

「サイエンス」「ネイチャー」両誌における福島原発事故評価

Matthew Penney

Between 2012 and 2014 we posted a number of articles on contemporary affairs without giving them volume and issue numbers or dates. Often the date can be determined from internal evidence in the article, but sometimes not. We have decided retrospectively to list all of them as Volume 10, Issue 54 with a date of 2012 with the understanding that all were published between 2012 and 2014.

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By Matthew Penney

On April 12 it was revealed that the Japanese government is [deliberating](#) raising the level of the Fukushima Daiichi disaster to 7 on the International Nuclear and Radiological Event Scale of the International Atomic Energy Agency. This is the highest level and the same as the 1986 Chernobyl accident. At the same time, the Japanese government has made [moves](#) to evacuate high radiation areas outside of the 20km radius. This move is welcome as critics have decried the original evacuation zone as arbitrary. Discussion has also begun on compensation for victims in the evacuation zone, with talk of 1,000,000 yen per family.

In this context, accurate information or honest acknowledgement of blind spots and areas for

which there is no scientific consensus is necessary. This article will survey recent assessments of the Fukushima Daiichi crisis from leading international journals *Science* and *Nature* which provide detailed information and insight into what the scientific community does and does not know.

Science reveals yet another example of TEPCO ignoring warning signs that a quake or tsunami could cause catastrophic damage to the Fukushima Daiichi plant. In “Scientific Consensus on Great Quake Came Too Late” (*Science*, April 1), Dennis Normile argues that governments and safety monitoring agencies are too slow at incorporating scientific research into their projections. The article cites a 2001 piece in the *Journal of Natural Disaster Science* in which Minoura Koji, a geologist at Tohoku University in Sendai, the heart of the region hit by the 3/11 quake, assessed a similar disaster that took place in the 9th century. An examination of sediments in the area established that a tsunami penetrated four kilometers inland. With evidence that such a devastating tsunami had taken place and knowledge that it could happen again, Normile asks why geological research of ancient earthquakes had not been adequately factored into official risk projections of events like those that devastated the Fukushima Daiichi plant. For most of Japan, it is revealed, paleoseismic studies which look at past quakes and tsunamis to inform policymaking, have been limited to the last 400 years. Minoura’s research on the much older quake, as well as follow-up studies by other scholars, was being reviewed for possible use in risk assessment

when the 3/11 quake hit. In addition, researchers had informed TEPCO representatives of the potential for a tsunami much larger than the Fukushima plant's 5.7 meter safety level in 2008. Normile laments the slowness of transition from peer-reviewed research to policy advice, both inside and outside Japan.

Both *Science* and *Nature* have presented visions of what the Fukushima aftermath might look like. Geoff Brumfiel's article "Japan's long road ahead" (*Nature*, April 5) points out that "Some believe that molten fuel may have flowed into the outer concrete containment vessel, whereas others suggest that nuclear chain reactions are still happening inside the fuel." While pointing out that the state of the core may be unknown for months, Brumfiel presents a range of scientific opinions that suggest the Fukushima cleanup may take longer than the 14 year Three Mile Island process. In "Fukushima Cleanup Will be Drawn Out and Costly" (*Science*, March 25) Richard Stone also favoured the Three Mile Island comparison and argued that the types of desperate measures taken at Chernobyl, including encasing the reactor in a massive concrete sarcophagus, will most likely not be necessary. In the following week's issue, however, Eli Kintisch's piece "Pool at Stricken Reactor #4 Holds Answer to Key Safety Questions", emphasized the lack of clear information surrounding reactor conditions and especially the issue of spent fuel pools. The article points to the dearth of public knowledge about these pools, brought about by a climate of official secrecy, "Some experts believe that governments and the nuclear power industry have done a poor job of sharing information on the risk of zirconium fires. Critics of NRC [U.S. National Research Council] say that studies conducted for the agency likely contain relevant data but have been kept classified to keep the information away from terrorists. "To

the extent that any experiments have been done at all, the public doesn't know about them," says spent-fuel expert Gordon Thompson of Clark University in Worcester, Massachusetts." With information poor or non-existent and the state of the Fukushima No. 4 fuel pool unclear, Kintisch concludes that it is far too early to predict an end to the ongoing disaster.

In this uncertain context, "Fukushima set for epic clean-up", Geoff Brumfiel's contribution in the April 11 issue of *Nature*, went beyond the earlier Three Mile Island comparisons to suggest that "a Chernobyl-like effort will be needed." Brumfiel writes, "Given the complexity of the task ahead, some think it may be better to abandon Fukushima entirely — at least for the time being. 'My bet would be: you seal it and wait a hundred years,' says Alan Johnson, a retired reactor physicist who was head of Britain's Sella-field nuclear processing site in the late 1980s."

In an equally alarming vein, David J. Brenner's article "We don't know enough about low dose radiation risk" (*Nature*, April 5), as the title suggests, emphasizes ongoing debates and gaps in scientific knowledge that make it difficult to predict the potential health impacts of Fukushima. Brenner argues that, "... the uncertainties associated with our best estimates of the health effects of low-doses of radiation are large." He also points out, "even if we knew the final extent of the releases and the extent of the population exposures, we do not know enough about the possible effects of low-dose radiation on health to be able to make rational decisions regarding evacuations." The lack of scientific consensus on the issue of low level radiation exposure leads Brenner to suggest that the Japanese government should expand the current evacuation area. In addition, impact outside of Fukushima

prefecture is equally difficult to gauge, “For almost everyone, any increase in individual cancer risk will be very small indeed, but we do not have a good understanding of the public-health consequences of millions of people all being exposed to minute increases in cancer risk.” He concludes, “To make rational decisions about these momentous questions, we need to understand the risks of low doses of radiation with a great deal more certainty. Otherwise the debate will be framed around the extreme positions of ‘radiation is universally dangerous’ and ‘low doses of radiation pose no risk.’”

There are counterpoints to Brenner’s position in the same *Nature* issue. Declan Butler’s “Fukushima health risks scrutinized” (*Nature*, April 5) reports that “Researchers emphasize ... that environmental levels of radiation outside the 20-kilometre evacuation zone around the power plant are currently far below levels that warrant concerns about human health. The greatest threat to human health from the disaster is consuming contaminated food and drink, they say.”

While scientific opinion diverges on the level of threat to humans, Jim Smith’s “A long shadow over Fukushima” (*Nature*, April 5) makes clear that environmental damage will be severe. “The implications of these data are far-reaching. If large areas are contaminated with 0.5 MBq m^{-2} or more, evacuation could be for the long term. After Chernobyl, long-term evacuation usually occurred in areas with radioactivity above 0.55 MBq m^{-2} , although some believe that this limit could have been safely set much higher. Contamination of the food chain will depend on soil type: soils rich in clay bind radiocaesium strongly: bioavailability in organic upland and forest soils is generally significantly higher than in mineral soils. On the basis of the Fukushima data seen so far, it seems likely that in some areas, food restrictions could hold for decades, particularly for wild foodstuffs such as mushrooms, berries and freshwater fish.”

Matthew Penney is an Assistant Professor of History at Concordia University, Montreal. He is a Japan Focus associate who researches contemporary Japanese cultural history.