

Ocean still suffering from Fukushima fallout

Continuing leaks and contaminated sediment keep radiation levels high.

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14 November 2012

TOKYO

Radioactivity is persisting in the ocean waters close to Japan's ruined nuclear power plant at Fukushima Daiichi.

New data presented at a [conference](#) held on 12–13 November at the University of Tokyo show that levels of radioactivity in the sea around the plant remain stable, rather than falling as expected. Researchers believe that run-off from rivers, as well as continued leaks from the plant, may be partially to blame. But contaminated sediment and marine organisms also seem to be involved.

The level of contamination is not likely to pose a significant health risk to humans. But it could have long-term economic consequences for fishermen along Japan's east coast.

On 11 March 2011, a magnitude-9 earthquake struck off the coast of Japan. The quake sparked a massive tsunami that hit the Fukushima Daiichi nuclear power plant. Three of the plant's six units suffered meltdown, releasing large quantities of radioactivity into the atmosphere. In the days after the accident, emergency cooling water leaked into the sea, adding to ocean contamination.

The Fukushima disaster caused by far the largest discharge of radioactivity into the ocean ever seen. A new model presented by scientists from Woods Hole Oceanographic Institution in Massachusetts estimates that 16.2 petabecquerels (10^{15} becquerels) of radioactive caesium leaked from the plant — roughly the same amount that went into the atmosphere.

Most of that radioactivity dispersed across the Pacific Ocean, where it became diluted to extremely low levels. But in the region of the ocean near the plant, levels of caesium-137 have remained fixed at around 1,000 becquerels, a relatively high level compared to the natural background. Similarly, levels of radioactive caesium in bottom-dwelling fish remain pretty much unchanged more than 18 months after the accident.

Triple blow

Researchers at the conference are convinced that something is preventing the radiation levels from dropping. "There must be a source," says Scott Fowler, an oceanographer at Stony Brook University in New York.

In fact, a fresh analysis by oceanographer Jota Kanda at the Tokyo University of Marine Science and Technology suggests that not one source, but three, are responsible. First, radioactivity from the land is being washed by rainfall into rivers, which carry it to the sea. Second, the plant itself is leaking around 0.3 terabecquerels (10^{12} becquerels) per month, he estimates.

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But Kanda thinks that the third source, marine sediment, is the main cause of the contamination. Around 95 terabecquerels of radioactive caesium has found its way to the sandy ocean floor near the plant. How it got there, Kanda says, no one is sure. It may have been absorbed directly by the sand itself, or it may be that tiny marine organisms such as plankton consumed the radioactive caesium and then deposited it on the sea floor through their excretions. Organic detritus from rivers could also be a source of the contamination, he says. Regardless of how it got there, "there must be some loaded organic material somewhere in the sediment", Kanda says.

Whether originating from plankton or sediment, the contamination is finding its way into the food chain. Bottom-dwelling fish in the Fukushima area show radioactivity levels above the limit of 100 becquerels per kilogram set by the Japanese government. Greenlings,



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Seafood from the seas around the destroyed Fukushima nuclear power plant is still not considered safe to eat.

for example, have been found to have levels as high as 25,000 becquerels per kilogram. But the contamination varies widely between species. Octopuses and squid seem to have escaped contamination, whereas other fish such as red snapper and sea bass are only sometimes found to be contaminated. Overall, the levels of caesium in fish and marine life seem to have begun dropping slightly this autumn, says Tomowo Watanabe, an oceanographer with the Fisheries Research Agency in Yokohama.

The implications are serious for the fishing industry, which lost an estimated ¥100 billion to ¥200 billion (US\$1.3 billion to \$2.6 billion) in 2011 as a result of the accident. Many fisheries remain closed, and because of the persistent contamination "we can't answer the basic question of when these fisheries will be able to open", says Woods Hole oceanographer Ken Buesseler.

Much more must be done to understand the accident, Buesseler says. He hopes that, in the coming months, researchers will be able to find out more about the various sources of radioactivity that continue to feed into the ocean, as well as how this affects different organisms.

Nature | doi:10.1038/nature.2012.11823