CRIIRAD
Commission de Recherche
et d'Information Indépendantes
sur la Radioactivité

**Valence**
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# Consequences of the Fukushima Daiichi Accident in Japan :

# A substantial and long-lasting contamination

The CRIIRAD institute went on a mission in Japan from May 24th to June 3rd, 2011. The present document gives account of the findings from the first analysis results. The radioactive cesium deposits on the soils have been of great magnitude. They generate, and will continue to do so for a long time to come, a flux of gamma radiation causing the irradiation of populations in widespread areas. Due to this external exposure and in the absence of protective measures, several hundreds of thousands of people will receive radiation doses far above the limit of 1 mSv/year. Must be added, the internal exposure (due to ingestion of contaminated foods) and doses received since March 12th that were extremely elevated during the first week from the level of contamination and the lack of protective measures.

## 1 / Scope of the contamination at over 60 km from the NPP : the case of Fukushima City

### External irradiation leads to an unacceptable risk level

Survey field measurements and soil analyses carried out by the CRIIRAD laboratory in the city of **Fukushima,** located 60-65 km from the nuclear power plant, indicate that the cesium 134 and 137 radioactive fallouts are several hundreds of thousands of $Bq/m^2$ : **490 000 $Bq/m^2$** on the lawn of the Moriai primary school and **over 700 000 $Bq/m^2$** in the Watari district.

When decaying, cesium atoms emit very penetrating gamma radiations. They can travel over 60 meters in the airstream. This is what allowed the Americans to plot charts on the fallouts using heliported probes. These radiations can also penetrate through walls and windows and irradiate people within their homes.

At the end of May 2011, the dose rates collected by the CRIIRAD in Fukushima city, at 1 meter above ground in the outside, was typically over 10 times, even over 20 times above normal (more than 1 and 2 µSv/h versus a normal level of 0,1 µSv/h). The irradiation is still measurable within buildings floors. Measurements carried out on the 4th floor of a building showed a radiation excess that increases when getting close to the windows (even when shut). Inside a home located in the Watari district, the CRIIRAD measured a dose rate over 3 times above normal on the tatami of the children's bedroom (0,38 µSv/h) and 6 times over at 1 meter above ground in the living room (0,6 µSv/h). In front of the house, measurement was 2,2 µSv/h in the garden and 2,9 µSv/h on the lawn of a nearby school (measurement taken at 1 meter above ground).

This irradiation will only decay very slowly. This is due principally to the cesium 137 and 134 that have long physical periods (30 years and 2 years respectively). This means that the cesium 137 radioactivity will be divided by half in 30 years. We can estimate that within the next twelve months, the **cesium 134** radioactivity will decline by only **30 %** and the **cesium 137** by **3%**.

**If nothing is done, the Fukushima city inhabitants could be exposed to an external irradiation of several milliSieverts within the next twelve months.** The dose, above which cancer lethal risk is considered as inacceptable by the ICRP (International Commission for Radiological Protection) is **1 milliSievert per annum, which corresponds to 5 deaths for 100 000 persons exposed to this effective dose.**



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Yet the Japanese authorities have set a dose limitation of **20 milliSieverts** as criterion for ordering - or not - the permanent evacuation of the population. This corresponds to a lethal cancer risk 20 times higher than the "acceptable" level. It is even more outrageous that the inhabitants of Fukushima have already been exposed very extensively. Doses due to internal contamination that these people continue to receive by ingesting contaminated foods and those due to the inhalation of dusts from contaminated soils must also be taken into account.

In another site in Fukushima City, the CRIIRAD measured a contamination in cesium 137 + 134 of 370 000 Bq/kg in the soil sampled under the **swings of the Moriai primary school**. **This soil has become a radioactive waste that should be stored in an appropriate zone without delay.**

**A population already severely exposed to radiations**

**The persisting contamination in iodine 131 of the soils sampled by the CRIIRAD at the end of May 2011 in Fukushima city allowed to determine the initial iodine 131 fallouts in millions of Bq/m$^2$.**

The iodine 131 has a physical period of 8 days, its radioactivity was therefore over 600 times higher during the fallouts. This attests of the severe contamination in the air during the incursion of the contaminated plumes, in particular on March 15$^{th}$, 2011.

Other radioactive substances were also present and which significantly decayed since such as : cesium 136, tellurium 129, tellurium 132, iodine 132, iodine 133, etc.. as well as radioactive gases such as xenon 133 and krypton 85 that did not build-up in the soils.

The inhabitants of this city have been subjected to a very severe internal contamination, first, by inhaling contaminated air and mostly by ingesting foods contaminated by the deposits of radioactive substances. The Japanese authorities adopted consumption restrictions within the FUKUSHIMA prefecture only on March 21st and 23rd (according to food types). **Populations therefore consumed, for a period of over a week, extremely contaminated foods without any restriction notice and with no information. They may have therefore received effective doses of several dozens milliSieverts (and even more) and doses to the thyroid gland exceeding the Sievert**.

For the record, the initial contamination of the spinach supply in iodine 131, at 100 km south of the nuclear plant was such that when consuming 200 grams, a young child would exceed the maximal annual dose admissible of 1 milliSievert; at 40 kilometers northwest, the plants were so contaminated that the annual limit would be reached when consuming only 5 grams of these foods.

It is essential that the exposed populations obtain reliable assessments on the dose levels they have been receiving and it is of utmost importance to strive to control further exposure in the future.

## 2 / Magnitude of the territories struck by the radioactive fallout

The fallout affects a very vast territory, well beyond the forbidden area of 20 km and far beyond the Fukushima Prefecture. Depending on weather conditions, contaminated air masses swept over hundreds of kilometers and precipitations (rain and snow) percolated radioactive particles down on the ground. Cesium 134 and 137 deposits are the cause of a lasting contamination.

This has been confirmed by the soil samples and the dose rate measurements conducted[1] by the CRIIRAD (at 1 meter above ground), from May 24 through June 3$^{rd}$ 2011. Measurements were :

- **0,47 µSv/h in Marumori (Miyagi prefecture),** at approximately 60 km north of the nuclear plant. The natural level calculated[2] is 0,1 µSv/h and the fallouts[3] in cesium 137 and 134 over 95 000 Bq/m$^2$.

[1] Measurements conducted by Christian Courbon, Bruno Chareyron (CRIIRAD institute) and Wataru Iwata (Japanese NGO Project 47) using an energy compensated proportional counter, type LB123 made by Berthold.



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- **0,33 µSv/h near Hitachi (Ibaraki prefecture**) approximately 88 km South of the nuclear plant. The natural level calculated is 0,07 µSv/h and the cesium fallouts over 50 000 Bq/m$^2$. The iodine 131 is still detected in the samples done on May 25th.
- **0,28 µSv/h in Ishioka (Ibaraki prefecture)** at around 160 km south, southwest of the nuclear plant. The natural level calculated is 0,06 µSv/h and the cesium fallouts over 48 000 Bq/m$^2$.

It is therefore established, that in both Ibaraki prefecture and in Miyagi, the artificial radiation level is more than 4 times above the natural level. For a person spending 50% of the time outdoors, this represents an added dose which is likely to exceed the maximum annual dose admissible of 1 milliSievert per year over the next twelve months ; regardless of the external irradiation received within the buildings, or the internal contamination caused by ingesting contaminated foods or by inhaling radioactive particles in suspension.

These results contradict information notices released by the French Nuclear Safety authority whose communiqué of June 28th states : « *outside the site, the decrease of the dose rates measured in the environment continues. In Fukushima, on June 7th, the dose rate was 1,6 µSv (microSievert)/h. The other 45 prefectures are presenting dose rates* ***under 0,1 µSv/h*** *».*

- In Tokyo, the residual exposure by external irradiation is likely to result in a non neglectable exposure. The CRIIRAD measured 0,14 µSv/h early June, in Wadabori-Koen park in Tokyo (around 235 km from the nuclear plant). In this park the natural level calculated is 0,06 µSv/h and the fallouts in cesium 134 and 137 are over 14 000 Bq/m$^2$. Additional data should be provided for the entire agglomeration.

This is why the CRIIRAD asks all Japanese citizens to demand for the publication of detailed charts on both the fallouts and residual contamination on a national scale and with sufficient precision, in other words, showing cesium fallouts starting from 1 000 Bq/m$^2$ instead of 300 000 Bq/m$^2$ as this was shown on the charts published on May 6$^{th}$, 2011.

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[2] As contamination is detectable everywhere including in Tokyo, it is difficult to determine the natural radiation level in the absence of contamination. Based on soil analyses used to determine the activity of natural gamma emitting radionuclides, the CRIIRAD laboratory recalculated the theoretical natural debit dose (telluric component and contribution of the cosmic radiation).

[3] This concerns fallouts evaluation based on cesium 137 and 134 concentrations measured in a 0-5 cm soil layer cored in a flat relief field, unrevised, and likely to have retained the deposit that occurred back in March 2011. The given surface activity is a preliminary estimate by default as analysis of the layers 5-10 cm and of fractions > 2 mm is still underway.



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