



“Skin of the Earth”

On Soil, Collaboration, and Temporality after Fukushima

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Abstract This article explores soil and the multiple pathways it has provided for the coconstitution of forms of life that might be possible following the Fukushima nuclear fallout. In Iitate, a former evacuation zone where radiation still lingers, farmers and concerned citizens deploy a coproduction framework that involves experts in making their own science. Incorporating tactile knowledge of the environment, they make life-strengthening claims on the future amid state promises of revival and progress. Soil becomes alive in *madei*, which emerges from the processes of separating radiocesium from topsoil, growing rice, and other improvisations for relating to soils that cascade to regenerate a livable world. This article discusses how the Japanese state utilizes temporal scales that orient its citizenry to a future associated with accelerated and intensified productivity as a sign of progress, incorporating decontamination technologies to assert control over organic lives and inorganic matter to make them productive for humans. Through *madei*, this article addresses how soil guides human attention to the rediscovery of interspecies temporalities, paces, and rhythms, reconfiguring radioactivity to create what I conceptualize as a regenerative time to underscore how actors reanimate the future(s) in the here and now.

Keywords soil, Fukushima, nuclear disaster, multispecies, temporality

Under a blue sky, rice seedlings were flourishing in water drawn from the nearby Mano River. Between the sky and the paddies lies the *satoyama* forest, where Sugiyama had often harvested wood for firewood and foraged for seasonal delicacies like mushrooms and butterbur sprouts.¹ The sun illuminated the rice paddies and the forest, leaving the furrows between them, along which Sugiyama was plowing with his tractor to plant cosmos, his favorite flower, in the shade. Solar panels powering his house were ground-mounted alongside the road where traffic had been gradually increasing. This

1. *Satoyama* is a transitional landscape in rural Japan that typically connects woodlands or forested spaces with land that is inhabitable by humans. See Takeuchi et al., *Satoyama*.



Figure 1. Sugiyama and his paddies in Iitate, 2017. Photograph by the author.

photograph (fig. 1) captures a snapshot of Sugiyama's livelihood in 2017 after the re-opening of Iitate, a village that was once exposed to radiation and where it lingers still.²

This was a landscape, as Elaine Gan and Anna Tsing have suggested, "made with multiple projects, human and non-human." Had the Fukushima nuclear disaster not occurred, Iitate would have been "layered with *satoyama* dreams, mycorrhizal explorations, nematode invasions, autumn matsutake outings, and much more."³ As their narrative implies, the Iitate that I describe here should have belonged to a bygone time. On March 11, 2011, tectonic movements in the earth's core triggered a fifteen-meter tsunami that breached the breakwater at the Fukushima Daiichi Nuclear Power Plant (FDNPP) and flooded the seaside reactors. The power plant operator, Tokyo Electric (TEPCO), had failed to provide backup power to cool down the three reactors, resulting in a series of hydrogen explosions in the days that followed. The radioactive plume joined seasonal

2. Iitate is located in the Abukuma mountain range in Fukushima prefecture, northwest of Fukushima Daiichi Nuclear Power Plant (FDNPP). Three-quarters of the village comprises forested land at an average altitude of 450 meters. It was home to a population of six thousand people who were scattered over 250 square kilometers of mountainous, forested terrain. For subsistence, villagers produced rice, vegetables, and flowers while raising cattle for beef and milk.

3. Gan and Tsing, "How Things Hold," 140.

winds and snow to arrive at Iitate shortly after the first explosion. Radioactive cesium precipitated into Iitate's forests, soils, and villagers' homes and barns.⁴ When the disaster struck, Sugiyama stopped eating wild mushrooms or harvesting new soils from the forest to replenish his rice paddies because he felt uncertain about whether mushrooms or rice grains would draw radiocesium into their metabolisms. They slipped beyond Sugiyama's control in a radioactive landscape.

After electricity was restored on the fourth day, Sugiyama still had no clue about the directional change in the wind that was bringing the radiation plume toward Iitate. Official scientists and ministry bureaucrats parachuted in to warn villagers to remain in their homes. Sugiyama lamented that the scientists were ill-equipped with radiation data to estimate the risks or answer simple questions such as whether his then-ninety-year-old father (we called him Oji-chan which literally means "grandpa") could touch the grass outside. Bureaucrats asserted control by taking heavy-handed actions over the villagers. Within weeks they had ordered Sugiyama's family to evacuate. Ami, Sugiyama's wife, felt depressingly idle in the first summer of evacuation—no housekeeping, sowing, or foraging. "Time is out of joint," as Kim Fortun described the aftermath of the Bhopal disaster.⁵ More worrying for the couple was whether Oji-chan would be able to return home in his lifetime. Indeed, they were racing against the clock to make a future possible at a home that was no longer a given.

In 2017, Sugiyama became the first farmer to restart rice cultivation when most villagers had chosen to leave Iitate. His return was closely tied with the soil and its regenerative capacities. In this article, I focus on Sugiyama's rice paddies to suggest new pathways for the coconstitution of a livable landscape despite the lingering radioactivity. I ask, how are technologies deployed to repair disrupted human-soil relations in the rice paddies? This article addresses how soil directs human attention to a rediscovery of interspecies temporalities, paces, and rhythms among living and nonliving beings, creating what I conceptualize as a regenerative time that diverges a future from that enacted by the biopolitical regime of the state.

Certainly, Sugiyama is not alone. Harada is a soil scientist from Tokyo who assisted in experimenting with new ways of relating to soil immediately after the fallout occurred. Asakura, a retired entrepreneur and an ex-student activist, came to Iitate to seek "something to do" and met Sugiyama and Harada in June 2011. Almost weekly over the next six years, Asakura visited regularly, and Asakura, Sugiyama, and Harada together created a nonprofit organization called Living Together with Fukushima (hereafter LiFu) to organize like-minded people to make Iitate knowable and thus livable. This

4. Radiation released from the meltdown contains more than a hundred human-made radioactive isotopes—strontium, cesium, plutonium, iodine, tritium, and so on—of which only a few can be found in nature. In Iitate, it was mainly cesium-134 and -137, with half-lives of two and thirty years, respectively, that irradiated the landscape unevenly in the initial months following the meltdown. In this article, I use the generic term "radiation" to denote both the radioactive substance and the energy emitted, that is, the source and its effect.

5. Fortun, *Advocacy after Bhopal*.

article is based on uninterrupted ethnographic fieldwork conducted over fourteen months beginning in June 2016. I lived in Iitate after its reopening in April 2017, talking to would-be returnees and those who had already settled in other places and driving around to talk with villagers who were struggling with their new life circumstances shaped by radiation.⁶

My attention was drawn to Sugiyama's farmland because he and LiFu's members did not follow but were ahead of the state's rehabilitation schedule. In contrast, for many environmental activists, Iitate was ruined by "black bags" that store low-level radioactive topsoils and other residues in temporary storage facilities known as *kariokiba* (fig. 2). Invisible radiation and the accompanying toxicity are writ large amid the proliferation of black bags (over two million) and *kariokiba* in Iitate's twenty hamlets, flattening its landscape while soils and farmlands are discarded and abandoned. Iitate has become another contributor to what Gabrielle Hecht calls the "anthropocenic apotheosis of waste."⁷ I began my fieldwork at the height of the production and accumulation of black bags. Nevertheless, I was struck not so much by the trajectory of biopolitical violence that many villagers experienced through their abandonment of farmlands but rather by the persistence of life in Sugiyama's rice paddies. I suggest that, coeval with this slow violence, LiFu has carved out pertinent processes to hold novel technologies, humans, and the damaged ecology together, orienting the future(s) toward alternative material and temporal relations with irradiated soils. This persistence begins with taking soil seriously through practices designed to repair disrupted human-soil relations that LiFu refers to as *madei*.

The word *madei* means "go to any expense, respectfully, but take the time to do something with one's whole heart" in the local vocabulary. *Madei* alludes to a temporal mode of being, complicated by LiFu's practices and methods for relating to soil. In Harada's words, soil is the "skin of the earth" (pers. comm., 2017). Skin, as Michel Serres offers in an important way of understanding, is the interface where "the world and the body touch, defining their common border. Contingency means mutual touching: world and body meet and caress in the skin. . . . The skin intervenes in the things of the world and brings about their mingling."⁸ Soil does not stand before the world as a function of products of geological processes through which life emerges and resources are exploited, managed, and owned for profit-taking; for Harada, as the skin of the earth, soil is reconceived through its "betweenness"—bios and geos, hosts and organisms-in-themselves, natural and engineered—to become the body-environment interface and the source of

6. Most villagers and many interlocutors chose to give up agricultural life altogether; a few, whom I have not included in this article, switched to vegetables and flowers to make a living. Some became activists and collaborated with the antinuclear groups to make claims for justice and compensation from the Japanese state. They represent a different voice from that of my interlocutors who, facing a diverse range of life circumstances, were trying to inhabit the radioactive landscape.

7. Hecht, "Interscalar Vehicles."

8. Serres, *Five Senses*, 97.



Figure 2. Temporary storage facility in litate for black bags of contaminated soil, 2017. Photograph by the author.

relationality.⁹ In this article, I trace how Harada and LiFu mingle science with irradiated soil to form a living whole, remaking science into a practice that goes beyond an objective inquiry into nature.¹⁰

I suggest that, through *madei*, Sugiyama, Harada, and like-minded Japanese citizens articulate and embody multiple temporalities through creative scientific and technological interventions.¹¹ Indeed, the village administration appropriated *madei* to name litate's recovery, which signals a double slowness—being embedded in the rural and urban dyad and following a timeline that permits the Japanese state to come in first to facilitate recovery. As I will show, *madei* has become a concept, an analytic, and a set of relations fabricated through soil, articulating a fine-tuned awareness in the disrupted

9. Lyons, *Vital Decomposition*; see also Krzywoszynska and Marches, “Toward a Relational Materiality of Soils”; Krzywoszynska, “Caring for Soil Life.”

10. Puig de la Bellacasa, “Making Time for Soil”; see also Tsing, *Mushroom*; Kohn, *How Forests Think*.

11. In Adriana Petryna's *Life Exposed*, she coins the notion of “biological citizens” to examine how the survival of Ukrainians who had been exposed to radiation in the Chernobyl accident was compromised in medical institutions where official experts and bureaucrats coproduced knowledge and policies to manipulate a population at risk. In contrast, LiFu's practices have demonstrated that those remaining in litate are not impoverished prey of the state. For the case of Belarus, see also Brown, *Manual for Survival*; Kuchinskaya, *Politics of Invisibility*.

environment that makes radiation reiteratively actionable—it creates regenerative time in soil, through which human collaboration and interspecies coordination overlap at the interface between the human and the nonhuman. I shift the site of inquiry to the microbiome of soil, developing ways of thinking about multispecies livability through soils whose metabolism animates new intimate relations with technologies, reconfiguring radioactivity to embrace multispecies temporalities. I revisit quotidian agricultural life to narrate a biopolitics of time through which an environment for life emerges.

In this article, I follow Harada and LiFu as they engage with time differently through soil. First, I review the role time plays in environmental disasters. I then detail the Japanese state's deployment of a radioactive waste infrastructure alongside other biopolitical technologies to translate radiation risks into what counts as safe in a new normal while varied trajectories of violence are unleashed in Iitate. In the remaining sections, I focus on *madei* to analyze how it offers multispecies pathways for unlearning and negotiating with radiation, reforging interspecies temporalities that are crucial for cultivating rice. I trace the temporal patterns involved in making regenerative time for soil that situates other projects concerning the survivability of Sugiyama's family. My final remarks trace recent developments in Iitate and Japan since I left the field. The COVID-19 pandemic has reminded us again that our survival is characterized by an open-endedness from which we have no escape but through which we coconstitute ourselves materially and symbolically as we navigate a multitude of fallout-like events. In Fukushima, I articulate this open-endedness to raise questions about what needs to happen.

Regenerative Time

Humanities and social science scholars have long reflected on the nature of time in environmental disasters. From the perspective of science and technology studies, Kim Fortun et al. challenge the notion of “disaster time” that confines disaster to a temporally delimited single event that divides disaster operations and practices into four phases, namely, “mitigation, preparedness, response, and recovery.”¹² Instead, they propose an expanded analytical time frame to include more narratives from stakeholders that have been ignored by official and expert accounts while documenting the latency effects of environmental contaminants that such accounts fail to trace scientifically over an extended period of time. Studies of acute disasters such as Bhopal, Chernobyl, and the BP oil spill have also shown that disasters are not characterized by specificities of time and space, or the discreteness of disaster relief, but rather by the perpetual and imperceptible uncertainties produced by disasters that people have to endure in everyday life across many generations.¹³ These studies scrutinize the linear temporality of disaster narratives, running the gamut from the framing of disaster as a chronic, slow

12. Fortun et al., “Researching Disaster.”

13. See Fortun, *Advocacy after Bhopal*; Petryna, *Life Exposed*; Bond, “Governing Disaster.”

process comprised of "environmental degradation and deferred maintenance on technological systems"¹⁴ to the articulation of post-disaster futures through "circular temporality," bringing the reiterative, sometimes messy, nonlinear trajectory of cleanups and decontamination to the fore.¹⁵

The linear model of disaster time makes the fading of disaster to normalcy both the condition and the ongoing goal of expert and policy interventions, with the aim of packaging perpetual uncertainties into acceptable risks. Yet, as Ulrich Beck has observed, risks in late industrial environments cannot be contained "in terms of time and space," nor can their delayed effects be predicted "according to established rules of causality, blame, and liability."¹⁶ Exploring how risk analysis was used to articulate the hazards of radiation and make safety claims in the Chernobyl disaster, Barbara Adam argues that time unfolds on multiple horizons around people and within ecological dynamics "where the entire earth community of living beings is implicated and affected to varying degrees for an open-ended period."¹⁷ Rooted in Western "habits of mind," she argues that linear temporality represents radiation impacts in chains of individual exposure events, utilizing time "in their chronology—their date, duration and order . . . to establish linear causality, abstraction, reduction and reversibility."¹⁸ Time is taken as external and objective by scientists and experts as they study radiation risk as a natural phenomenon. Meanwhile, the open-endedness of disasters like Chernobyl is brought to a close through processes of normalization and naturalization that bind radiation hazards within safety limits measured in finite time durations. Risk calculations based on safety limits introduce a time lag between fallout events and their environmental repercussions, which Joseph Masco highlights as "a major psychosocial achievement of the industrial age, where in the name of commerce or security, consequences are loaded into an uncertain future . . . , making industrialism an ever unfolding temporal as well as physical force."¹⁹ This force requires us to grapple with time as a technique, with which expert knowledge is produced to reorient a post-disaster future secured by state governance and embedded in capital relations.²⁰

In Japan, after the prime minister declared a nuclear emergency, scientists and state bureaucrats at multiple levels mobilized to eradicate unknowns concerning the fallout and compress the multiple temporalities of radiation into time maps, incorporating the linear disaster time model.²¹ For example, within weeks following the meltdown, the unit of measurement for airborne radiation was changed from the Gray (Gy/hr) to the Sievert (Sv/hr) to align the assessment of the health effects of radiation with the human

14. Knowles, "Learning from Disaster?" 777.

15. Kiessling and Maxwell, "Conceptualizing and Capturing Outcomes of Environmental Cleanup."

16. Beck, "World Risk Society as Cosmopolitan Society?," 31.

17. Adam, *Timescapes of Modernity*, 201.

18. Adam, *Timescapes of Modernity*, 200.

19. Masco, "Age of Fallout," 153–54.

20. Bear, "Time as Technique."

21. Tam, "Enlivening Data."

body.²² New standards for measuring the decay of radionuclides in Becquerel (Bq) units were implemented to evaluate radionuclides entering rice, milk, meat, and water from the disrupted ecologies. Becquerel and Sievert are functions of time used to express bodily exposure at hourly, daily, and annual rates. Operating in “empty, homogenous time,”²³ these measurements rework the political stakes of environmental governance in post-disaster Japan. In this article, I turn to soils and examine how the Japanese state has invested in the decontamination of Iitate’s radioactive landscape, asserting human control over the environment to create an economy of anticipation for a clean and safe future.²⁴

Soil has always been a target of state control and manipulation. Brett Walker writes that, throughout the history of Japanese modernization, Fukushima’s soil had been exploited in sericulture and agriculture to support the nation’s expansion in wartime before it was reclaimed to build the first nuclear power plant (FNDPP) to produce electricity for Tokyo urbanites. The nation and the center of its political economy have always come first, and the people and soil in Fukushima have come second.²⁵ Under this ideology, contamination and suffering are ignored, as state bureaucrats pursue what Maria Puig de la Bellacasa characterized as the pace of “the productionist ethos”—“a linear imperative of progress versus fears of regression.”²⁶ Modern productionism has utilized a temporal scale that orients humans to a future associated with accelerated and intensified productivity as a sign of progress, incorporating technoscience to assert control over organic lives and inorganic matter to make them productive for humans. The demise of the safety myth of nuclear power and mistrust of government have, however, given rise to new future-making projects among the citizenry. They deploy a coproduction framework that involves experts in making their own science, incorporating tactile knowledge to understand radiation hazards amid the state promise of revival and progress still powered by nuclear and fossil fuels.²⁷

After Fukushima, the relational force in radiation risk is symbolized in the notion of *shin* (or *kokoro*)—one’s heart.²⁸ *Shin* and skin, through *madei*, are interfaces between the human body and the environment, relating a new kind of temporality to the figure of living soil. Time is not an abstract entity that simply passes but is lived by humans

22. MEXT, “Strengthening of Monitoring.”

23. Benjamin, *Illuminations*, 261.

24. Adams, Murphy, and Clarke, “Anticipation.”

25. Walker, *Toxic Archipelago*; see also Stolz, *Bad Water*.

26. Puig de la Bellacasa, “Making Time for Soil,” 694; see also Tsing, *Mushroom*.

27. For example, see Kimura, *Radiation Brain Moms*; Sternsdorff-Cisterna, *Food Safety after Fukushima*. See also Morita, Blok, and Kimura, “Environmental Infrastructures”; Slater, Morioka, and Danzuka, “Micro-politics of Radiation.”

28. The new coinages *anzen* (safety) and *anshin* (peace of mind) are widely used to mediate concerns with food safety among the citizenry. See Sternsdorff-Cisterna, *Food Safety after Fukushima*. For a discussion of how the heart (*shin/kokoro*) is invoked in Japanese conversations to refer to the importance of the community ideals of cultivating mutually beneficial relationships, see Kirby, *Trouble Natures*.

and nonhumans. As Serres writes, time folds and twists to "make contradiction possible."²⁹ In *madei*, to paraphrase Serres, time percolates through soil.³⁰

Treating radioactivity as both material and relational, Gan and Tsing are shocked but fascinated by the disruptive energy that radiocesium has released to unmake the ecological sociality of forests. They offer a nonverbal way of studying interdependent temporalities in soils, situating the soil microbiome in the biota of landscapes, which serve as "sites of struggle and negotiation among many ways of being."³¹ They propose the idea of interspecies coordination to explore how time holds things together when coordination becomes a "fugue-like play of life" that comprises "temporal rhythms across varied practices that together produce a new capacity or emergence."³² Timing is not about living at a faster or slower pace; rather, it is about weaving lifecycles of both organic lives and inorganic matter into knots to form a timescape that makes historically consequential claims on the future. Indeed, as Tim Ingold notes,³³ temporalizing the (radioactive) landscape means taking temporality as relational in a place and looking for what people do to correspond with other living and nonliving things. To think with Ingold, what *madei* substantiates is the simultaneous processes involved in human relearning to repair ecological relations on a radioactive landscape, in which one makes powerful claims on the future through "doing within undergoing."³⁴

Puig de la Bellacasa rethinks soil as a "living, interdependent community" and proposes the notion of care time that nurtures the maintenance and repair of the "multispecies world" within soils, juxtaposing the technoscientific futurity in which "teleological, progressive, and shiny ideals of innovation" are anchored.³⁵ I extend these concern with the specificity of soil in a somewhat different direction: my goal is to examine how Sugiyama, Harada, and Asakura make what I call regenerative time in conjunction with their own context, that is, when having a future seems impossible and the hope that animates it manifests in the here and now. Regenerative time adds nuances to what it means to take care in productive ways, like Sugiyama, who wants to bring the nuclear disaster to an end to make his father's homecoming possible. Regenerative time is a kind of temporality that denies human control over nature; instead, it stresses the agentic potential of time that enables actors to reanimate the landscape as an environment for life.

Decontamination and Its Discontent

The Chernobyl fallout, Adam argues, has exposed temporal complexities across European societies and the world through its enormity and the expansive half-lives of radionuclides that are inaccessible to human senses. Rather than characterizing time as

29. Serres, *Conversations*, 50.

30. Serres, *Conversations*, 58.

31. Tsing, "Multispecies Ontological Turn?," 248.

32. Gan and Tsing, "How Things Hold," 103. See also Gan, "Timing Rice"; Rose, "Multispecies Knots."

33. Ingold, "Temporality of the Landscape."

34. Ingold, "Toward a New Humanism."

35. Puig de la Bellacasa, "Making Time for Soil," 692, 702, 708.

external and objective, as represented by the clock utilized by modern capitalist states, she addresses time as contextualized and embedded in particular experiences and actions that coalesced radiation to “bring to the fore the networked connectivity of earthly existence.”³⁶ In Fukushima, however, I realized that, through soil, there is a deliberate manipulation of time manifested in the state’s responses, which have involved materially and symbolically separating radiation from the environment to compress the multiple temporalities of radiation into a single time line. The decontamination policies and technoscience of the Japanese state have detemporalized irradiated soils and deescalated the nuclear emergency.

Within weeks after the disaster, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) standardized the scales used to assess radiation. MEXT established a monitoring network and a food-inspection system to track radiocesium using the measures Sievert (Sv) and Becquerel (Bq). Here, Becquerels and Sieverts are exclusively human temporal scales that translate our biological experiences—breathing and eating—as exposure events utilizing a linear temporality to establish chains of causality. For example, the risk that Fukushima’s children could develop thyroid cancer was assessed by reference to radiation exposure in Sieverts in the first weeks of the disaster. The standardization of scales is also a normalizing process through which citizens have developed new intimacies with radiation, the physical and biological half-life of which is rendered visible and legible to state bureaucrats and scientists.³⁷ Maps, charts, and graphs that were widely circulated via social media and official websites reinforced the two scales (Becquerels and Sieverts) to rework the safety limits of radiation as environmental biomonitors and indicators, further empowering ministry officials to issue evacuation orders and make other policy decisions.³⁸

Based on temporal assessments of radiation, Iitate was divided into two zones: one zone, mainly of forests, with unacceptably high radiation, and the other zone with radiation levels that could be reduced to a nationally accepted 1–20 mSv of annual external exposure. The latter zone was expected to be inhabitable by 2017. Farmland was categorized by the amount of radiocesium it contained in Becquerels and decontaminated using excavators to strip topsoil.³⁹ Excavated soil was loaded into the abovementioned black bags and discarded in *kariokiba*. With the new legibility of radiation came an environment that was defensible by the Ministry of Environment (MoE),⁴⁰ where Iitate’s landscape was reconfigured as an object for effective governance following the state’s recovery timeline.

36. Adam, *Timescapes of Modernity*, 204.

37. Weston, *Animate Planet*.

38. Sternsdorff-Cisterna, *Food Safety after Fukushima*; Tam, “Enlivening Data.”

39. Ministry of Environment, *Decontamination Guidelines*.

40. Bond, “Governing Disaster.” According to Bond, large-scale disasters like the BP oil spill open up the disrupted environment as a new frontier of knowledge and technological intervention that aims at rendering uncertainties and disorders legible. Instead of being an obvious place for protection or restoration, the environment emerges as a result of the science of new normal.

Kariokiba space ran out quickly owing to the rapid accumulation of black bags. Officials started to grab farmlands that became known as "temporary temporary storage grounds (*karikariokiba*)" among Iitate villagers—in which the notion of "*karikari*" denotes the linearity of time in cascading form. Many evacuees surrendered their farmland because the topsoil had been replaced with impoverished sand that they called "guest soil" (*kyakudo*). In time, more than two million black bags (one-tenth of the national total) were stored in Iitate. After Iitate reopened in 2017, some black bags were moved to Iitate's no-return zone, Nagadoro, which became what I called the *karikarikiokiba* to depict the indefinite process of land-grabbing for waste storage. Over many decades to come, the Interim Storage Facility (ISF) in the vicinity of the FDNPP at Tomioka and Naraha will eventually be the final resting place of the black bags.⁴¹ Trashing soil like dirt, decontamination has become a geoenvironmental process whereby black bags and *kariokiba* are monumental and indexical to the progress of local recovery and national revival. Measurements of progress are contingent on the productionist accounting of time—faster/slower paces, shorter/longer timelines, and the cost-effectiveness of the timescape—to envision a future. In this waste-production chain, Iitate is designated as a temporary space for discarding what Hecht calls the "temporal excess" of the state.⁴²

Decontamination is a scalar project that engages soils with multiple temporal scales through which Iitate's radioactive environment is reframed as legible. As Hecht argues, scales are not merely measurements but "outcomes of social, cultural, and technological processes."⁴³ Becquerel and Sievert are scales implemented as both political and analytical categories to deescalate the fallout from a crisis to the status of a mere accident, driving the production of black bags and their pervasive display in (*karikari*) *kariokiba*. Their hyper-visibility not only enabled the citizenry to grasp the enormity of the fallout through its parts;⁴⁴ spatially, it enacted new boundaries of safety after the fallout was proclaimed to have been contained exclusively in Fukushima. Fearsome and incomprehensible radiation during the emergency was translated by maps, charts, and statistics in daily news and official reports; in turn, its risks were tracked and assessed in Becquerels and Sieverts as slowly but constantly and unsurprisingly diminishing entities. At the end of the state planner's recovery timeline, "normal life" would resume, in which black bags and *kariokiba* would recede from public attention and time would dissolve into clocks ticking in the background, as before.

41. Ministry of Environment, *Environmental Remediation*.

42. Hecht, "Interscalar Vehicles." In this article, Hecht explores how the deployment of multifarious scales in uranium-mining operations produces biopolitical violence in place-making at Mounana, Gabon. Scales are utilized not only to measure but also to classify, orient, and (dis)empower, always unevenly, certain actors. As a modernizing force, uranium substantiates multiple scalar claims in which many and diverse actors find themselves pressed into service together in the transnational circuits of the uranium trade to make and unmake the scalability of nuclear-powered world(s).

43. Hecht, "Interscalar Vehicles," 111.

44. Carr and Fisher, "Interscaling Awe, De-escalating Disaster."

State bureaucrats, as committed productionists, adopted the same suite of temporal scales to organize their objects of knowledge, anchoring and reorienting themselves to pursue the fastest recovery.⁴⁵ In this linear time line, the scalability of decontamination is premised on the legibility of radiation, which is spatially and aesthetically epitomized in the uniform, transparent, and ordered arrangement of black bags and *kariokiba*.⁴⁶ Moreover, as a promise of progress, decontamination anticipates a future without contamination. Along this vein, Nishimura, the village head, named Iitate's recovery a *madei* process, echoing its first introduction by himself in the late 1980s to brand the then-picturesque village as a "slow life paradise" (pers. comm., 2017); this time followed a time line that let the nation come first. While *madei* carries a nostalgic sense for him, it points to the future(s) for Harada.

Making Actionable Time for Soil

Soil is the skin of the Earth. Compared with an apple, the thickness of this soil is less than the apple's skin. On this soil, life of the Earth is being nurtured, as though it were skin that regulates the environment of the Earth. To protect our beautiful Earth, we have to take care of the soil like what we do every day to our own skin.

—Harada

I found this quote (originally published in 2000) in an autobiographical essay about Harada's research career that was written in 2015. He is hardly the first soil scientist to call the attention of the urbanites and policymakers to the problem of soil degradation.⁴⁷ Yet, when I interviewed Harada in 2017, I noticed that soil has created a new relationality involving himself and other villagers. He said, "Had this nuclear disaster not happened, I would have continued to be a 'normal' academic, whose main duty is to write research papers. . . . However, in my participation in Iitate, I have to go beyond my role as a researcher. I have to ask myself to consider things from the perspective of villagers, to search for their real voice [*honneté*]" (pers. comm., 2017).

This quote hints that Harada could no longer treat soil as a research object after the nuclear disaster. While skin is implicated in a scalar claim about the uniqueness and fragility of soil on the Earth, it inspires Harada with the figure of living soil in exploring a possible future with villagers. Following Serres, I consider Harada's figurative description

45. I am not saying that there were no conflicts of interest among the state bureaucrats. For example, the MEXT and MoE's priorities over economic and environmental governance were fulfilled at the expense of the duties of the Ministry of Agriculture, Forestry, and Fisheries to protect farmers' livelihoods, laid bare in their expression "guest soils" and acts of abandonment.

46. The uniformity and transparency of black bags and *kariokiba* are captured by numerous images taken by drones and MoE's graphic illustrations. James Scott has traced this style of legibility to the rise of scientific forestry in eighteenth-century European states, in which forests were stripped down to maximize timber yield (Scott, *Seeing Like a State*).

47. Lyons, *Vital Decomposition*.

of soils a move from scientific discussion into a conversation about what he feels about soils, alluding to sensory engagements—touching, smelling, tasting, hearing, and seeing—closely getting under the skin.⁴⁸ Through the notion of skin, he places soil on a planetary scale to delineate the geological relationship between soil and earth while intimating the delicate and capacious interface between the geos and bios of soil. Skin also opens up Harada's journey, in which he travels from the deep time—planetary temporality—of soil to interspecies lifetimes and sets foot in making quotidian time for soil a matter of care as a living being. Although Harada adopts the vocabulary of the MoE, *jōsen* (literally translated as "decontamination"), to frame his experiments with removing radiation from Sugiyama's paddies, I take them as a rearrangement rather than a decontamination precisely because he insists that soil cannot be wasted.

Harada's experiments demonstrate a different orientation to innovation because he entangles himself in the more-than-human temporalities in soil. He found at first that villagers would plow farmlands and pastures before winter to turn organic matter into soil, thereby accelerating its decomposition and nutrient cycles while disrupting the growth of weeds. During the harsh winter of Iitate, a thin layer of frozen topsoil formed on the plowed farmlands that could be worked by villagers' hands or backhoes (fig. 3). Scraped topsoil was buried in ditches. After this process, soil samples from farmland showed significantly reduced radiocesium contamination.⁴⁹ Harada proposed that this process could be used instead of MoE's decontamination using excavators, because it produced less radioactive waste and preserved more nutritious soils. Although the MoE's handbook mentioned that preserving fertile topsoil as much as possible was desirable, there was in practice no punishment for or disadvantage in overdoing by the mechanical power of excavators and bulldozers. Harada also said that it was not uncommon among the operators to dig deeper; after all, it was not "wasteful" to stuff black bags with contaminated things. Harada asserted that Iitate's seasonality worked—not in a disastrous way as when the nuclear meltdown occurred—for the removal of radiocesium through the stripping of frozen topsoils.⁵⁰

Soil revealed itself quickly to Harada as an unruly being, owing to its interactions with precipitated radiocesium and organisms inhabiting Iitate. First, radiation reached varying depths in the soil with its irregular spread over time on the uneven surfaces of plowed farmland. In some hamlets, Harada found that radiocesium had penetrated into subsoils. Second, it was difficult to manage the timing for stripping the contaminated but nutritious topsoil to preserve farmland productivity. Worse, the frozen soil on pastures was not hard enough because of its low bulk density. Third, in the summer,

48. Serres, *Five Senses*.

49. The first experiment was conducted during the winter of 2012. Participants were members of LiFu who came mainly from Tokyo.

50. On Sugiyama's farmland, Harada showed that surface radioactivity was reduced by nearly 90 percent (from 1.28μSv/h to 0.16μSv/h), whereas radioactivity in the stripped soil and unfrozen soil of the farmland was measured at 23,760 Bq/kg and 2,670 Bq/kg, respectively. These results showed that Harada's method was as effective as the MoE's decontamination in reducing radioactivity.

Figure 3. Topsoil grazed by hand during the harsh winter in Iitate, January 2012. Photograph by a member of LiFu.



boars and monkeys grazed on the farmlands and pushed radiocesium into deeper layers with their feet; weeds and grasses grew after humans retreated. Interactions between and interdependence within the local biota made the soil more unpredictable and undermined the effectiveness of Harada's scheme. Harada concluded that this scheme would fail to treat other farmlands and paddies as long as living and nonliving beings continued to mingle.

Meanwhile, policymakers in the environmental ministry were pursuing a more hubristic decontamination plan. Racing against the bureaucratic schedule to scrape valuable topsoil into black bags, Harada was perplexed and anxious. After another two months of discussion with Asakura and Sugiyama, they found another pathway to align soil temporalities that Harada later called the "*madei* method" (pers. comm., 2016).

As mentioned, the village administration also used *madei* to brand its plan to recover Iitate from the fallout, which involved large-scale infrastructural investments, such as new highways, shopping malls, a community center, and schools equipped with new gyms and sports grounds. Conversely, Harada turned away from these objects of massive accumulation; his version of *madei* entered the microbiome of soil compounded with radiocesium molecules. It was driven by the situatedness of Iitate's farmers and his decision to go beyond the role of expert that he had previously played. He said, "Had I not come to Iitate, I would never call myself a soil scientist again" (pers. comm., 2017). As such, "soil is the skin of the Earth" should be understood as what Sarah Ahmed called a "sweaty concept,"⁵¹ borne out by "a bodily experience that is trying," as illustrated by Harada's second attempt at removing radiation from Sugiyama's paddies.

After Chernobyl, scientists found that weathered mica, clay minerals in the soil, can bind radiocesium through exchange with potassium retained in clay molecules.

51. Ahmed, *Living a Feminist Life*, 12–13.

Despite being water-soluble, radiocesium bound in clay molecules exhibits a much lower penetrability in soil when it has reached a depth of approximately ten centimeters. To catch these molecules, Harada experimented with letting them "go with the flow" after the soil defrosted in the spring.

Before this experiment, LiFu's members were busied with mapping and analyzing the radioactivity in the ambient environment and radiocesium levels in food samples.⁵² Asakura organized visits to Iitate on a weekly basis, arranging time recursively to form a rhythm that Chloe Ahmann posits as "incrementality," a response to slow violence through "a gradual buildup that sometimes coalesces into something."⁵³ Thus, Asakura was able to swiftly mobilize LiFu's members to join in improvising with the soil in Sugiyama's paddies. They flooded the paddies with river water and then repurposed a manual rotary weeder to agitate the soil surface. Clay molecules were released and remained temporarily on the muddy surface water before sedimentation began, and soil particles were deposited again. This was the fleeting moment on which they seized to facilitate a transition—the muddy water was swept into a drainage ditch with a brush, and following evaporation of the water, the clay molecules with the bound radiocesium would slowly penetrate the soil in the ditch and be trapped at a depth of six to seven centimeters. A clean layer of soil was spread to cover the ditch to prevent weathering or leakage. Harada also installed a Field Monitoring System (FMS) comprised of sensors and a solar-powered data-transmission network, which connected to a mobile app to monitor the movement of radiocesium trapped in the ditch. In the summer of 2012, with the FMS in place, LiFu began the first rice planting in Sugiyama's paddies, where a drastic 80-percent drop in radioactivity was observed.

Much like the interspecies coordination in *satoyama* described by Gan and Tsing, timing is vital as the basis of coordination if organic lives and inorganic matter are to correspond with each other when they offer their temporal cycles and sequences to make Sugiyama's paddies thrive again. In Harada's first attempt, neither the physical nor the biological times in frozen soils coordinated with Iitate's seasonality as he had anticipated. Meanwhile, *madei* involves a mode of coordination that Harada codesigned with the soil in Sugiyama's farmland. Among the beings there, living (rice, boars, monkeys, weeds, forest) and nonliving (cesium, water, mica), that were brought together through *madei*, some were aligned in temporal coherence before the disaster, while others were new or were becoming strange in the post-disaster radioactive landscape. *Madei* has also revealed the complex, sometimes frictional, temporalities and arrangements among humans and beyond within seasonal cycles that further open up the possibility of human agriculture. Otherwise put, through *madei* Sugiyama's everyday life, which the fallout had disrupted, had been partially and tentatively reconnected.

Human disturbances like raking and pollarding are temporal acts that overlap with other interspecies coordination to nourish the emergence of *satoyama*. Indeed, while

52. Tam, "Enlivening Data."

53. Ahmann, "'It's Exhausting,'" 154. On slow violence, see Nixon, *Slow Violence*.

coordination takes time to become enduring, it plays a hidden but more prominent role than human interventions in the resurgence of *satoyama*. In contrast to rakes, the tools used in *madei*—manual family-owned rotary weeders and the FMS brought from other field sites by Harada—have shown that technoscientific intervention of humans remains crucial in tackling the fallout, because humans are responsible for the revitalization of the soil. Weeders and sensors are not shiny but novel technologies Harada brought into trial-and-error experimentation to cultivate relationships that are otherwise incommensurable. Weeders have connected the agitation of soil in river water and drainage of radiocesium bound by clay molecules in a sequence, while the sensors track the movement of radiocesium that has been trapped and remains in the soil of the ditches and farmland. In the previous winter, Harada failed to make the stripping of frozen topsoil work for the rice planting the following summer. That failure tells us something about irradiated soil and its “sweatiness” as the skin of the Earth.

As Alex Nading points out, nuclear power—weaponry and energy—has turned numerous places first into exclusion zones and then into ecological laboratories in which experimental attempts are undertaken to navigate and contain disruptive effects of radiation on people’s homes and more-than-human assemblages. Such attempts are not limited to knowledge production in natural science; they also create experiential spaces to explore new aesthetic practices and moral grammar.⁵⁴

Considering Iitate as an ecological lab and Sugiyama’s rice paddies as an experiential space, I suggest that Harada’s *madei* method has taught him lessons not only technical but also moral when soil is cultivated as though it is as alive as animals and plants. One lesson pertains to collaboration, which has brought human responsibility back in the future-making of post-disaster Fukushima. Ignoring top-down state-imposed restrictions on entering Iitate, Harada met with other citizens and scientists who had persisted with their technostruggles in a radioactive landscape.⁵⁵ In the divergent processes used to single out radiocesium, soil was so overflowing with radiation that it had become too relational, making Harada wonder: “No one knows exactly where the safety limit is . . . to the subtleties involved [in radiation], we have to observe, experiment, and analyze repeatedly; meanwhile, we have to be *careful* [*shinchō*] in making decisions. This is what we call science” (pers. comm., 2017). Irradiated soil made him recognize the limitations of his knowledge of soil engineering and management for productivity.

In a different context, Annelise Riles and Hirokazu Miyazaki observe that financial professionals in Tokyo developed a new kind of collaborative thinking when the failure of market coordination had stripped them of their sense of agency during extreme

54. Nading, “Living in a Toxic World.” Indeed, in laboratories where animals and plants are treated as experimental entities, anthropologists have raised questions about what counts as nature, what counts as life (valuable or killable), and how professionals and experts differentiate their relationships with the research entities from each other. For example, see Sharp, *Animal Ethos*; Chao, “Seed Care.”

55. In *Animate Planet*, Weston coins the notions of technostruggle and techno-intimacy to analyze the use of flexible technologies such as handheld dosimeters that produce new science and knowledge about radiation and help people make decisions that contend with the course of action asserted by the Japanese state.

uncertainties. Riles and Miyazaki differentiate collaboration from coordination, which they consider autonomous and top-down, and notice that the experts have undergone what Miyazaki calls a "retooling,"⁵⁶ through which they reinvigorate expertise and regain agency by suspending top-down discipline in collaborations to become amateurs who "do not lay claim to an instrumental purpose for their work (no matter how skilled or dedicated they may be)."⁵⁷ Similarly, in *madei*, Harada redressed a soil that had become both operational and indeterminate through unlearning the scientific practices that treat soil as an object that he had adopted before the disaster; meanwhile, through new relationalities among villagers, LiFu members, and himself, he relearned his practices alongside the living and nonliving beings in the altered ecologies.

As its etymology suggests, *madei* demands a deliberate engagement with time in practice with one's whole heart.⁵⁸ Through soil, Harada has also learned to cultivate intimate knowledge and interaction in a series of technological interventions that emerged from the rediscovery of interspecies temporalities and rhythms of nonliving beings cascading to regenerate a livable world. In Sugiyama's paddies, Harada deployed sampling devices and monitoring sensors to demarcate operational boundaries that created conditions suitable for planting rice. Harada used Iitate's radioactive soil to relate to people who wanted to correspond with each other through their own retooling. Note that collaboration has its tempos and enmeshes soil in other scales—maps, charts, graphs, and illustrations—that Harada enlisted to tease out the multiplicity of temporalities in soil across living and nonliving beings, telling stories about soil from the planetary to the microbiomic scale. As such, *madei* has added another layer of meaning to the idea of soil as the skin of the Earth: it enables soil to mingle, like the skin that Serres describes, with humans and more-than-humans to explore new pathways of life that are inextricably entangled in multispecies relationalities that are difficult to define objectively.

I am not saying that radiation can be easily overcome. As Tsing notes, it obviated multispecies coordination in *satoyama* forests and unmade anthropocentric times. In Sugiyama's paddies, however, rice is reanimated to open up a temporal field of regenerative capacities in which scientists and citizens learn together to grapple with the vulnerabilities and disruptions that radiate from the fallout. Since 2012, the repetition of rice cultivation rehearsed a pattern that became concrete and enduring, intensifying the motivation (*yaruki*, as Sugiyama puts it) to grow sake rice to make Japanese rice wine for the first time in Sugiyama's and his wife, Ami's, entire lives. Sugiyama also joined some returned villagers to form a joint venture, turning deserted farmlands and (*kari*) *kariokiba* into small solar farms that regenerate soils to become pastures. While these

56. Miyazaki, "Saving TEPCO."

57. Riles. "Market Collaboration," 565.

58. In *Crafting Selves*, Kondo suggests that *kokoro*—one's heart—conjoins one's feelings and thoughts with everyday practices to the realization of one's selfhood in relation to the others in one's family and workplace. See also Kirby, *Troubled Natures*.



Figure 4. Sugiyama's father returned home, 2017. Photograph by the author.

will be stories for another paper, they offer us a glimpse into Sugiyama's dreams beyond the state's promise of progress—one in which the world is reversible once nuclear power is made predictable and Fukushima is under control again.

Conclusion

"Return to nature, gently," wrote Asakura in his eulogy for Sugiyama's father, Ojīchan. He died peacefully a year after his return to Iitate. During the evacuation, he walked every day for his health and counted every little step to homecoming. For Asakura, because Ojīchan lived a dignified life, his death means not an end but an opening; for Sugiyama, Ojīchan's knot in the family's generational time has been tightened.⁵⁹ My precious memory with him recalls his gentle touch with the grass and soil when we chatted in the garden (fig. 4). As I write, I realize his homecoming was also timely.

As I have suggested throughout this article, soil has provided multiple pathways for the coconstitution of prospective forms of (human) life on a radioactive landscape. Soil has been enacted by the practices of Asakura, Harada, and Sugiyama working together as a research entity, a platform of getting together, and a stratum for agriculture,

59. Rose, "Multispecies Knots."

but it is more than that. Soil enfolds the uneasy intimacies with radiation with which it has been infused as well as Harada's care. Its ambivalent, dense, and entangled relationality opens up new frontiers of knowledge and reserves interstices within which radiocesium meets clay molecules, citizens and scientists come together, farmers are troubled with boars and monkeys, rice germinates, and solar farms emerge. "Soil is the skin of the Earth" underscores the ideal of a livable earthen planet as constituted of collaborations between humans and nonhumans. Science, in this sense, is an immersive mode of learning that renders the environment both conceivable and perceivable. With soil, Asakura, Harada, and Sugiyama have become more than citizens and scientists in reclaiming science, agriculture, and dignity from the damaged ecology, because there is always an overflow of relations within soil as life in *madei*.

I began this article with the claim that *madei*, constituted by the practices and methods of relating to soil, guides human attention to a mode of sociality that differs from that enforced by the biopolitical regime of the state. *Madei* emerges from the processes of separating radiocesium from topsoil, cultivating rice, and other improvisations for relating to soils, making a regenerative time to orient a future that might become reality. Regenerative time is a reminder of the impossibility of asserting human control over the environment, as many scholars have already pointed out by questioning the linear disaster time model and risk analysis premised on anthropocentric assumptions. More importantly, it admits that human life is only a moment in the environment, contaminated or not, whereby the future is imagined and experimented. Amid the COVID-19 pandemic and climate change, which have underscored the long-term crises of humanity, regenerative time demands us to rethink the notion of productivity and seek practices to achieve it right away when soil is embroiled in *madei*.

This future is not a regression to any specific past but a rediscovery of interspecies temporalities, paces, and rhythms of the living and nonliving beings cascading to regenerate soils in farmlands, *satoyama*, and forests. As exemplified in Sugiyama's paddies, *madei* emerges from the coordination and collaboration that bring technological arrangements and interspecies temporalities together to attend to disrupted relations and incommensurable differences in ecological assemblages. Under the official rubric of decontamination, soil is devalued—"worthless" in Sugiyama's words—as unproductive waste, deemed legible and manageable as evanescent dots along a single timeline of recovery. Denial of soil as alive unleashed a homogenizing force that let black bags and *kariokiba* gain traction, disparaging everyday temporalities that soil had capacitated. *Madei*, whose interventions are of and in time, engages the nuclear past and present by scaling them against geological and ecological times.

In 2019, three days after Typhoon No. 19 swept across Japan from the Pacific Ocean, a piece of news occupying a small corner of the country reported that radioactive wastewater in the tanks at the FDNPP had leaked into the sea and black bags storing radioactive soil at Iitate were lost to the river.⁶⁰ The prime minister has since

60. *Mainichi Shinbun*, "11 Bags of Contaminated Soil."

proposed discharging wastewater into the sea and recycling contaminated soils for road construction despite opposition from fishers and environmentalists. Antinuclear NGOs condemned the proposals as time-wasting by scaling the waste against the half-lives of radionuclides that will outlast many generations; nonetheless, they failed to mobilize as many Japanese as they had in 2011.⁶¹ Yet, these NGOs were half-wrong. State officials are committed productionists seeking to bring the fallout to closure and restart the old nuclear reactors to address climate change.⁶² These double promises encompass a progressivist future that is contingent on the linearity of time that treats radiation as ephemeral, predictable, and controllable, which, as I have argued, establishes the very conditions of the violent entanglements in *litate*.

Silence is a “failure to acknowledge the gravity of violence.”⁶³ In this sense, anti-nuclear activists’ relentless decrying of the open-endedness of the fallout is justifiable in its own right. Yet, such anti-politics may produce harm if it ignores or rejects alternative practices in search of the persistence of life in attuning to the contaminated present.⁶⁴ I have discussed in this article other pathways for exploring the open-endedness of the fallout that do not make captives of the people affected, who stay with the troubles of an irretrievable past and a vulnerable present without an apparent future. In *litate*, I learned that collaboration can be achieved without relying on top-down disciplines, becoming improvisational and conjunctural in times of indeterminacy, opening up new modes of sociality along with radiation and other beings. I see new symbiotic relations between humans and soil that stimulate more innovative and scalable, while at the same time compassionate, responses in the face of a crisis as grave as nuclear fallout, contending with the state for the real.

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61. For example, see Burnie, *Reality of the Fukushima Radioactive Water Crisis*.

62. *Financial Times*, “Japan Says Nuclear Crucial.”

63. Rose, “Multispecies Knots,” 139.

64. Roberts, “What Gets Inside.”

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