報道発表

文部科学省 MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

August 30, 2011

Preparation of Distribution Map of Radiation Doses, etc. (Map of Radioactive Cesium Concentration in Soil) by MEXT

A map of radioactive cesium concentration in soil was prepared in the course of the project commenced on June 6, 2011, under the 2011 Strategic Funds for the Promotion of Science and Technology, entitled "Establishment of the Base for Taking Measures for Environmental Impact of Radioactive Substances — Study on Distribution of Radioactive Substances."

1. Objective of the survey

In order to continuously check the impact of radioactive substances deposited on the ground surface on the health of residents and the environment, MEXT measured air dose rates at around 2,200 locations within approximately 100 km from the Fukushima Dai-ichi NPP, and at the same time collected soil samples from the 5 cm surface layer at around five points at each location to analyze nuclides by using germanium semiconductor detectors, prior to the rainy season, before any changes occurred on the soil surface. (The results of the measurement of air dose rates were already publicized on August 2 and 12. The method to collect soil samples and the means for nuclide analysis are as shown in Attachment 1.)

Regarding around 3% of all the samples, the results of nuclide analysis by different analysis organizations were compared by each other, and then the Conference for the Preparation of Distribution Map of Radiation Dose, etc. (Attachment 2), which was established in MEXT, checked the extent of the variation in those results, made comparisons with readings of other monitoring surveys, and finally verified the validity of the readings of this survey.

2. Details of the survey

○Soil collecting periods:

First period: June 6 to June 14

Second period: June 27 to July 8

○Entities that collected soil samples:

Osaka University, University of Tsukuba, The University of Tokyo, Japan Atomic Energy Agency, The Federation of Electric Power Companies of Japan "Local support team," and others (see the List of Organizations Offering Cooperation in the

Preparation of Distribution Map of Radiation Dose, etc. released on August 2 and 12 for details)

○Entities that conducted nuclide analysis:

The Japan Chemical Analysis Center, the University of Tokyo, and 19 other organizations (see Attachment 3 for details)

○Targets: Concentration per unit area of Cs-134 and Cs-137 deposited on the ground surface

3. Readings of this survey

The soil concentration maps compiling the results of nuclide analysis of Cs-134 and Cs-137 contained in soil samples are as shown in Attachments 4-1 and 4-2.

For verifying the validity of the results of nuclide analysis, we made comparisons between nuclide analysis results of part of the soil samples conducted by universities and the Japan Chemical Analysis Center respectively and the results of in-situ measurement* carried out by using germanium semiconductor detectors at the same locations where the soil samples were collected (Attachment 5), as well as between nuclide analysis results of the overall soil samples and the results of the third airborne monitoring survey (Attachment 6).

* In-situ measurement using germanium semiconductor detectors: Means to analyze the concentration of radionuclides accumulated in soil by installing transportable germanium semiconductor detectors in the environment and detecting gamma rays that are emitted from radiation sources distributed in soil. Measurement is carried out targeting the overall soil surface, and this is an effective method to ascertain the average radiation levels at flat places without any buildings, etc. nearby.

The aforementioned soil concentration maps were prepared under the following conditions.

- ○ The maps are based on the results of nuclide analysis of the soil samples that MEXT collected between June 6 and July 8 in the course of the project under the 2011 Strategic Funds for the Promotion of Science and Technology, entitled “Establishment of the Base for Taking Measures for Environmental Impact of Radioactive Substances — Study on Distribution of Radioactive Substances.”
- ○ Nuclide analysis of the soil samples was conducted by using germanium semiconductor detectors at 21 research organizations nationwide.
- ○ As there was an interval between the first period and the second period for collecting soil samples, upon preparing maps, we corrected measured values into radiation levels as of June 14, the final day of the first period, taking into consideration the half-life period for each nuclide.
- ○ As the airborne monitoring in April revealed that spots showing high radiation doses were concentrated in areas within 80 km from the Fukushima Dai-ichi NPP, MEXT, in principle, conducted measurement at one location per 2×2 km^2 grid for these areas, and at one location per 10×10 km^2 grid for the areas 80 to 100 km from the Fukushima Dai-ichi NPP and other

parts of Fukushima prefecture.

4. Consideration

○ As soil samples for this survey were collected at locations with certain areas free from disturbance, we were able to ascertain the distribution of radioactive substances as of June to July widely and in detail. Therefore, the obtained results are expected to be utilized as valuable initial data when assessing people's exposure doses and monitoring chronological changes in the concentration of radioactive substances in the future.

○ As shown in Attachment 5, when comparing the results of in-situ measurement using germanium semiconductor detectors and the results of nuclide analysis of soil collected at the same locations, which was also conducted by using germanium semiconductor detectors, it was confirmed that at five locations out of seven, analysis results for Cs-134 and Cs-137 coincided with the results of the in-situ measurement with differences no greater than 20%.

○ As shown in Attachment 6, it was also confirmed that the results of nuclide analysis for Cs-134 and Cs-137 contained in the soil samples showed mostly similar trends as the results obtained through airborne monitoring, although there were some local differences.

○ When comparing the total concentration of Cs-134 and Cs-137 contained in the soil samples and air dose rates at points where soil samples were collected, a certain correlation was observed between them (Attachment 7). Therefore, we will be able to estimate Cs-134 and Cs-137 concentrations in soil from measured air dose rates by calculating ratio of the concentration of Cs-134 and Cs-137 in soil based on the results of in-situ measurement using germanium semiconductor detectors, as well as properly assessing how nuclides migrate into soil.

5. Future plans

○ Analysis results for radioactive cesium were thus released today. Regarding other nuclides (in particular, I-131), whose concentration is very low, the validity of measurement results is being verified and methods for preparing maps are being discussed, based on experts' opinions. The results will be released as soon as the verification is completed and the methods are determined.

○ Results of the survey to ascertain the movements of radioactive substances will be compiled and publicized by the end of September.

Contacts
Emergency Operation Center
Horita, Oku
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Attachment 1

Procedure for Soil Sampling and Method for Nuclide Analysis of Soil Samples

1. Method to collect soil samples

○ We collected soil samples at around five points selected at each of the accessible locations, preferably within an area of 3 m×3 m. We tried to collect samples at regular intervals to the extent possible.

○ Through a preliminary survey, it was confirmed that I-131, Cs-134, and Cs-137 exist in soil within 5cm from the ground surface. Therefore, we collected soil from the surface to the depth of 5cm. We sufficiently stirred collected soil and put them in U8 containers.

○ In order to ascertain the deposition of radioactive substances released from the Fukushima Dai-ichi NPP, we collected soil together with small weeds or other vegetation if there were any. We also collected root zones as soil samples.

○ We took photos to record collected soil samples, clearly showing labels with sample numbers, soil types, and soil colors, for the purpose of identifying them. We put each soil sample into a bag separately and attached a label with the sample number, date and time on which the sample was collected, and the name of the person who collected it. We thus tried to make sure not to mix up samples.

○ We measured and recorded dose equivalent rates of the surface of sample containers as reference data to be used when conducting nuclide analysis.

○ We changed cotton gloves and rubber gloves each time when collecting soil samples and thus tried to avoid cross-contamination and mixture of nuclides among samples.

○ In order to avoid cross-contamination, we decontaminated tools used for collecting soil samples after each use.

○ After confirming that containers were completely sealed, we wiped their surfaces with alcohol tissue, etc. for decontamination, put them into bags, and transported them to analysis organizations. When transporting them, we complied with the regulations for Type-L packages.

2. Method for nuclide analysis of soil samples

○ Measurement of radiation concentration in soil samples was conducted by using germanium semiconductor detectors (Ge detectors), which were calibrated based on standard radiation sources with known radiation levels.

○ Considering the possibility of detecting short-half-life radionuclides, measurement was conducted for a maximum of one hour. Even when the values for short-half-life radionuclides were below the detection limits, obtained nominal radiation levels are also indicated (< A_{LD} (detection limit) Bq/m^2; A±B Bq/m^2).

○ After finishing the measurement of each soil sample, we conducted decontamination of the inside of the detector shield to place samples or confirmed that no radioactive substances adhered to the detector.

3. System to verify analysis results

○ In order to avoid mixing up soil samples at the time of measurement and to ensure the validity of measurement results, we prepared check lists for each procedure as a measurement record books and repeated checks by multiple people.

○ In order to ensure that the method for spectral analysis for nuclide identification can be checked all the time, we retained all information, including spectral data, count numbers, and measurement results for standard samples. Then these data were made up by responsible persons of respective measurement organizations, and the analysis method and results were checked independently by the organization in charge of integrating the overall results.

4. Cross-checking of nuclide analysis results

○ Regarding 3% of the collected soil samples, same samples were analyzed by the Japan Chemical Analysis Center and another organization, or by the University of Tokyo and another organization, for cross-checking.

Attachment 2

Concerning the Conference for the Preparation of Distribution Map of Radiation Dose, etc.

1. Objective of holding the conference

Based on the "Plan to Strengthen Environmental Monitoring" (Nuclear Emergency Response Headquarters; April 22, 2011) and the "Policies for Emergency Responses for Those Affected by the Nuclear Incident" (Nuclear Emergency Response Headquarters; May 17, 2011), MEXT decided to prepare a distribution map of radiation doses and other maps for the purpose of utilizing them to ascertain the overall picture of the accident and consider the removal of the designation of evacuation areas.

Prior to the preparation of the maps, the Conference for the Preparation of Distribution Map of Radiation Dose, etc. is held to discuss technical matters.

2. Matters to be discussed

- ○ Technical matters related to the preparation of an "Air Dose Rate Map" which shows the distribution of radioactive substances
- ○ Technical matters related to the preparation of a "Soil Concentration Map" which shows the accumulation of radioactive substances in the surface layer of soil
- ○ Technical matters related to the preparation of a "Radioactivity Concentration Distribution Map for Farmland Soil" which shows the accumulation of radioactive substances in farmland soil
- ○ Technical matters related to the movements of radioactive substances from the soil surface (movements to rivers and groundwater, etc., resuspention of soil dust from the soil surface, and infiltration into soil, etc.)

3. Clerical work

Clerical work of the Conference is handled by the Nuclear Safety Division of the Science and Technology Policy Bureau.

4. Conference members

Name	Professional affiliation
IKEUCHI Yoshihiro	Commissioner, Japan Chemical Analysis Center
KIMURA Hideki	Vice Counselor, Nuclear Safety Division, Department of Environment and Public Affairs, Aomori Prefectural Government
KOYAMA Yoshihiro	Division Chief, Nuclear Safety Division, Department of Living Environment, Fukushima Prefectural Government
SAITO Kimiaki	Superior Researcher, Headquarters of Fukushima Partnership Operations, Japan Atomic Energy Agency
SHIBATA Tokushi	Visiting Researcher, Japan Proton Accelerator Research Complex, Japan Atomic Energy Agency
SHIMO Michikuni	Visiting Professor, Fujita Health University
SUGIURA Nobuyuki	Professor, Kinki University Atomic Energy Research Institute
TAKAHASHI Takayuki	Vice President (in charge of research) and Library Director, Fukushima University
TAKAHASHI Hiroyuki	Professor, Department of Nuclear Engineering and Management, The University of Tokyo
TAKAHASHI Tomoyuki	Associate Professor, Division of Nuclear Engineering Science, Kyoto University Research Reactor Institute
CHINO Masamichi	Vice Directorate Head, Nuclear Science and Engineering Directorate, Japan Atomic Energy Agency
NAGAOKA Toshi	Head of the Safety Management Division, Japan Synchrotron Radiation Research Institute
NAKAMURA Hisashi	Professor Emeritus, Tohoku University
HASEBE Akira	Research Supervising Chief, National Institute for Agro-Environmental Sciences
HISAMATSU Shunichi	Department Director, Department of Radioecology, Institute for Environment Sciences
MURAMATSU Yasuyuki	Professor, Department of Chemistry, Faculty of Science, Gakushuin University
YOSHIDA Satoshi	Unit Chief, Operation and Planning Unit, Research Center for Radiation Protection, National Institute of Radiological Sciences

Attachment 3

List of Organizations Offering Cooperation in the Nuclide Analysis for the Preparation of a Distribution Map of Radiation Doses, etc. (Soil Concentration Map)

●Total participants: 340 people

●Cooperative research organizations: 21 organizations

----- List of Universities and Facilities -----	**Number of people**
Osaka University Research Center for Nuclear Physics Graduate School of Science/School of Science Graduate School of Engineering/School of Engineering Graduate School of Pharmaceutical Sciences Graduate School of Medicine Department for the Administration of Safety and Hygiene	84
Osaka Electro-Communication University Department of Engineering Science, Faculty of Engineering/Graduate School of Engineering	11
Kanazawa University Faculty of Chemistry, College of Science and Engineering Graduate School of Natural Science and Technology/School of chemistry, College of Science and Engineering School of Health Sciences, College of Medical, Pharmaceutical and Health Sciences Graduate School of Medical Science/School of Health Sciences, College of Medical, Pharmaceutical and Health Advanced Science Research Center	24
Kyushu University Graduate School of Sciences	10
Kyoto University Kyoto University Research Reactor Institiute Graduate School of Engineering Faculty of Science	11
High Energy Accelerator Research Organization Institute of Particle and Nuclear Studies Accelerator Laboratory	5
Konan University Faculty of Science and Engineering	6
Saga University Faculty of Culture and Education	1

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----- List of Universities and Facilities -----	**Number of people**
Tokyo Metropolitan University Graduate School of Science and Engineering/School of Science and Engineering, Faculty of Urban Liberal Art	21
Shinshu University Faculty of Education (Natural Science and Mathematics Education Course)	1
University of Tsukuba Graduate School of Pure and Applied Sciences	1
Tokyo Institute of Technology Graduate School of Science/School of Science Center For Biological Resources and Informatics	21
The University of Tokyo Center for Nuclear Study, Graduate School of Science	16
Tohoku University Graduate School of Science/Faculty of Science Research Center for Electron Photon Science	29
The University of Tokushima Institute of Socio-Arts and Sciences, The University of Tokushima Graduate School Institute of Health Biosciences, The University of Tokushima Graduate School Integrated Material Science Studies, Department of Mathematical and Material Sciences, Faculty of Integrated Arts and Sciences Department of Radiologic Science & Engineering, School of Health Sciences、Faculty of Medicine	7
Niigata University Faculty of Science/Graduate School of Science and Technology Center for Instrumental Analysis	11
Nihon University College of Humanities and Sciences/Graduate School of Integrated Basic Sciences	5
Japan Chemical Analysis Center Radiation Analysis Division	7

List of Organizations Offering Cooperation in the Nuclide Analysis for the Preparation of a Distribution Map of Radiation Doses, etc. (Soil Concentration Map)

●Total participants: 340 people

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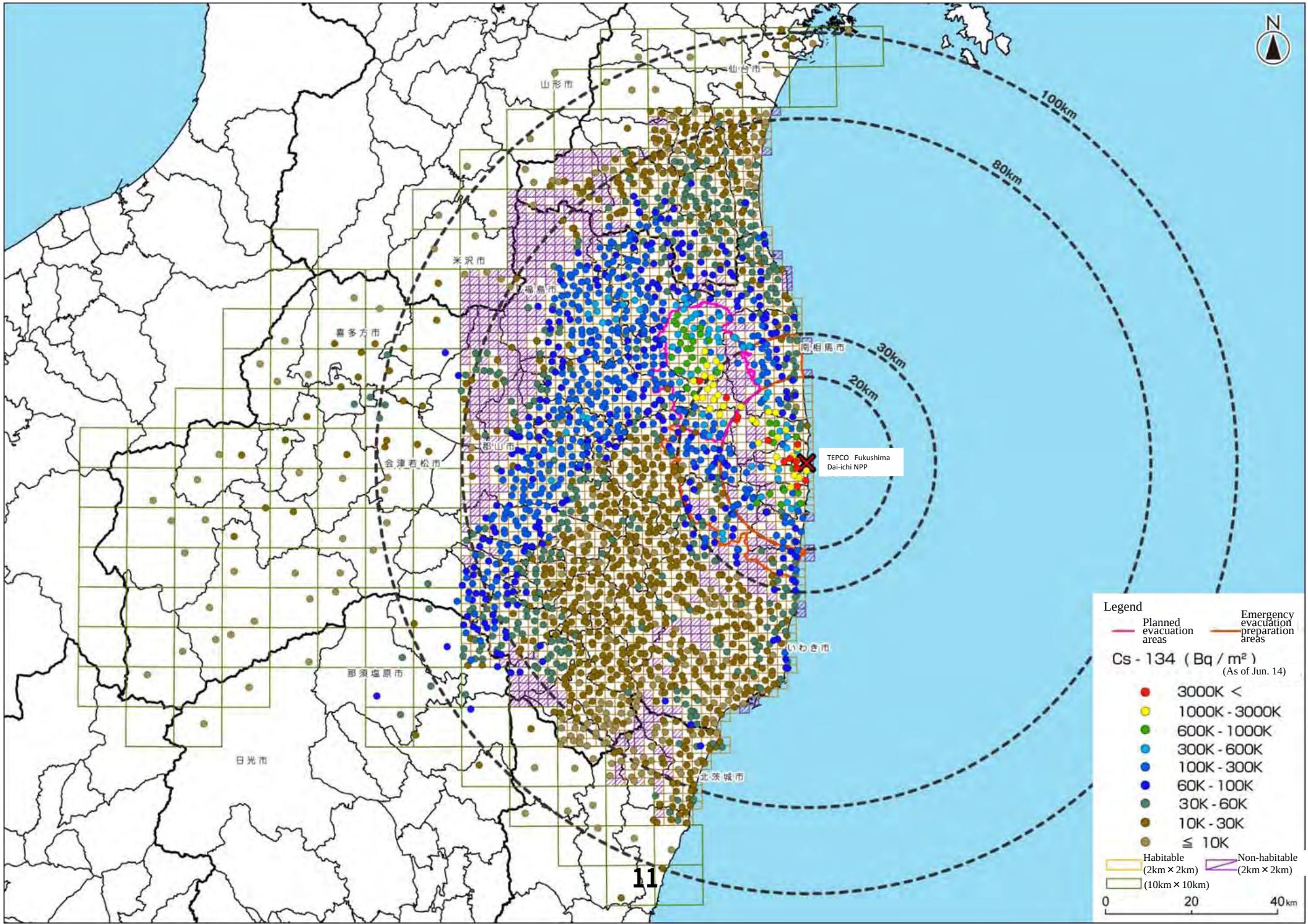
----- List of Universities and Facilities -----	**Number of people**
University of Miyazaki Faculty of Engineering/Graduate School of Engineering	5
RIKEN Nishina Center for Accelerator-Based Science Advanced Research Promotion Division	30
Rikkyo University College of Science/Graduate School of Science	34

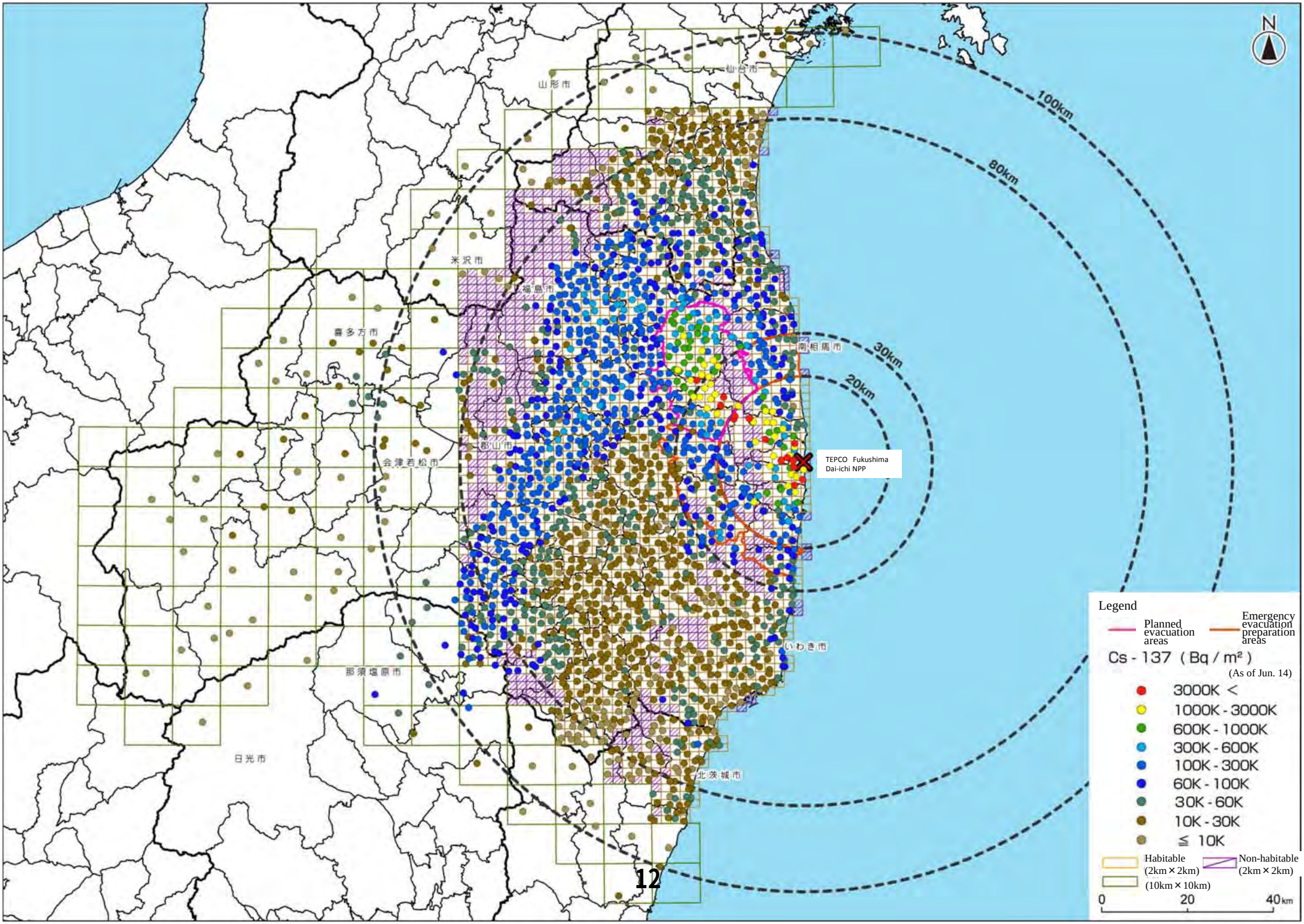
Map of Concentration of Cs-134 in Soil

Attachment 4-1



Map of Concentration of Cs-137 in Soil

Attachment 4-2



Attachment 5

Comparison between Nuclide Analysis Results and Results of In-situ Measurement using Germanium Semiconductor Detectors of Soil Samples

1. Objective

○ For verifying the validity of nuclide analysis of soil samples collected at nearly 2,200 locations, we conducted in-situ measurement using germanium semiconductor detectors at some of these locations and the results are compared with the results of analysis of soil samples at the same locations.

○ Out of flat places with no shielding obstacles nearby, we selected seven locations where we had collected soil samples and where relatively high and low air dose rates were detected.

○ We selected the aforementioned seven locations from among the locations for which universities and the Japan Chemical Analysis Center conducted nuclide analysis independently, so as to verify the validity of their nuclide analysis equally.

○ We conducted in-situ measurement using germanium semiconductor detectors based on the in-situ measurement method specified in the MEXT's Radiation Measurement Method Series. Referring to ICRU REP. 53, as the parameter to show vertical distribution of radioactive substances in soil, we used values under the conditions where less than a year has passed after being deposited and the amount of precipitation is 3 mm or more.

2. Details of the measurement

○Responsible entity: Japan Chemical Analysis Center

○Dates: August 13 (Sat.) and 14 (Sun.)

3. Comparison results

○ As shown below, when comparing the results of in-situ measurement using germanium semiconductor detectors and the results of nuclide analysis of soil collected at the same locations, which was also conducted by using germanium semiconductor detectors, it was confirmed that at five locations out of seven, analysis results for Cs-134 and Cs-137 coincided with each other with differences no greater than 20%.

○ At the remaining two locations, the range of variance in the results of nuclide analysis for Cs-134 and Cs-137 among the sets of five samples collected at each location was about 300%. Said differences in nuclide analysis results among the five samples may

have been caused not only by measurement errors but also by heterogeneous distribution of radioactive substances deposited on the ground surface. If we increase the number of samples per location or assess the movements of nuclides into soil more properly when conducting in-situ measurement using germanium semiconductor detectors, nuclide analysis results and in-situ measurement results will show more consistent trends.

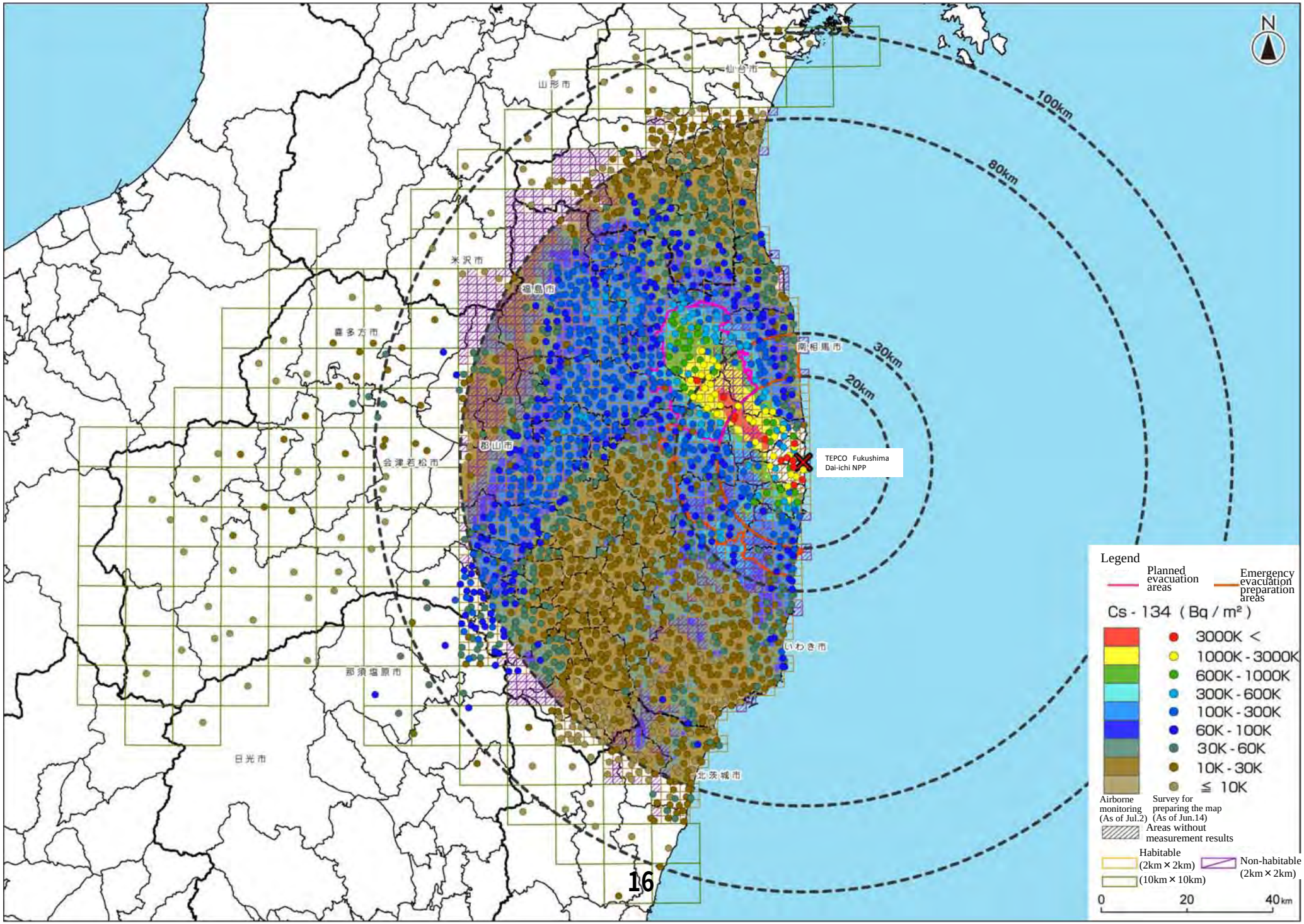
Comparison between Results of Nuclide Analysis of Soil and Results of In-situ Measurement Using Germanium Semiconductor Detectors

Attachment 5

Soil sample	Analysis organization	Air dose rates (μsv/h)	Sample number	Cs-134 concentration (Bq/km^2)	Cs-137 concentration (Bq/km^2)	Comparison between resutls of in-situ measurement using germanium semiconductor detectors and arithmetic mean values of nuclide analysis of soil	
						Ratio of Cs-134 concentration	Ratio of Cs-137 concentration
Sample ①	University	1.52	Sample ①－1	2.12E+11	2.18E+11		
			Sample ①－2	2.16E+11	2.17E+11		
			Sample ①－3	1.40E+11	1.41E+11		
			Sample ①－4	1.58E+11	1.61E+11		
			Sample ①－5	1.60E+11	1.64E+11		
			Arithmetic mean value	1.77E+11	1.80E+11	0.92	0.86
			In-situ analysis results	1.93E+11	2.10E+11		
Sample ②	Japan Chemical Analysis Center	2.15	Sample ②－1	5.92E+11	6.82E+11		
			Sample ②－2	2.09E+11	2.43E+11		
			Sample ②－3	1.96E+11	2.22E+11		
			Sample ②－4	6.23E+11	7.12E+11		
			Sample ②－5	2.97E+11	3.53E+11		
			Arithmetic mean value	3.83E+11	4.42E+11	1.89	2.01
			In-situ analysis results	2.03E+11	2.20E+11		
Sample ③	University	1.44	Sample ③－1	1.71E+11	1.64E+11		
			Sample ③－2	2.21E+11	2.17E+11		
			Sample ③－3	6.83E+10	5.88E+10		
			Sample ③－4	2.12E+11	2.01E+11		
			Sample ③－5	1.58E+11	1.50E+11		
			Arithmetic mean value	1.66E+11	1.58E+11	0.79	0.69
			In-situ analysis results	2.11E+11	2.29E+11		
Sample ④	University	0.24	Sample ④－1	3.57E+10	4.00E+10		
			Sample ④－2	3.79E+10	4.02E+10		
			Sample ④－3	3.04E+10	3.34E+10		
			Sample ④－4	3.08E+10	3.26E+10		
			Sample ④－5	3.39E+10	3.69E+10		
			Arithmetic mean value	3.37E+10	3.66E+10	0.99	0.97
			In-situ analysis results	3.42E+10	3.76E+10		
Sample ⑤	University	0.3	Sample ⑤－1	3.47E+10	3.83E+10		
			Sample ⑤－2	3.95E+10	4.20E+10		
			Sample ⑤－3	3.15E+10	3.38E+10		
			Sample ⑤－4	3.77E+10	4.01E+10		
			Sample ⑤－5	2.42E+10	2.85E+10		
			Arithmetic mean value	3.35E+10	3.65E+10	0.95	0.95
			In-situ analysis results	3.52E+10	3.83E+10		
Sample ⑥	Japan Chemical Analysis Center	0.56	Sample ⑥－1	8.20E+10	9.04E+10		
			Sample ⑥－2	6.96E+10	7.72E+10		
			Sample ⑥－3	8.89E+10	9.65E+10		
			Sample ⑥－4	6.48E+10	7.32E+10		
			Sample ⑥－5	1.05E+11	1.21E+11		
			Arithmetic mean value	8.21E+10	9.17E+10	1.05	1.07
			In-situ analysis results	7.84E+10	8.53E+10		
Sample ⑦ (8S52)	Japan Chemical Analysis Center	0.44	Sample ⑦－1	4.37E+10	5.28E+10		
			Sample ⑦－2	4.10E+10	4.64E+10		
			Sample ⑦－3	3.69E+10	4.15E+10		
			Sample ⑦－4	4.22E+10	4.80E+10		
			Sample ⑦－5	5.88E+10	6.94E+10		
			Arithmetic mean value	4.45E+10	5.16E+10	1.09	1.17
			In-situ analysis results	4.09E+10	4.43E+10		

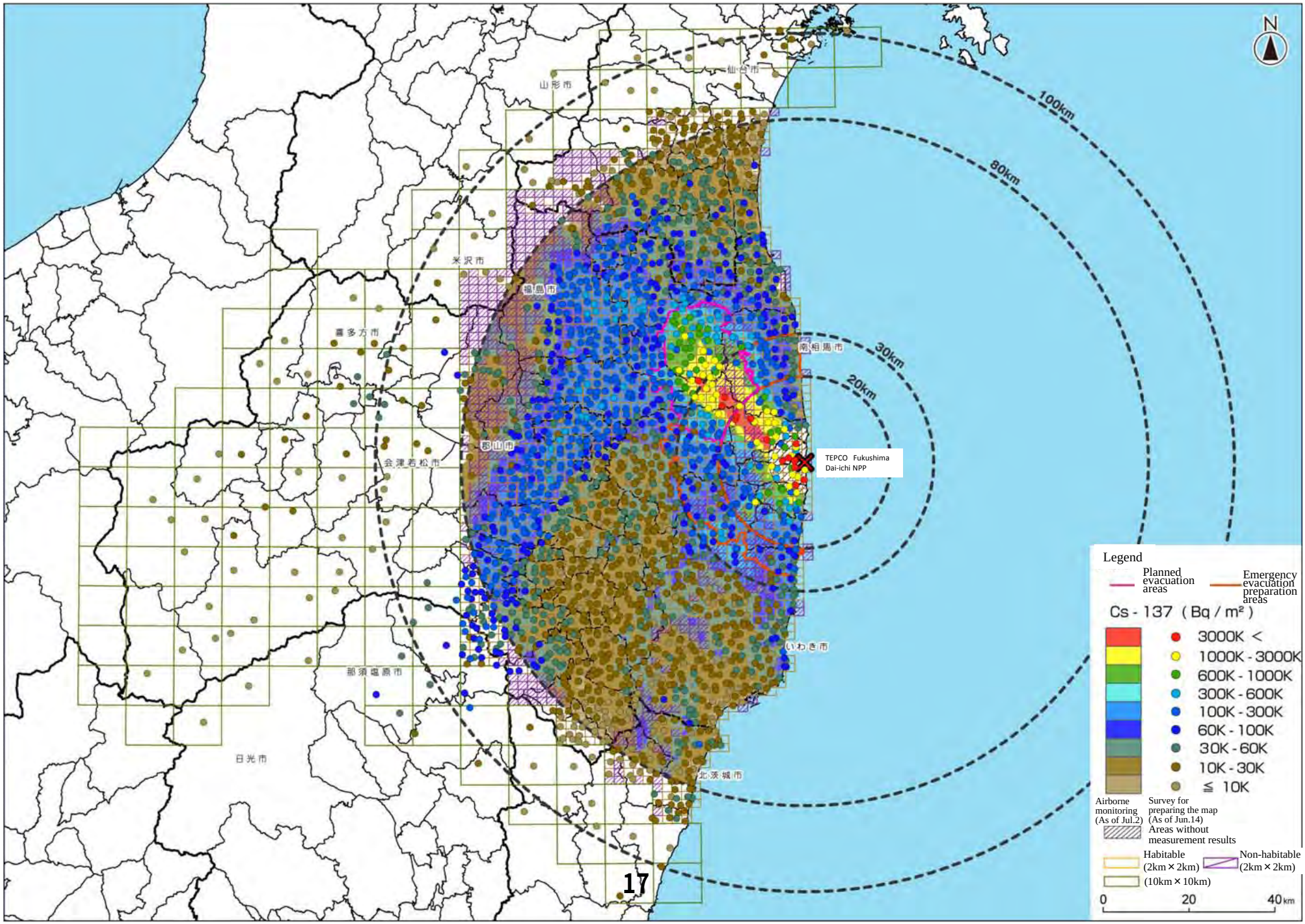
Attachment 6

Comparison between Third Airborne Monitoring Results and Map of Cs-134 Concentration



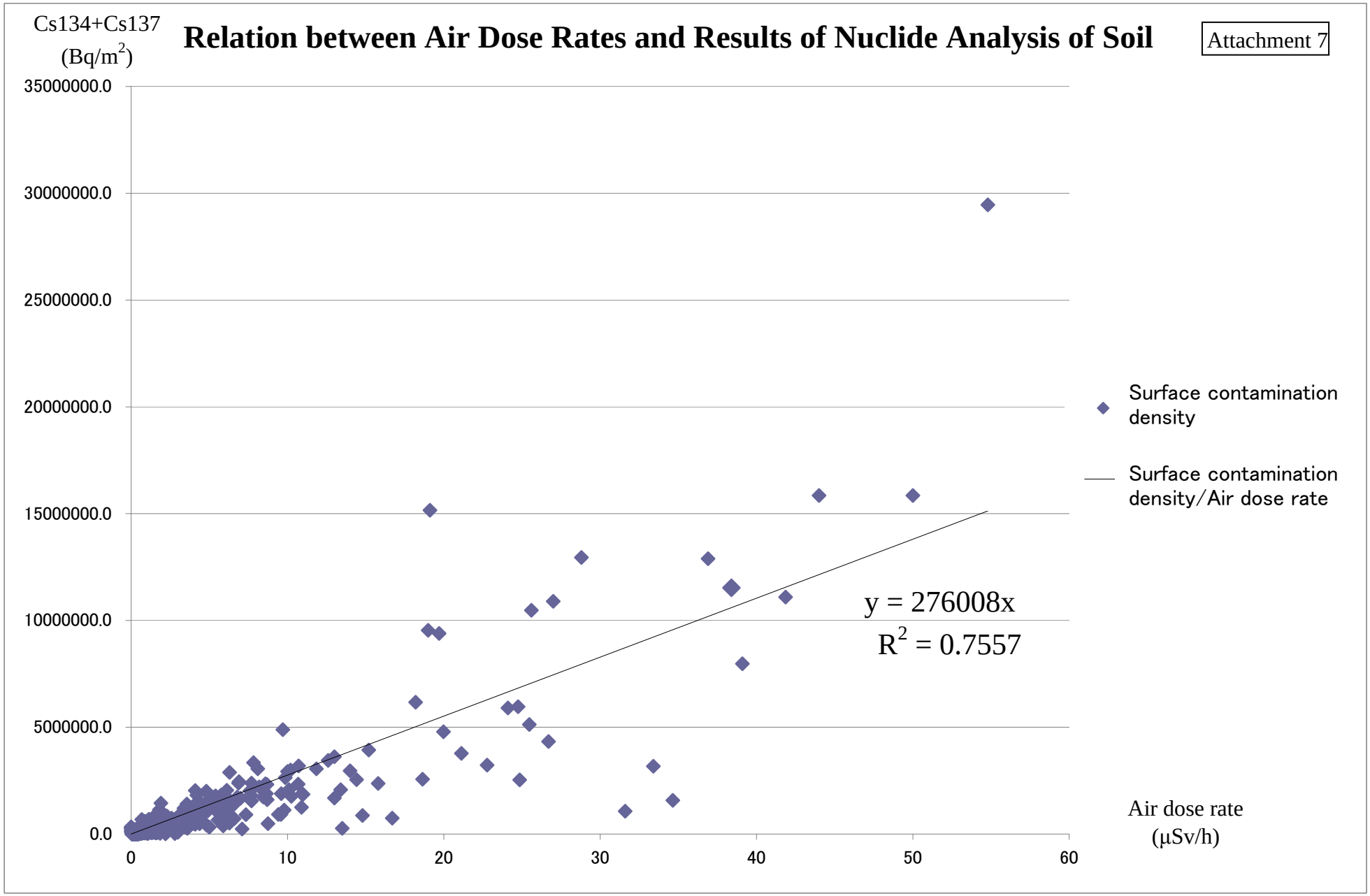
Attachment 6

Comparison between Third Airborne Monitoring Results and Map of Cs-137 Concentration



Relation between Air Dose Rates and Results of Nuclide Analysis of Soil

Attachment 7



(Reference)

Accuracy of Nuclide Analysis Results in this Survey

1. Objective

○ With regard to soil samples collected at nearly 2,200 locations (at around five points at each location) within approximately 100km from the Fukushima Dai-ichi NPP, responsible analysis organizations were assigned to each location and the Japan Chemical Analysis Center and other 20 organizations nationwide conducted nuclide analysis.

○ As various organizations were involved, cross-checking was conducted regarding around 3% of all the soil samples by different organizations so as to examine differences in analysis results among organizations.

2. Details of the examination

○ Regarding the mean values of nuclide analysis results of each location's five soil samples, we compared the measurement results by the Japan Chemical Analysis Center and those by other analysis organizations. Under the assumption of normal distribution, it was confirmed that 68.26% of the results by other analysis organizations fell within the range of 98%±12% of the results by the Japan Chemical Analysis Center (Reference 1).

○ In the meantime, previous surveys conducted by MEXT have revealed the fact that the concentration of radioactive substances deposited on the ground surface varies significantly even among soil samples collected at nearby locations.

○ Therefore, we examined proportions of the standard deviation (variation coefficients) against the mean value of nuclide analysis results among each location's five soil samples, and found that they range up to over 1, but most are about 0.3 (Reference 2).

○ Given these facts, differences in measurement results by analysis organization were found to be smaller than those in the standard deviations against the mean concentration of each location's five soil samples. Therefore, we concluded that differences in the accuracy of nuclide analysis results by analysis organization can be ignored.

○ The Japan Chemical Analysis Center has proved its high analysis capabilities at the past proficiency test hosted by IAEA, where it successfully analyzed provided soil samples with absolute accuracy.

○ Considering that there were not large differences in nuclide analysis results between the Japan Chemical Analysis Center and other analysis organizations, all

the results presented by the 21 organizations can be judged to have a certain degree of accuracy.

(Reference 1)

Cross-Checking of Nuclide Analysis Results by Different Analysis Organizations

1. Objective

In order to verify the validity of nuclide analysis results by different analysis organizations, we conducted cross-checking of the analysis results for 275 samples, around 3% of all the soil samples collected.

2. Results of the cross-checking

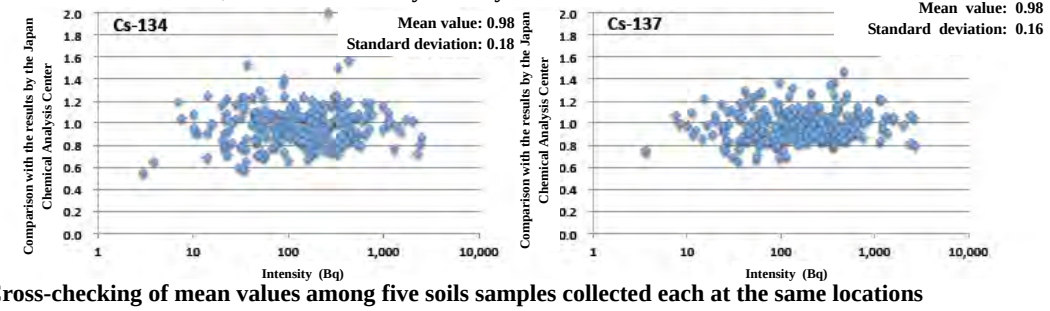
The University of Tokyo and other universities and organizations conducted nuclide analysis for the soil samples, for which the Japan Chemical Analysis Center had already conducted nuclide analysis, and we compared the results.

Furthermore, with regard to the mean values of nuclide analysis results of soil samples collected at five points at the same location, we compared the results of nuclide analysis conducted by the Japan Chemical Analysis Center, the University of Tokyo, and other universities and organizations.

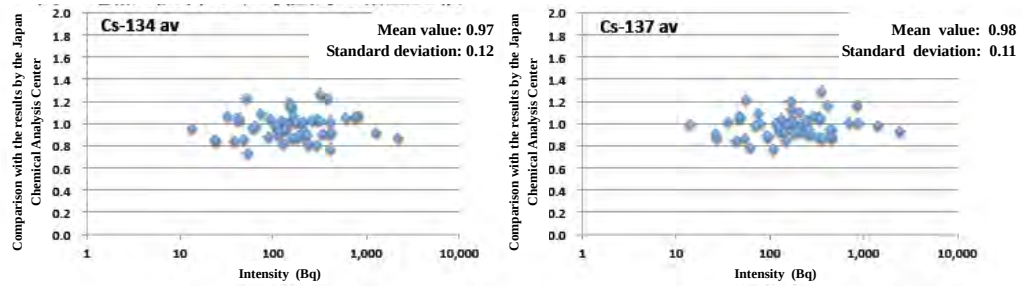
The former comparison showed that the standard deviations were less than about 0.2, although analysis results varied by 200% for part of the samples.

The latter comparison showed that the standard deviations were mostly no greater than 0.1, although the mean values of some locations' five soil samples differed by around 30% at the maximum from the mean values of other locations' five soil samples.

Comparison of measurement results of same soil samples (275 samples) between the Japan Chemical Analysis Center and other universities, and the University of Tokyo and other universities



Cross-checking of mean values among five soils samples collected each at the same locations



(Reference 2)

Examination of the Differences in Nuclide Analysis Results among Sets of Five Soil Samples Collected at the Same Locations

1. Objective

The soil samples were collected at five points within an area of 3 m×3 m at each of the selected locations. Radioactive substances are deposited on soil unevenly, depending on how they fell on the relevant location, the characteristics of the collected soil, the existence of organic substances in the soil, and other conditions. Therefore, we examined the differences in nuclide analysis results among such sets of five soil samples thus collected at the same locations.

2. Differences in nuclide analysis results among sets of five soil samples collected at the same locations

We confirmed the variation from the mean value (standard deviation) of nuclide analysis results among the sets of five soil samples collected at the same locations.

As shown below, the standard deviations against the mean value among the sets of five soil samples collected at the same locations were mostly around 0.3.