

# Radioactive Mosquito Bite and Its Surreal Life

## Science, the State, and the Invisible

RYO MORIMOTO

### Science as Disaster

As of October 2022, over fifty-seven thousand residents are living in Minamisōma, Fukushima Prefecture—ten to thirty-four kilometers away from the crippled nuclear power plant—against the odds and despite the risk of radiological exposure catalyzed by the 2011 Great East Japan earthquake, tsunami, and nuclear accident. Over the last decade, scientific uncertainties surrounding radiation’s harmful effects on human biology and ensuing social and political fissures have challenged people’s trust in science and the state, and the lay public’s confidence in their perceptions of risk and the world. Their apprehension concerning low-dose radiation exposure has persisted despite (or as the direct consequences of) the state and the nuclear industry’s persistent efforts to use scientific reasoning to objectify radiation and contain the fear of the invisible threat as a knowable, avoidable, or compensable risk.

As a result of using coastal Fukushima as a real-life laboratory, the science of low-dose radiation has become more sophisticated over time. Nonetheless, a 2021 national survey of 4,200 Japanese citizens by the Ministry of the Environment shows that more than 45 percent of Japanese outside Fukushima believe in adverse intergenerational hereditary consequences of the Tokyo Electric Power Company (TEPCO) accident compared to around 27 percent of Fukushima residents.<sup>1</sup> The survey results indicate how the state and the nuclear industry have failed to regain the trust of the residents and the broader public and mediate their divide using scientific facts.

Gregory Button (2010: 179) discusses the role science plays in producing uncertainty in the wake of industrial, environmental contamination. “Like all other dis-

1. An abridged version of the survey result in Japanese can be accessed at [web.archive.org/web/20220608234031/https://www.env.go.jp/chemi/rhm/portal/communicate/result/](http://web.archive.org/web/20220608234031/https://www.env.go.jp/chemi/rhm/portal/communicate/result/).

ciplines,” he writes, “science is more than politics, but it cannot evade the ideological currents in our culture any more than other sectors of society.” Locally, a Minamisōma resident once expressed her growing mistrust of what was presented to her as science this way: “If scientific uncertainty led to social anxiety, wouldn’t scientists be accountable for causing a social disaster? People talked about how the TEPCO nuclear accident was a human-made disaster [*jinsai*]. I would include science as a part of this *jinsai*.”

In this article, I approach the last decade of postfallout coastal Fukushima not just as a region-specific concern nor a nuclear catastrophe. While even a globally shared invisible threat like the COVID-19 virus causes dissimilar damage to differently organized societies, our collective experience of the global pandemic since March 2020 shows an uncanny resemblance to the diverse and atomized experiences in postfallout coastal Fukushima. Nuclear or viral, it seems hazards that are not immediately visible lead to a struggle of interpretations in society. When encountering invisible threats like COVID-19, questions arise: Do I need to wear a mask? If so, when, where, for how long, and what kind? Who is more vulnerable, and who can resume “normal” life? How can I relate to others or accept their subjective experience when their risk perception radically differs from mine? What might be the long-term consequences of the virus even for those of us it does not kill?

Those are strikingly similar to coastal Fukushima residents’ questions upon confronting the TEPCO accident in 2011. Since then, they have experienced the surreal social life of radiation, in which the collective imagination of the invisible risk walked around independent of their lived experience of radiation and, at times, spoke louder than the growing body of empirical data. Over fifty years ago, while researching industrial disasters like Minamata disease in the 1970s, the Japanese environmental scientist Jun Ui ([1971] 2006) identified the effects of the invisible on society—rumors, discrimination, and misinformation—as the extrascientific, “surreal” dimension of environmental disaster.

Dr. Masaharu Tsubokura faced the inseparability of science from politics, facts from judgments, and “real” from “surreal” in postfallout coastal Fukushima. In particular, the nuclear accident challenged him as a medical expert to communicate the emerging empirical data concerning the risk (or the lack thereof) of low-dose radiation exposure without denying someone’s subjective reality.

What happens when science and the state try to render radiation as a single, purely objective technoscientific reality independent of any social, cultural, political, historical, and economic contexts of those living with radiation? This article revisits Dr. Tsubokura’s struggles to consider the role of science and the state in addressing the more than objective, surreal life of invisible hazards in society. Fol-

lowing Ui, I will employ the analytics of the surreal to capture the incommensurable divide produced between science and people's diverse perceptions of invisible radiation. In so doing, I highlight how the technoscience of radiation and the state's use of it to contain its citizens' fear produced further uncertainty among them and invalidated their personal, social, and political suffering, which is not empirically falsifiable. I will conclude by suggesting the role of social science as a critical stakeholder in addressing the surreal to mediate between science and the lay public, the state and the citizen, and risk and life.

## Radioactive Mosquitoes of Minamisōma

On April 16, 2011, a group of residents started the local radio station Hibari FM in Minamisōma. Initially a hub for providing postdisaster recovery information to the region's remaining residents, the FM station evolved into a communication platform for combating locally specific issues in postfallout life. Until its termination on March 25, 2018, Hibari FM grappled with the lingering and shape-shifting effects of the TEPCO accident on residents in coastal Fukushima. In particular, the station worked toward a necessary dialogue among the divided local communities, corroded by the accident and the ensuing ad-hoc policy interventions. This resident-initiated effort reflected the slogan the city named in December 2011 as the goal of its revitalization plan: "All hearts united for the rebirth of Minamisōma."

One of the popular programs Hibari FM hosted between 2012 and 2013 was *I, Tsubokura, Will Answer Your Concerns*. The premise of the program was the following: Dr. Masaharu Tsubokura, a specialist in hematology and researcher of radiation health, communicated empirically grounded information about radiation exposure to concerned residents. Through this platform for expert-resident dialogue, Dr. Tsubokura received questions from anonymous local listeners. Some questions he received over the show's twenty-five episodes include the potential effects of external exposure and radiation exposure through food intake. Listeners also sought advice on how much longer to wear a mask, and who should be more concerned about exposure. This radio program captures questions and concerns the residents had on their minds between 2012 and 2013, which they otherwise struggled to communicate publicly because of differences in individual risk perception, rapidly changing scientific facts, and unstable state policies.

In the sixth episode, aired in the summer of 2012, Dr. Tsubokura received a surreal question that his scientific expertise could not fully address. The host, Konno, prepared to read the question, as he always did, on behalf of the listeners, describing it as intriguing. Then he read, "Is it the case that we take radioisotopes in the body

from mosquito bites?” The question seemed to indicate the listener’s concern about radiation and its potential pathway to expose the human body. Konno continued,

Mosquitoes tend to hatch eggs in the bottom of ponds or puddles where radioisotopes are known to be highly concentrated. That’s the kind of environment where mosquitoes grow, and in the process, they probably absorb lots of radioisotopes inside their bodies. Therefore, mosquitoes must be highly radioactive. I wonder if radioisotopes would get transferred intravenously, and we would get contaminated with a poison they leave in the body when those radioactive mosquitoes bite. Would mosquitoes this year be safe?

As Konno finished reading the question, Dr. Tsubokura nervously laughed, signaling that he had not thought of mosquitoes as a radiological agent. He was new to the field, having begun researching various effects of low-dose radiation only after the accident. Unlike Dr. Tsubokura, residents imagined probable crossroads between radioisotopes and their everyday lives. A mosquito bite was one of them, especially in a city where forest, rice fields, and farms cover over 70 percent of its land. What background knowledge about radiation exposure allowed this local listener to imagine a mosquito dilemma when a medical expert had not?

From the beginning of his program, Dr. Tsubokura was particularly keen on educating the listeners about the scientific distinction between external and internal exposure. In Japan, there is a tendency to generalize all radiation exposure as one cultural-historical category of *Hibaku*—the violent, dehumanizing, and irreversible form of suffering—exemplified by the atomic bomb victims of Hiroshima and Nagasaki. External exposure occurs when radioactive materials in the vicinity emit different types of ionizing radiation (alpha, beta, gamma, and neutrons), and individuals are exposed to them. The body is also subject to external exposure medically, such as during a CT scan and dental X-rays. In contrast, internal exposure occurs when individuals inhale or ingest radioactive particles inside their bodies. Some examples include inhaling radon in air and ingesting radioactive materials from contaminated foods.

The heart of the mosquito riddle touched on the gray zone between what is external (a mosquito) and internal (the human body) and the permeability and transferability of radioisotopes in everyday life. By mid-2012, the primary concern of the local listeners had become not just the presence of radioisotopes in the environment, easily detected by technoscientific instruments like a dosimeter and Geiger counter and constantly visualized by various radiation monitoring posts installed by the state in the region. Instead, they were concerned about the possible pathways

through which haphazardly spread fallout residue in their living environment could enter their bodies. Mosquitoes were one such potential local agent.

During the radio show, Dr. Tsubokura struggled to solve the mosquito puzzle and offered a scientific answer. He emphasized how small a mosquito is and how each bite could inject only a trivial amount of (radioactive) poison into the body. Even if it is highly contaminated, he concluded, there was no reason to worry about mosquito bites causing significant internal exposure. More important, he argued that being bitten repeatedly might raise other health-related risks, like a viral infection. The assurance that radiation is only one of many risks we face in life was Dr. Tsubokura's consistent expert advice throughout the program.

According to the global medical community, an exposure event higher than 700 mSv (millisievert =  $10^{-3}$ ) or more is known to cause acute radiation sickness. In these instances, individuals irradiated with a high dose of radiation experience severe symptoms, such as loss of hair, skin problems, GI issues, and extreme nausea (Hall and Giaccia 2019). In comparison, an exposure of around 10–20 mSv in a discrete event like a CT scan is not immediately detrimental to one's health, although there could be long-term issues, especially if such exposure is repeated in a short period. Nonetheless, the delayed onset of disease makes it difficult, empirically, to determine the causal link between a past exposure event and a present condition. The longer the time between exposure and onset of the disease, the more possible it is that something else, such as other toxicants or unhealthy lifestyle choices, could have propelled its development.

The debate surrounding the increased incidences of thyroid cancer exemplifies the difficulty of determining a causal relationship between radiation exposure and a disease.<sup>2</sup> The medical experts and the lay public have been divided on how to interpret about 287 cases of thyroid cancer among Fukushima's youth.<sup>3</sup> The national and international medical communities alike have pointed out the possibility of "screening bias" as the factor accounting for the increased incidences of thyroid cancer in Fukushima rather than the TEPCO accident.

From the residents' perspective, however, the TEPCO accident led to the discovery of cancer that did not exist previously. Therefore, experientially, the experts' scientific reasoning is hard to swallow. While the residents were seeking account-

2. Chernobyl taught the international medical community that a nuclear accident could lead to increased incidence rates of thyroid cancer among youth (Cardis et al. 2006).

3. Since October 2011, the local government has been closely monitoring over three hundred thousand children who resided in Fukushima in March 2011 and were under the age of eighteen at the time of the accident. A collection of research articles on thyroid issues can be found at [web.archive.org/web/20220126140126/http://kenko-kanri.jp/publications/thyroid-examination/](http://web.archive.org/web/20220126140126/http://kenko-kanri.jp/publications/thyroid-examination/).

ability, the experts were concerned about empiricism. The surreal lurked in the gap between the lack of accountability and shifting empirical knowledge, thus complicating the relationship between science, the state, and the invisible. The thyroid debate exemplifies not only the politics surrounding the interpretation of scientific data but also the difficulty in communicating scientific knowledge of radiation, which at times invalidates individual subjective experiences for the sake of the greater logical coherency of facts.

Many residents felt alienated by what Ulrich Beck (1987: 158) calls the “emergency-scientization of everyday life” following the TEPCO accident. Similar to one resident blaming science as a part of the disaster, they experienced the state’s approach to the accident as a technological problem that justified their use of science as a technique of state-sanctioned social control (Carroll 2006). As with other technological disasters, such as the Bhopal accident and the Chernobyl disaster, the state and experts forced residents to accept science’s cryptic terminology as the descriptors of their postfallout lives (Das 2007; Kuchinskaya 2014). In this context, the question of the radioactive mosquitoes was an attempt by a resident to translate science and state policy back into more mundane life experiences.

### **From the Science of Half-Lives to Life Itself**

Dr. Tsubokura arrived in coastal Fukushima one month after the accident.<sup>4</sup> Born in Osaka city and a graduate of Tokyo University Medical School, he had no previous tie to the region. An international phone call he received from his mentor in April 2011 in France, where he was attending a conference, changed his life path. Only after the phone call did Minamisōma become an actual place on his mental map.

After years of commuting to coastal Fukushima from Tokyo, in 2020, he took a professorship at Fukushima University, where he now leads the Department of Radiation Health Management. I first met Dr. Tsubokura in 2013 when he was giving a talk to a temporary housing community in Minamisōma. Despite his outsider status, his commitment to the health and well-being of residents and sustained face-to-face engagements with them gained him their trust, unlike some other experts who crunched numbers from afar. He once explained to me his dedication to coastal Fukushima as a small gesture of bereavement for the suffering experienced by countless people following the TEPCO accident.

From his early exposure to the community in social, political, and technological

4. Denise Normile (2021) wrote a brief biography of Dr. Tsubokura’s last decade of work in Fukushima in *Science*. My account here draws from both my personal interactions with Dr. Tsubokura and Normile’s article.

crises, Dr. Tsubokura learned that medical care in coastal Fukushima required more than expertise in the science of radiation; it required communication of radiation's risks. Against the state's top-down communication strategy, which aimed to normalize low-dose exposure and labeled those who failed to follow the "objective standards" as irrational and neurotic (Kimura 2016), Dr. Tsubokura took a more action-oriented approach. By honoring their individual decisions to stay in the region and their realistic and surreal perspectives on radiation, he suggested that the residents do what they could to reduce their total amount of measurable exposure internally and externally.

For example, he reasoned even if individuals avoided going outside and received less external exposure on average, any carelessness about the food they chose to consume could result in a high amount of internal exposure from ingestion. The radiological threat had an intimate relationship to lifestyle; where one lived and went and what one did and ate each day mattered. Dr. Tsubokura's message was that the residents could effectively avoid unnecessary radiation exposure individually and collectively. More important, the postfallout data revealed that excessive avoidance of radiation by limiting outside activities, avoiding local produces, and living away from one's familiar place could open up individuals to other health risks.

By 2014, Dr. Tsubokura's research with the locals increasingly betrayed both public impressions about the TEPCO accident and the related media and antinuclear discourses. In the rural, aging region, where almost 37 percent of residents are over sixty-five years old, evacuation posed far more significant risks to the health and well-being of evacuees and residents around the evacuation zones than radiation (Tsubokura 2018). The most recent research from 2021 by Dr. Tsubokura's team (Kobashi et al. 2021) suggests that the elderly population who returned to a former evacuation zone required less long-term care than those who remained evacuated.

Dr. Tsubokura's data revealed a fundamental flaw in the state's emergency evacuation policy that initially produced over 160,000 evacuees in Fukushima Prefecture alone. The state policy put the central emphasis on taming the public fear of radiation exposure over residents' sense of well-being. More immediate than radiation's scientifically verifiable effects on individual molecular cells and DNA, the state policy led to the deterioration of the displaced residents' general health, disintegration of the existing social fabric, and public stigmatization of the remaining residents as "the exposed" population.

Although the accumulation of his locally specific empirical data on radiation exposure provided positive news for concerned residents of Minamisōma and elsewhere, Dr. Tsubokura revealed his frustration to me in June 2015. He shared that, unintentionally, his research data had come to tell a narrative that denied the

residents' and evacuees' subjective experiences of anxiety and fear of living with radiation—a story that normalized the TEPCO accident.

Speaking strictly in terms of his professional medical perspective, he lamented, “Many people inside and outside often accuse me of being a pronuclear doctor working for TEPCO and the state because, as a scientist, what I tell people based on the data is this: There is almost no significant radiological risk from the accident for people around the evacuation zones.” His research helped generate local data that validated the possibility of postfallout lives for those who remained at the edges of evacuation zones and challenged the state's ineffective disaster management. However, many people, especially outsiders, received his research findings as evidence supporting the state and corporate efforts to underplay the extent of the accident. For the social life of radiation in society, communication of radiation risks is in constant negotiation with people's risk perception. The expert knowledge, however generalizable it may be, cannot be detached from its receivers, who bring their situated perspectives in their efforts to interpret it.

The medical knowledge of an expert like Dr. Tsubokura was much valued when the residents felt uncertain and scared about the invisible presence of radiation. Once his study gradually visualized the medically negligible intersectionality between the various half-lives of radioisotopes and residents' everyday lives, his expert knowledge became less valuable, even to the point that some people began to devalue it as ideologically skewed. The tension arose, especially as the state started using the local data to revise their returning policy, claiming the accident caused negligible health impacts on the Japanese population.

Dr. Tsubokura's experience offers a view into the limitation of science's role or its disputed authority in communicating an invisible threat. In times of crisis and uncertainty, scientific data are critical. The data produce facts and help inform the public, but the data do not necessarily validate or speak to individuals' subjective experiences. At times, the data might deny these experiences or can be used to invalidate others. Observing the divided social body during the Chernobyl disaster in 1986, Beck (1987: 157) diagnosed science as only capable of offering “probable security.” Should the scientific experts' job be to call out people and correct their “irrational” thinking as surreal if the lay public's concern is about radioactive mosquitoes or honoring their curiosity and interests in radiology? That is not a scientific question, but it has social, political, and moral implications that require other stakeholders like social scientists to participate in the discussion.

One lesson Dr. Tsubokura learned in Minamisōma is that scientists' and authorities' data should be consistent in their efforts to communicate risk in a radiological danger zone. In contrast, the Japanese state and the state-sanctioned experts



kept shifting their stances, changing what was “permissible” or “real” and ultimately deferring the risk assessment to individual residents. Dr. Tsubokura believes that the lack of trust in experts and the state emerged not from lack of transparency but of consistency.

More important, Dr. Tsubokura suggests that risk communication should be done by other actors, like social workers, counselors, community leaders, and other care specialists who can better attend to people’s situated experiences and specific needs and concerns. Similarly, Dr. Sae Ochi (2021: 193), a medical doctor at Jikei University and a part-time physician in Sōma city just north of Minamisōma, observed the broader effects of the TEPCO accident among her patients. “The residents may not think of radiation as science in the first place,” she writes, and when they talk about their concerns, they are talking about “life instead of science.”

Dr. Tsubokura’s struggle to tame the state’s selective attention to radiation exposure with local data and redirect public attention to secondary health issues illustrates the limits of science and the state as the dominant authority of an invisible hazard in society. Ochi, who similarly grappled with risk communication issues, discusses the violence of scientific vindication that “sometimes hurts the victims of a disaster even if they [the experts and the state] do not intend to be paternalistic” (193). Ochi points out that the primary concerns of disaster-affected populations show that “a context-specific rationality among residents” had “a more potent influence on decision-making than epidemiology and statistics” (193). All they need, Ochi argues, is “life communication” that does not quickly dismiss what appears to some as surreal questions—like potential exposure from a radioactive mosquito bite—as unscientific and irrational.

## **Social Science of the Surreal**

The radioactive mosquitoes in Minamisōma that Dr. Tsubokura encountered in the summer of 2012 captured the tension residents experienced between science and the state, between public anticipation and local concerns. In the entanglement of science, politics, and economy in a country with the lingering traumatic histories of radiation exposure in Hiroshima and Nagasaki, Dr. Tsubokura’s research data emerged as a potential threat; his locally specific findings appeared to support the state as well as TEPCO’s efforts to “underplay” the degree and extent of the accident. Such an interpretation is far from accurate. His conclusion was not that “there is no risk from the TEPCO accident” but that “radiation was not the primary health risk among the residents living around the evacuation zones,” for which the state and TEPCO had failed to be accountable.

The TEPCO accident led the state, experts, the media, national and international activists, and the lay public alike to attend to the invisible by making its presence and its relation to humans visible. While this was a necessary response to the unprecedented crisis, the selectively visualized radiation in the region gradually became an obstacle for the residents and evacuees to envision their life after the accident. This discursive and interpretative shift in society from “life itself” to a radiation-centered “half-life” alienated the residents from their lived experience. It rendered the technoscientifically measurable presence or absence of nuclear things invisible to the public the central social, political, and moral project.

Dr. Tsubokura’s struggles with the surreal, extra-scientific dimensions of the TEPCO accident exemplify how selective attention to the invisible fissured the atoms of the community. While Beck (1992) argues that the individualization of risk is the defining characteristic of modern society, what is individualized in postfallout is not the risk but its perception, resulting in the division of the community and culminating in social disintegration (Freudenburg 1997). Experts like Dr. Tsubokura, who tried to expose the locally specific interrelationship between the residents and radioactive materials, became another victim of the surreal, in the discriminating process that follows an environmental disaster.

A mosquito bite might not expose an individual internally or externally, and thus it bears no medical or epidemiological significance. Nonetheless, a bite might expose the individual to other risks. Anxiety and fear arising from the lack of an adequate answer about the bite’s meaning might lead the same individual to seek information on the Internet, in the media, and on social media, where scientific (mis)information and (mis)translations live, go viral, and mutate (Hasegawa et al. 2020; Tsubokura et al. 2018; Valaskivi et al. 2019).

Here is one lesson from the TEPCO accident: a not-immediately-visible risk like low-dose radiation produces shape-shifting science, politics, law, and media. This biomedically driven, exposure-centered approach to visualizing and arresting the shape of such risk delimits individuals’ ability to articulate and share their situated experiences, not only of the risk itself, but also of their overall life.

When confronting an invisible threat in society, social science must participate in the conversation with science and the state to help them address the resulting social disintegration—the atomization of experience, which makes us vulnerable to a totalitarian regime (Arendt [1951] 1973). It is not science and its commitment to objective knowledge but social science and its acknowledgment of the messiness of the human that could attend to the surreal life of invisible risks in society.

Reflecting on the limits of science in containing the surreal, extra-scientific life of radiation, Dr. Tsubokura once commented to me, “Perhaps what the people

want and need after the emergency phase is not the medically grounded knowledge someone like me could offer, but more psychological support to help reduce the stress and the anxiety of living with radiation and its associated negative images.” His remark suggests that the inability of science to offer “explicit guidance about what should or should not be done in daily life” (Leppold, Tanimoto, and Tsubokura 2016: 60) in the face of an invisible threat like radiation contributes to the proliferation of the surreal in society.

With the global pandemic, Dr. Tsubokura’s past challenges seem to repeat themselves even among diverse populations and with greater geographical and cultural reach. The case of radioactive mosquitoes in Minamisōma might appear distanced, unfamiliar, and surreal to the reader. If so, we should all reflect on our experience with the COVID-19 pandemic. Have not science and the state, yet again, been coproducing the surreal in society and allowing it to bite us surreptitiously?

**Ryo Morimoto** is a first-generation college student and scholar from Japan. He is currently an assistant professor of anthropology and Richard Stockton Bicentennial Preceptor at Princeton University and a facilitator of “Nuclear Princeton.” His scholarly work addresses the planetary impacts of our past and present engagements with nuclear things.

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