

**Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Distinguished Professor of Earth and Planetary Sciences, UC Santa Cruz.**

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**Fukushima—The Continuing Saga**

Nuclear power plants are different in one very significant respect from any other form of electrical power generation. If radiation is released - and there are a number of places in the Uranium mining, refining, transport, power generation and then storage cycle where this can happen - you don't get it back. We can't see it but we can measure it. And over days or decades, it can spread globally in the air and water.

The three major nuclear power plant disasters - Three-Mile Island, Chernobyl, and Fukushima - made that painfully clear. And unfortunately, the people who run these plants, just like all the rest of us, aren't perfect. People get tired, mistakes are made, accidents and natural disasters happen.

Ken Buesseler, a chemical oceanographer at the Wood Hole Oceanographic Institution, almost single-handedly took on the job of analyzing water samples from the Pacific Ocean following the Fukushima explosion, meltdown and fire. He has continued this work for seven years and has been carefully analyzing water samples collected by ships crossing the Pacific.

It took about three and a half years until trace amounts of the radioactive element being sampled (Cesium-137) were first detected in the ocean off the US west coast.

As discussed two weeks ago, the currents in the North Pacific move pretty slowly and there has now been seven years of dilution, decay and dispersion.

The most recent samples analyzed and reported from along the central California coast (offshore Bodega Bay, Point Reyes and Morro Bay) indicate gradually increasing but very low concentrations of Cesium 137 (1 to 7 Becquerels per cubic meter of seawater- a unit of radiation that doesn't mean much to most of us).

In Dr. Buesseler's words, "While elevated, these levels are still well below regulatory limits of 7,400 Becquerels/cubic meter set for drinking water (U.S. EPA). By our calculations, even if levels increase, swimming eight hours every day for an entire year would only increase one's annual dose by an amount 1000 times less than a single dental X-ray." I'm going to have to take his word on this one.

The bigger and more challenging problems lie at Fukushima itself. The cooling system failure, the meltdown, and explosions left a mangled pile of steel, concrete and thousands of damaged fuel rods filled with uranium oxide pellets. Even after seven years there are still unknowns as to what exists beneath the pile of debris and how to deal with it. Two years ago the power company estimated that the overall price tag for cleaning up the disaster would exceed \$200 billion. A private think tank in Japan now believes the final cleanup could exceed \$500 billion. That's a 5 followed by 11 zeroes and is equivalent to 58% of Japan's total 2018 budget.

And how long is this effort going to take? The utility company anticipates that they can do the job in 30 to 40 years, but others believe this is optimistic. Thirty to forty years and \$200 to \$500 billion to clean up a nuclear power plant meltdown should

provide us serious pause before we ever consider building another nuclear plant in this country.

Water is still being continuously pumped through all of the reactors to keep the fuel cool, and there are now about 1,000 tanks on site storing one million tons of water that has been contaminated in the cooling process. And this burden increases by about 100 more tons or 26,500 gallons every day.

A subsurface refrigeration system was constructed at a cost of \$325 million in an attempt to build an ice wall around the entire site as a way to eliminate water flowing beneath the reactors and carrying additional radiation to the sea. This experimental approach hasn't worked as well as hoped, and there is still no plan for how to deal with the one million tons of contaminated water sitting in the 1000 tanks. This is a massive problem that was never anticipated and it's not going away any time soon.

I should also say that this month marks ten years that Dan Haifley and I have been writing Our Ocean Backyard columns. Congratulations Dan!