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Conflictual collaboration:

Citizen science and the governance of radioactive contamination after the Fukushima nuclear disaster

A B S T R A C T

In the aftermath of the 2011 Fukushima nuclear disaster, citizen scientists collectively tracked and monitored residual radioactivity in Japan, legitimizing alternative views to an official assessment of the radioactive contamination. But initial practices of resistance have evolved in collaboration with the official Japanese politics of radioactive governance, supporting hegemonic understandings of radiation danger and normative visions of postdisaster recovery. Civic resources used to resist and reinterpret official narratives of contamination end up reinforcing a state-sponsored normalization of this disaster. Meanwhile, they become crucial techniques of neoliberal governmentality designed to govern the conduct of populations amid contaminated environments. [*nuclear disaster*, *radioactive contamination*, *citizen science*, *governance*, *neoliberalism*, *Fukushima*, *Japan*]

2011 年福島原発災害の後、市民科学者たちは日本各地で放射能汚染を測定し、政府の公式なアセスメントとは異なる見解を正当化する役割を果たした。しかし彼らの当初の政府に対する抵抗の動きは、実は放射線の危険性に関する支配的な理解及び災害後の復興の規範的ビジョンを裏書きする形を取っており、日本政府の公式な放射能ガバナンスのあり方と連携の上に発展したといえる。つまり汚染に対する公的な言説への抵抗の手段であった市民科学者たちの慣行は、結果として国家によるこの災害を正常化しようとする動きを強化することとなったわけである。そしてこうした市民科学者たちの抵抗の慣行は次第に新自由主義的ガバナンスの極めて重要な技巧の1つとなり、汚染された環境の中での人々の行動を統治している。 [原発災害, 放射能汚染, 市民科学, ガバナンス, 新自由主義, 福島県、日本]

As we approached a metal gate near a small ditch, I began sweating profusely—my Geiger counter was registering 13 microsieverts per hour, a high level of radioactivity. Alarmed, I glanced at my guide, Mr. Kan'no.[1] He was unperturbed, however. "See?" he said with a wry smile. "I told you the radiation level would be high near the gate!"[2] Mr. Kan'no was not a nuclear scientist but a former farmer from the village of Iitate in Fukushima Prefecture, Japan. He belongs to a citizen science nonprofit network that aims to revitalize the sociocultural lives of the citizens affected by the nuclear disaster unleashed on March 11, 2011, when Japan experienced a devastating earthquake and tsunami. This led to a meltdown in the Fukushima Daiichi Nuclear Power Plant. As a result, harmful radioactive pollutants—such as iodine-131, cesium-134, cesium-137, strontium-90, and plutonium-238—were released and spread predominantly throughout the Fukushima region.

With the aim of helping Iitate's residents shed light on the invisible harm afflicting their village, Mr. Kan'no's nonprofit had provided them technology to measure and analyze the residual radioactivity in the environment. Many resident members of this nonprofit own Geiger counters, which measure an area's level of radiation, and personal dosimeters, wearable devices that record a person's cumulative dose of external radiation. Other members test for radioactivity in rice paddies, which the residents decontaminate using processes they have developed on their own.

Five years after the disaster, such citizen-led initiatives were thriving in Iitate, even though the Japanese government's Ministry of the Environment had ended much of its official decontamination of the village, deeming it free of harmful radiation. Yet these grassroots practices continued because many Iitate residents were dissatisfied with how the state experts had assessed radioactive contamination. As one local man angrily told me, "The government has decontaminated a 20-meter radius around our houses, but they didn't do any kind of follow-up. And every time it rains, the radioactive pollutants

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in the nearby mountains are washed down, and it gets recontaminated." Against this backdrop, citizen science, which evokes technoscientific practices enacted by citizens themselves to assess their needs and concerns (Irwin 1995; xi), provided answers that state officials failed to supply. As one resident summarized it,

> This is a disaster that we couldn't see with our eyes, a problem that we couldn't smell or hear. At the beginning, we had no way of knowing if our radishes [*daikon*] were contaminated or not. And that's hard, because that's a big part of our culture. Everyone was wondering what life would come to under these conditions. That was our biggest problem. But by "seeing" the radiation through the data [that we have produced], we were able to know what to eat and what not to eat. We could know how dangerous it was. Our anxiety [*fuan*] has disappeared.

In 2016 observations like these were commonplace during my fieldwork as I tracked the work of citizen science networks—through which former laypeople generated their own knowledge about radiation.[3] As I interviewed the founders of different citizen science networks, it became clear that state-sanctioned experts had been unable to provide clear guidelines to help residents cope with the potential dangers of ionizing radiation, a form of energy that penetrates the body and that, in high doses, is known to cause cancers and harmful genetic effects.[4] This void led to an important increase in public skepticism about the legitimacy of the state's institutional experts (Miyazaki 2015; Slater, Morioka, and Danzuka 2014). Ultimately, residents educated themselves about radiation and began unofficially monitoring it.

While people of various backgrounds entered citizen science after Fukushima, the four citizen science networks that represent the focus of this article share a similar characteristic: they were created by citizens who have no previous history of political activism and who are driven by a dissatisfaction with the state's management of radioactive hazards.

At first glance, the rise of citizen science in postdisaster Japan appears to be a "renaissance in civil society" (Aldrich 2013, 264), since citizen scientists endeavor to resist the normalizing forces of governmental, industrial, and academic expertise on radiological risk protection. In this context, citizen science networks developed independent safety channels outside the normative medium of Japanese bureaucracy (Rosenberger 2016), allowing citizens to critically assess institutionalized perspectives on radiation hazards and to "circumvent the state's expertise to protect the health and life of current and future generations" (Sternsdorff-Cisterna 2015, 456). And while dynamic forces like postfeminism, scientism, and neoliberalism sometimes render radical political activism inappropriate for Japanese women, practices of radiation monitoring legitimize alternative views to an official assessment of the radioactive contamination (Kimura 2016), thereby making it possible for citizens to do "politics by science." Citizen science thus illustrates how people use the "practice of politics" (Li 2007) to refuse the status quo and challenge dominant forms of governance.

At the same time, however, the resident-led radiation-monitoring practices I witnessed were conducted in places, like Iitate, that were arguably uninhabitable because they had such high levels of radiation. After all, in 2011, Japanese officials adjusted the acceptable radiological exposure dosages for the public to 20 times higher than it had been before the disaster. Thus, residents publicly engaged with residual radioactivity even though it was unsafe for them to be living there in the first place, at least according to the previous safety standards.

Here, citizens' intervention in matters of radiological protection echoes a different set of debates around neoliberalism, according to which citizens have to take care of themselves (Ottinger 2010b). Indeed, socially innovative forms of governance, like that of citizen science, are often supported by state and market forces pursuing a neoliberal agenda (Lave 2012; Swyngedouw 2005). Such agendas seek to reduce public expenditure, protect corporate polluters from accountability, guarantee minimal government intervention, and privatize risk, meaning that risk becomes a matter of personal business rather than the state's responsibility (Harvey 2007). These practices of civic environmental monitoring echo Michel Foucault's (1991) idea of "governmentality," according to which nation-states exercise political sovereignty by governing people's conduct. The self-responsible citizen thus becomes an "entrepreneur of himself" (Foucault 2008, 226).

When I was invited by the Iitate nonprofit to help farmers decontaminate rice paddy fields, wearing only a pair of rain boots as protection—while my guides assured me it was safe (*anzen*) to do so—I began to ponder the Janus face of resistance and risk privatization that epitomizes their work (see Figure 1). As I watched farmers working with their feet in radioactive mud, I asked, How does this fostering of science in society intersect with official state politics of governing postdisaster Fukushima?

In many instances citizen science involves "conflictual collaboration," in which citizen scientists—even though they resist the Japanese state's practices of monitoring radioactivity—collaborate with state actors or nuclear lobbies in either downplaying radiation hazard or reifying normative visions of postdisaster recovery at the expense of others. This is particularly ironic given that postdisaster citizen science emerged out of a concern over whether institutional experts could manage the risks of residual radioactivity. Conflictual collaboration, as a set of alternative practices of resistance that intersect with governmental tactics, straddles the gap between governmentality ("the

Figure 1. Citizens in Iitate village, Japan, try to decontaminate irradiated rice paddy fields in 2016. [This figure appears in color in the online issue]

conduct of conduct") and the "practice of politics," which challenges governance.

In anthropological studies of political ecology, governance accounts for a plurality of actors and institutions that compete and overlap in managing environmental problems and goals (Gururani and Vandergeest 2014; Mathews 2011). Consequently, even though different actors often focus on common projects, they can successfully maintain separate political agendas, as in the case of forest industries (Tsing 2005) or matsutake mushroom farming (Hathaway 2014). The notion of conflictual collaboration reveals a different story, namely how *separate* projects lead to a *common* agenda. In Fukushima this means that citizen scientists' resistance can evolve into collaboration with the state politics of governance, legitimizing hegemonic visions of radiation danger and normative vision of recovery. Ultimately, civic resources and efforts used to resist and reinterpret official narratives of contamination end up reinforcing a state-sponsored normalization of the disaster.

Radioactive governance

The 2011 nuclear disaster initially prompted the Japanese government to evacuate the areas surrounding the Fukushima power plant. By March 12, 2011, the evacuation order encompassed a 20-kilometer radius around the plant. Many citizens living beyond the officially restricted zone fled of their own initiative; they later became known as "voluntary evacuees" (*jishu hinansha*). In December 2011 the evacuation zone was reorganized, and Fukushima became a patchwork of three different areas with well-defined boundaries defined by the annual level of atmospheric radiation.

Under normal circumstances, exposure to radiation is not supposed to exceed one millisievert (mSv) per year (World Nuclear Association 2018). Yet, based partly on the recommendation of the International Commission on Radiological Protection, the Japanese government in 2011 increased the permissible radiation exposure levels from one mSv to 20 mSv per year. State experts contended that a full-scale evacuation based on the previous standard of one mSv per year would be more damaging to the population than the risk associated with radiation exposure (Jacobs 2016). In the months after the disaster, members of the local and central government, as well as nuclear-related agencies, repeatedly stated that the levels of radiation released were too low to have serious adverse health effects.

These arguments were notably supported by a medical doctor appointed by the central government as Fukushima Prefecture's radiation risk management adviser. In 2011 this doctor noted that "as long as annual exposure does not exceed 100 mSv, there is no impact on health." He added, "Go ahead and let your kids play outside" (FBPC 2015, 30). Indeed, above a certain level of exposure—namely, 100 mSv per year—radiation increases the risk of cancers and other health problems, and it impairs the immune system's ability to fight infection (Morris-Suzuki 2014, 336).

The radiation risk management adviser does not mention, however, that "low doses" of ionizing radiation, below 100 mSv per year, can also increase the risk of long-term health problems (World Health Organization 2016). This is a scientific topic long shrouded in historical secrecies (Nakagawa 1991) and controversies (Goldstein and Stawkowski 2015). Similarly, there are important limitations on institutional experts' assessments of low radiation doses and their risks (Morris-Suzuki 2014; Yagasaki 2016).

First, the official radiological safety measures used to define evacuation areas were exclusively based on external exposure, and the revised allowable dose threshold did not take into consideration contamination from radioactive particles internalized by breathing contaminated air or ingesting contaminated food. Second, the Japanese state created a narrative in which the radiological disaster was over, disregarding long-term consequences from chronic low-dose radiation exposure that might appear decades later or be transferred to future generations. Third, the state's threshold of 20 mSv per year focuses on the health of the average individual and fails to reflect the risk to children and adolescents, who are more sensitive than adults to radiation (World Health Organization 2016).

Notwithstanding these problems, the Japanese state resettled former irradiated areas of Fukushima, supported by a massive program of radioactive decontamination there (see Figure 2). Evacuees were longing to return to their former homes, according to speakers at state-sponsored recovery symposia that I attended and state officials I interviewed. Officials emphasized the psychological suffering

Figure 2. Piles of black plastic bags filled with radioactive soil and debris in Iitate, Japan, 2016. These were by-products of state-sponsored decontamination work. No one knew how to properly dispose of them. [This figure appears in color in the online issue]

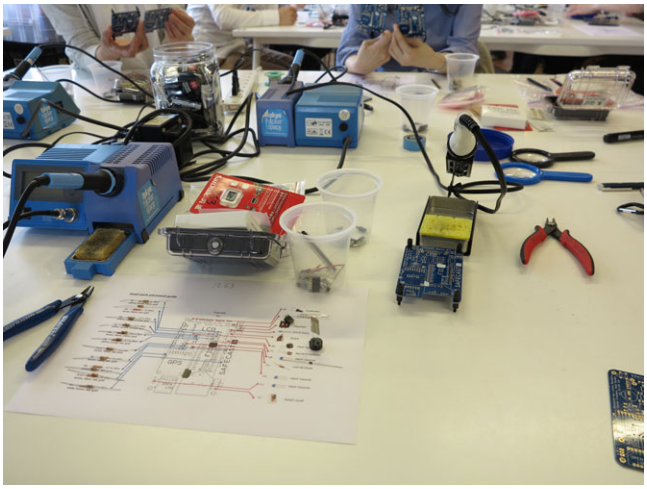

Figure 3. Technical instructions for assembling radiation-monitoring devices at a 2016 workshop held by a Japanese citizen science network. [This figure appears in color in the online issue]

induced by being separated from one's native village (*furusato*). The state therefore became the driver of a policy that promoted postdisaster recovery as a return to Fukushima rather than as long-term evacuation. Citizens who promoted evacuation were consequently perceived as egotists hampering Fukushima's revitalization. One voluntary evacuee whom I regularly interviewed during my fieldwork argued that political elites and communities accused those who left Fukushima of being unpatriotic (*hikokumin*) (Polleri 2018).

Against this backdrop, many citizens were and continue to be wary of voicing their concerns about radiation risks, which became a taboo subject. The state, amid its discourse of radiological safety, initially saw citizen science networks as an attack on its authority and swiftly repressed them. But when I conducted my fieldwork, citizen science networks were no longer a novelty. The chaos of the disaster had settled down, and I noticed that the relationship between state actors and citizen networks had evolved in new directions: the expertise of some citizen scientists was now intersecting with the official governance. How does a situation like this develop?

To find out, I interviewed core members of different networks, as well as the citizens who participate in radiation monitoring and tracking. I paid close attention to the factors that led them to initially clash with the state, while participant observation of the networks' activities allowed me to understand how data about radioactive contamination were collected, interpreted, and used. Citizen science networks came to downplay radiation harm and understand recovery as a form of permanent resettlement in Fukushima for three reasons: the production of apolitical data, neoliberal forces, and tropes of social recovery.

The Truth Is Out There

In 2016, on the top floor of a crowded Tokyo building, I attended a workshop on do-it-yourself (DIY) radiation-monitoring devices organized by a network of citizen scientists. With a dozen participants, I had the opportunity to build a Geiger counter of my own out of a kit designed by the network. The kit was composed of a number of parts: a motherboard, LCD displays, resistors, and a low-voltage pancake mica window (see Figure 3).

There was a look of excitement on the participants' faces—many Japanese and a few foreigners—as each of us received our kits and started to decipher the instructions. The whole task required dexterity, since participants had to weld the right color resistors to the motherboard without burning themselves. After a few hours the task was completed, and all of us proudly held our Geiger counters in the air as the organizers of this Tokyo-based network snapped a photo of our achievement. Workshop participants were invited to test their newly made Geiger on a contaminated piece of wood brought from Fukushima, which triggered an elevated reading on our screens.

Like many of the participants, I had become familiar with this network by hearing about their DIY Geiger workshop. Intrigued, I initially attended one of their conferences, where a founding member of the organization revealed why he became involved in citizen science:

> There were a lot of problems with how governmental measurements were being conducted. For example, the measurements [of radiation levels] were taken 30 meters in the air and only concerned gamma rays, while we suspected that other rays, like beta ones, could also be present. Even when measurements were made public, through the United States military, for instance, it

took more than a year before reaching the public! So this kind of data was useless to the public.

In light of what they perceived as ineffective state measures, the founders of the Tokyo network decided to measure the radioactive contamination themselves and provide their measurements in real time on the internet. To maximize the usage of their limited number of Geiger counters, they began tracking contamination with monitors attached to their cars, like the camera-mounted cars that capture images for Street View in Google Maps. Yet the scope of this work was overwhelming. As a result, the organization decided to focus instead on running workshops to enable local citizens to build their own monitoring devices. Throughout these efforts, the Geiger was described as a Promethean gift that could produce raw data for a population urgently in need of information. The latter point was emphasized by the group's motto: The Truth Is Out There.

These workshops quickly became a success, enabling participants to build their own Geiger counters and upload radiation data on a centralized website created by the Tokyo network. As one of the founders proudly exclaimed, "Citizen science has beaten the preplanning of any governments in a matter of weeks!" Members boasted that 40 million measurements had been collected so far—a shining example, they thought, of what citizen science can accomplish, even with its limited capacity. Rapidly, DIY Geiger counters enabled citizens to track radiation where no data were previously available, thereby more closely addressing residents' concerns. During the conference one resident from Fukushima, holding his own homemade Geiger, thanked the organization for helping him "see" radiation and lower his anxiety (*anshin*).

Yet, in the midst of its success, the Tokyo network began facing public and political pressure to clarify its position on radiological safety. Worried that any sort of political affiliation might compromise the integrity of their data, the network's core members decided not to take an official position on the danger or safety of radiation exposure. "We are often asked if we are antinuclear or not," the group's director said. "Well, we always respond that we are pro-data!" During the workshop, participants made few remarks about the relationship between radiation risks and the measurements on the screens of our Geiger counters. No one explained, for example, what a microsievert is and how it relates to human health.

No founding members of the network dealt with issues of scientific legitimacy regarding radiation hazards. Rather, the Tokyo network was simply providing technical means to generate raw data, which actors could then freely use and interpret. This outcome led to the first instance of conflictual collaboration: downplaying and normalizing the extent of radiation dangers.

In 2016 some core members began to visit Fukushima High School in Fukushima city in order to produce a series of DIY workshops. Since the network focuses on producing raw data, its work is perceived by those in the Japanese educational system as a scientific endeavor unbiased by political affiliation, as opposed to, for instance, antinuclear citizen science networks that produce data on radioactive contamination with clear political aims.

Therefore, in collaboration with the science teachers of this school, the teenagers of Fukushima learned to make their own Geiger counters. During these workshops, teenagers were asked if they knew about their locality's radiation level and then had the chance to measure it. The Tokyo network even created smaller Geiger counters that elementary students could build. As a network member explained to me, students were surprised to see that the radiation level of their environment was often lower than that detected during an intercontinental flight, making them feel confident about the safety of living in Fukushima.

The analogy is not considered a political position on radiological safety but simply a matter of highlighting the "facts." But by depicting the Geiger counter as a tool that simply produces raw data, the Tokyo network does not engage with the limitations of this monitoring device, which fails to thoroughly represent radioactive hazards in Fukushima. While the aforementioned comparisons paint an optimistic view of radioactive levels in Fukushima, they are in fact misguided, as a doctor of medicine specialized in radiation and cancer explained to me.

DIY Geiger counters are useful only for measuring levels of external radiation present in the surrounding environment, but they are not intended to gauge the risk of alpha- or beta-emitting particles, which can cause cancers if inhaled or swallowed (Jacobs 2016). For example, strontium-90 is a dangerous bone seeker that mimics calcium, staying within one's bone marrow and weakening the immune system. Measurements produced by Geiger counters also produce a limited understanding of radiation harm, since they do not consider the temporality of radiation-induced illness. Lastly, Geiger counters measure external radiation levels, but they do not tell users how different radionuclides react to bodies of different ages or sexes. In fact, the science of radiation protection is generally based on protecting the health of the average individual (an adult male), which is a theoretical concept based on mathematical averages. Measurements gleaned with Geiger counters to gauge potential health effects on a population lead researchers to turn a blind eye to the potential risks faced by segments of the population, in this case children, that are not captured through radiation protection's data standards.

In previous decades, the Japanese Ministry of Education provided primary and secondary school textbooks that downplayed the dangers of nuclear accidents like

Chernobyl (Pilling 2014). After the meltdowns in Fukushima, the ministry recalled these textbooks and provided new ones on radioactivity education (*hōshanō kyōiku*), in which the general guideline for teachers was to create an understanding that no clear evidence demonstrates that low-dose levels of radiation cause disease.

The Tokyo network's technologies and protocols reinforce this kind of radioactivity education by mobilizing a scientific language that is already compromised and that falls within the limited understanding of the Japanese state's management of radiation risk, which disregards internal contamination, neglects to account for future long-term risks, and dismisses individualized radiation risks.

What's more, government publications on the revitalization of Fukushima indicate that the state is now mobilizing the raw data produced by the Tokyo network in an attempt to downplay radiation risks. In a 2016 document produced by the Fukushima prefectural government, the radiation detected by the DIY Geiger counters is listed as comparable to the levels detected in other cities around the world, like Beijing or New York. This gives the impression that radiation exposure in Fukushima has reached normal levels—a tactic that reframes the discussion of radiation risk in terms of simple, naturalistic explanations unrelated to the specific risks found in Fukushima (Hirakawa and Shirabe 2015).

In the management of environmental issues, knowledge often travels via uneven power relationships (Tsing 2005), in which it can be mobilized by powerful actors to advance a specific purpose or political agenda (Mathews 2011, 143). Similarly, when I pointed out that the Tokyo network's data were being used to minimize radiation risk, one of the network's core members expressed surprise and displeasure but contended that this was the price to pay for producing raw data.

While the Tokyo network initially sought alternatives to state measurements of residual radioactivity, their technoscientific practices of gathering raw scientific data ended up directly (through school workshops) and indirectly (through official state documents) endorsing state-sanctioned generalizations about the nuclear disaster. Separate projects can thus harmonize with a common agenda, particularly in crystallizing normative understandings of radiation hazards.

"It can't be helped"

Every three months, Kimiko organized meetings in her citizen science network, situated in the southern part of Fukushima, near the town of Suetsugi. There, local residents discussed their personal levels of radiation exposure and shared tactics to lower their doses. Even though the Suetsugi network had one of the smallest centers that I visited during my fieldwork, it had become famous for collaborating with an NGO called Ethos, known for having ties to the nuclear lobby.

I heard about this peculiar relationship at the 2016 Fukushima Medical University International Symposium, where Jacques Lochard, the chief representative of Ethos and a member of the International Commission on Radiological Protection's Main Commission, came to discuss his NGO's work with the Suetsugi network. During his speech, Lochard explained that Ethos was founded after the Chernobyl disaster with the aim of improving the living conditions of victims of nuclear accidents. One way to do so, he argued, is to involve citizens in postdisaster management. In Fukushima, Ethos's mission was similar: to empower the population with knowledge about radiation.

Yet, while Ethos claims to be an independent organization, it is an offspring of the European nuclear lobby, created by the Commissariat à l'énergie atomique et aux énergies alternatives and joined by AREVA, a multinational nuclear power group, with financing from Électricité de France, an important player in nuclear energy (Ribault and Ribault 2012). Ethos's work with Chernobyl victims has promoted citizen empowerment in areas afflicted by chronic exposure, leading to new forms of neoliberal abandonment, in which the responsibility for dealing with harm is transferred from the nuclear polluters to the population (Topçu 2013).

In Fukushima the neoliberal implications of Ethos's agenda were comparable (Kimura 2017), although critics assumed that Ethos seamlessly imposed its program of self-responsibility in a traditional governmental way. Ethos, however, never reached out to Suetsugi residents to set up a network (as it did with Chernobyl victims). Rather, as I learned from Kimiko, the director of the network, it was the citizens of Suetsugi who initially contacted Ethos, knowing full well the organization's pronuclear agenda. Why would citizens do such a thing?

To answer this question, it is important to consider that laypeople's reflexive capability to articulate responses to issues of radioactive contamination is inseparable from preexisting historical and political factors, as in the cases of northwest England (Wynne 1992), Soviet Ukraine (Petryna 2013), and Kazakhstan (Stawkowski 2016). In the region of northeastern Japan, bureaucrats in the Japanese Ministry of International Trade and Industry had long developed economic policies that rewarded collaboration with the nuclear utilities by presenting nuclear power plants as a way of saving the rural lifestyle of depopulated, economically depressed villages (Kainuma 2011). It was precisely the "third rate" peripheral regions, like Fukushima Prefecture, that were given the role of producing energy for the main metropolitan centers like Tokyo (Allison 2013). This created an asymmetrical relationship between rural and urban spaces, one that was not merely economic but informational (Yamashita 2012). The resources that

Suetsugi citizens had for resisting the state's management of radiation hazards were thus initially constrained.

When I first visited the Suetsugi network, five years had passed since the official evacuation of the town on April 22, 2011. When the evacuation order was lifted, one month later, citizens were left with two options: come back to Suetsugi or voluntarily evacuate. But because the livelihoods of this poor rural area were heavily tied to food production, long-term evacuation was not a viable option for many residents. As a former resident from Fukushima explained to me, "All the rich have left Fukushima. It's easy to do so if you have money, but for the poor it's not the same."

Moreover, in contrast to technology-rich metropolitan areas, citizens of Suetsugi had no access to preexisting information centers with radiation-monitoring devices, such as those maintained by antinuclear organizations, consumer activists (Sternsdorff-Cisterna 2015), or hacker science (Hemmi and Graham 2014). The only information available was state-sponsored monitoring data. But as Kimiko argued, "These measurements didn't mean much to us. What was a high or low level of exposure? This was very ambiguous." Returnees were thus concerned about the adverse health effects of radiation exposure, especially after the increased threshold for radiation exposure. As Kimiko explained, the departure of the first government nuclear adviser, Toshiso Kosako, who resigned in protest of the state's policies of 20 mSv per year, amplified citizens' anxieties.

Feeling abandoned by state experts, Kimiko invited academic experts to Suetsugi to gain general knowledge about radiation, but academics were unable to answer fundamental questions like Can I eat the food produced in my garden? Kimiko therefore began to educate herself on the internet, and she eventually reached out to Ethos, taken in by its culture of radiation protection and the concrete steps it provided to improve the living conditions of nuclear victims. With the initial help of Ethos, the residents of Suetsugi created their own independent citizen science network, where, as Kimiko put it, "radiation was no longer taboo" and "people could talk about radiation with a smile!" This was an environment that the state had failed to provide, according to Kimiko. While Ethos did not provide monitoring devices, it gave them something that a poor and depopulated rural region did not have: visibility. The association with Ethos enabled the Suetsugi network to raise funds for radiation-monitoring materials, while pressuring the regional government district to provide dosimeters to the citizens.

It was therefore citizens' ongoing feeling of abandonment by their own state, coupled with the perceived inefficacy of academic experts, that forced them to collaborate with this nuclear-affiliated NGO and to mobilize resistance against the uncertainty brought about by radioactive contamination. Connecting with Ethos made sense given that residents had few choices regarding postdisaster recovery. In this context of neoliberal precarity, the only option available was to monitor the radiation. "It can't be helped [*shikata ga nai*]," as one member said.

When questioned about the ethics of collaborating with Ethos, Kimiko told me that being pro- or antinuclear is not relevant to the network. "It's not linked to our reality or our lived experience," she said. "We might be receiving different experts, but in the end it is the individuals who make their choices." Still, processes of collaboration are never symmetrical, and collaborators can initially have different agendas for working together (Tsing 2005). While the citizens of Suetsugi are looking to regain a sense of control over their lives, Ethos has vested interests in collaborating with the nuclear victims.

Since Ethos is associated with the International Commission on Radiological Protection, it promoted an exposure philosophy called "as low as reasonably achievable" (ALARA) to the citizens of Suetsugi. This philosophy is based on a cost-benefit calculus that manages radiation exposure as an unfortunate yet necessary part of modern life. Yet, ALARA is a neoliberal concession to economic and political imperatives, one that minimizes issues of chronic low-dose exposure and brings benefits to nuclear lobbies (Cram 2016; Hecht 2012, 44). Consequently, the epistemic collaboration that Ethos maintained with the Suetsugi network has led to questionable interpretations of this calculus.

This was made evident during the Suetsugi network's quarterly meetings for returned citizens. While attending one of these meetings in 2016, I noticed that members wore dosimeters to measure their cumulative dose of external radiation. The dosimeter data were compiled electronically so that citizens could follow their exposure histories. The citizens involved in the Suetsugi network argued to me that their doses of external radiation were low because they were not much different from what is present in other parts of the world; they interpreted this as a sign that it was safe "enough" to pursue their lives in Fukushima.

Beyond monitoring external doses of radiation, the Suetsugi network also tested food. During one meeting, I witnessed an elderly man present shiitake mushrooms from the forest (see Figure 4). "What is it? What is it?" asked one member's child. "Some mushrooms," replied the organizer. "We'll test them for radiation—but don't touch them before that, OK?" The mushrooms were sliced and put in a blender. "I want to press the button!" exclaimed one child. The resulting brown paste was then put into a device that measures radioactive contamination in food, and the children bounced excitedly, shouting, "Not yet? Not yet?" (*Mada*, *mada*). Many members of the Suetsugi network argued that Japan's current radiation threshold for food—100 becquerels per kilogram—was the strictest in the world, and that tested foodstuffs often fell below this threshold.[5]

Yet the average amount of radioactive cesium present in food before the disaster was near nonexistent. Rice, for

Figure 4. Forest mushrooms being tested for radioactive cesium by a citizen science network, in Suetsugi, Japan, in 2016. [This figure appears in color in the online issue]

example, had an average measure of 0.012 becquerels per kilogram (Nihon Bunseki Sentā 2008). Thus, Japan's limit of allowable becquerels—which takes into account *only* cesium—is an important increase in comparison to the level of cesium that people previously ingested. Some experts stated that this increased ingestion presents a risk of adverse health effects (Kodama 2011; Yagasaki 2016).

Through its philosophy of exposure, Ethos also promoted a specific understanding of recovery that minimizes long-term evacuation. Indeed, the agenda for postdisaster recovery lies in tracking and measuring radioactivity in an attempt to lower people's exposure through ALARA. It is therefore no surprise that the government, keen to resettle the population in Fukushima, quickly began to embrace the work of Ethos and the Suetsugi citizen science network.

Indeed, in 2015, the Suetsugi network was invited to become part of a system of consultation in the Japanese government, and Kimiko began to give talks about their tracking and monitoring activities during state-sponsored symposia. This ultimately led the Suetsugi network to receive government funding, allowing them to pursue their work without seeking donations. Such a case is not unique to Suetsugi, given that the Japanese state and international pronuclear lobby are incorporating forms of citizen science into their agenda. For instance, the Tokyo network was invited to the 2016 Nuclear Industry Summit to discuss solutions for a safe nuclear future; in 2015 the group gained recognition from the International Atomic Energy Agency (IAEA) for its DIY Geiger counter (importantly, the IAEA's main aim is to convince the population that the radiation risks posed by the nuclear industrial complex are low, necessary, and acceptable).

This collaboration is an important departure from the traditional expert-led management model adopted in postdisaster Japan, whose nuclear experts initially attempted to educate a population that knew little about radiation harm (Shirabe, Fassert, and Hasegawa 2015). Amid a crisis of expertise, in which citizens were wary of institutional experts, citizen science networks provided the state an opportunity to bypass traditional forms of governance so that citizens themselves would engineer the normalization of Japan's radioactive thresholds. Recognizing such monitoring capacities is a means of shifting some of the state's responsibility for ensuring safe living conditions onto the shoulders of citizen scientists.

This was made evident in the Suetsugi network, whose members often blamed themselves ("I shouldn't have eaten those mushrooms"). While monitoring practices lower overall risk exposure, they deter people from perceiving themselves as victims of state policies, such as the increased official radiation threshold, and they reduce the liability of corporate polluters like Tokyo Electric Power Company (TEPCO), the former owner of the Fukushima power plant. As one mother who initially fled from Suetsugi told me, "I was angry at everything. I felt so much rage and hate toward TEPCO. But I don't think about TEPCO anymore. It's just a waste of energy."

In the end, the Suetsugi network members' views on the normalization of radioactive contamination were not as optimistic as those of the Japanese state and Ethos. When questioned about the safety of Suetsugi, Kimiko answered, "I think there are risks, even if some old people don't think so or don't care about [them]." Here, members were attempting to establish their home as safe enough. Yet, in light of the neoliberal sense of self-responsibility, this version of "enough" is heavily tainted by Ethos's pronuclear rhetoric. This not only replicates a normative vision of radiation risk and recovery but also promotes an increased normalization of risk in which self-responsible citizens take care of themselves. The irony of this conflictual collaboration is that preexisting neoliberal factors have forced the citizens in the Suetsugi network to collaborate with doubtful actors, a collaboration that ultimately reinforces and expands the neoliberalization of citizen science.

"It would have still been in my head . . ."

A foul odor greets all who walk in the door of the Iwaki citizen center. It is the smell of various foods waiting to be tested for contamination in the center's Food Radiation Screening System. The center's director, Naomi, was a housewife before the disaster; now she runs one of the most high-tech citizen science centers in Fukushima. Before the center's creation, Naomi was constantly hearing the same complaints from neighbors: "I don't know what's safe for my children to eat" and "Is it safe to live here?" In her mind, the government did not do much to alleviate the anxieties of Iwaki city residents:

Figure 5. An automated radiation monitoring post in Fukushima city, Japan, in 2016. [This figure appears in color in the online issue]

> The initial response was from municipalities, which are underprepared and unequipped to properly calculate radiation levels. Many only calculate radiation levels in terms of city averages or what is present in the air. And the official maps overlook a lot. They don't show hot spots [areas where the levels of radiation are significantly higher] or the range of radiation levels in a city. For example, levels might be very low on the right side of a road, but the left side can be a completely different story!

Indeed, in the aftermath of the disaster, the government installed monitoring posts that display atmospheric levels of radiation on an electronic board, allowing citizens to gauge the risk of exposure (see Figure 5). But because residual radioactivity accumulates in ditches, drainages, and playgrounds, results near the ground are often higher than what the posts detect. Consequently, many citizens were concerned that children would be more exposed, especially since they are closer to the ground and tend to put things in their mouths. Soil samples tested by their network later revealed extremely high amounts of radioactivity in the ground, going as high as 1 million becquerels per kilogram when the standard for radioactive waste (*anzen ni sairiyō dekiru kijun*) is set at 8,000.

According to Naomi, these insufficient bureaucratic responses hastened the need for a citizen science network in Iwaki. "It just came naturally, as something that we had to do!" she told me. The center was initially created as a stopgap measure to fill voids in government oversights. Echoing cases in which citizen scientists work as governmental watchdogs (Ottinger 2010a), the network began by demanding an administrative response whenever the network's data indicated a significant threat to local citizens.

Yet, as Naomi noted, this did not work as planned. "Initially," she said, "we conducted some tests and contacted the municipality, but they didn't pass on the results we gave them." So, in addition to unsuccessfully attempting to get the state to conduct more thorough monitoring, the Iwaki network became primarily focused on using its data to help local residents become more aware of risks of exposure to elevated radiation. As Naomi emphasized, "We want to know for ourselves [*jibun de shiru*] [. . .] to help people have safer and more comfortable daily lives." Now the center offers many services in that regard, such as a whole-body counter to measure internal levels of contamination (cesium-137 and cesium-134), thyroid cancer testing (iodine-131), and food contamination screening. The latter, in particular, has kept them busy.

Currently, the state guarantees the safety of market products, but the food people bring to the Iwaki network comes from forests, home gardens, and the like—and the center's food testing has revealed an extreme range of radiation levels. Chestnuts, mushrooms, and honey have high radiation levels that often exceed the allowable becquerels for food. Likewise, the Iwaki network explains how vacuum cleaners and air-conditioning filters bear high levels of contamination, forcing residents to rethink their relationships with everyday objects. Indeed, many citizens are reluctant to turn on their air-conditioning (used for both heating and cooling in Japan), knowing that doing so puts them at greater risk of exposure.

Gradually, through its technoscientific practices, the Iwaki network produced data that contradicted the narrative of radiological safety that underlies the government's resettlement policy. Although Naomi gathered worrisome information and argued that it was not normal that untrained citizens should be exposed to the same maximum annual dose allowed for radiation workers (20 mSv per year), she never took legal action on behalf of residents. This sharply contrasts with Ukraine's "biological citizens," who after the Chernobyl disaster used scientific expertise as a key resource in litigation practices that marked the politics of victimization in their recovery (Petryna 2013).

Nonstate actors attempting to build populist alternatives to state power sometimes reproduce certain categories and hierarchies of state political culture in pursuing their own political agendas (Tsing 2005, 250–51). A similar but slightly different process happened with the Iwaki network, as specific visions of social obligation and recovery led them to share common ground with the state's attempt to reinstate life in Fukushima—even when the citizen science data ironically demonstrate a significant amount of contamination. This constitutes the final root of conflictual collaboration.

Indeed, in the case of Iwaki the consumption of citizen-generated data is embedded in a network of social

relationships and cultural identities that promote a specific vision of social recovery—a vision that works with the state's attempt to normalize the disaster. As in the Suetsugi network, anxiety about health hazards was only one of the many problems facing Iwaki residents. Families became fragmented (*bara bara*), social ties (*ningen kankei*) were severed, and rural traditions that typically brought neighbors together disappeared after community members evacuated. Some Iwaki residents had been producing their own food for more than 40 years before the disaster. "After Fukushima, this was no longer possible," explained Naomi. "The culture of food exchange, giving and taking [*yaritori*], was slowly dying." Through their network practices, however, trust is slowly being rebuilt, and people are beginning to partake in *yaritori* again.

The data collected by the Iwaki network, therefore, amount to more than technical knowledge. They are part of the ties keeping this community together and reveal the experiences of the center's patrons. As Naomi put it, "We see the people who come to our center, we meet them, we listen to their problems. Then we go out into the field and take samples." By being so socially meaningful, the center's data contrast with what Naomi calls *gariben*—ivory tower experts who produce paper-based evidence.

In the members' view, data used for political purposes would result in an even more fragmented community of people who were bound to remain in Iwaki either by circumstance (as in Suetsugi) or, perhaps more compellingly in this case, by social consideration. For instance, a technical member of the Iwaki network explained that using data on food contamination for radical action risks hampering the economic recovery of the farmers living in the region.

Similarly, when asked if she had ever considered evacuating for good, Naomi replied, "Of course, but you can't really escape. Even if I had moved to another country, it would have still been in my head." The proclivity of Japanese normative models are apparent in Naomi's discourse. These models emphasized harmony (*wa*) and groupism (*shūdan shugi*) as ideal cultural values, according to which citizens are expected to stick with their group in times of hardship, to remain attached to their native village (*furusato*), and to uphold the kinship obligations of their household (*ie*).

Still, according to Naomi, there are two Japans: that of individuals (*kojin*) and that of the state (*kokka*). And despite apparent differences of views on radiation protection, there is a strong consensus that Fukushima's citizens wish to live there for the long term rather than be evacuated. As a result, official views about recovery go unchallenged. The Iwaki network's vision, meanwhile, falls squarely within the state's postdisaster governance, which focuses on the revitalization (*fukkō*) of life in Fukushima. In contrast to other citizen science networks, the Iwaki organization is not a "hand-in-hand" partnership between state experts and laypeople, but its vision of social obligation undermines discussion of people's right to refuse to live in irradiated areas—the main concern of voluntary evacuees. Rather than inviting thinking about how the existing social order might be transformed, the Iwaki network mobilizes its data to help residents feel comfortable in their increasingly normalized environment.

Therefore, the network does not just align with the result of state policies but reproduces structured social inequality within the state by reinforcing a narrative of nonevacuation. This is made more salient when considering that financial supports for voluntary evacuees ended in March 2017. This policy leaves voluntary evacuees with few choices but to return to Fukushima. As a technical adviser employed by the Ministry of the Environment explained to me in 2016, "We don't believe that there is health risk, so there is no need for financial support." While citizen scientists like the Iwaki network produced data that clearly show high levels of contamination, they are reluctant to demand evacuation, since they work above all to reduce social fractures.

For former evacuees to return to Fukushima with some peace of mind, many will have to engage in citizen science practices of monitoring and testing, just like those emphasized by the Tokyo, Suetsugi, and Iwaki networks. This is particularly essential in mountain and forest areas that are not part of the state-sponsored monitoring and decontamination policy, notably because of the elevated risk of landslides. When I asked a Ministry of the Environment technical adviser about the surrounding areas' risk of exposure, he optimistically pointed to the work of citizen scientists. "Well," he said, "there won't be any additional dose if people don't enter those areas. If they do enter, at least they can measure the levels by themselves. They have the [technical] means to do so."

Nonetheless, for many evacuees, the practices of citizen science are not synonymous with recovery per se. In the prefecture of Nagano, I interviewed voluntary evacuees from Fukushima who explained that mushroom picking or mountain hiking were parts of the rural imaginary in their former lives in Fukushima. For these evacuees, Fukushima is now a place where citizens—not the state—are responsible for their radiological protection. Their former native land was not a place where children need to build Geiger counters and test food for radioactivity. Moreover, for many Japanese mothers who were concerned by the effects of chronic low-dose exposure on their children, recovery meant permanent evacuation, not the revitalization of the rural economy (Polleri 2018).

In the end, the Iwaki network is another instance in which the deployment of citizen science data evolves in collaboration with the state's vision—not in opposition to

it. And while the Iwaki network does not reproduce forms of ignorance as do other citizen science organizations, it holds a vision of revitalization similar to the state's, excluding other social perspectives on recovery.

Smiling in the face of disaster

To varying degrees, citizen science networks' initial practices have clashed with the official management of the Fukushima nuclear disaster. Yet this conflict does not obstruct broader forms of collaboration with the same actors that, ironically, attracted these groups' frustrations in the first place. This relationship is what I have called conflictual collaboration. While citizen science is a form of politics that can legitimize alternative views to the state, it also reinforces a certain state- or industry-sanctioned governance of this disaster.

Citizen science and official science are thus not antithetical. But when nonstate actors claim an expertise once monopolized by state agencies, there are inherent political complexities involved, in Japan and throughout the world (Gururani and Vandergeest 2014). In general, conflictual collaboration—being removed from the dual pole of governmentality or the practices of politics—demonstrates that while some citizen scientists can engage in political contestation, their work risks becoming part of the techniques of neoliberal governmentality designed to govern the conduct of populations amid a contaminated environment.

In Fukushima the political stakes of citizen science are evolving beyond spaces of contestation that fall outside the formal scope of politics or that become ideological loci of resistance in a limited context of political radicalism. Anthropologists are well placed to study the sociocultural factors in which citizen science reinforces the power of nation-states and corporate polluters, leading to further social injustices and a greater lack of accountability. Ultimately, this bears on the question of the different roles that nonstate actors play in the governance of environmental issues. In the case of Fukushima, it is doubtful that citizen science will place responsibility back onto the public-private institutions, nor will it transcend its apolitical stance and demand the right to evacuation on behalf of Fukushima's residents.

Yet there is potential for fruitful collaborations between state and nonstate actors as citizen scientists merge their local knowledge with the state's resources. This, however, raises a set of complicated ethical questions: To what degree does citizens' participation put them at risk of adverse health effects? What are the rights of those who refuse to be part of such projects? And how can they collaborate with the state without reinforcing neoliberal models of governance that burden citizens with the responsibilities of environmental protection? These questions will drive important political debates, but the overall picture of Fukushima remains bleak. Throughout my fieldwork, I've seen children wearing dosimeters pinned to their jackets, as one would do with a piece of jewelry.

Burned into my memory is the following scene: children smiling with pure delight and playing with monitoring devices as if they were precious toys. In the end, what will be the legacy of citizen science?

Notes

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1. All personal names used in this article are pseudonyms except those of public figures.
2. The sievert (Sv) measures radiation's health effect on the human body. Radiological safety standards also use smaller increments like the millisievert (mSv) and the microsievert (μSv), where 1,000 mSv equal one Sv and 1,000 μSv equal one mSv. In addition to the *amount* of radiation (dose), the *rate* at which a dose is delivered, such as microsieverts per hour (μSv/hour), is significant. In 2010 the normal background radiation level in Fukushima Prefecture oscillated from 0.02 to 0.13 μSv/hour (Fukushima Prefecture, n.d.). Thirteen μSv/hour represents an increase in radiation levels attributable to the release of radioactive elements from the nuclear disaster.
3. I conducted fieldwork in Japan from September 2015 to August 2016, with follow-up trips from November 2016 to May 2017. I spent time in state-sponsored symposia, citizen science organizations, temporary evacuee housing, and contaminated farms, among other places, while conducting more than 70 semistructured interviews with citizen scientists, state officials, and voluntary evacuees. I translated all interview excerpts in this article.
4. Ionizing radiation is divided into different types: alpha particles, beta particles, and gamma rays, each having a different capacity to penetrate and damage living tissue.
5. A becquerel (Bq) represents the amount of radioactivity released by the decay of radioactive material per second.

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