Madsen asks several of the nuclear industry employees what they would say to our descendents, who many thousand years from now might be investigating Onkalo. One woman responded emphatically, "Go back up to the surface and take better care of the earth than we did. Good luck."

Jenny McBride is a member of the *Synthesis/Regeneration* editorial board. She lives in Illinois, the US state with the most nuclear power plants.

Sea Level Rise Brings Added Risks to Coastal Nuclear Plants

by Alyson Kenward

California's Diablo Canyon power plant is one of nine US nuclear power plants located on the coast. How these coastal plants will withstand sea level rise-related impacts remains unclear. In many parts of the world nuclear reactors are often located near the ocean, due to their requirement for abundant supplies of water for cooling purposes. While tsunamis, like the one that hit Japan in March 2011, aren't a threat everywhere, the sea can pose other challenges. Hurricanes, for example, can push walls of water ahead of them, like the storm surge that did most of the damage to New Orleans when Hurricane Katrina swept through in 2005. In fact, one US nuclear plant has already been dealt a direct hit by a severe hurricane.

But scientists anticipate that in the future, sea level rise will cause hurricanes and their storm surges, as well as flooding caused by other types of storms, to be more severe than during the past few decades. In the wake of the Japanese crisis, which involved a more devastating tsunami than planners anticipated, nuclear analysts in the US are now asking themselves how vulnerable coastal nuclear plants are to a comparable emergency.

Nuclear reactors are often located near the ocean, due to their requirement for abundant supplies of water for cooling purposes.

"After the events in Japan, we took a hard look at whether our operating facilities are protected, based on current regulations and operating procedures," says Roger Hannah, a senior public relations official with the US Nuclear Regulatory Commission (NRC). Relying on models of expected flood levels and storm surges, along with "real-world experience with hurricanes," the NRC believes all US coastal nuclear facilities are already built to withstand the worst-case storm scenario, Hannah says. On March 23, the NRC also launched an additional two-step review of US nuclear plants, aimed to last about three months.

Of course, the Fukushima Daiichi plant was also designed to withstand what officials considered a worst-case earthquake and tsunami, but that wasn't enough. All of the nine US nuclear plants that are within two miles of the ocean were built at least 30 years ago. But during these three decades the sea has been rising as a result of climate change (not to mention local changes in the geology at some locations, where the land is sinking), and sea level will continue inching up throughout the next century. If the sea is higher to begin with, that means storm surges or tsunamis will pack an extra punch. The worst case, in short, could be worse than anyone imagined when these plants were first built.

In 1992 Hurricane Andrew blew directly over Florida's Turkey Point nuclear plant, cutting off access to external power. The diesel generators supplied back-up power for five days and maintained reactor safety. At Fukushima Daiichi, workers had just a few minutes warning that a tsunami was on its way; at Turkey Point, however, officials were aware of Hurricane Andrew's approach for days in advance. That extra time was crucial: employees began to shut the plant down a full 12 hours before the storm was scheduled to strike.

The reactors and their protective concrete shells, built nearly 20 feet above the ground, resisted Andrew's hurricane-force winds. Yet across the rest of the Turkey Point property, owned and operated by Florida Power & Light Company (FPL), the combination of high winds and floodwaters brought down the fire-safety system, compromised the security system, and interrupted communication to stations off the property. Potentially the most hazardous incident was a loss of access to external power for five days. Engineers at Turkey Point were forced to rely on the on-site diesel generators to maintain cooling of the reactors' cores. Fortunately, this back-up system was enough to keep everything operating safely. In Ja-

The Fukushima Daiichi plant was also designed to withstand what officials considered a worst-case earthquake and tsunami.

pan, however, an equivalent back-up system was wiped out by the tsunami.

Turkey Point expansion

Next year, Florida's Turkey Point nuclear plant will celebrate its 40th birthday and is set to operate until at least 2032. It may also be expanding. In 2009, FPL submitted an application to build two new reactors on the same property.

The Obama administration has already endorsed nuclear power. That position hasn't changed since the Japanese emergency.

Turkey Point survived Category 5 Hurricane Andrew. Two new reactors are proposed at Turkey Point, but the safety assessment for them likely doesn't include realistic estimates of future sea level rise. The planned reactors are among 28 new ones the NRC is currently reviewing for construction nationwide. It's been 30 years since a nuclear plant was built in the US, but in recent years nuclear power has become a popular energy choice among policy makers who want to lower America's greenhouse gas emissions. For proponents of the nuclear industry, nuclear power is an existing low-carbon technology that can be implemented as soon as new plants are built. The Obama administration has already endorsed nuclear power as an important part of the country's plan to move away from fossil fuels, such as coal and natural gas. That position hasn't changed since the Japanese emergency began to unfold.

In its 2007 report, the UN Intergovernmental Panel on Climate Change (IPCC) found that global sea levels had been rising since the 1930s. The IPCC also found that today, on average, ocean levels are creeping upwards about 1.2 inches every decade. That might not sound like a lot, especially when nuclear plants are built 20 or 30 feet above sea level. But rising sea levels also raise the baseline level upon which storm surges are built. So what might once have been a nonthreatening storm surge can become a distinct danger.

"With sea-level rise, it's not the slow creeping that's the problem. It's the fact that with storms and other extreme events you push more water farther inland, which can create real problems," says environmental historian John Perkins from Evergreen State College in Olympia, WA., who has recently been studying the impacts that climate change may have on nuclear plants in the US.

In a 2008 study with graduate student Natalie Kopytko, Perkins specifically assessed what risks sea level rise posed for nine reactors along the East and West Coasts. Their findings, Perkins says, show that sea level rise isn't only important in terms of long term changes at the shoreline adjacent to nuclear plants. "[Kopytko] showed it was storms that were really behind the risk. These are US coastal reactors, and hurricanes can pile an awful lot of water in front of them."

In their study, Perkins and Kopytko used estimates of future sea level to calculate how much water might encroach upon nuclear plants. They found that the plants in the US were all built high enough to withstand sea level rise alone over the next 50 years (which goes beyond the expected operating lifetime of the current plants). But they also discovered that with the IPCC's expected rate of sea level rise, storm surges from Category 4 or 5 hurricanes will completely inundate the nuclear plants within their projected lifetimes. Their findings were published in the January 2011 issue of the journal *Energy Policy*.

As sea levels continue to rise, scientists say the storm surges of these hurricanes will get even larger. Worse yet, climate scientists now believe that while Atlantic hurricanes may become less frequent later this century, they're likely to get more powerful on average.

The NRC says it considers these factors when assessing the safety of nuclear plants, and that the existing facilities at Turkey Point, in particular, are capable of withstanding future storms, as proven by the experience with Hurricane Andrew. "We currently have models for all the nuclear facilities that exist, and those do take into account the expected levels of flood and storm surges," says the NRC's Hannah. A storm surge is an abnormal wave of water created during a storm, which rises above regular sea level.

Rising sea levels raise the baseline level upon which storm surges are built.

A new "worst-case scenario?"

Following the 2004 tsunami in the Indian Ocean, which was particularly devastating to Indonesia, the NRC reviewed its estimates of how big a threat storm surges could be to US coastal nuclear facilities—but ultimately decided not to change the way they calculate the "worst-case" scenario at each location. Since the Japanese tsunami, however, the NRC has issued a new report, calling for nuclear plants to become more prepared for future floods and to improve accident mitigation.

When it comes to figuring just how much sea level rise could affect the proposed new plants, which could have at least 100-year lifetimes from beginning of construction to complete decommissioning, Hannah says, "we look at the expectations for effects in the area in the future, and that includes storm surges."

During its safety assessment for the new reactors' applications at Turkey Point, FPL has modeled a worst-case scenario, based on what they estimate to be the highest tide conditions paired with the worst potential hurricane to strike the area—plus an additional 10% for an extra margin of safety. Based on these estimates, FPL predicts the maximum storm surge at the location of the new Turkey Point reac-

tors would likely be no higher than 24.8 feet, which is 1.2 feet below the plant's safety facilities.

In particular, these calculations of a likely maximum storm surge include an estimate that sea level could rise by between 0.78 and 1 foot in Biscayne Bay during the next century. This rate of sea level rise was based on observations taken at a nearby NOAA tide gauge between the years 1931 and 1981 and then extrapolated forward. Scientists, however, have observed that in recent decades the rate of sea level rise has been accelerating. According to a Climate Central analysis of sea level rise in the same region, but based on readings for the most recent 30-year period, the rate of sea level rise around Turkey Point is already about 15% higher, or about 1.1 feet per century, than what FPL used in its assessment. Consequently, FPL's assessment that Turkey Point can withstand a worst-case scenario storm might fall short.

There is already a growing consensus among scientists that the rate of sea level rise is higher than the IPCC estimated in their 2007 report. For example, a 2010 report from the National Academy of Sciences confirmed that the future rate of sea level rise may actually be higher than that projected by the 2007 IPCC assessment because that report didn't take into account future ice losses from Greenland and Antarctica. Consequently, FPL has likely failed to account for how much sea level will rise at Turkey Point in the next 100 years.

Because these rates of sea level rise are included in the calculations of how large storm surges could be at Turkey Point, FPL may also be underestimating their "worst-case scenario." Greenland holds enough ice to raise sea level 23 feet. That won't happen by the 2100, but scientists now say that Greenland will probably contribute to more sea level rise than the IPCC predicted in their 2007 report.

Scientists have already recommended that major coastal installations, including industrial plants and naval bases, prepare for more sea level rise in the next century than what FPL has estimated. For example, in a new report on sea level rise, the Academy recommends that the Navy prepare for an average of 2.6 feet of sea level rise by 2100. That report also emphasized the threat posed by storm surge-related flooding, rather than the increase in baseline sea levels.

The extent of sea level rise that FPL has incorporated into their estimates of the maximum possible storm surge has already become a point of contention in the safety assessment for the new Turkey Point reactors. The Miami-Dade County Climate Change Advisory Task Force (CCATF) has called for the NRC to request that a much higher level of sea level rise be included in the assessment.

In support of a petition against FPL's proposal to build the two new reactors at Turkey Point, University of Miami geologist Harold Wanless has testified on behalf of the Miami-Dade CCATF: "With what is happening in the Arctic and Greenland, many respected scientists now see a likely sea level rise of at least 1.5 feet in the coming 50 years and a total of at least 3 to 5 feet by the end of the century, possibly significantly more."

Consequently, FPL's assessment that Turkey Point can withstand a worst-case scenario storm might fall short.

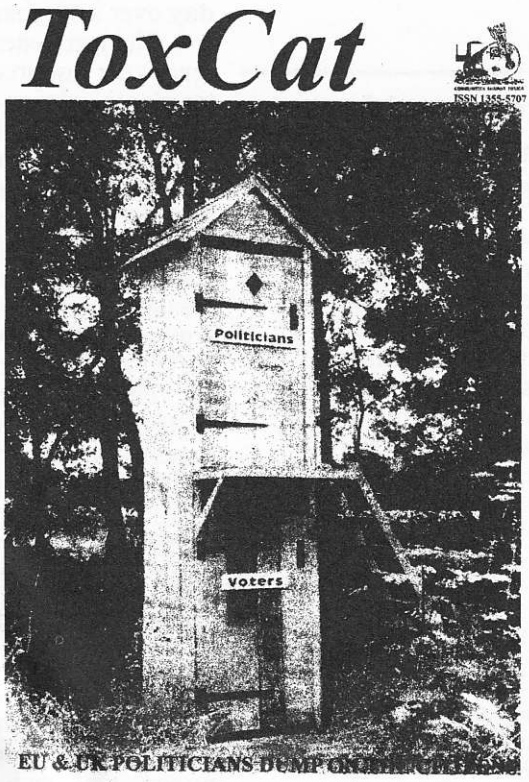
Wanless, who also chairs Miami-Dade's climate change task force, further testified that "incorporating [realistic] future sea level changes will change the safety and structural integrity of the complex during major storms." Currently the safety assessment for the new Turkey Point reactors is still under review and the NRC has not authorized the construction of the new reactors.

However, David Lochbaum of the Union of Concerned Scientists doesn't expect that the NRC will change its policies to demand that a higher estimate of sea level rise be incorporated into maximum storm surge calculations.

"Thus far, the NRC has been looking backwards in terms of predicting changes [to sea level rise]," he explained, "And if they've been doing that for 30 years, I don't anticipate they'll change that soon."

Alyson Kenward is a scientist and journalist with Climate Central, a nonprofit collaboration between research scientists and communicators. Climate Central's Heidi Cullen, Andrew Freedman, and Michael Lemonick contributed reporting to this story. Senior Scientist Claudia Tebaldi conducted sea level rise calculations.

See the original story at http://www.climatecentral.org/news/sea-level-rise-brings-added-risks-to-coastal-nuclear-plants



ToxCat provides information on the technical, scientific and medical aspects of toxic issues in an understandable language. Communities Against Toxics, P.O. Box 29, Ellesmere Port, Cheshire CH66 3TX United Kingdom, +44(0)151 339 5473 www.communities-against-toxics.org.uk