# Monitoring air dose rates from a series of car-borne γ-ray surveys after the Fukushima Daiichi NPS accident

July 24, 2013

Radiation Monitoring Division
The Secretariat of
The Nuclear Regulation Authority, Japan

NRA, Japan
Nuclear Regulation Authority

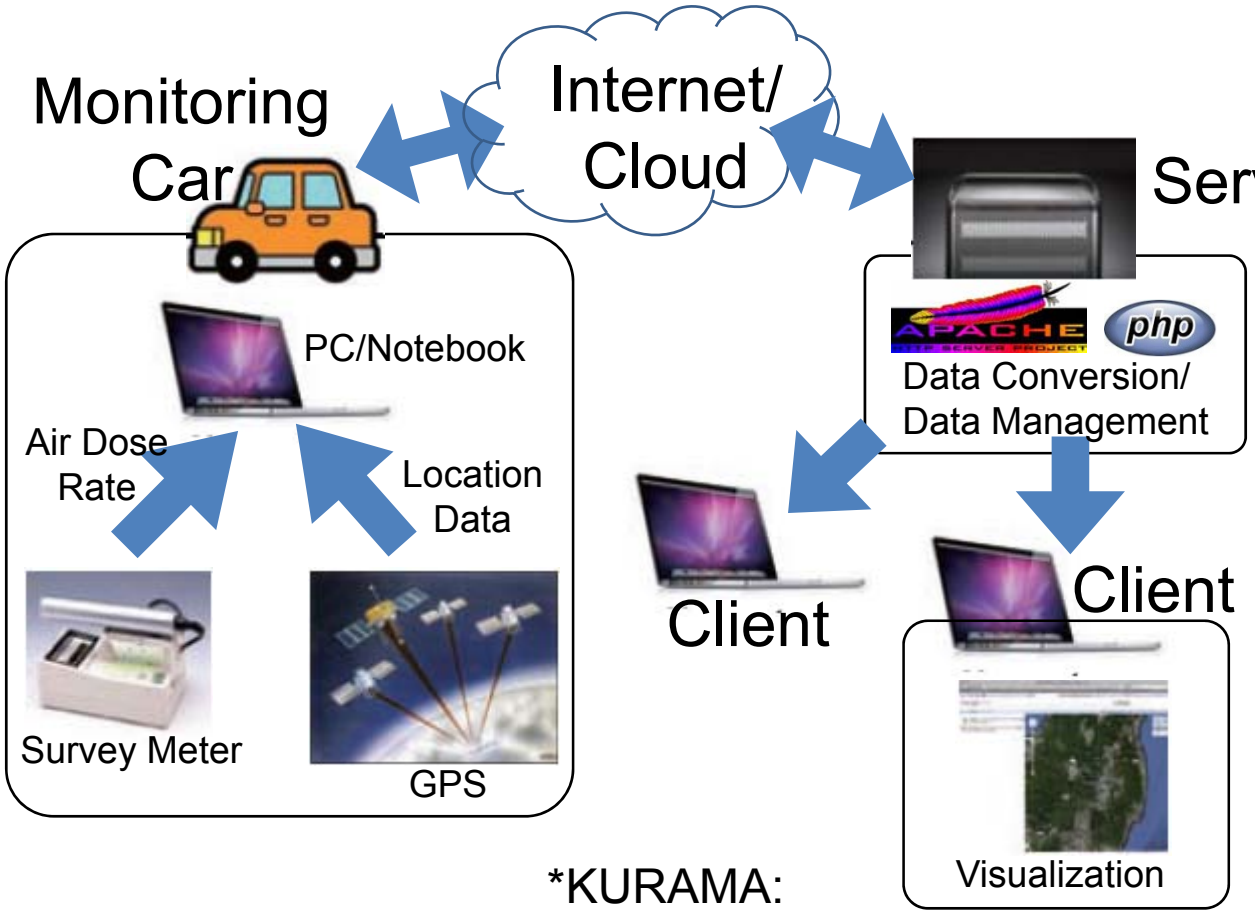
# Contents

Surveys were conducted on five occasions to evaluate the effects of the following factors on the reduction of air dose rates;

- Land use
- Land heights

# Car-borne γ-ray survey system -1

A compact radiometric survey system, named KURAMA*, is based on GPS and network technology, and intended for the real-time data accumulation of multiple mobile monitoring stations, such as monitoring cars.




Modified;
Tanigaki M, *et al.* Development of a car-borne survey system, KURAMA. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 2013, **726**, 162-168

*KURAMA:
Kyoto University Radiation Mapping system
http://www.rri.kyoto-u.ac.jp/kurama/index.html

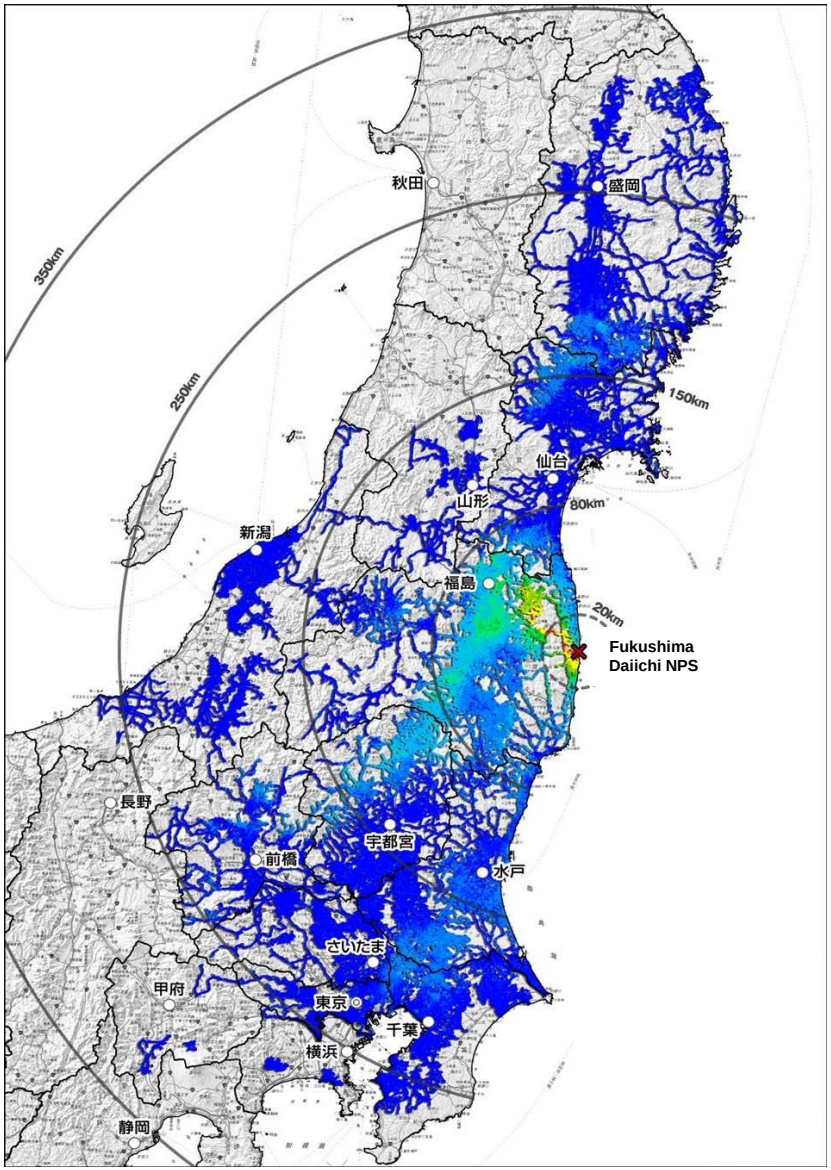
# Car-borne γ-ray survey system -2
## (date, areas, total distance)

- The 1st (June 4- June 13, 2011)
  Fukushima, Ibaraki, Gunma, Tochigi, Niigata, Miyagi, Yamagata; 17,000km
- The 2nd (Dec5 – Dec 28, 2011)
  Fukushima, Ibaraki, Gunma, Tochigi, Iwate, Miyagi, Yamanashi, Kanagawa, Saitama, Chiba, Tokyo; 40,000km
- The 3rd (March 13 – March 30, 2012)
  Fukushima, Ibaraki, Gunma, Tochigi, Miyagi, Yamanashi, Kanagawa, Saitama, Chiba, Tokyo; 70,000km
- The 4th (August 20 – Oct 12, 2012)
  Fukushima, Ibaraki, Gunma, Tochigi, Iwate, Miyagi, Yamanashi, Kanagawa, Saitama, Chiba, Tokyo, Niigata, Yamagata; 85,000km
- The 5th (Nov 5 – Dec 10, 2012)
  Fukushima, Ibaraki, Gunma, Tochigi, Iwate, Miyagi, Yamanashi, Kanagawa, Saitama, Chiba, Tokyo, Niigata, Yamagata; 65,000km
- The 6th (June 2013 - )

*In addition:
Monitoring surveys have been conducted out in evacuation-directed zones according to “Comprehensive Radiation Monitoring Plan”.
KURAMA II system is operating by cooperation of Kyoto University and the city bus companies in Fukushima Prefecture (Fukushima transportation, Inc., Aizu Bus Co., Ltd and Shin Joban Kotsu Co., LTD.).

# Air dose rate map created by car-borne surveys

## One and half years after the Fukushima Daiichi accident




Surveys were conducted out on Aug 20 – Oct 12, 2012.

Air dose rate (μSv/h)

| |
|---|
| 19.0 < |
| 9.5 - 19.0 |
| 3.8 - 9.5 |
| 1.9 - 3.8 |
| 1.0 - 1.9 |
| 0.5 - 1.0 |
| 0.2 - 0.5 |
| 0.1 - 0.2 |
| ≦ 0.1 |

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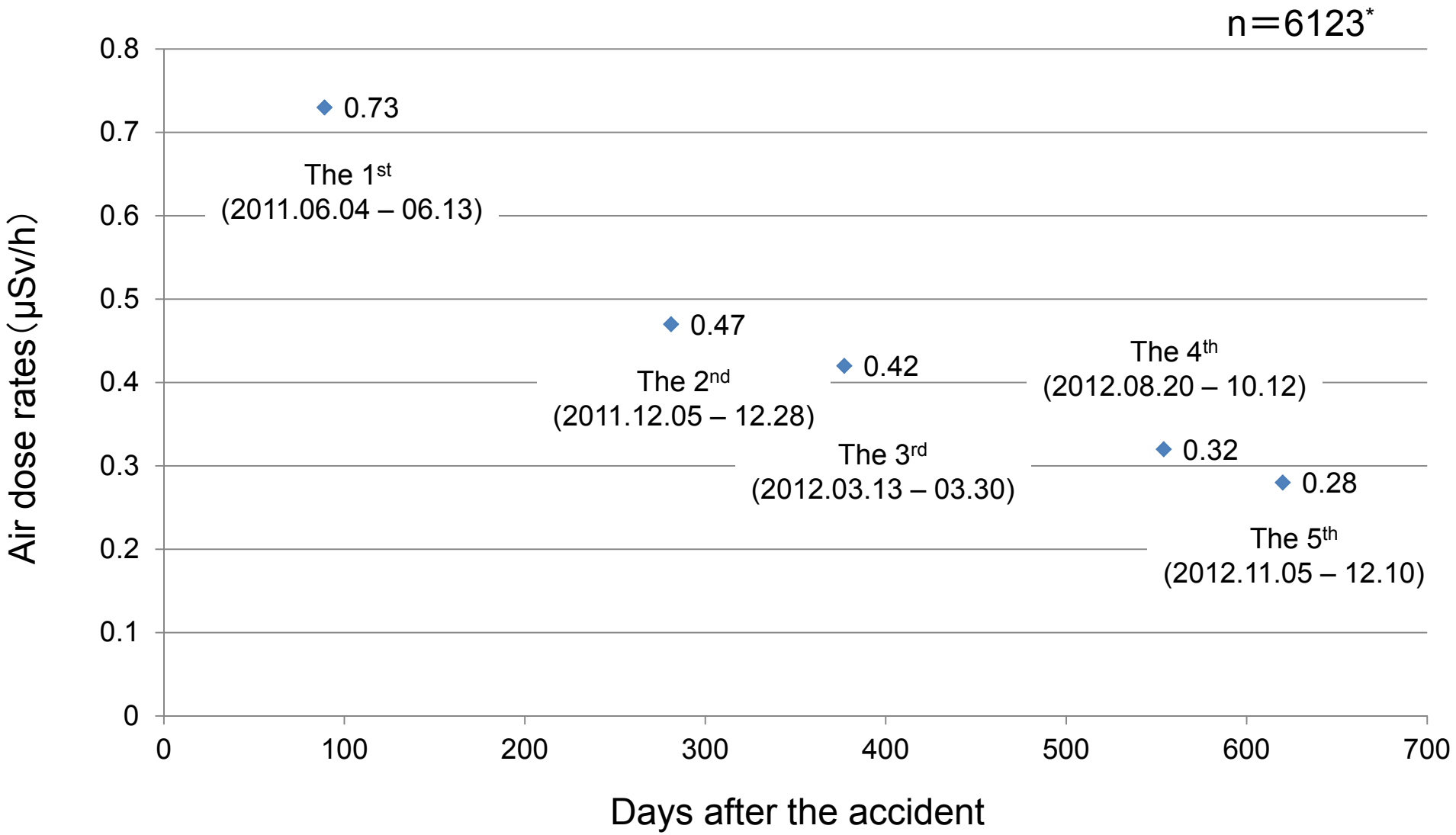
Reference: http://fukushima.jaea.go.jp/initiatives/cat03/pdf05/02-2.pdf

# Air dose rates (average) in the 80km zone from Fukushima Daiichi NPS obtained by car-borne monitoring surveys

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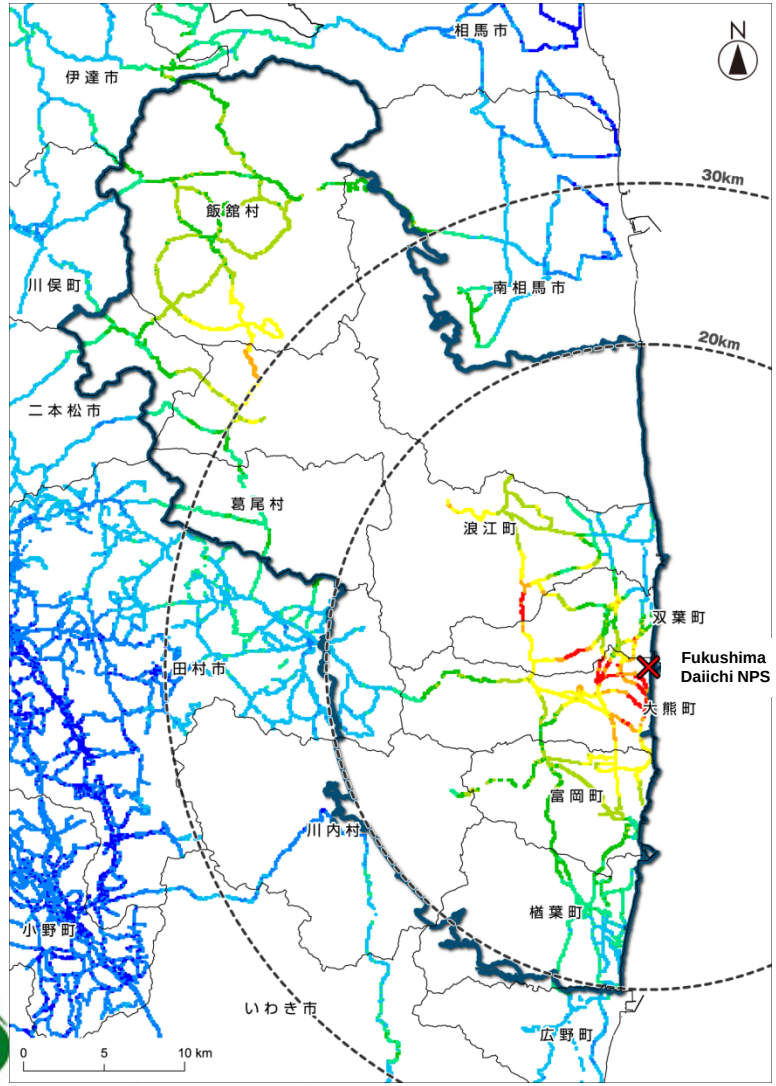
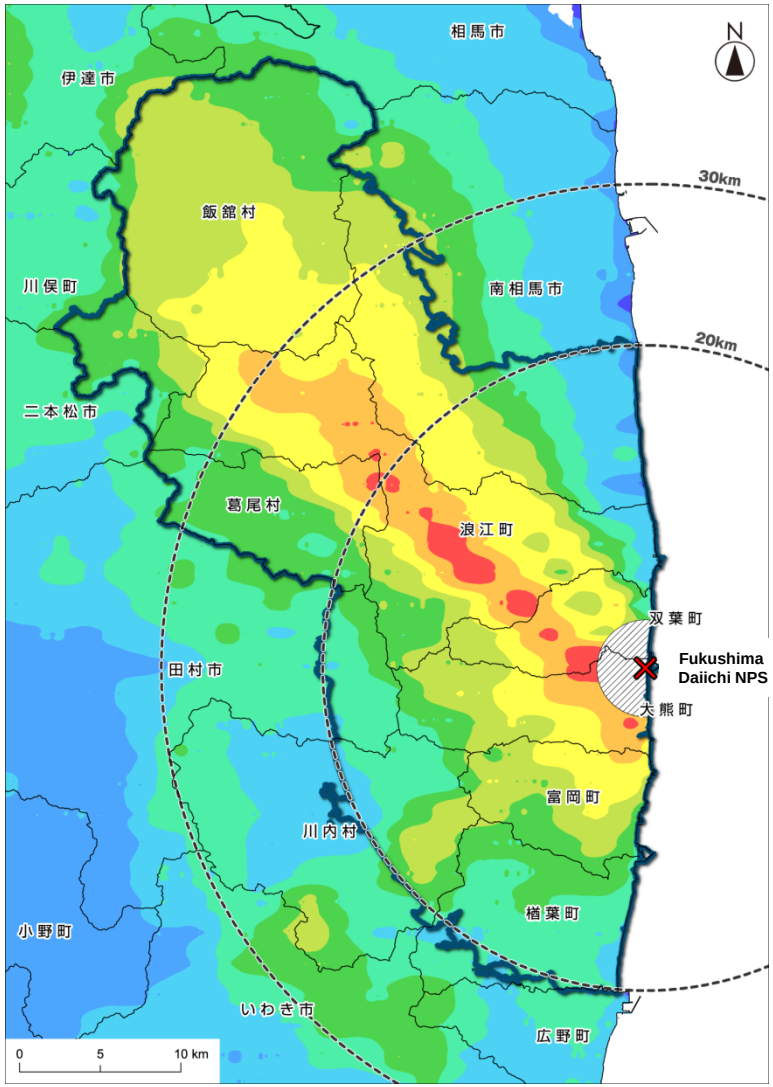
*The total number of measured points which were common throughout all five occasions.
**Standard deviations are omitted in the figure.

# Air dose rate maps in the evacuation-directed zones

The 5th car-borne monitoring survey
(Nov 5 – Dec 10, 2012)

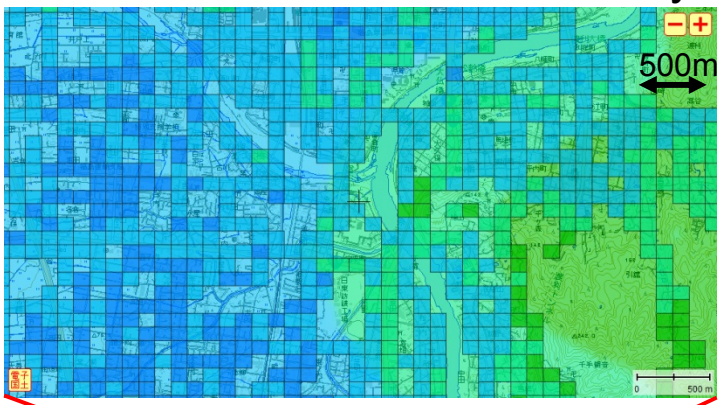



The 6th aircraft monitoring survey
(Dec 28, 2012)

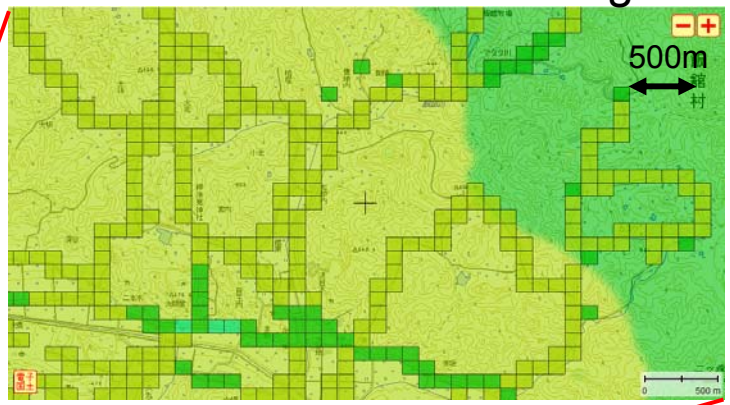


# Air dose rate maps in the 80km zone (maps magnified)

One of areas in Fukushima City

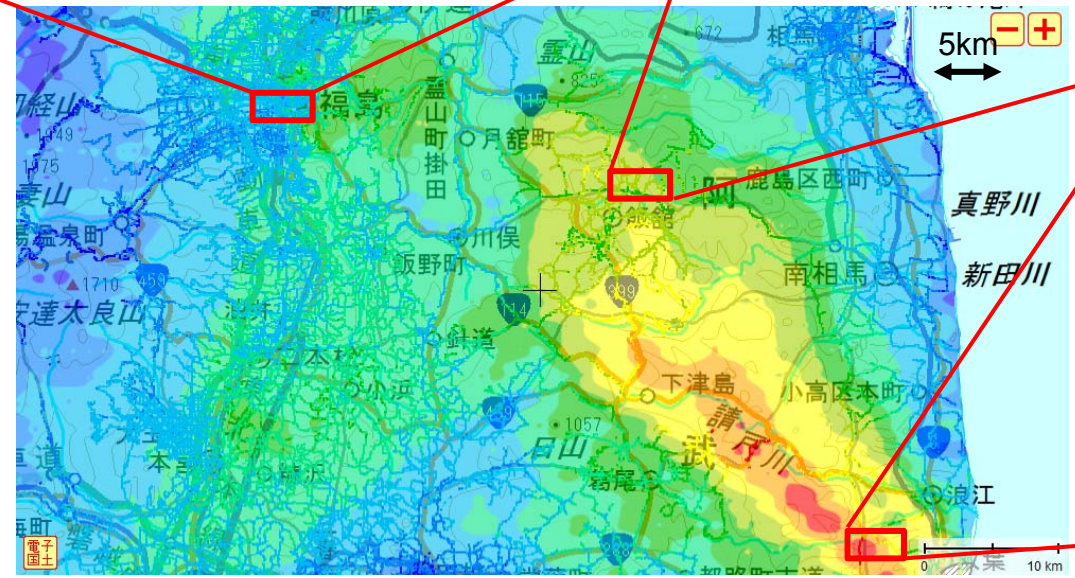



One of areas in Iitate Village

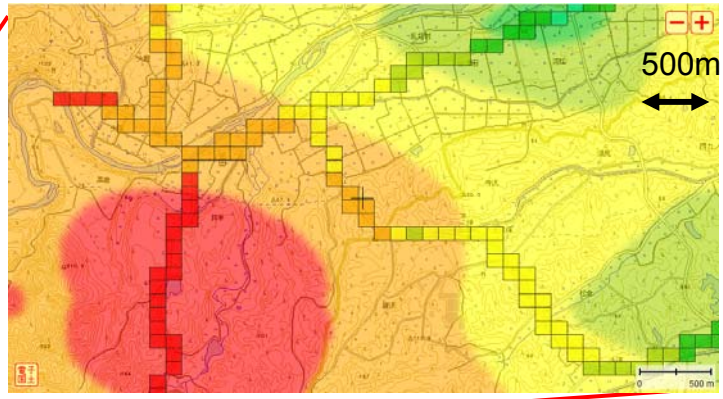



Air dose rate (μSv/h)

| |
|---|
| 19.0 < |
| 9.5 - 19.0 |
| 3.8 - 9.5 |
| 1.9 - 3.8 |
| 1.0 - 1.9 |
| 0.5 - 1.0 |
| 0.2 - 0.5 |
| 0.1 - 0.2 |
| ≦ 0.1 |




One of areas in Namie Town




The 4th car-borne monitoring (Aug 20 – Oct 12, 2012)
The 6th aircraft monitoring (Dec 28, 2012)

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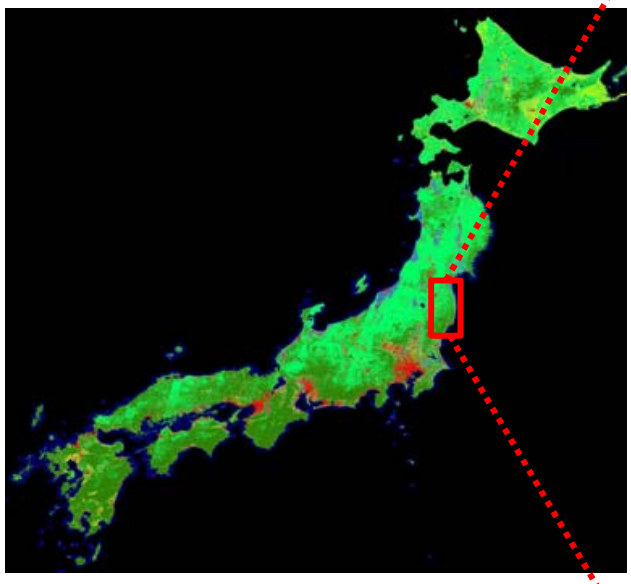
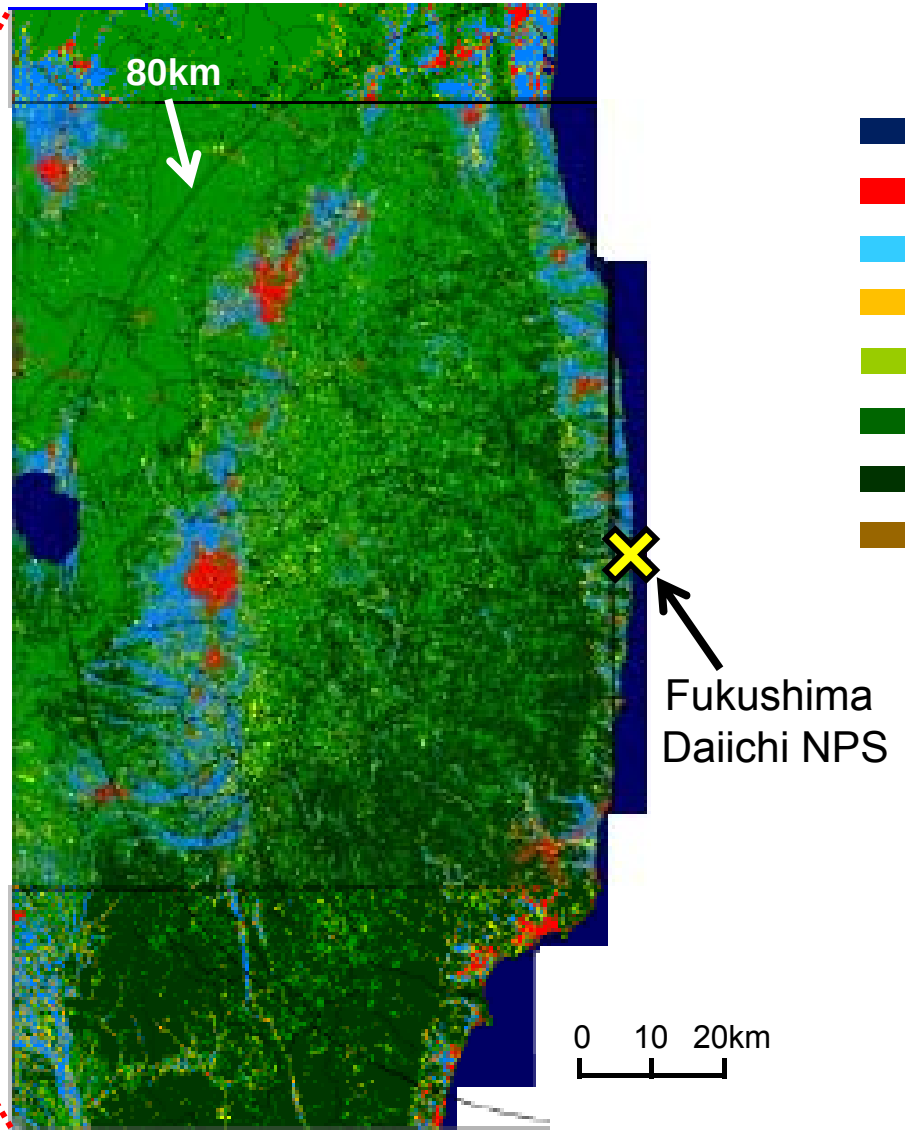
Reference:
http://ramap.jmc.or.jp/map/map.html

# 1. Land use

The high-resolution map which covers how lands are utilized (©JAXA)
http://www.eorc.jaxa.jp/index.php






Water
Urban
Paddy
Crop
Grass
Deciduous forest
Evergreen forest
Bare land

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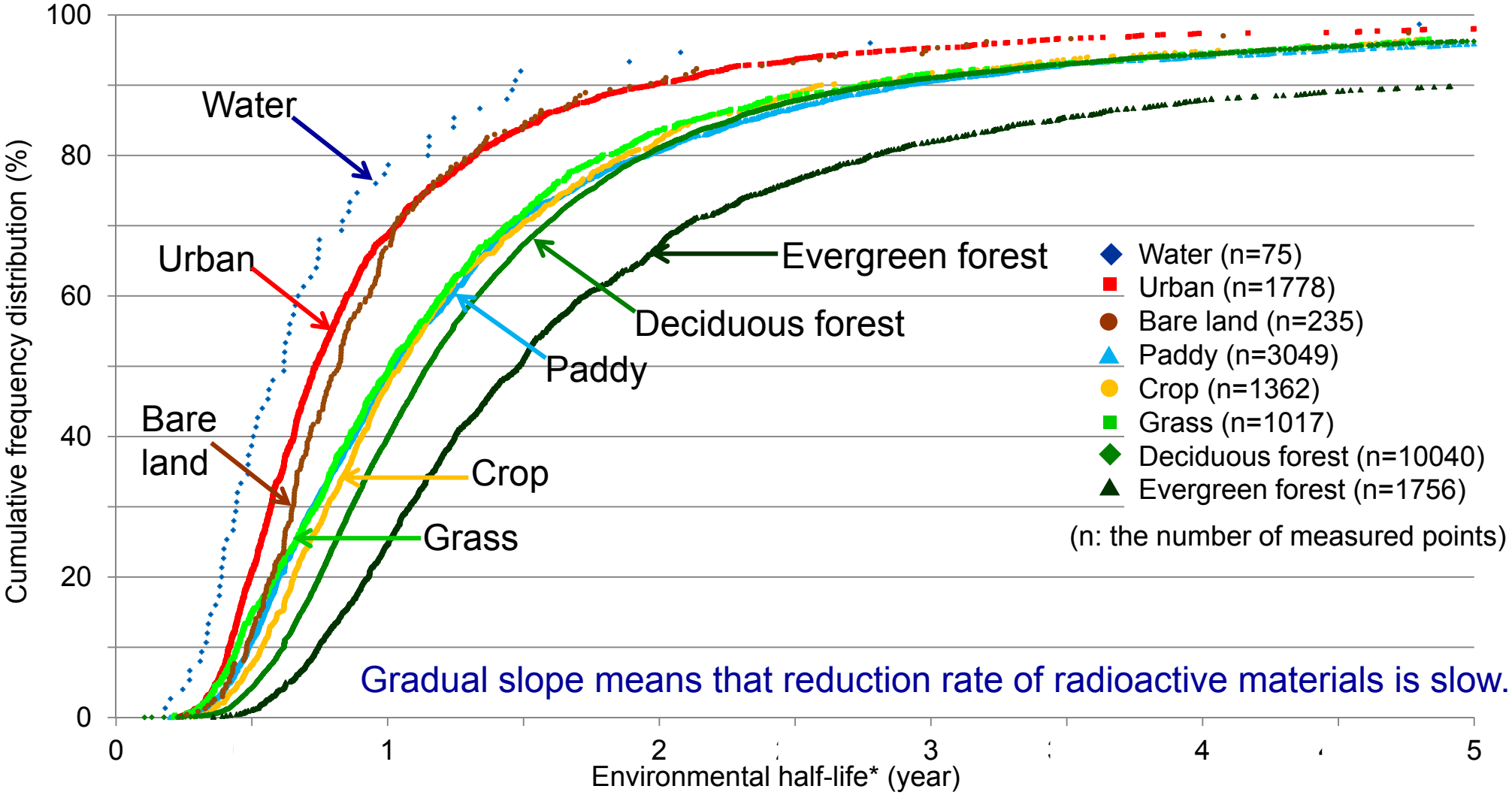
# Land use and decrease in air dose rates -1




*Environmental half-life means the time required for an environmental system or compartment to eliminate, by environmental processes, half the amount of a radioactive material that has entered it. Here, environmental half-life was calculated from air dose rates in the given environment obtained by the 1st and 2nd car-borne monitoring surveys and physical half -life was corrected.

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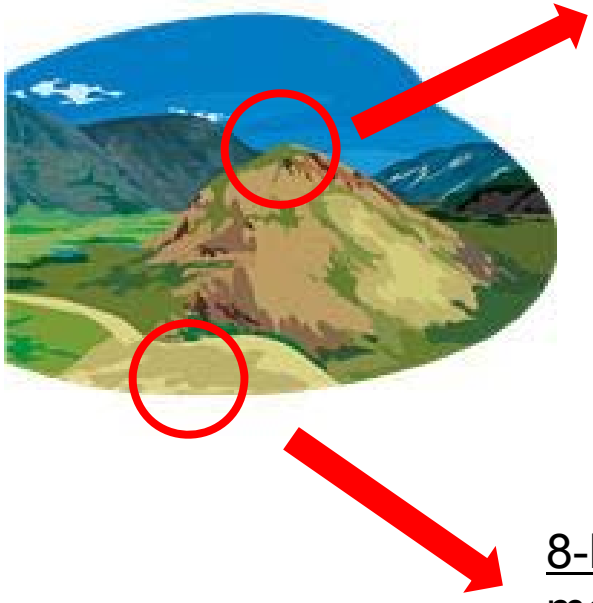
# Land use and decrease in air dose rates -2

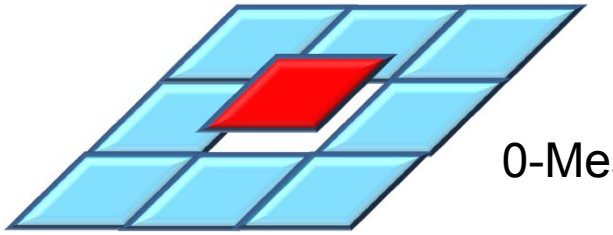
| Environmental half-life (year) | Cumulative frequency distribution (%) | | |
|---|---|---|---|
| | Water | Urban | Evergreen forest |
| 0.5 | 39 | 21 | 1 |
| 1 | 77 | 69 | 25 |
| 2 | 93 | 90 | 67 |
| 3 | 96 | 95 | 82 |
| 5 | 99 | 98 | 90 |

# 2. Land heights

Land height is expressed by the “Mesh Number” which is determined by the number of adjacent meshes higher than the given land level, namely;

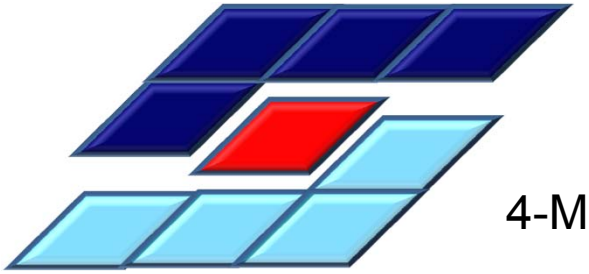


0-Mesh: No adjacent meshes are higher than the given land level (upland).



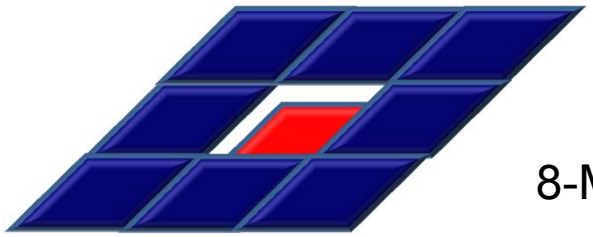
0-Mesh

4-Mesh: The four adjacent meshes are higher than the given land level.



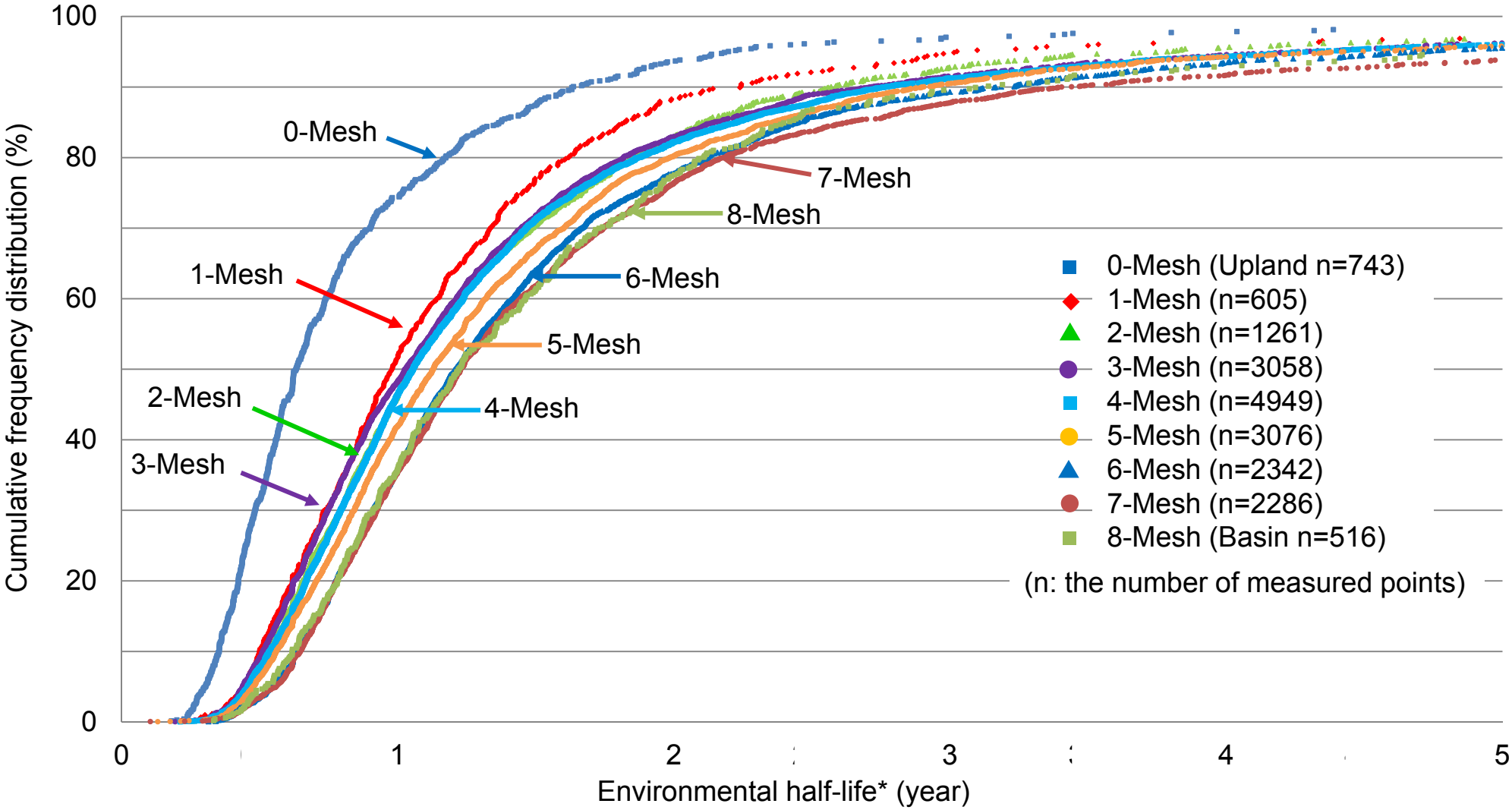
4-Mesh

8-Mesh: All eight adjacent meshes are higher than the given land level (basin).



8-Mesh

# Land heights and decrease in air dose rates -1



# Land heights and decrease in air dose rates -2

| Environmental half-life (year) | Cumulative frequency distribution (%) | | |
|---|---|---|---|
| | 0-Mesh (Upland) | 4-Mesh | 8-Mesh (Basin) |
| 0.5 | 31 | 8 | 4 |
| 1 | 74 | 46 | 36 |
| 2 | 94 | 82 | 77 |
| 3 | 97 | 91 | 90 |
| 5 | 98 | 96 | 95 |

# Summary

- The car-borne γ-ray survey system enabled us to monitor real-time air dose rates without a break at the measured points.
- Car-borne γ-ray surveys were conducted out on five occasions, and the effect of land use and heights on the reduction of air dose rates were studied.
- As far as the 1st and 2nd surveys concerned;
  - In the water and urban areas, air dose rates were decreased faster than the other areas.
  - The faster reductions were observed in the higher land when the given land levels were higher than their adjacent levels.