NRA JAPAN
Nuclear Regulation Authority

Radiological Effect on Workers and Residents during Post-accident Recovery Phase Studied by JNES

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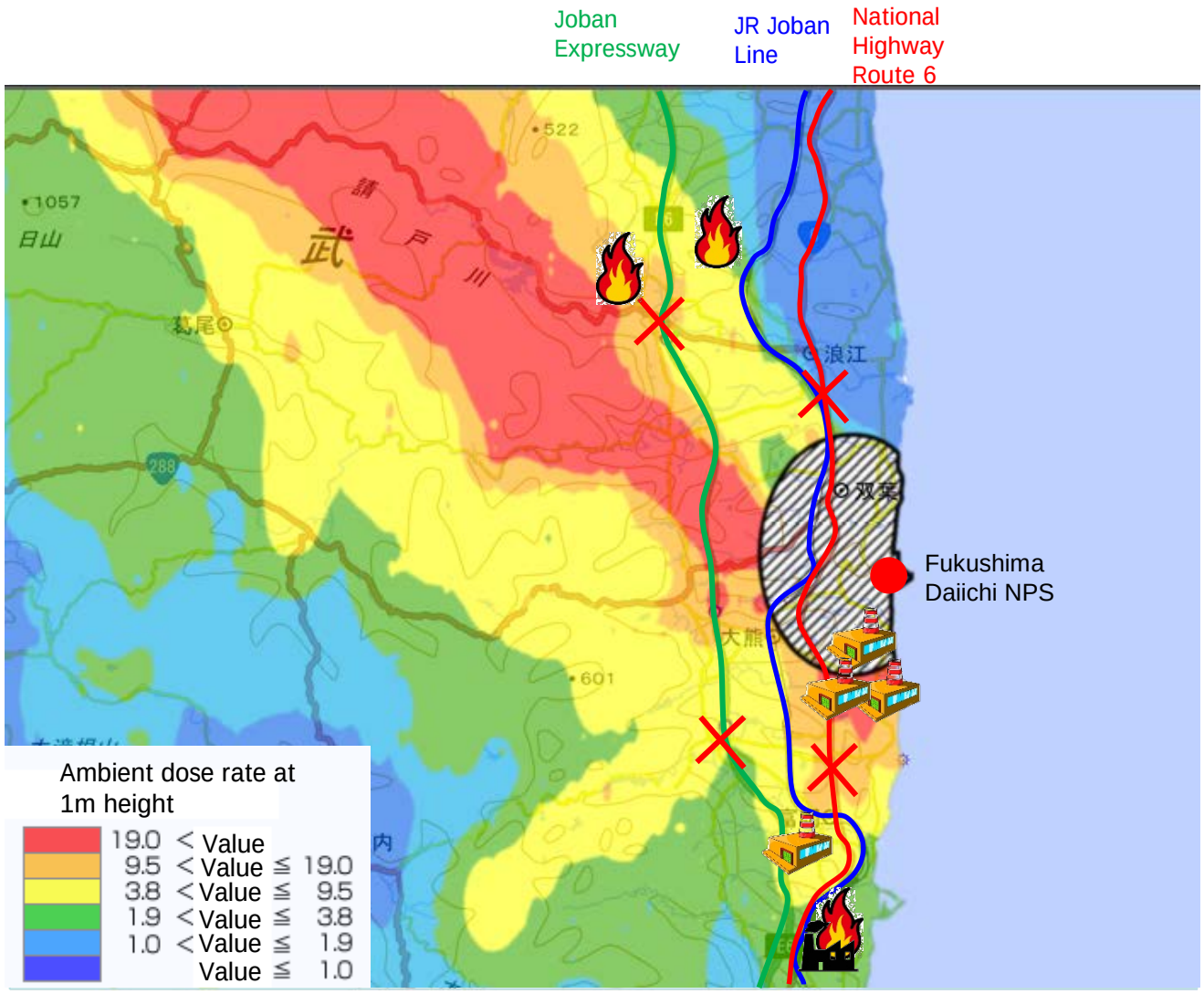
Lessons from Experience , 18-19 February 2020

This presentation is mainly based on the outcome of Japan Nuclear Energy Safety Organization (JNES), which was the former TSO of the NRA.

Background (1/2)



Background (2/2)

- **Restoration and resume operation of infrastructure**
  - Joban Expressway, National Highways, Prefecture roads
  - Railway (JR Joban Line)
  - Chemical plant, gas station etc.
  - Combustible waste incineration facility, sewage treatment facility etc.
- **Other activities**
  - Firefighting
  - Carrying out of hazardous materials (e.g., chemical materials, petrol, gas cylinder) from the evacuation zone,
  - Management of disaster waste (e.g., broken house, appliances, cars)

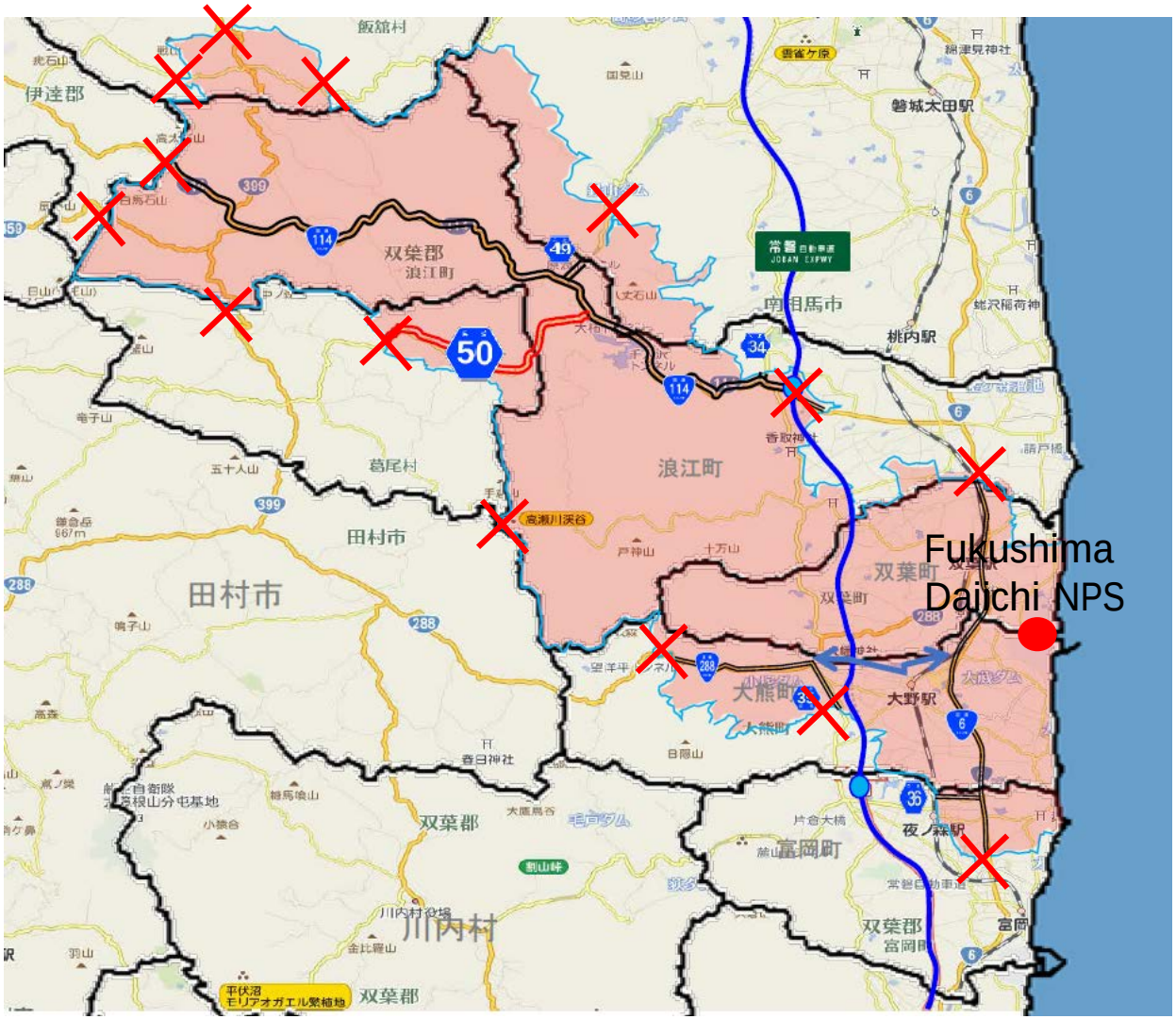
These activities caused **exposure of workers and users**, and potentially, **the secondary dispersion** of radioactive materials. Need to investigate consequences of these activities.

Challenges we faced

- **Unprecedented situation**
  - Difficulties in developing investigation plan
    - Unknown site condition,
    - Limited use of equipment
    - Needed to make a decision onsite,
  - How to avoid oversighting possible contamination?
  - How to prove “no” contamination?
  - How detail is detail enough?

- **Providing “reliable” data to establish confidence**
  - QA, QC, data reproducibility.
  - What is the appropriate level of details on informing the result to public?
  - Ultimately, developing investigation manual for following investigations.

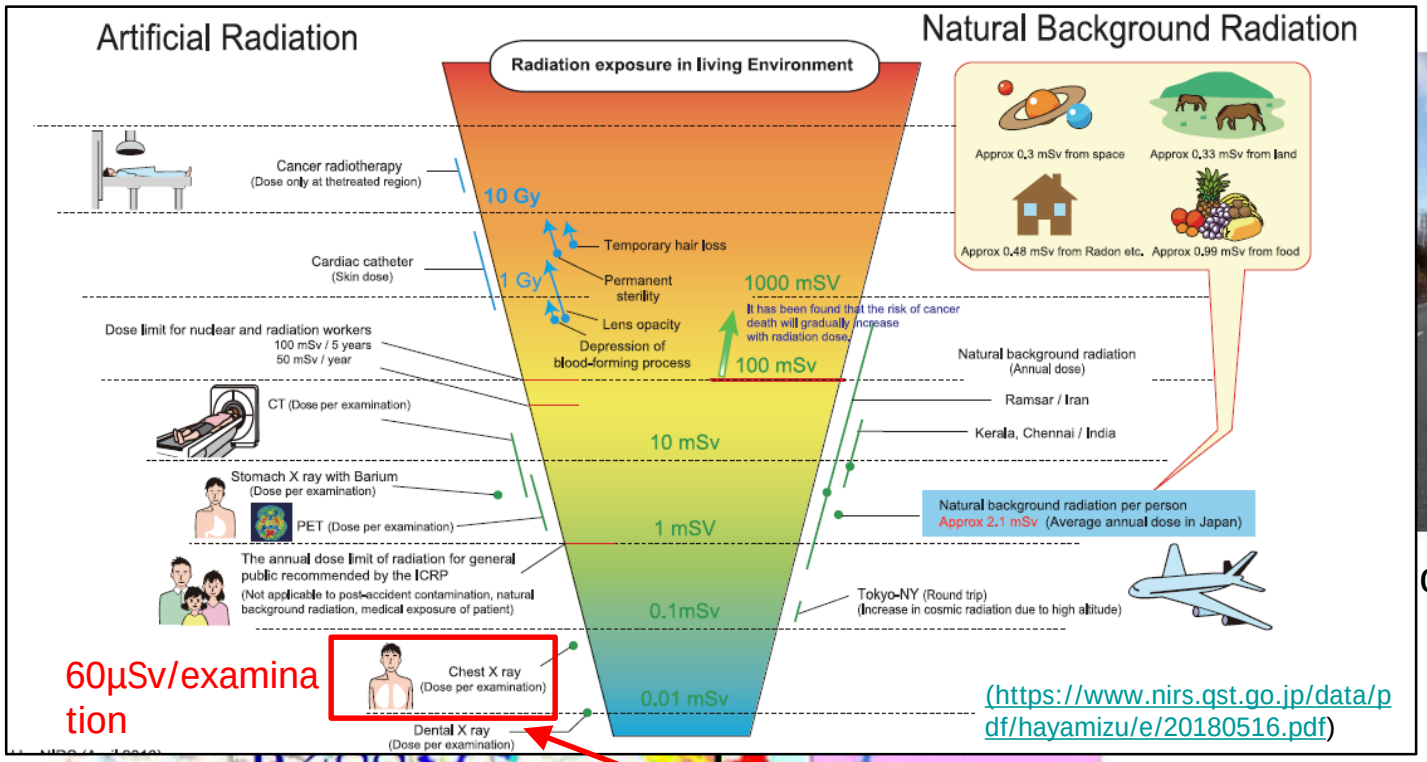
Case 1: National highway etc.



- **Investigation**
  - Survey on contamination status of the road and cars driven in the evacuation zone.
  - Measurement of ambient dose rate.
  - Airborne dust sampling.

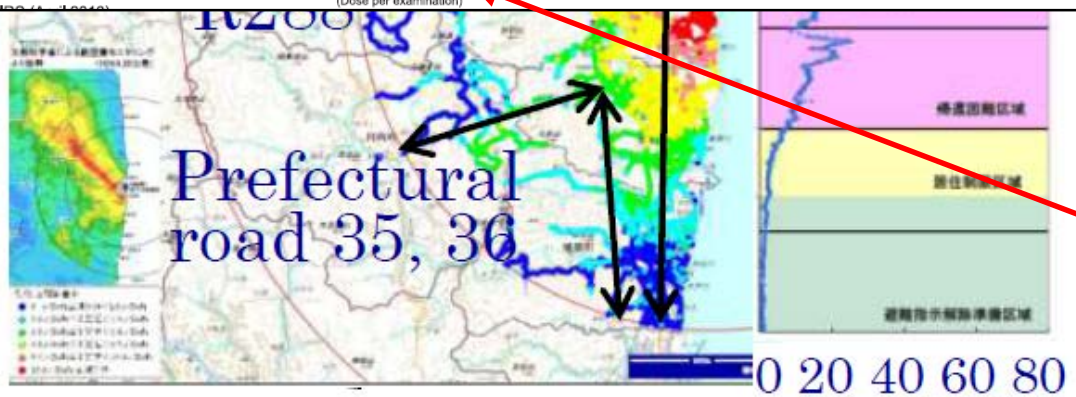
- **Dose assessment**
  - Driver
  - Car mechanics
  - Workers of the tool gate

Case 1: National highway etc.



60μSv/examination

(https://www.nirs.qst.go.jp/data/pdf/hayamizu/e/20180516.pdf)



Ambient dose rate on the National highway route 6 (as of March 2012)

of airborne dust (as of March

Dose of car driver
(as of March 2012).

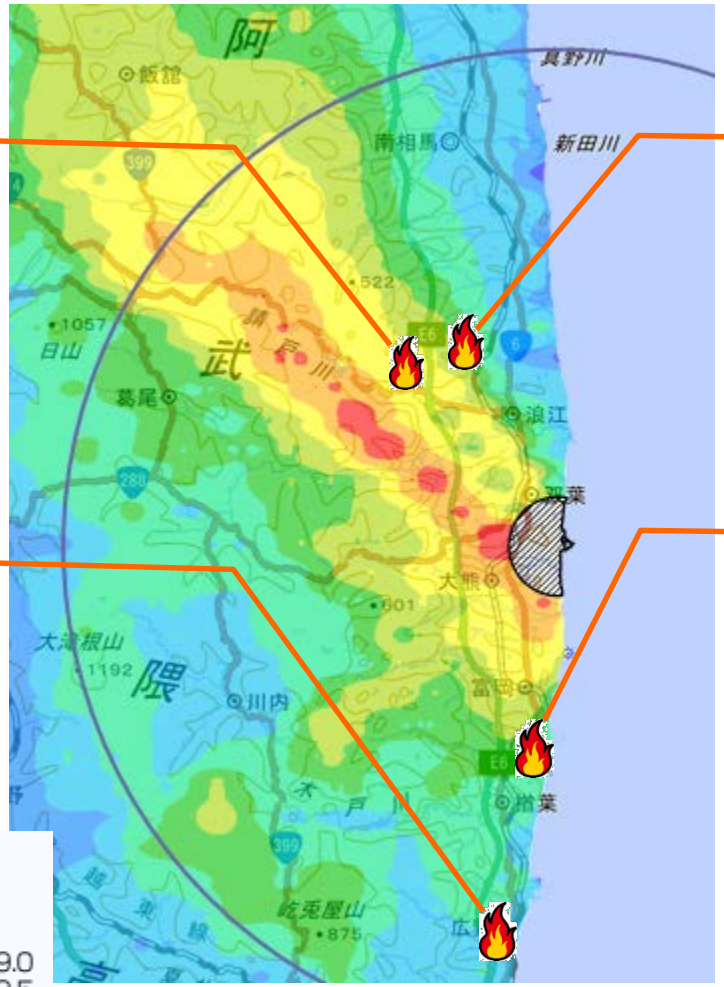
Type	Dose(μSv/ 1 travel)
External exposure	6.0×10^{0}
Internal exposure	8.0×10^{-3}
Total	6.0×10^{0}

(More information: JNES-RE-2012-0002)

Case 2: Consequence of wildfire

Field type : Graveyard, field and field fallow
Ambient dose rate : 3.8～9.5μSv/h*)
Fire scale : about 4ha
Fire duration : about 2hours

Field type :Forest and field fallow
Ambient dose rate : 0.2～0.5μSv/h*)
Fire scale : about 8ha
Fire duration : 16hours



Ambient dose rate at 1m height

19.0 < Value	
9.5 < Value ≦	19.0
3.8 < Value ≦	9.5
1.9 < Value ≦	3.8
1.0 < Value ≦	1.9
Value ≦	1.0

Ambient dose rate as of December 2012

Field type : Forest
Ambient dose rate : 1.0～1.9μSv/h*)
Fire scale : about 0.08ha
Fire duration : about 3hours

Field type : Slope of grassland
Ambient dose rate : 1.0～1.9μSv/h*)
Fire scale : about 0.05ha
Fire duration : about 1hour

Case 2: Consequence of wildfire

Field investigation of wildfire occurred within 30km from the Fukushima Daiichi NPS

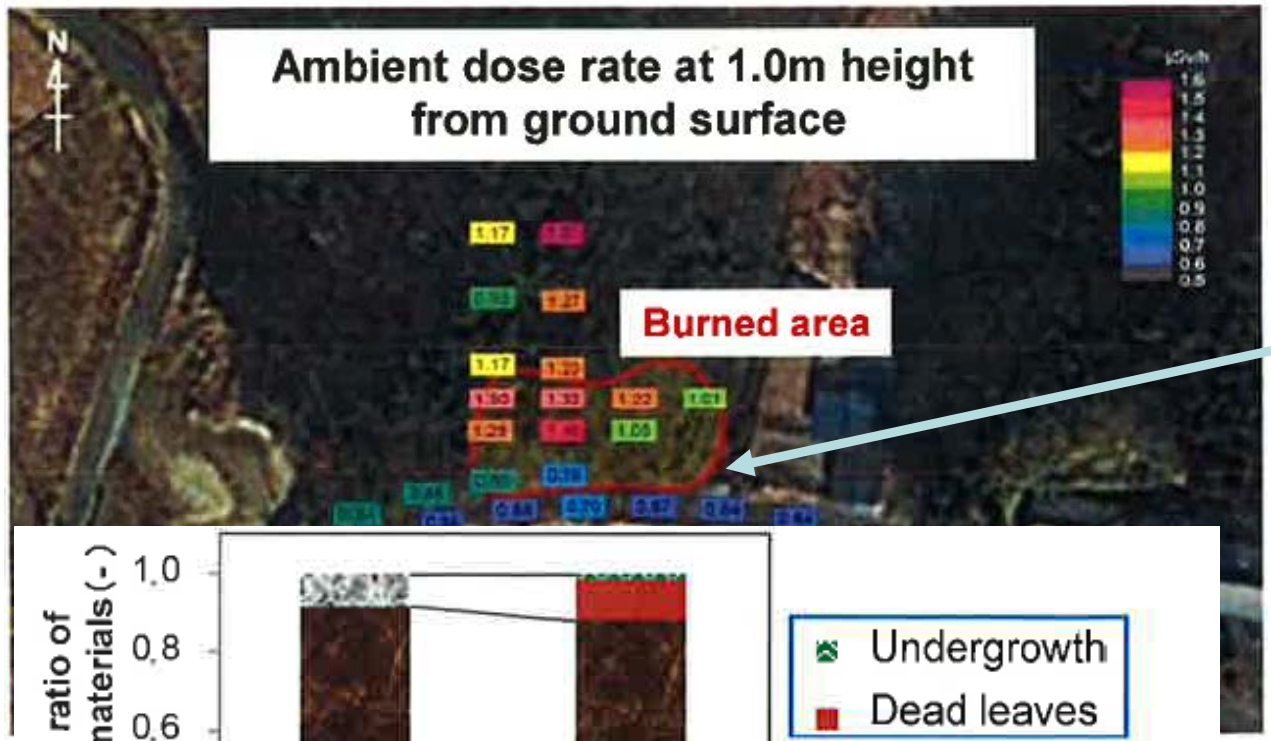
Dose of firefighters and crew members of a helicopter during firefighting operation

Investigation of potentially contaminated water source (e.g., lake, fire cistern)

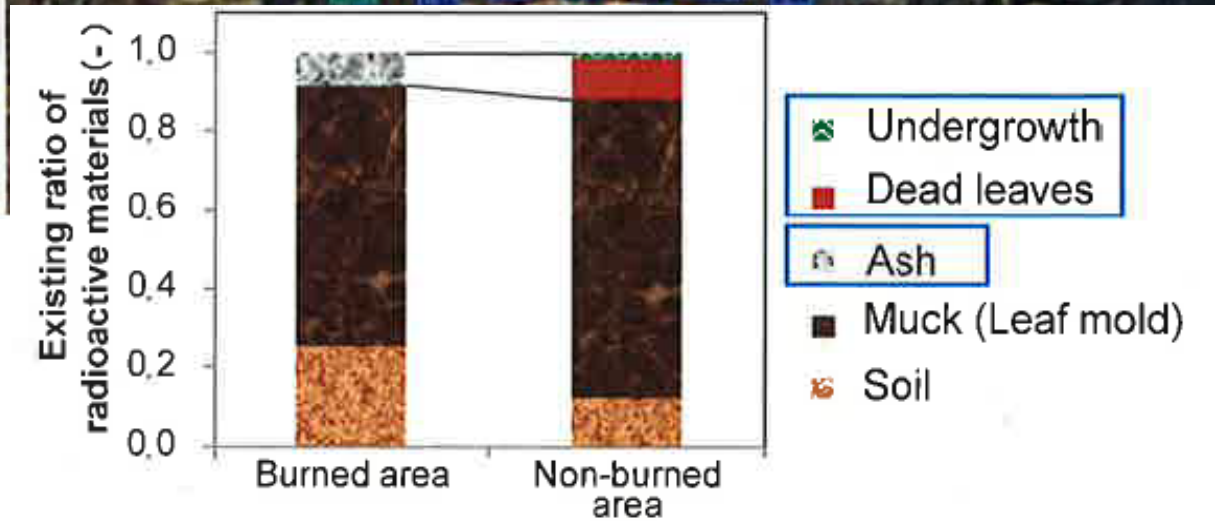
Development of MS Excel based tool on quick estimation of dose

Case 2: Consequence of wildfire

Wildfire occurred in Namie Town on May 2013



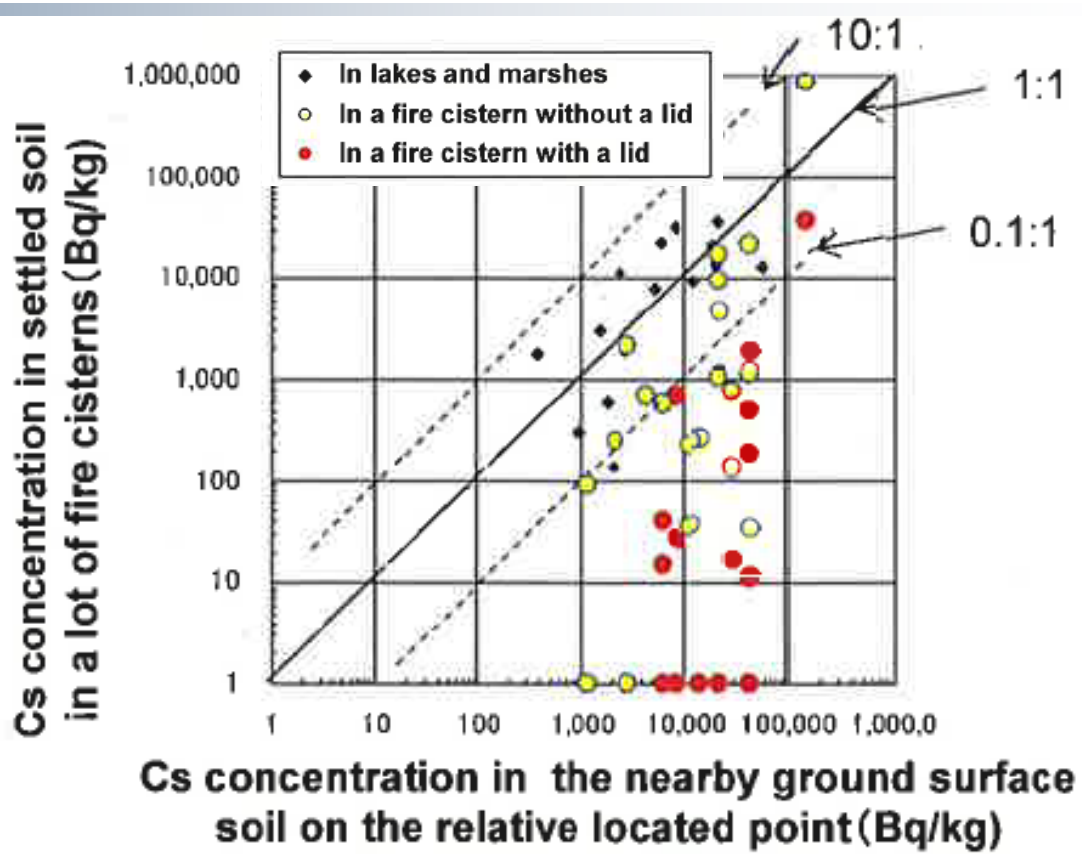
Fire scale: 0.08ha
Fire duration: 3 hours
Type: Surface fire



Abundance ratio of radionuclide

- No significant change in ambient dose rate between fire affected area and the other area
- The ratio of radioactive nuclides in ash is comparable that of undergrowth and dead leaves corrected from non burned area

Case 2: Consequence of wildfire



Cs concentration of soil collected within and outside of water source

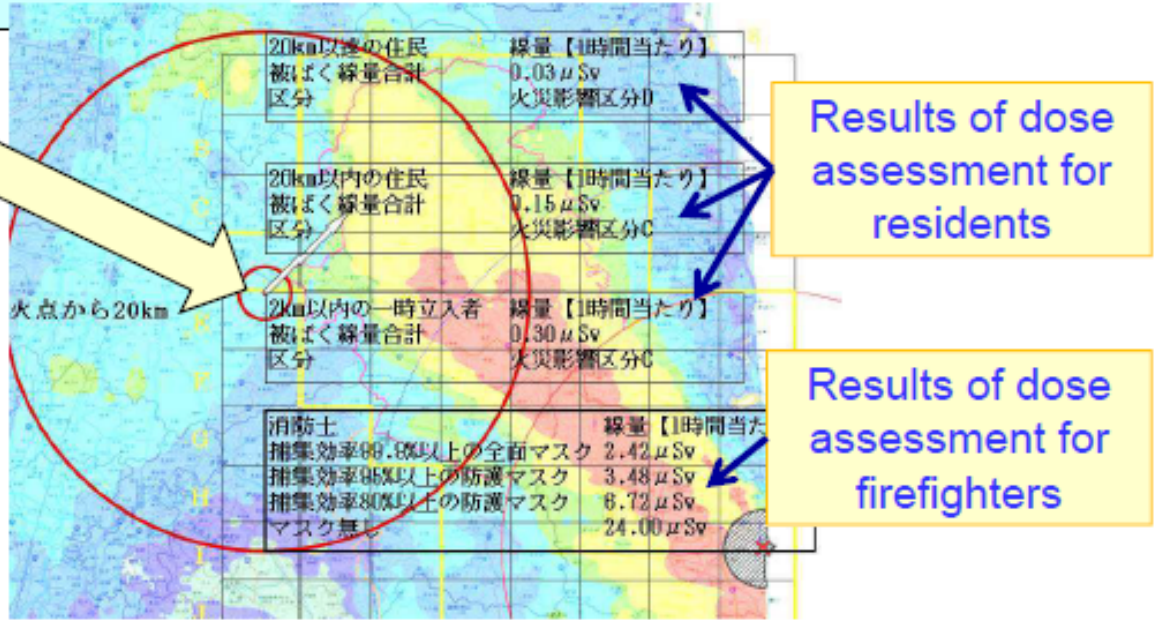
- Lakes and marshes: Cs concentration of settled soil is comparable with that of grand surface soil.
- Fire cistern: the concentration was lower than that of grand soil, especially, when the cistern had a lid.

Case 2: Consequence of wildfire

[Input Data]

Fire duration	西暦 2011 年 11 月 5 日 12 時 0 分	
	西暦 2011 年 11 月 5 日 18 時 0 分	
Position of fire	住所	
	東経 140.60	度
	北緯 37.60	度
Cs concentration	0.3~0.6MBq/m2 (水色)	
Land use	◉森林 ○森林以外	
Terrain	○山間部◉山間部以外	
Fire scale	0.5~1ha	
Wind direction	南西	
Wind velocity	1~2m	
Temperature	25	℃
Humidity	70	%
Weather	薄曇り	

[Output Data]



Background：distribution of Cs concentration

- MS Excel based tool.
- Easy and quick estimation of dose of firefighters.
- Dose can be calculated by conservative assumption even if the full-set of data is not available.

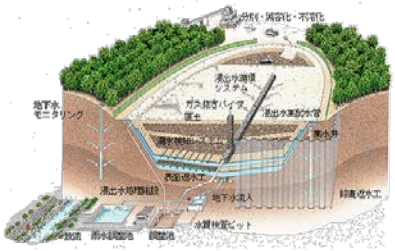
This tool had distributed to firefighting office in Fukushima Prefecture.

(More information: JNES-RE-2011-0004)

Case 3: Hazardous materials

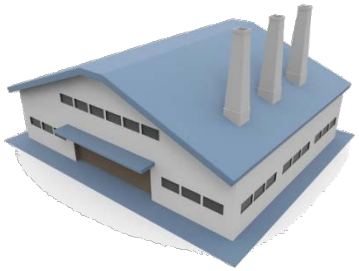
Evacuation zone

13,000 cpm



disposal

8,000 Bq/kg



treatment

0.3 μSv/h at surface (voluntary industry criteria)

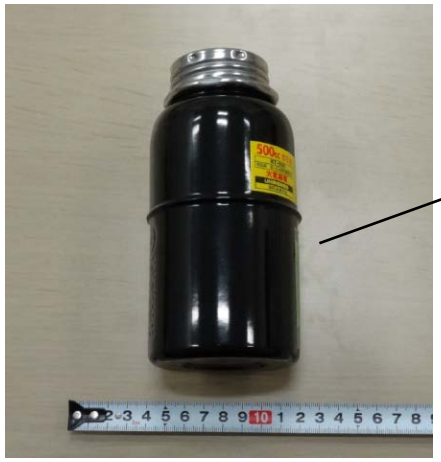
Case 3: Hazardous materials

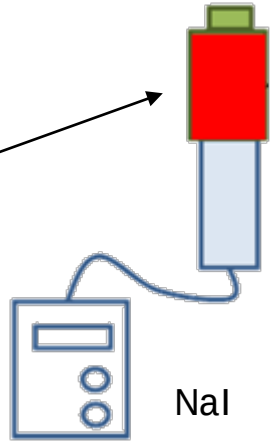
- **How to measure hazardous materials?**
  - flammable
  - explosive
  - corrosive
  - toxic etc.
- **Needed to judge on-site.**
- **Various storage situation.**

QAD-CGGP2R

0.023 μSv/h（ρ=0.78g/ml）
0.028 μSv/h（ρ=1.00g/ml）

<0.3 μSv/h





Case 3: Hazardous materials

Reduction of BG

(More information: JNES-RE-2013-9042)

Summary (1/2)

- **We had tackled unprecedented challenges on dose investigation related to remediation and restoration activities inside and outside of the evacuation zone.**
- **Dose assessment based on 'reliable' data is the key information for decision making and communication with workers and users in different phase.**

Phase	Contamination investigation	Dose assessment

Planning phase	• Decision making for taking action;
	  • decontamination
	  • restoration
	  • carry out
	• Basis for dose assessment
		• Decision making for taking action
		• Development of restoration plan
		• Communication with workers

Action phase		• Risk management (firefighter)
After restoration	• Basis for dose assessment	• Decision making for resume operation • Communication with users (public) and workers

Summary (2/2)

- **Lessons from our experience and developed methodology/tool will be beneficial for preparedness for post-accident recovery process.**

  - **Methodology**
    - **Investigation manuals on:**
      - ✓ **Road**
      - ✓ **Hazardous material**
    - **Communication plan with users (public)**

  - **Tools**
    - **Dose assessment of firefighters**
    - **Dose assessment of car drivers**

References

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