Radiation Dose Measurement by a car Borne Survey Method and γ Ray Spectrometry by NaI Detector in Fukushima Prefecture, Japan

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1.Introduction

The Tohoku District-off the Pacific Ocean Earthquake and Tsunami caused by the earthquake attacked the Fukushima Dai-ichi Nuclear Power Plant of TEPCO on March 11, 2011. A nuclear accident followed at an unprecedented scale and huge amounts of radioactive material were released into the environment.

Distributions of dose rate in Fukushima prefecture were measured on April 18-21, June 20-22 and October 19-21, 2011 by a car borne survey method using a NaI(Tl) scintillation survey meter. The distribution of high dose rate was observed at a northwest direction of Fukushima Dai-ichi NPP. The gamma-ray spectrometry by a NaI(Tl) detector was also done at several points. The gamma-ray peaks of I-131, Cs-134 and Cs-137 were mainly detected at the April in gamma-ray spectrum. Dose rate near Fukushima Dai-ichi NPP and at Iitate-mura, Fukushima-city was high (1- >30 mSv/h). Because of the distribution of dose rate was uneven, further investigation is necessary to estimate the external exposure in detail.

2.Objective

(1) Temporal variation of dose rate by car-borne survey method
(2) External dose estimation
(3) Distribution of released radionuclide by γ ray spectrometry

3. Methods

A car-borne survey method using a 1" × 1" NaI(Tl) scintillation survey meter (TCS-171, ALOKA Co., Japan) and GPS units was employed. Measurements were carried out at any time and the measurement positions were determined using the synchronized time of GPS.

In-situ γ spectra were obtained using a 2" × 2" NaI(Tl) scintillation detector (ADP-122, ALOKA Co., Japan) and a spectrometer (ASM-303, ALOKA Co., Japan) for 600 sec. at several points, 1 m above the ground. The spectrum analysis was done using the response matrixes method.

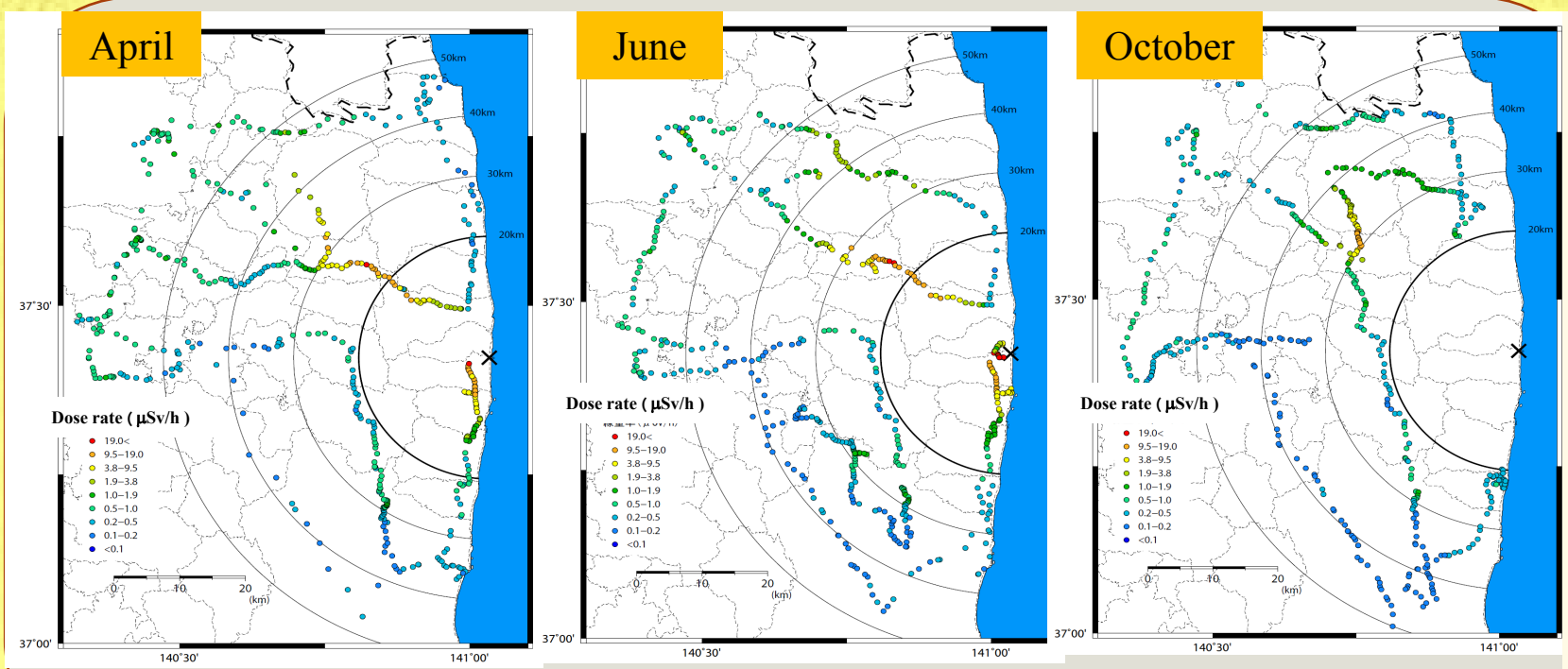


Figure 1. Results of car-borne survey methods

4.Results

The survey route and a distribution map of dose rate inside the car are shown in Fig. 1. The dose rates did not depend on the distance from the Fukushima Dai-ichi NPP . The most contaminated area (high dose rate) was to the north-west direction from NPP as already reported from the Ministry of education, Culture, Sports, Science & Technology in Japan. Shielding by the car body was estimated by measuring the dose rate inside and outside of the car. A shielding factor 1.6 was calculated. This factor was used for correction to present outside dose rate.[1)]

Table 1 shows the dose rate measured by the survey meter (TCS-171), max. value :40 μSv/h, min. value: 0.1 μSv/h.

The γ-ray spectra obtained at 15 points are shown in Figure. Photon peaks generated by I-131, Cs-134 and Cs-137 were observed. I-131 was detected at the spectra on April only due to the short half-life.

The dose rate from these radionuclides were calculated by the software using response matrix method developed by Minato.[2)] The distributions of I-131, Cs-134 and Cs-137 on April were different depending on the direction from the NPP. Ratio of I-131 is high with south direction. This is thought that it is the difference of occurrence source or condition of wet deposition.

Sampling points of γ-ray spectra

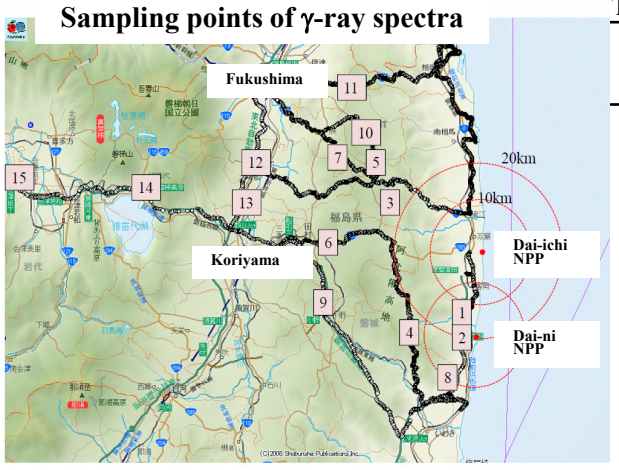
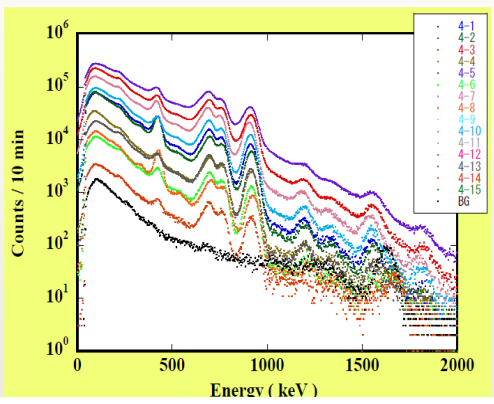


Table 1. Dose rate at sampling point by the survey meter

No.	Name	April (μSv/h)			June (μSv/h)			October (μSv/h)		
		outside		inside	outside		inside	outside		inside
		1m	1cm		1m	1cm		1m	1cm	
1	Tomioka	4.2	5.7	2.2	3.0	4.1	1.7			
2	Futaba	5.0	7.3	2.3	3.9	5.7	2.7			
3	Minami Tsushima	19.3			16.0	22.2	9.8			
4	Ogawa	1.5	1.9	0.9	1.3	1.7	0.8	1.1	1.5	0.7
5	Akougi	39.0			30.0		14.6	25.0	40.0	11.3
6	Tamura	0.7	1.0	0.4	0.6	0.7	0.4			
7	Mizukagami	12.7	14.9		9.9	14.0	6.4	7.8	10.4	5.6
8	Yotsukura	0.6	0.9	0.4	0.4	0.6	0.3			
9	Abukuma	0.3	0.4	0.2						
10	Nishihara	6.6	9.7		4.9	7.3	2.5			
11	Ishida	1.4	1.9		1.3	1.8	0.8			
12	Nihonmatsu	2.3	2.8	1.4						
13	Adatara	1.4	2.0							
14	Inawashiro	0.2	0.3	0.2						
15	Aizu	0.1	0.1	0.1						

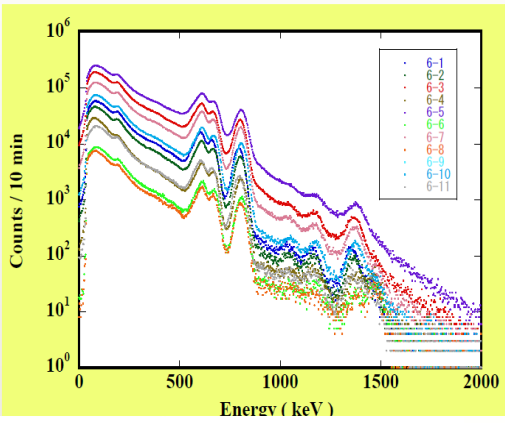
γ-ray spectra (April, 2011)



Max. 4-5 >30μSv/h

Min. 4-15 0.11 μSv/h

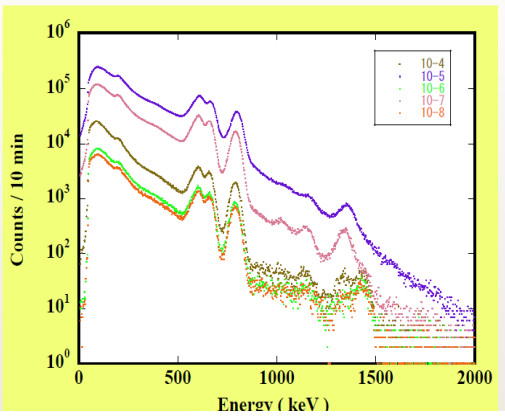
γ-ray spectra (June, 2011)



Max. 4-5 >30μSv/l

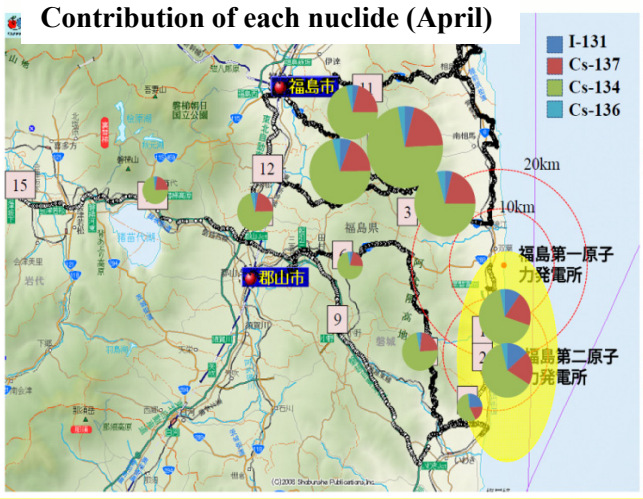
Min. 6-8 0.43 μSv

γ-ray spectra (October, 2011)

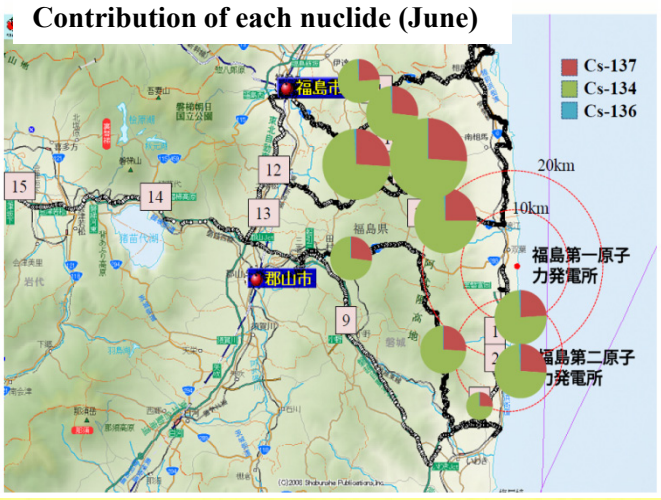


Max. 5 25μSv/h

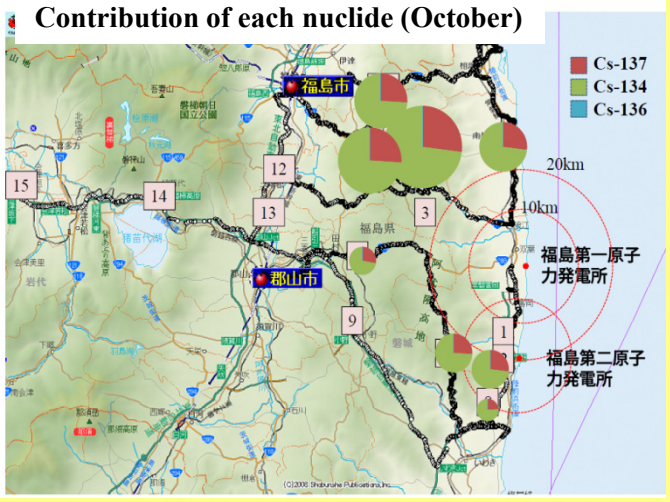
Contribution of each nuclide (April)



Contribution of each nuclide (June)



Contribution of each nuclide (October)



Ref. 1)Hosoda, M. *et. al* The time variation of dose rate artificially increased by the Fukushima nuclear crisis. *Scientific Reports* 1, Article number; 87 (2011).
2)Minato, S. Evaluation of radioactivities released from the Fukushima Nuclear Power Plant by response matrix method. *RESL Rep*. SCS-0073, pp.1-8 (2011).