

Radiation Measurements for the Fukushima Nuclear Accident

National Institute of Radiological Sciences,
Japan

Yukio UCHIHORI, Hisashi Kitamura

WRMISS-16, Sep. 6th - 9th, 2011, Prague

The Earthquake

- The earthquake happened at 14:46 on March 11th, 2011. The magnitude was 9.0.
- 15,726 people died and 4,593 people were missing still. 110,000 houses were destroyed completely. 82,634 people are still staying evacuation centers.



Tsumami



<http://www.reuters.com/news/pictures>

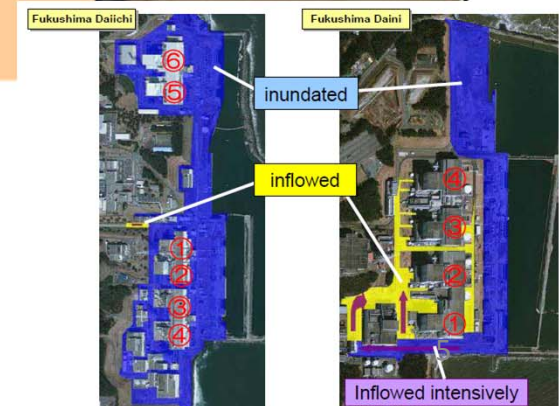
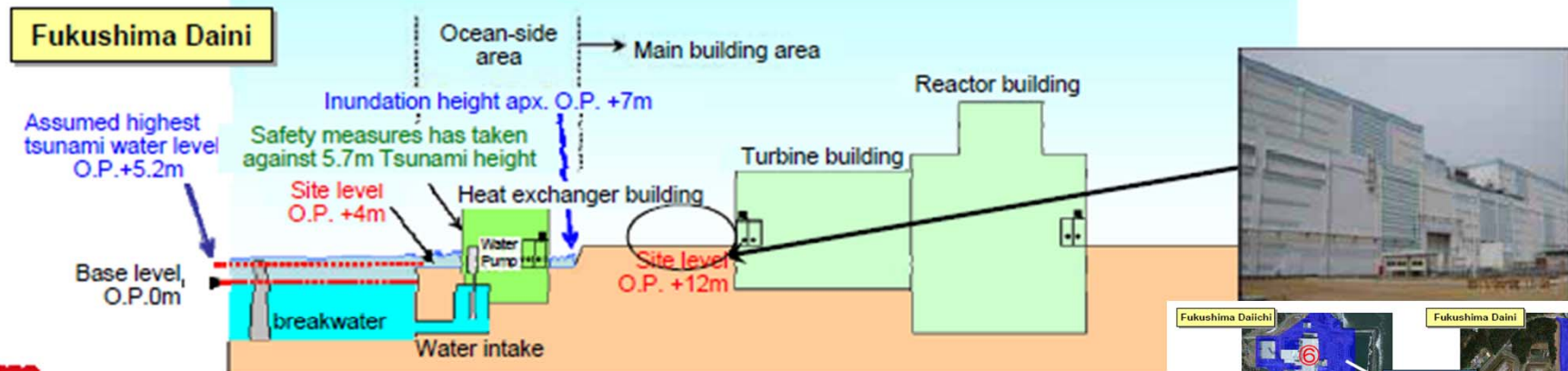
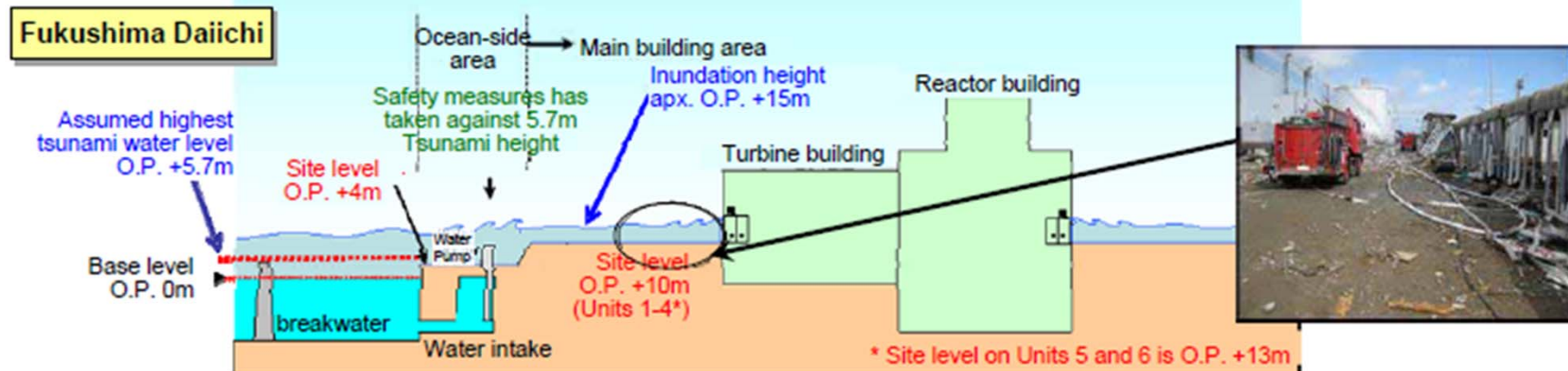
<http://www.yomiuri.co.jp>

<http://www.dailymail.co.uk/news>

Fukushima Daiichi Nuclear Power Station



Tsunami for Fukushima Daiichi and Daini



Fukushima Daiichi being struck by Tsunami

Taken from near the south side of Unit 5, looking east



Taken from radwaste building 4th floor, looking north

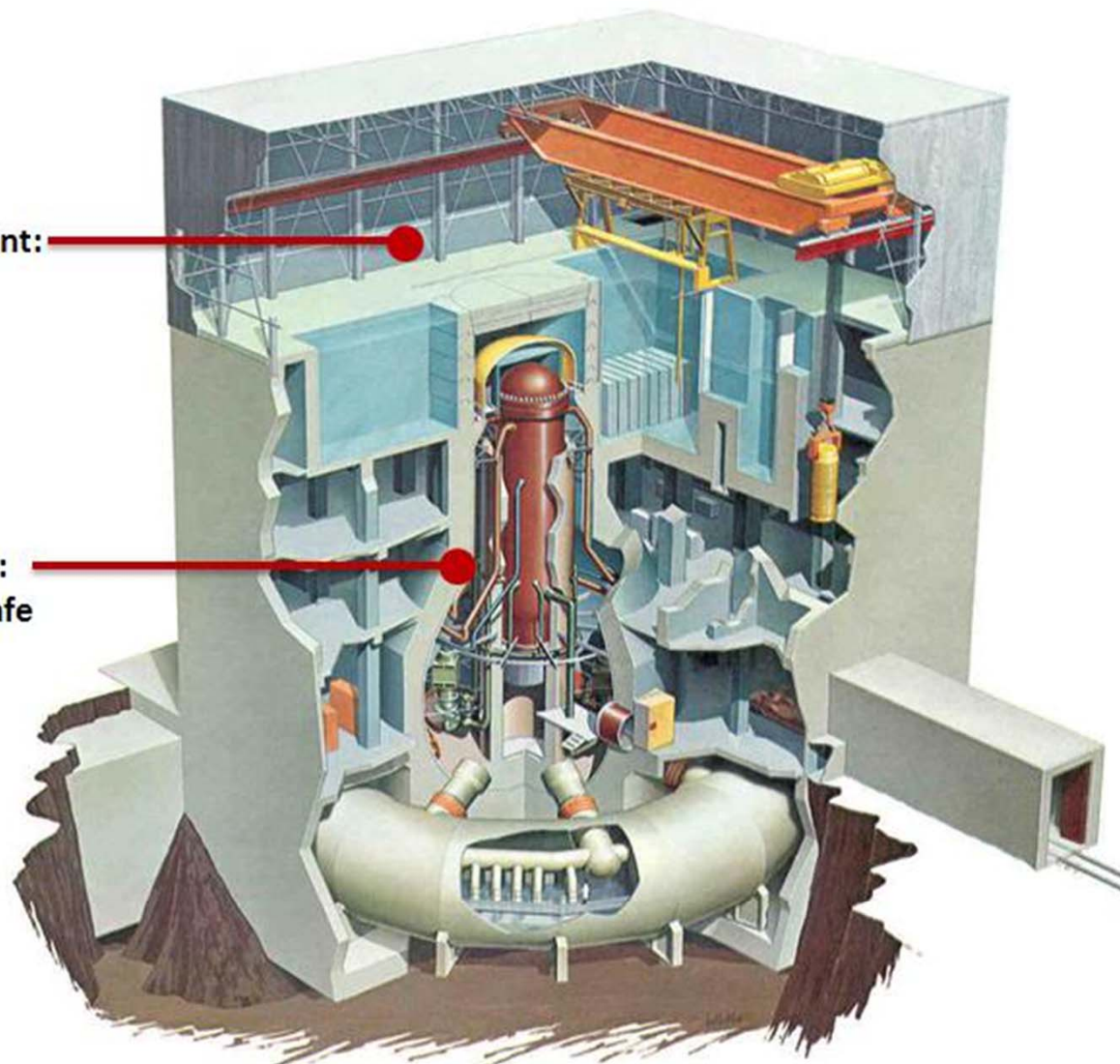
Tank Height about 5.5m
(height of ground : O.P. +10m)



O.P. : Onahama bay construction base level

Secondary containment:
Area of explosion at
Fukushima Daiichi 1

Primary containment:
Remains intact and safe



Boiling Water Reactor Design

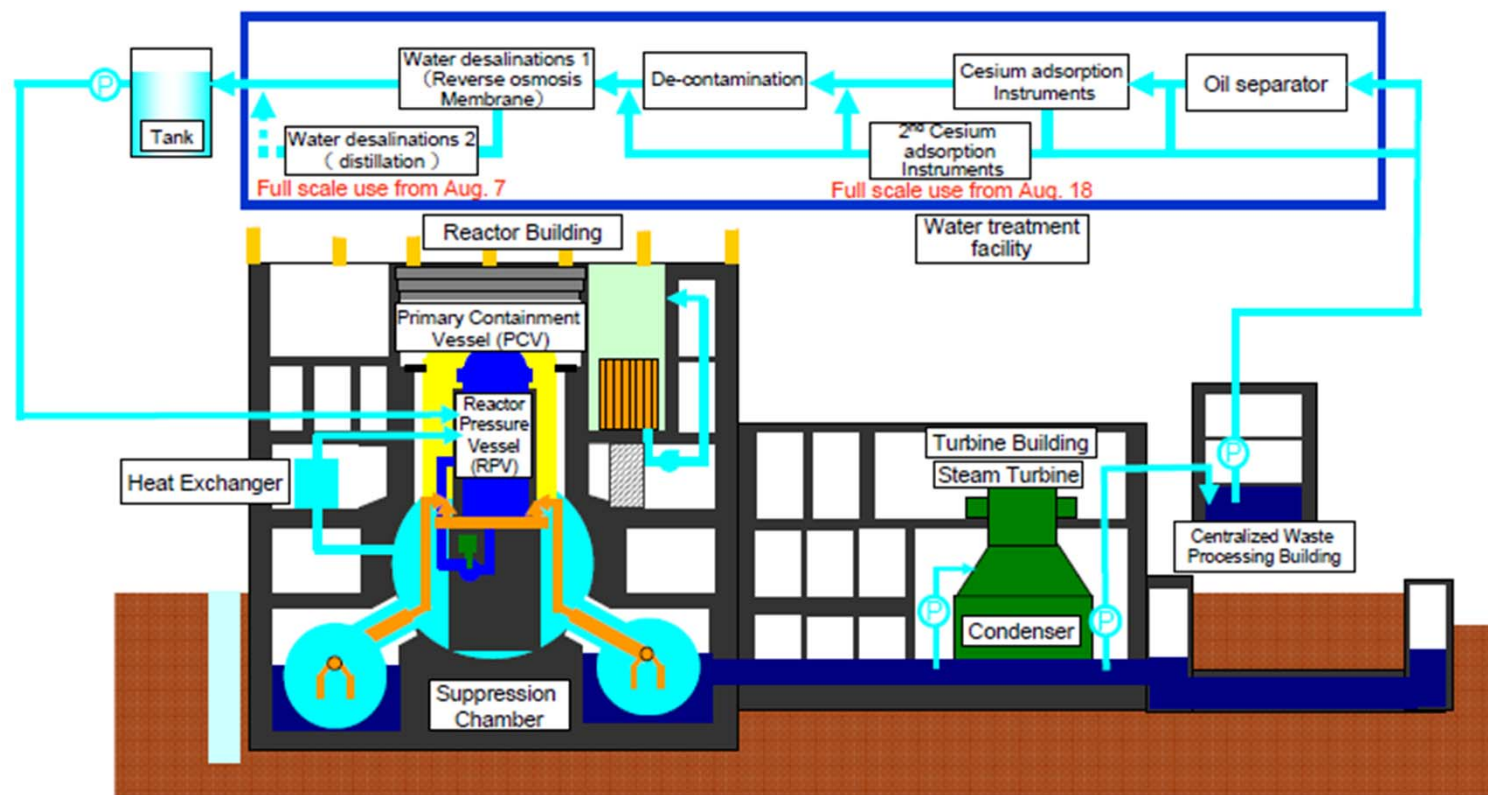
<http://bravenewclimate.com/2011/03/13/fukushima-simple-explanation/>

Plan



<http://www.reuters.com/news/pictures>





Plant Status : Fukushima Daiichi

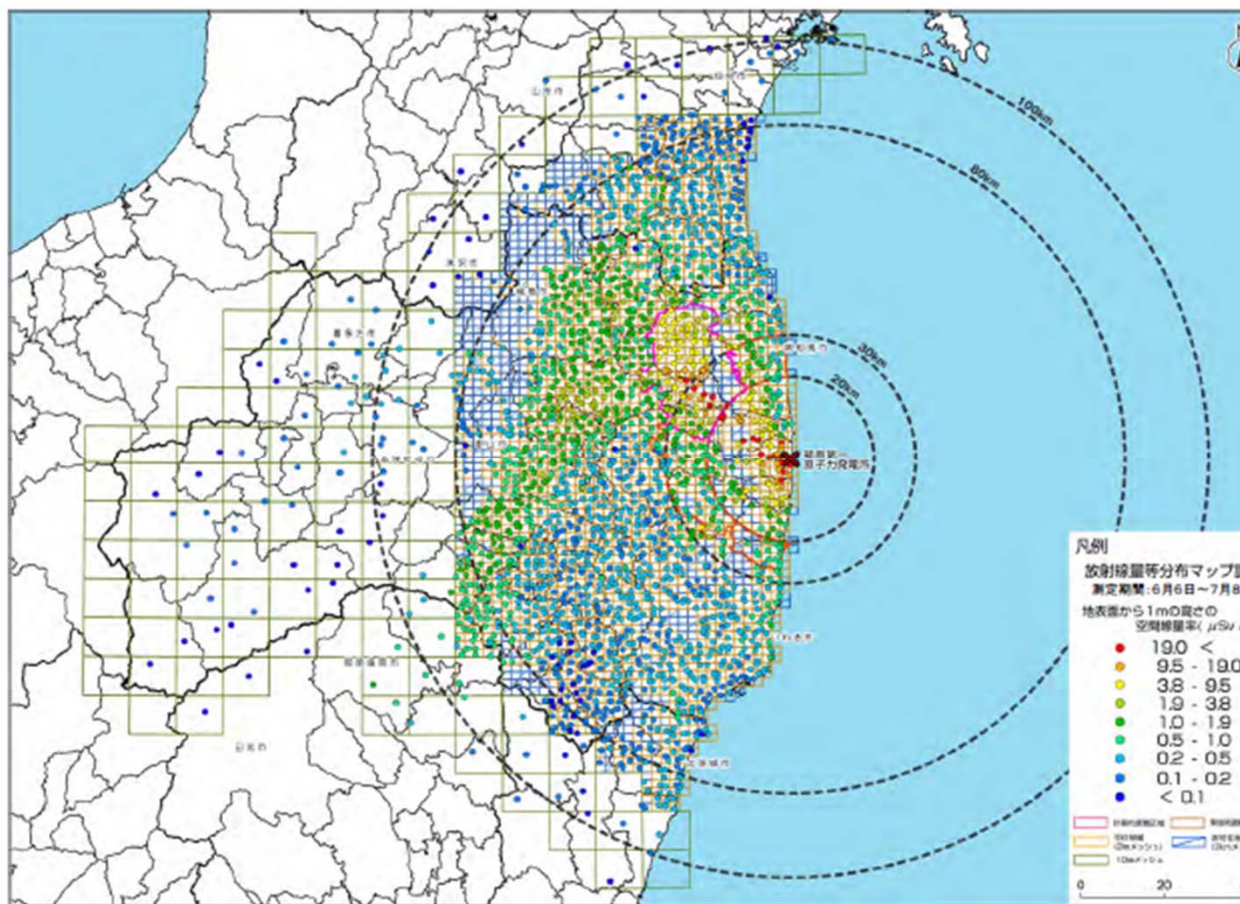
- Units 1-3: Implementing circulating water cooling reusing the accumulated water in order to cool the fuels in reactors.
- Units 1-4: Have launched stable circulating cooling in order to cool the fuels in spent fuel pool (SFP).
- Units 1-3: Found contaminated water with high radioactive materials in turbine buildings. Continuation on decontamination of the water by processing facility.
- Units 1-3: Injecting N₂ into PCV to lower the possibility of hydrogen explosion.
- Units 5&6: Under cold shutdown.

| | | #1 460MW | #2 784MW | #3 784MW | #4 784MW | #5 784MW | #6 1,100MW |
|--------------|---------|--|--|--|---------------------------------|--------------------|--------------------|
| Shutdown | | ○ Automatic Shutdown | | | Shutdown for Outage | | |
| Cooling | Reactor | △ Circulating Water Cooling Injecting N ₂ | △ Circulating Water Cooling Injecting N ₂ | △ Circulating Water Cooling Injecting N ₂ | — Fuels have been removed | ○ Cold Shutdown | ○ Cold Shutdown |
| | Pool | ○ Circulating cooling system | ○ Circulating cooling system | ○ Circulating cooling system | ○ Circulating cooling system | ○ | ○ |
| *Containment | | △ Highly contaminated water has been found Began decontamination of the water by processing facility | △ Highly contaminated water has been found Began decontamination of the water by processing facility | △ Highly contaminated water has been found Began decontamination of the water by processing facility | △ | ○ | ○ |

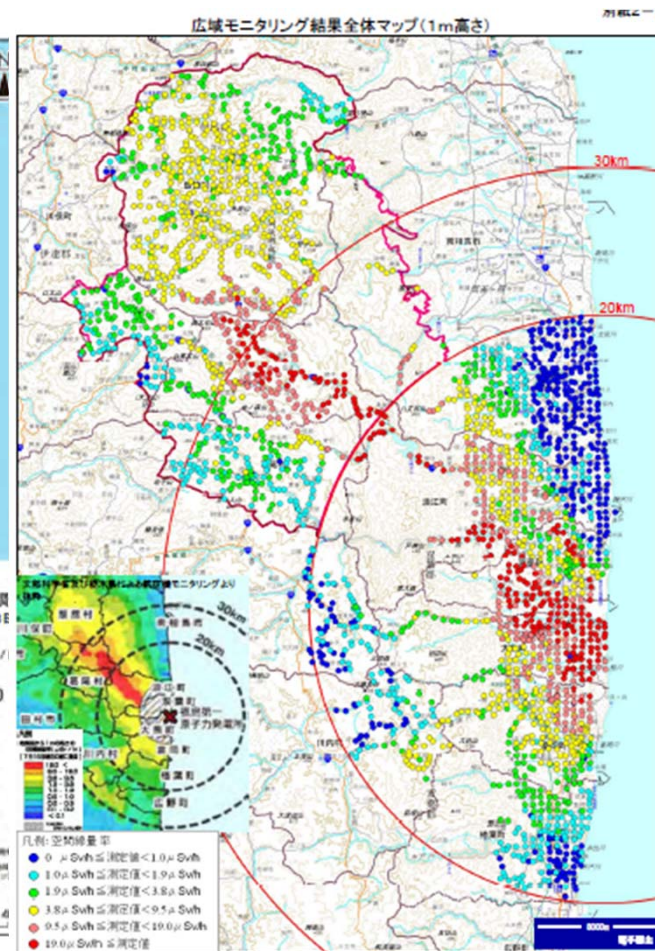
Comparison with Chernobyl

- On April 12, Nuclear and Industrial Safety Agency released as below:
 - Tentatively assigned Level 7 on INES for the accident at Fukushima Daiichi Nuclear Power Station.
 - In this regard however, the amount of released radioactive materials is one-tenth as much as the accident at Chernobyl.
- We are wrestling with hurdles such as cooling the reactors or reducing the diffusion of radioactive materials in order to resolve the situation as soon as possible. We will commit in full force to resolve this situation along with close coordination and cooperation with the national and local governments.

| | Estimated release from Fukushima Daiichi | | (Reference) Release from Chernobyl |
|-----------------------------|--|--|--|
| | by NISA | by Nuclear Safety Commission | |
| Iodine 131 (a) | 130 thousands T Bq (1.3×10^{17} Bq) | 150 thousands T Bq (1.5×10^{17} Bq) | 1,800 thousands T Bq (1.8×10^{18} Bq) |
| Cesium 137 | 6 thousands T Bq (6.1×10^{15} Bq) | 12 thousands T Bq (1.2×10^{16} Bq) | 85 thousands T Bq (8.5×10^{16} Bq) |
| Iodine value conversion (b) | 240 thousands T Bq (2.4×10^{17} Bq) | 480 thousands T Bq (4.8×10^{17} Bq) | 3,400 thousands T Bq (3.4×10^{18} Bq) |
| (a) + (b) | 370 thousands T Bq (3.7×10^{17} Bq) | 630 thousands T Bq (6.3×10^{17} Bq) | 5,200 thousands T Bq (5.2×10^{18} Bq) |



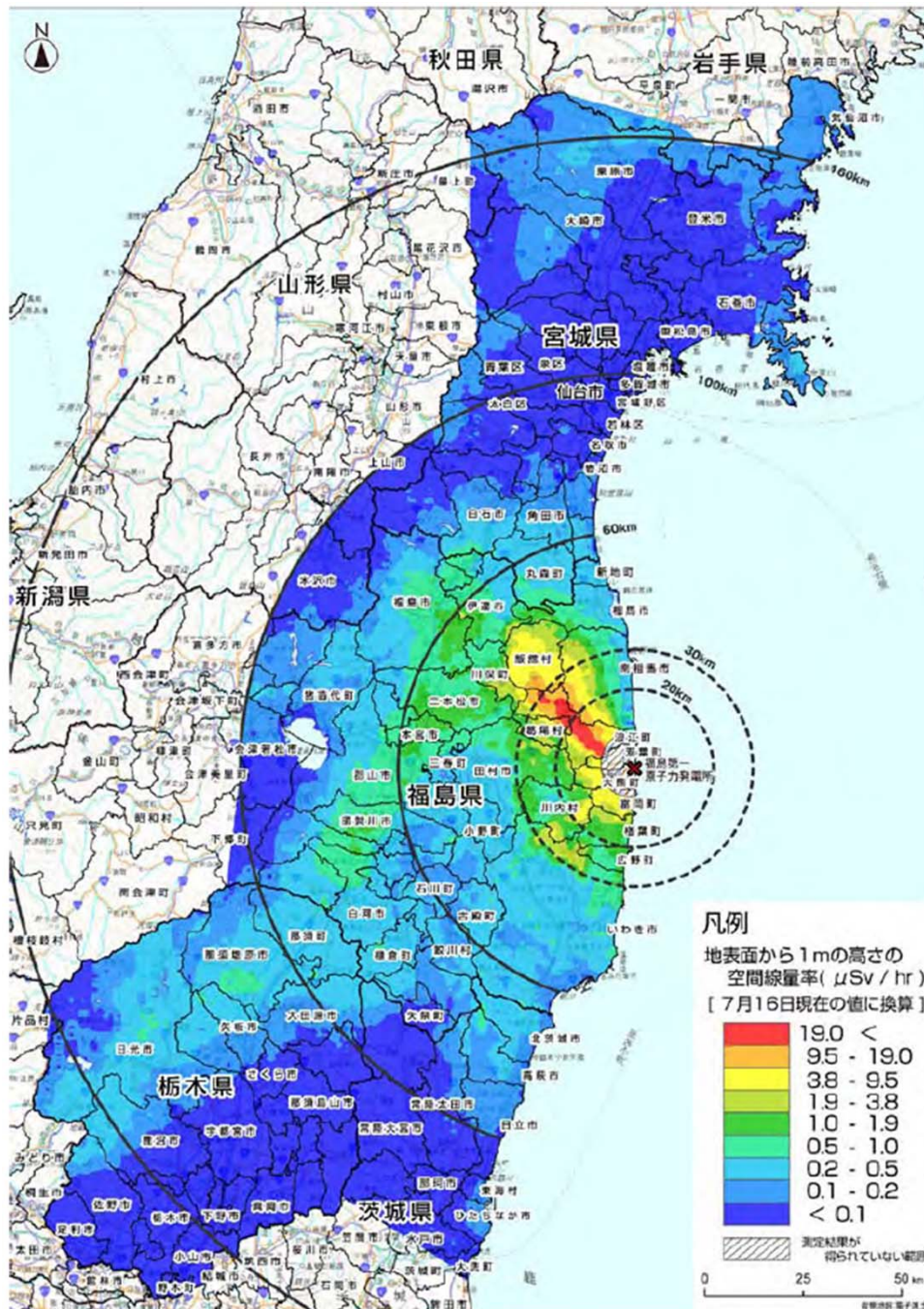
土壤採取地点における線量測定マップ



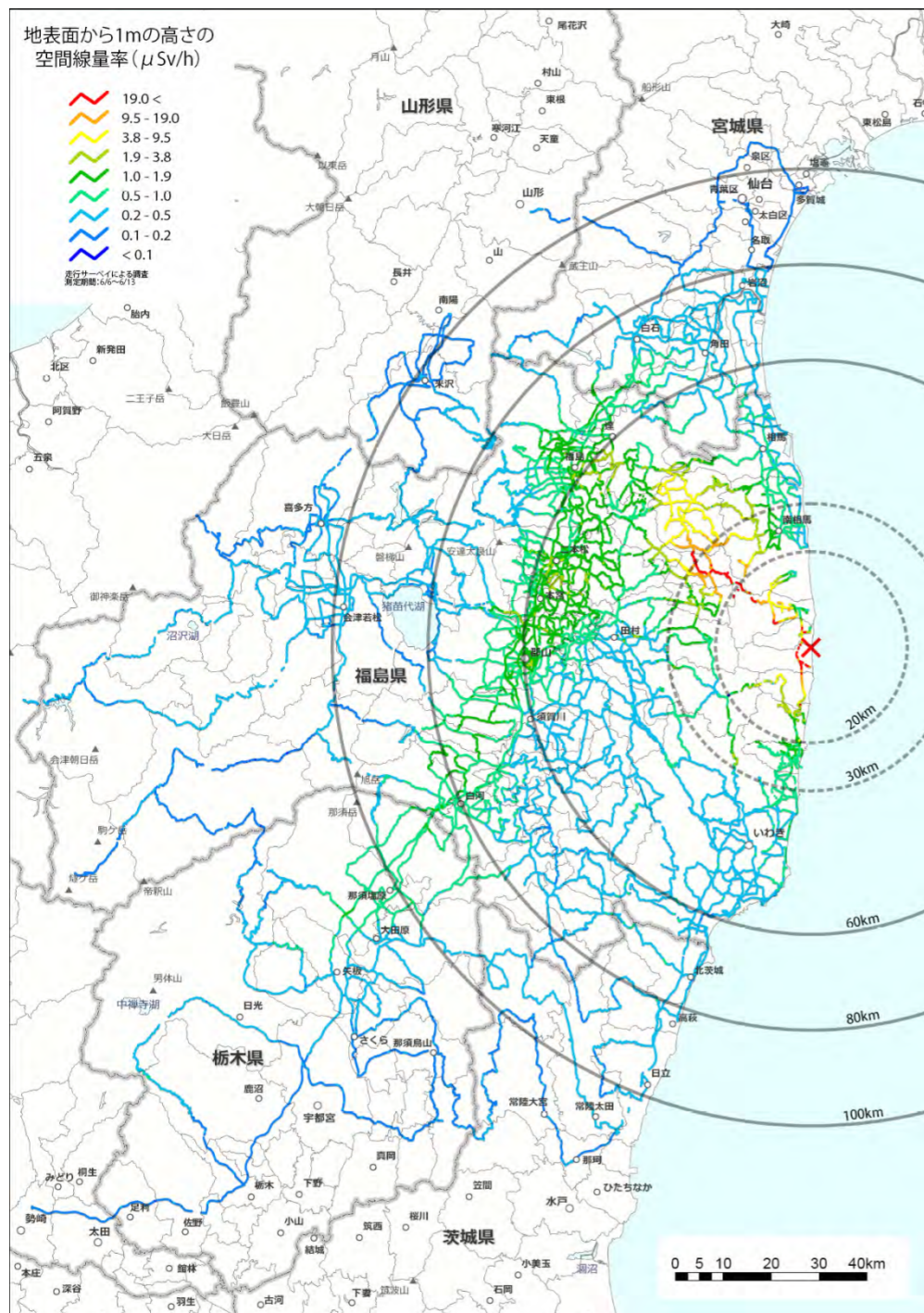
Max. 139uSv/h (Sep. 1st, 2011)

<http://www.meti.go.jp/earthquake/nuclear/20110901.html>

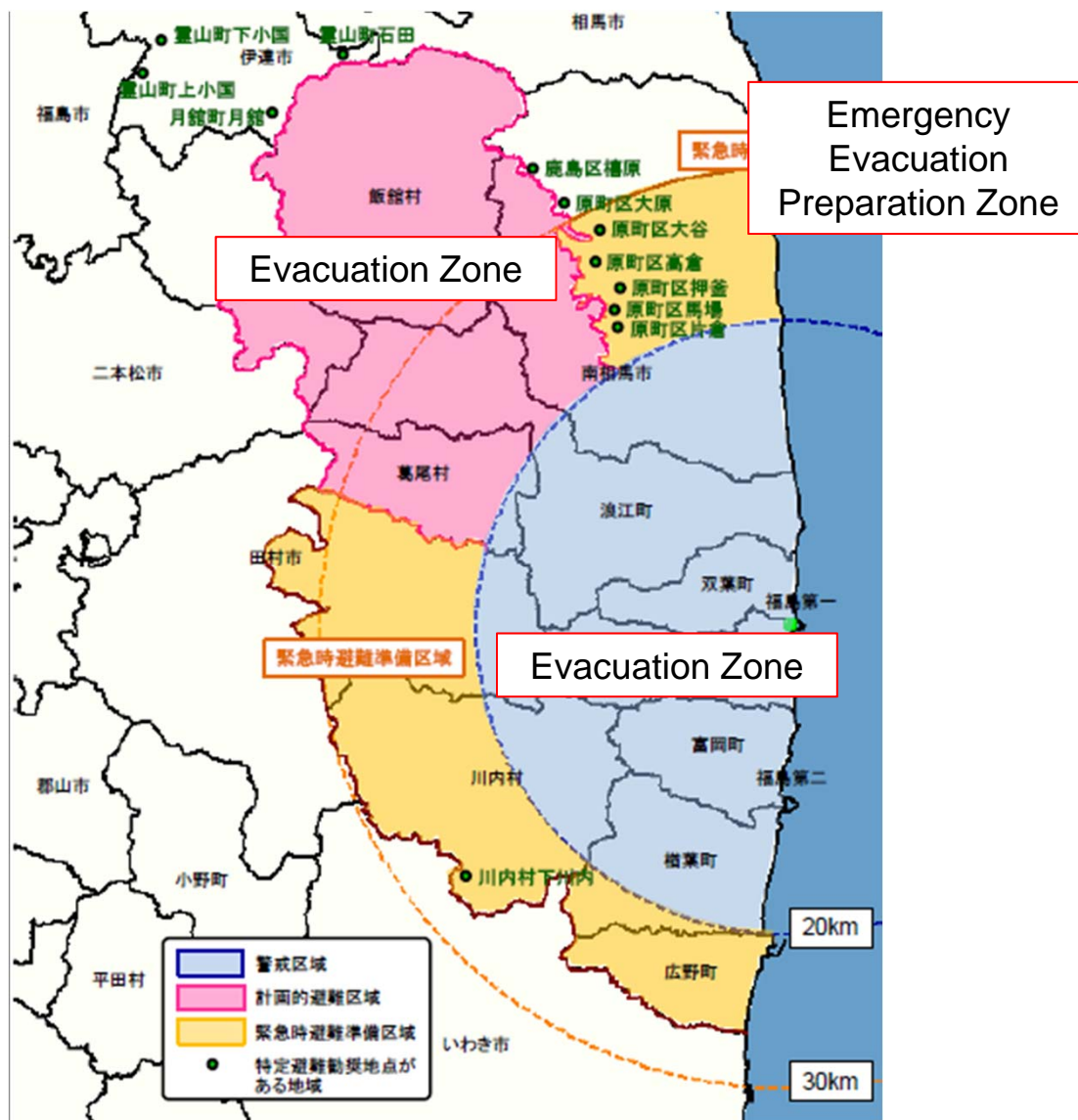
Airborne Measurement



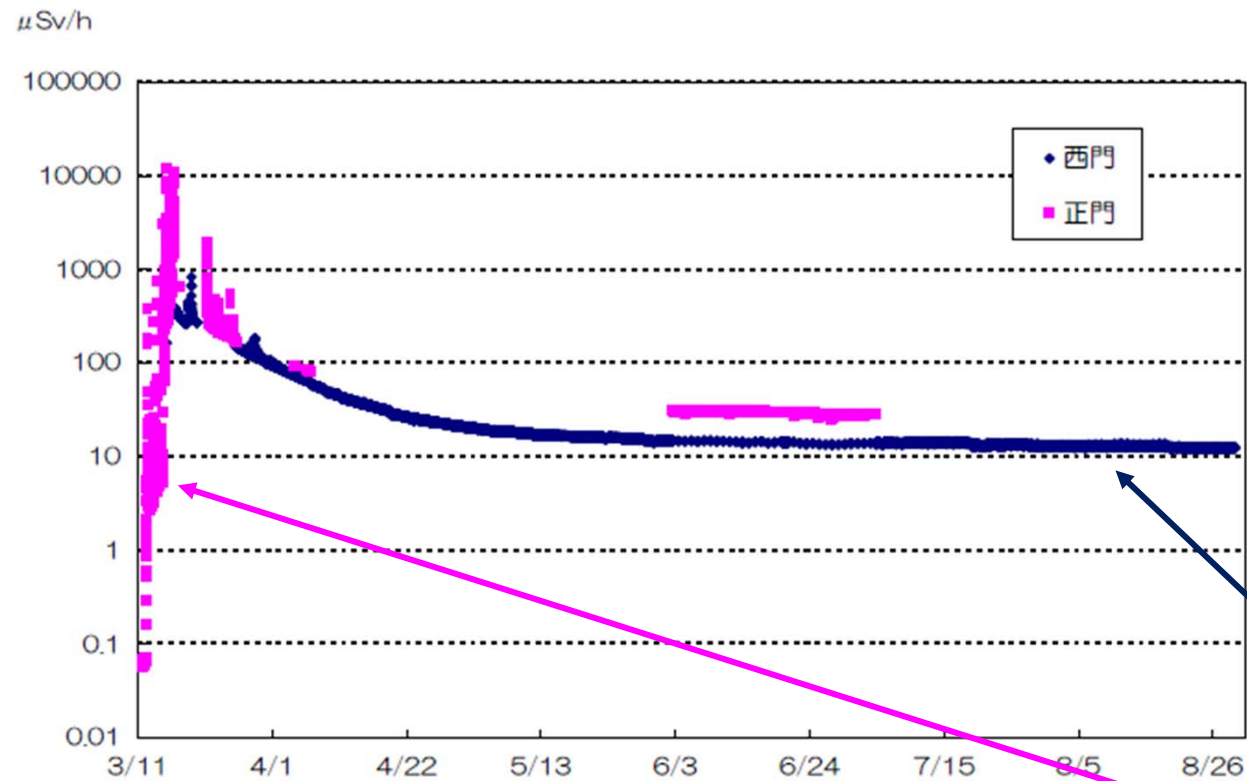
http://radioactivity.mext.go.jp/ja/1940/2011/07/1305819_0727.pdf



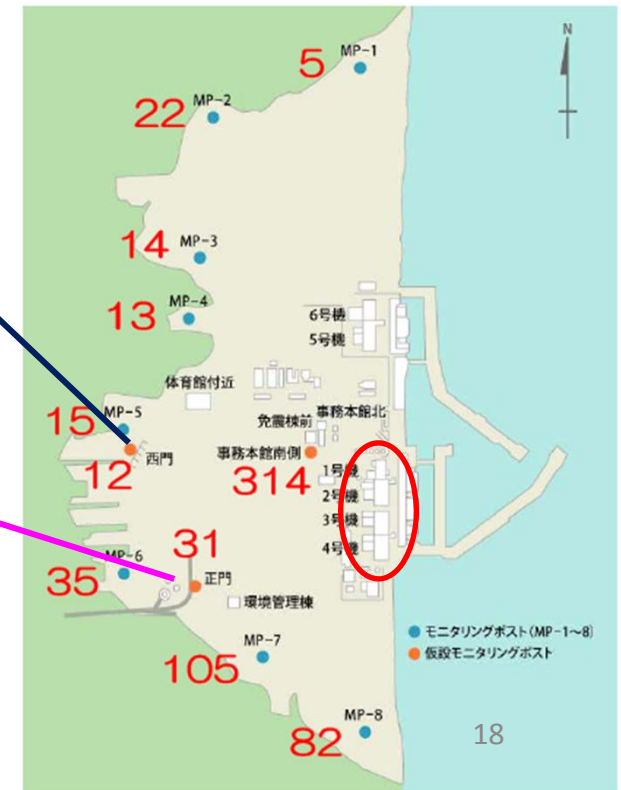
http://radioactivity.mext.go.jp/ja/senryou_map/2011/08/5600_080218.pdf



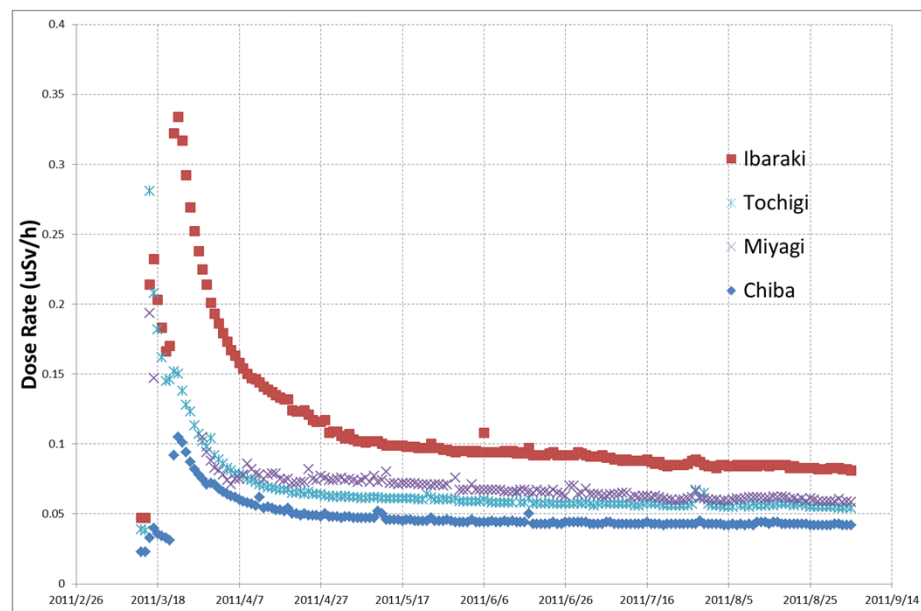
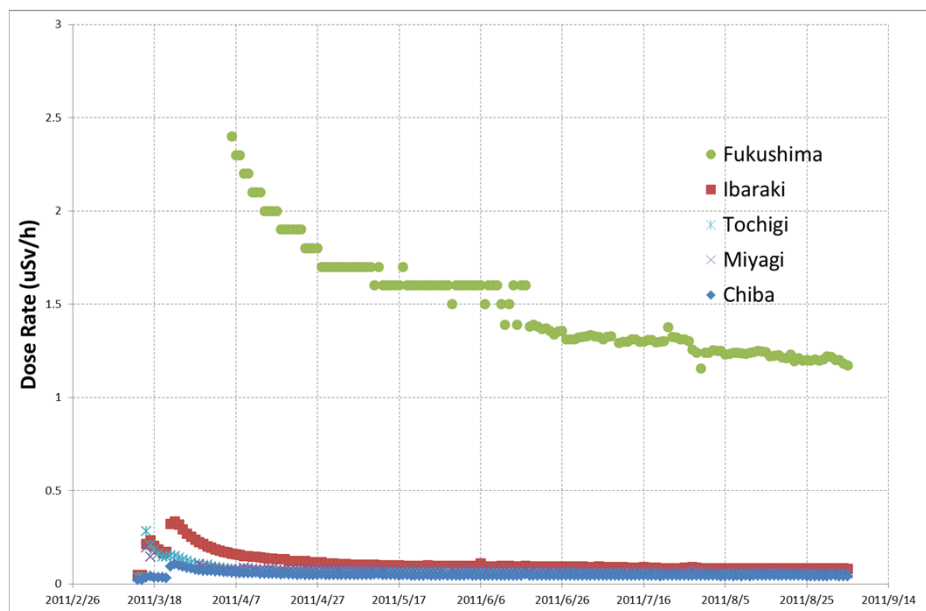
Monitoring Data



Aug. 29, 2011
 $\mu\text{Sv/h}$



Area Monitoring



Made from MEXT web site

Contamination in PPT

(Bq/kg, Dry)

| Location | Ground (WNW 500m) | Forest (W 500m) | Gavages (SSW 500m) |
|---------------|-----------------------------|-----------------------------|-----------------------------|
| Date | Aug. 8 th , 2011 | Aug. 8 th , 2011 | Aug. 8 th , 2011 |
| I-131(8d) | N.D. | N.D. | N.D. |
| I-132(2h) | N.D. | N.D. | N.D. |
| Cs-134(2y) | 1.8E4 | 1.6E3 | 1.8E6 |
| Cs-136(13d) | N.D. | N.D. | N.D. |
| Cs-137(30y) | 2.1E4 | 1.7E3 | 2.0E6 |
| Sb-125(3y) | N.D. | N.D. | N.D. |
| Te-129m(34d) | N.D. | N.D. | 1.5E5 |
| Te-132(3d) | N.D. | N.D. | N.D. |
| Ba-140(13d) | N.D. | N.D. | N.D. |
| Nb-95(35d) | N.D. | N.D. | N.D. |
| Ru-106(370d) | N.D. | N.D. | N.D. |
| Mo-99(66h) | N.D. | N.D. | N.D. |
| Tc-99m(6h) | N.D. | N.D. | N.D. |
| La-140(2d) | N.D. | N.D. | N.D. |
| Be-7(53d) | N.D. | N.D. | N.D. |
| Ag-110m(250d) | N.D. | N.D. | N.D. |

Pu Contamination in PPT

| Location | Date | Pu-238 | Pu-239, Pu-240 |
|--------------------|-----------------------------|---------------------------------|---------------------------------|
| Ground (WNW 500m) | Aug. 8 th , 2011 | $(5.4 \pm 0.75) \times 10^{-2}$ | $(2.9 \pm 0.54) \times 10^{-2}$ |
| Forest (W 500m) | | N.D. ($< 1.0 \times 10^{-2}$) | $(2.0 \pm 0.46) \times 10^{-2}$ |
| Gavages (SSW 500m) | | $(5.4 \pm 0.75) \times 10^{-2}$ | $(4.8 \pm 0.90) \times 10^{-2}$ |
| in Japan | | N.D. $\sim 1.5 \times 10^{-1}$ | N.D. ~ 4.5 |

(Bq/kg, Dry)

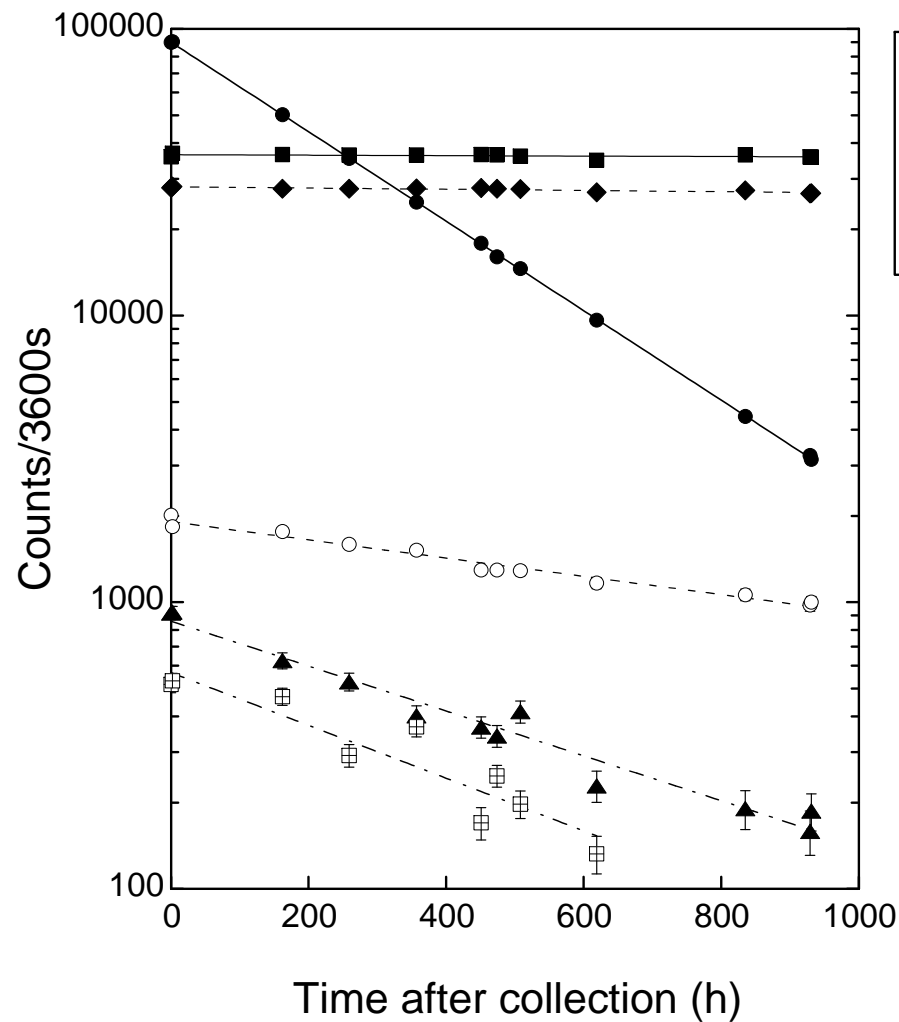
Edited from :

http://www.tepco.co.jp/cc/press/betu11_j/images/110825w.pdf

| Date of collection | Soil depth, cm | ^{131}I Bq kg ⁻¹ | ^{134}Cs Bq kg ⁻¹ | ^{136}Cs Bq kg ⁻¹ | ^{137}Cs Bq kg ⁻¹ | $^{129\text{m}}\text{Te}$ Bq kg ⁻¹ |
|---------------------------------|----------------|---|--|--|--|--|
| J Village April 20, 2011 | 0-2 | 22030±1300 | 10050±160 | 360±40 | 11480±540 | 20720±540 |
| | 5-7 | 1850±150 (0.08) | 530±20 (0.05) | N.D. | 630±30 (0.06) | 1020±10 (0.05) |
| | 10-12 | 460±40 (0.02) | 130±10 (0.01) | N.D. | 140±10 (0.01) | N.D. |
| J Village April 28, 2011 | 0-2 | 9360±420 | 10050±310 | 180±10 | 11750±200 | 16400±750 |
| | 5-7 | 590±50 (0.06) | 290±10 (0.03) | N.D. | 3310±10 (0.03) | 420±140 (0.03) |
| | 10-12 | 110±20 (0.01) | 40±5 (0.004) | N.D. | 50±10 (0.004) | N.D. |
| J Village May 5, 2011 | 0-2 | 2540±140 | 4120±20 | 70±10 | 4920±170 | 5280±250 |
| | 5-7 | 830±10 (0.34) | 1110±10 (0.26) | N.D. | 1220±60 (0.25) | 1720±160 (0.33) |
| | 10-12 | 100±20 (0.04) | 120±10 (0.03) | N.D. | 140±10 (0.03) | N.D. |
| Chiba city April 25, 2011 | 0-1 | 409±14 | 827±15 | N.D. | 973±23 | 48±14 |
| | 1-2 | 117±7 (0.29) | 137±6 (0.17) | N.D. | 155±10 (0.16) | N.D. |
| | 2-3 | 69±6 (0.17) | 49±4 (0.06) | N.D. | 59±7 (0.06) | N.D. |
| | 3-4 | 42±4 (0.10) | 15±3 (0.02) | N.D. | 24±4 (0.02) | N.D. |
| | 4-5 | 20±3 (0.05) | 15±4 (0.02) | N.D. | 17±3 (0.02) | N.D. |

K. Tagami, Y. Uchihori, H. Kitamura, et al., Science of the Total Environment, to be published.

Specific activities of ^{131}I , 134 , 136 , ^{137}Cs , and $^{129\text{m}}\text{Te}$ at the time of soil sampling on a dry mass basis (<2mm fraction). Numbers in parentheses are the ratio of specific activity of a radionuclide in a layer to its specific activity in the 0-2 cm soil layer.



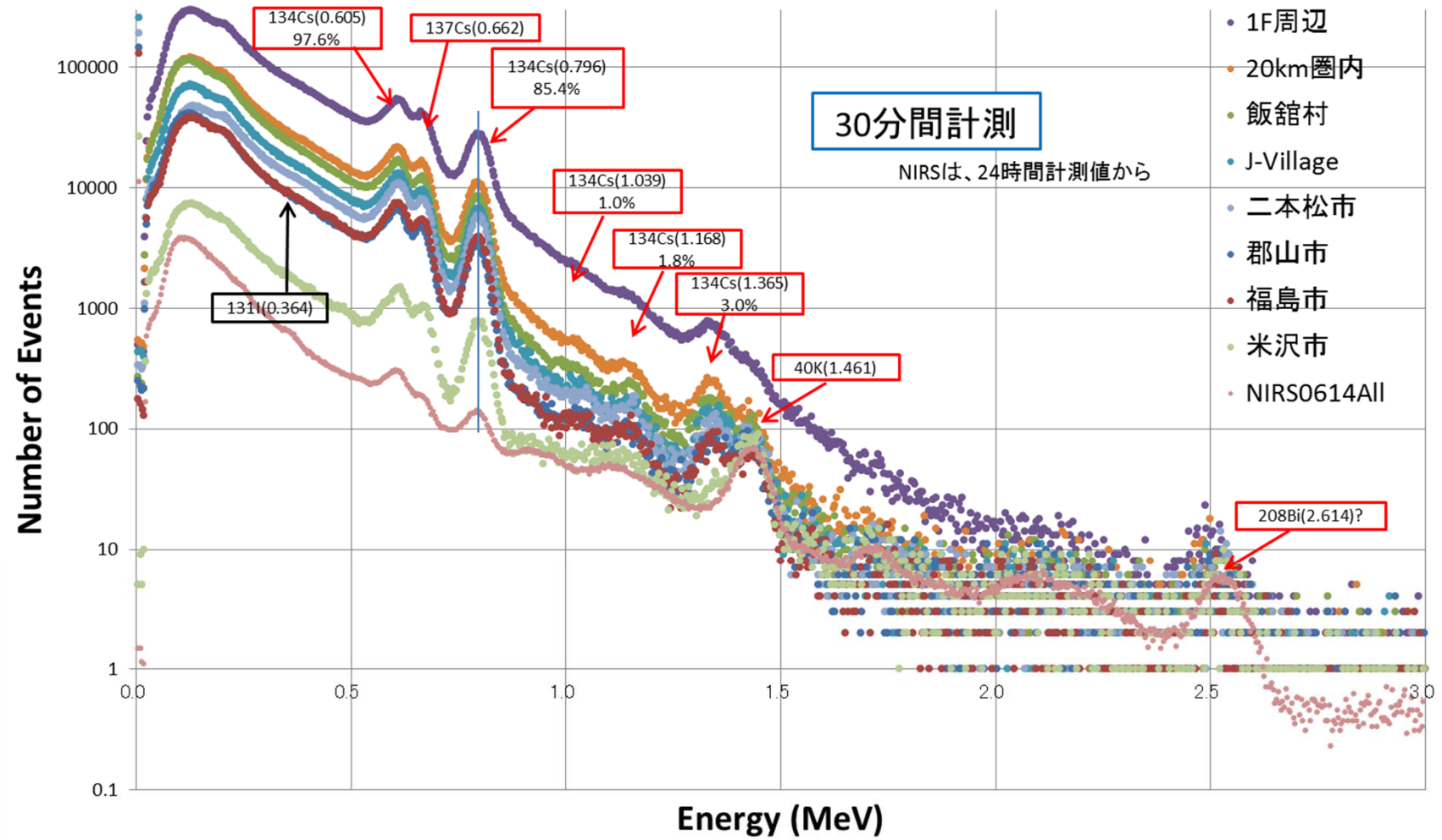
K. Tagami, Y. Uchihori, H. Kitamura, et al., Science of the Total Environment, to be published.

Time dependence of radioactivity in a 0-2 cm soil sample collected on April 20, 2011. Error bar shows 1 sigma counting error.

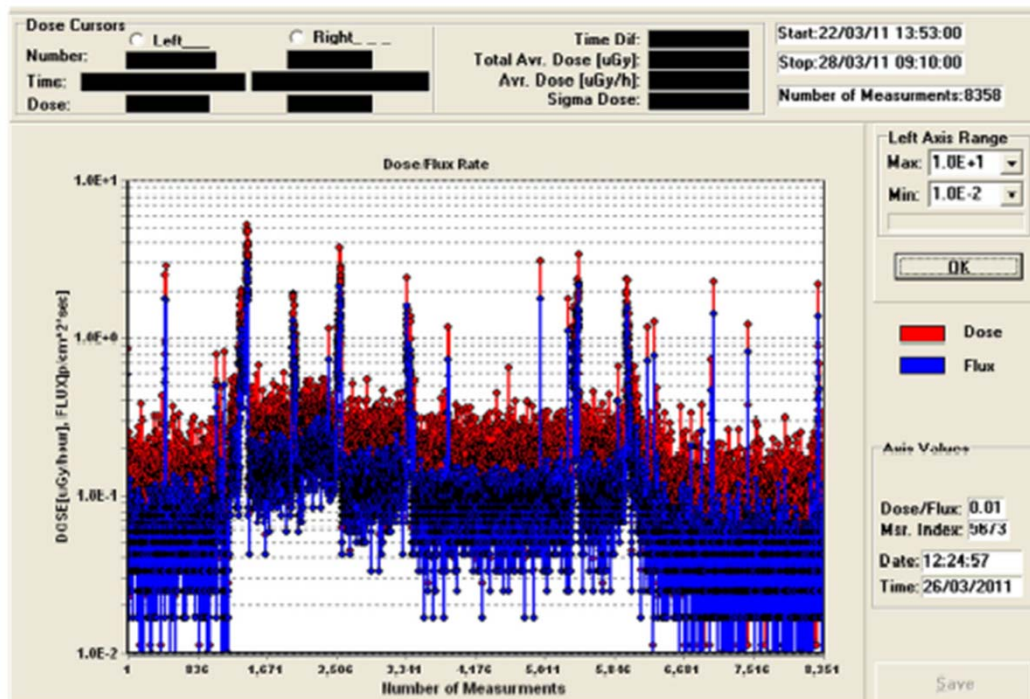
Nal Spectrometer with GPS



走行サーベイ NaIスペクトロメータ



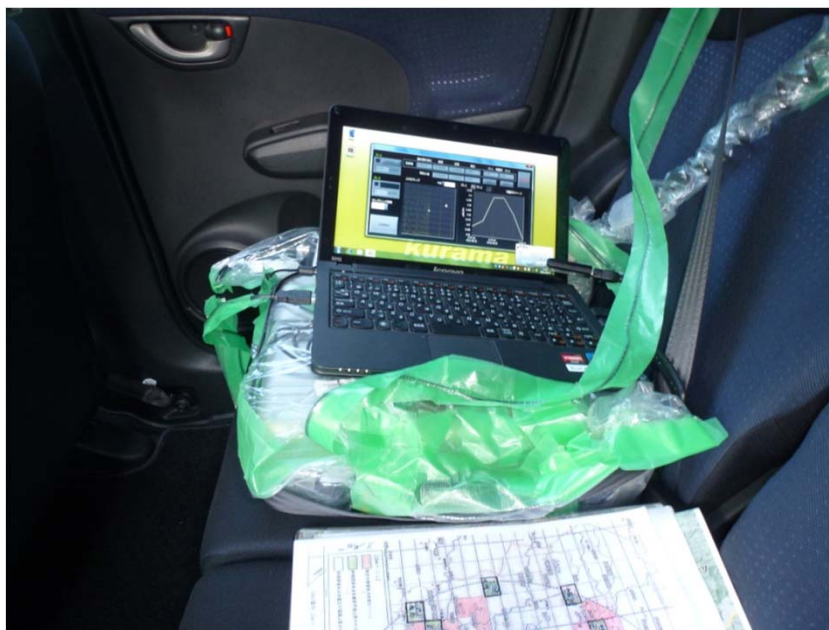
Measurement by Liulin-4J



J-Village in Fukushima
Mar. 22nd to 28th, 2011

by Dr. Ondrej Ploc

Our Activities

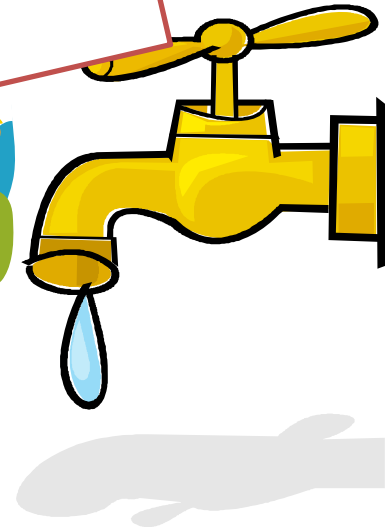
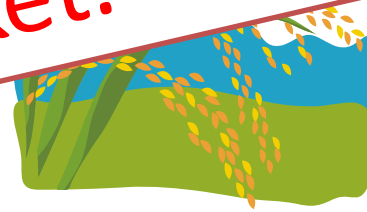


Car-Borne Survey by MEXT, Jun 3rd to 13th, 2011
Around Iitate-mura, Namie-machi, etc.

- I have stayed for 50days in 6 months in Fukushima and exposed dose is about 500 uSv totally.



If they are contaminated,
they are **NEVER** allowed
to be in market.



COMMISSION IMPLEMENTING REGULATION (EU) No 351/2011

of 11 April 2011

amending Regulation (EU) No 297/2011 imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station

- Regulation (EU) No 297/2011 provides for the requirement for pre-export control by the competent authorities of Japan. Action levels for iodine, caesium and plutonium in food have been established by the competent authorities of Japan. The Commission was informed on 17 March 2011 of these action levels applicable in Japan but it was indicated that these action levels were adopted for the time being as provisional regulation values. The authorities from Japan also informed the Commission that products that are not allowed to be placed on the Japanese market, are also not allowed to be exported. It becomes now evident that these action levels will be applied in Japan for a longer term. It is therefore appropriate in order to provide consistency between the pre-export controls performed by the Japanese authorities and the controls on the level of radionuclides performed on feed and food originating in or consigned from Japan at the entry into the EU, to apply on a provisional basis the same maximum levels in the EU for radionuclides in feed and food from Japan as the action levels applicable in Japan as long as these are lower than the EU values.

Maximum levels for foodstuffs ⁽¹⁾ (Bq/kg)

| | Foods for infants and young children | Milk and dairy products | Other foodstuffs, except liquid foodstuffs | Liquid foodstuffs |
|---|--------------------------------------|-------------------------|--|--------------------|
| Sum of Isotopes of strontium, notably Sr-90 | 75 | 125 | 750 | 125 |
| Sum of Isotopes of iodine, notably I-131 | 100 ⁽¹⁾ | 300 ⁽²⁾ | 2 000 | 300 ⁽²⁾ |
| Sum of Alpha-emitting isotopes of plutonium and trans-plutonium elements, notably Pu-239, Am-241 | 1 | 1 ⁽²⁾ | 10 ⁽²⁾ | 1 ⁽²⁾ |
| Sum of all other nuclides of half-life greater than 10 days, notably Cs-134 and Cs-137, except C-14 and H-3 | 200 ⁽²⁾ | 200 ⁽²⁾ | 500 ⁽²⁾ | 200 ⁽²⁾ |

⁽¹⁾ In order to ensure consistency with action levels currently applied in Japan, these values replace on a provisional basis the values laid down in Council Regulation (Euratom) 3954/87.

⁽²⁾ In order to ensure consistency with action levels currently applied in Japan, this value replaces on a provisional basis the value laid down in Commission Regulation (Euratom) No 770/90.

Exchange of soil



Decontamination



Personal Dosimeter

<http://www.asahi.com/>

Thank you so much for your all help, support and warm words for Japanese people.

We believe that we will be able to recover from this disaster very soon.



Soccer Women's Word Cup
Nadeshiko Japan



Don't give up, Japan.
Don't give up, Tohoku

<http://www.independent.co.uk/>