MARITIME FORUM

# Outcome of EU-Japan meeting to assess risk to marine environment from Fukushima

Event date:
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A meeting on 3 October, 2011, was held to (1) assess the risk of contaminated seafood reaching the EU market (2) determine whether the EU marine science community could assist their Japanese colleagues following the catastrophic events of March 2011. They were a follow-up to an earlier risk assessment meeting on 16 May 2011 and the EU Japan summit of 28 May 2011.

Release

Radionuclides were released into the ocean both directly and by atmospheric deposition.. The Iodine 131 ($^{131}$I) with its eight-day half life is no longer of radiological significance, Caesium 134 ($^{134}$Cs) and caesium 137 ($^{137}$Cs) were measured everywhere in roughly equal quantities but as yet there is no agreement as to the total released.

The Japanese Atomic Energy Agency assumed 8.5 petabequerels (PBq) of$^{137}$Cs and 10 PBq of $^{134}$Cs were directly released into the ocean whereas the French Institute for Radioprotection and Safety estimated 26 PBq of 137Cs alone. However, because of the subsequent exponential drop in radioactivity due to dilution in ocean currents, this degree of uncertainty may affect only the risk analysis in coastal waters.

The Japanese government estimated a release of about 18 PBq of $^{134}$Cs and 15 PBq of $^{137}$Cs into the atmosphere. Given the prevailing westerly winds in the days following the accident, it is likely that a substantial portion of this fell in the ocean. There are, as yet, no reasonable estimates of where this was deposited into the ocean. Almost certainly it was not evenly distributed. However, the point source assumption is conservative concept from the view of the dose calculation using the maximum concentration.

Contamination in water

A number of measurements have been carried out by the several organizations (MEXT, TEPCO, etc.). The summary presented by the Japan Atomic Energy Agency showed a falling off of radioactivity with time and distance from the Fukushima plant. Levels at deep sea have been lower than detection limits of the measurement technique. Future measurements will focus on a wider area and will be able to measure lower levels by increasing the volumes of seawater measured and the time spent measuring it.

Pavel Povinec put the measurements in a historical perspective. He said that Fukushima has contributed to about 10% of the total radioactivity in waters of the Pacific. Most of the background is due to global fallout from bomb testing in the 1960s. The fallout from Chernobyl was visible but not to the same extent.

Distribution of the background is uneven, mostly concentrated in the top kilometre of the water column and slightly greater in magnitude in the northern hemisphere than the south. This thorough sampling of the "before" contamination provides a good baseline for estimating the additional activity caused by the Fukushima accident.

Several organisations had made simulations of the circulation of the ocean and convection of contaminant following the accident. These included JCOPE2 and LAMER by the Japanese government, Mercator's global model, IRSN/Ifremer circulation model and Sirocco's coastal model. The results indicated rather good agreement with the measurements close to the plant and at the measuring stations 30km away, particularly at times two months after the accident. Residual uncertainties are due to atmospheric deposition, circulation modelling[1] [2], and resuspension from sediments.

Contamination in marine life

The Japanese Fisheries Agency is working under exceptionally difficult conditions. On top of the 20,000 people killed, the tragedy of March 2011 had destroyed 25,000 fishing vessels, 300 fishing ports and the livelihoods of 70,000 fishermen. Nevertheless they have managed to prepare and implement a strategy to ensure that contaminated fish landed in Japanese waters do not reach the market.

The maximum permissible levels for contamination (500Bq/kg for 137Cs, 2000Bq/kg for 131I) are within the international standards. Measurements above this limit up to 26 September 2011 are summarised in the table below.

| | **samples** | **Samples above limit** | **Species above limit** |
|---|---|---|---|
| Saltwater fish | 1370 | 61 | Japanese sandlance (12), white bait (4), Fat greenling (9), Brown hakeling (6), Stone flounder (3), Goldeye rockfish (2), Rockfish (4), Ocellate spot skate (12), Slime flounder (1), Olive flounder (3), Marbled flounder (2), Seabass (1), Black rockfish (1) |
| Invertebrates | 336 | 12 | Mediterranean mussel (1), Surf clam (4), Northern sea urchin (6), Japanese mitten crab (1) |
| Seaweed | 55 | 8 | Wakame seaweed (1), Hijiki seaweed (1), Arame seaweed (6) |
| Processed sea-food | 22 | 0 | |
| Freshwater fish | 411 | 41 | Ayu sweetfish (21), land-locked cherry salmon (8), Japanese smelt (5), Japanese dace (4), White spotted char (2), Willow gudgeon (1) |
| Marine mammals | 27 | 0 | |

All these contaminated samples of marine species were found off the coast of Fukushima prefecture. The only exception were from northern Ibaraki where six samples of Japanese sandlance and one of brown hakeling were above the limit. No fishing activities are allowed off Fukushima and no bottom trawler is operating in northern Ibaraki. The intensity of monitoring samples has been increasing and the proportion of those exceeding the provisional regulatory values has been decreasing.

Collecte Localisation Satellites (CLS) have made some efforts to simulate contamination from phytoplankton, through micronekton to skipjack tuna. The simulations indicate that that tuna feeding in the contaminated area could be caught outside the Japanese exclusive economic zone. However, of the approximately one hundred 100 skipjack that have been sampled so far within the Japanese exclusive economic zone, none have shown any contamination above the limit.

Measurements of imports

The European Commission's Directorate General for Health and Consumers summarised actions taken at an EU level to prevent contaminated food and feed entering the EU market. All products from twelve

contaminated prefectures must be certified as being compliant with the maximum levels and 10% of imports are checked on entry. Imports from the unaffected prefectures require a certificate confirming their origin from outside this zone and 20% of these are checked on entry. The 694 consignments sampled by EU competent authorities included some marine products. None of these were contaminated above 10Bq/kg. The limit is the same as Japan – 500Bq/kg.

In addition the Commission has recommended that fish, fishery products and other marine products caught in the rest of the Pacific be monitored on a random basis. This monitoring should not result in transit delays. So far 216 samples have been analysed and none were contaminated with radioactive caesium at a level above 10 Bq/kg.

Risk

There is zero risk to human consumers from Pacific fish. Maximum radioactivity levels are set at a level that requires years of exposure to harm human health. No contamination has been found and even if it were, the health-risk of consuming one tin of tuna with contamination slightly above the limit would be of the same order as smoking one cigarette.

However it is necessary to maintain consumer confidence. No contaminated products at all must be allowed on the EU market. The experts were asked to assess the risk that this could happen for fish caught outside the Japanese exclusive economic zone.

Although few measurements have been made in the deep ocean, the simulations all indicate that the concentrations in the seawater far from the coast are much too low to cause concern and will fall still further due to dilution. So the risk that fish will become contaminated through ingesting water or feed beyond the Japanese waters is almost zero. The United States Food and Drugs Administration and National Oceanic and Atmospheric Administration do not anticipate contamination of living marine resources in United States waters. It would take about two years for currents to carry the contamination to Hawaii and another two years to California.

However, tracking experiments indicate that albacore, skipjack and other predators can swim faster than the currents so, in principle, could become contaminated by feeding near the Fukushima coast and then be caught outside the Japanese exclusive economic zone. Radioactivity levels in some samples of potential prey caught off Fukushima are still four times the maximum permitted level and the predators are capable of crossing the whole Pacific Ocean (from Japan to the United States west coast) in a few months. For example, a juvenile bluefin tuna tagged near Japan reached Californian waters in two months[2] [3].

Even here the risk is small. Experiments show that marine fish do not accumulate radionuclides in their tissue but excrete them to establish an equilibrium in the osmotic pressures. A relationship, the contamination factor, can be established between radioactivity in the water and in the fish. Therefore contamination levels in any fish that have left the contaminated zone will now be diminishing. Using the half-life of 58 days that the literature indicates, one can estimate that the speediest fishes, potentially contaminated offshore Japan, would reach the United States west coast with a contamination half the value when leaving Japanese waters. Such fast migrating fish caught in the middle of their migration (say offshore Hawaii) would remain with a contamination rate of about 70 % of the initial value. Since no fish have been found with contamination more than four times the legal limit, a fish that had left the contaminated zone more than four months ago would not pose any risk.

So, whilst continuing to maintain a cautious approach, the experts suggested that the EU's recommendation for monitoring imports from the Pacific should be relaxed. Only migratory pelagic fish should be monitored - tuna (albacore, bluefin, bigeye and skipjack) and billfishes (swordfish, marlin).

There was some debate as to whether fish caught in the Pacific but outside zone 61[3] [4] need be monitored. The probability *Pc* that an individual fish caught outside the region is contaminated beyond the

limit of 500Bq/kg is :

*Pc < Pf Pa Pe*

Where *Pf* is probability that it has passed through Fukushima area within the past four months, *Pa* is probability that it had gorged itself with prey contaminated at least twice the permitted level and *Pe* is probability that this feeding raised its own contamination to the same level.

So far no contamination of these migratory species has been observed anywhere in the Pacific and this gives confidence that the probability is indeed low enough to neglect and that monitoring of imports from outside are 61 can be stopped.

Nevertheless contamination measured in Japanese waters would provide an early warning of an increased risk elsewhere. So results from Japanese monitoring of these species sampled inside the waters off the Fukushima prefecture should continue to be watched. It would be useful if the Japanese could provide a spreadsheet of their measurements that can be read digitally. The file posted on the Ministry of Foreign Affairs web site is extremely useful but laborious to analyse.

Follow-up

The European Commission is putting in place measures that could provide finance support to Japan in monitoring the marine environment through its instrument for nuclear safety cooperation. A visit is planned to assess the needs. Furthermore the Euratom work programme for 2012 and 2013 invites proposals from consortia of laboratories to research topics that include the aftermath of Fukushima.

The experts were invited to remain in contact through e-mail or Facebook (http://www.facebook.com/#!/groups/200295596670161/ [5]). Another meeting to follow-up progress will be organised if necessary.

Participants

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The presentations made are available through;

https://webgate.ec.europa.eu/maritimeforum/node/2263 [6]

[1] [7] Sirocco found eddies and alongshore circulation changed depending on whether Mercator or the US Navy NCOM code provided the boundary conditions.

[2] [8] Itoh et al. Migration patterns of young Pacific bluefin tuna (Thunnus orientalis) determined with archival tags. Fish. Bull. 101:514–534 (2003).

[3] [9] The current recommendation is for all species and the whole of the Pacific (61, 67, 71, 77, 81 and 87)

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