

Study says Fukushima disaster was preventable

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The worst nuclear disaster since the 1986 Chernobyl meltdown never should have happened, according to a new study.

In the peer-reviewed *Philosophical Transactions A of the Royal Society*, researchers Costas Synolakis of the USC Viterbi School of Engineering and Utku Kâno?lu of the Middle East Technical University in Turkey distilled thousands of pages of government and industry reports and hundreds of news stories, focusing on the run-up to the disaster. They found that "arrogance and ignorance," design flaws, regulatory failures and improper hazard analyses doomed the coastal [nuclear power plant](#) even before the tsunami hit.

"While most studies have focused on the response to the accident, we've found that there were design problems that led to the disaster that should have been dealt with long before the earthquake hit," said Synolakis, professor of civil and environmental engineering at USC Viterbi.

"Earlier government and industry studies focused on the mechanical failures and 'buried the lead.' The pre-event tsunami hazards study if done properly, would have identified the [diesel generators](#) as the lynch pin of a future disaster. Fukushima Dai-ichi was a sitting duck waiting to be flooded."

The authors describe the disaster as a "cascade of industrial, regulatory and engineering failures," leading to a situation where critical infrastructure - in this case, backup generators to keep the cooling the plant in the event of main power loss - was built in harm's way.

At the four damaged nuclear power plants (Onagawa, Fukushima Dai-ichi, Fukushima Dai-ni, and Toka Dai-ni) 22 of the 33 total backup diesel generators were washed away, including 12 of 13 at Fukushima Dai-ichi. Of the 33 total backup power lines to off-site generators, all but two were obliterated by the tsunami.

Unable to cool itself, Fukushima Dai-ichi's reactors melted down one by one.

"What doomed Fukushima Dai-ichi was the elevation of the EDGs (emergency diesel generators)," the authors wrote. One set was located in a basement, and the others at 10 and 13 meters above sea level; inexplicably and fatally low, Synolakis said.

Synolakis and Kölu report that the Tokyo Electric Power Company (TEPCO), which ran the plant, first reduced the height of the coastal cliffs where the plant was built, underestimated potential tsunami heights, relied on its own internal faulty data and incomplete modeling - and ignored warnings from Japanese scientists that larger tsunamis were possible.

Prior to the disaster, TEPCO estimated that the maximum possible rise in water level at Fukushima Dai-ichi was 6.1 meters - a number that appears to have been based on low-resolution studies of earthquakes of magnitude 7.5, even though up to magnitude 8.6 quakes have been recorded along the same coast where the plant is located.

This is also despite the fact that TEPCO did two sets of calculations in 2008 based on datasets from different sources, each of which suggested that tsunami heights could top 8.4 meters - possibly reaching above 10 meters.

During the 2011 disaster, tsunami heights reached an estimated 13

meters at Fukushima Dai-ichi - high enough to flood all of the backup generators and wash away power lines.

Further, the 2010 Chilean earthquake (magnitude 8.8) should have been a wake-up call to TEPCO, said Synolakis, who describes it as the "last chance to avoid the accident." TEPCO conducted a new safety assessment of Fukushima Dai-ichi - but used 5.7 meters as the maximum possible height of a tsunami, against the published recommendations of some of its own scientists. TEPCO concluded in November 2010 that they had "assessed and confirmed the safety of the nuclear plants," presenting its findings at a nuclear engineering conference in Japan.

"The problem is that all of TEPCO's studies were done internally, there were no safety factors built in the analysis, which anyway lacked context. Globally, we lack standards for the tsunami-specific training and certification of engineers and scientists who perform hazard studies, and for the regulators who review them, who can in principle ensure that changes be made, if needed." Synolakis said. "How many licensing boards have tsunami-specific questions when granting professional accreditation?"

Lacking tsunami specific training, certification and licensing, the potential for similar mistakes to occur in hazard studies for other coastal nuclear power plants exists, he said. He points to recent studies around the world where lack of experience and context produced tsunami inundation projections with Fukushima size underestimation of the hazard.

Synolakis and Känou's paper was published on September 21. Their research as supported by ASTARTE Grant 603839 and the National Science Foundation, Award CMMI 1313839. In the same issue of the Philosophical Transactions, another review paper from the universities of Oxford, Cambridge and USC discusses hazards in the Eastern

Mediterranean, where [nuclear power](#) plants are being planned for construction in the next few years.

Provided by University of Southern California

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