to put in place the technical and financial means to accompany the co-expertise process on the ground.

Conflict of interest

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Authors contribution

Win Thu Zar: Conceptualization, literature review; **Jacques Lochard:** Conceptualization; **Yasuyuki Taira:** Advice and internal reviewing; **Noboru Takamura:** Advice and internal reviewing.

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