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Engagement on risk and uncertainty – lessons from coastal regions of Fukushima Prefecture, Japan after the 2011 nuclear disaster?

Leslie Mabon[a]* and Midori Kawabe[b]

[a]*School of Applied Social Studies, Robert Gordon University, Aberdeen, Scotland, UK;* [b]*Department of Marine Policy and Culture, Tokyo University of Marine Science and Technology, Tokyo, Japan*

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This paper uses the case study of the south-east coast of Fukushima Prefecture in Japan to draw lessons for risk communication under situations of high uncertainty and conditions of varying trust. Based on an existing field of research into the social and ethical aspects of governing risks around environmental radioactivity, empirical qualitative material collected in Fukushima Prefecture over 2014 and 2015 is analysed around three key questions: who is undertaking risk communication and how they are perceived (in particular their motivations and perceived competence); what is the purpose of engagement with citizens and stakeholders on risk and uncertainty (i.e. whether it is to 'convince' people or allow them to come to their own informed decision); and whether risk communication may be considered responsive to the needs of the affected populations. The findings are then applied to Kasperson's four questions for the future of risk communication in order to assess their wider implications. Particular attention is paid to how the individual or institution conveying the risk message is perceived, and in whose interests risk communication is undertaken.

Keywords: environmental sociology; Fukushima nuclear accident; qualitative research; risk communication; risk governance

1. Introduction

On 11 March 2011, a powerful earthquake and tsunami off north-east Japan left over 17,000 people either dead or missing. Cooling systems at the Fukushima Dai'ichi nuclear power plant (FDNPP) were taken offline. The resulting overheats and hydrogen explosions released radioactive matter over the land and sea of Fukushima Prefecture and beyond. For fuller overviews of the nuclear disaster and subsequent radioactive contamination, see Wakeford (2011) and Saito et al. (2015) respectively.

The nuclear disaster particularly affected Fukushima's coastal corridor, known as *Hamadori*. Many of the approximately 154,000 people evacuated due to radioactivity were from *Hamadori*. Whilst remediation is underway, areas remain where residents will have long-term difficulties returning (annual air dose exposure estimated over 50 milliSieverts/year). Sites for storing waste generated by remediation are still being secured (Ministry of the Environment 2015). Accommodation of displaced persons and decontamination has also been required outwith evacuated areas (Kawazoe, Urano, and Nozaka 2014). Radioactive contamination of soil and

*Corresponding author. Email: l.j.mabon@rgu.ac.uk

seawater – and associated concerns over health effects from contaminated produce – led to restrictions on Fukushima produce. This is particularly significant given the importance of agriculture and fisheries to the prefecture. Despite gradually returning to sale if within monitoring limits, anxiety about the 'safety' of Fukushima produce remains (Buesseler, Aoyama, and Fukasawa 2011). There have been suggestions of tension between evacuees and residents of communities they have relocated to, over differences in compensation (Saito and Slodkowski 2014), and of Fukushima residents suffering psychological distress or stigmatisation (Edwards 2013). Whilst it is impossible to discuss each of these issues within a single paper, it is important to note governance of and communication about risk associated with environmental radioactivity comes against a larger backdrop of societal change following the FDNPP disaster.

This paper uses data collected in Iwaki City, a coastal municipality south of FDNPP, to evaluate opportunities and challenges for enacting the risk communication principles proposed by Kasperson (2014). Kasperson argues the design and implementation of risk communication practice seems little changed over recent decades, with more pluralistic and deliberative modes of communication now required to respond to declining societal trust and ongoing difficulties in communicating uncertainty. Kasperson argues for risk communication to be (a) more ambitious and sustained over time; (b) broadened to encompass values and lifestyles in risk issues; (c) more aware of which uncertainties *matter* in risk terms and which can be reduced; and (d) cognisant of the effect of limited trust on the nature of communication. Iwaki provides a good test case for Kasperson's principles given the significance of uncertainty and trust in the area post-disaster. Iwaki was not evacuated but did receive radioactive contamination. The fisheries vital to its coastal villages economically, socially and culturally were suspended (Wada et al. 2013). Risk communication in Iwaki must thus address uncertainties from both land (decontamination, air-based monitoring) and sea (effects on fisheries, indeterminacies engendered by flows of water across spatial boundaries). Restart of coastal and deep-sea fisheries is also contingent on trust. This entails fishers trusting the FDNPP situation is under control with no further leakage, and buyers trusting marine produce is not harmful. Post-disaster Iwaki may thus yield lessons for communicating risk under a situation of major and potentially irreversible environmental change, one where socially and culturally valued practices are affected as well as economic activity.

2. Risk communication, environmental radioactivity and Fukushima

We first clarify key terms. Following Árvai (2014), we take 'communication' to mean not correcting misunderstandings or aligning different views of risk with dominant ideological framings, but rather a two-way dialogue for balancing differing views of risk in decision-making. So 'communicating' risk about radioactivity in Iwaki ought to mean listening to – and acting on – the concerns of citizens and stakeholders as well as information provision. Likewise, we acknowledge from Bradbury (1989) that the term 'perceived risk' may imply stakeholder or citizen views of risk are only 'mere' perceptions. As Oughton (2013, 22) explains referring to Drottz-Sjoberg and Persson (1993), 'perception of risks is complex and it is a mistake to dismiss public anxiety towards radiation risks as being "irrational" or "wrong"'. We hence understand 'risk perception' as how any person – citizen,

stakeholder, 'expert' or otherwise – evaluates risk. For clarity, we broadly define 'stakeholders' as those with an interest in, and/or having to make decisions themselves about, living and working within post-disaster radioactive contamination.

Radiation is of course real and potentially harmful, not simply an ethical or moral issue. Yet perceptions of environmental radioactivity can be complex, involving significant value dimensions or emotional investment. Oughton (2013) provides a comprehensive overview of the breadth of concerns that may be at play in discussions around post-contamination remediation, which can be summarised into three points. First, alongside dose reduction, social and psychological factors such as level of personal choice and control, familiarity, closeness and the distribution of risks versus benefits all inform perception of risk from radiation. Second, the possibility to carry out voluntary actions or increase understanding and control may be perceived as positive by both citizens and stakeholders, whereas risk management measures viewed as disruptive, infringing upon liberty or restricting normal practices may be received negatively. And third, communication policies showing sensitivity to these socio-psychological factors stand greater chance of success (Oughton 2013). Moreover, even seemingly objective 'expert' risk-taker or assessor (scientists, governors, operators) risk perceptions may reflect emotions, cultural context, personal identity or their own exposure to the risk (McKechnie 2003; Sato 2014; Kastenberg 2015).

Turcanu et al. (2016) hence believe traditional societal governing modes – e.g. nation-state-level representative party democracy, 'objective' science, education within disciplinary boundaries – may not encompass the full range of moral positions around what is an 'acceptable' level of risk from nuclear technology. Even if the knowledge base for evaluating nuclear risk was agreed, differing opinions on acceptability of the risk would thus likely exist (Turcanu et al. 2016). Pidgeon (2014) argues risk communication researchers and practitioners need to take seriously values and citizen deliberation, given the complexity of contemporary technological and environmental hazards and the ever-broadening scales over which people may be exposed to risk. Recent contributions to this journal on Fukushima likewise recognise the effect of moral emotions on risk perceptions (Taebi and van de Poel 2015) and the need to imagine problems stretching into the future due to long timescales over which disaster recovery and remediation necessarily occur (Westerdahl 2014; Löfquist 2015). Moving towards governing radioactivity risk in practice, Fahlquist and Roeser (2015) identify a lack of trust or a sense of hopelessness as key barriers to communication that is sensitive to emotions and values.

In sum, for national, regional and/or municipal authorities ultimately responsible for regulation and remediation of environmental radioactivity to lead 'better' decision-making processes and outcomes, attention needs to be paid to drivers of public and stakeholder understanding and perceptions of what is an appropriate course of action. It is the opportunities to enact such decision-making in practice – and implications for risk communication more widely – that this paper assesses.

3. Methodology

Given these complexities in environmental radioactivity risk perception, a qualitative approach was adopted. Stakeholders were asked in open-ended in-depth interviews to talk about life in Iwaki and Fukushima and discuss their role in relation to post-accident environmental radioactivity. This focus on participants' own life contexts

and narratives has value in explaining how exactly people understand risk for complex issues like nuclear power (Henwood et al. 2010). Chase (2005) adds that narratives represent – and give researchers insight into – a particular social context. Working in-depth and intensively with a small number of key informants therefore offers analytical purchase on how an issue is understood within a particular area or culture.

For as deep an understanding as possible, a small number of people covering key sectors on the Fukushima coast were thus selected rather than a larger sample with more limited explanatory power. Thirty-five people were interviewed over summer 2014 and 2015, encompassing prefectural (i.e. regional) government specialists in land-based and marine radiation monitoring; university professors researching human dimensions of the nuclear accident; local politicians concerned with the effects of the accident; managers of business organisations affected by radioactivity (fisheries cooperatives); and affected stakeholders/informed citizens with less direct influence over decision-making processes (fishers and fisheries cooperative administration staff). Most interviews were conducted in Iwaki itself, however some took place in Fukushima City to access relevant government or research expertise. Due to potential ethical sensitivities around a traumatic event like the March 2011 disasters, an intermediary local government contact recruited participants less empowered to influence decision-making processes. More empowered stakeholders (e.g. university professors, high-level regional government employees) were recruited through a combination of existing contacts from previous research, snowball sampling and internet search of relevant media outlets to identify institutions involved in communicating environmental radioactivity risk.

All interviews were in Japanese and audio-recorded. Whilst there was no formal interview guide, all interviews began by asking participants to narrate their experiences of living and working in Fukushima and Iwaki. This built rapport with interviewees before discussing radiation specifically, and also gleaned contextual information about life in the area. Each interview then aimed to cover the broad topics of the interviewee's role post-disaster with regard to risk communication and management; their feelings on how successful the governance of risk from radiation had been thus far; and what they thought the main difficulties remaining around risk management and communication were for Fukushima radiation. With the intention of letting participants raise issues they perceived as important rather than forcing the discussion towards what the researchers assumed to be significant, these topics were however deployed as starting points for discussion rather than specific questions. Following Henwood et al. (2010), in the main, the interviewers let the interviewees take the lead in steering the conversation. When necessary, to keep the discussion flowing, follow-up questions were asked to further probe issues the interviewees raised.

The interviews were simultaneously transcribed and translated into English. Although both authors who undertook the interviews are proficient in Japanese, for accuracy English translations were double-checked with an additional native speaker separate from the research. However, as a guard against analysing the translation rather than the 'original' (Smith 1996) the Japanese language recordings in the main formed the basis for analysis. This also meant interpretation progressed as far as possible in the same language to that in which the original research was undertaken (Gawlewicz 2016). The data were analysed qualitatively, identifying emerging themes through an iterative process of listening for concepts mentioned by

participants in the interviews and then refining or developing these themes via subsequent re-listening. Such iterative analysis is widely used in energy and environmental social research (e.g. Kempton et al. 2005; Parkhill, Butler, and Pidgeon 2014), and gives flexibility to start with issues participants themselves identify as being important, rather than imposing researchers' own interpretative frameworks on the data. Both authors identified broadly similar themes through separate analysis. However, as our use of this more grounded approach involves each researcher drawing out their own ideas (which may not be identical) from the data as a whole rather than assigning data into pre-determined categories, it was not possible or arguably suitable to quantify inter-rater reliability via Cohen's Kappa or similar (Henwood and Pidgeon 2012). In Section 5, we reflect on these challenges around reliability and language.

The rest of this paper discusses themes the authors identified – trust, uncertainty, traceability of radiation and sociocultural dimensions of risk. Given the small and intensive sample size, it should be reiterated that our aim is to draw wider lessons for how publics and stakeholders perceive risks and decision-making around environmental radioactivity, rather than offering a complete characterisation of risk perception in Iwaki or Fukushima per se. With this in mind, we structure our analysis around three broader questions: who undertakes risk communication and management on the Fukushima coast and how they are perceived; how these communication efforts address uncertainty and complexity and to what end; and whether the content and nature of risk communication is responsive to citizen and stakeholder requirements. Where appropriate, links to existing studies are made to illustrate how our findings either build on or challenge recent research.

4. Data and analysis

4.1. Who is 'communicating', and how are they perceived?

Interviewees reported a range of information sources – or points of contact for discussion – on risk from radiation. These included national government departments (e.g. Fisheries Agency of Japan), nuclear plant operator Tokyo Electric Power Company (TEPCO); the prefectural government (especially fisheries and environmental sections); prefectural or municipal fisheries cooperatives; researchers working for universities both within and outwith the prefecture; and non-governmental organisations concerned with measuring environmental radioactivity.

More than any differences in data on radioactivity itself provided by these various organisations, what came across in the interviews were differences in the perceived trustworthiness of these communicating actors. The significance of trust in assessment of risks associated with high techno-scientific complexity is widely acknowledged (e.g. Wynne 1992; Pellizzoni 2003). Within this, we focus on two factors contributing to trust in the institution managing risk: perceived exposure to risks versus benefits; and perceived competence.

Firstly, perceived exposure to risks versus benefits. Both the fisheries research station in Onahama (operated by Fukushima Prefecture) and the fisheries cooperative narrated the process of restarting fisheries by explaining fishers' livelihoods could still be at stake even if fisheries *were* restarted:

> There were two feelings in the fishing community. One was that they wanted to fish, they had a strong feeling for fishing, so no matter what they wanted to fish. The other

> was that, it wasn't that they didn't want to fish, but they worried that radioactivity from the nuclear plant would flow out to sea, be picked up by fish and then be passed on to consumers. (Fisheries resources manager, Fukushima Prefecture Fisheries Research Station, Onahama)

> In Iwaki itself the radiation level in the air is low, there are no particular issues. A large proportion of the fish we catch, only a very small proportion are over the contamination level. I know people look at Fukushima as being a dangerous place but it's not, it's quite safe, we are eating safe food and we are actually producing safe food. (Fukushima Prefectural Federation of Fisheries Cooperative Associations project manager, Iwaki fisheries building)

The fishers' ultimate objective is clearly restarting commercial fisheries and the life they had before the disaster. Yet doing so too quickly could equally backfire and jeopardise their livelihood if they are seen to be responsible for exposing consumers to contaminated fish. Small-scale coastal fishers thus have a vested interest in restarting fisheries in a manner perceived as 'responsible'. This is compounded by the fact they and their families live in the area and may themselves end up consuming contaminated fish if monitoring is not sufficiently stringent. For reasons like this, people within institutions may come to be viewed as 'locals' with a personal and physical stake in the outcomes of radiation monitoring processes, even if only to ensure the sustainability of their businesses. Indeed, this idea of embeddedness within the setting as an indicator of the sincerity of institutions' motives repeatedly emerged when participants were asked how they communicated information on environmental radioactivity:

> For people who don't eat the fish, it seems to be that they don't understand the numbers. But if they come to the aquarium and see the aquarium staff eating things in front of their eyes, they might think okay, it must be fine, there are lots of people who have started to eat fish again because of that. For example, before the disaster there was a guy who did rod fishing, caught the fish and ate them, but after the accident he stopped eating the fish. He said to me 'I can't eat the fish, can I?' I said to him 'I eat them, they're delicious!' (Marine scientist, local aquarium)

> People involved with farming and university students and [*NAMES RESEARCH INSTITUTE*] were doing a promotion where they talked about the research they can do to find out how much radioactive matter there is, what results are coming up and what they mean, so that one can feel relieved because this is what the researchers do. But of course you can't just say it's safe, you also have to say we sometimes get this result, which is bad because of this or that reason […] if the prefecture and the city hall say it's safe, people don't really trust them, but if they hear it from people like university students themselves the message can travel better. (Disaster prevention professor, Fukushima City)

The risk communicators here may be seen to be embedded within the community and hence exposed to any risks themselves. The aquarium scientists back up their claims to the safety of Fukushima seafood by consuming produce themselves, and students studying at a long-established local university connect with farmers producing in the area to communicate with citizens on radiation monitoring methods. This tallies with other Fukushima-specific research suggesting that institutions operating at the local scale (Kimura and Katano 2014; Morris-Suzuki 2014) may have a role to play in providing 'trustworthy' information on radiation. This may be especially true if these institutions are seen as distinct from national government or industry-led communication efforts aiming to 'prove' the safety of nuclear power for restarts or continued use (Sugiman 2014).

We now address perceived competence. Participants were generally sceptical of any claims made by TEPCO, providing anecdotes about the plant when pressed on concerns about the coastal radiation situation going into the future:

> A labourer related to the work somewhere saw the noticeboard and got in touch. He only got paid eight thousand Yen a day. This person had no experience, the people around him had no experience. But this person was concreting under tanks for contaminated water – and he had no experience. (Local politician, Iwaki City Hall)

> The thing that worries me is inside the nuclear power station, in case there is some kind of contamination or not. We don't know that, so that is a worry. (Iwaki City Fisheries Cooperative board member, Iwaki fisheries building (see also Mabon and Kawabe (2015))

> People in their fifties, when the nuclear plant has been there since they were born, were saying it's safe, it's safe, it's safe, in this area working for TEPCO was a status symbol, it was a good thing, for a lot of people it was almost a dream job. So there was a lot of trust in TEPCO, a lot of trust in the government. But that was a lie! The plant exploded! It was like a betrayal. (Sociology professor, Fukushima City)

In the first two cases, anecdotal evidence about work on site at FDNPP is used to justify a cautious or sceptical stance towards information about environmental radioactivity provided by TEPCO. This anecdotal evidence is used to cast into doubt claims that the situation at the plant is under control, and thus to suggest information from the operator about radioactive releases from the plant cannot be fully trusted. A belief that the operator lacks competence translates into a lack of trustworthiness, which as the third quote indicates is intensified by the step change in relationship between the operator and community since the disaster.

The above data suggest that whilst a broad range of actors provide information about risk from radioactivity on the Fukushima coast, after McKechnie (2003) it may be those perceived as 'insiders' – local fishers and fisheries cooperatives, regional government employees working within communities, 'local' researchers – who are seen as more trustworthy due to their more direct exposure to any negative effects arising from risk management decisions. Also at play may be the perceived competence of the institution or individual, as illustrated by the use of anecdotes to question TEPCO's ability to understand and manage risks from FDNPP. What the ultimate goal of these actors' risk communication efforts – and how in particular they handle uncertainty – is the subject of the next section.

4.2. What is the goal of engagement on uncertainty and complexity?

We now address whether the goal of specific risk communication initiatives is to 'convince' people about the safety of produce or environments, or to help people come to an informed decision of their own on what course of action to take. A key issue in Fukushima – echoing Turcanu et al. (2016) for environmental radioactivity and Kasperson (2014) more broadly – is responding to differing interpretations of uncertainty depending on people's value systems. Post-disaster, the concept of *fuhyo higai* (usually translated as 'harmful rumours', e.g. Wada et al. 2013; Kawazoe, Urano, and Nozaka 2014) has been deployed by national and regional governments. The implication of *fuhyo higai* is that economic harm to Fukushima's produce and tourism stems from a lack of consumer information, and that more and/or better education is required to dispel such baseless rumours. Kimura and Katano (2014)

however hold that labelling those with a cautious stance towards the safety of produce as somehow unsupportive towards recovery may overlook the heterogeneity of risk perceptions existing within communities or even families. This continuing diversity of opinion, even as more information on radiation in produce has become available, came across when interviewees involved in fisheries were asked to narrate the process of restarting operations post-disaster:

> Of course there was the nuclear plant situation, and every month we would meet. When will it be safe again, naturally the nuclear plant situation was still a worry, can we fish in the future ever again, the discussions on compensation were at stake […] At the beginning the anxiety was a lot stronger and we had to respect those opinions. (Iwaki City Fisheries Cooperative board member, Iwaki fisheries building)

> Now monitoring has been undertaken that says the fish are safe and we can buy things in the shops, there are people who buy the fish without worrying. But there are also people who don't. It's not that they don't have trust, just that some people are still worried. When I'm working in the office, I have the feeling we are getting fewer inquiries and questions, there are fewer phone calls from people asking if the fish are safe or not. People that will buy the fish will buy them. People that won't, won't ask and won't buy. (Senior researcher, Fukushima Prefecture Fisheries Research Station, Onahama)

Rather than attempting to convince consumers of the safety of produce, the response to this division for coastal fisheries at least appears to be provision of information on monitoring processes and data to allow consumers to reach their own decision on whether or not to buy locally caught fish. For instance, results are uploaded to a publicly viewable website where the monitoring process itself is explained (Fukushima Prefectural Federation of Fisheries Cooperative Associations 2016). Moreover, the first quote also demonstrates the importance of respect for risk communicators in such situations. Rather than dismissing more cautious standpoints as 'irrational' or harmful, respect is given to the possibility that people may interpret uncertainties and risks differently, or hold legitimate concerns stemming from their values and world views.

Part of such respect may be realisation that even if initial awareness is low, people can in certain situations quickly come to terms with complexity and live within uncertainties (Katsukawa 2012). When asked what citizens found difficult to understand about radiation, a leader within Fukushima's radiation monitoring team argued citizens' awareness of the surrounding environment has risen post-disaster:

> If people look at the [*radiation*] monitors they can understand the number. Before the accident, residents of Fukushima Prefecture understandably didn't know very much about radiation, after the accident the highest level we would see inside Fukushima City was 20 microSieverts per hour. Compared to now, we now get 0.3 or 0.4, so people can look at the readings every day and feel they are safe. If the display stops working, they'll be on the phone to us right away! […] There is information about it everywhere in the environment around you, on TV, newspapers, there are lots of occasions to come across the radiation level, so it has become part of daily life. (Fukushima Prefecture radiation monitoring team leader, Fukushima City)

A scientist and communicator similarly responded that given appropriate space and time, citizens can understand even seemingly complex issues:

> There is nothing that is particularly difficult to explain if you can take time. If people are willing to listen and you have time to explain slowly and in a way that is easy to understand, nearly everyone will come to understand it. But you have to create the

> chances to do that, which is perhaps very difficult. The most difficult thing is people who are not interested, people who don't want to eat, who are a bit concerned but are not actively looking for information. How do you get information to people like that? (Marine scientist, local aquarium)

Publics and stakeholders can quickly become aware of the complexities in measuring environmental radioactivity, understand the difficulty of making generalised conclusions and be able to accept that the radiation situation remains dynamic over time. People may thus not expect/trust there to be no radiation in the environment, or that scientists and authorities completely understand the variations in radioactive contamination that can occur across short distances. Rather, what may be sought is evidence of adequate monitoring procedures and contingency plans for what to do should high levels of radioactivity through different pathways be discovered. Blanket assurances about safety could even arouse suspicion or distrust (Kimura and Katano 2014). Participants asked to expand on how they dealt with uncertainties in risk communication frequently admitted to the limitations of their knowledge, and acknowledged the importance of allowing citizens and stakeholders to make their own informed judgements based on interpretations of uncertainty:

> No matter how much you say to people who won't eat food that it's okay, it's safe they won't really eat it. You can't really force people like that to eat […] people will go to the supermarket and won't eat Fukushima produce, but will go out to a restaurant and eat things without really knowing where they've come from, that's maybe more dangerous. So I hope this can be good opportunity to teach people to understand their food and to think about where their food comes from, so they can decide for themselves based on correct information. (Disaster prevention professor, Fukushima City)

> I don't know overall, but there are some areas where the radiation levels are higher, for forestry where workers have to go into the mountains and spend a long time there, we are thinking about how we can reduce the exposure by considering various decontamination processes, but the forest is big with very complex and variable vegetation so it is not easy to decontaminate. (Fukushima Prefecture radiation monitoring team leader, Fukushima City)

> If data only came out that said everything was safe nobody would trust it, so we need to be able to clearly say this is no good, that is no good […] our role is to explain things, so we have a responsibility to explain not only what is bad and good and what the numbers are, but also what would happen if you ate certain fish and why it is that some things are off-limits. (Marine scientist, local aquarium)

Evident is the admission of the limitations of current knowledge and also an acceptance of the complexity of ecosystems. Previous research in the context of Fukushima (Katsukawa 2012; Kimura and Katano 2014; Mabon and Kawabe 2015) has similarly shown that such honesty may offer a more nuanced pathway to restoring public faith, and that experts and decision-makers should thus not be hesitant in admitting where areas for further research may lie.

Clear here is that engagement on risk and uncertainty with the goal of allowing citizens and stakeholders to come to their own informed decision on a particular course of action may ultimately be more effective than attempts to 'convince' people or 'dispel' myths. The above data also suggest there is value for those tasked with communicating the physical nature of environmental radioactivity in openly discussing limitations of existing knowledge and the steps being taken to improve this knowledge. Citizens and stakeholders alike may accept uncertainty under highly complex conditions, perhaps even being suspicious of blanket assurances to

knowledge. In turn, there is a need when communicating potential risk management strategies to respect legitimate concerns grounded in interpretations of uncertainty, and not to dismiss public or stakeholder concerns offhand. Moving beyond the idea of risk communication as purely the one-way 'correction' of misunderstandings is the aim of the next section.

4.3. Is the nature of risk communication responsive to risk bearers' requirements? If not, how may it become so?

Árvai (2014) expresses concern that the aim of much risk communication is still to correct misunderstandings or bring perceptions in line with a dominant ideological framing. Kasperson (2014) adds that conditions of high social distrust may require more inclusive and deliberative forms of risk communication. This section builds on these challenges and the points raised at the end of Section 4.2 to consider how risk communication on Fukushima's coasts may (or may not) be responsive to the actual needs of publics and stakeholders.

First, however, it is important to remember that respect for different framings of uncertainty and acknowledging limitations to knowledge does not mean 'anything goes'. Potentially harmful radiation was and continues to be emitted from FDNPP, with a general high-level understanding of how radiation is distributed across space (Saito et al. 2015). There is therefore place for the work McKinley, Grogan, and McKinley (2011) identify around effectively communicating the underpinning scientific data on radioactive contamination and contextualising the effects of events like the Fukushima disaster. Nonetheless, on the theme of respect there is a parallel need to create space for publics and stakeholders to air their own concerns and monitoring requirements. Discussion on the underpinning scientific and policy principles without such opportunity may lead to disenfranchisement:

> [I]nformation meetings are held. They explain compensation, exchange on the future of towns and villages, ask people to gather together and so they can hear their opinions. But no matter what they say, it's a terribly difficult situation that is not going well, so no matter what the town or the prefecture or the government says people's own lives are not recovering. There is a feeling that attending is a waste of time. (Sociology professor, Fukushima City)

Given the trust issues outlined in Section 4.1, work to rebuild citizen trust in measures taken by 'government' across a range of scales may be required to avoid disengagement of this nature. Interviewed Fukushima Prefecture staff did acknowledge this, explaining that based on concerns raised during surveys with prefectural residents they are now working with citizens with different activity patterns to estimate more fully the exposure received through daily living. This 'building in' of public and stakeholder concerns to monitoring emerged in other interviewed institutions' narratives of how they collected data about radioactivity:

> Fishers catch fish and bring them here, in the lab we process the fish for monitoring, take only the meat and bring it into the lab. When the results come in, first of all we explain the data to the fishers who have brought us the samples, so they can know where the level is high, the level of danger in their fish. (Fisheries resources manager, Fukushima Prefecture Fisheries Research Station, Onahama)

> After the accident, first of all we wanted to check for ourselves. There were lots of people who couldn't trust the national government or the prefectural government's

> research, so the aquarium has a role to release monitoring information that could be seen as independent and like a 'double check' […] we have been working with the UmiLabo people to run an event called TabeLabo, which means researching so that we can eat! (Marine scientist, local aquarium)

Citizens or stakeholders can actively collect environmental radioactivity data – for land-based radiation, citizens with different lifestyles and movement patterns play a role in creating more nuanced data on the exposure people may receive as they go about their daily routines. For marine radiation, fishers' skills and machinery are utilised to catch more fish samples than would be possible were the prefectural researchers to use their equipment alone. In the 'TabeLabo' events run at the aquarium in conjunction with local non-governmental organisation UmiLabo, publics get involved in catching fish themselves, viewing radiation monitoring processes for fish, and eating local produce. This 'citizen fishing' creates additional data which help to keep a check on government radiation statistics (UmiLabo 2015). Involving a wider range of actors in data collection in this way has instrumental value in allowing more data to be collected on which to base decisions about environmental radiation. Further, the spaces, opportunities and conditions of mutual understanding required for more dialogic forms of risk governance to emerge may be created as a result.

Beyond communication needs, dialogic processes may additionally play a role in debating the nature and pace of remediation and recovery along Fukushima's coast. This was illustrated by how two participants responded when pressed on what they saw as the purpose and value of their engagement on risk:

> We explain the current situation at a meeting which includes quite high-up people from fisheries and also the fishers who are doing the trial fisheries or want to take part in trial fisheries. Probably either us or people from the prefecture, I mean public sector, will explain the current situation, these fish are still high, these fish have become lower. We discuss if the fishers wanted to fish again, this is the route they would take to get there. (Fisheries resources manager, Onahama Fisheries Research Station)

> Town hall staff also talked about how they didn't know what would happen next. There are no resources to make a decision about what to do in the future. Staff and citizens both said the thing that worried them most was not knowing what would happen in the future. (Sociology professor, Fukushima City)

Here, more than measuring radiation and associated risks, input from stakeholders is used to suggest what actions are to be taken next given the available information. Based on the newest data (which fishers themselves have produced) fishers are involved in discussions over which fish should be targeted for the resumption of sale. Residents of an evacuated town are able to raise issues they themselves feel are of concern, with local government staff too given a chance to air their views as citizens (albeit to a research project rather than a direct planning consultation). Yet in order for this kind of discussion to emerge, it is crucial for the involved parties to have a space where they feel they can air their concerns. In the case of fishers, this is an informal meeting with opportunity for discussion with civil servants before and after. For the residents, it is a closed discussion with facilitators perceived as non-judgemental and not overly invested in the decision reached.

Our data indicate more 'top down' modes of risk communication may miss what publics and stakeholders feel they actually need to know about environmental radioactivity, especially if trust in authorities and operators viewed as managing or communicating the risk is already low. At the same time, environmental

radioactivity is real and potentially very harmful, and decisions do ultimately have to be taken about remediation, rehabilitation and consumption. The initiatives identified here that involve publics and stakeholders in data collection may therefore have value in building a wider and more 'independent' evidence base for decision-making at all scales. Collaborative data collection may also help to foster the kind of relationships required for dialogic discussions over future directions for remediation and monitoring to take place.

5. Discussion

We finish by considering our findings in light of the four principles for future risk communication laid down by Kasperson (2014). We draw links between Kasperson's thoughts and our findings to illustrate ongoing challenges for engagement on risk and uncertainty. We also reflect on future directions for Fukushima-specific and wider environmental risk research raised by this study.

Kasperson's first principle is that '[r]isk communication programs need to be more sustained over time, better funded, and more ambitious in the goals adopted and the outcomes sought' (Kasperson 2014, 1237). Environmental radioactive contamination of the kind found in Fukushima will retain potential to harm humans for many years. The complexity of land and marine ecosystems makes it difficult to know how radioactive material will travel long term and if/how this may ultimately affect humans. Continuing uncertainties around longer term effects of low-level exposure across a range of pathways further demonstrate the need for continued monitoring into the future. A lesson that can be drawn in support of Kasperson's first principle is the importance of those responsible for the management of environmental radioactivity, especially national/regional government and plant operators, building understanding of the timeframes over which citizens and stakeholders envision the issues at hand, and ensuring the timeframes of their risk communication strategies match accordingly. The incremental restarts adopted by fisheries cooperatives, and Sato's (2014) identification that evacuated residents within Fukushima imagined resettlement over a period of 30 years (as opposed to the central government's five years), illustrate that publics and stakeholders may envision responses to risks stretching over decadal timescales. Sustaining risk communication programmes over time in the way Kasperson imagines may hence require risk managers and/or decision-makers taking steps to align their communication programmes with citizen expectations of the timeframe over which risk governance is to take place.

Kasperson secondly states 'risk communication should be broadened to internalise conflicting issues of concern and decision-makers should deepen their analysis to address the embedding of risk issues in value and lifestyle structures' (Kasperson 2014, 1237). This is illustrated through concerns over how well existing governance regimes for Fukushima radiation reflect the exposure people receive through daily living (Morris-Suzuki 2014), and through emerging awareness at local government level of the need to more fully understand the heterogeneity of lifestyles as discussed previously. What our data and other social research on Fukushima radiation add is the importance of taking seriously the sociocultural implications of being exposed to risk. Sato (2014) coins the phrase 'evacuated in daily life' to describe the effect of living in environs subject to restrictions on daily doings such as consumption of food. Issues around recreational activity in the countryside, and the desire of fishers to be back out fishing (Mabon and Kawabe 2015), demonstrate how potential

exposure to risk can affect ability to undertake socially or culturally meaningful practices. As per Kasperson's second principle, then, it may be that regulators' and operators' conceptualisation of 'risk' needs to extend beyond techno-scientific risks to encompass implications for citizens' daily practices and the possibility of exposure to risk restricting or affecting culturally significant practices.

Kasperson's third principle is that

> [i]f uncertainties are large and deeply embedded, more communication will be needed, particularly that regarding those uncertainties that really matter in risk terms and not the full catalogue of uncertainties that scientists uncover. Attention will also be needed to identify which uncertainties can and cannot be reduced over time and within what time frames. (Kasperson 2014, 1238)

We add to this the importance of scientists, decision-makers and operators perceived as taking or assessing the risks being honest about where uncertainties remain, and demonstrating competence to work under conditions of uncertainty. Fisheries cooperatives, working towards incremental restarts based on stringent screening of produce where both results and the monitoring process are open to scrutiny, seem able to garner some support from buyers and consumers. Conversely, anecdotal evidence about FDNPP itself is deployed to cast doubt on the competence of the plant operator to manage and respond to uncertainties. To build on Kasperson's argument about the need for more communication if uncertainties are large and deeply embedded, it may also be that people can in cases accept and understand uncertainty provided adequate monitoring and remediation procedures are in place, and that sufficient attention has been given to 'worst-case' scenarios. Publics and stakeholders may not expect there to be no uncertainty, with assurances to this extent even arousing suspicion or distrust. However, evidence is required that steps are being taken by those assessing or taking the risks to monitor and consider the potential effects of uncertainties.

Fourth and final is Kasperson's view that 'where high social distrust prevails, and this is increasingly common, a thorough revamping of the goals, structure, and conduct of risk communication will be needed' (Kasperson 2014, 1238). Our data reinforces the significance of how the person or institution 'communicating' information about risk is perceived. One driver in this regard is the motives of the engaging individual or institution – whether they stand to benefit from quickly taking decisions on risk instead of a more cautious and incremental approach. A second is whether the communicator will themselves have to bear any risks from the decision taken, either to their own health or to their long-term livelihood. And a third, as above, is the perceived transparency and competence of the institution. Adding to Kasperson, therefore, is the value of drawing local-level actors into risk communication and engagement. The reason for this is that those operating at the local scale may be viewed as citizens exposed to the same risks as the surrounding community, and thus as having a personal stake in the outcome of risk governance decisions. By contrast, national governments, large utility operators or even spatially distant 'experts' could be thought of as coming from afar to pass detached judgement.

We lastly discuss limitations of the study and directions for future research. As noted in Section 3, the iterative and highly qualitative data analysis technique deployed in this paper makes quantifying the reliability of the analysis by assessing inter-rater reliability difficult. We nevertheless believe there is value in analysis techniques that afford the researcher greater interpretative flexibility given the overarching concern with avoiding assumptions about how risk bearers will perceive

or respond to risks. However, this does raise a wider issue about interpretative 'reliability' and translation in risk research – especially when members of the research team speak different native languages. Although no translation challenges arose within this study, following Gawlewicz's (2016) procedure for 'conceptual equivalence' (adding notations to the transcript to explain concepts that cannot be directly translated) may form a useful component of subsequent, more systematic data analysis. This would allow issues such as consistency of or differences in the researchers' interpretations across languages and cultures to be assessed.

6. Conclusion

Acknowledging radiation risk perception is socially and culturally contingent does not mean 'anything goes' – radiation certainly is harmful or even lethal. But indeterminacies and uncertainties remain around the overall effects on humans of environmental radioactivity associated with the FDNPP accident, meaning decisions have to be taken under conditions of uncertainty. Issues of energy and environment go right to the heart of how people may live their lives. Both publics' and stakeholders' responses to communication and the decisions they make on indeterminacies, uncertainties or 'facts' may hence be guided by their underpinning values. We have sketched out challenges we see on Fukushima's coast for working with these value-laden dimensions, so that (a) citizens and stakeholders may use their own values and world views to make judgements based on an understanding of where uncertainties and indeterminacies remain; and (b) risk management by governments at all scales, researchers and operators in terms of communication and monitoring can evolve over time in order to take into account what members of society actually require and how they feel about risk and uncertainty.

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