



March 1, 2013

(i) Results of the Sixth Airborne Monitoring and (ii) Airborne Monitoring out of the 80km Zone of Fukushima Dai-ichi NPP

The results of (i) the airborne monitoring within the 80km zone of Fukushima Dai-ichi NPP by MEXT (the sixth airborne monitoring) and (ii) airborne monitoring out of the 80km zone of Fukushima Dai-ichi NPP by MEXT (second time in FY2012) (Published: Oct 26, 2012) were summarized today, so they are provided here.

1. Objective of this monitoring

In order to ascertain the changes in the situation regarding the effect of radioactive materials, MEXT has conducted ongoing airborne monitoring within the 80km zone of the TEPCO's Fukushima Dai-ichi NPP, and outside the 80km zone of the Fukushima Dai-ichi NPP in areas with relatively high air dose rates.*¹ MEXT was recently able to ascertain the situation of air dose rates and the deposition of radioactive cesium within the 80km zone of the Fukushima Dai-ichi NPP as of June 28, 2012, as well as the air dose rates and the deposition of radioactive cesium outside the 80km zone of the Fukushima Dai-ichi NPP as of May 7, 2012.*²

In the meantime, in order to ascertain the factors influencing changes in radioactive materials, including rain and other natural phenomena, it is necessary to continue airborne monitoring of areas covered in past monitoring surveys to confirm changes in air dose rates and in the deposition of radioactive cesium on the ground surface.

Therefore, this monitoring survey (October 31 to December 28, 2012) covered the following areas to ascertain changes in the situation with regard to radioactive materials, including changes due to rain and other natural phenomena, since the prior surveys:

- (i) Within the 80km zone of Fukushima Dai-ichi NPP (the sixth airborne monitoring)
- (ii) Western Fukushima prefecture beyond the zone 80km from Fukushima Dai-ichi NPP, Ibaraki prefecture, southern Iwate prefecture, northern Chiba prefecture, Gunma prefecture, Tochigi prefecture, Miyagi prefecture, and eastern Yamagata prefecture (areas containing a certain range of areas which previously showed air dose rates of 0.2 μ Sv/h or higher, and surrounding areas)

*1: A technique in which highly sensitive, large radiation detectors are installed in an aircraft, and gamma rays from radioactive substances accumulated in the ground are quickly measured over a large part, in order to check the surface deposition.

*2: See (i) the results of the fifth airborne monitoring and (ii) the results of the airborne monitoring out of the 80km zone of Fukushima Dai-ichi NPP (published on Sep 28, 2012) for detail.

2. Details of this monitoring

(i) The sixth airborne monitoring (airborne monitoring within the 80km zone of Fukushima Dai-ichi NPP)

- Targeted areas: Within the 80km zone of Fukushima Dai-ichi NPP
- Monitoring dates: October 31 to November 16, 2012 (37 flights in total)
- Aircraft: 1 Bell 430 helicopter
- Monitoring Organization: OYO Corporation
- Analyzing institution: Japan Chemical Analysis Center, the Nuclear Safety Technology Center
- Items covered: Air dose rates at a height of 1m above the ground surface and the deposition of radioactive cesium on the ground surface within the 80km zone of Fukushima Dai-ichi NPP

(ii) The Airborne monitoring out of the 80km zone of Fukushima Dai-ichi NPP

- Targeted areas: Areas beyond the zone 80km from the Fukushima Dai-ichi NPP in which air dose rates and the deposition of radioactive cesium were found to be relatively high in the monitoring surveys conducted between June and November 2011^{*3} and surrounding areas
 - *3: Areas beyond the zone 80km from the Fukushima Dai-ichi NPP which were found to contain a certain range of areas which showed air dose rates of 0.2 μ Sv/h or higher, and surrounding areas (the western part of Fukushima prefecture, Ibaraki, the southern part of Iwate prefecture, the northern part of Chiba prefecture, Gunma, Tochigi, Miyagi, and the eastern part of Yamanashi prefecture)
- Monitoring dates: October 31 to December 28, 2012 (87 flights in total)
- Aircraft: 1 Bell 430 helicopter
1 Bell 412 helicopter
- Monitoring Organization: the Nuclear Safety Technology Center
- Analyzing institution: JAEA (Japan Atomic Energy Agency)
- Items covered: Air dose rates at a height of 1m above the ground surface and the deposition of radioactive cesium on the ground surface out of the 80km zone of Fukushima Dai-ichi NPP

3. Results of this monitoring

(i) The results of the sixth airborne monitoring

- Attachment 1 is the “dose monitoring map” showing the distribution of air dose rates at a height of 1m above the ground surface in the zone 80km from the Fukushima Dai-ichi NPP, compiled based on the results of the sixth airborne monitoring survey. Attachments 2 to 4 are the “soil concentration maps” showing the deposition of radioactive cesium on the surface soil in the same zone.

In preparing these maps, the results obtained from the survey were adjusted for decay as of the final day of the sixth airborne monitoring survey (November 16, 2012).

(ii) The results of the airborne monitoring out of the 80km zone of Fukushima Dai-ichi NPP

- Attachment 5 is the “dose monitoring map” showing the distribution of air dose rates at a height of 1m above the ground surface beyond the zone 80km from the Fukushima Dai-ichi NPP, compiled based on the monitoring results. Attachments 6 to 8 are the “soil concentration maps” showing the deposition of radioactive cesium on the surface soil in the same zone.

In preparing these maps, the results obtained were adjusted for decay as of the final day of the airborne monitoring survey conducted beyond the zone 80km from Fukushima Dai-ichi NPP (December 28, 2012).

Portions of the targeted areas were covered with snow (western Fukushima prefecture, Gunma, and eastern Yamagata prefecture, etc.), and the measured air dose rates in these portions might be lower than their actual values due to the effects of snow coverage. Therefore, in order to show snow coverage,^{*4} the relevant areas are shown in white, enclosed by solid lines.

^{*4} To identify areas covered with snow, we used monitoring data from NASA’s earth observation satellites, Terra and Aqua, which is available on JASMES via the Japan Aerospace Exploration Agency (JAXA). The data corresponds to a 500m resolution grid and can reveal even snow coverage of at least 5cm in depth, but may fail to accurately judge thinner snow coverage depending on the ground surface conditions. Therefore, there may have been snow in areas other than those shown in white enclosed by solid lines on the maps in Attachments 5 to 8.

In addition, in order to respond to inquiries concerning air dose rates and the distribution of radioactive cesium, we prepared maps (References 1 to 4) showing the results of the airborne monitoring conducted beyond the zone 80km from the Fukushima Dai-ichi NPP and the results of the sixth airborne monitoring survey within said zone.

In preparing these maps, the results of the sixth airborne monitoring were adjusted for decay as of the final day of the airborne monitoring survey conducted beyond the zone 80km from the Fukushima Dai-ichi NPP (December 28, 2012). The effect of movement of radioactive material due to rain, wind or other natural environmental factors was not taken into account.

The details of the conditions used to prepare these maps are as shown in Reference 5.

4. Considerations on the results of this monitoring survey

- In order to ascertain changes in the situation with regard to radioactive materials, this monitoring survey targeted areas both within and beyond the zone 80km from the Fukushima Dai-ichi NPP. Beyond the zone 80km from the Fukushima Dai-ichi NPP, snow coverage was observed in some areas of western Fukushima prefecture, in Gunma prefecture, and in eastern Yamagata prefecture, and its effect in reducing air dose rates could not be accurately ascertained, complicating efforts to evaluate overall changes in the air dose rates. Therefore, we examined the trend in declining air dose rates based on the results of the monitoring survey conducted within the zone 80km from Fukushima Dai-ichi NPP.

- When the results of the fourth airborne monitoring survey (air dose rates as of November 5, 2012) were compared with those of the sixth airborne monitoring survey (air dose rates as of November 16, 2012), it was confirmed, as shown in Attachment 9, that air dose rates have declined by around 40% over the approximately one year between these two monitoring surveys, although there were differences in such changes depending on the location measured. Air dose rates declined approximately 21% due to the physical attenuation of radioactive cesium during this period, meaning that the decline in air dose rates within the zone 80km from the Fukushima Dai-ichi NPP was larger than that caused by physical attenuation. The factors responsible for this larger decline may include the influence of rain and other natural environmental conditions.

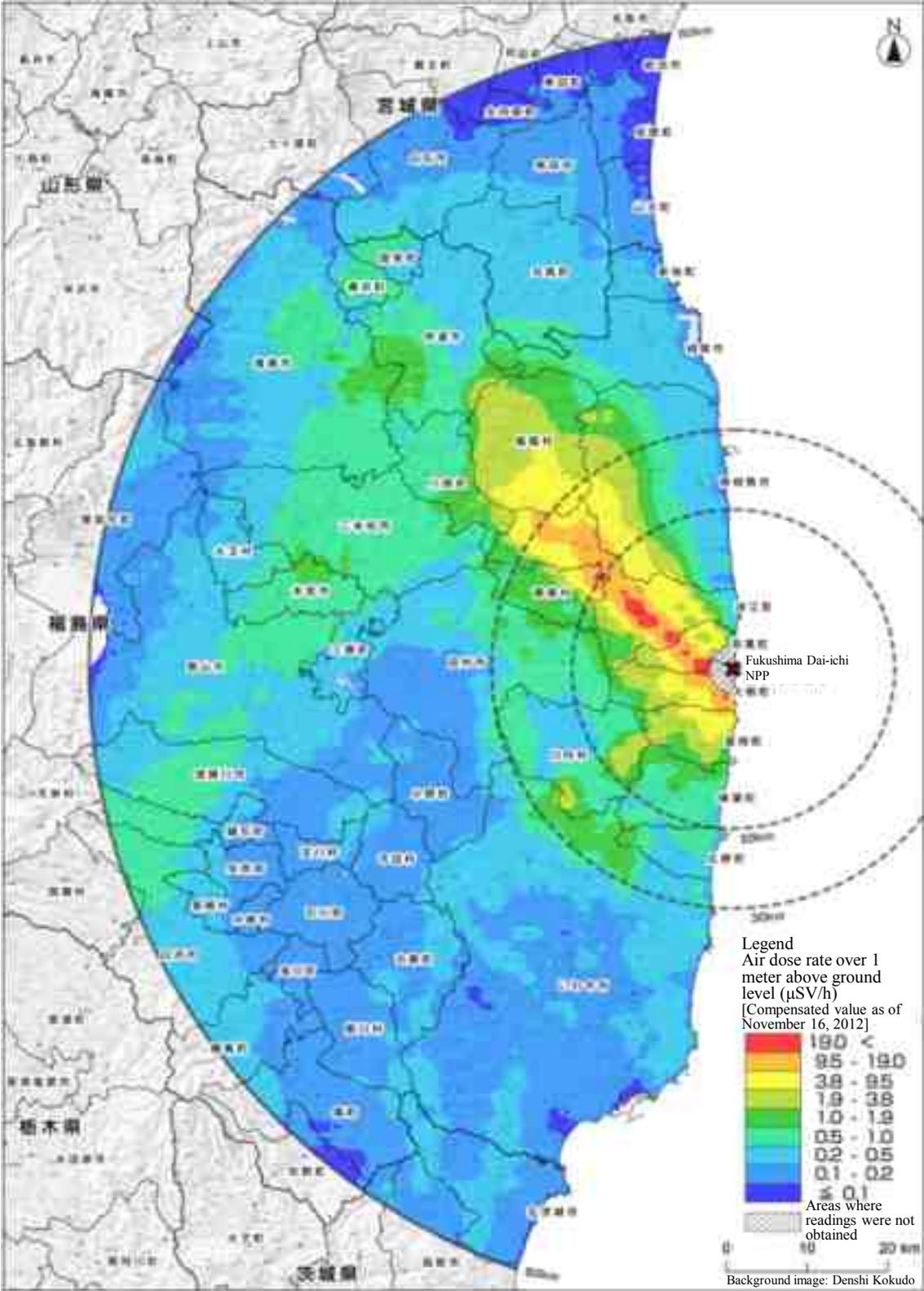
Emergency Operation Center

Kato

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Air Dose Rate Map

Air dose rates at 1m above the ground surface within the zone 80km from the Fukushima Dai-ichi NPP
(the Sixth Airborne Monitoring, as of November 16, 2012)

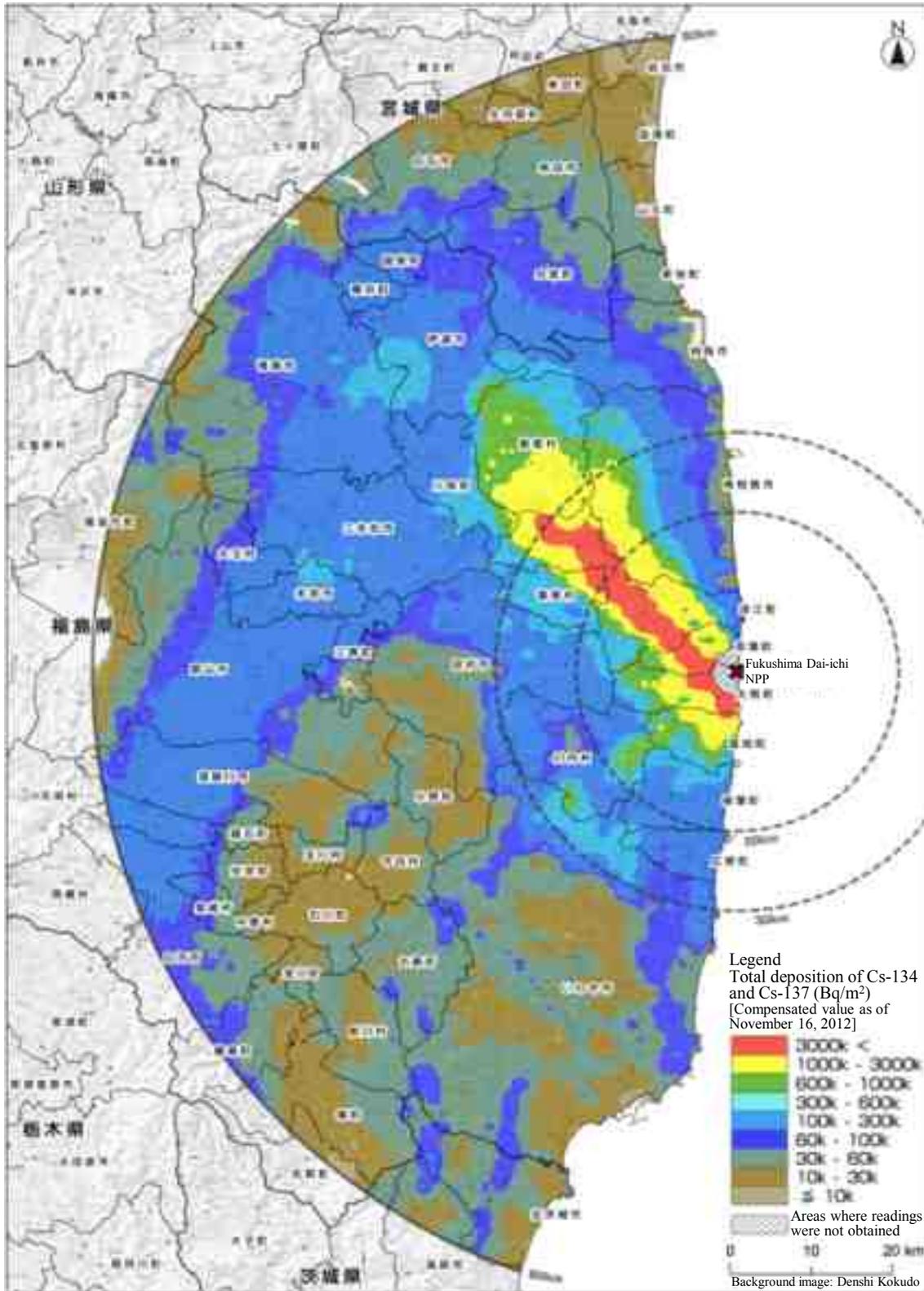


*This map contains air dose rates by natural radionuclides.

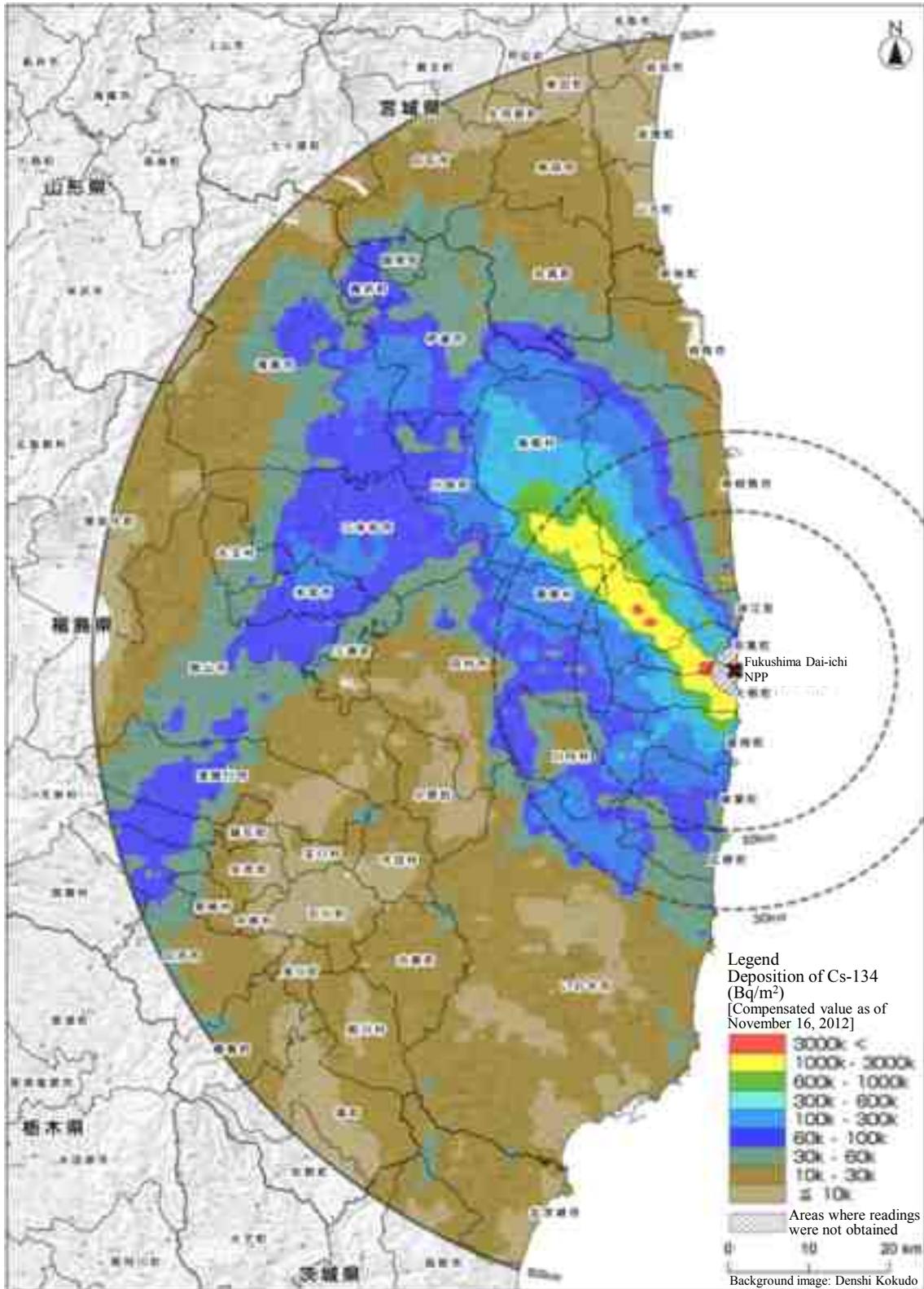
Soil Concentration Map

(Total amounts of Cs-134 and Cs-137 deposited on the ground surface within the zone 80km from the Fukushima Dai-ichi NPP)

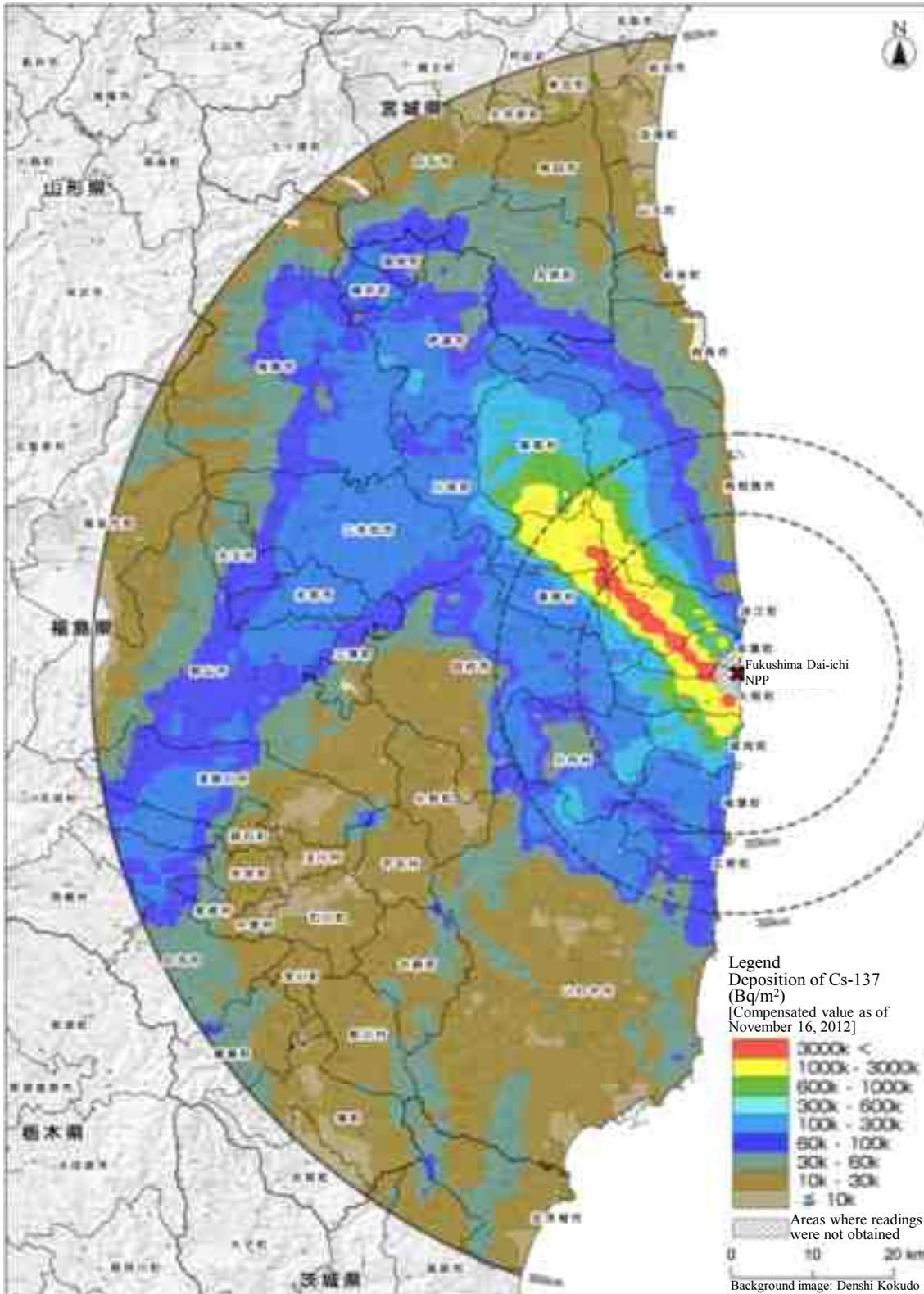
(the Sixth Airborne Monitoring, as of November 16, 2012)



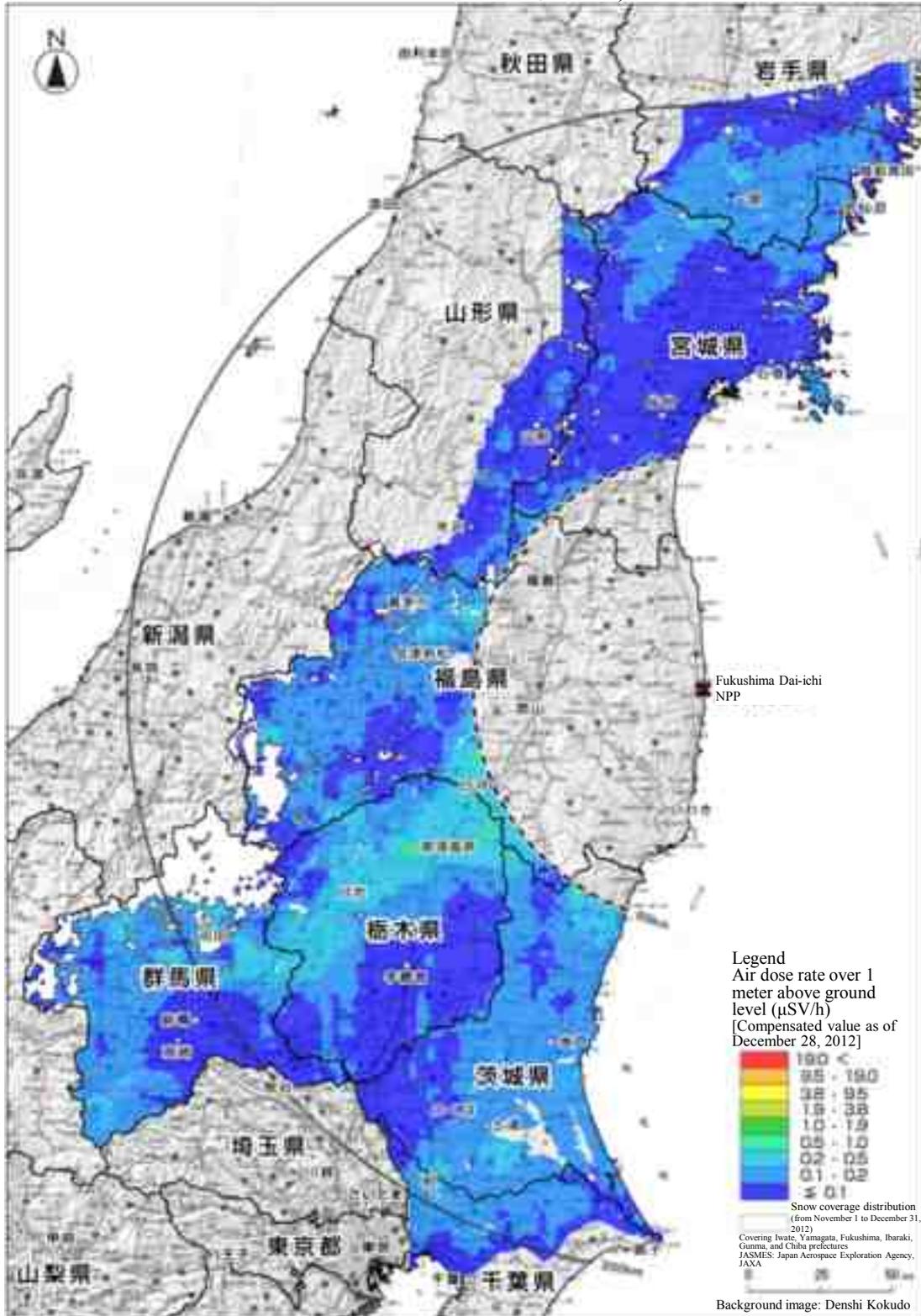
Soil Concentration Map
(Deposition of Cs-134 on the ground surface within the zone 80km
from the Fukushima Dai-ichi NPP)
(the Sixth Airborne Monitoring, as of November 16, 2012)



Soil Concentration Map
 (Deposition of Cs-137 on the ground surface within the zone 80km
 from the Fukushima Dai-ichi NPP)
 (the Sixth Airborne Monitoring, as of November 16, 2012)



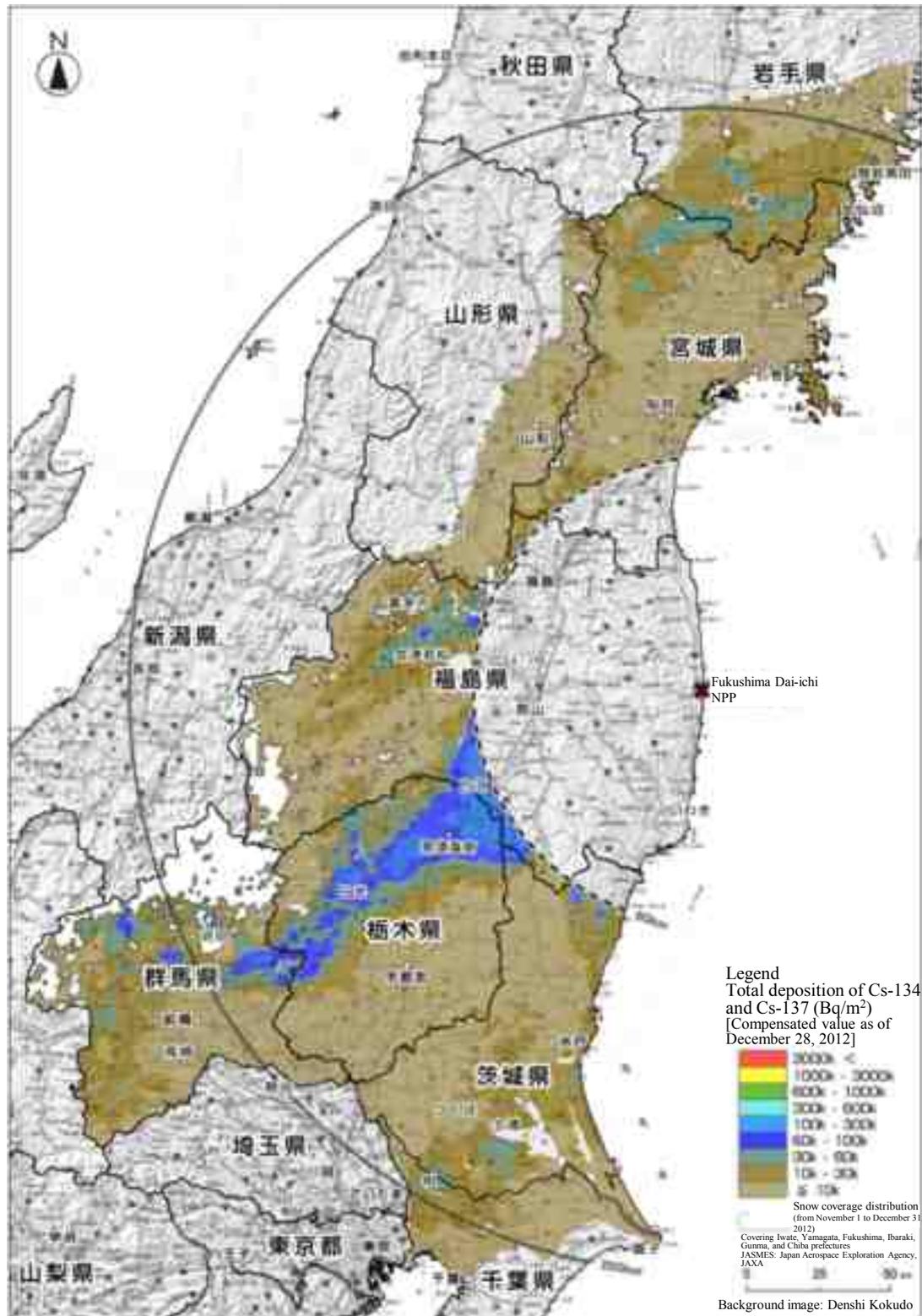
Air Dose Rate Map (Air dose rate over 1 meter above ground level)
 (Airborne Monitoring out of the 80km Zone of Fukushima Dai-ichi NPP,
 as of December 28, 2012)



* This map contains air dose rates by natural radionuclides.

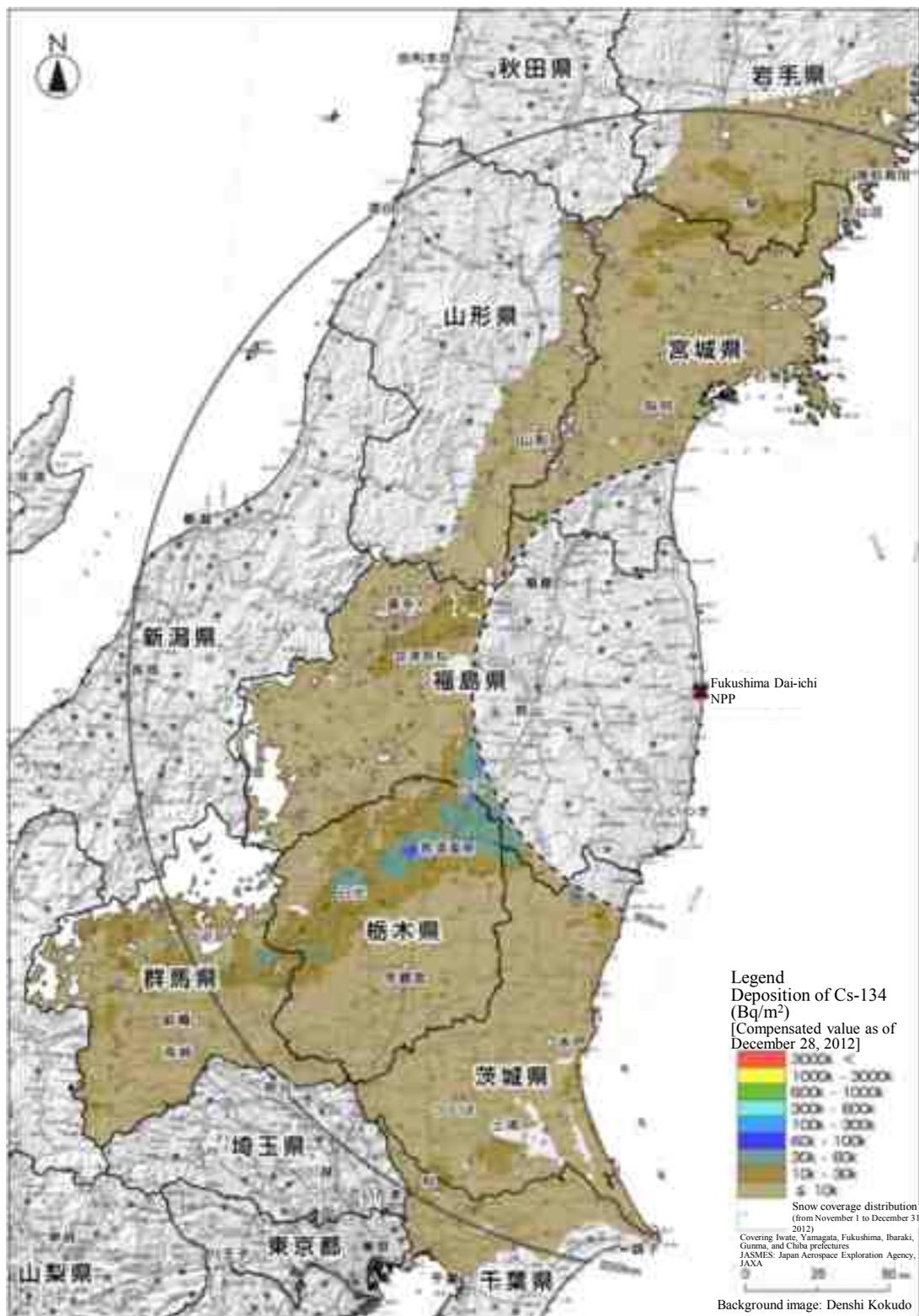
* White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

Soil Concentration Map (Total deposition of Cs-134 and Cs-137 on the ground surface) (Airborne Monitoring out of the 80km Zone of Fukushima as of December 28, 2012)



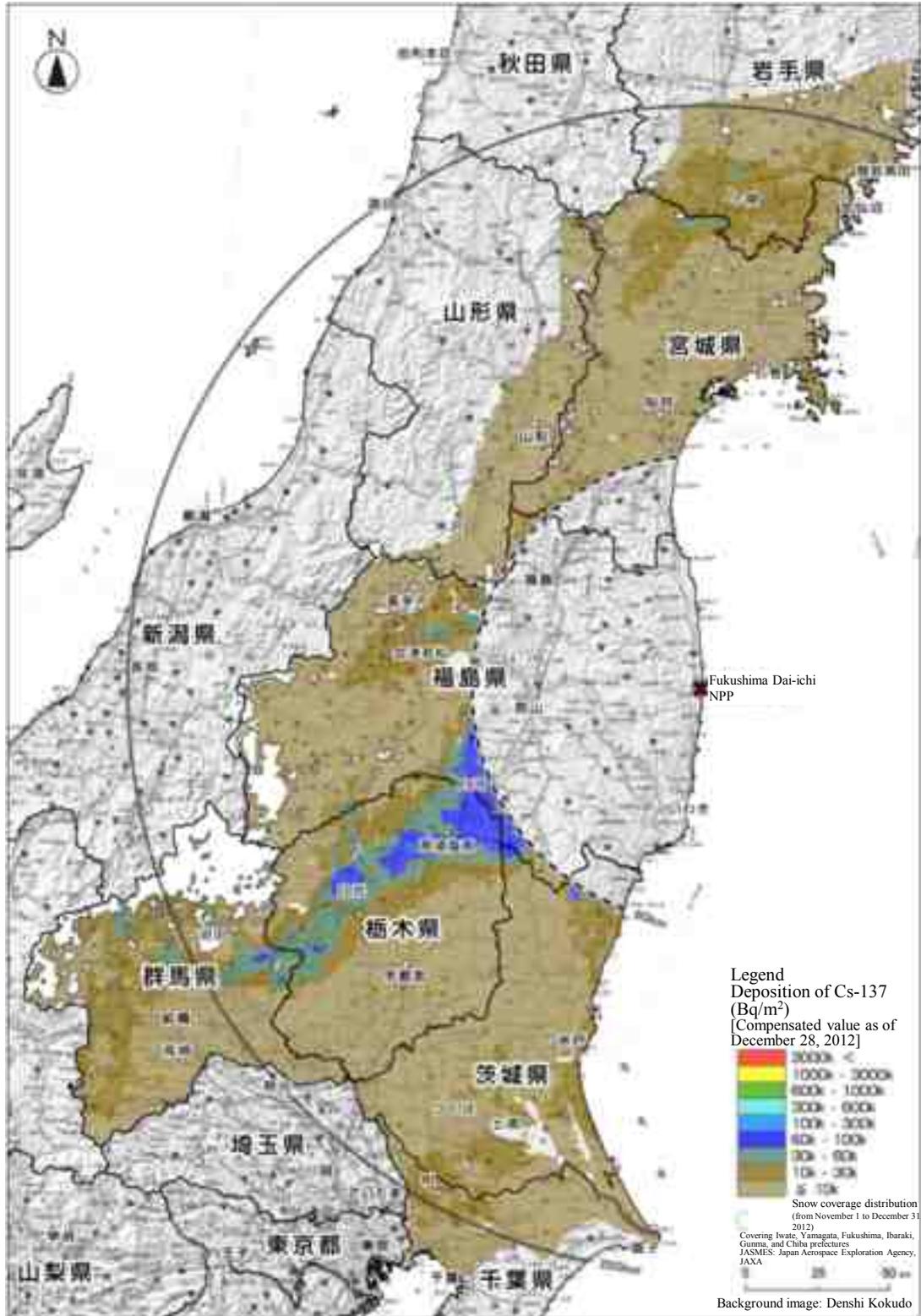
* White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

Soil Concentration Map (Deposition of Cs-134 on the ground surface)
 (Airborne Monitoring out of the 80km Zone of Fukushima Dai-ichi NPP,
 as of December 28, 2012)



* White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

Soil Concentration Map (Deposition of Cs-137 on the ground surface)
 (Airborne Monitoring out of the 80km Zone of Fukushima Dai-ichi NPP,
 as of December 28, 2012)



* White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

Results of the Comparison of Air Dose Rates Measured in the Fourth and Sixth Airborne Monitoring Surveys

- In order to ascertain air dose rate trends, we compared the measurement results (air dose rates) from the fourth and sixth airborne monitoring surveys.
- As a result, it was confirmed that air dose rates have declined by around 40% over the approximately one year between the fourth and the sixth airborne monitoring surveys within the zone 80km from the Fukushima Dai-ichi NPP, with some differences observed depending on the location measured. (For reference, the Results of the Comparison of Air Dose Rates Measured in the Fourth and Fifth Airborne Monitoring Surveys (published on Sep. 28, 2012) are also shown in a graph.)
- Air dose rates declined approximately 21% due to the decay of radioactive cesium during this period, meaning that the decline in air dose rates within the zone 80km from the Fukushima Dai-ichi NPP was larger than that caused by physical attenuation.

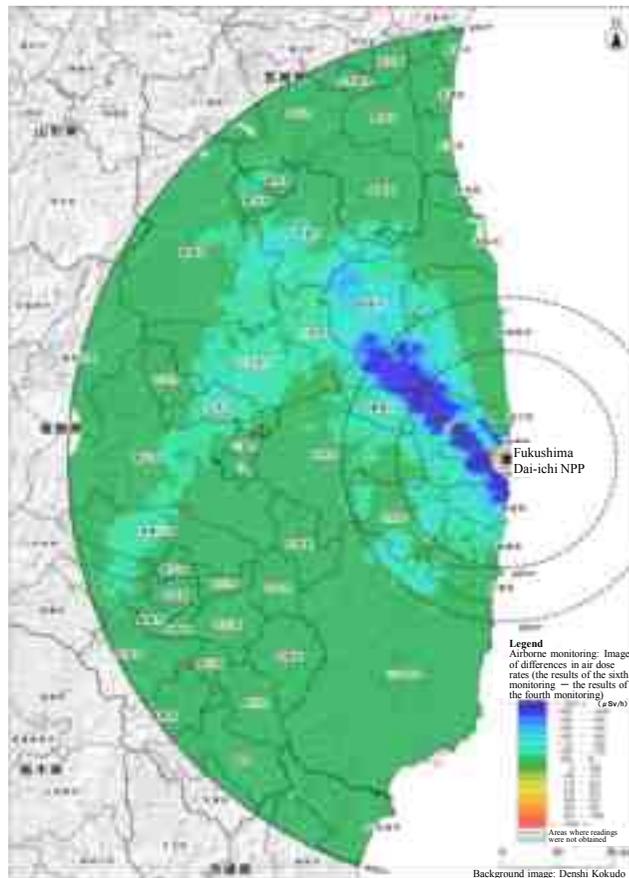


Figure: Distribution of Differences in Air Dose Rates Measured in the Fourth and Sixth Airborne Monitoring Surveys

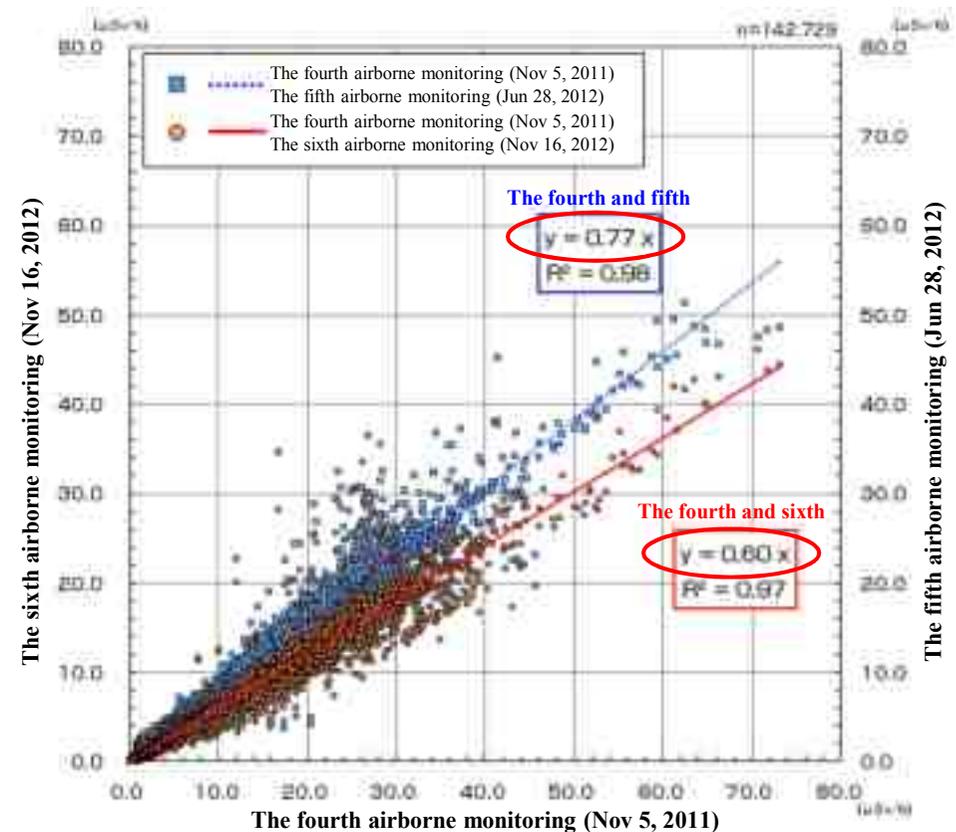
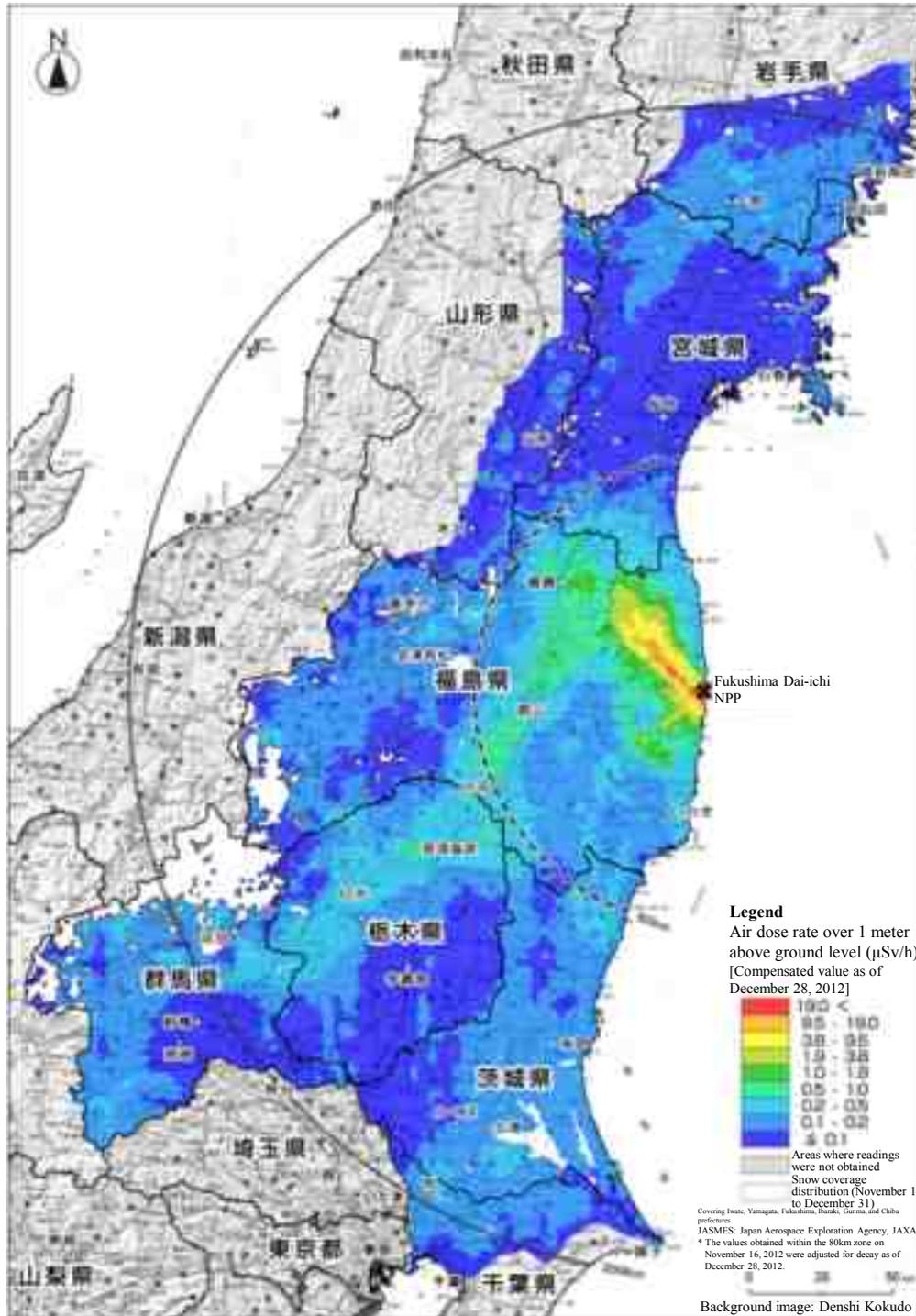


Figure: Relationship between Air Dose Rates Measured in the Fourth and Fifth Airborne Monitoring Surveys and in the Sixth Airborne Monitoring Survey

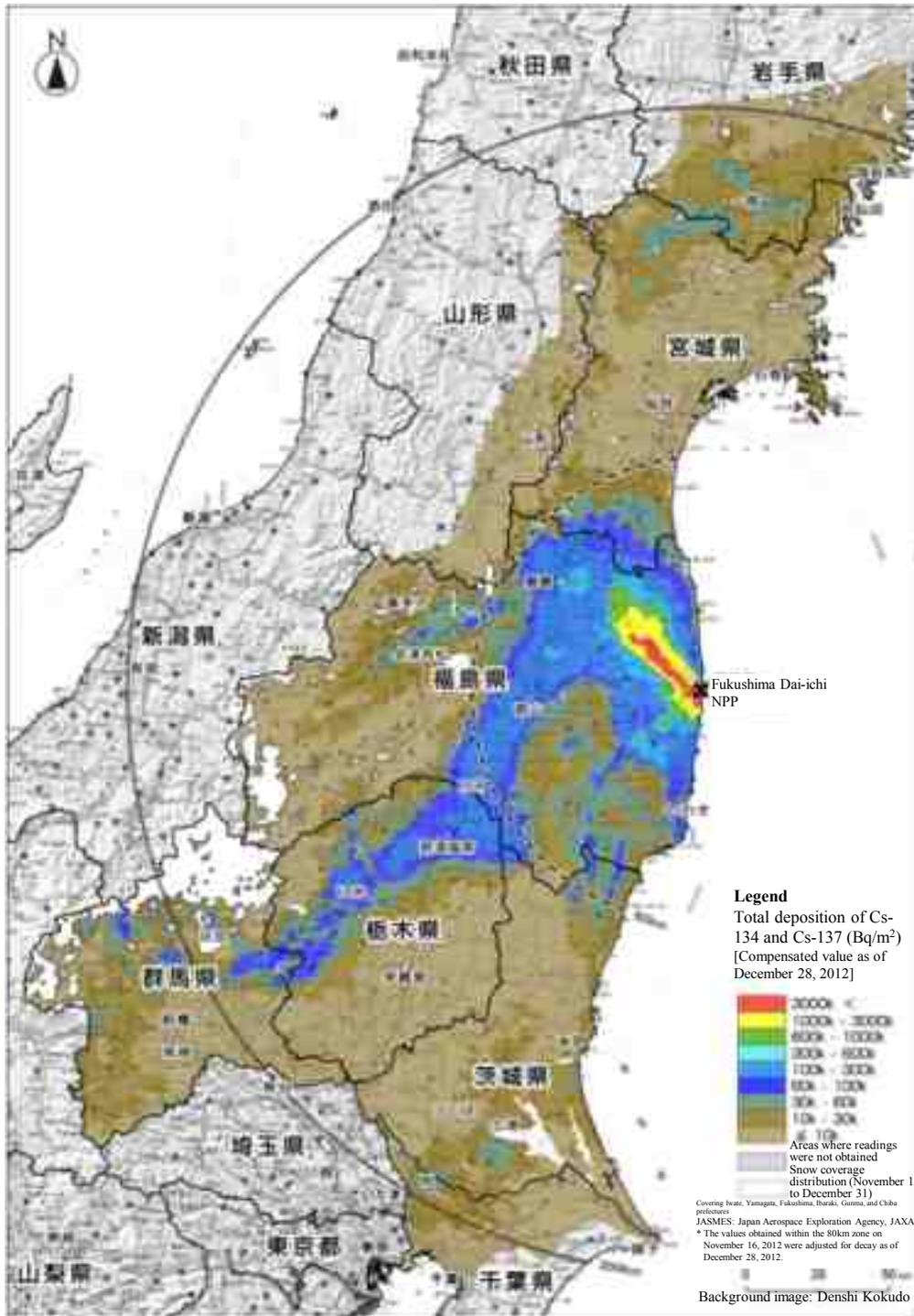
Air Dose Rate Map (Air dose rate over 1 meter above ground level)
(As of December 28, 2012) (The results of the monitoring survey conducted
beyond the zone 80km from the Fukushima Dai-ichi NPP*¹ were added to
the results of the sixth airborne monitoring survey.)



- *1: The measurement results of the sixth airborne monitoring survey were adjusted for decay as of the time at which the measurement results of beyond the zone 80km from the Fukushima Dai-ichi NPP were obtained (December 28, 2012). The effect of the movement of radioactive material due to rain, wind or other natural environmental factors was not taken into account.
- *2: White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.
- *3: This map contains air dose rates by natural radionuclides.

Soil Concentration Map

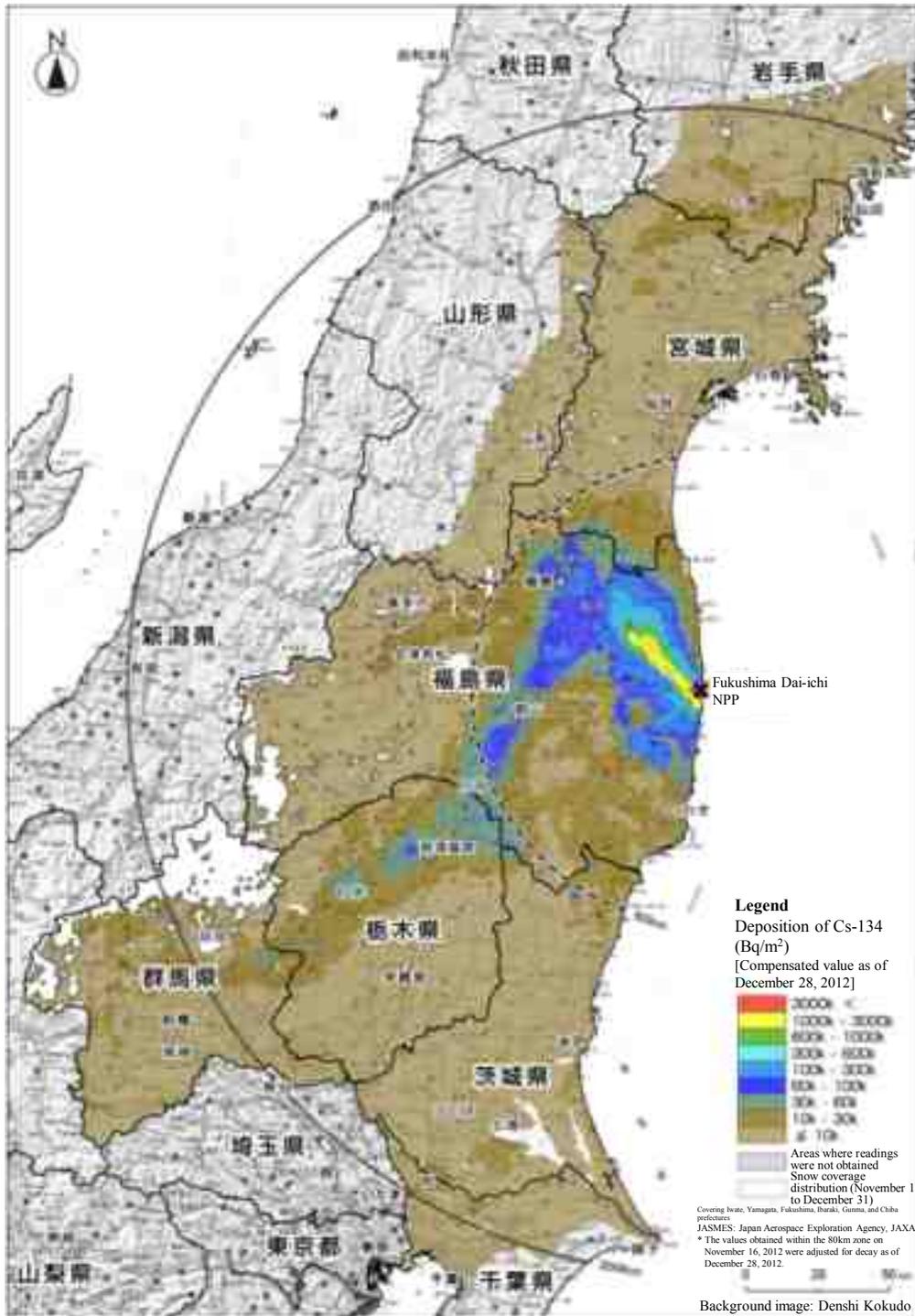
(Total Deposition of Cs-134 and Cs-137 on the Ground Surface) (As of December 28, 2012)
(The results of the monitoring survey conducted beyond the zone 80km from the Fukushima Dai-ichi NPP*¹ were added to the results of the sixth airborne monitoring survey.)



*1: The measurement results of the sixth airborne monitoring survey were adjusted for decay as of the time at which the measurement results of beyond the zone 80km from the Fukushima Dai-ichi NPP were obtained (December 28, 2012). The effect of the movement of radioactive material due to rain, wind or other natural environmental factors was not taken into account.
*2: White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

(Reference 3)

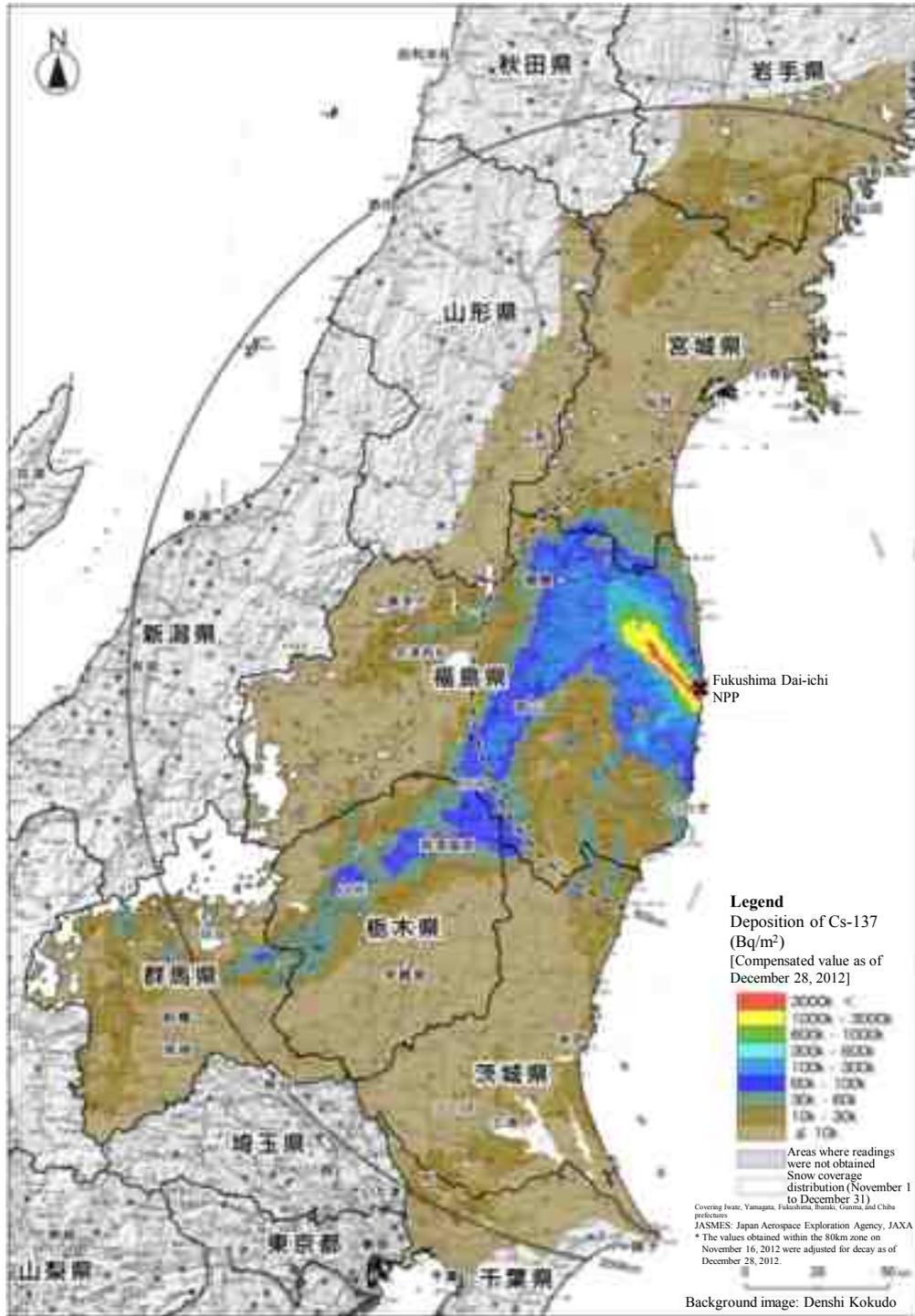
Soil Concentration Map (Deposition of Cs-134 on the Ground Surface)
(As of December 28, 2012) (The results of the monitoring survey conducted beyond the zone 80km from the Fukushima Dai-ichi NPP*¹ were added to the results of the sixth airborne monitoring survey.)



*1: The measurement results of the sixth airborne monitoring survey were adjusted for decay as of the time at which the measurement results of beyond the zone 80km from the Fukushima Dai-ichi NPP were obtained (December 28, 2012). The effect of the movement of radioactive material due to rain, wind or other natural environmental factors was not taken into account.

*2: White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

Soil Concentration Map (Deposition of Cs-137 on the Ground Surface)
(As of December 28, 2012) (The results of the monitoring survey conducted beyond the zone 80km from the Fukushima Dai-ichi NPP*1 were added to the results of the sixth airborne monitoring survey.)



*1: The measurement results of the sixth airborne monitoring survey were adjusted for decay as of the time at which the measurement results of beyond the zone 80km from the Fukushima Dai-ichi NPP were obtained (December 28, 2012). The effect of the movement of radioactive material due to rain, wind or other natural environmental factors was not taken into account.
*2: White areas enclosed by solid lines are areas covered with snow. Air dose rates obtained in these areas and in surrounding areas may have been suppressed by the snow coverage.

Details of the Conditions for Preparing Distribution Maps of Air Dose Rates and Maps of Radioactive Cesium Concentrations in Soil, based on the Results of the Sixth Airborne Monitoring Survey and the Airborne Monitoring Beyond the Zone 80km from the Fukushima Dai-ichi NPP

- The flight altitudes were from around 300m above the ground and the values for this monitoring survey are the averages of the measured values in circles with a diameter of around 600m (varies by flight altitude) below the aircraft.
- The width of the track was around 1.85km for the fifth airborne monitoring survey and around 3km for the airborne monitoring survey beyond the zone 80km from the Fukushima Dai-ichi NPP
- In order to prepare distribution maps of air dose rates, we first obtained the relation between counting rates (cps) measured above the test line established at each of the monitoring areas and air dose rates ($\mu\text{Sv/h}$) at the height of 1m above the ground measured around the test line using NaI scintillators, and then calculated air dose rates at the height of 1m above the ground using counting rates measured in the air above respective measuring points.
- Maps showing the deposition of radioactive cesium were prepared by first assessing the characteristics of energy spectra of gamma rays measured in the air by type of helicopter and measuring equipment used, and then sorting out areas where the energy spectra of radioactive cesium (Cs-134 and Cs-137) were detected significantly and those where they were not. The details are as follows (See Attachment 9 of the “Results of Airborne Monitoring Survey by MEXT in the Kyushu Region and Okinawa Prefecture” (published on May 11, 2012) for details).
 - (i) Areas where the energy spectra of radioactive cesium were detected significantly
 - In order to calculate detailed radioactive cesium deposition amounts, the method newly adopted in the airborne monitoring surveys of the western Japan and Hokkaido to assess the influences of natural radionuclides in detail based on information on the gamma ray energy spectra measured in the air was also adopted in this monitoring survey.
 - Based on this method, deposition amounts of radioactive cesium were calculated by deducting the contribution by natural radionuclides from measurement results of air dose rates at respective measuring points, and also based on the correlation between air dose rates and the results of the in-situ measurement* using germanium semiconductor detectors, which was conducted by the Japan Chemical Analysis Center in the course of the project, 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.”
 - * 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.
 - (ii) Areas where the energy spectra of radioactive cesium were not detected significantly
 - In the same manner as before, they were indicated on maps as areas showing the minimum range of radioactive cesium ($\leq 10\text{kBq/m}^2$) for the sake of simplicity.