Five years later, nuclear expert offers three lessons from the Fukushima disaster

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Fact-finding team leader Mike Weightman of the International Atomic Energy Agency examines Reactor Unit 3 at the Fukushima Daiichi Nuclear Power Plant on May 27, 2011, to assess tsunami damage and study nuclear safety lessons that could be learned from the tragedy.

It has been five years since the emergency sirens sounded at Japan's

Fukushima Daiichi power plant following the massive 2011 earthquake and subsequent devastating tsunami. The partial meltdown of three reactors caused approximately 170,000 refugees to be displaced from their homes, and radiation releases and public outcry forced the Japanese government to temporarily shut down all of their nuclear power plants. The events at Fukushima Daiichi sent waves not only through Japan but also throughout the international nuclear industry. Rodney Ewing, an expert on nuclear materials, outlines three key lessons to be taken from the tragedy at Fukushima.

Lesson One: Avoid characterizing the Fukushima tragedy as an 'accident'

One of the biggest lessons to be learned from Fukushima Daiichi revolves around the language used to describe nuclear disasters. In the media and in scientific papers, the event was frequently described as an accident, but this does not properly capture the cause of the event, which was a failure of the safety analysis.

As an example, Ewing points specifically to the domino chain of events that led to the partial meltdown at reactors 1 and 3. Following the powerful magnitude 9.0 earthquake, the power plant automatically shut down its reactors, as designed. Emergency generators immediately started in order to maintain circulation of coolant over the nuclear fuel, a critical process to avoid heating and eventual meltdown. But the tsunami that followed flooded the diesel engines that were supplying power, and so cooling could no longer be maintained.

"The Japanese people and government were certainly well acquainted with the possibility of tsunamis," said Ewing, the Frank Stanton Professor in Nuclear Security and senior fellow at the Center for International Security and Cooperation in the Freeman Spogli Institute.

"Communities had alert systems. But somehow, this risk didn't manifest itself in the preparation and protection of the backup power for the Fukushima reactors. The backup power systems, the diesel generators for reactors 1 through 5, were low along the coast where they were flooded and failed. They could have been located farther back and higher, like they were at reactor 6. These were clearly failures in design, not an accident.

"This is why when I refer to the tragedy at Fukushima, it was not an accident," said Ewing, who is also a professor of geological sciences in Stanford's School of Earth, Energy & Environmental Sciences. "When some speak of such an event as an 'act of God,' this has the effect of avoiding the responsibility for the failed safety analysis. We need to use language that doesn't seek to place blame, but does establish cause and responsibility."

Lesson Two: Rethink the meaning of 'risk'

Shortly following the disaster at Fukushima, Tokyo Electric Power Company (TEPCO) received heavy criticism for its lack of planning and response. For Ewing, this criticism speaks to a larger issue: "We need to rethink what we mean by 'risk' when we perform risk assessments. Risk is more than the loss of life and property."

Reassessing risk also begins with changing our language, Ewing said. When we say a risk like an earthquake or tsunami is rare or unexpected, even when the geological record shows it has happened and will happen again, it greatly lessens the urgency with which we ought to act and prepare.

"It can be that the risk analysis works against safety, in the sense that if the risk analysis tells us that something's safe, then you don't take the necessary precautions," he said. "The Titanic had too few lifeboats because it was said to be 'unsinkable.' Fukushima is similar in that the assumption that the reactors were 'safe' during an earthquake led to the failure to consider the impact of a tsunami."

When evaluating risk, Ewing recommends that we carefully consider the way in which we frame the question of risk. For example, a typical risk assessment usually only considers the fate of a single reactor at a specific location. But perhaps that question should be asked in a different way. "You could ask, 'What if I have a string of reactors along the eastern coast of Japan? What is the risk of a tsunami hitting one of those reactors over their lifetime, say, 100 years?'" he said. "In this case, the probability of a reactor experiencing a tsunami is increased, particularly if one considers the geologic record for evidence of tsunamis."

Ewing acknowledges that incorporating geological hazards into a standard risk assessment has proved to be difficult because of the long recurrence intervals of damaging events. But ongoing research at Stanford Earth continues to analyze the seismic and tsunami risks around Japan and over the entire world. Professor Paul Segall and graduate student Andreas Mavrommatis analyze dense GPS networks and small repeating earthquakes to better understand unprecedented accelerating fault slip that took place in advance of the surprisingly large 2011 earthquake. Associate Professor Eric Dunham, graduate student Gabe Lotto and alum Jeremy Kozdon create mathematical models to better understand the relationships between fault motions, ocean floor properties and tsunami generation. And Assistant Professor Jenny Suckale is working to improve tsunami early warning messages that will allow populations in Indonesia to receive the specific information they need to prepare. This research, and more, helps quantify some of the geological risks that should have been considered.

Lesson Three: Nuclear energy is strongly linked to the

future of renewables

In the five years since the tragedy at Fukushima, Ewing has seen a number of ripple effects throughout the nuclear industry that will have a great impact on the future of renewable energy resources.

In the United States, the Nuclear Regulatory Commission has required that all reactor sites reassess risks from natural disasters. This includes not only earthquakes and tsunamis, but also flooding risks, particularly in the central United States. But this reaction wasn't shared globally.

"In countries like Germany and Switzerland, the Fukushima tragedy was the last straw," Ewing said. "This was particularly true in Germany, where there has always been a strong public position against nuclear power and against geologic waste disposal. Politically, Germany announced that it will shut down its nuclear power plants."

In a region like Germany, which is far more seismically stable than Japan, this move away from nuclear power marks an important – and expensive – transition for global energy systems. During the recent 21st Conference of the Parties meeting in Paris, Germany and a large number of other countries pledged to reduce carbon emissions.

"To me, Germany is a wonderful experiment," Ewing said. "Germany is a very technologically advanced country that is going to try to do without nuclear energy while simultaneously reducing its carbon emissions. This will require a significant investment in renewable energy sources, and that will be costly. But it's a cost that many Germans seem willing to pay."

As recently as 10 years ago, nuclear energy was quickly gaining support as a carbon-free power source. While the costs of renewables such as solar and wind remain more expensive than some fossil fuels, the steady decline in their costs and the boom of natural gas combined with the tragedy at Fukushima has once again muddied the waters of many countries' energy future.

"The biggest need for the U.S. right now is to have a well-defined energy policy," Ewing said. "With an energy policy, we would have a clear picture of how our country will address its energy needs."

Provided by Stanford University

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