Aerial radiological monitoring of East Japan after the Fukushima Daiichi NPP accident

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Introduction

We measured the ambient dose-rate and the deposition amount of radioactive cesium by using four helicopters in the whole area of East Japan to investigate the influence of the radioactivity that released in the atmosphere due to the disaster of the Fukushima Daiichi NPP (Nuclear Power Plant), Tokyo Electric Power Company (TEPCO), occurred by the East Japan earthquake and tsunami on March 11, 2011.

Mission Goals are ….
- to create the radiation map of East Japan for grasp on the influence of a radiocesium.
- to establish the method of aerial radiological monitoring

Achievement of aerial radiation monitoring

Date	Mission	Note
25 Mar. 2011	MEXT Press release of plan for aerial radiation monitoring	
5 Apr. 2011	60km zone from NPP(DOE)+60-80km zone from NPP(NUSTEC)	**<1st monitoring>**
17 May. 2011	80-100km zone from NPP(NUSTEC)	**<2nd monitoring>**
17 May. 2011	40km zone from NPP(DOE+JAEA*1)+40-80km zone from NPP(NUSTEC)	**<3rd monitoring>** *1：DOE system in helicopter of the Self-Defence Forces
21 Jun. 2011	Miyagi-pref., Toshigi-pref., and Ibaraki-pref. (NUSTEC+JAEA*2)	*2： DOE system in helicopter of the air-rescue
2 Aug. 2011	MEXT project **<Research for diffusion condition of radionuclides using aerial radiation monitoring>**	

Aerial monitoring system

- Count rate was obtained by helicopter with large detector
- Height above the ground 150-300m
- Flight space: 3km
- Acquisition rate: 1 second interval

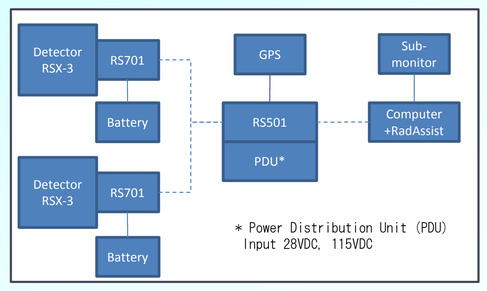
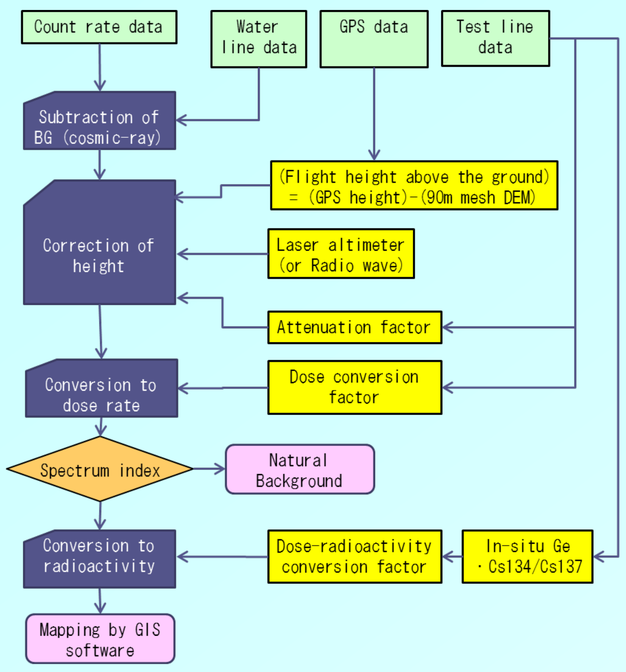


Table Aerial monitoring system

System	Install	Det. size(inch), quantity	Energy range	Channel	Altimeter
A	Inside	16"×4"×2", 6 detector	0.02 - 3 MeV	1,024 ch	GPS
B	Outside	16"×4"×4", 4 detector	0.05 - 3 MeV	256 ch	Laser
C	Outside	16"×4"×4", 8 detector	0.2 - 3 MeV	256 ch	Radio wave
D	Inside	16"×4"×4", 4 detector	0.05 - 3 MeV	256 ch	GPS

Methods

I. Procedure of data analysis

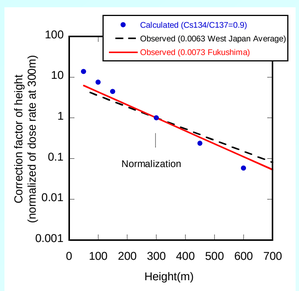


II. Correction factor

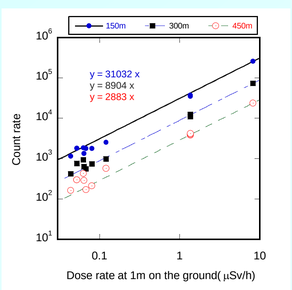
$$D_{1m} = (GC - BG) \times Cd \times HF$$

$$HF = \exp(\mu(H_{sd} - H_{Fly}))$$

GC: Gross count rate (cps)
BG: Cosmic-ray, Body contamination (cps)
Cd: Dose conversion factor (cps/μSv/h)
HF: Height correction factor
μ: Attenuation factor (m^{-1})
H_{sd}: Standard height (approximaetly 300m)
H_{fly}: Flight height



Attenuation factor

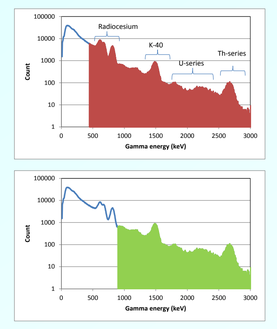


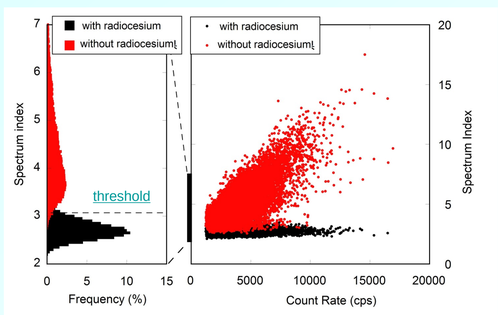
Dose conversion factor

IV. Discrimination between radiocesium and natural radionuclides

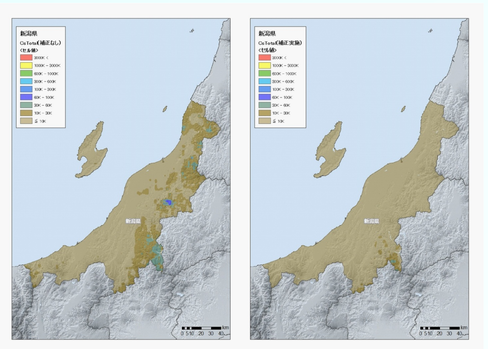
Spectrum index (SI) method was applied for discrimination between radiocesium and natural radionuclides.

$$SI = \frac{C_{>450keV}}{C_{>900keV}}$$





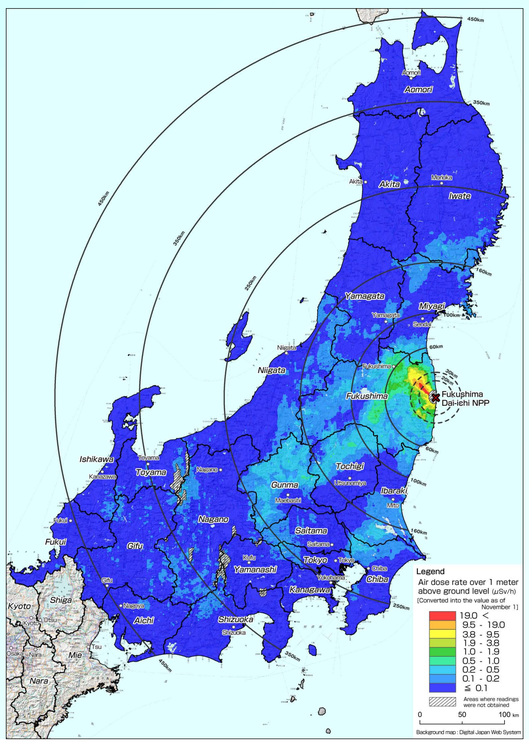
Example of SI distribution

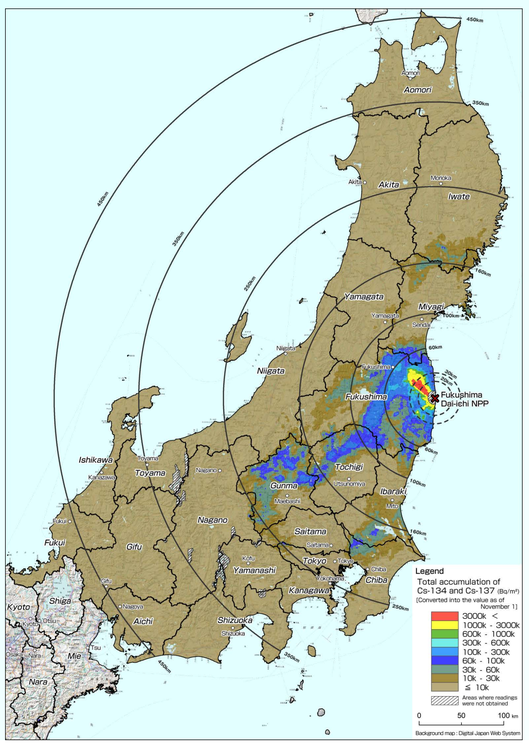


Comparison of contamination map by SI method

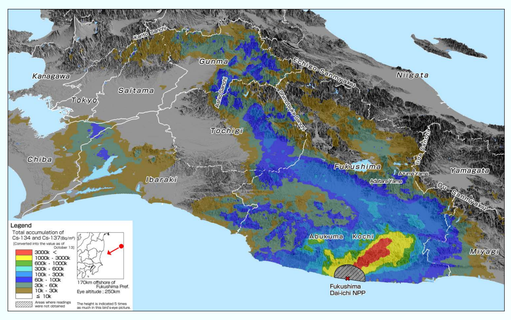
Results

I. Map of dose rate and the deposition



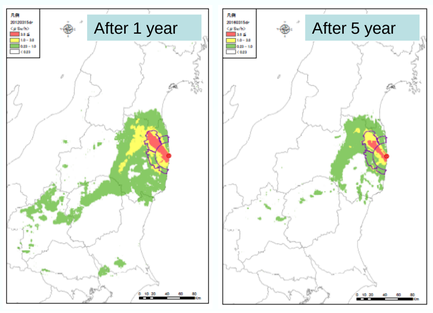


II. 3D map of the deposition



Radiocesium that emitted into the atmosphere was deposited along Ou Mountains, Iide Mountains, Echigo Mountains, Shimotsuke Mountains and Kanto Mountains.

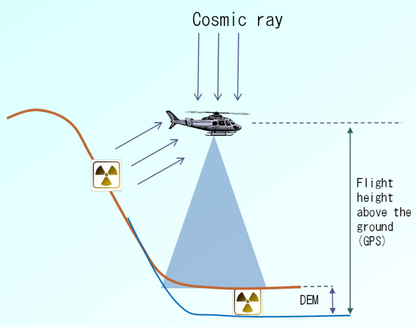
II. Prediction of dose rate

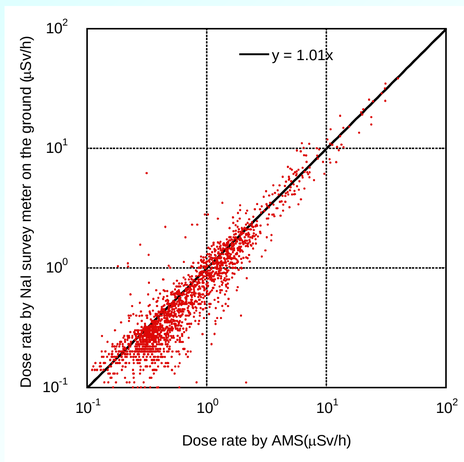


Based on the created map, the prediction map was made in consideration of half-life.
- Area of above 0.23 uSv/h(=1.9 mSv/y) was limited to Fukushima, Tochigi* and Gunma* after 5 years. (* mountainous region)

Comparison with the ground survey

AMS data was compared to ground survey data (NaI survey meter).
- On the whole, it was well in agreement.
- In the following cases, the data of AMS may not match ground survey data.
  (1) Area of a fold of hills
  horizontal effects
  (2) Cosmic ray
  time, season and weather





Summary

- The radiation map which can be used for the plan of decontamination or the determination of a refuge zone was able to be made.
- The method of aerial radiological monitoring was established.
  * the conversion method to a dose rate
  * discrimination between radiocesium and natural radionuclides

It has been understood for the region where the dose-rate is high to extend from the NPP for northwestward, and wide to Gunma Prefecture from the vicinity of Fukushima City in the direction of the southwest. This map is utilized to determine the decontamination area and estimate the variation of contamination areas.