Reasonable Exposure:
Nuclear Infrastructure and Technopolitics of Health and Well-Being

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How have nuclear power plants shaped the ways we understand and practice health and well-being?

During ethnographic fieldwork in Japan during 2017-2018, I repeatedly heard the phrase "There is no correct answer" (*seikai ga nai*) from my interlocutors, living in the ongoing aftermath of the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant Accident in 2011. The reverberating and chronic sense of "living without answer" has been at the heart of my research on how health and well-being have been negotiated in the years following the nuclear fallout. Caught between the government that repeatedly claimed their safety and oppositional voices that predicted their doom, residents in Japan were left to decide on their own what to do and what the future held for them.

In this thought piece, I consider the role that nuclear infrastructures have played in shaping the experience of health and well-being after the nuclear accident in Japan. Here, I engage the nuclear power plant not only as an infrastructure that produces energy in its regular functioning and a catastrophe in its breakdown, but also as a device that orders the world in specific ways through its very presence (Winner 1980:127). I argue that "living without answer" signals a deep entanglement with the paradox of the nuclear age and with the shared but profoundly uneven condition of our time, of being "reasonably exposed."

Geographer Shannon Cram argues that nuclear infrastructures exist in a paradox, in which nuclear workers have to be kept safe while they are necessarily exposed to radiation during their work (Cram 2016:522). To enable the presence of nuclear infrastructures, safety and protection could no longer be about absence of harm. Instead, safety and protection become a matter of negotiating what level of exposure to deem *reasonable* given the biological risk of exposure and political economic and military interests of taking that risk (ICRP 2007).

Under "reasonable exposure", radiological protection was ultimately about how much individuals were willing to compromise, rather than what measures the government and industry would take to protect the citizens

Nuclear infrastructures therefore require the health and well-being of certain people and communities to always already be a compromise. Guidelines on radiological protection developed through the Cold War to accommodate the presence of commercial nuclear power plants and nuclear weapons testing that made exposure inevitable for nuclear workers and increasingly for the general public. Under reasonable exposure, radiological protection was ultimately about how much individuals were willing to compromise, rather than what measures the government and industry would take to protect the citizens (Masco 2010). I call this the "politics of reasonable exposure."

In the wake of the fallout, it was the politics of reasonable exposure, long masked by the safety myth, that shaped the prevalent but uneven sense of living without answer among the general public in Japan. This in turn led to divides among those who had to decide whether and how to negotiate what was *reasonable* for them to protect their health

and well-being amidst the fallout. While the main political terrain was shaped around radiation and its health effects, the risk of radiation was not the only concern people negotiated when making their decisions. Many negotiated the social, economic, and place-based relationships that constituted their broader social safety net and sense of well-being.

Thus, depending on their social economic positionalities, people and communities faced the fallout in uneven intensity. Some were still able to live with a sense of security and stability, while others were thrown into chronic uncertainty. For the latter, the most urgent questions were how to live *well* without an answer, without recourse to absolute safety, and without promise of escape to another time and place (cf. Masami 2017, Murphy 2017). Such experimental modes of *living in paradox* entailed social and psychological costs, as the decisions residents made in extreme uncertainty led to multiple social divides and traumatized them over the years. On the other hand, it also entailed potentials for alternative politics and ethics, as residents sought to live well in excess of governmental and industrial framings of health and well-being.

Attention to the politics of reasonable exposure elucidate the co-production of nuclear infrastructures with regulatory policies in ways that unevenly subsume health and well-being as a compromise, as well as create social divides through divergent decisions citizens make to protect their health and well-being.

In a context in which projects of recovery and energy transition in Fukushima have gestured towards a sense of moving "beyond" the disaster, I put forth "reasonable exposure" as an analytic lens to examine the uneven distribution of risk, as well as the ways people and communities continue to make life meaningful in deeper entanglement with the paradox of the nuclear age. Attention to the politics of reasonable exposure elucidate the co-production of nuclear infrastructures with regulatory policies in ways that unevenly subsume health and well-being as a compromise, as well as create social divides through divergent decisions citizens make to protect their health and well-being. In doing so, it opens up to a critique of the technopolitical order of the nuclear age, at the same time as it directs our attention to the ordinary practices of health and well-being from within the paradox, its potentials, and its exhaustions.

This leaves us with questions for ethnographic research on high-risk complex infrastructures, regulatory policies, and environmental health grounded in the politics of reasonable exposure. What does it mean to do fieldwork in and from the paradox, while being pulled and shaped by its social arrangements full of rifts and divides? How does this social arrangement affect the ways we are able to do research, the kinds of questions we are able to ask, and the kinds of writing we are able to do? How do we situate ourselves in the paradox, as scholars, advocates, and educators, who are often able to live as if we have the right answers and make everyday decisions without being traumatized by it? Lastly, how could we account for the divergent stakes and politics of our interlocutors, without insisting that the views we bring are the correct answer?

Reference Cited

ICRP. 2007. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP publication 103. https://pubmed.ncbi.nlm.nih.gov/18082557/.

Masami, Yuki. 2017. Meals in the Age of Toxic Environments. In The Routledge Companion to the Environmental Humanities, pp. 56–63. London: Routledge.

Masco, Joseph. 2010. Atomic Health, Or How The Bomb Altered American Notions of Death. In Against Health: How Health Became the New Morality, pp. 133–156. New York University Press.

Murphy, Michelle. 2017. Alterlife and Decolonial Chemical Relations. Cultural Anthropology 32(4): 494–503.

Winner, Langdon. 1980. Do Artifacts Have Politics? Daedalus 109(1): 121–136.

Discussion Comments

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Living in Paradox: Technopolitics of Health and Well-Being in Fukushima

I am pleased and honored to be here and to have this opportunity to converse with these thought-provoking scholars of Fukushima, and in particular, to discuss Hiroko Kumaki's paper. In order to speak to just a few of the interrelated the concerns raised in Kumaki's essay—radiation exposure and the politics of reasonable exposure—and to build on those concerns, I am going to draw from some of my own published work[1] and work in progress that examine the features of the nuclear age in Brazil in light of Fukushima and other nuclear age accidents.

Concern #1: Radiation Exposure

The first concern raised by Kumaki's essay is the question of radiation protection guidelines in light of the future lives of actual subjects living in affected zones of contamination near the Fukushima Daiichi nuclear plant. As Kumaki describes, these people—differently—have had to negotiate the unstable and uncertain knowledge systems connected to the science of radiation dosing after a nuclear catastrophe, made all the more challenging by the government's ever-changing guidelines about safety levels (e.g., Polleri 2019). As Kumaki points out, this life theme of 'how to be protected but also how to live' with the uncertainties of radiation exposure has created confusion and stress, and with this uncertainty people such as Nozaki-san speak to feeling "dragged by our future."

Captured by Kumaki in the words of Sasaki-san, each individual remains burdened with trying to figure out how to live with the possible damage caused by radiation. Nobody can really agree on what that radiation exposure damage will look like in the future—Will there be thyroid abnormalities? Will there be excess cancers of diverse kinds? Will the damage be limited to this generation? There is no agreement among residents about what a reasonable approach to these questions should be as people decide whether to make their way back to areas contaminated to different degrees. Among Kumaki's interlocutors there seemed to be an underlying concern about what effects low-dose ionizing exposure might produce in younger people—now and in the future. What we do know is that radiation exposure is cumulative and additive over time and so living with ongoing exposure starting at a younger age is something that the residents negotiating their decisions about where and how to live are forced to think about.

But as I learned working closely with epidemiologists in Brazil in the Angra dos Reis nuclear reactor zone, non-nuclear zones with allegedly "normal" contamination levels, such as zones associated with the offshore petroleum industry, provide the comparison group for the science of nuclear contamination, which is to say that studying health effects and getting answers to what the comparative health effects are *is not an easy task*. There is so much contamination from a variety of sources, that when it is time to design a paired study of nuclear zones to other industrial zones, nuclear zones without accidents can appear to be less contaminated. Government manipulation of safety standards is a problem, but this is not the only issue.

[1] I draw from the following previously published papers: Goldstein 2012; Goldstein and Stawkowski 2015; Goldstein 2017; Goldstein 2017a; Goldstein 2018.

I have for many years now been on a journey seeking out an understanding of our scientific knowledge about the health effects of radiation exposure, entailing deep archival dives into the biographies and scientific output of scientists interested in this question, such as the biological anthropologist and geneticist, Dr. James V. Neel. Neel was an original member of the Atomic Bomb Casualty Commission and scientist who traveled to Japan to study the survivors of the atomic bomb. As it happens, Neel also was deeply connected to work in Brazil among the Yanomami indigenous peoples, who represented for Neel an interesting study population because—in comparison with the population he studied in Japan—the Brazilian Yanomami represented an alleged zero exposure to radiation effects, living, as he understood it, deep in the Amazon under a dense forest canopy. Importantly, Neel spent his later professional years in international scientific debates about the safety of nuclear reactors, finding himself in disagreement with post-Chernobyl scientists in Ukraine writing about the deleterious effects of low-dose (chronic) radiation exposure on human genetics.

As part of my work on nuclear futures in Brazil, I examined documents related to Neel's work in Japan in the post-War years and how they informed his later science. Looking at some of the same documents that science historian Susan Lindee has written so cogently about and putting them in perspective with Neel's later work in Brazil and in debates about nuclear reactor safety, I came into close contact with the interpretive possibilities of data sets and how many of the studies about the nuclear era provide an ample space of ambiguity and scientific uncertainty (Goldstein 2017a; 2014), particularly given the technopolitical context of the studies. While Lindee (1994) grapples with the political context of Neel's Atomic Energy Commission work and does not clearly resolve it, Neel himself writes quite securely in his papers and memoir of what he sees as "the triumph of science over politics." Neel was a true believer in the idea that science was neutral and that politics was a distraction.

Neel fiercely defends his position concerning his work for the ABCC in Japan—that his studies of survivors of the atomic bomb *were not slanted by sponsorship by the organization devoted to the development of atomic energy*. He indeed felt secure in his research about long-term genetic health effects, writing in 1994, "I can state categorically that at no time over the past 48 years have I been aware of any improper pressures with regard to the content or analysis of the genetic studies. Exchanges with the AEC concerning the program there were, but it was science, not politics, that prevailed" (Neel 1994: 89). Also critical to the successful future of the nuclear industry worldwide was his finding that there was *no overt evidence of significant variation in the mortality of cohorts of children born to parents who were exposed to radiation at Hiroshima and Nagasaki* (Kato et al., 1966, p. 371 and reprinted in Neel and Schull, 1991, p. 323).

Yet the genetic effects of low-dose radiation—and radiation effects more generally— have vexed scientists since at least 1945 (Lindee, 1994), and a number of scientists (e.g., Richardson, 2012; Wing et al., 1999; Walker, 1994) have argued that the harm caused by radiation is underestimated in Neel's Hiroshima and Nagasaki data. These oppositional scientists claim that the multiple conflicts of interest involved in the professions of radiation health and health physics (also known as the physics of radiation protection) have contributed to this underestimation[2] (Goldstein and Stawkowski 2015).

Neel was clearly comfortable in his role as research scientist, and, as withso many of the ABCC participants of that generation, he viewed science as something apart from everyday political jockeying. In short, Neel's long career is

[2] Among those who have been critical of these studies include Gofman (1981) and Bertell (1985). At the other extreme from this position, there now exist a few scientists and professional associations who interpret the Japan data as having over- estimated the risk from low-dose radiation, including Roger Clarke, President of the International Commission on Radiological Protection (Moore, 2002).

marked by his insistence on a devotion to rigorous methodology, an acceptance of the division between treatment and research, and a belief in the separation of science and politics.

But then, reading more deeply into Neel's papers and archives and working together with my friend and colleague Magda Stawkowski, we have also tried to look comparatively at this long-term health question by looking at the genetics studies carried out in the US and Europe (also involving James Neel) and the studies carried out by the scientist Yuri Dubrova—originally from Ukraine, but who later migrated to England— on the occurrence of mutations as seen by looking at minisatellite DNA. Minisatellites are the place where repetitions occur on the human genome. Part of the debate is what is to count as a mutation and whether that mutation would be harmful to future human generations. What we found was that Neel at every turn worked hard to debate the scientists who were studying mutations in genetics with data used from the Chernobyl disaster of 1986 and in some critical ways continued to defend his legacy research with the ABCC, resisting any studies that would propose generational effects in humans. Recent anthropological studies of science assume that social, historical, political, and economic conditions are already embedded in the fundamental directions of scientific research (e.g., Latour, 1987, 1988; Latour and Woolgar, 1986; Fujimura, 1998). Applying this reasoning to our understanding of genetics and ionizing radiation, *we recognize that there is a set of interests at play in the determination of our current scientific knowledge.* In other words, the research on the genetic effects of low-level ionizing radiation exposure has been "co-configured" by scientific advances and socio-political context.

So in returning to Kumaki's paper and the politics of reasonable exposure— and to the other interlocutors here today—I do want to note that I personally have always found it tragic and paradoxical that Neel, one of the giants involved in the Atomic Bomb Casualty Commission who worked in Japan after the bombings of Hiroshima and Nagasaki after World War II, wound up being a key figure in setting the stage for how a number of scientific communities interpreted genetic damage from ionizing radiation and for helping to determine radiation safety guidelines for nuclear workers and civilian populations for years to come. Late in his career, Neel's scientific work was used to depose against workers in the UK who were claiming injury in the form of negative health effects (a form of a rare leukemia) on nuclear worker children. With regard to the Japan data, Neel was deeply concerned that survivors of Hiroshima and Nagasaki would not be stigmatized or locked out of the marriage or kinship market. Sadly, I think some of this concern is palpable in Kumaki's interlocutors as they contemplate futures, not just for themselves but for their children, although this point is not entirely remarked on in the context of this brief paper.

The Nuclear Zone in Brazil and the Nuclear Zone in Fukushima

In fieldwork in the nuclear reactor zone in Angra dos Reis, Brazil in 2015, I found that a large contingent of nuclear workers had already made various trips to Fukushima post 2011, as the Brazilian nuclear reactors share some structural and engineering likenesses to the Daiichi plant and the events in Fukushima alerted Brazilian nuclear scientists and engineers to think about vulnerabilities in their own existing systems. In Brazil, the perspectives of pro-nuclearism are well entrenched. Talk of zero carbon emissions is always present. In Brazil, technophilia–an abundant love for everything technological— works to nuclear technology in the name of modernity and progress.

This leads me to Kumaki's second concern, that of the politics of reasonable exposure. Kumaki points out that based on ICRP (International Commission of Radiological Protection) guidelines, the Japanese government set their standard exposure allowable to be 20 times higher than the level of radiation exposure permitted for the general public in normal times, so the guidelines left a great deal of room for uncertainty and for citizens to question whether these guidelines

had been loosened in the wake of an emergency. Citizens had to decide what and how much they were willing to compromise, leaving the government acting as an intermediary or voice for risk communication. For those trying to decide how to live with these uncertainties—What are the long-term health effects? Will I get cancer from staying here? Can I eat these vegetables? Will the next generation be safe from radiation?—Kumaki describes a situation where people in limbo are being dragged into the future, a future that is unknown. The people themselves recognize that they are experimenting with growing vegetables and with seeing what food is possible to raise in different areas, but also live in the paradox of trying to figure out what to do while remaining true to their homes, their towns, their regions and the uneven social, economic and health consequences that are nurtured by nuclear infrastructures.

One radiation and dosimetry expert in Brazil I interviewed had been on the Fukushima tour. She travelled to Fukushima shortly after the disaster, where she was given access to the exposure data of workers at the site. What impressed this scientist about the Fukushima data was that the dose received by the workers 'was well below what I was expecting'. She was also impressed with the coordination and organisation of the Japanese workers in dealing with the critical conditions of the reactors (Goldstein Interview with Abreu, March 2015). As our conversation drifted into the details about Fukushima, we spoke about the group of nuclear workers—mostly beyond reproductive age—who were named by the media as 'The Fukushima 50' and who have been acknowledged in Japan for their bravery, that is, for remaining on-site while younger, more vulnerable workers had evacuated. I asked this radiation expert what she thought would happen in a similar situation in Brazil. She laughed, suggesting that there would be no willing volunteers in a similar Brazilian scenario, adding 'not (the) elderly, not (the) impoverished, not (the) wealthy' (Goldstein Interview with Abreu, March 2015). The scenario she imagines is not so different from how the anti-nuclear activists in Brazil imagine a nuclear catastrophe in Brazil—as a nightmare with many unpredictable and as yet unknowable aspects.

Concluding Comments

In conclusion, what struck me as profound about Kumaki's paper was her recognition that nuclear infrastructures are planned in places where the populations are not seen to count in the same way that populations in dense urban centers like Tokyo count. Yet, the demand for energy production in places like Tokyo, São Paulo and Rio de Janeiro and the drive to fortify specific modes of modernity's imagined progress, work to keep nuclear plans in the mix of what is reasonable. Kumaki's essay provides us a glimpse of the place where people are beginning to carry out experiments on their own behalf. They provide proof that life is possible in a contaminated zone. My worry, however, is also that these same populations may also provide proof that life in contaminated zones is completely safe. I also do not wish for these same people to become living experiments for science performed elsewhere or victims of undone or un-doable science that can never fully acknowledge the vulnerable populations that share the space with these spectacles of modernity.

References

Bertell, Rosalie. 1985. No Immediate Danger: Prognosis for a Radioactive Earth. London: Women's Press.

Fujimura, Joan. 1998. ''Authorizing Knowledge in Science and Anthropology.'' American Anthropologist 100(2): 347–360.

Gofman, John. 1981. Radiation and Human Health. San Francisco: Sierra Club Books.

Goldstein, Donna M. 2012. "Experimentalité: Pharmaceutical Insights Into Anthropology's Epistemologically Fractured Self." In: Susan Levine, ed. Medicine and the Politics of Knowledge. Cape Town, South Africa: HSRC, pp. 118-151.

Goldstein, Donna M. 2014. "Toxic uncertainties of the nuclear era: Anthropology, history, memoir," American Ethnologist, Volume 41(3): 579-584.

Goldstein, Donna M. and Stawkowksi, Magdalena E. 2015. "James V. Neel and Yuri E. Dubrova: Cold war debates and the genetic effects of low-dose radiation." Journal of the History of Biology 48: 67-98.

Goldstein, Donna M. 2017. “Fukushima in Brazil: Undone Science, Technophilia, Epistemic Murk.” Culture, Theory and Critique 58(4): 391-412.

Goldstein, Donna M. 2017a. “Commentary: Science, Politics, and Risk: Catastrophic Asia From the Perspective of a Brazilianist Anthropologist.” Journal of Asian Studies 76(2): 481-497.

Goldstein, Donna M. 2018. “Already innocent: radioactive bribes, white-collar corruption and nuclear expertise in Brazil.” Culture, Theory and Critique, 59(4): 354-379.

Kato, Hiroo, Schull, William, and Neel, James. 1966. “A Cohort-Type Study of Survival in the Children of Parents Exposed to Atomic Bombings.” American Journal of Human Genetics 18: 339–373.

Latour, Bruno. 1987. Science in Action: How to Follow Scientists and Engineers Through Society. Cambridge, MA: Harvard University Press.

Latour, Bruno. 1988. The Pasteurization of France. Cambridge, MA: Harvard University Press.

Latour, Bruno, and Woolgar, Steve. 1986. Laboratory Life: The Construction of Scientific Facts. Princeton, NJ: Princeton University Press.

Lindee, Susan. 1994. Suffering Made Real: American Science and the Survivors at Hiroshima. Chicago: University of Chicago Press.

Moore, LeRoy. 2002. ‘‘Lowering the Bar.’’ Bulletin of the Atomic Scientists 58: 28–37.

Neel, James V. 1994. Physician to the Gene Pool: Genetic lessons and Other Stories. New York: Wiley.

Neel, James V. and Schull, William. 1991. The Children of Atomic Bomb Survivors: A Genetic Study. Washington, DC: National Academy Press.

Polleri, Maxime. 2019. “Post-political uncertainties: Governing nuclear controversies in post-Fukushima Japan. Social Studies of Science 50(4): 567-588.

Richardson, David. 2012. “Lessons from Hiroshima and Nagasaki: The Most Exposed and Most Vulnerable.” Bulletin of the Atomic Scientists 68(3): 29–35.

Walker J. Samuel. 1994. ‘‘The Atomic Energy Commission and the Politics of Radiation Protection, 1967–1971.’’ Isis 85(1): 57–78.

Wing, Steve, Richardson, David, and Stewart, Alice. 1999. ‘‘The Relevance of Occupational Epidemiology to Radiation Protection Standards.’’ New Solutions 9(2): 133–151.

Interviews (All Names are Pseudonyms)

Dr. Larissa Abreu, Vice-Coordinator of Research at the Research Institute of Radiation Protection and Dosimetry (IRD) Barra de Tijuca RJ, and Representative of Brazil to UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation), March 2015.

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