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Japan and the Fukushima accident: an additional chapter to a long history ?

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The worst events causing radioactivity in Japan's history seem to be closely related: in August 1945, Japan was hit by two nuclear bombs, with over 200,000 lives lost in Hiroshima and Nagasaki; in April 2011, after an earthquake caused a tsunami, the nuclear power plant (NPP) complex of Fukushima, comprising six NPPs, was severely affected, leading to serious environmental contamination, as illustrated Figure 1.

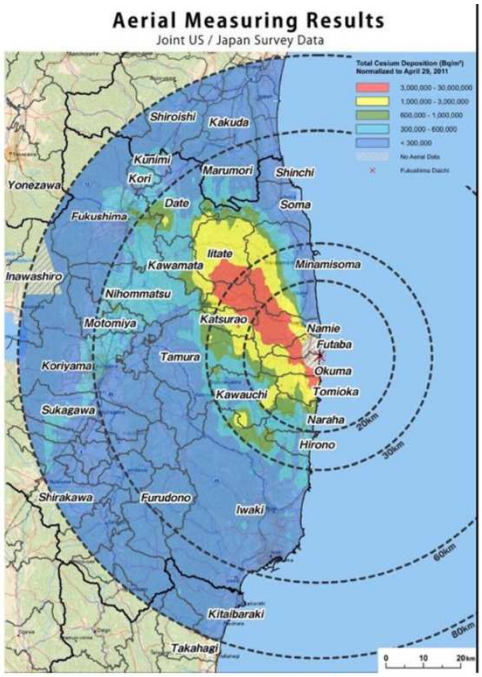

Figure 1: Total $^{137}Cs+^{134}Cs$ soil deposition over the Fukushima region, from aerial survey of April 29th, 2011 (source IAEA)

Regarding the recent tsunami, after information came in from the local NPP operator about the partial core melt at Units 1, 2 and 3 and after the accident was reclassified to level 7 of the INES scale, an inevitable, although quite controversial, comparison between the Fukushima and Chernobyl accidents appeared in the media. According to the IAEA, the radioactivity released during the Fukushima accidents corresponds to approximately 10% of that released during the Chernobyl accident. During the Chernobyl accident, the winds blew the radioactive contamination to Europe, mainly Belarus and Scandinavia, while during the Fukushima accident, the vast majority of the Fukushima-Daiichi-NPP fallout fell into the Pacific Ocean or far beyond Japan's coastline (IAEA).

Comparing Figure 1 to the contamination map of Europe after Chernobyl (Figure 2), the most obvious difference is the area involved: one exhibits a trans-boundary contamination while the other is local. Another visible difference is the scale of contamination. The Fukushima blue scale is<300 kBq m^{-2}, while in Figure 2, the red scale represents values between 185 and 1,480 kBq m^{-2}. This difference can lead to questions about a lack of transparency related to the present accident, as posted on a recent webpage[1].

Therefore, the first radioecology task in Japan is to answer the following questions. Using a similar scale applied to Europe after Chernobyl, how does the contamination map in Japan relate? Starting from the 37-175 kBq m^{-2} zone for radiation control up to >1,440 kBq m^{-2} zone of alienation, what is the affected area of Japan? Because the yellow area in Figure 1 corresponds to a total cesium contamination between 1,000 and 3,000 kBq m^{-2}, the yellow and red zones are potential zones of alienation, representing a challenge for radioecologists in Japan. Because of the use of mixed uranium-plutonium fuels in Fukushima, soil monitoring for other radionuclides in addition to ^{137}Cs+^{134}Cs will demand additional effort from radioecology groups in Japan. Taking into account that some groups are facing problems related to damage to their infra-structure and because of the earthquake itself, international cooperation may be required.

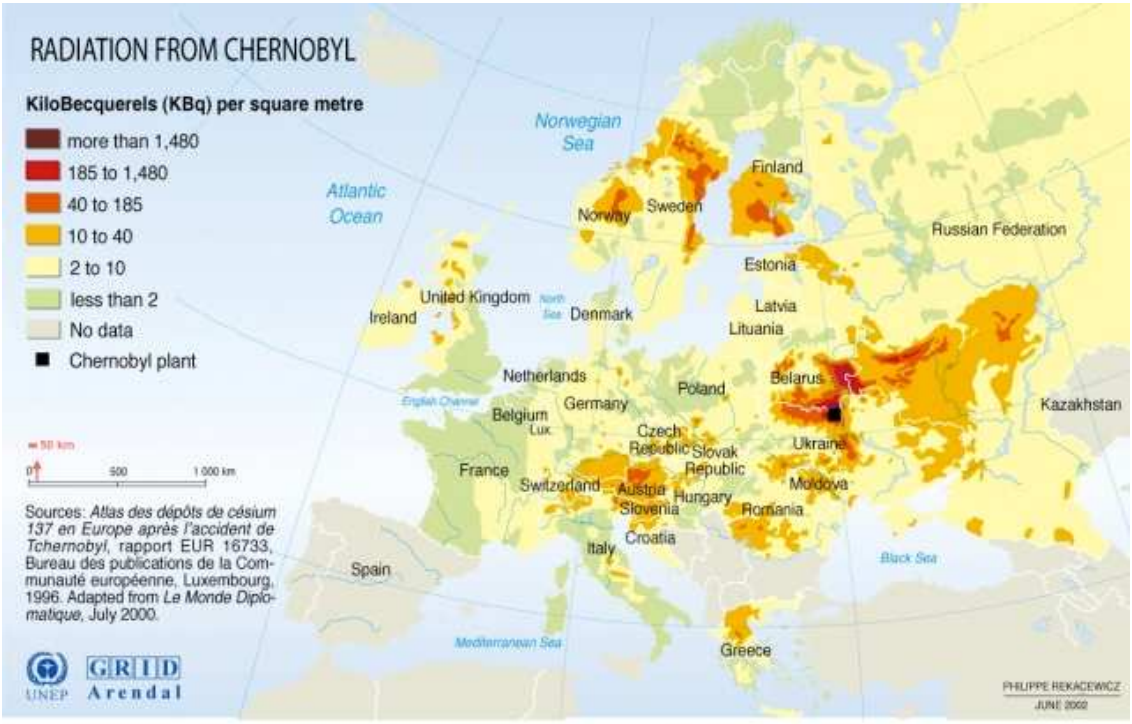

Figure 2: Europe soil contamination map after Chernobyl

During many phases of the accident, the wind was blowing seaward together with a total cesium release of approximately $2x10^{15}$Bq, and at the end of April, the wind was blowing directly toward the coastal areas. Consequently, marine radioecology also becomes an issue. According to the IAEA-Monaco report, ^{137}Cs concentrations up to 1,000 Bq L^{-1} were measured in the seawater 10 km from the discharge point. The first reports were based only on sand lance fish samples above the total cesium Japanese regulation for food (500 Bq kg^{-1}), but the most recent IAEA report (12-18 May) included other fish species, such as whitebait, ayu and Japanese smelt. Still, qualitative and quantitative

[1] http://allegedlyapparent.wordpress.com/2011/05/19/fukushima-2011-versus-chernobyl-1986-a-fallout-map-comparison/

information are missing that would allow a thorough evaluation of the current contamination in the marine environment, particularly close to the reactor site.

The measurement data provided by the reactor operator[2] show a $^{134}Cs/^{137}Cs$ activity ratio of approximately 1, which is almost twice that originating from the Chernobyl accident. This high activity ratio will probably allow the use of ^{134}Cs as good tracer of the Fukushima plume for both marine and terrestrial environments.

The Sirocco project homepage[3] shows a simulation of the ^{137}Cs concentration on surface seawater originating from the aerial deposition and the from direct release to the coastal area.

In 2009, the Hiroshima Peace Science group published an article (volume 31, 65-86) titled "Radioactive Contamination and Social Consequences Caused by the Chernobyl Nuclear Accident". This article offered the following prophetic conclusion:

"On July 16, 2007, a 6.8 magnitude earthquake hit the Kashiwazaki-Kariwa NPP in Niigata prefecture, the largest NPP in the world (7 BWRs, 8.2 GWe), the epicenter of which was 16 km northwest from the NPP and 17 km under the ground. Although a maximum acceleration more than 2 – 3 times larger than the resistant-earthquake design was recorded, fortunately the four reactors that were operating at the time could be stopped without serious discharge of radioactivity. Some nuclear energy proponents are saying this earthquake indicated the integrity of the safety system of NPP in Japan. On the other side, serious people are considering that this earthquake was a warning against building nuclear power reactors on islands where earthquakes will inevitably occur again in future.

Currently (December 2009), 435 nuclear power reactors (total 373 GWe) are in operation in the world, producing about 16 % of electricity. In Japan about 30 % of electricity is produced by 54 nuclear power reactors (49 GWe). It should be pointed out that the most dangerous thing is that the people working at nuclear facilities believe that there is no danger in nuclear energy. Considering the huge scale of a nuclear catastrophe, the decision whether or not our society will rely on nuclear energy should not be made by nuclear engineering specialists. It should be made based on the opinion of ordinary citizens."

Although quite prophetic for the actual Japanese situation, these words may be valid for many other countries. Therefore, the Fukushima accident should be used as motivation for the reevaluation of all the risk analysis carried out for the existing and planned nuclear installations

[2] http://www.tepco.co.jp/en/press/corp-com/release/betu11_e/images/110518e10.pdf

[3] http://sirocco.omp.obs-mip.fr/outils/Symphonie/Produits/Japan/SymphoniePreviJapan.htm#Tra1S_field