Caesium Workshop: Fukushima recovery - understanding, modeling and managing radiocaesium decontamination,
CORASSE Fukushima, Japan, September 30th - October 3rd, 2013, Organized by JAEA in cooperation with SUERC with support by Obayashi/MCM)
Session 2: Fundamental approaches toward development of radiocaesium removal methods from soil and other related materials, waste reduction and management optimization Strategy of waste reduction
2013 Oct. 1st Tue. 13:00 - 13:40
Theme: "Strategy of waste reduction"

Management of Radioactive Cesium Contaminated Wastes and Significance of the Volume Reduction after the Decontamination

- Practical Approach to Wet Classification as an relevant experience -

Kenichi ITO[1] ([1]University of Miyazaki)

Issues

- 1. Basic schema of decontamination and its management forward disposal
  -Determinate matters and indeterminate matters-
- 2. Feasible methods of volume reduction
  -Applicability of volume reduction techniques from existing civil engineering techniques by way of the wet classification used on heavy metals contaminated soil, for example-
- 3. Scientific Evidence for the Secure Social Implementation

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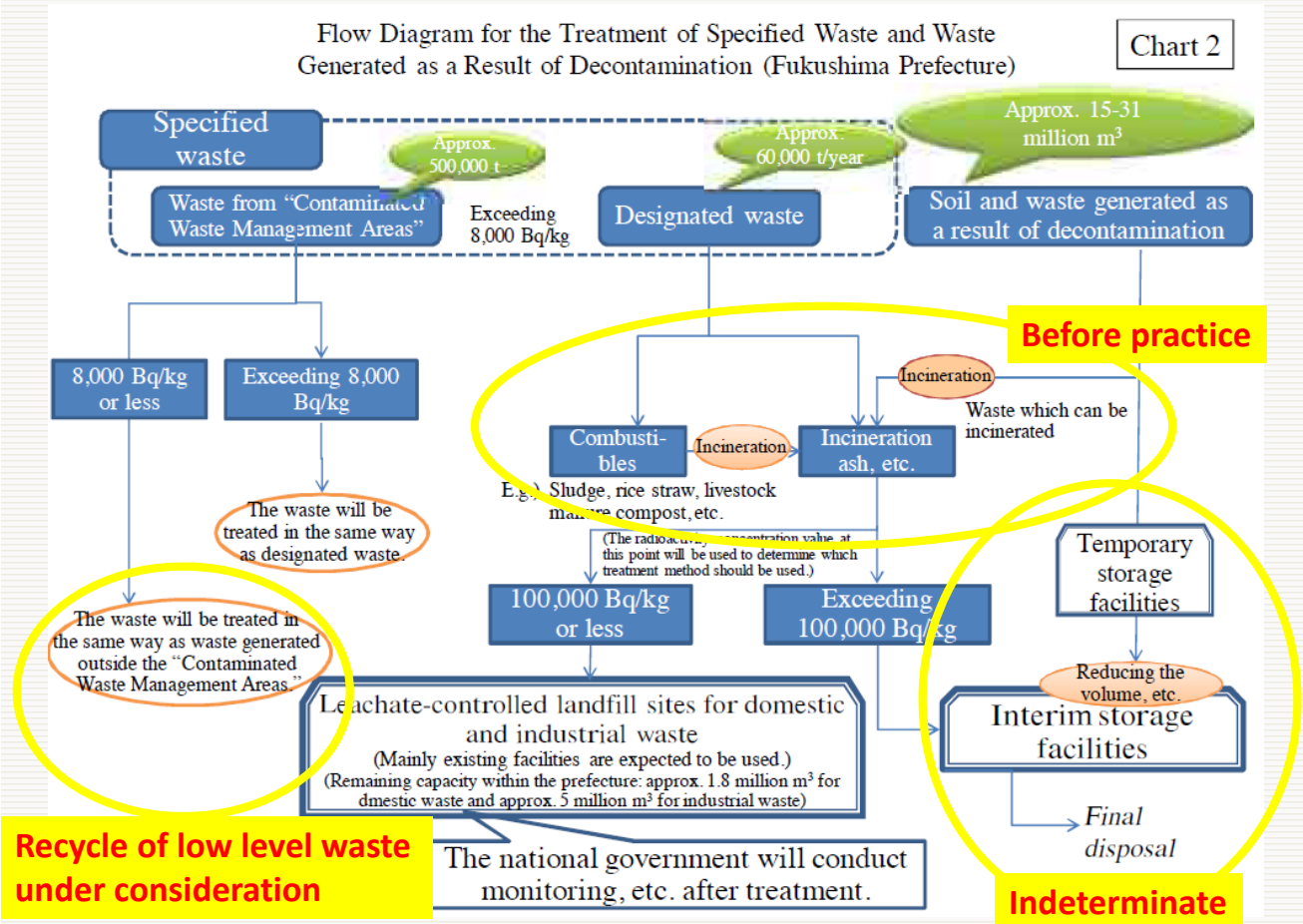
Objects for Decontamination and Volume Reduction

http://www.nies.go.jp/shinsai/images/image5b.jpg

Most substance on the surface



Japanese: http://www.env.go.jp/jishin/rmp/attach/roadmap111029_a-2.pdf
English: http://josen.env.go.jp/en/roadmap/pdf/chart1_5.pdf

Flow Chart of Soil and Waste from Decontamination in Fukushima

Amount of Soil and Waste:

15 million ~ 31 million m³

(from urban area, residential area, rural area, agricultural area and a part of forest)

(However, the specified waste is excluded.)

After Incineration

15 million ~ 28 million m³

http://www.env.go.jp/jishin/rmp/attach/roadmap111029_a-6.pdf

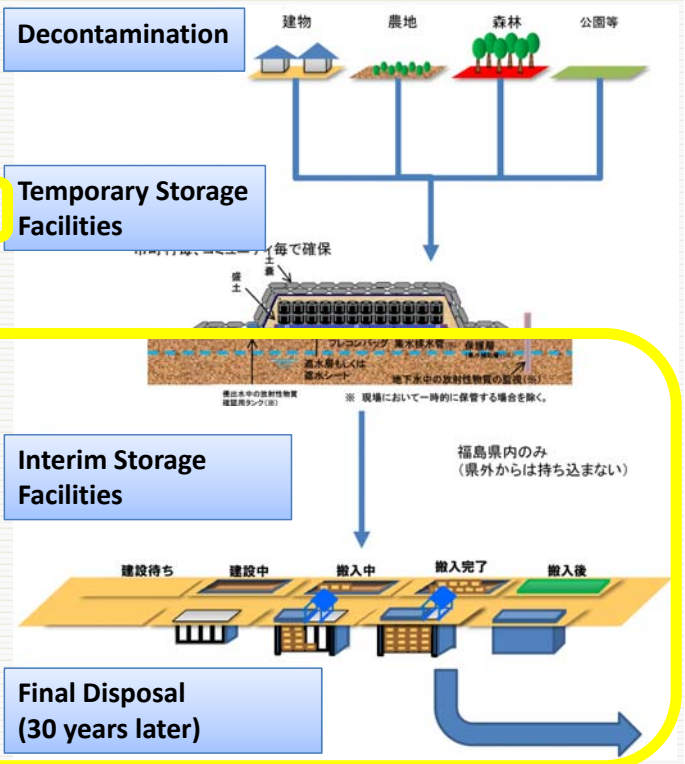
Estimated Capacity:

15 million ~ 28 million m³

Estimated Lot Area:

About 3 ~ 5 km²

(about 420 ~ 700 football grounds (7,140m²))



http://josen.env.go.jp/area/processing/interim_storage_facility.html#03

http://www.env.go.jp/jishin/rmp/attach/roadmap111029_c.pdf

Flow Chart of Soil and Waste from Decontamination in Fukushima

Amount of Soil and Waste:

15 million ~ 31 million m^3

(from urban area, residential area, rural area, agricultural area and a part of forest)

(However, the specified waste such as ash and general waste is excluded.)

Incineration

Further Volume Reduction

Tentative Temporary Storage Facilities

What a waste of Fukushima's natural resources!

The practical installation of volume reducing techniques is one of the most urgent issues.

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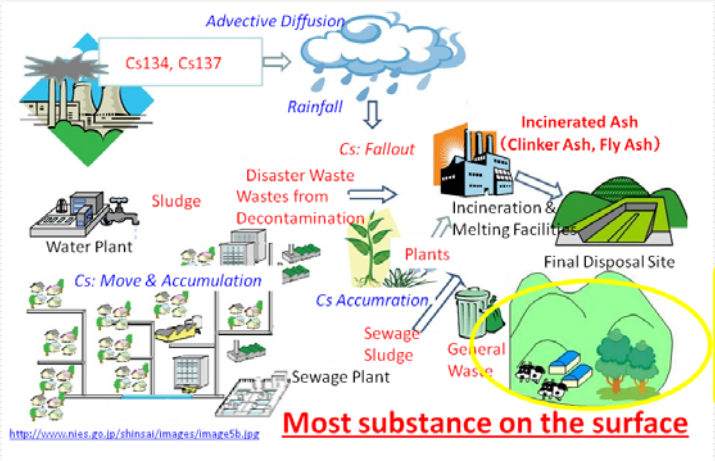
Objects for Volume Reduction



Principal Object:

Inorganic Substances

"Incinerated Ash"

- Washable Cs: comparatively soluble
- The amount is less than soil.

"Contaminated Soil"

- Huge amount
- Heterogeneous mixture
- Including low level substances

Cs-137 distribution in Soil (Chernobyl, summer 1993)	
Water solubility	<0.1-0.9%
Ion-exchange	0.2-11%
Acid leaching	0.6-14%
Residue (immobilized)	79-99%

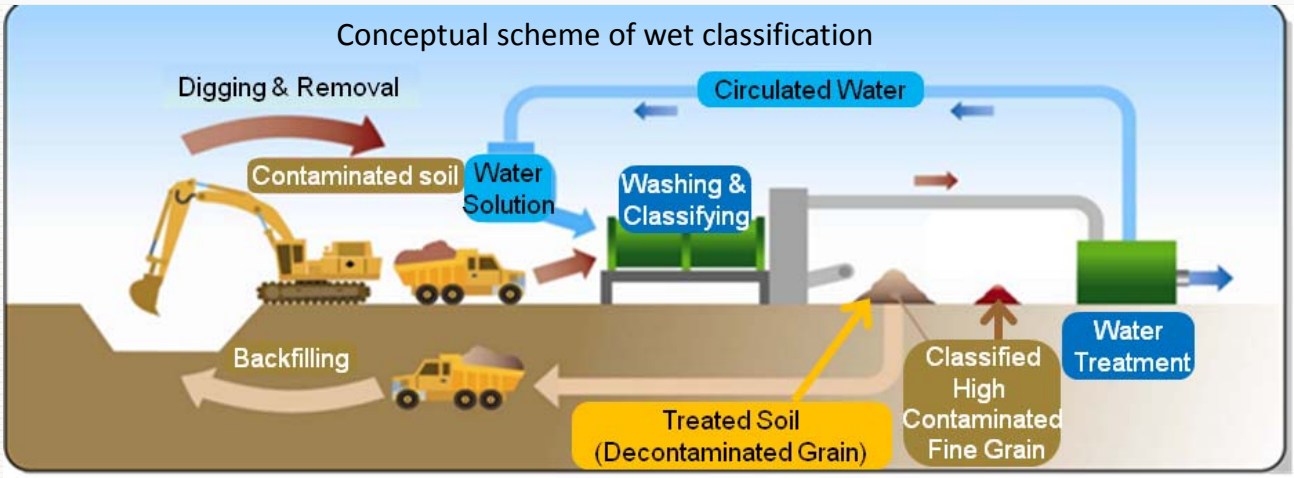
Removal of Cs using chemical extraction is very difficult.

The condition of Cs similar to heavy metals.

Applicability of civil engineering technique,
"Wet Classification method" ,
a physical process.

Wet Classification

The processing method is a common and effective measure for soil contaminated with heavy metals. This technique is useful for volume reduction, and uses a recycle method to remove only the fine grain which accumulates heavy metals by a classification such as washing, sieving and screening. Accordingly, a model test of wet classification to reduce the volume of contaminated soil was carried out at Iitate village in Fukushima.



http://www.env.go.jp/water/dojo/gb_me/
環境省水・大気環境局 土壌環境課 (2011) 区域内措置優良化ガイドブック-オンサイト措置及び原位置措置を適切に実施するために-

Sampling and Testing

Soil Sampling (Oct., 2011)


Paddy field


Crop field


Baseball ground

Experiment (Oct., 2011)

Soil wet classification and washing procedure

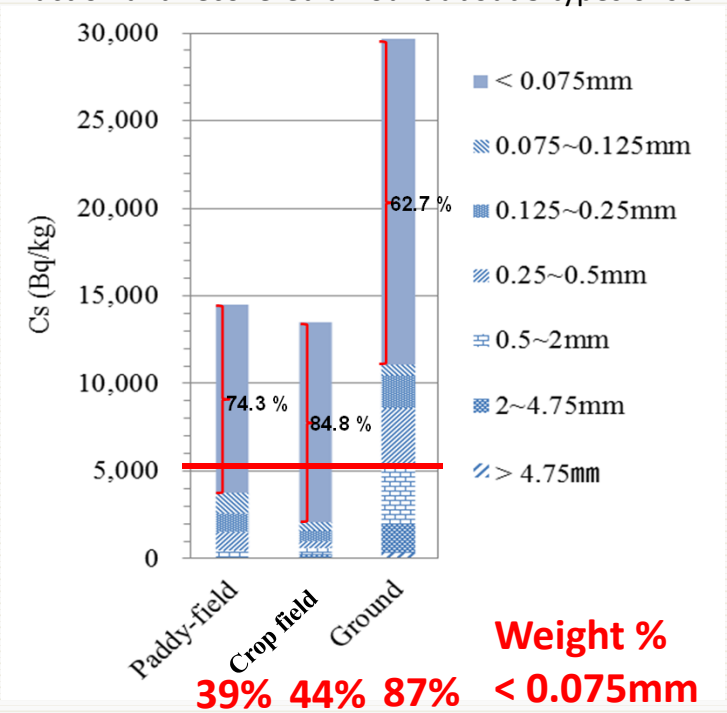
1. Homogenization of soil samples
2. Wet classification by electric test sieve shaker and hand
3. Classified each particle fractions from soil sample

Results of Wet Classification

According to the test, each percent of radioactive cesium in the removed < 0.075 mm particle fraction was 74.3 % in paddy-field, 84.8 % in crop field, and 62.7 % in ground. However, almost all classified particle fractions, except coarse grain, exceeded the cropping restriction level of "5,000 Bq/kg". Consequently each ratio of weight for soil less than 5,000 Bq/kg was 12.2 % in paddy-field, 29.5 % in crop field, and 0 % in ground.

These results shows that the simple wet classification method was not enough in the volume of the contaminated soil.

Radioactive cesium integral density of particle fraction and recovered amount about 3 types of soil



Weight %

39% 44% 87% < 0.075mm

75% < 0.25mm

Tests of Improved Processing

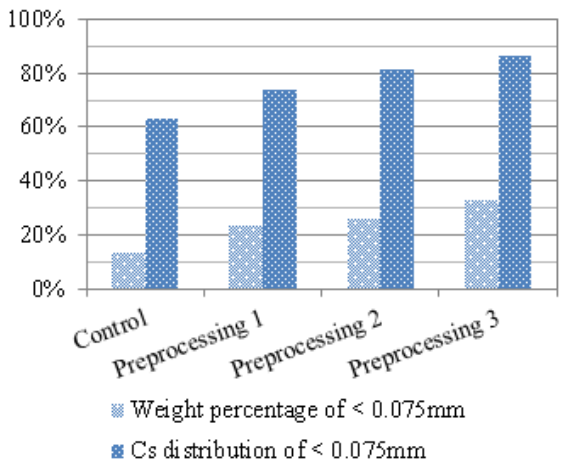
3 types of preprocessing were used to examine contaminated soil, and one intermediate process was used to examine coarse grain from 0.125 mm to 4.75 mm after sorting, with the aim of improving wet classification as a feasible decontamination method.

Method Target and equipment	Effect
Preprocessing 1: Ultrasonic vibration	Dispersion
Dispersing soil particles by about 20 kHz Ultrasonic vibration.	
Preprocessing 2: Vibration using degasser for fresh concrete	Dispersion, shaking
Dispersing and shaking soil particles using with about 120 Hz vibration using degasser for fresh concrete.	
Preprocessing 3: Pot-mixing with rubber weight	Weighted attrition
Mixing soil in rotary pot with rubber weight ball frictionally.	
Intermediate processing: Attrition by vibrator and mortar	Surface attrition
Rubbing soil with rubber coating 6,500 Hz vibrator in deep mortar.	

Tests of Improved Processing

These results showed that the ratio of the distribution of radioactive cesium in < 0.075 mm particle fraction increased in preprocessing 3, preprocessing 2, preprocessing 1 in more effective order, although each ratio of weight of < 0.075 mm particle fraction also increased.

In particular, rubbing particles in preprocessing 3 was more effective in removing the radioactive cesium from contaminated soil.



	Cs Bq/kg				Size Distribution %				Cs Distribution %			
	Control	Preprocessing 1	Preprocessing 2	Preprocessing 3	Control	Preprocessing 1	Preprocessing 2	Preprocessing 3	Control	Preprocessing 1	Preprocessing 2	Preprocessing 3
4.75<mm	30,968				1.1%				1.1%			
2-4.75mm	16,732	15,535	6,249	6,239	9.5%	13.8%	12.1%	18.2%	5.3%	5.3%	1.7%	2.0%
0.5-2mm	9,946	10,252	10,449	9,555	33.0%	16.7%	26.3%	19.5%	11.1%	4.2%	6.3%	3.3%
0.25-0.5mm	10,701	14,175	12,234	12,857	31.4%	20.7%	11.1%	10.1%	11.3%	7.2%	3.1%	2.3%
0.125-0.25mm	19,733	15,206	12,879	12,762	9.6%	17.0%	19.6%	12.0%	6.4%	6.4%	5.8%	2.7%
0.075-0.125mm	26,228	15,697	18,095	23,385	2.4%	8.6%	5.6%	7.7%	2.1%	3.3%	2.3%	3.3%
0.075>mm	142,500	128,531	139,832	147,705	13.0%	23.2%	25.3%	32.5%	62.7%	73.5%	80.8%	86.3%

Tests of Improved Processing

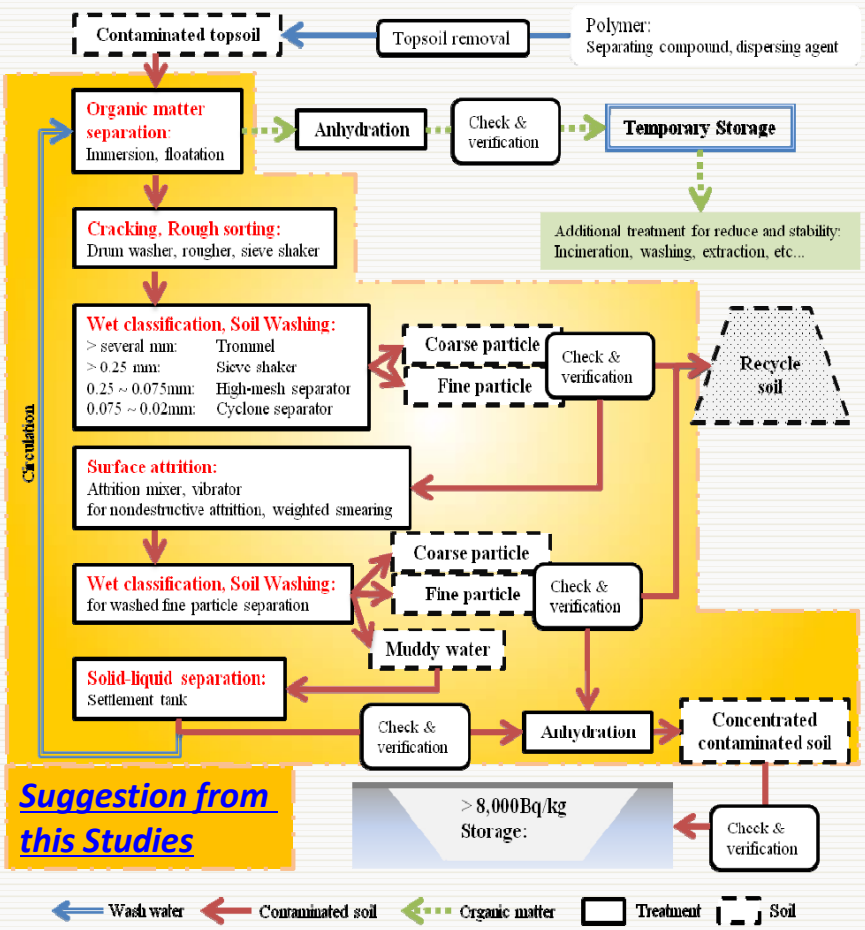
To prevent the fine grain from impeding the rubbing intermediary processing tests under 2 conditions were carried out to remove the coarse grain from the fine grain. As a result, the ratio of reduction of radioactive cesium in the soil was higher than the ratio of increase of fine grain, although the processing time and the ratio of soil to water did not influence decontamination in the range of these conditions. The effectual volume reduction of the radioactive cesium-contaminated soil was confirmed by adding an intermediate process such as the surface attrition in vibrator.

Efficiency of intermediate processing on wet classification

	Cs Bq/kg	Residual rate	
		Soil %	Cs %
Control 0.125-4.75mm	**11,706**	-	100.0%
Condition 1	**6,490**	**93.6%**	**55.4%**
Condition 2	**6,217**	**89.5%**	**53.1%**

Conceptual schema for improved wet classification reducing the amount of radioactive cesium contaminated soil

The results of these on-site, hot tests with the processing model using the improved wet classification method for the decontamination of radioactive cesium contaminated soil.
It is suggested that a large amount of radioactive cesium contaminated soil can be reduced by using this processing model.



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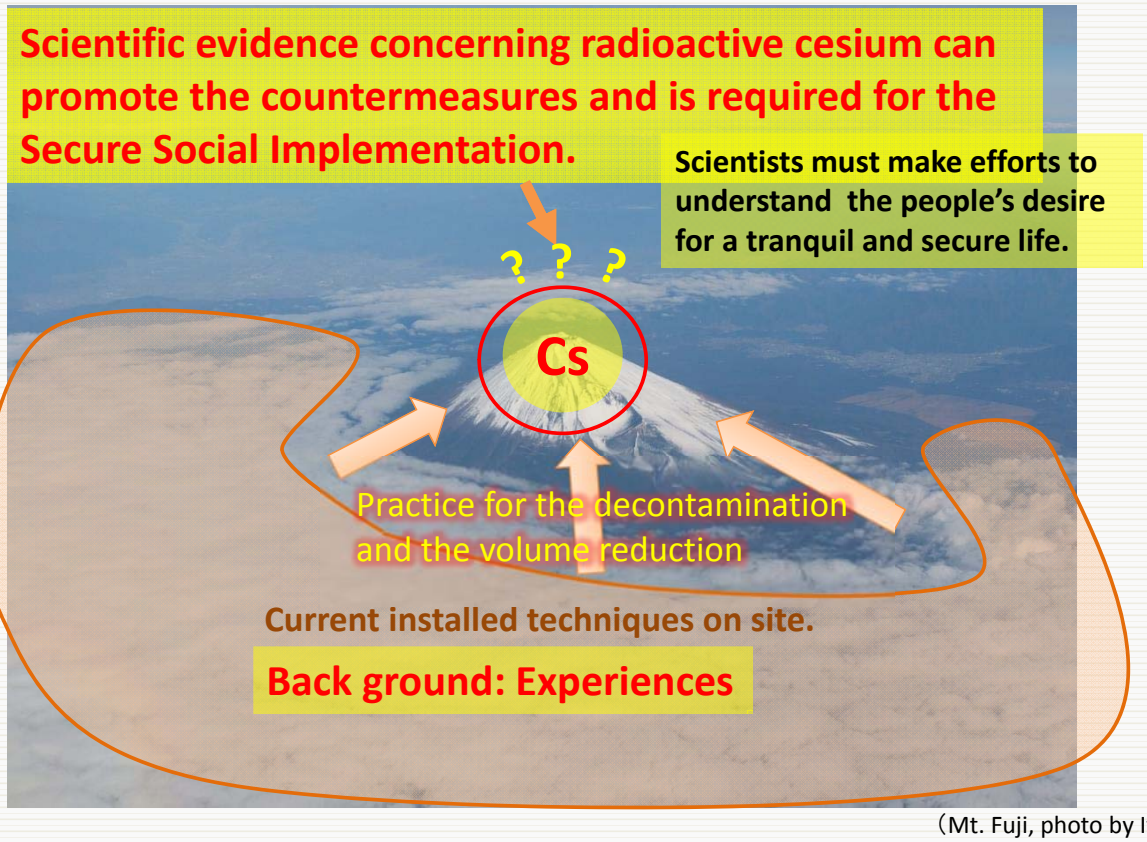


(Mt. Fuji, photo by Ito.)

For Effective Utilization of Knowledge & Experiences

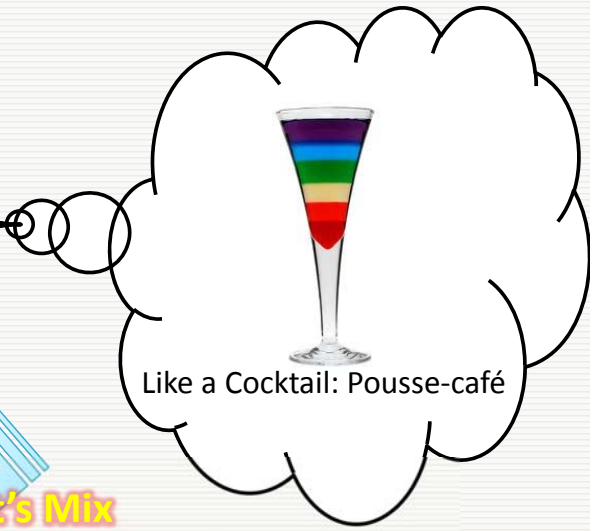
Current situation

Each field and each department have tackled the same problem on each way individually so far.

Concrete actions by engineer

Political determination
Making policies

Scientific evidence & knowledge



Let's Mix
Knowledge & Experiences

For making "Good Solution"

Thank you for your kind attention!

Please allow me to use this opportunity to offer my thanks to…
Iitate Village Office
Dr. Manpuku, JIRCAS
JAEA
And, all Members of this cooperative research.