Radiation and Radioactivity Monitoring in the Surrounding Environment after Fukushima Dai-ichi Nuclear Power Plant Accident
- Overview -

Takashi Nakamura

Prof Emeritus of Tohoku University

Head of Monitoring Committee, MEXT

IPRA-13, Glasgow, UK

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(1)-① Introduction

〇MEXT, in order to confirm the long-term influences on people's health and environmental impact continuously, conducted ambient dose rates measurement and various surveys on the ground surface deposition of radioactive nuclides, based on the results of airborne monitoring and other environmental monitoring in Fukushima Prefecture and neighboring prefectures .

〇Targeted Areas :

- Within 80km from the Fukushima Dai-ichi NPP : 2 km × 2 km grids
- 80 ～ 100km from the NPP : 10 km × 10 km grids

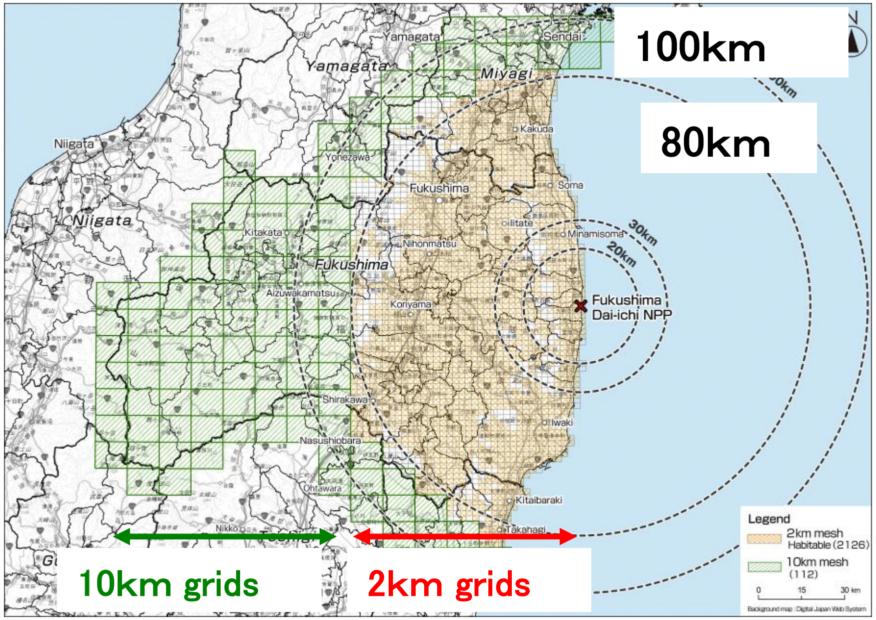
〇Sampling locations of soil : about 2,200 locations

〇Survey period :

- Ambient dose rate measurement and Soil sampling
  → (1) June 6 – June 14, (2) June 27 – July 8
- Ambient dose rate measurement by vehicle
  → June 6 – June 13

〇Survey contracted by Japan Atomic Energy Agency (JAEA), and

- Ambient dose rate measurement and Soil sampling
  : 107 Organizations, 440 Persons
- Ambient dose rate measurement by vehicle
  : 21 Organizations, 291 Persons



(1)-② History

○2011.03.11　The Tohoku District – off the Pacific Ocean Earthquake and tsunami caused by the earthquake

○2011.04.22　Enforced Plan on Environmental Monitoring

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○**2011.05.26**　Establish “the Advisory Board of Distribution Map of Radiation Dose, etc.” within MEXT

○2012.01.24　Fixed the plan of the Distribution map in #15 the advisory board

↓

○**2012.03.14**　Release the report “Results of the Research on Distribution of Radioactive Substances Discharged by the Accident at TEPCO’s Fukushima Dai-ichi NPP”

(1)-③ Soil sampling

○Soil samples : about 11,000 samples

(collected at 5 points in principle at each location)

Sampling case

Completion

(1)-④ Nuclide analysis of Soil sampling (γ-emitting nuclides)

○Detector : Germanium semiconductor

○Output : the deposited amounts (radiation levels per unit area)
of Cs-134, Cs-137, I-131, Te-129m, and Ag-110m

(All of the analysis organizations conducted a cross-check using 3% of all samples.)

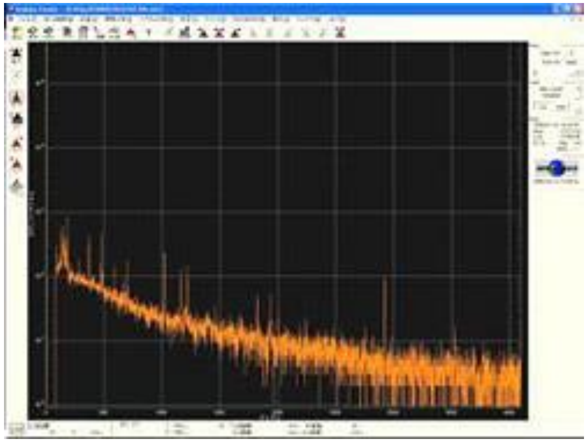
Deposited amounts
(Cs134,Cs137,I131
,Te129m,Ag110m)

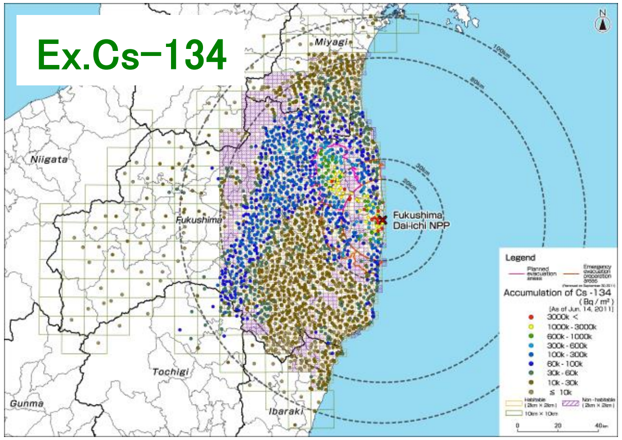
\+

GPS information

=

maps of deposition
density in soil
(γ-emitting nuclide)





(These maps were continuously
released from 2011.08.30)

(1)-⑤ Nuclide analysis of Soil sampling (α , β -emitting nuclides)

○Method : Radiochemical analysis

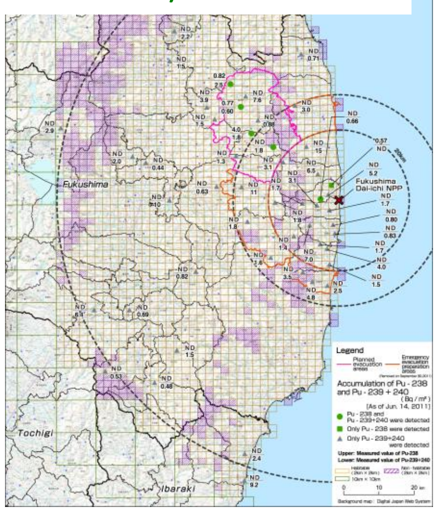
○Output : the deposited amounts (radiation levels per unit area)

- Pu-238, Pu-239+240 (α -emitting nuclides)
- Sr-89, Sr-90 (β -emitting nuclides)

○Soil samples : 100 samples (collected at 1 points at 100 locations)

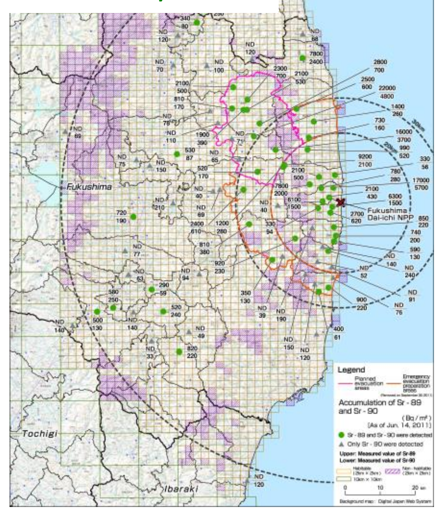
Deposited amounts (Pu238,Pu239+240, Sr89,Sr90) + **GPS information** = **maps of deposition density in soil** (α , β -emitting nuclide)

Ex.Pu238,Pu239+240



● ■ : Where Pu-238 and Pu-239+240 are considered to have been newly deposited due to the accident at the Fukushima Dai-ichi NPP

Ex.Sr89,Sr90



● : Where Sr-89 and Sr-90 are considered to have been newly deposited due to the accident at the Fukushima Dai-ichi NPP

(These maps were continuously released from 2011.09.30)

(1)-⑥ Ambient dose rate measurement

〈Fixed point measurement〉

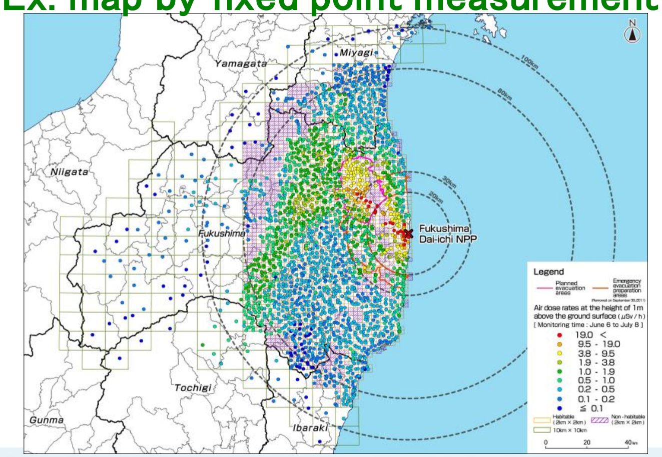
- ○Ambient dose rates were measured at a height of 1m above the ground surface at the same locations as soil sampling (nearly 2,200 locations in total).
- ○Survey meter : NaI (Tl) scintillator, ionization chamber type meter

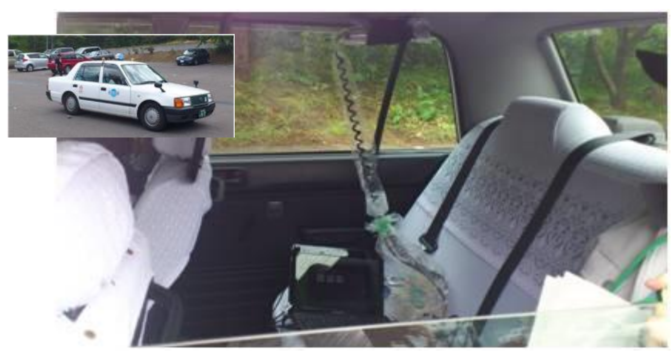
〈Continuous measurement by vehicle〉

- ○Ambient dose rates were continuously measured at a height of 1m above the ground surface mainly at national and prefectural roads in the targeted areas by vehicle-borne survey.
- ○Survey system : "KURAMA", originally developed by Kyoto Univ.

Fix point measurement (Ambient dose rates)
Vehicle-borne measurement (Ambient dose rates)
\+ GPS information = Maps of Ambient dose rates

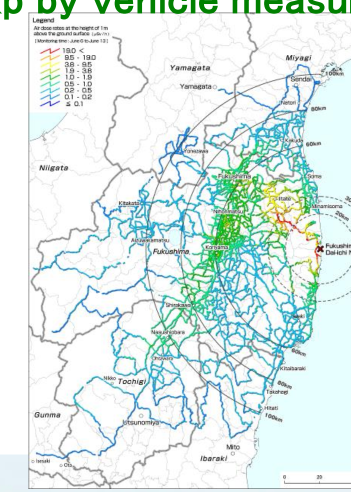
Ex. map by fixed point measurement





KURAMA system

Ex. map by vehicle measurement

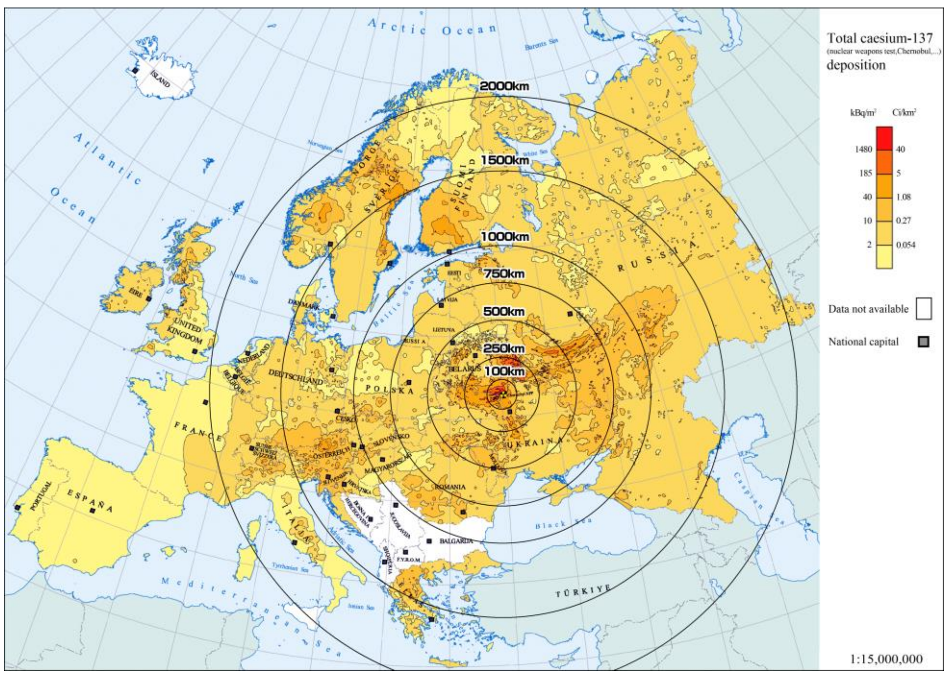


(1)-⑦ Comparison with effects of radioactive substances due to the Chernobyl accident

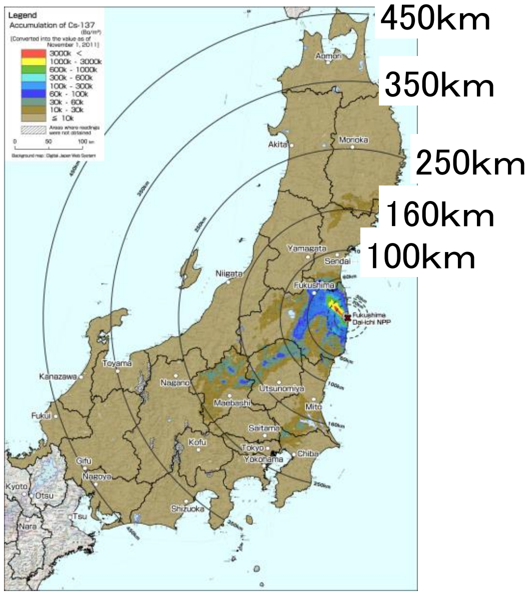
○A considerable amount of radioactive Cesium was distributed over the vast area of the east Japan and around, and deposited from the south side of Iwate prefecture as the north limit to Yamanashi prefecture and Nagano prefecture as the south limit.

○About a one-tenth for I-131 and Cs-137 was estimated in terms of the amounts discharged due to the Fukushima Dai-ichi accident compared with the Chelnobyl accident.

○The scope of effects of radiation discharged into environment due to the Chernobyl accident was one decimal place larger than the effects due to the Fukushima Dai-ichi accident.



Deposition of Cs-137 All over Europe after the Chernobyl Accident
(Converted as of December 1989)



Results of Airborne Monitoring Covering All Areas in East Japan
(Deposition density of Cs-137 deposited on the ground surface)
(Converted to radiation levels as of November 5, 2011)
(Around 8 months from the accident)

(1)-⑧ Estimated effective doses over 50 years for each radionuclide by using IAEA-TECDOC-1162 conversion factors

○In terms of contributions to estimated doses over 50 years, Cs-137 and Cs-134 accounted for nearly 96% and nearly 4% of the total, respectively.

Table Estimated Effective Dose over 50 Years at Points where the Maximum Amount of Each Type of Radionuclides was Detected

Radionuclide	Half-life period	Maximum deposition density level*1 (Bq/m^2)	Estimated effective dose over 50 years	
			Conversion factor ($\mu Sv/h$)/(Bq/m^2)	Obtained results (mSv)
Cs-134	2.065 years	1.4×10^{7}	5.1×10^{-3}	71
Cs-137	30.167 years	1.5×10^{7}	1.3×10^{-1}	2000 (2.0Sv)
I-131	8.02 days	5.5×10^{4}	2.7×10^{-4}	0.015
Sr-89	50.53 days	2.2×10^{4}	2.8×10^{-5}	0.00061 (0.61 μSv)
Sr-90	28.79 years	5.7×10^{3}	2.1×10^{-2}	0.12
Pu-238	87.7 years	4.0	6.6	0.027
Pu-239+240	2.411×10^{4} years	15.0	8.5	0.12
Ag-110m	249.95 days	8.3×10^{4}	3.9×10^{-2}	3.2
Te-129m	33.6 days	2.7×10^{6}	2.2×10^{-4}	0.6

(1)-⑨ Access to maps and database

<Website to enlarge distribution maps of radiation doses, etc.>

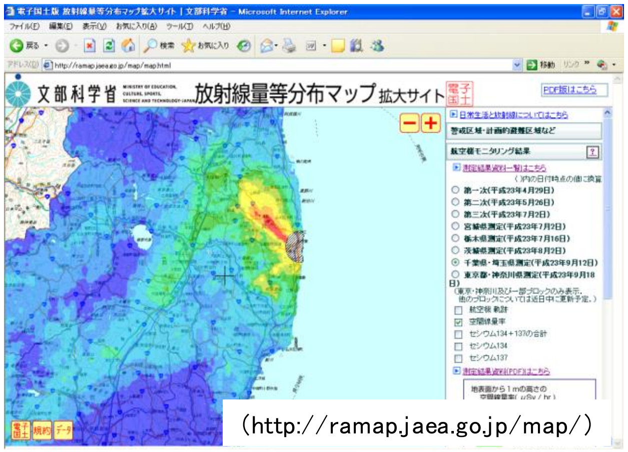
○maps : Radiation doses, Soil deposition density, Ambient dose rates, etc.

○URL : http://ramap.jaea.go.jp/map/ (←Sorry, Japanese only!!)

<Database on Radiation Doses, etc.>

○Data : Measurement Results conducted since immediately after the accident

○The database website is now under construction.



Website to enlarge distribution maps of radiation doses, etc.

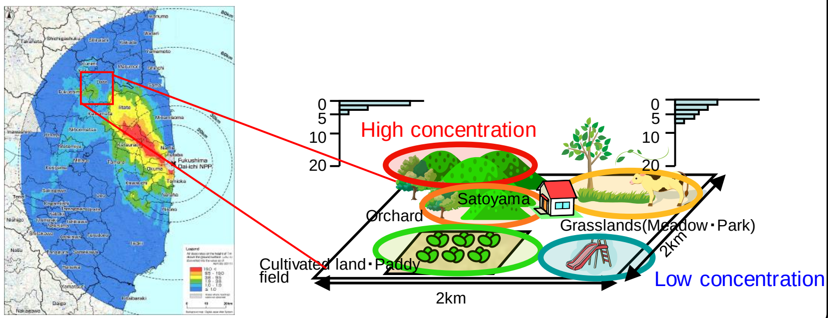
Database on Radiation Doses, etc.

(2)-① Introduction

○The distribution of radioactive materials in soil is considered to differ even within a 2×2km grids, depending on the character of the soil and other various manners in the environment in accordance with the movement of water and wind.

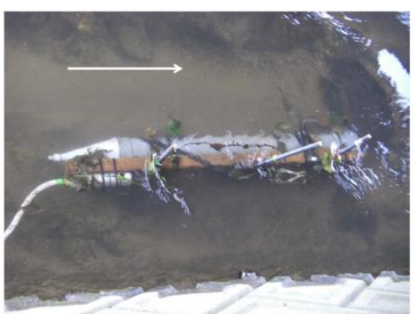
○MEXT, therefore, in order to examine the migration of radioactive substances discharged due to the accident, conducted research surveys relating to distribution maps of radiation doses, etc.

(a) The Distribution of Radioactive Substances within a Narrow Area of Soil

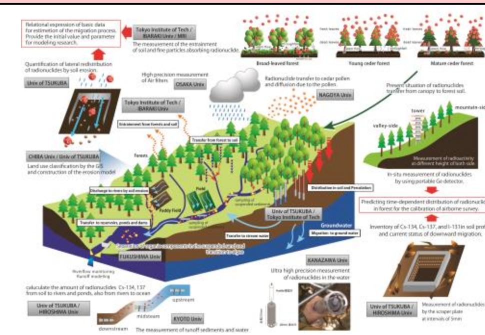


(b) The Vertical Distribution of Radioactive Substances in Soil, and Examination of Factors for the Distribution

(c) Time-dependent Changes in Concentration Levels of Radioactive Substances in Rivers and Well Water



(d) Comprehensive Migration of Radioactive Substances in the Model Area



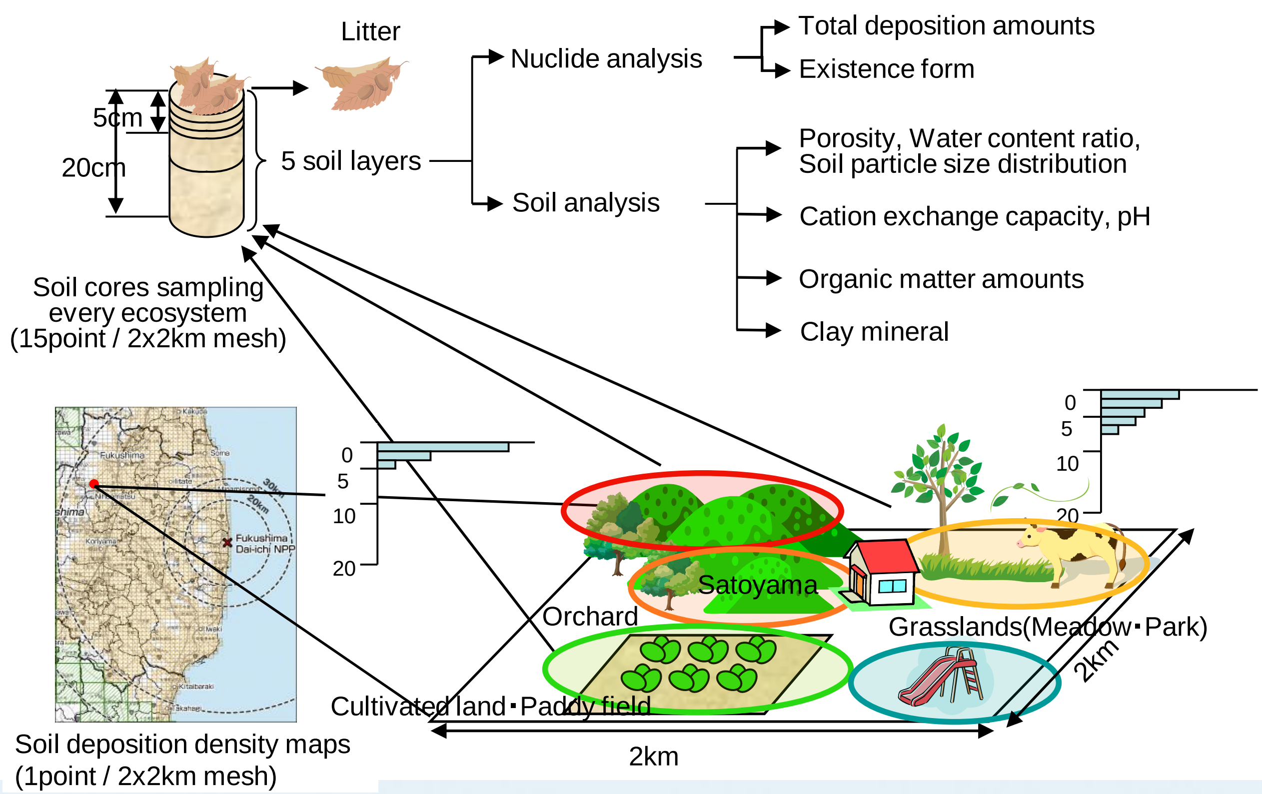
(2)-② Confirmation of the Distribution of Radioactive Substances of Soil within a Narrow Area

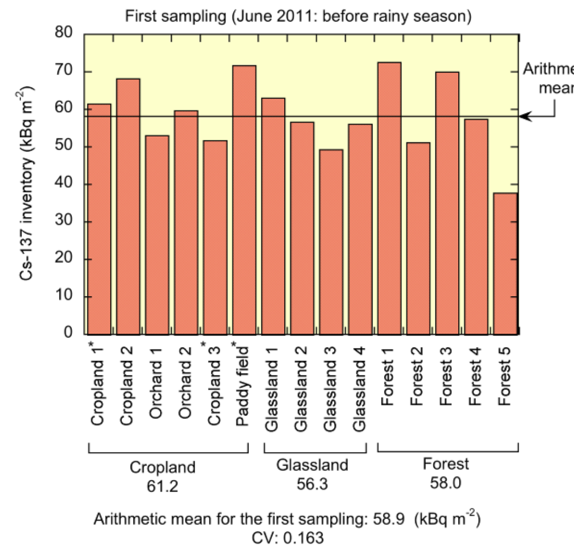
○Physical and chemical features of soil that may affect such uneven deposition were examined and a correlation between those features and deposition of radioactive substances was sought.

○Measurement points :

- 6 points in agricultural land (3 in upland fields, 1 in a paddy field, 2 in orchards)
- 4 points in grass fields (3 in meadows, 1 in a lawn)
- 5 points in the forests (3 points on broad-leaved forests, 2 on needle-leaved forests)

(Within the 2×2km grid in the southwest part of Fukushima city, located at around 73km from the Fukushima Dai-ichi NPP)





○The vertical distribution of radioactive substances in soil as of June 2011 was examined with soil survey results using geoslicers.

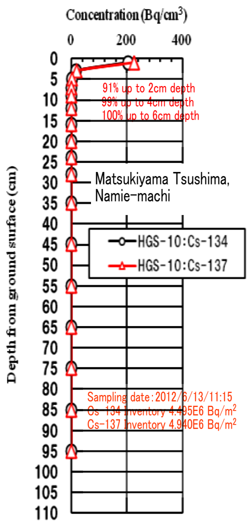
○The characteristics of radioactive substances in soil (diffusion coefficients and dispersion coefficients) were confirmed from the basic data such as half-life periods of radioactive substances and soil character.

○Procedure :

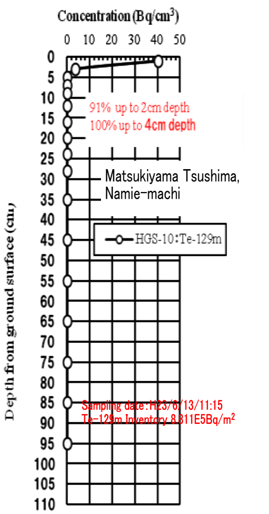
- Sampling soil by using geoslicers
- Measurement of dose rates by survey meters
- Nuclide analysis by Germanium semiconductor detector

Geoslicer

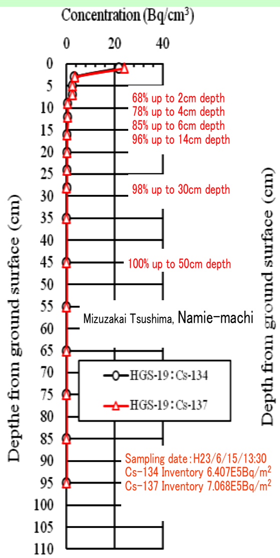
Portable Type Geoslicer



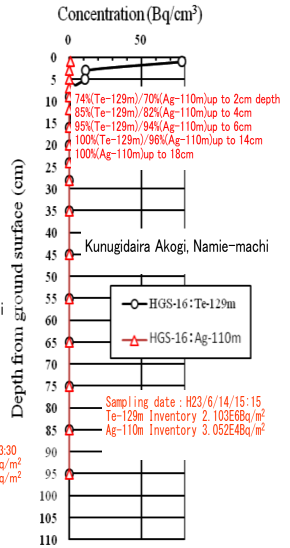
Cesium 134 and 137 of HGS-10 samples without contamination (non-farmland surface)



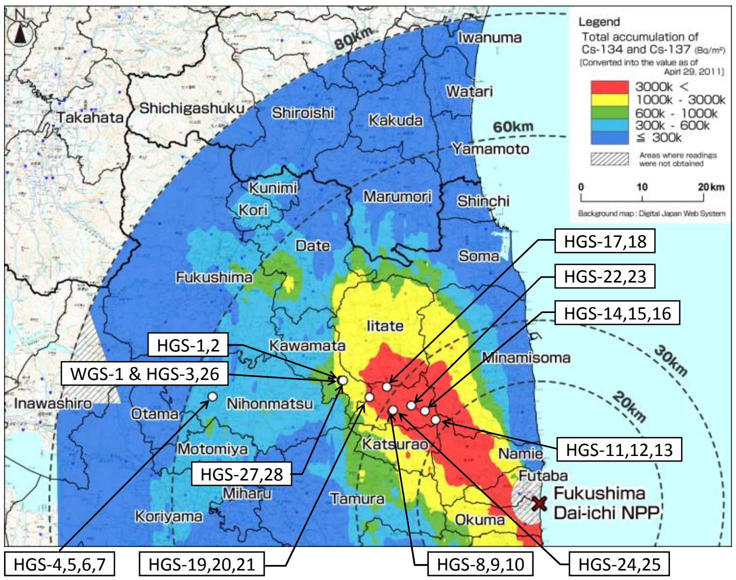
Tellurium of HGS-10 samples without contamination (non-farmland surface)



Cesium 134 and 137 of HGS-19 samples with contamination (former farmland)



Tellurium and silver of HGS-16 samples with contamination (former farmland)



(2)-④ Confirmation of the Vertical Distribution of Radioactive Substances in Soil, and Examination of Factors for the Distribution (Survey using iron pipes)

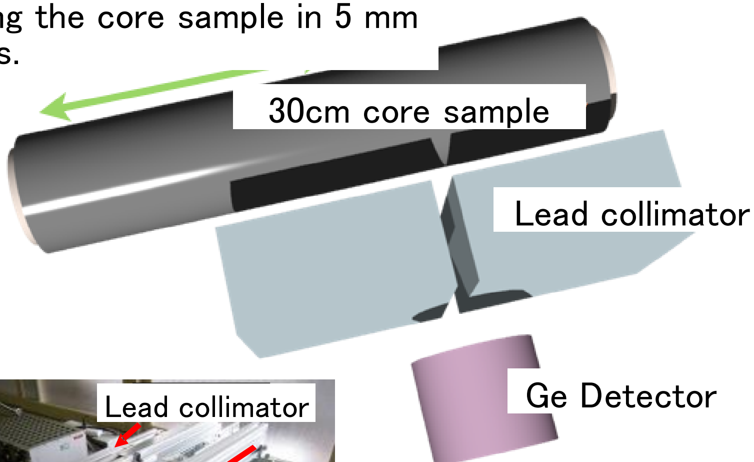
○The vertical distribution of radioactive Cesium in soil as of June 2011 was examined with soil survey results of soil core samples collected by using iron pipes.

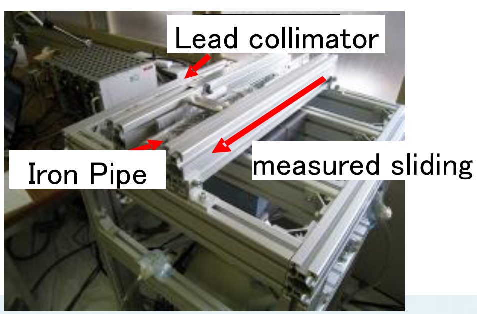
○Counting rates of radioactive Cesium contained in each core sample were measured by using a germanium semiconductor detector with a lead collimator.

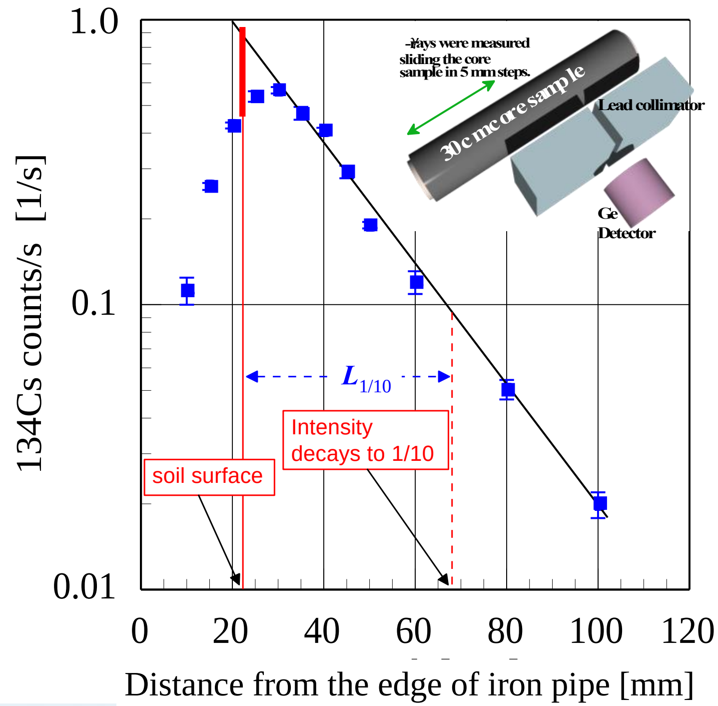
○Procedure :

- Sampling soil by using iron pipes
- Counting rates of radioactive Cesium in sliding the core sample in 5 mm steps

Gamma rays were measured sliding the core sample in 5 mm steps.







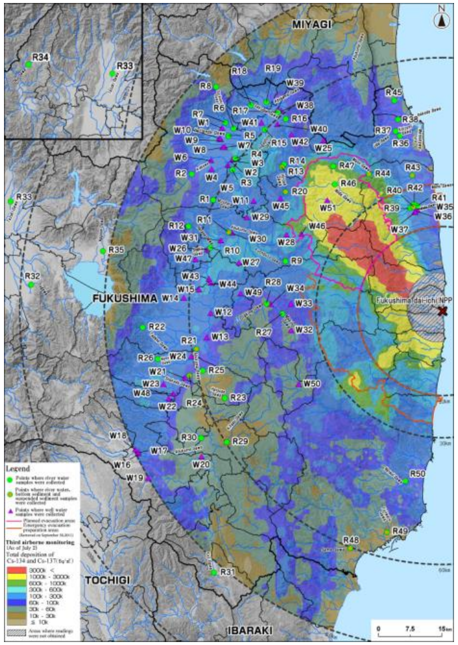
(2)-⑤ Confirmation of time-dependent changes in concentration levels of radioactive substances in rivers and well water

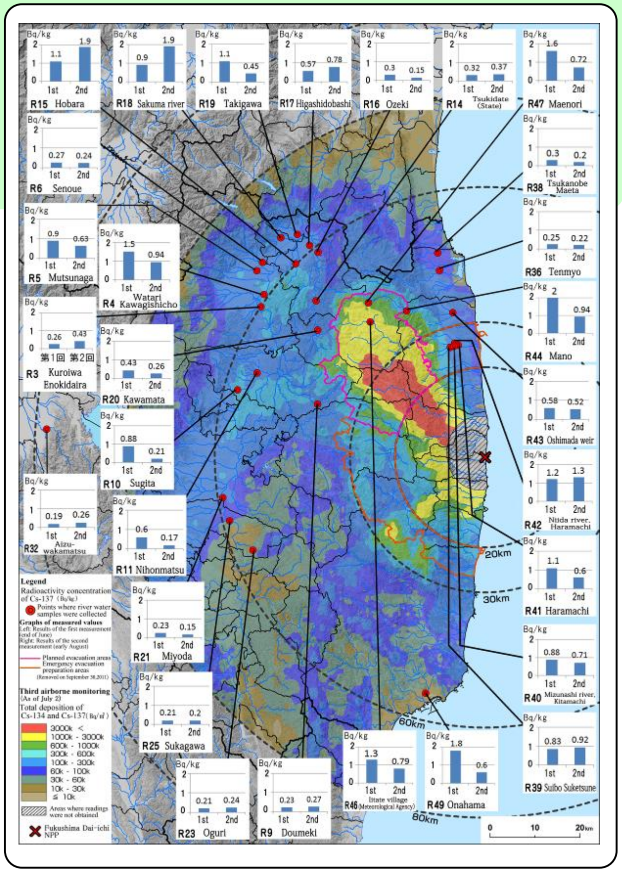
○Changes in concentrations of radioactive substances before and after the rainy season were surveyed, targeting rivers (river water, subsoil, and suspended sediment) and wells (well water) in Fukushima prefecture.

○The movement of radioactive substances discharged from the Fukushima Dai-ichi NPP into rivers and wells was confirmed.

○Measuring the concentration of radioactive nuclides :

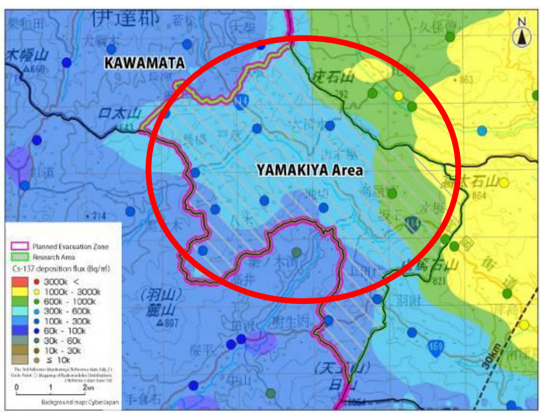
- River water : Cs-137, I-131, Pu-238, Pu-239+240, Sr-89, Sr-90
- River subsoil : Cs-137, I-131
- River suspended sediment : Cs-137, I-131
- Well water : Cs-137, I-131, Sr-89, Sr-90



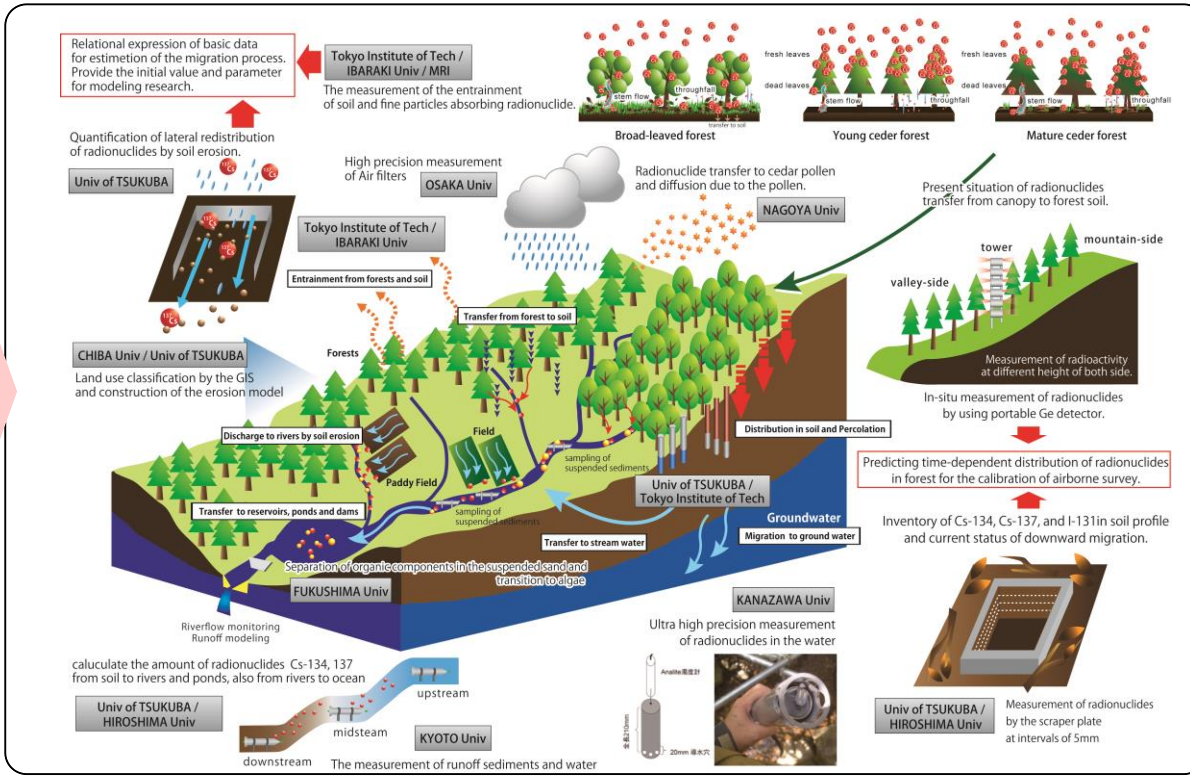


(2)-⑥ Confirmation of Movement of Radioactive Substances Comprehensively in the Model Area

- ○The experience of the Chernobyl accident, etc. has revealed that radioactive substances accumulated on the ground surface later move in accordance with natural phenomenon of soil and rivers.
- ○Comprehensive survey was conducted with regard to the movement of radioactive substances in the forests, soil, underground water, and river water, as well as on their movement after being blown upward from trees and soil in a chosen model area.
- ○Forecast future changes in accumulated amounts of radioactive substances.



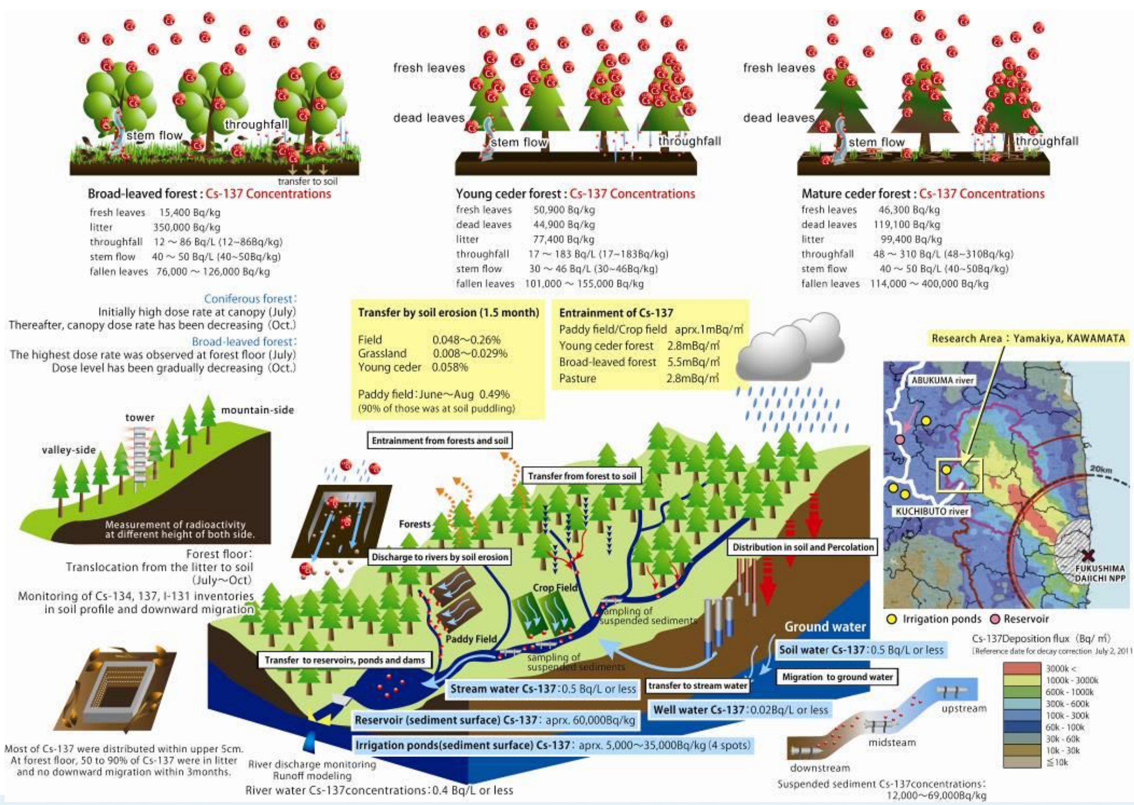
Survey points :
the Yamakiya district (as the planned evacuation areas), etc. in Fukushima pref.



(2)-⑦ Confirmation of Movement of Radioactive Substances Comprehensively in the Model Area

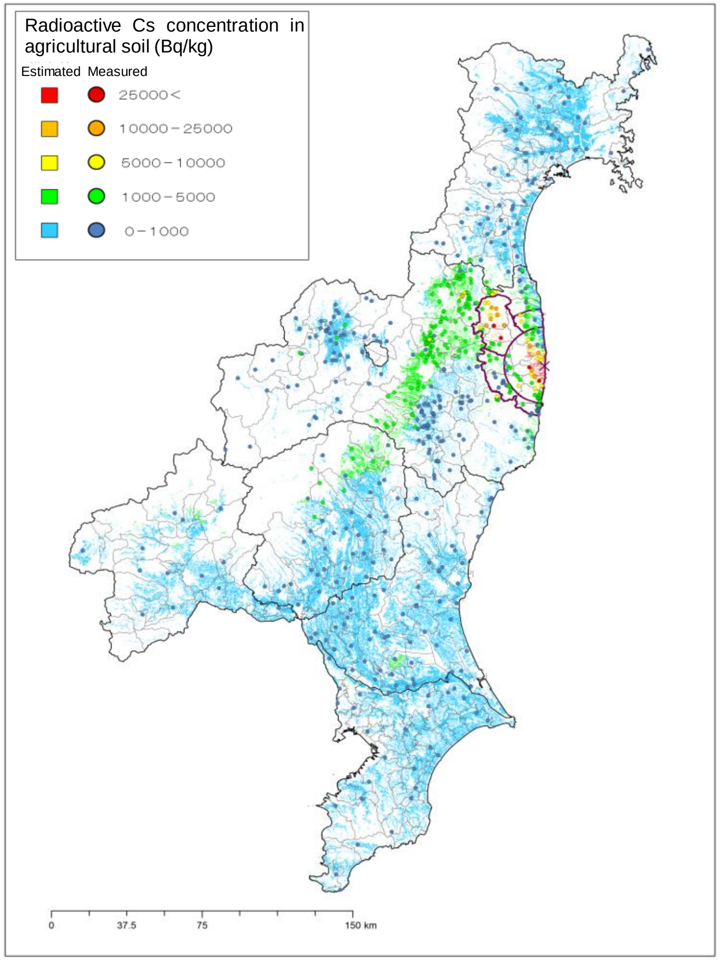
〇Outputs :

- The surveys on movement of radioactive substances in various natural environments
- The surveys on the movement of radioactive substances from soil and the forests, etc., and the movement of radioactive substances through hydrologic circulation processes of rivers and lakes, soil water, and underground water, etc.
- Analysis of the comprehensive movement of radioactive substances in such natural environments as air, soil, river.



(3) Report on the Research relating to Radiation Concentration Distribution Maps for Farmland Soil

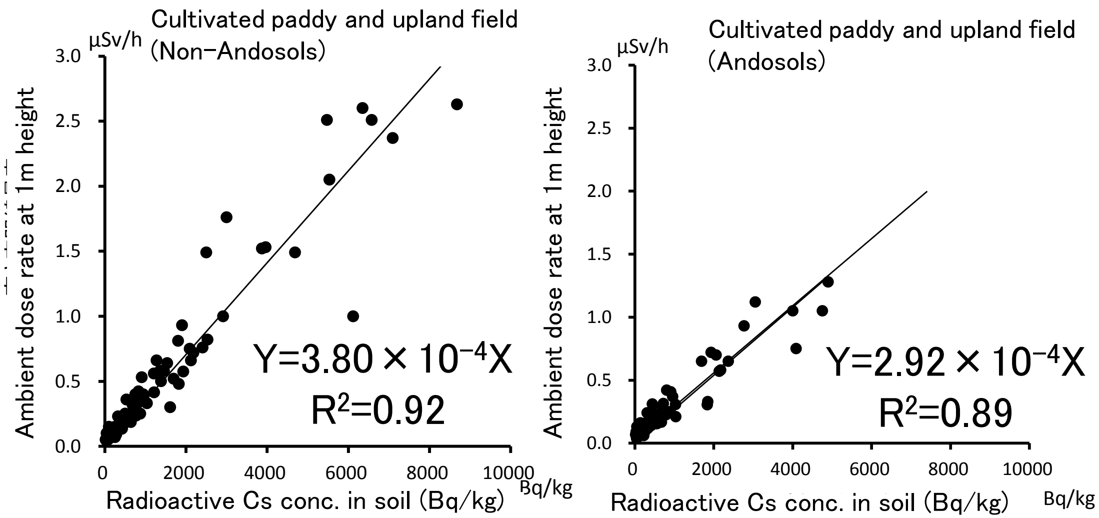
○MAFF, in order to analyze the contamination status and to advance farmland decontamination and the effort of application for farming, measured the concentration of a radioactive substances in soil and grasped its face distribution.



Measured and estimated spatial distribution of radioactive Cesium (Cs) concentration in agricultural soil

○Measuring points :
About 580 points in Fukushima and 5 prefectures around Fukushima

○Results :
－ Similar trend of air dose rate distribution was obtained in the past such as air-borne monitoring of MEXT.
－ There is a certain correlation between air dose rate and contamination level of farmland.



The correlations between radioactive Cs concentration and ambient dose rate in different soil and land use units

Next Challenges

<MEXT> *conducting the second investigation about the distribution status of radioactive substances*

- Only a part of the results of I-131 analysis are obtained.
- Only 100 sampling points of Pu and Sr are analysed.

⇒ The radioactive substances contained in soil need further to be investigated for the detailed check of the diffusion condition of radioactive substances.

- The results of aerial monitoring indicate a relatively high dose rate in Tochigi, Gunma, Chiba prefecture.

⇒ There is need to expand the area of soil survey.

- The accumulation status of the radioactive substances on the ground surface significantly change due to the influences of rain and storm, etc.

⇒ It is necessary to confirm the status on accumulation and migration of radioactive substances continuously.

<MAFF> *expanding the area of the investigation in six prefs around Fukushima, and creating more detailed distribution map in farmland soil*

⇒ It is indispensable to grasp how much farmland soil is contaminated in order to advance the measure towards farming of futures.

Thank you for your attention！

「KIZUNA」

Next Challenges (specific measurement items)

[MEXT]

(1) Continuous measurement of ambient dose rate by means of KRAMA 1 (Vehicle-borne survey)

(2) Continuous measurement of ambient dose rate by means of KRAMA 2 (Vehicle-borne survey)

(3) Conducting in-situ measurement of radioactivity substances concentration in soil

(4) Investigation of depth distribution status of radioactive Cs by means of scraper plate

(5) Investigation of depth distribution status of radioactive Cs by means of large-diameter boring

(6) Refinement of distribution map of radioactive I-131 in soil based on the results of I-129 analysis

(7) Continuous making of distribution map of Pu-238 and Pu-239+249

(8) Continuous making of distribution map of Sr-89 and Sr-90

(9) Making distribution map of Pu-241

(10) Confirmation of changing trend of radioactive concentration in river (river water, river bottom soil and suspended sediment)

(11) 2nd comprehensive investigation of migration behavior of radioactive substances

(12) Investigation of influence of radioactive substances in residential area

[MAFF]

(1) Investigation of distribution status of radioactive substances in farmland soil of 15 prefectures