# Prior Estimation of Dose Reduction as a Result of Decontamination in Fukushima Pilot Project

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# Prior Estimation of Decontamination Effects

- After the Fukushima Dai-ichi nuclear accident, Japan Atomic Energy Agency (JAEA) was chosen by the Government to conduct decontamination pilot projects at selected sites in Fukushima prefecture.

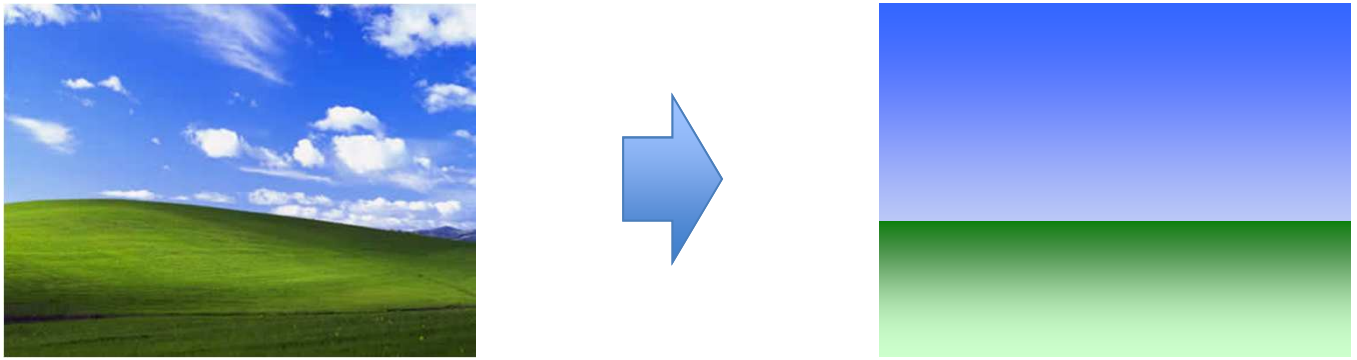
- As a component of this work, **a prior estimation of potential dose reduction over large areas** was derived using the "Calculation system for Decontamination Effect (CDE)", which was developed by JAEA.

- CDE is a simple computer program to estimate air dose rates before and after decontamination from measured (or estimated) surface contamination by gamma-emitters (Cs-134 and -137 in this case).

# Calculation System for Decontamination Effect

- In general, calculation of air dose rate from gamma-emitters is very heavy work, because Monte Carlo transport simulation on large computer (cluster, supercomputer, etc.) is usually needed.
- In particular, large-scale calculation is almost impossible mainly due to limitation of computational resources.

- **JAEA developed simplified computer program for easy estimation of the air dose rate.**
- The name is "**Calculation system for Decontamination Effect (CDE)**".
- CDE is based on a key assumption for easy calculation on small PC, which is **neglect of undulation in target area.**



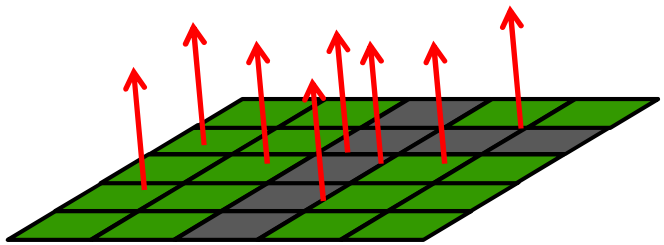
- **CDE has been verified against a standard code for a planar surface test case.**

# Procedure

**Calculation scheme of CDE for evaluation of decontamination effect**

**Before decontamination**

**Output 1: air dose rate before decontamination**



**Input 1: land-use map (mesh type)**
**Example: Farmland, road**

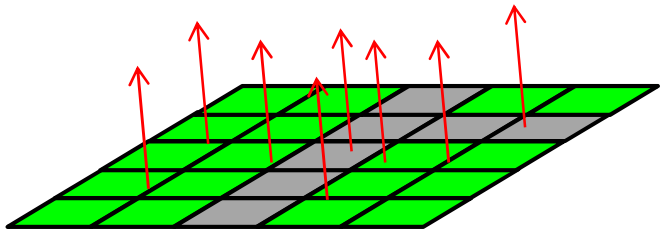
**Input 2: surface contamination density**

X 1/DF

**Input 3: DFs**

**After decontamination**

**Output 2: air dose rate after decontamination**



- We make mesh-type **land-use map** by hand using satellite images.
- **Surface contamination density** is put to the map.
- **Decontamination factors (DFs)** depend on land-use, e.g., soil removal for school ground, washing by high-pressure water for road, etc. We prepare the values of DFs obtained by measurements in the project.
- DF is applied to corresponding mesh.
- CDE calculates **air dose rate before and after decontamination.**

# Results(1)

## Target area

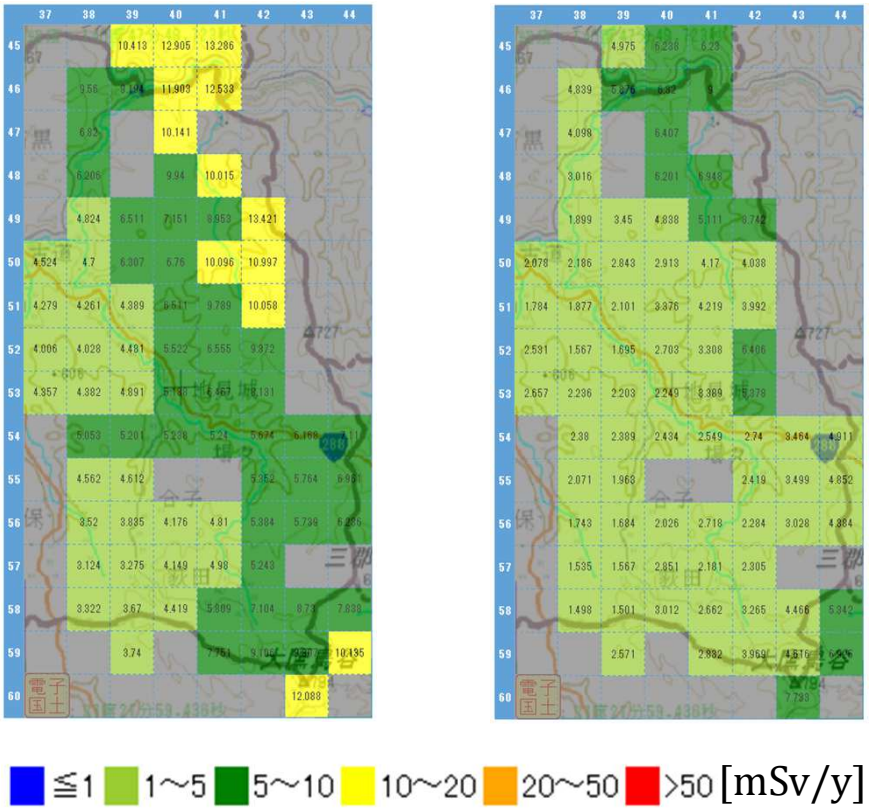
A part of **Tamura city**

- The place for first application of large-scale decontamination by the Government
- Distance from Fukushima Dai-ichi NPP is about 20km.
- About 4,200ha


## CDE calculation

**Before decontamination**

**After decontamination**



# Results(2)

- Estimation of total amount of waste

Once the mesh-type map is made, we can estimate total amount of waste.

An example of the mesh-type map (5m x 5m mesh)

: Forest (excluded from decontamination area)

: Forest (decontamination area)

: Agricultural land (decontamination area)

: road (decontamination area)

: house (decontamination area)

… …

**We can know roughly areas for each land-use by counting the number of corresponding mesh.**

**Amount of soil waste generated by soil removal**

**Average number of waste package obtained in the pilot project.**

| Land-use | # of mesh | The number of waste package / 1ha [1/ha] | The number of waste package |
|---|---|---|---|
| Forest | 163,800 | 200 | 81,900 |
| Ground | 81,226 | 500 | 101,500 |
| Total | - | - | 183,400 |

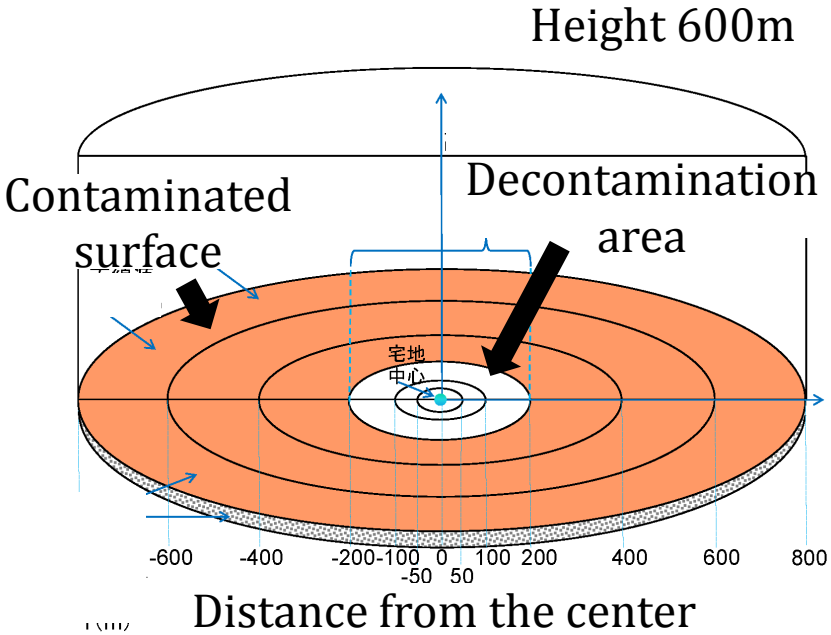
# Summary

- A prior estimation of potential dose reduction over large areas has been done using CDE which has been developed by JAEA.
- CDE calculation requires 3 inputs:
  - Land-use map
  - Surface contamination density
  - Decontamination factors
- Application for a part of Tamura city, where is one of the places for first large-scale decontamination by the Government.
  - We can know potential dose reduction roughly before decontamination.
  - We can know approximately total amount of waste before decontamination.
- Note
  - Calculated decontamination effect depends in a large part on topographical relief and the value of DFs. Users must pay attention to this point.
- JAEA continues to develop CDE.

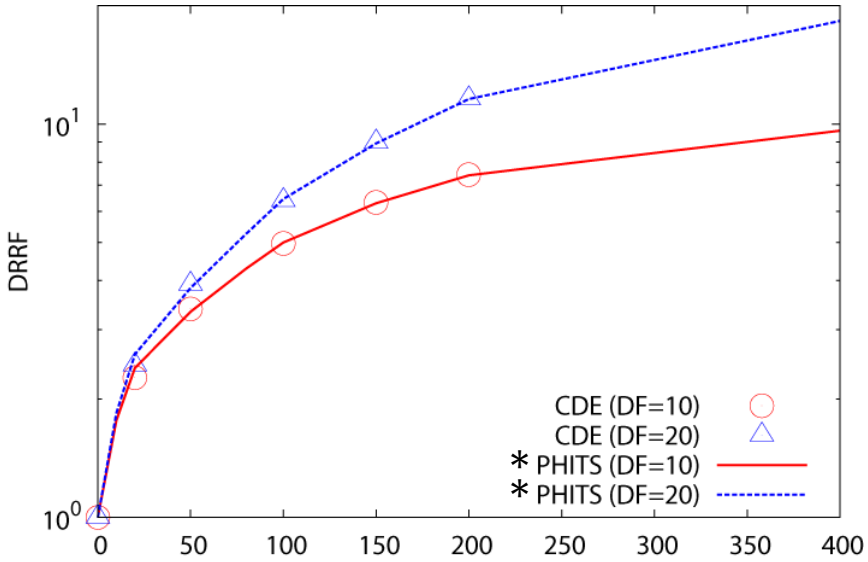
# Backup Slides

# Verification

## Simulation setting




## Comparison between CDE and PHITS*



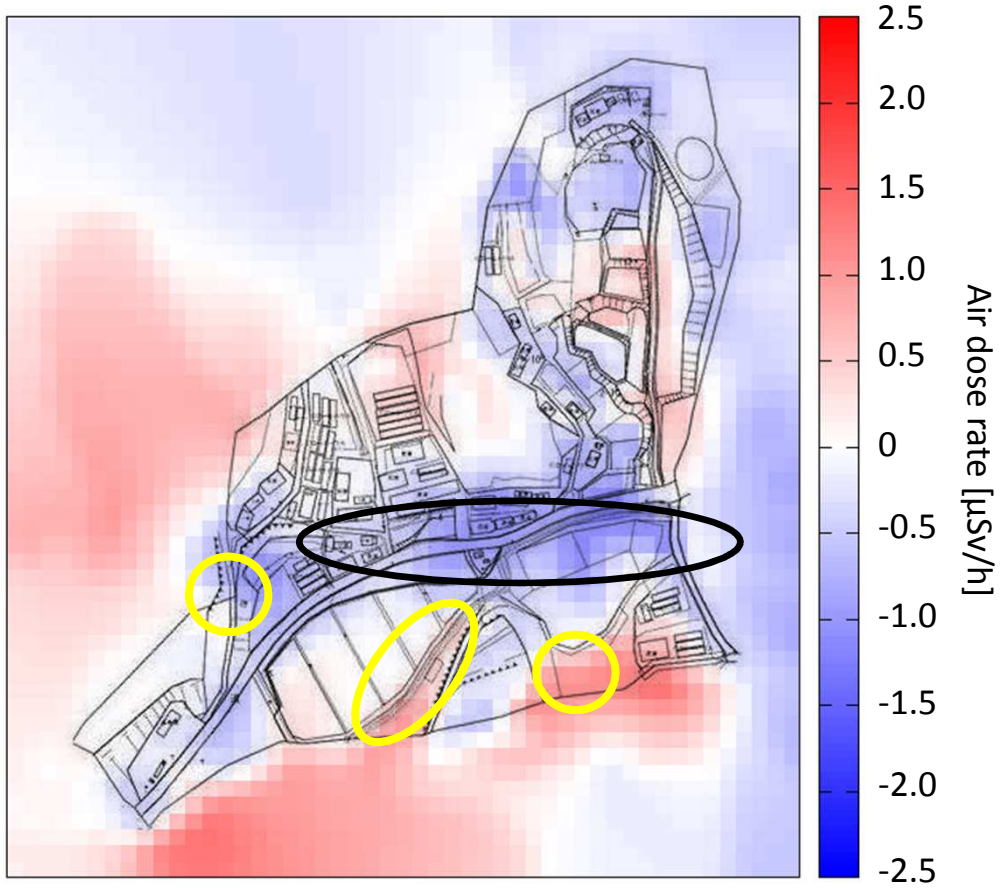

**The results of CDE are in a good agreement with ones of PHITS.**
**This result implies that CDE works well within this setting.**

Figures are taken from JAEA-Research 2012-020

* PHITS is a Monte Carlo simulation code
http://phits.jaea.go.jp

# Validation

- Validation of CDE: application to Kawamata-machi in the pilot project
  - Figure shows deviation of a CDE result using measured DFs from air dose rate measured after decontamination.




Deviation is large at yellow and black circle

- Yellow circle represents undulating landscape
- Black circle represents residential area (screening effect by houses)

Conclusion

- CDE gives good result at flat landscape.
- If landscape is undulating, deviation becomes large.

# Surface Contaminate Density

- Surface contaminate density is obtained from air dose rate measured by airplane.
- Transformation constant is used.
- This transformation gives one of origins of ambiguity in CDE calculation.