JAEA Activities on Decontamination toward Environmental Restoration of Fukushima

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JAPAN ATOMIC ENERGY AGENCY

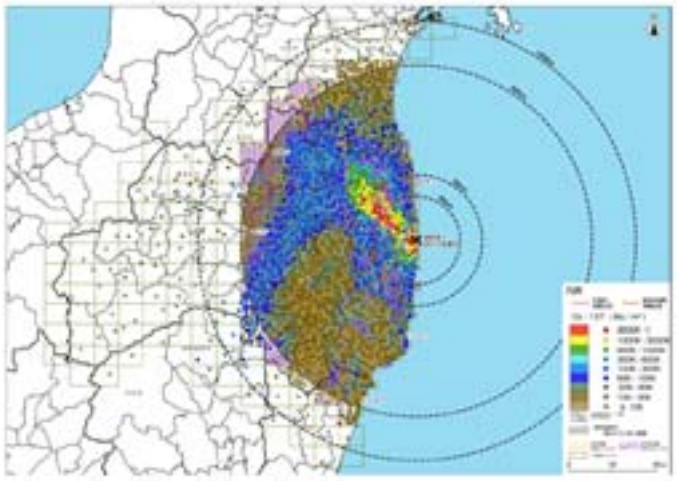
JAEA Activities for Environment Restoration

1. Assessments of Radiological Contamination Situation
   - monitoring and mapping
2. Demonstration of Decontamination Measures
   - schoolyard and swimming pool
   - model projects for residential areas
3. R&D on Environmental Restoration
   - monitoring system using an AUH
   - computer simulation for dose reduction, etc.
4. Communication Activities for Reliable Information

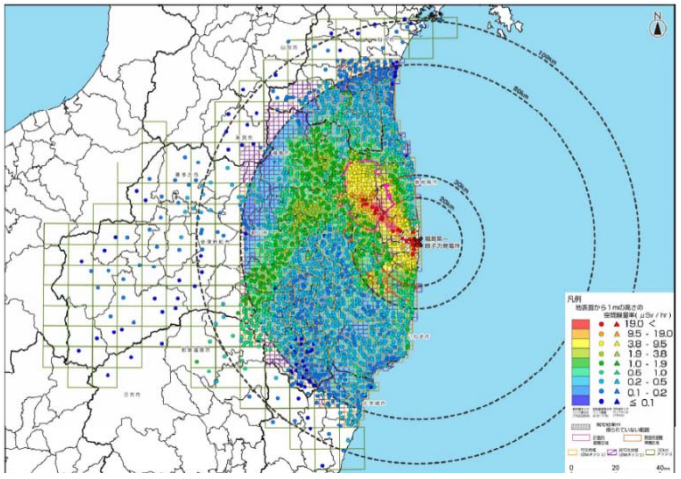
1. ASSESSMENTS OF RADIOLOGICAL CONTAMINATION

Surface survey

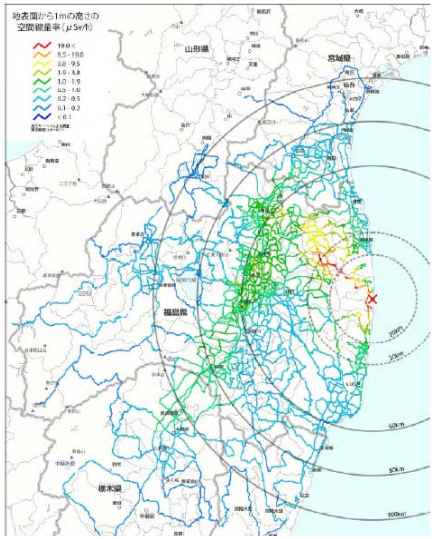
- Detailed measurements and mapping of ground surface deposition distribution of radionuclides
- Wide area radiation dose-rate distribution measurements and mapping using monitoring vehicles
- The results provides the source term for predictive models of future radioactive spread.



Cs-137 deposition distribution map



Dose-rate measurement at each mesh elements

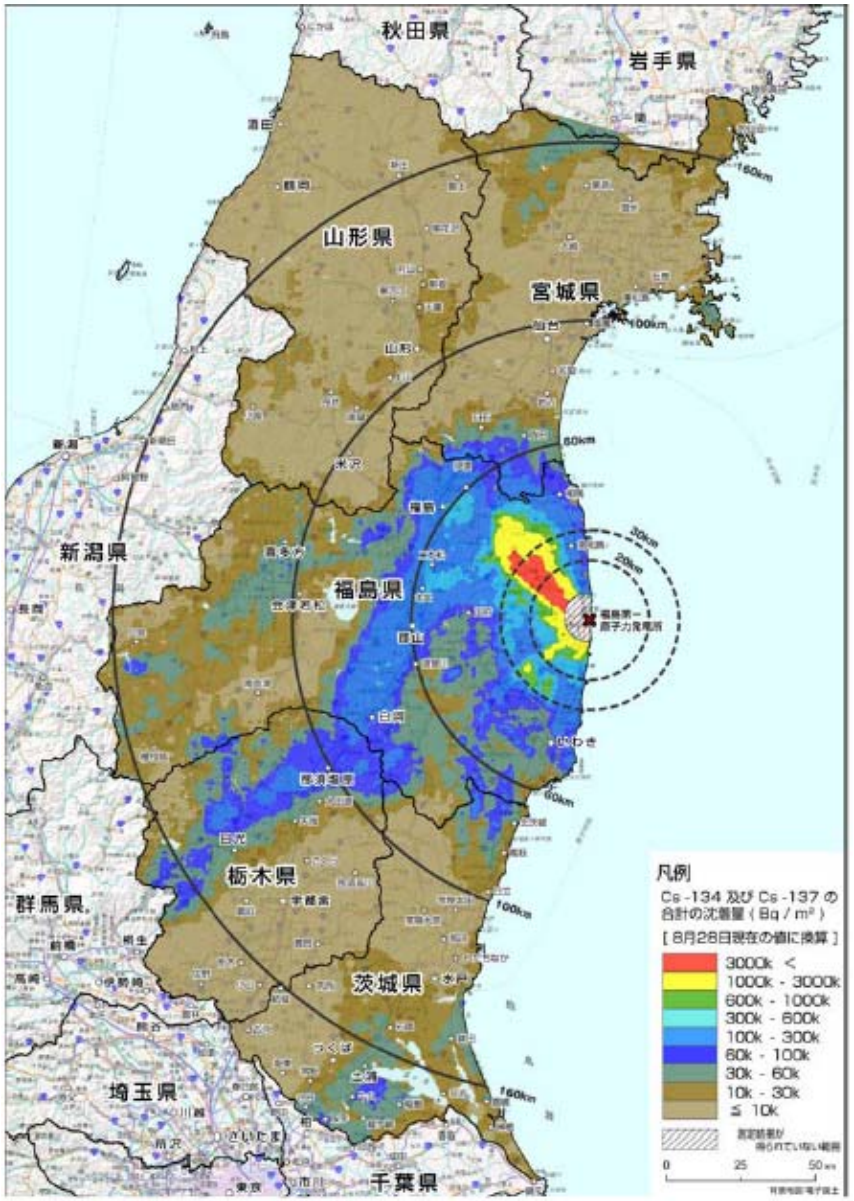


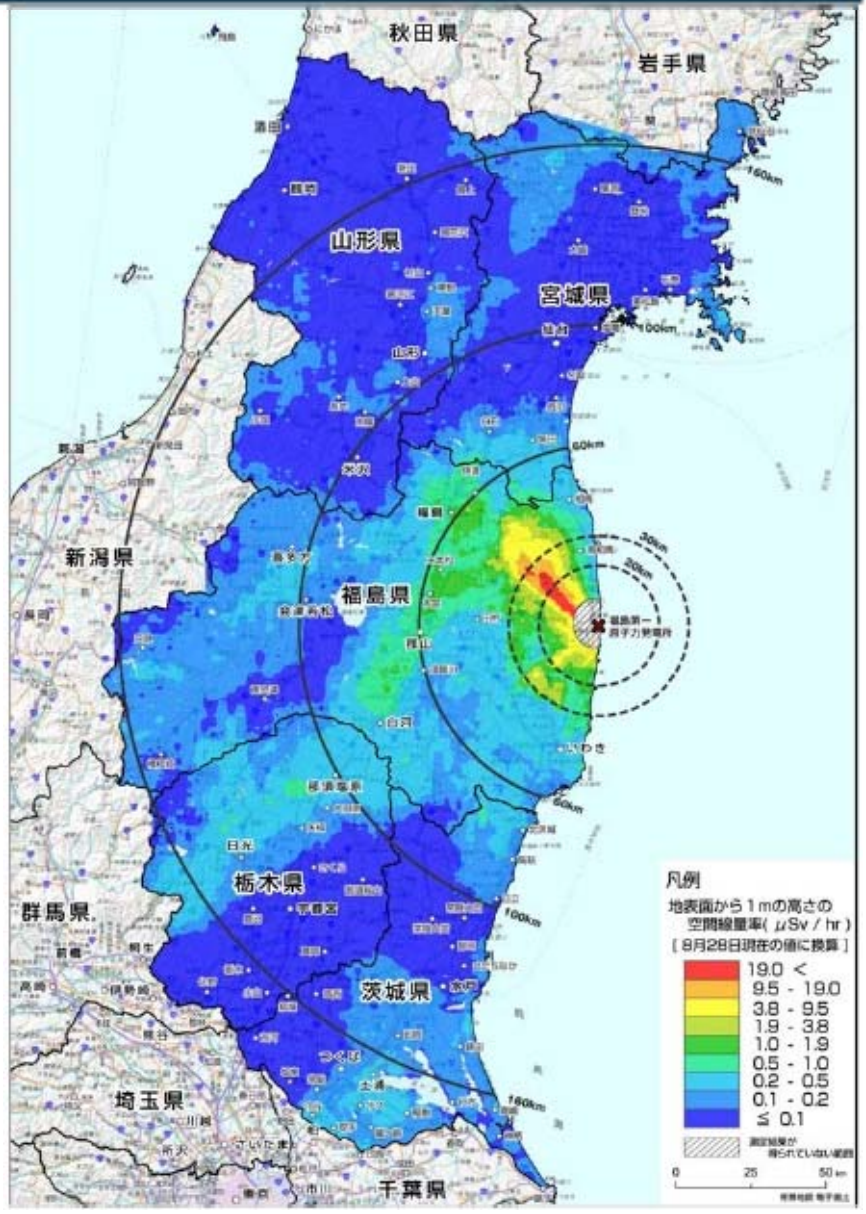
Measurement using survey vehicles

Radiation dose-rate distribution maps

1. ASSESSMENTS OF RADIOLOGICAL CONTAMINATION

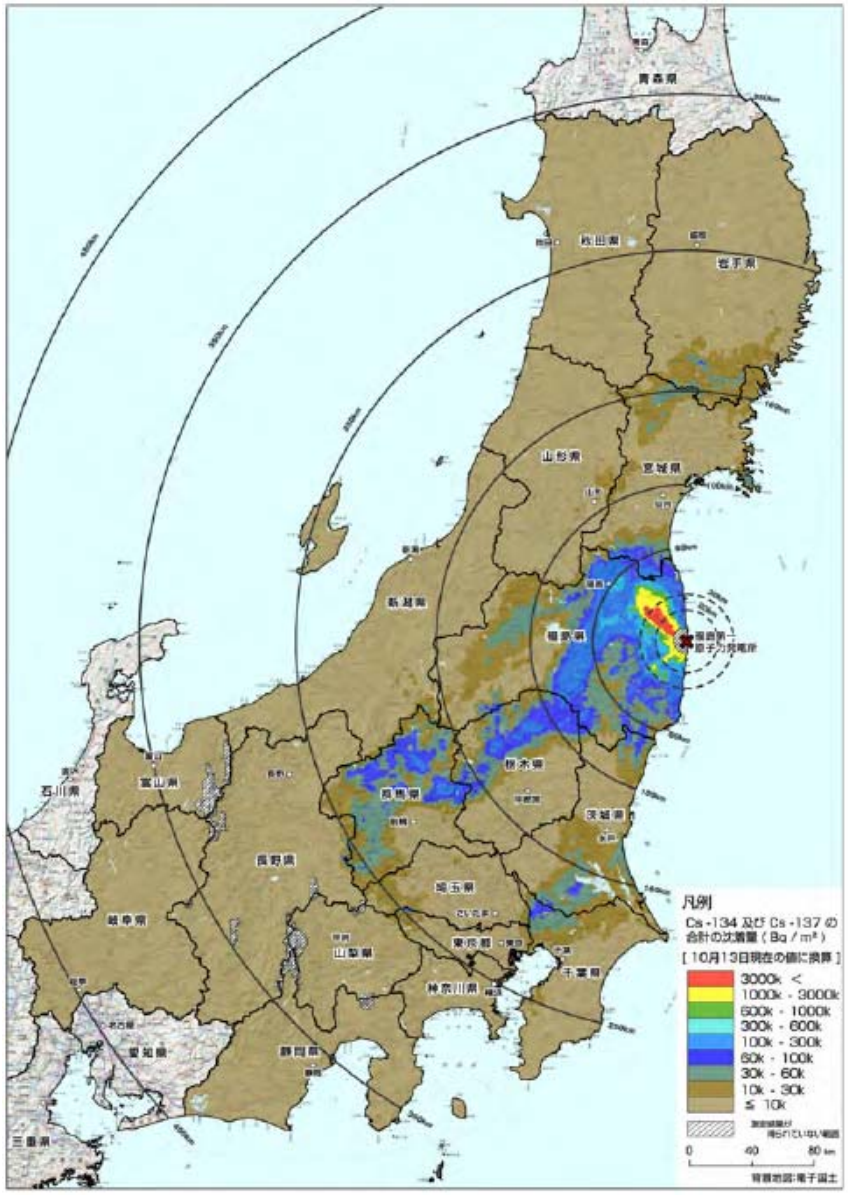
Aircraft radiation monitoring around Fukushima NPP1

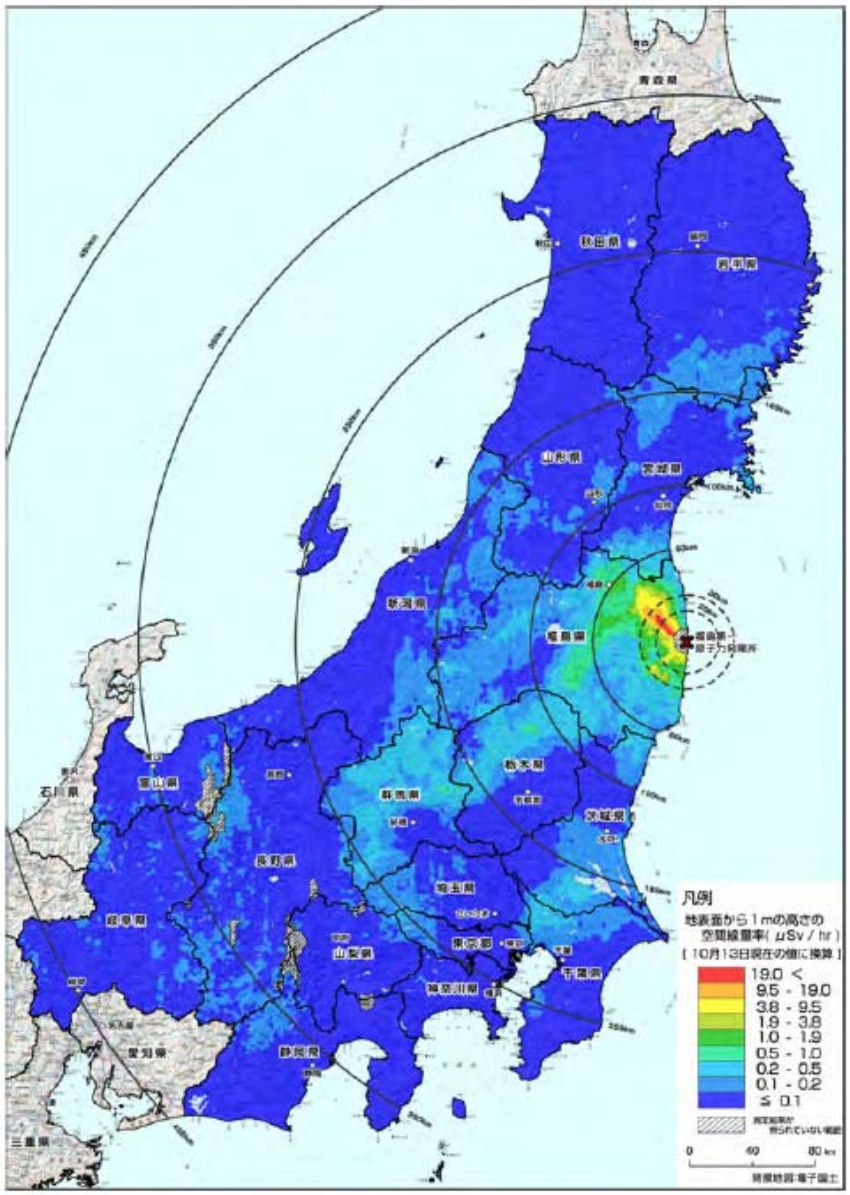




1. ASSESSMENTS OF RADIOLOGICAL CONTAMINATION

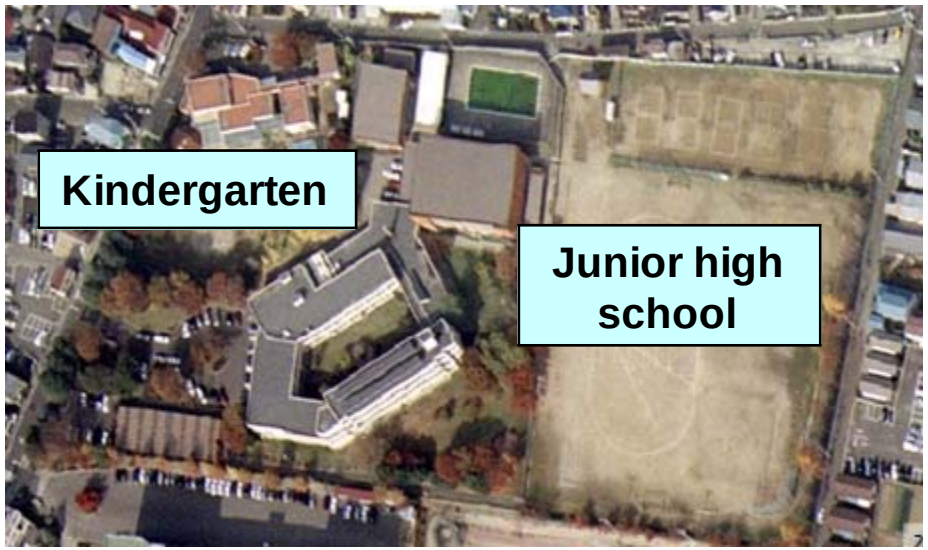
Aircraft radiation monitoring around Fukushima





2. DEMONSTRATION of DECONTAMINATION MEASURES

School and kindergarten playground



◆ First aid: “Decrease the playground dose rate and store the removed soil in-situ.”

◆ JAEA team;
- ✓ performed precise dose rate measurements,
- ✓ identified the cesium intrusion depth, and
- ✓ estimated the safety of underground trench storage of the removed soil. .

◆ Contaminated surface soil of 5-cm thick was removed and put into trenches in a corner of the schoolyard.

◆ Dose rate significantly reduced by factors of 10 to 20;
- ✓ School: (avg.) 2.5 → 0.15 μSv/h at 1 m^H
- ✓ Kindergarten : (avg.) 2.8→ 0.22 μSv/h at 50 cm^H

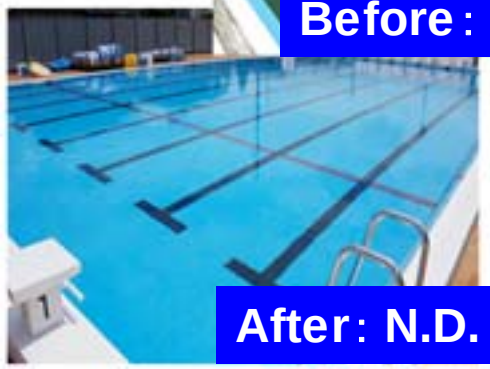
◆ The results underlies the government, MEXT, announcement to apply the remove-and–trench work as a tentative dose reduction to Fukushima schools.

2. DEMONSTRATION of DECONTAMINATION MEASURES

School swimming pool

- Not a few outdoor swimming pools still hold Cs rich water.
- The flocculation method applied for purification of water.
- Radioactive sludge was collected and stored at a temporary storage space.
- User-friendly handbook; “Guide for Decontaminating Swimming Pool at Schools” was published.
- Fostered a trustful relationship with school officials, municipality and residents through dialogue and decontamination works.

Before : Over 200 Bq/L - Cs



After : N.D.

National Fukushima Univ. Junior High School

“Kizuna” (絆: bond) team and JAEA staff for school pool decontamination

2. DEMONSTRATION of DECONTAMINATION MEASURES

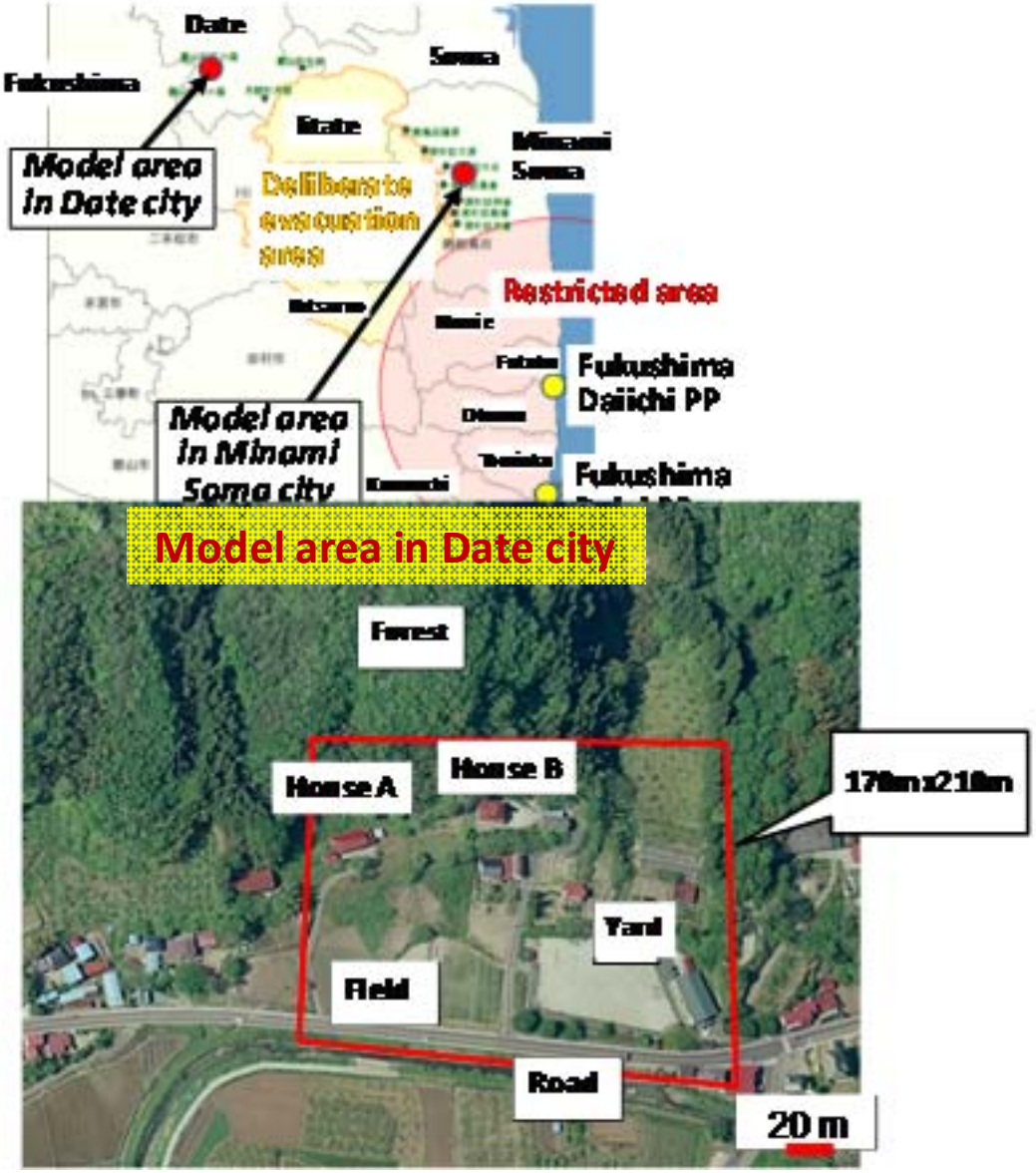
Demonstration of decontamination measures for residential areas

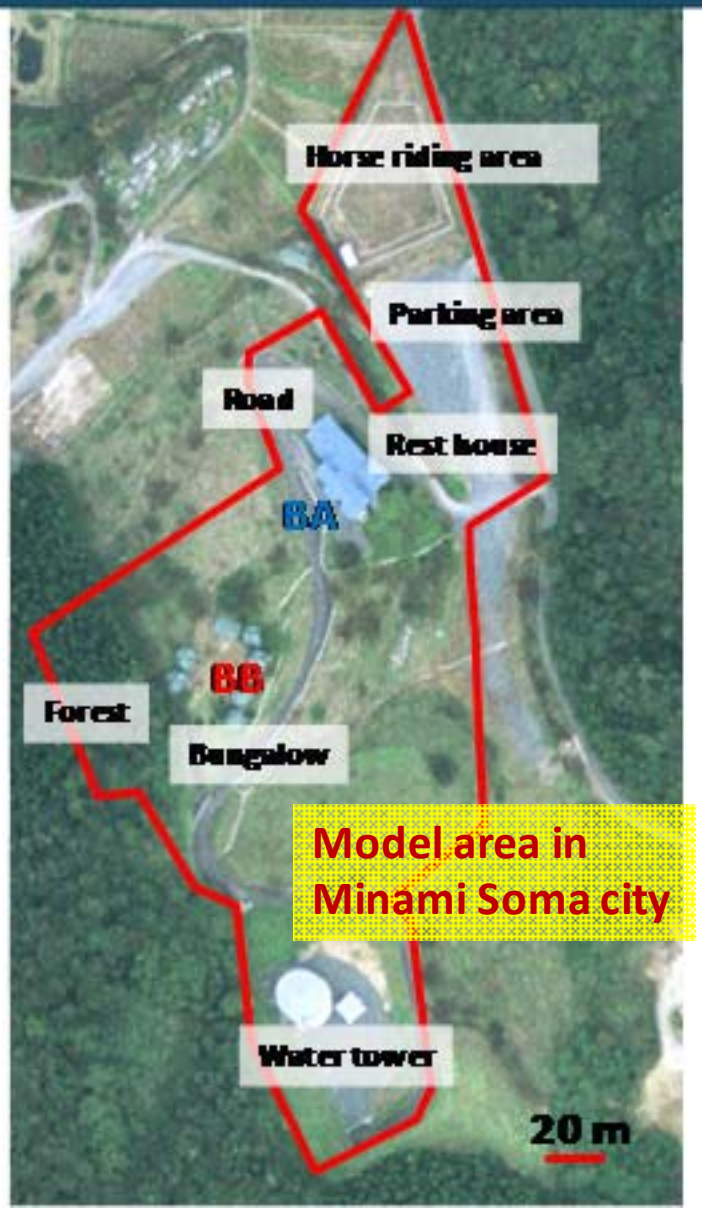
- **Demonstration of Decontamination Technologies;**
  - ✓ review previous experiences,
  - ✓ apply proven/improved/new technologies to the model sites,
  - ✓ evaluate efficiency, cost, generation of waste, safety, and so on.
  - ✓ establish "technologies catalogue"
- **Demonstration of Decontamination Methodology;**
  - ✓ propose brief approach and draft guideline
  - ✓ extract points to be considered during decontamination at model sites
  - ✓ update guideline
- **Demonstrations of decontamination measures at model sites;**
  - ✓ Model area-1: Areas including "Specific Spots recommended for Evacuation" (2 sites)
  - ✓ Model area-2: Areas including "Deliberate Evacuation Area" & "Restricted Area" (12 municipalities)

2. DEMONSTRATION of DECONTAMINATION MEASURES

Demonstration of decontamination at model area-1

- City of Date and City of Minami Soma -



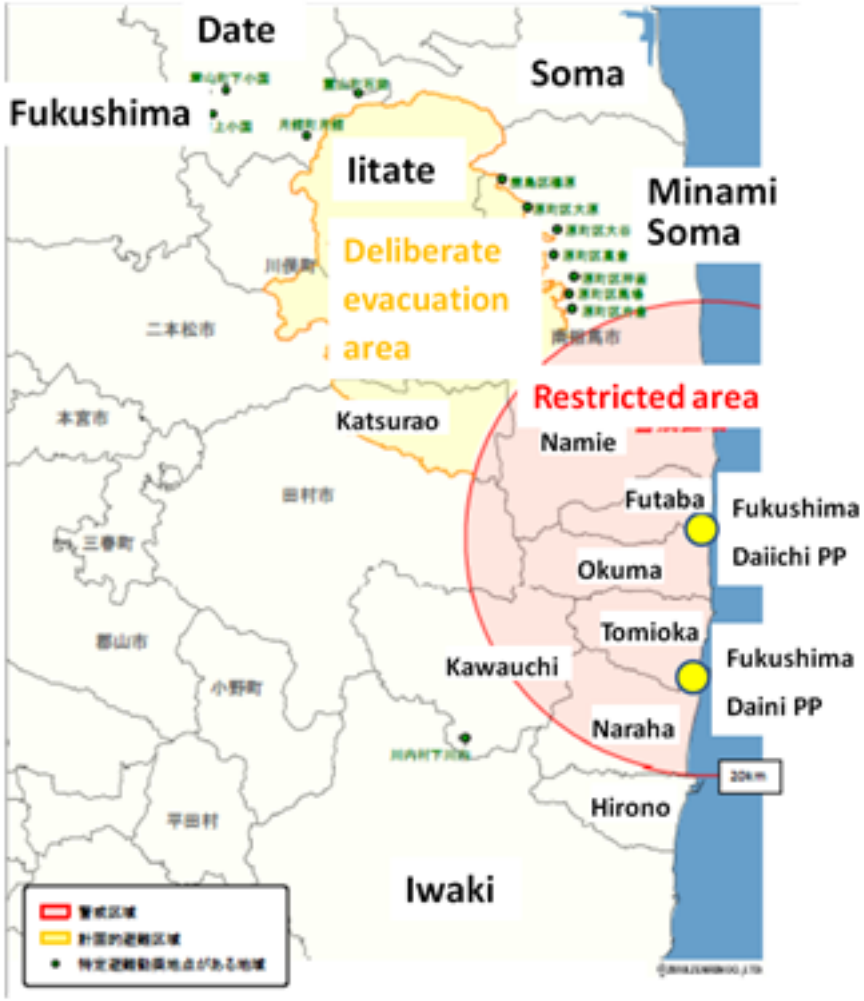


2. DEMONSTRATION of DECONTAMINATION MEASURES

Demonstration of decontamination at model area-2

Demonstration of area decontamination

- Decontamination at model areas in Restricted / Deliberate Evacuation Areas in 12 municipalities
- The areas include;
  - ✓various components to be decontaminated: forests, fields, residences, buildings, roads
  - ✓various dose rate levels; high (> 100 mSv/y), intermediate (20 – 100), and low (5 – 20)
- Evaluation of efficiency, generation of wastes, cost, safety.

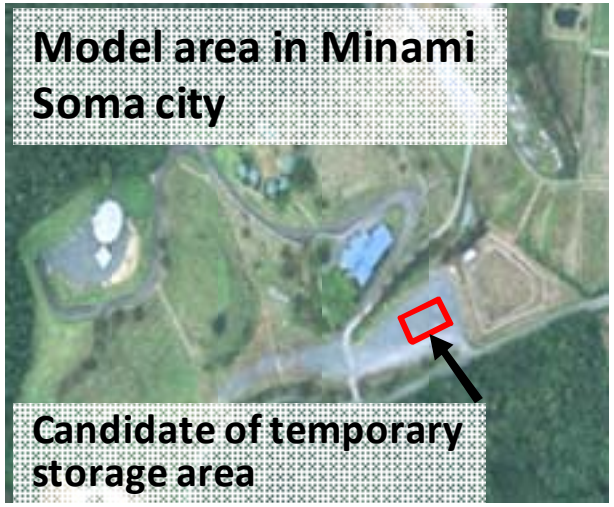


Demonstration of technologies

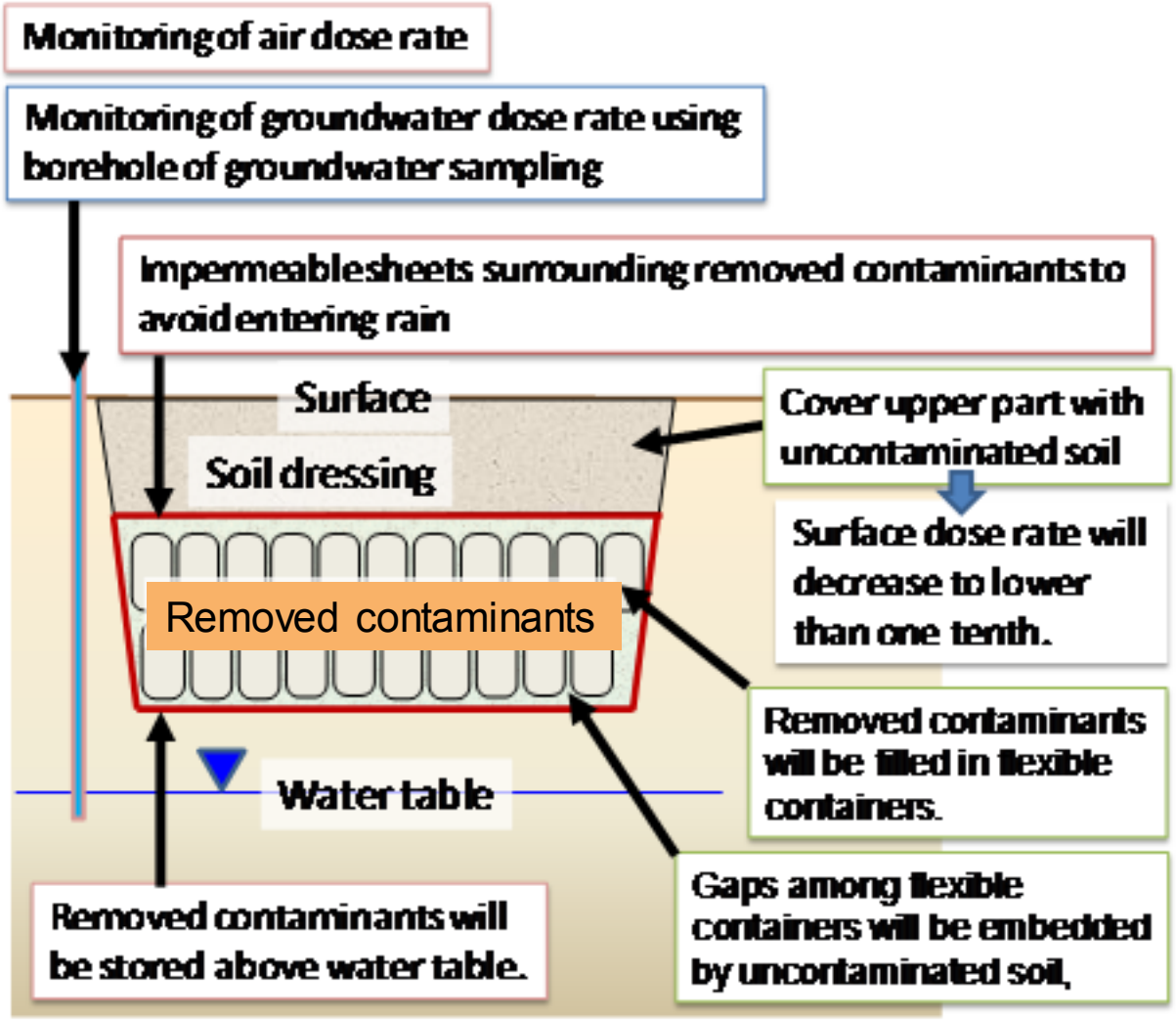
- Competition of improved/innovative decontamination technologies
  - ✓ select 25 feasible and applicable proposals
- Demonstration at the site(s)
- Evaluation of efficiency, generation of wastes, cost, safety.

2. DEMONSTRATION of DECONTAMINATION MEASURES

Temporary storage trench for removed contaminants



Temporary storage methods will be changed depending on radioactivity of removed contaminants and style of land utilization.



3. R&D for ENVIRONMENTAL RESTORATION

Monitoring system using an Autonomous Unmanned Helicopter (AUH)

Monitoring system using AUH


The AUH and the detector (below)

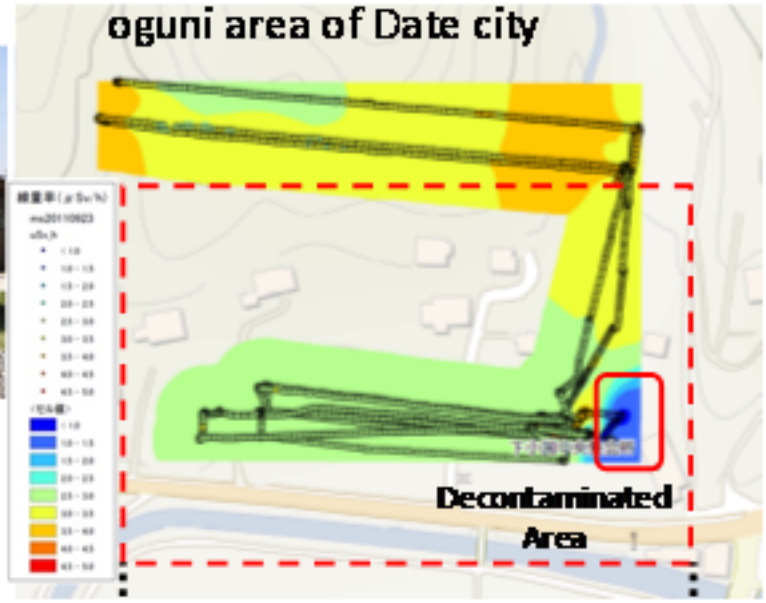

Grand station

Air dose rate (1 m high) can be measured from an altitude of 30 m

Monitoring above rice paddy/forest

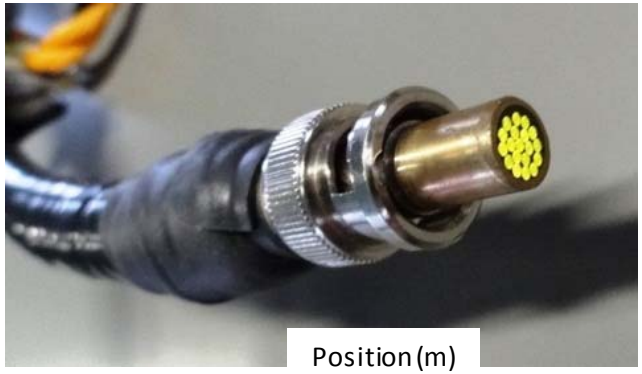
Monitoring above Shimo oguni area of Date city

Monitoring results for Shimo oguni area of Date city

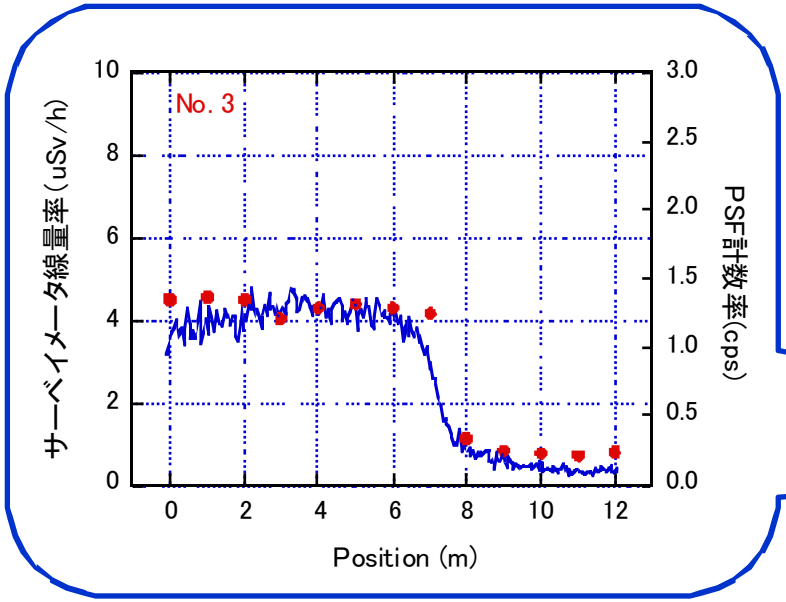


3. R&D on ENVIRONMENTAL RESTORATION

Measurement of radiation distribution by Plastic Scintillation Fibers (PSFs)



- Two-dimensional measurement
- Rolling and contoured surface, due the bendable nature.
- Underwater surface such as brook bed and pond settlement, due to the waterproofness.

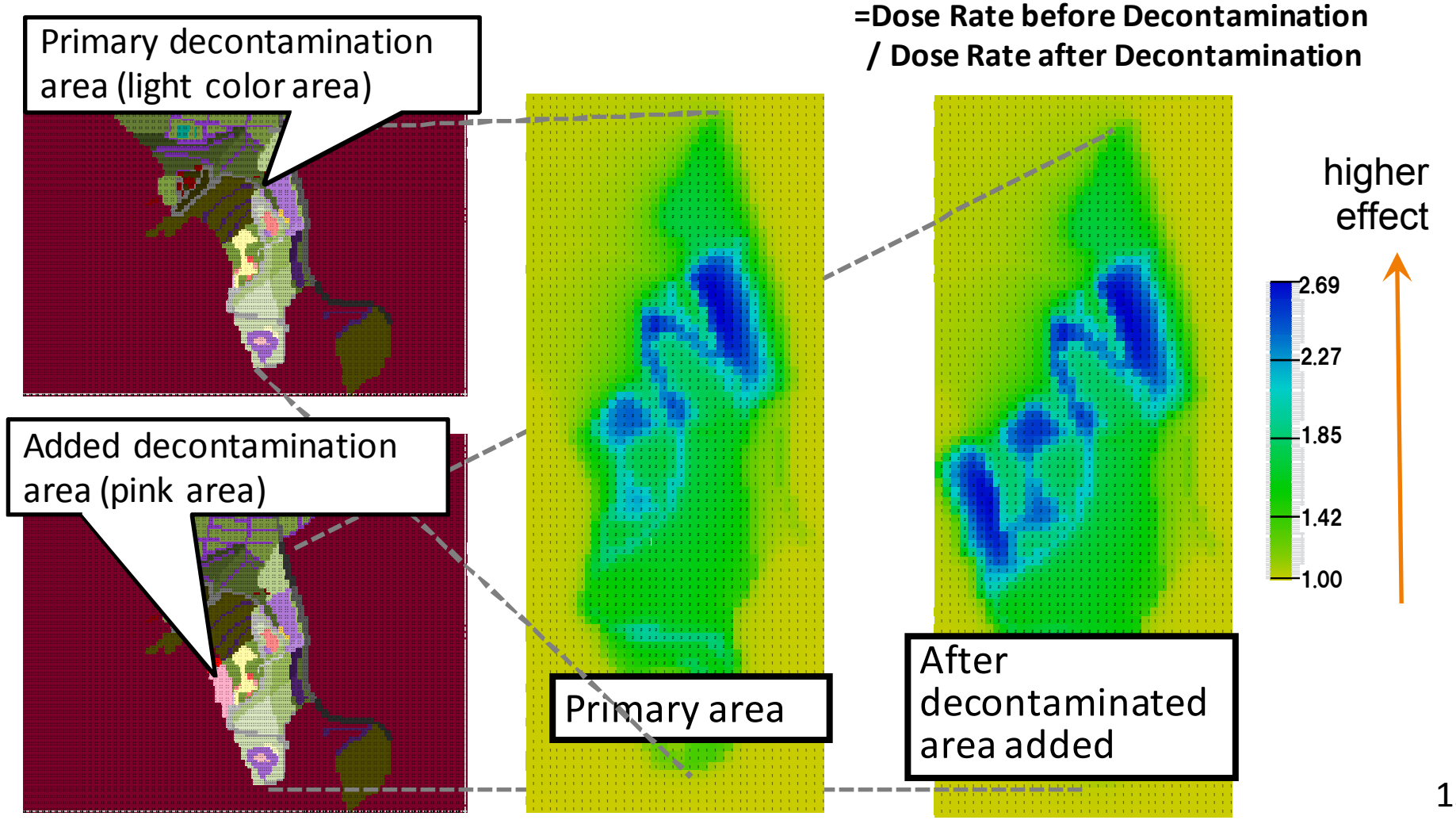


PSFs' data
Survey Meter

Computer Simulation for Dose Reduction

The computer simulation helps planning of decontamination projects by providing information including effective decontamination measures, spatial priority, and waste generation.

Decontamination effect **: Ratio of dose rate**
=Dose Rate before Decontamination
/ Dose Rate after Decontamination



4. COMMUNICATIONS and INSTRUCTIONS

Question-and-answer session on radiation and health

- JAEA technical staff are dispatched to Fukushima prefecture schools (from kindergartens to junior high schools) upon their request
- After briefings on radiation, JAEA staff members talk face-to-face with parents and teachers, answering their questions on radiation and its health effects.
- 132 sessions have been held since July, and a total of 142 sessions are scheduled as of December 4.

Briefing materials

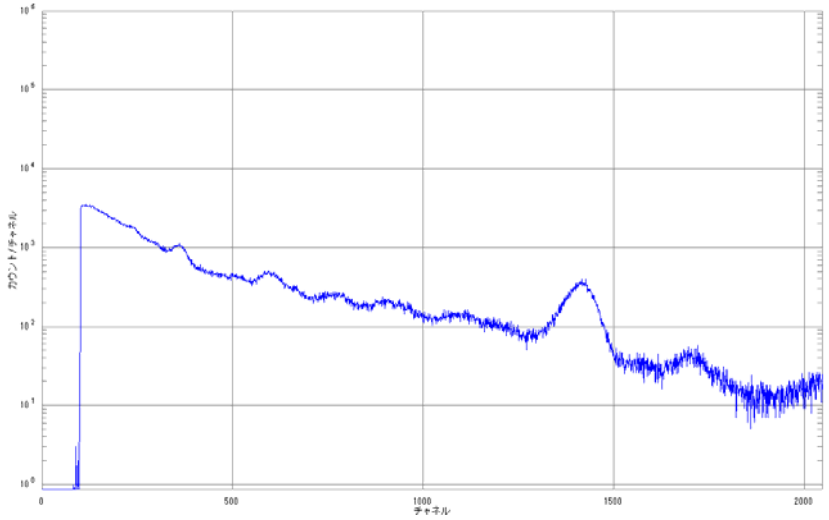
4. COMMUNICATIONS and INSTRUCTIONS

WBC measurement for Fukushima pref. residents

JAEA have measures internal exposure of people within the restricted area and deliberate evacuation area using the Whole Body Counter (WBC) in Tokai Laboratory

- ✓ About 100 persons are measured per day
- ✓ About 7,300 have been measured by last November, and a total of 8,000 persons are scheduled by the end of December, 2011.
- ✓ 15 minute-to-1 hour Q&A after measurement per person is welcomed

Measurement by Whole Body Counter



Energy spectrum measured

4. COMMUNICATIONS and INSTRUCTIONS

Dispatch of supervisors to training sessions on "Certified Decontamination Workers/Operators"

- JAEA dispatches its experts to official training course of decontamination works planned by Fukushima pref., as supervisors to ensuring safety and enhancing the skills of workers and operators engaging in decontamination works.
- Participants completed are certified by the governor of Fukushima.
- 3,000 workers and operators (equivalent to half of constructors in Fukushima) will be anticipated by the end of FY2011.


修 了 証 書

[redacted] 様

あなたは 平成23年度除染業務講習会（第1回）において所定の課程を修了したことを証します

平成24年2月3日

福島県知事 佐藤雄平

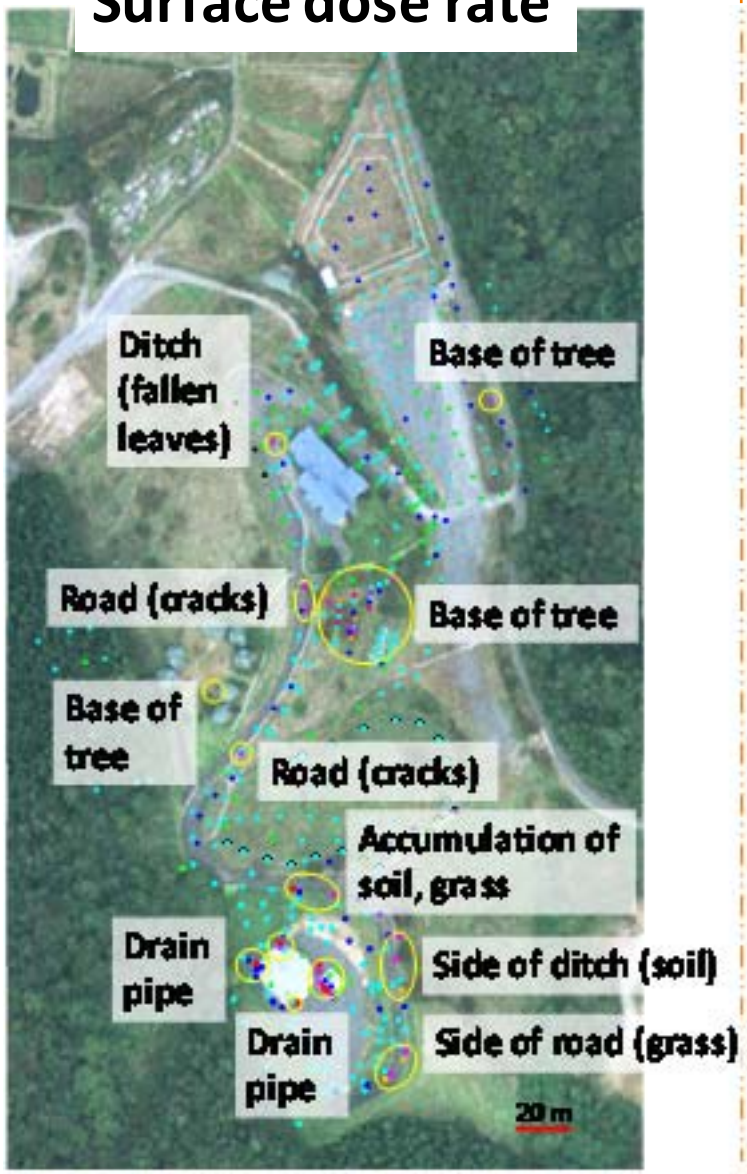
Completion certificate

Curriculum of training session

Day 1	Day 2
Opening	5. Safety management during decontamination works
1. Overview of the accident	
2. Fundamental knowledge on radiation	6. Radiation effects on human health
3. Radiation safety management	7. Demonstration and practice
4. Decontamination method	8. Exam.
	Closing

Radiation survey (whole area to be remediated)

Surface dose rate



Air dose rate [1 m]

Dose rate (μSv/h)
- ~1
- 1~3
- 3~5
- 5~10
- 10~20
- 20~30
- 30~

Model area in Minami Soma city

参考スライド
Reference Slides

Radiation survey (whole area to be remediated)

Surface dose rate

Dose rate (μSv/h)
- ~1
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- 5~10
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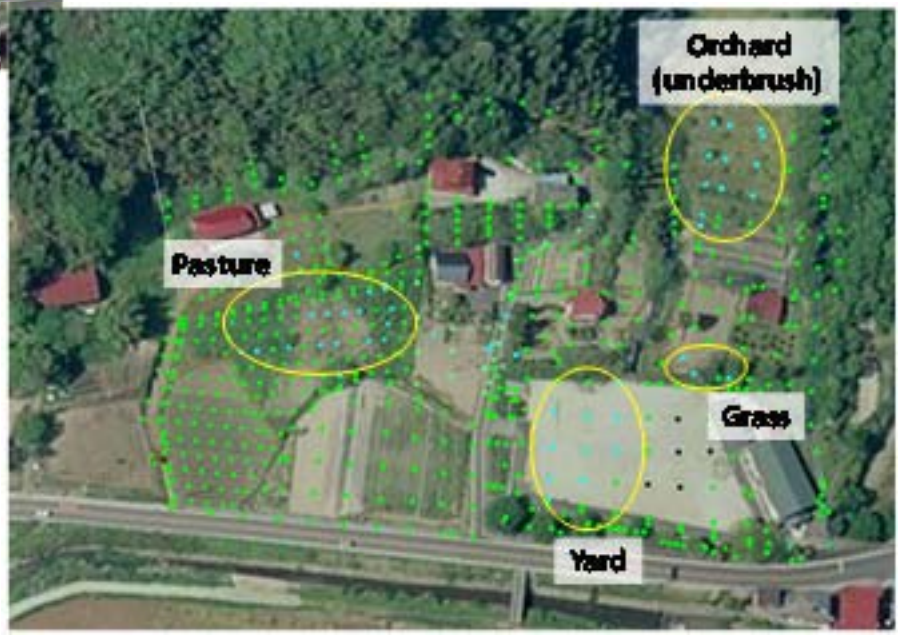
- 30~

Model area in Date city

Air dose rate [1 m]



Overview of approach

Preliminary planning for remediation

- Select demonstration site(s)
- Establish remediation goals and targets
- Estimate remediation sub-areas and inventories of contaminants
- List potentially appropriate remedial tools & methods

Radiation survey before remediation

- Detailed surface dose survey of the entire area
- Radiochemical assessment of relevant samples at appropriate locations
- Simple model assessment of inhabitant exposure

Establish remediation plan

- Integrate planning and site characterization data to develop improved site model
- Assess effectiveness of potential approaches to remediation for sub-areas on the basis of dose reduction, cost and safety
- Evaluate inventory of removed contaminants and interim storage and waste management requirements (conditioning, packaging, transportation, …)
- Rank options and establish remediation plan (time schedule, remediation goals, uncertainty management processes, etc.)
- Workers safety

Apply remedial measures

- Stepwise implementation with monitoring procedures to check effectiveness of all remedial action
- Development of a complete inventory of all resultant materials in interim storage

Evaluate effectiveness of remedial measures

- Radiation survey after remediation, with associated sampling and analysis as required
- Examine remediation effectiveness in terms of radiation dose to critical groups
- Assess waste inventory, conditioning/packaging/transportation effectiveness and management options
- Record experience (including staff feedback)

Review effectiveness & establish Remediation Guidelines

Basic approach to establishing a remediation plan

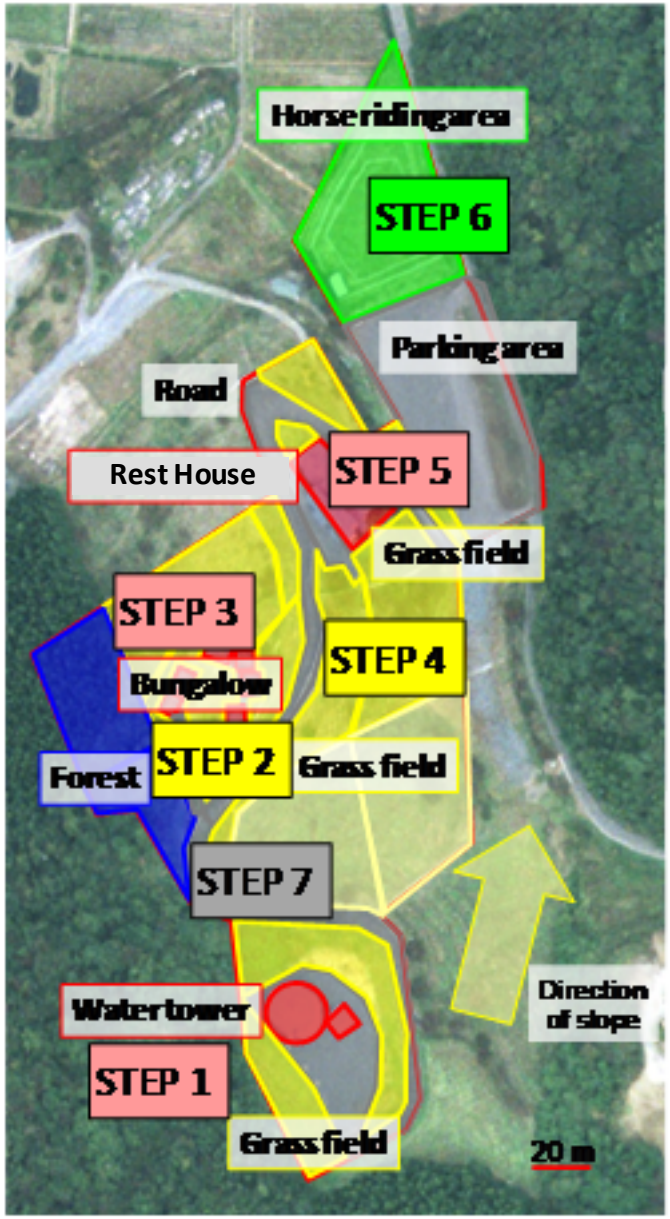
- **Remedial measures**
  - Use well-tried, easy and practical measures
  - Ensure amounts of removed contaminants as low as practically achievable
  - Restrict use of water to the extent possible to avoid secondary contamination
  - Take measures to reduce environmental impact of remediation, if needed

- **Procedures**
  - Optimize remedial actions using a calculation tool to estimate dose rate reduction due to alternative approaches
  - Generally implement remediation from higher to lower ground to reduce the risk of re-contamination
  - An example of remedial actions for different target contaminants; Remediation of forest; restricted to a few meters - tens meters from the edge of the forest
  - In all cases, continuous radiation monitoring during actions to assess effectiveness and develop inventories of resultant waste

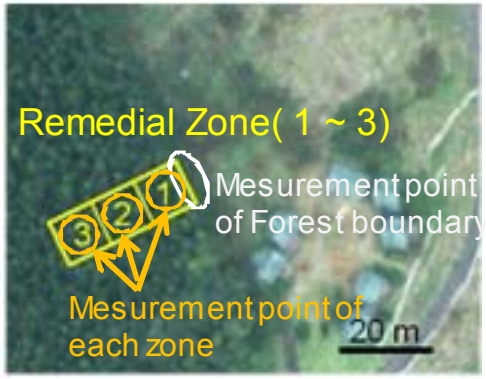
Remediation plan

Model area in Minami Soma city

STEP 1	**Principal remediation methods for water tower** ・Roof and drain pipe: Removal of dust (man power), wash and wipe (man power) ・Field : Removal of fallen leaves and grass (man power), Removal of topsoil and soil dressing/compaction (man power, machine)
STEP 2	**Principal remediation methods for forest and grass field** ・Fallen leaves : Removal of leaves (man power) ・Grass : Removal of grass (man power, machine) ・Tall tree : Trim ・Topsoil : Removal of topsoil (man power, machine), Soil dressing/compaction (machine)
STEP 3	**Principal remediation methods for bungalow** ・Roof and drain pipe : Removal of dust (man power), wash and wipe (man power) ・Field : Removal of fallen leaves and grass (man power), Removal of topsoil and soil dressing (man power, machine)
STEP 4	**Principal remediation methods for grass field** ・Fallen leaves : Removal of leaves (man power) ・Grass : Removal of grass (man power, machine) ・Tall tree : Trim ・Topsoil : Removal of topsoil (man power, machine), Soil dressing/compaction (machine)
STEP 5	**Principal remediation methods for training house** ・Roof and drain pipe : Removal of dust (man power), wash and wipe (man power) ・Field : Removal of fallen leaves and grass (man power), Removal of topsoil and soil dressing (man power, machine)
STEP 6	**Principal remediation methods for horse riding area and parking area** ・Fallen leaves : Removal of leaves (man power) ・Grass : Removal of grass (man power, machine) ・Tall tree : Trim ・Topsoil : Removal of topsoil (man power, machine), Soil dressing/compaction (machine)
STEP 7	**Principal remediation method for roads** - Pave road : blast (machine)



Trial of remedial actions for forest



Bird's-eye view of Trial Area


Before remedial actions


Removal of fallen leaves


Removal of leaf mold


After remedial actions

The trial area is divided into 3 zones. Dimension of the zones are 10m wide and 10m length, respectively.

- Following remedial items were examined in every remedial zone.
  1) weeding, 2) removal of fallen leaves, 3) removal of leaf mold.
- Finally, branches up to 4m height were cut off from the trees on forest boundary.
- Surface (at 1cm height) and ambient (at 1m height) dose rates were measured in the remedial zone and at forest boundary after carrying out every remedial item.

Dose rates after remedial items in each zone (μSv/h)

	Before remediation		remedial items					
			weeding		removal of fallen leaves		removal of leaf mold	
	surface	ambient	surface	ambient	surface	ambient	surface	ambient
Zone 1	3.4	2.5	3.5	2.5	2.8	2.5	1.6	1.8
Zone 2	3.3	2.7	3.2	2.5	2.4	2.3	1.7	1.7
Zone 3	3.1	2.5	3.2	2.4	2.5	2.2	1.6	1.4

After removal of leaf mold, surface and ambient dose rates were decreased 50% and from 30% to 40% lower than the condition before remediation, respectively.

Ambient dose rates at forest boundary after remedial actions of every zone and cutting off branches (μSv/h)

	before remediation	after zone 1	after zone 2	after zone 3	cutting off branches
forest boundary	2.4	2.2	2.3	2.4	2.1

Dose rates were not significantly decreased because of influence of contaminated materials around the trial area