Institute for Global Environment
財団法人 地球環境戦略研究機関

“USE of Simulation Capabilities of the ERMIN by FAIRDO Project after Fukushima”

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Institute for Global Environmental Strategies

At NERIS-TP dissemination workshop
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OUTLINE

1. Overview of FAIRDO project

2. Research Activities

3. Research Results

3-1. Application of ERMIN (Okuma town)
3-2. Application of ERMIN (Tomioka town)
3-3. Comparison of decontamination strategies (Tomioka town)

1 Overview of FAIRDO Project

- **Objective :**

  FAIRDO (Fukushima **A**ction **R**esearch on **D**econtamination **O**peration**) aims at providing substantive inputs to the ongoing decontamination/ remediation operations, reflecting the realities of local conditions for effective designing and implementation**

- **Components and mode of operation :**

(1) Governance for Effective Remediation/Decontamination Operations

Prof. Hiroshi Suzuki,
Fukushima University/Chair of Reconstruction Committee in Fukushima Pref.
With IGES and Institute for Advanced Sustainability Studies (IASS)
Tokyo Keizai University, Chiba University of Commerce, Nagoya University,
Karlsruhe Institute of Technology (KIT)

(2) Development of remediation / decontamination strategies reflecting the local conditions

Tokyo University of Agriculture and Technology, Fukushima University, KIT, Bundesamt fur Strahlenshutz (BfS)

(3) Effective communications to promote collaboration with those affected in contaminated areas

Tokyo Institute of Technology, Fukushima University, Berlin Freie Universitat.

- **Major outputs/outcomes :**
  - Substantive inputs to the ongoing decontamination/remediation operations through relevant experts' channels
  - **Japan optimal model based on EURANOS/RODOS developed**
  - Guidelines for effective decontamination/remediation operations shared

Overview of FAIRDO Project

FAIRDO's messages

Toward better decontamination and recovery

Integrated discussions and planning of decontamination and recovery

Better communication among municipalities on their experiences and lessons

Development and utilisation of tools to understand and reflect local situations in decontamination/recovery

Establishment of the Information Platform
to facilitate information sharing and ensure transparency/credibility

Review of the current decontamination plans to include clearer visions toward recovery and development of the local societies

Introduction / dissemination of participatory decontamination planning and implementation

Development (or review) of local reconstruction plans envisaging that some of radioactive matters aren't cleared even after decontamination

Application of brief assessment

Utilisation of RODOS model to
enable clear understandings of effects, costs, amounts of wastes and workloads.

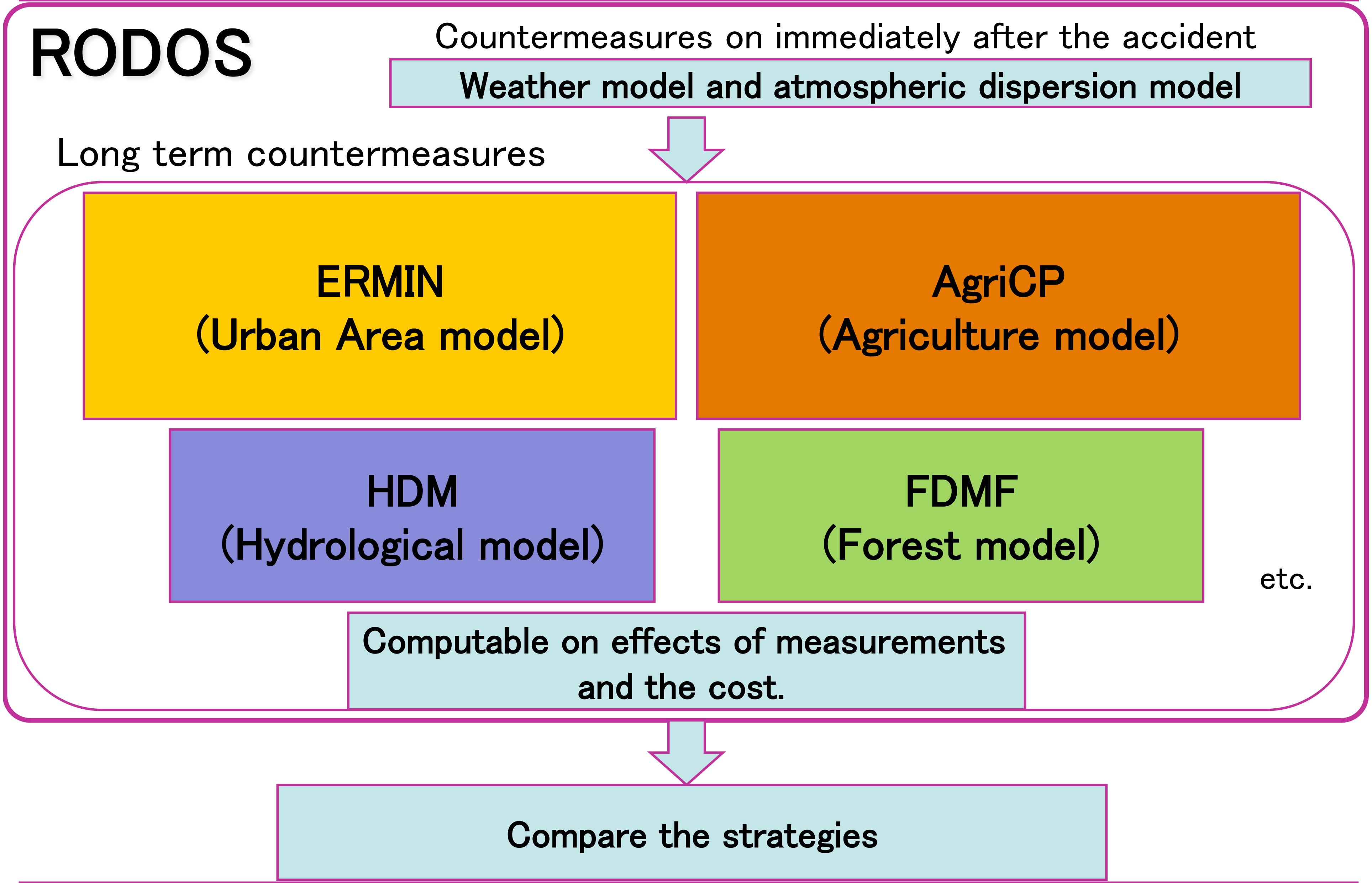
More utilisation of experts such as Decontamination Promotion Workers

Establishment of community roundtables at each municipality

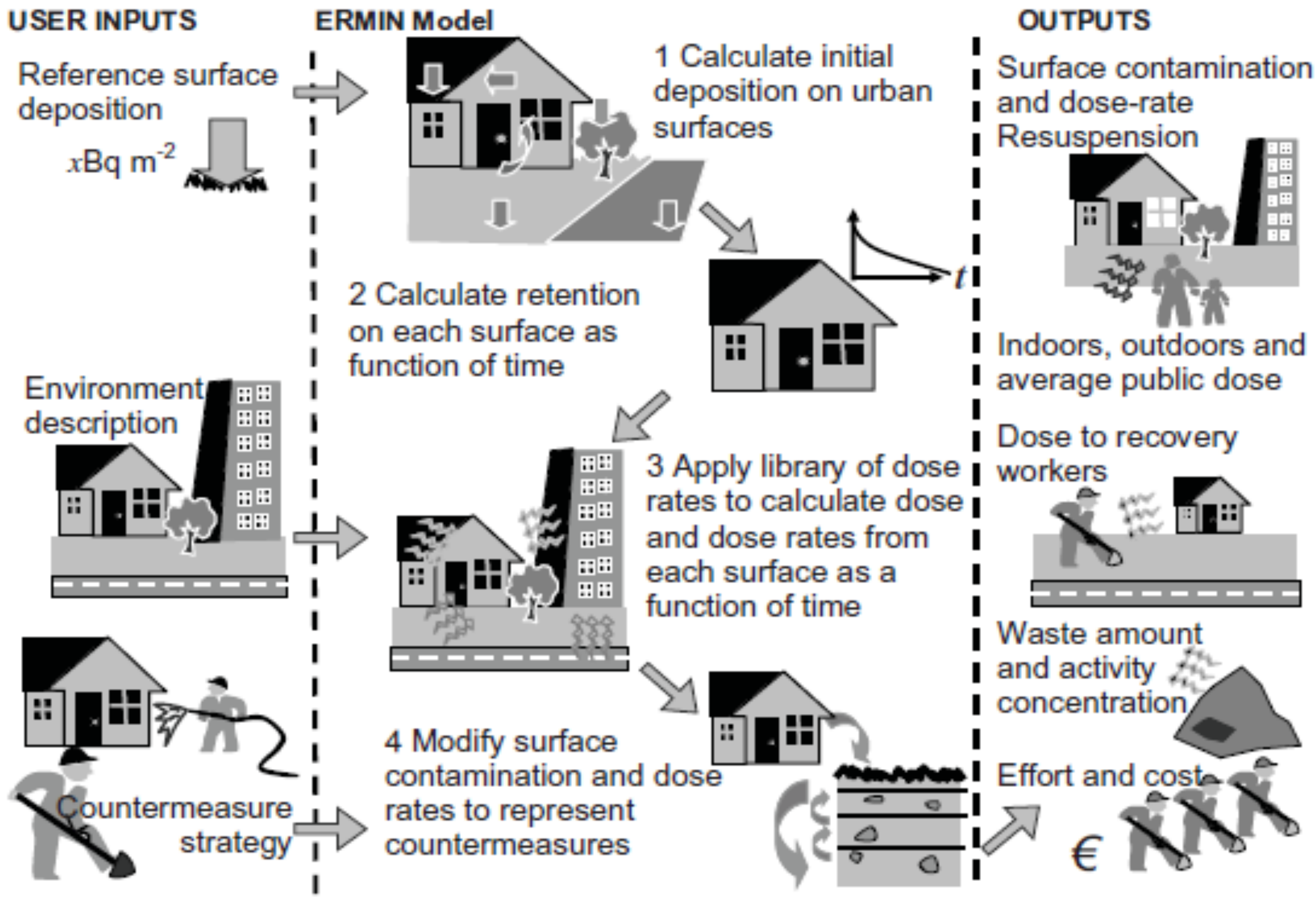
Research Activities

- Application of ERMIN into "Okuma Town Office" and "Yo-no-mori at Tomioka town"
- Comparison the simulation results and actual decontamination plan (as of model project)
- Reproducibility improvement and sensitivity analysis of ERMIN
- Comparison results of decontamination strategies

Overview of RODOS



Overview of ERMIN model



Reference：EURANOS

3 Research Outcomes

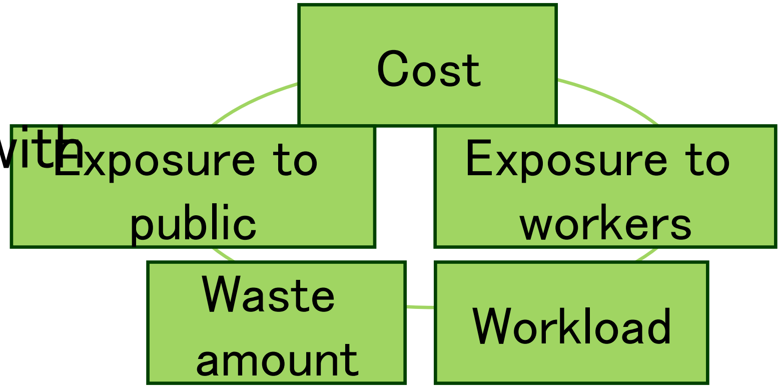
3-1. Applying ERMIN to Okuma town office

Calculate air dose rate at residential area (indoor and outdoor)
→ exposure of residents (normal living)

- Predict exposure reduction through decontamination
- Predict differences of exposure caused by decontamination with the consideration of time

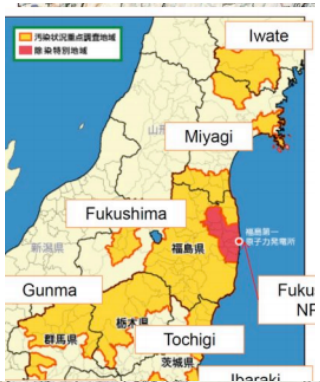
3-2. Applying ERMIN to Tomioka town(yonomori) and 3-3. Comparing decontamination strategies

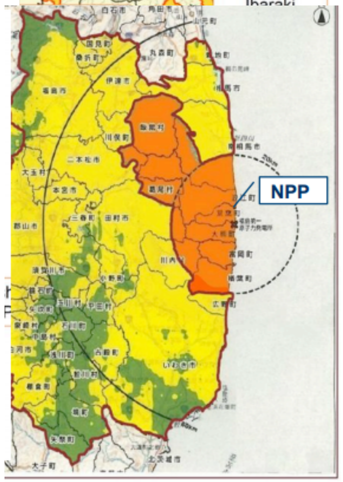
Comparison on methodologies, places, results of decontamination, regarding with the five points of view

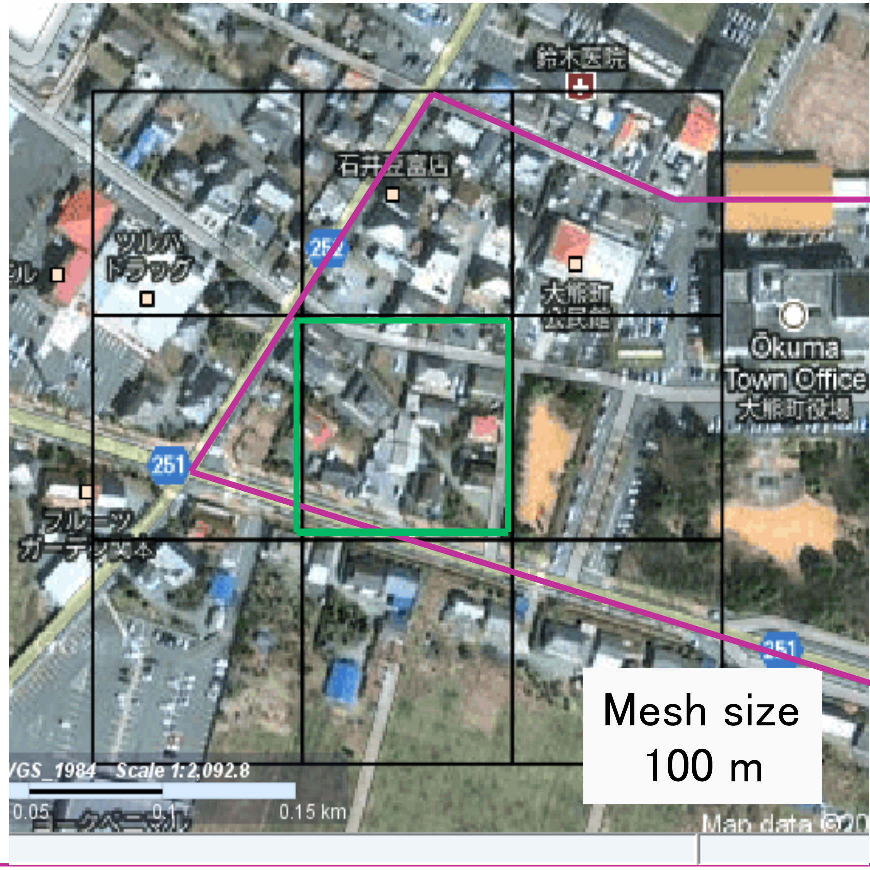


- Possibility of Development of decontamination strategies reflecting local conditions

3-1 Applying ERMIN to Okuma town office and the environmental setting







Purple: **model project area by JAEA** **Green**: **calculation area**

Calculating area of environmental media by using GIS ➡ Input data into ERMIN

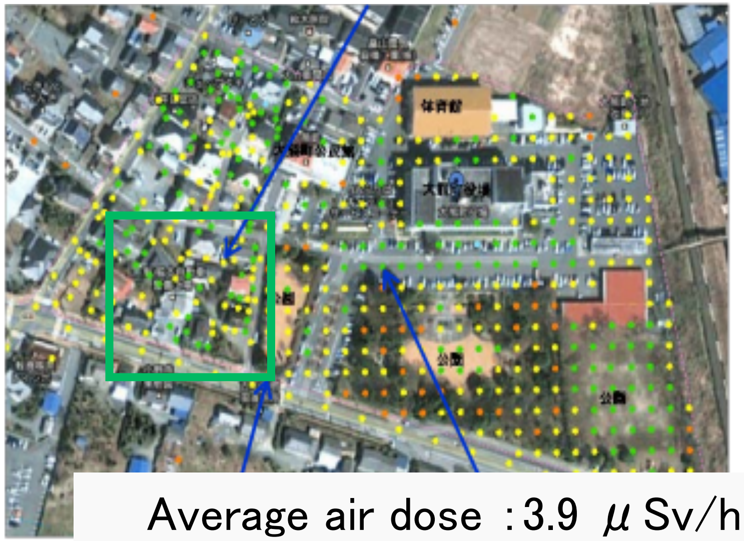
3-1 Estimation of Initial Deposition

Before of decontamination

After of decontamination

Average air dose rate : 11.5 μSv/h

公園:最大値 33.1μSv/h　道路:最大値 43.6μSv/h



Average air dose : 3.9 μSv/h

公園:最大値 16.7μSv/h　道路:最大値 13.5μSv/h

Reference: JAEA

Estimation of Initial Deposition

Inverse Calculation of Cs decay

air dose rate(μSv/h)→deposition(Bq/m^2)

(conversion factor)

Conditions

- natural radiation from soil: 0.04 μSv/h
- ratio of ^{134}Cs to ^{137}Cs from FDNPP: 1:1
- date of deposition: 2011, Mar. 21st・wet deposition
- conversion factor: ^{134}Cs: 5.4×10^{-6}, ^{137}Cs: 2.1×10^{-6} (unit: [μSv/h]/[MBq/m^2])

Initial deposition

1.79×10^6

(Unit: Bq/m^2)

＊ IAEA-TECDOC-1162

3-1 Input of Decontamination Parameters

Road surface removal

Top soil and turf removal

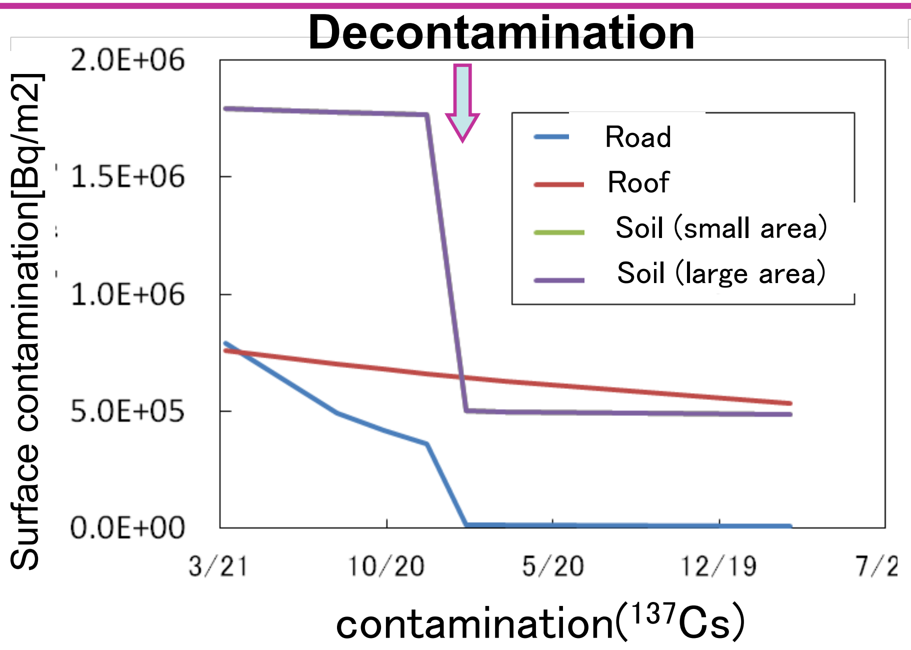
Reference：JAEA

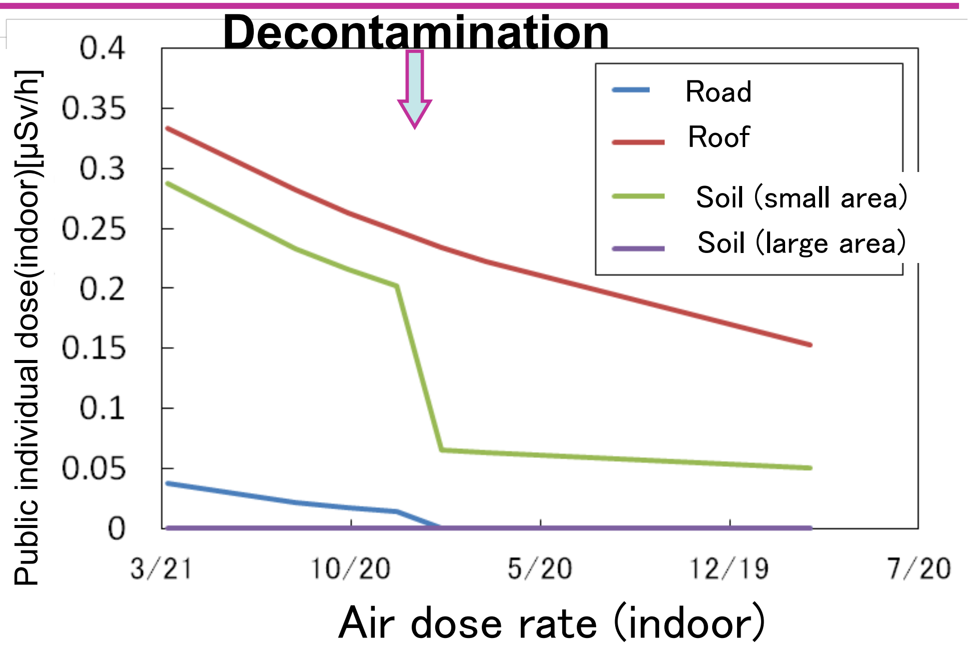
methods and parameters of decontamination

CM	Waste	Waste rate [kg/ m²]	Depth removed [m]	DF	Team size	Work-rate [m²/ team.hr]	Equipment cost [€/ m²]	Material cost [€/ m²]	Labour cost [€/ m²]
Top soil and turf removal (mechanical)	Soil and turf	60 **30**	0.05 **0.02**	20 **5**	2 **8**	400 **66**	0.09	0	0.2 **5.3**
Road surface removal	asphalt	60 **11.2**	0.04 **0.005**	8 **22**	2 **9**	400 **173**	0.2	0.1	0.2 **3.9**

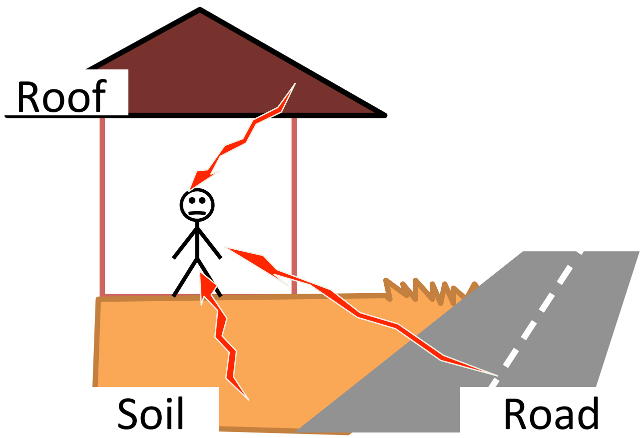
- Black: as default value of ERMIN
- Red: as adjusted parameters in Japan based on the model project of JAEA

3-1 Radiation Dose (indoor) from Contamination



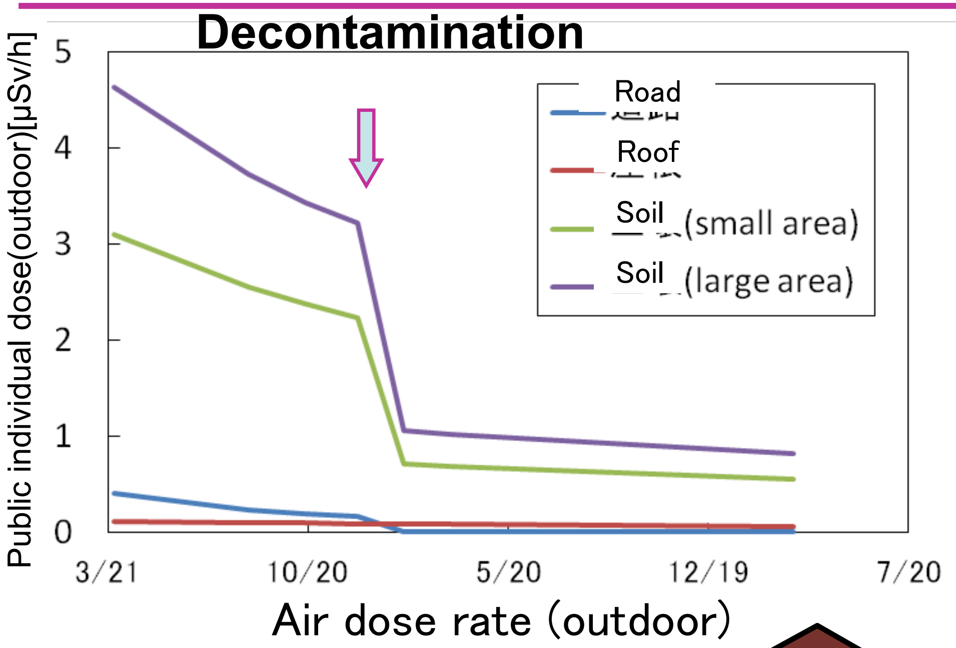


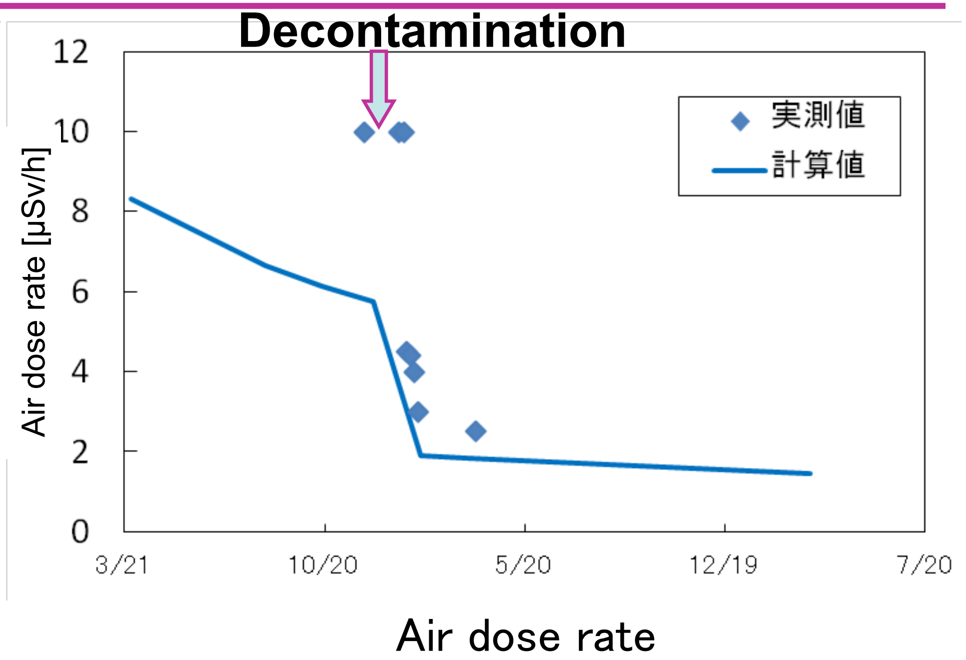
・Behavior of each environmental media
・Decontamination effect



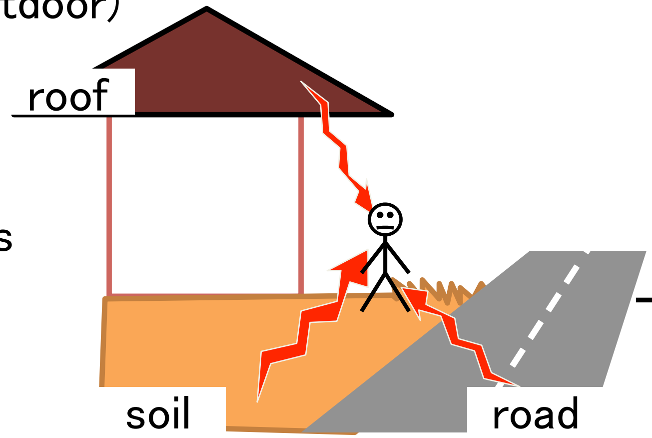
Identify contribution of Environmental medias to Radiation Dose

3-1 Radiation Dose (outdoor) from Air Dose Rate





94% of radiation dose is contributed from soil



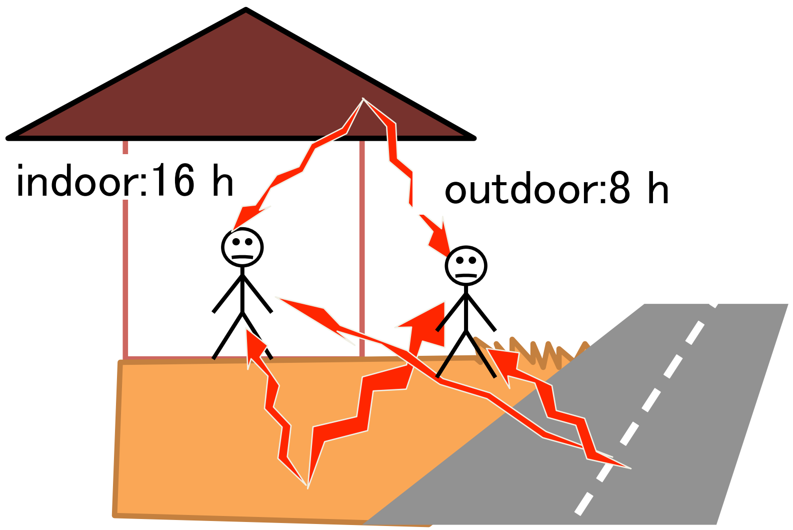
Fitting was difficult due to the lack of un-measured data.
→**however, the result shows the trends semi-quantitatively.**

- Identification of transition of contamination and the radiation dose(indoor and outdoor).
- Reflection of trends ofair dose rate

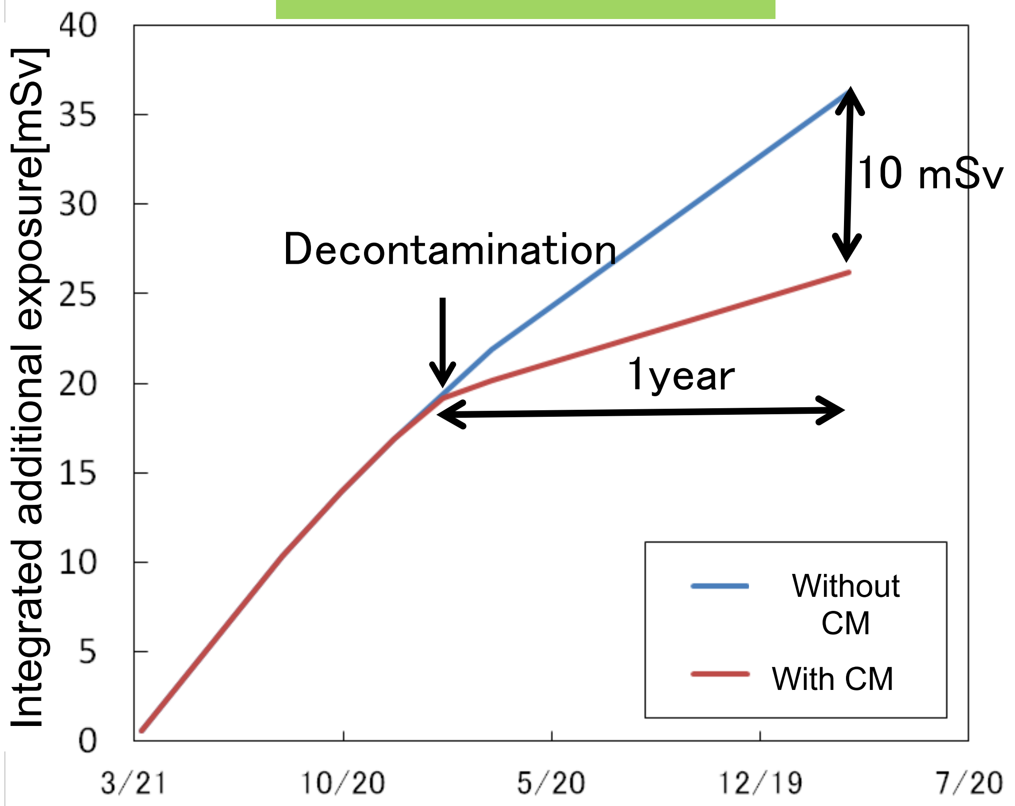
3-1 Integrated Additional Exposure

Precondition

- ☐normal living (indoor:16 h)
- ☐dose reduction factor is differ from buildings
- ☐presence time is proportional to environment description
- ☐mooing range is only one grid



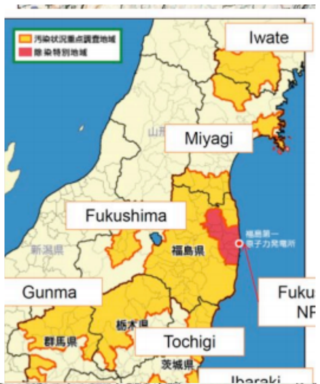
Calculation Result

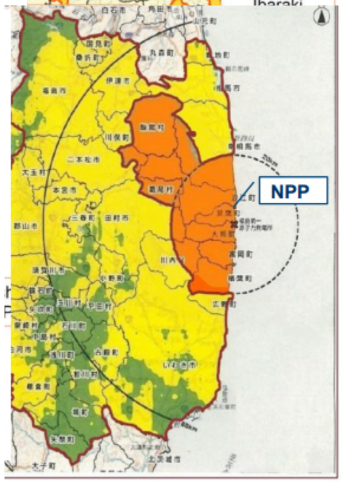


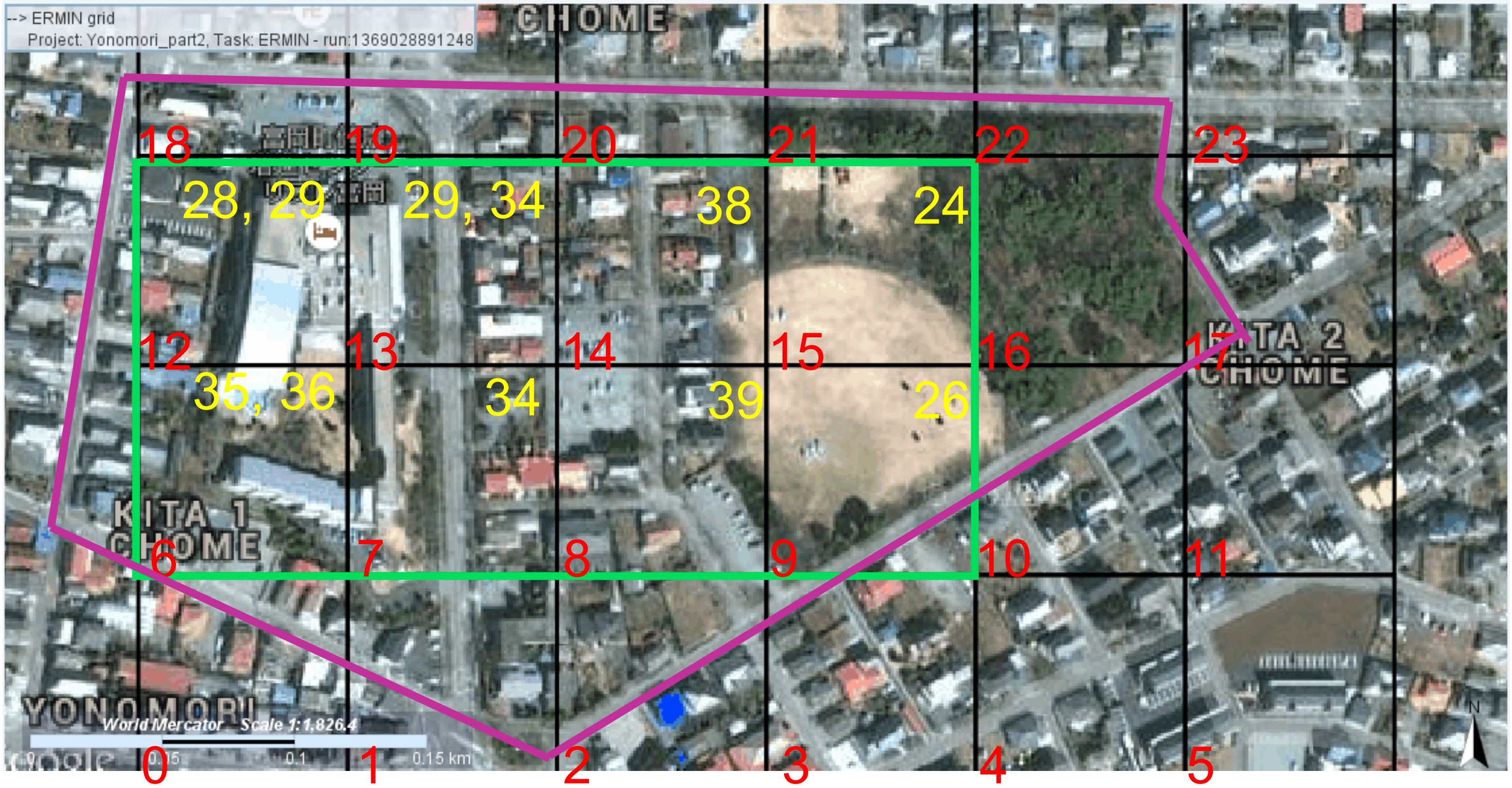
Reduction effect of integrated additional exposure by decontamination

- Predict exposure reduction through decontamination
- Predict differences of exposure caused by decontamination time

3-2 Applying ERMIN to Tomioka town (Yonomori) and the environmental setting





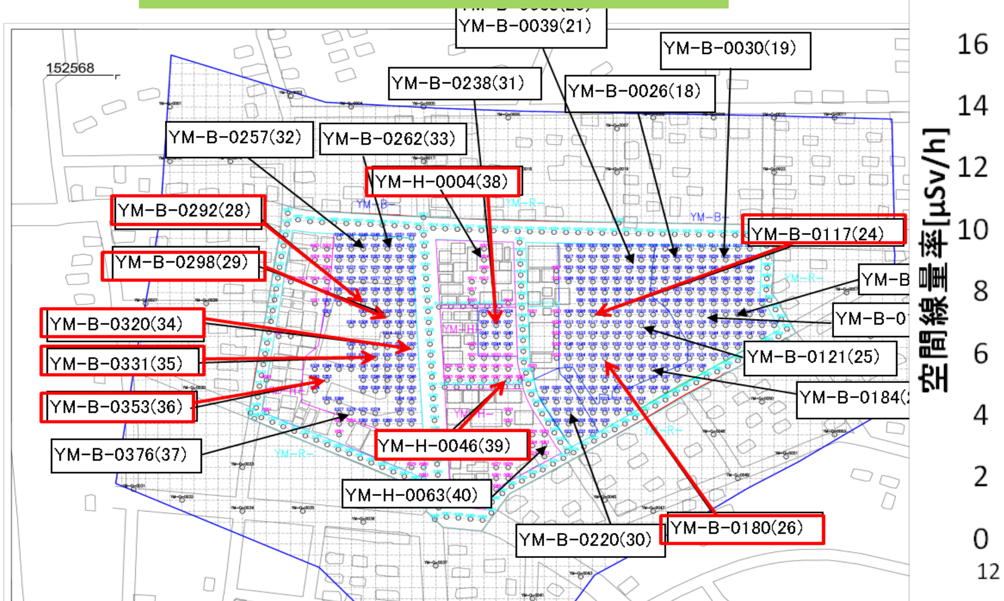


Purple : model project area by JAEA Green : calculation area
Red : mesh ID Yellow : monitoring point number

Calculating area of environmental media by using GIS ➡ Input data into ERMIN

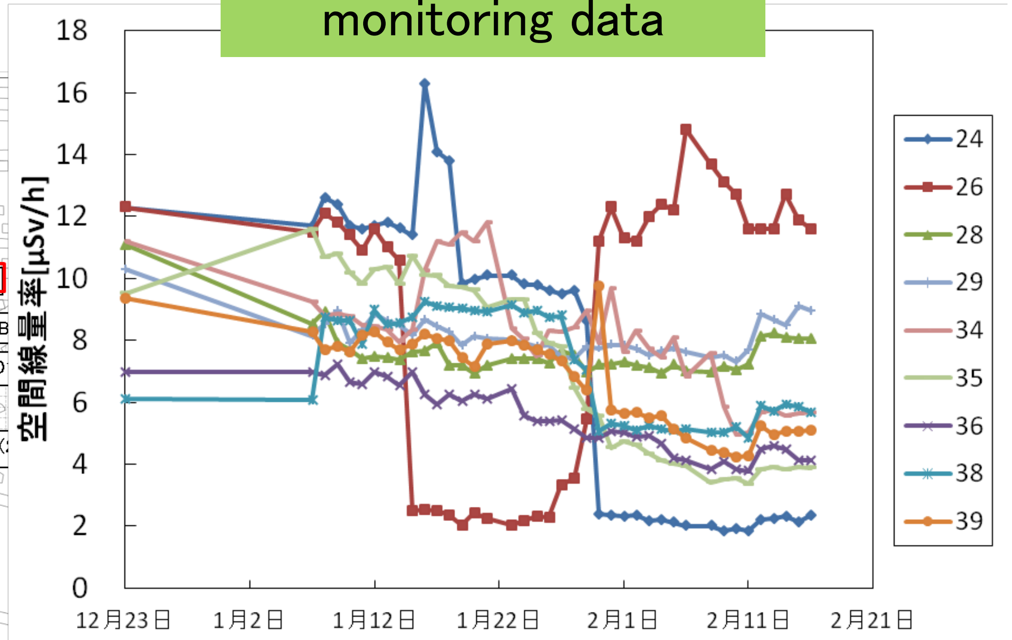
Estimation of Initial Deposition

monitoring point



Red: applied monitoring point

monitoring data



Estimation of initial deposition

inverse calculation of Cs decay

air dose rate(μSv/h)→deposition(Bq/m²)

(conversion factor)

Conditions

- natural radiation from soil: 0.04 μSv/h
- ratio of ^{134}Cs to ^{137}Cs from FDNPP: 1:1
- date of deposition: 2011, March, 21st・wet deposition
- conversion factor: ^{134}Cs: 5.4×10^{-6}, ^{137}Cs: 2.1×10^{-6} (unit: [μSv/h]/[MBq/m²])

Table. Initial deposition

ID	^{134}Cs, ^{137}Cs [Bq/m²]
6	1.41×10^{6}
7	1.79×10^{6}
8	1.31×10^{6}
9	1.91×10^{6}
12	1.71×10^{6}
13	1.72×10^{6}
14	1.23×10^{6}
15	1.96×10^{6}

＊ IAEA-TECDOC-1162

Reference: MOEJ

3–2 Input of Decontamination Parameters

Road surface removal

Top soil and turf removal

Roof brushing

Decontamination methods and parameters

CM	Waste	Waste rate [kg/m^2]	Depth removed [m]	DF	Team size	Work-rate [m^2/team. hr]	Equipment cost [€/m2]	Material cost [€/m^2]	Labour cost [€/m^2]
Top soil and turf removal(mechanical) (small scale)	soil and turf	30	0.02	3	8	66	0.09	0	5.3
Top soil and turf removal(mechanical) (large scale)	soil and turf	30	0.02	3	8	66	0.09	0	5.3
Road surface removal	asphalt	11.2	0.005	22	9	173	0.2	0.1	3.9
Roof brushing	dust	3	–	1.5	8	17.5	0	0	10.9

出典:JAEA

3-2 Decontamination Strategies Settings

To compare actual decontamination operation to other decontamination strategies (in terms of radiation dose change and resource consumption)

Strategy 1：case of actual decontamination strategy (as default)

applying decontamination work such as removal of soil, cutting road surface, and brushing roofs to all mesh (ID=6,7,･･･15)

Strategy 2：case of strategy1 without roof brushing

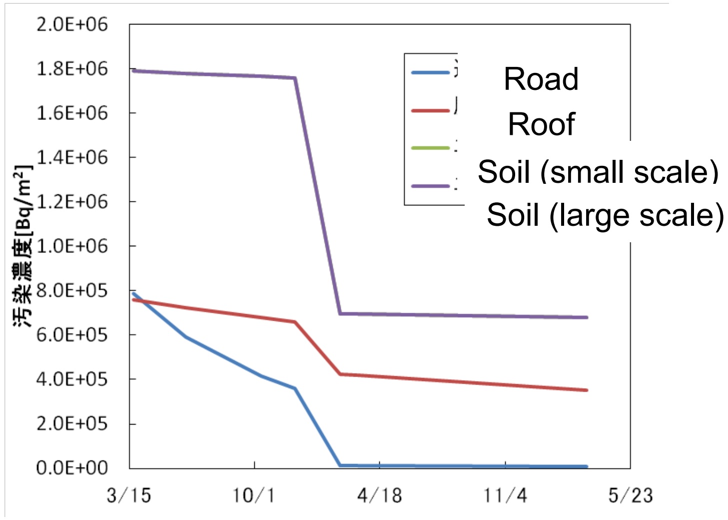
For evaluate different decontamination method.
Despite high cost and high workloads of roof brushing, the effect is very limited, which revealed from the model project.

Strategy 3： case of strategy2 without decontamination of ID=12

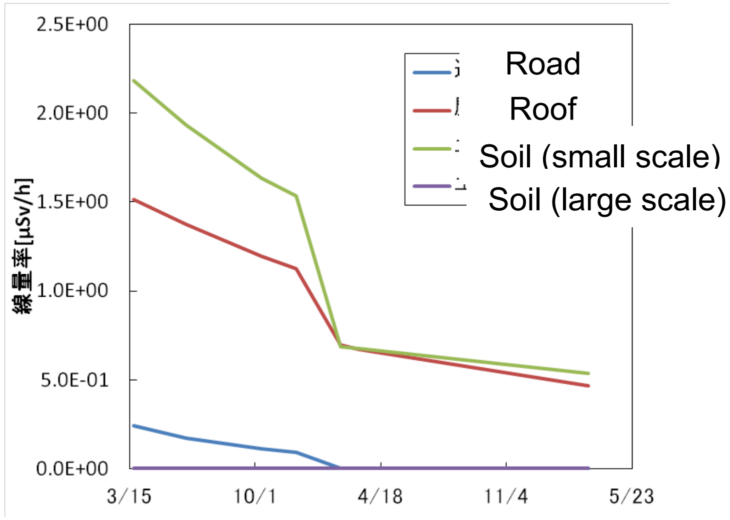
For evaluate changes of decontamination area.
To see how decontamination area will affect the result, without decontamination of ID=12, where shows the least effects of decontamination from monitoring data.

Calculation results

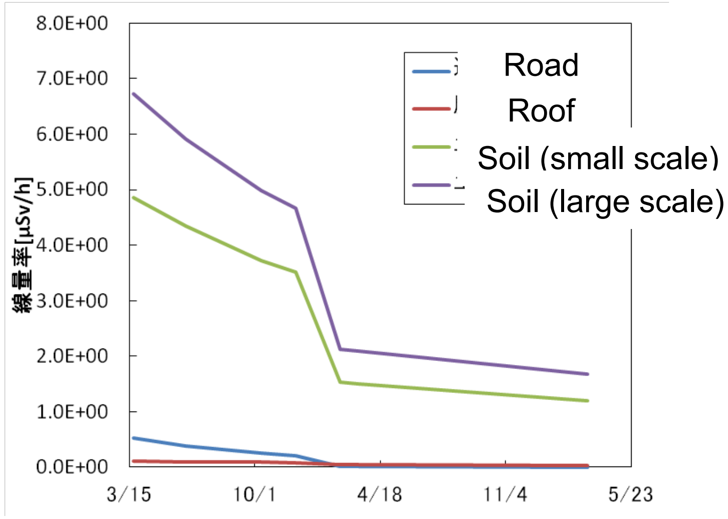
Strategy 1 (ID=7)



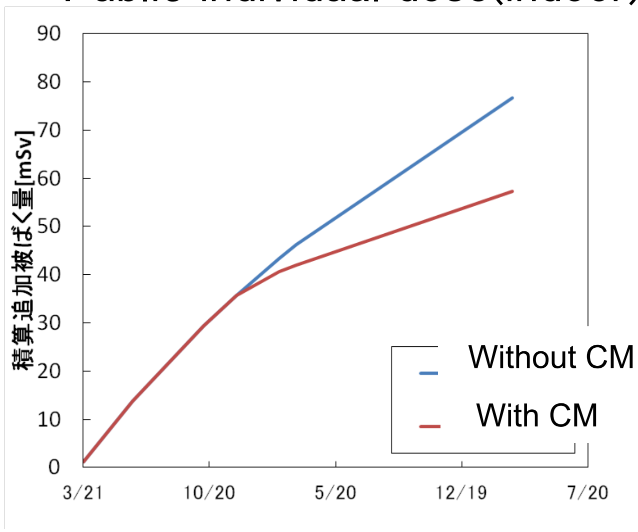
Surface contamination of environmental media



Public individual dose(indoor)



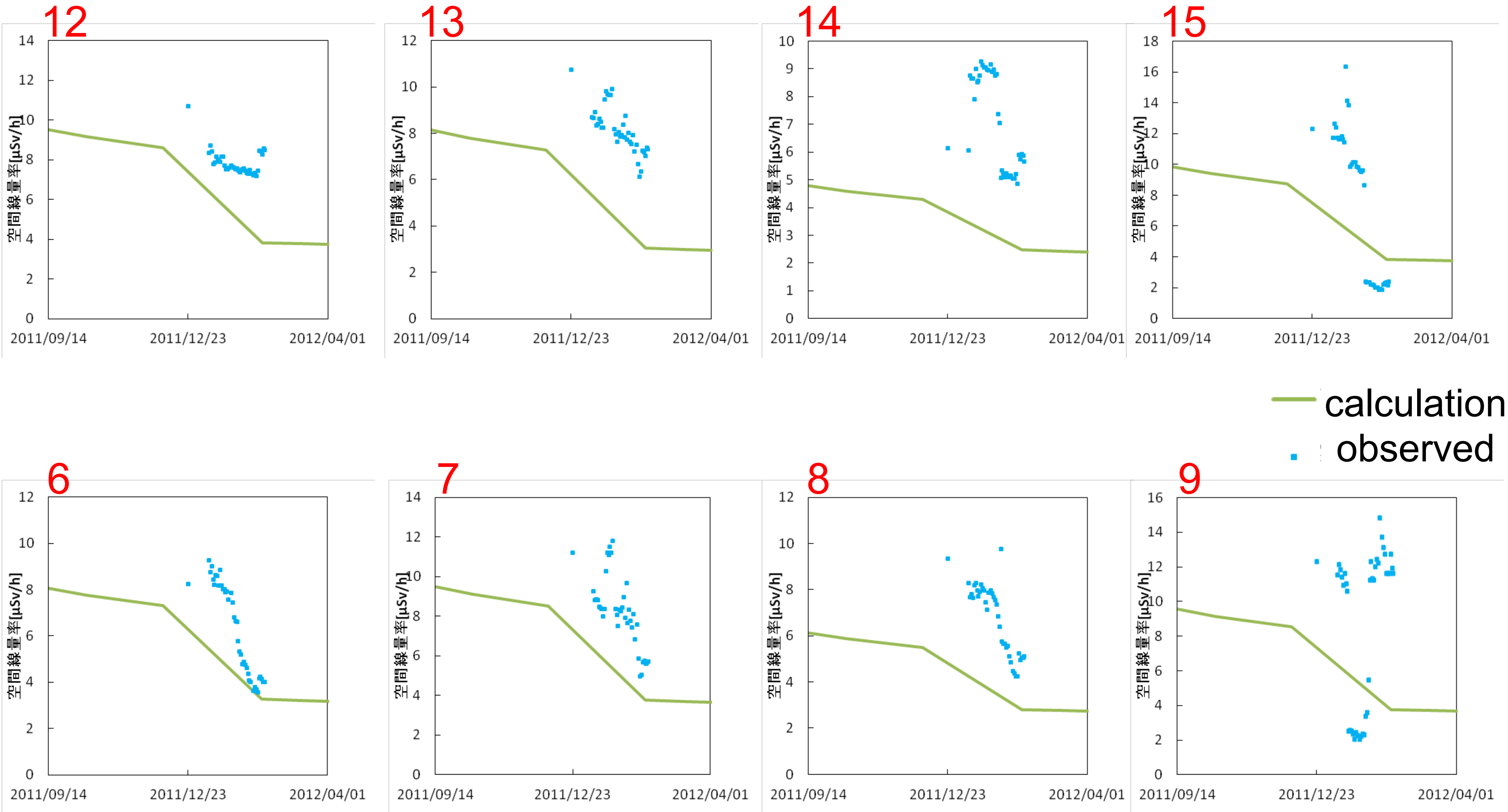
Public individual dose(outdoor)



Integrated additional dose

3-2 Calculation results(to be continued)

Air dose rate at from ID=6 to ID=15 in the case of strategy1



Comparison on the decontamination strategies

Table. Comparison among decontamination strategies

Values	No-countermeasure	Strategy 1	Strategy 2	Strategy 3
Exposure to public [man-Sv]	1.29	0.928	0.970	1.01
Exposure to worker [man-Sv]	0	0.120	0.0216	0.0179
Cost [€]	0	6.55×10^5	2.11×10^5	1.89×10^5
Waste amount [kg]	0	2.61×10^6	2.57×10^6	2.27×10^6
Workloads [man-days]	0	943	166	141

※Exposure to public was calculated at the periods of three years later after initial deposition

Important to show specific numerical values

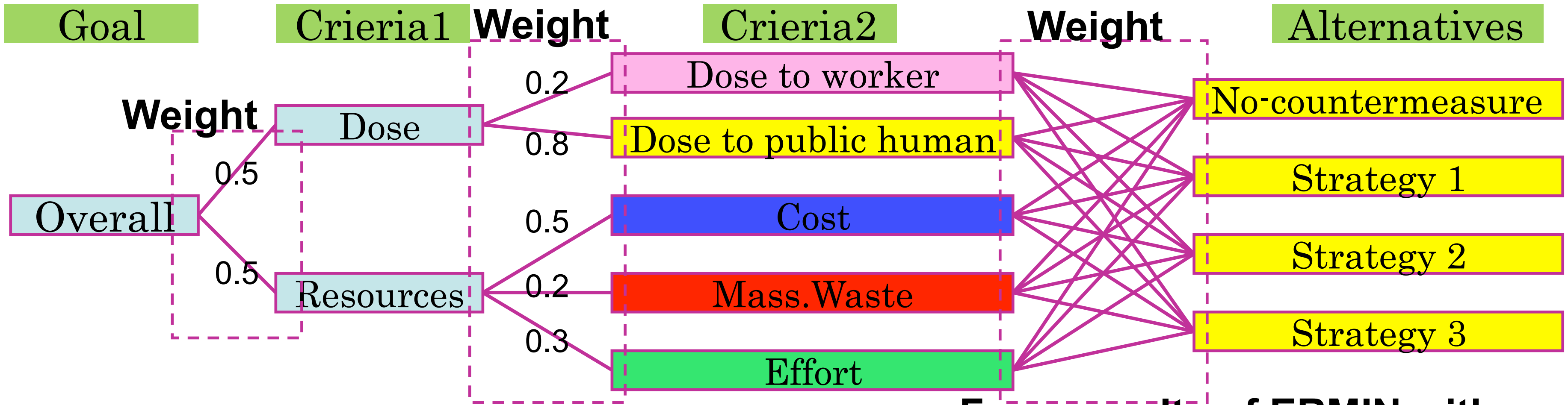
➔Useful to know by visualizing which parts are relatively good comparing to other

➔Possibility of Development of decontamination strategies reflecting local conditions


Thank you very much
for your kind attention!!

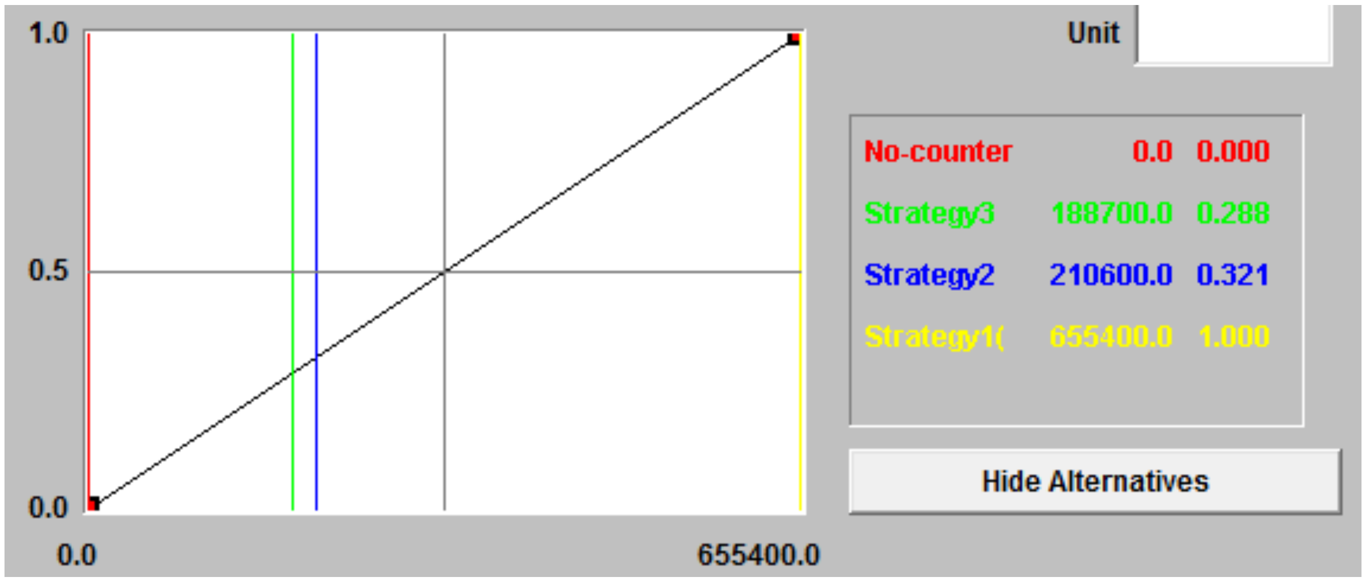
3-3

Comparison on the decontamination strategies with Web-Hipre



Decision by Policy Maker

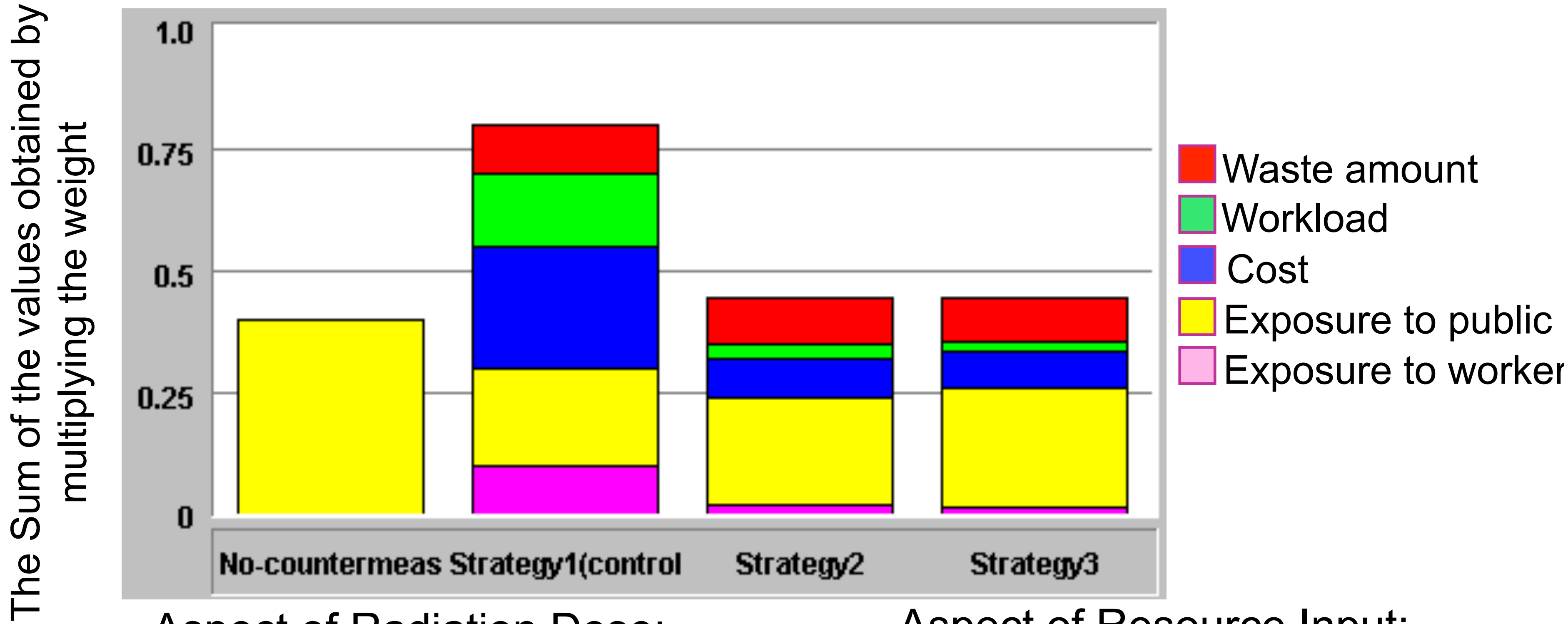
From results of ERMIN with considered weight of factors



Example of cost

3-3

Comparison on the decontamination strategies with Web-Hipre



<u>Aspect of Radiation Dose;</u>
No.1 is the best, but No.2 and 3 show also not much difference

<u>Aspect of Resource Input;</u>
Comparing No 2 and 3, No1 shows twice higher.

➔ No. 2 or 3 are effective plan in the comprehensive manner in this case

Possible to compare the several decontamination strategies from the point of view of radiation dose and resource input based on the on places, methods, and effect of decontamination.