Title
Nuclear Waste: Forever Contaminated?

Journal
Berkeley Scientific Journal, 19(2)

ISSN
1097-0967

Author
Wang, Andrew

Publication Date
2015

DOI
10.5070/BS3192028609

Undergraduate

Nuclear Waste: Forever Contaminated?

Andrew Wang

Mention the word "nuclear" and immediately thoughts of Hiroshima, Nagasaki, Three Mile Island, Chernobyl, and Fukushima are elicited. The iconic mushroom clouds and the thought of a nuclear apocalypse during the Cold War have dominated fears for a significant part of the last century. It is no wonder people cringe at the thought of nuclear power. Especially with nuclear disasters like Chernobyl and Fukushima, most people are worried that anything nuclear will lead to an uninhabitable wasteland. However, there is no reason to immediately dismiss nuclear energy. Besides the fact that we are increasingly reliant on nuclear energy, it provides over 10% of the world's energy and data from both Fukushima and Chernobyl show that the land is recoverable ("World Statistics", 2015). Drawing upon both of these infamous nuclear disasters we will examine how nuclear waste affected the environment.

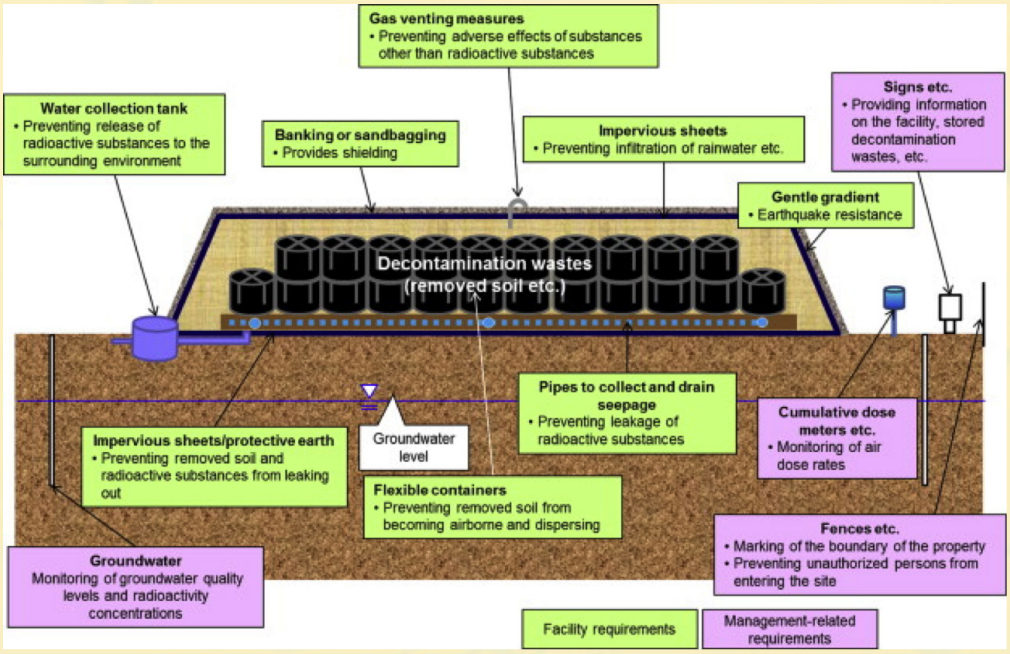

Figure 1. A Schematic of the process to clean-up the topsoil around Fukushima.

It has been almost four years since Fukushima and almost thirty years since Chernobyl, but both still remain in the public conscience. Nuclear Energy is created by a steam turbine, where the heat given off by a nuclear reaction, boils the water surrounding it, which drives the blades of the turbine. A process that does not release a significant amount of carbon dioxide into the atmosphere. However, the Fukushima nuclear meltdown happened on March 11, 2011 when an 9.0 magnitude earthquake caused the nuclear power plant to shut down. However, the earthquake triggered a tsunami that prevented the emergency procedures from being activated, allowing nuclear waste to slowly leak into the environment. The danger was so great that Japan immediately ordered an evacuation of all people within 20 km to 30 km (~12.5-18.6 miles). The Fukushima Daiichi disaster still impacts Japan and cleanup remains underway to this day. This was the second largest nuclear disaster since Chernobyl. Chernobyl happened on April 26, 1986, when a reactor exploded and sent a huge plume of radioactive material into the atmosphere and caused 31 deaths and long term effects that are still being researched today (Danzer, 2014). The public worry increased so much in both cases that people still refuse to eat food such as fruits and berries deemed safe. Moreover, Chernobyl still remains an isolated ghost town due to mass scale evacuation right after the incident and the lack of effort dont to repair it.These two events are the only ones to be rated 7, the highest rating on the INES scale, International Nuclear Event Scale, a scale determining the severity of nuclear incidents. Both of these events, while disastrous, allow us to study the effects of nuclear waste on biological systems, while spurring research into disposing of nuclear waste.

Both nuclear disasters exposed radioisotopes into the environment and since it is unwise to leave radioactive isotopes in otherwise useable land, clean up is very necessary. The most important step was a mass scale evacuation of people living near the reactor and for a temporary ban on food exports from the contaminated region. People who experience high levels of atomic radiation will develop Acute Radiation Sickness, which harms the skin and bone marrow possibly beyond repair, or develop cancer in the long term. In Fukushima, to dispose of the radiation, the clean up crew used high power water pressure to wash off the soil or any other type of debris (Hardie, 2013). They also removed most of the topsoil, which was most likely to be affected by radiation, through ploughing and used heating to reduce the amount of radioisotopes. The topsoil, as well

as any organic matter, was taken to a plant, where it is dried and will remain, until the radioisotopes, specifically Cesium, decompose (Hardie, 2013). Similar procedures were used in Chernobyl. It is worth mentioning that this cleanup effort is extremely expensive, costing on the order of billions of dollars. The Fukushima cleanup is still going on today and even behind schedule.

Figure 2. A picture of Fukushima after the disaster.

Generally, when a nuclear meltdown occurs, it is not just the heat that is released from the blast. The greatest danger from a nuclear disaster as previously mentioned are radioisotopes, most common strontium-90 and cesium-137 (Merz, 2015). Cesium can mimic the properties of potassium, while Strontium can mimic the properties of Calcium, which can be taken up by physiological processes and as they further decay, harm the body beyond repair. ("Fission Fragments", 2015) It is not uranium that is dangerous as commonly assumed because it is actually a relatively stable radioisotope, but it is what uranium splits into when undergoing nuclear fission. Iodine -131 is another byproduct of nuclear fission, but that is less of a concern when studying the environment because the half life of Iodine-131 is only 8 days and will become relatively harmless Xenon (Buesseler, 2011). In addition, Strontium-90 and Cesium-137 are more of a concern because they each have a half life of approximately 30 years and therefore will be in the environment for potentially hundred of years ("Strontium", 2012).

"The Fukushima cleanup is still going on today and even behind schedule"

In the short term, radiation does not affect humans very much. If exposed to radiation it may trigger nausea and other flu-like symptoms. One of the biggest problems is the fact that animal products become contaminated with radiocesium and vegetables become contaminated with radiostrontium (Merz, 2015). For instance, in Chernobyl many children experienced greater radiation because of the milk they drank, which contained an excess amounts of Strontium-90 (Hatch, 2005). People were not aware at the time of the dangers of drinking contaminated milk. This also poses a problem for the government because people still have to eat. Interestingly enough, foods only showed dangerous radioactive levels in the first year, whereas by the second year only deer meat and mushrooms showed significant levels (Merz, 2015). It can be assumed that most of the radiation is absorbed into the crops the first year, so the radioactivity decreases to acceptable levels. Unlike land-locked Chernobyl, Fukushima had a significant amount fallout went into the Ocean and rivers which prevented the water from being immediately drinkable.

In the long term, effects are still being discovered. From Hiroshima, we know that excess cancer risk associated with exposure is known to persist over 50 years (Steinhauser, 2014). In Chernobyl, there was an increase in thyroid cancer in children in the years following the accident. While only 31 people died in the following days, the radiation exposure is 175-3000 times higher than the dose that the average person will receive in a year (Danzer, 2014). In Chernobyl, the winds carried the fallout across Europe, while in Fukushima, the fallout mostly went into the ocean because of Japan's mostly mountainous topography (Steinhauser, 2014). In Fukushima there is a ban on fishing because radiostrontium can remain in the bones of fish and other marine life for a significant time.

Since nuclear power is new and it is hard for scientists to study the effect of radiation over generations, some scientists have decided to study the effect on animals. In Japan, they have noted the wildlife near the the reactor. For instance, the wild monkeys and the pale grass blue butterfly are currently being studied. It has been concluded that the wild monkeys suffer from a low blood count (Hiyama, 2015). Since the life cycle for the pale-blue butterfly is only 2 years, it is easily to study the generational changes between. The study concluded that the worst defects on butterflies occurred during the fifth generation, and then there were gradually less genetic defects (Hiyama, 2015). Extrapolating this data, it will take us into the 2100 for affected people's progeny to no longer suffer the worst of the nuclear meltdown.

One last thing to note is the sociological effect of the meltdown. Upon hearing about the meltdown, people rationally had an anti-nuclear sentiment. Both Germany and Japan attempted to go nuclear free, but Japan eventually had to reverse its decision due to its energy needs (Davies, 2011). The United States remained mostly indifferent as they attributed Fukushima to environmental factors and since the United States has its reactors in a mostly isolated area inland, they did not think it was to change policy. The main lesson

"...it will take us into the 2100 for affected people's progeny to no longer suffer the worst of the nuclear meltdown."

from Fukushima and Chernobyl is that governments needs to work closely with scientists to plan ahead in case disasters happen. In Fukushima, people were banned from drinking tap water until about two months later, despite the fact that it had been well below unsafe radiation limits after only 30 days (Hamada, 2014).

In the end, we should follow the words of Albert Einstein, who not only contributed significantly to theoretical physics, but helped create the atomic bomb, "A new type of thinking is essential if mankind is to survive and move toward higher levels." Nuclear power is a way to create cleaner energy to meet the demands of the ever industrializing world and while it may be dangerous we need to push forward, but not abandon caution and to learn from the mistakes we have already made.

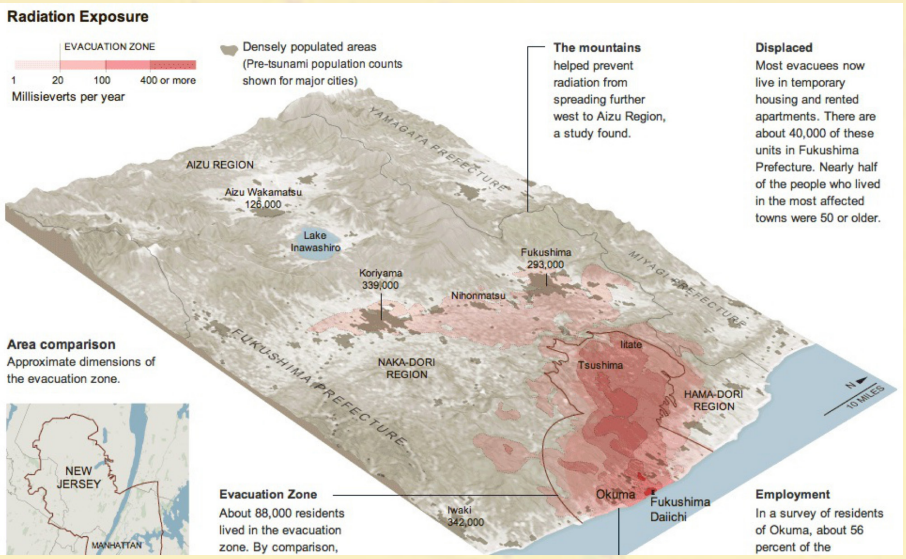

Figure 3. Image of the Fallout that spread across Fukushima

References

Buesseler, K., Aoyama, M., & Fukasawa, M. (2011). Impacts of the Fukushima nuclear power
plants on marine radioactivity. Environmental science & technology, 45(23), 9931-9935.

Danzer, A. M., & Danzer, N. (2014). The Long-Run Consequences of Chernobyl: Evidence on
Subjective Well-Being, Mental Health and Welfare. Mental Health and Welfare (June 25,
2014). CESifo Working Paper Series, (4855).

Davies, L. L. (2011). Beyond Fukushima: Disasters, nuclear energy, and energy law. Nuclear
Energy, and Energy Law (December 20, 2011). Brigham Young University Law Review,
2011, 1937-1989.

Fission Fragments. (n.d.). Retrieved March 28, 2015, from http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/fisfrag.html

Hamada, N., & Ogino, H. (2012). Food safety regulations: what we learned from the Fukushima nuclear accident. Journal of environmental radioactivity, 111, 83-99.

Hardie, S., & Mckinley, I. (2013, 12). Fukushima remediation: Status and overview of future plans. Journal of Environmental Radioactivity. doi:10.1016/j.jenvrad.2013.08.002

Hatch, M., Ron, E., Bouville, A., Zablotska, L., & Howe, G. (2005, 12). The Chernobyl Disaster: Cancer following the Accident at the Chernobyl Nuclear Power Plant. Epidemiologic Reviews, 27(1), 56-66. doi:10.1093/epirev/mxi012

Hiyama, A., Taira, W., Nohara, C., Iwasaki, M., Kinjo, S., Iwata, M., & Otaki, J. M. (2015). Spatiotemporal abnormality dynamics of the pale grass blue butterfly: three years of monitoring (2011–2013) after the Fukushima nuclear accident. BMC Evolutionary Biology, 15(1), 15.

Kharecha, P.A., and J.E. Hansen, 2013: Prevented mortality and greenhouse gas emissions from historical and projected nuclear power. Environ. Sci. Technol., 47, 4889-4895, doi:10.1021/es3051197.

Merz, S., Shozugawa, K., & Steinhauser, G. (2015, 12). Analysis of Japanese Radionuclide Monitoring Data of Food Before and After the Fukushima Nuclear Accident. Environmental Science & Technology, 49(5), 2875-2885. doi:10.1021/es5057648

Steinhauser, G., Brandl, A., & Johnson, T. E. (2014). Comparison of the Chernobyl and Fukushima nuclear accidents: a review of the environmental impacts. Science of the Total Environment, 470, 800-817.

Strickland, E. (n.d.). Explainer: What Went Wrong in Japan's Nuclear Reactors. Retrieved March 28, 2015, from http://spectrum.ieee.org/tech-talk/energy/nuclear/explainer-what-went-wrong-in-japans-nuclear-reactors

World Statistics. (n.d.). Retrieved March 28, 2015, from http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics

Yasunari, T. J., Stohl, A., Hayano, R. S., Burkhart, J. F., Eckhardt, S., & Yasunari, T. (2011, 01). From the Cover: Cesium-137 deposition and contamination of Japanese soils due to the Fukushima nuclear accident. Proceedings of the National Academy of Sciences, 108(49), 19530-19534. doi:10.1073/pnas.1112058108

Image Sources

http://www.sciencedirect.com/science/article/pii/S0265931X13001847#gr4

http://www.dailymail.co.uk/news/article-1372589/First-clear-pictures-true-devastation-Fukushima-nuclear-plant-Japan-flies-unmanned-drone-stricken-reactor.html

https://namhenderson.wordpress.com/2011/12/19/decontaminating-fukushima-prefecture/

http://l.rgbimg.com/cache1nOAIp/users/j/ja/jaylopez/600/mk80aXq.jpg

Layout by Jingting Wu