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PAWEES2013

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# Development of decontamination method farmers can do by themselves in paddy contaminated by radioceasium in Fukushima

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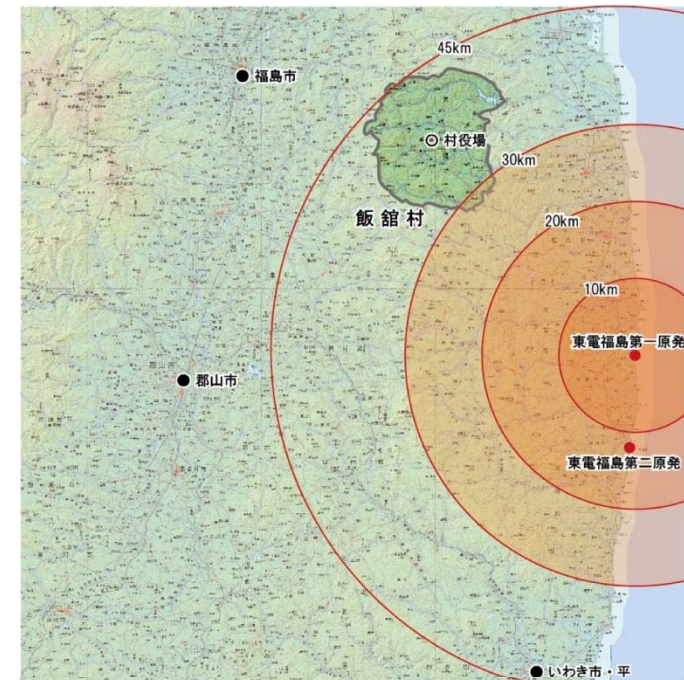
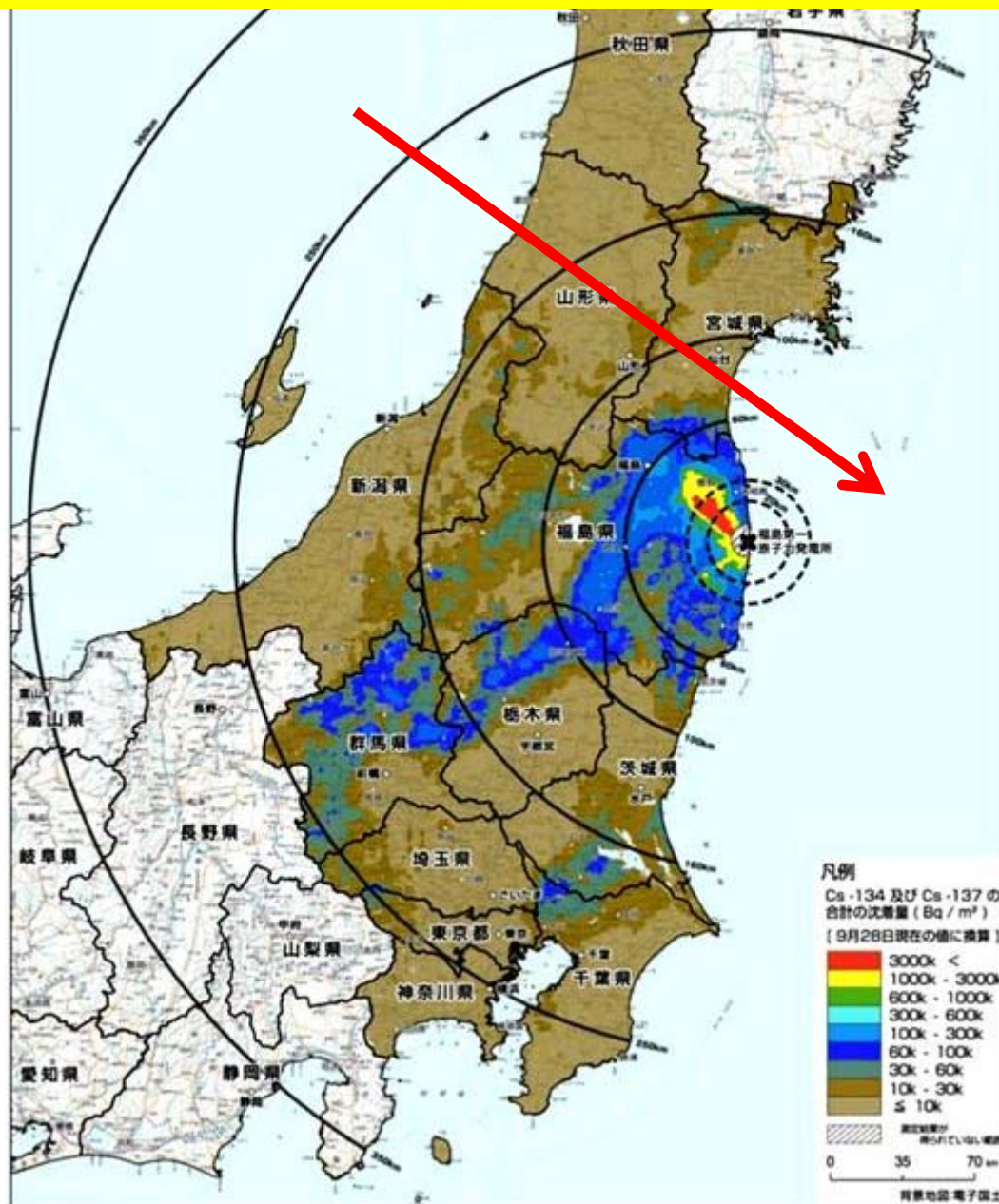


# Introduction

- On March 11, 2011, a massive earthquake struck the eastern region of Japan
  - causing widespread devastation.
- Agricultural engineers in Japan are currently working on a variety of restoration projects
- We are challenging remediation of farmland
  - Desalinization of paddy field flooded by sea water
  - Decontamination of soil contaminated by radioactive cesium
- In this keynote speech, I report propose our trials for the decontamination of soil in Fukushima
  - that can farmers can do by themselves

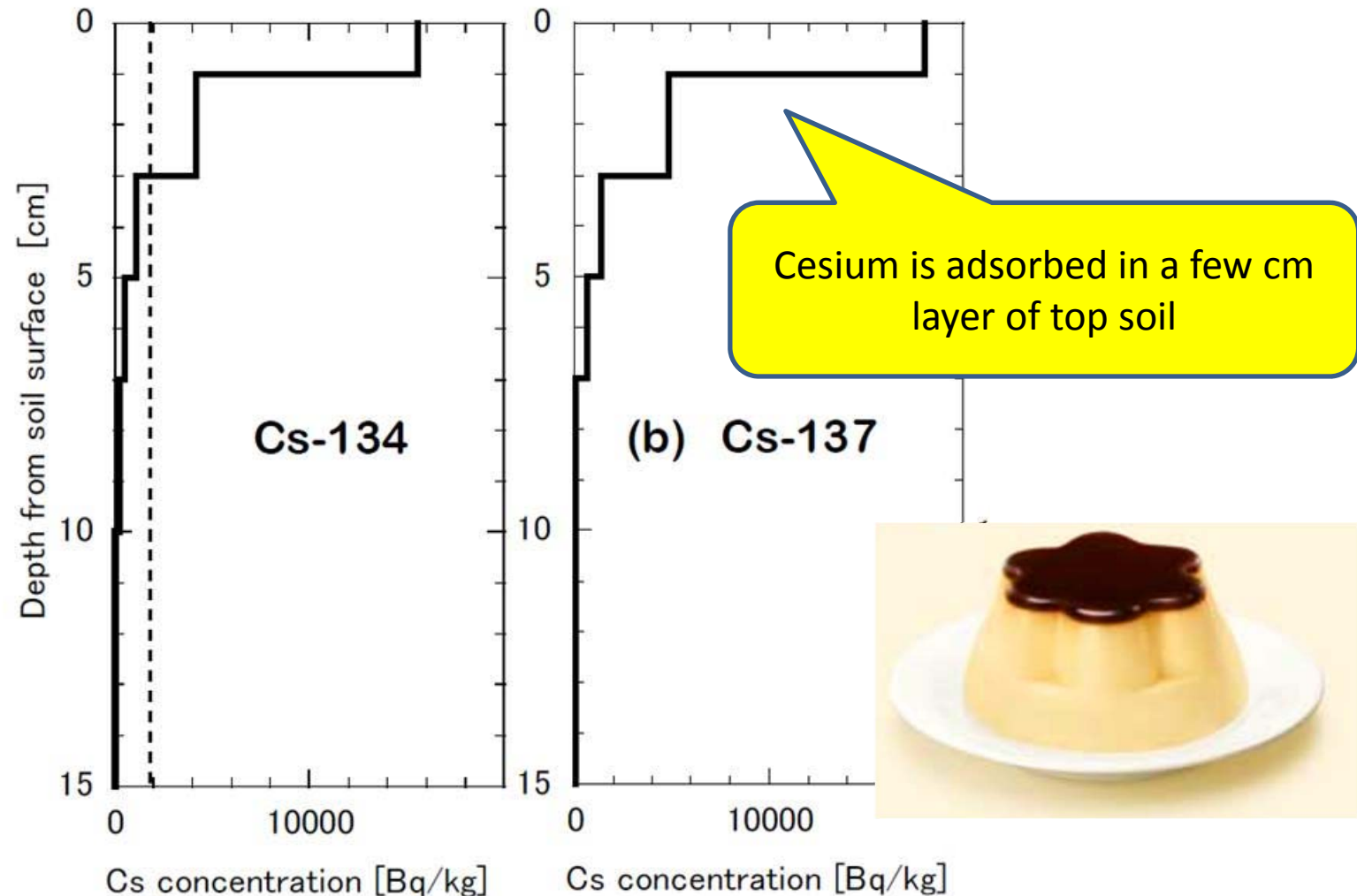


# Iitate Village in Fukushima Prefecture



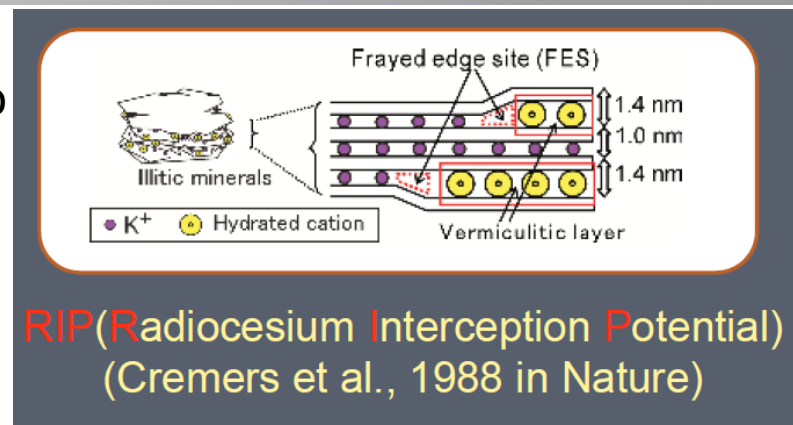
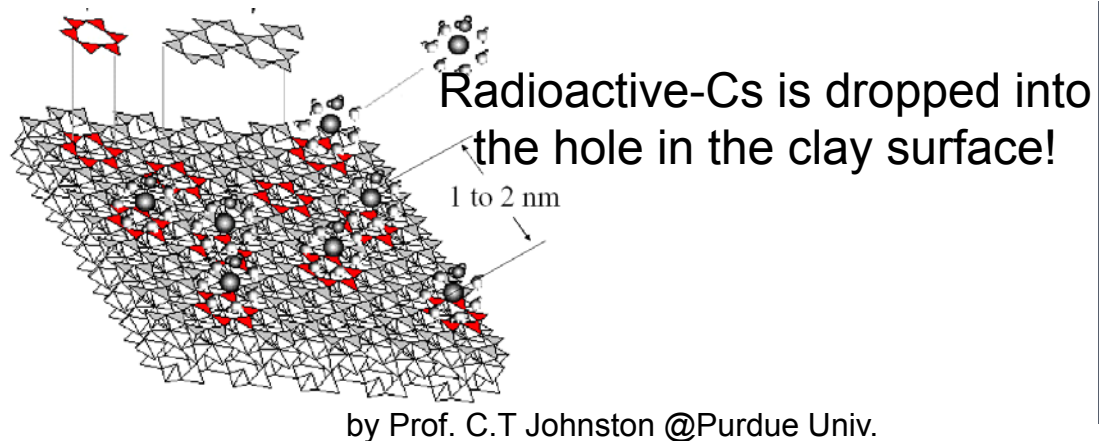
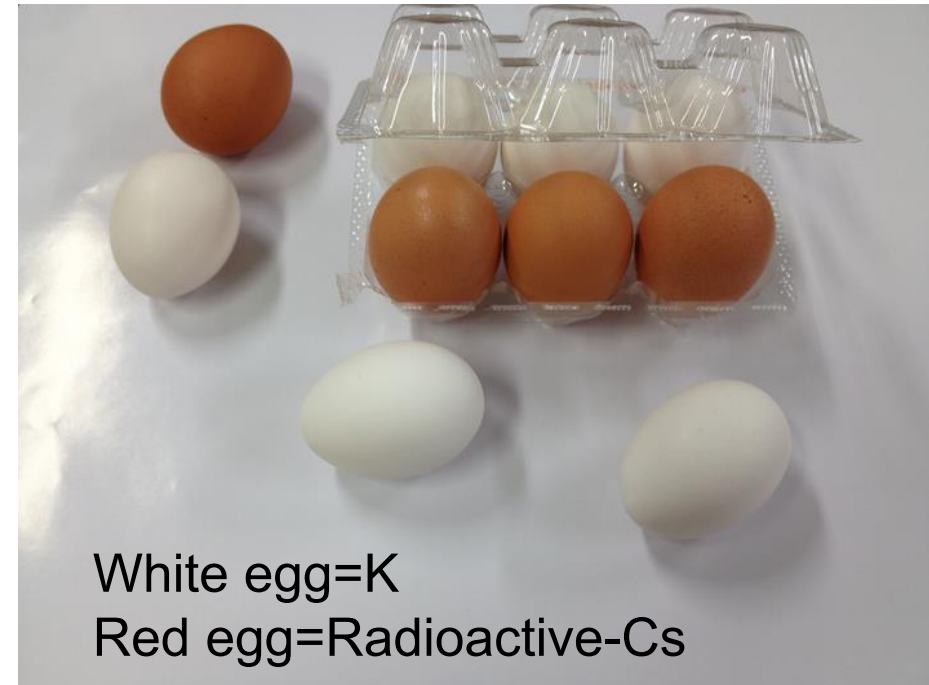
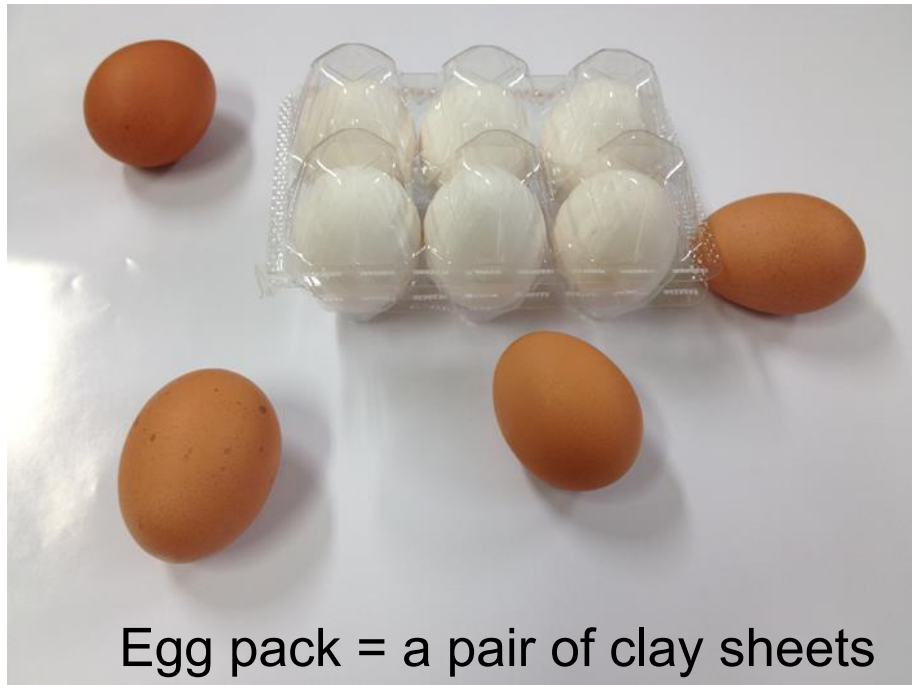
<http://blog.goo.ne.jp/yampr7/e/3252>

# Radioactive Cesium Conc. In soils (2011.5.24)



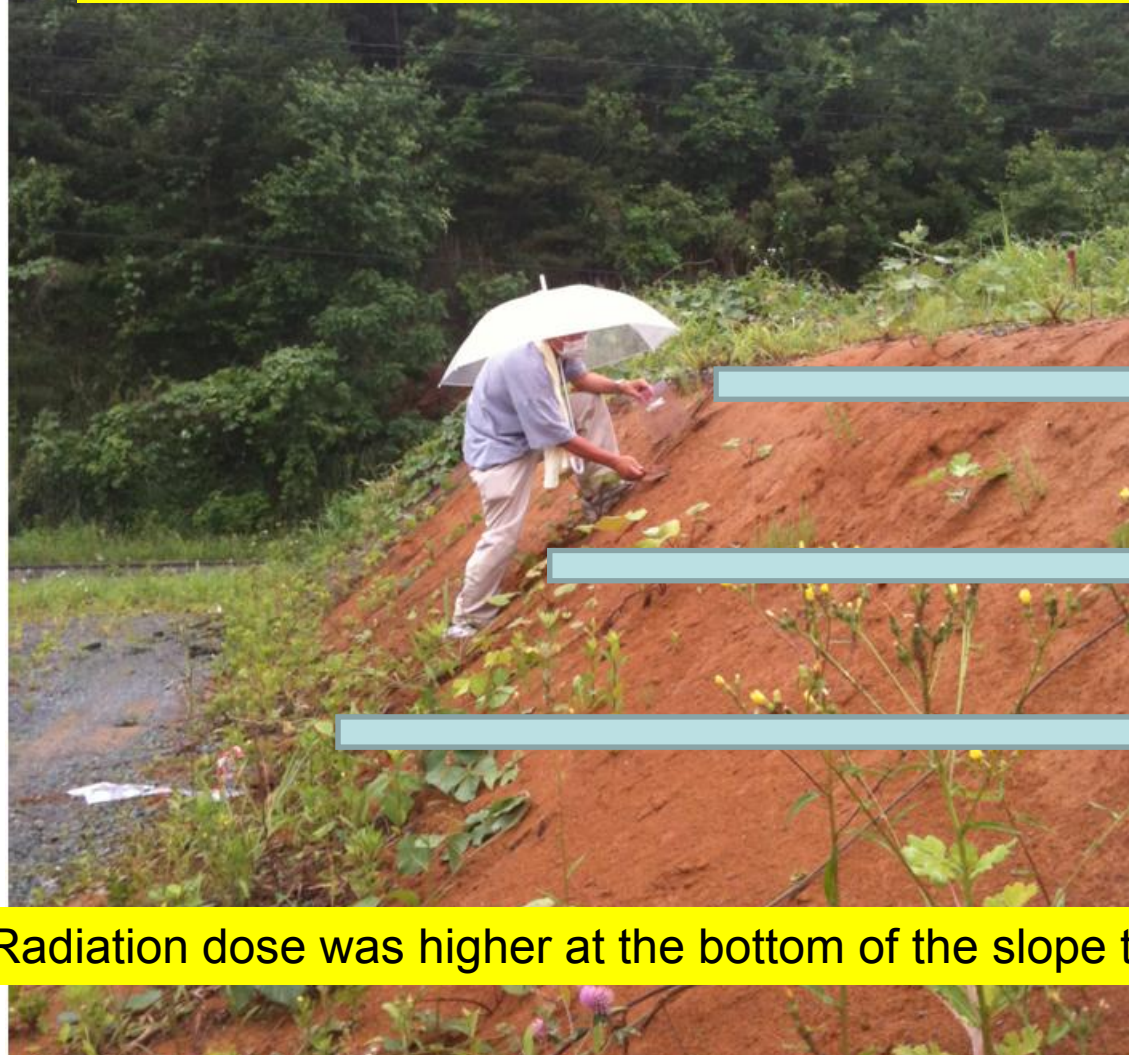
Shiozawa, et.al: Vertical Concentration Profiles of Radioactive Cesium and Convective Velocity in Soil in a Paddy Field in Fukushima, RADIOISOTOPES, 60, 323-328 (2011)

# Radioactive-Cs is replaced with K and fixed to the clay particles





Measurement of radiation dose on a  
slope near the Iitate Village office  
(2011.6.25; Mizoguchi and Noborio)



2.5  $\mu\text{Sv/h}$

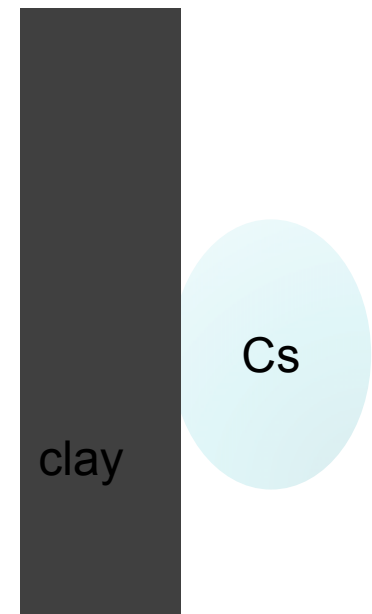
3.5  $\mu\text{Sv/h}$

7.0  $\mu\text{Sv/h}$

Radiation dose was higher at the bottom of the slope than at the top of the slope

# How to think of radioactive cesium

- Regard as a complex of cesium and clay particles
  - Clay colloid
- Note the movement of the clay
- Think the removal of the clay
  - Absorbing radioactive cesium





Stripping topsoil method



Soil puddling method

# 農林水産省

Official decontamination  
methods by Government

**MAFF**

Ministry of Agriculture, Forestry and Fisheries

From August, 2012



Deep plowing method



# Where is the destination of a pile of flexible container bag containing the contaminated soil



Kusano, iitate, Fukushima  
(2012.6.24)



Sugaya, iitate, Fukushima  
(2013.8.17)



# What about the paddy field decontamination of mountainous land?



Weed cut  
(2013.8.3)



Harm of monkey



Harm of wild boar  
(2012.4.14)



# The purpose of the field test

- **Madei-method**
  - Development of combination decontamination method that farmers can do by themselves
    - Stripping topsoil + Deep plowing method
    - Soil puddling + Deep plowing method
- **Madei-monitoring**
  - Monitoring of living space and farmland
    - Crop cultivation and after decontamination
    - Environmental change and weather conditions
    - Soil radiation dose and dose space

Madei means "carefully" and "heartfully" in the dialect of Iitate village, Fukushima

# Practices utilizing the properties of cesium and clay



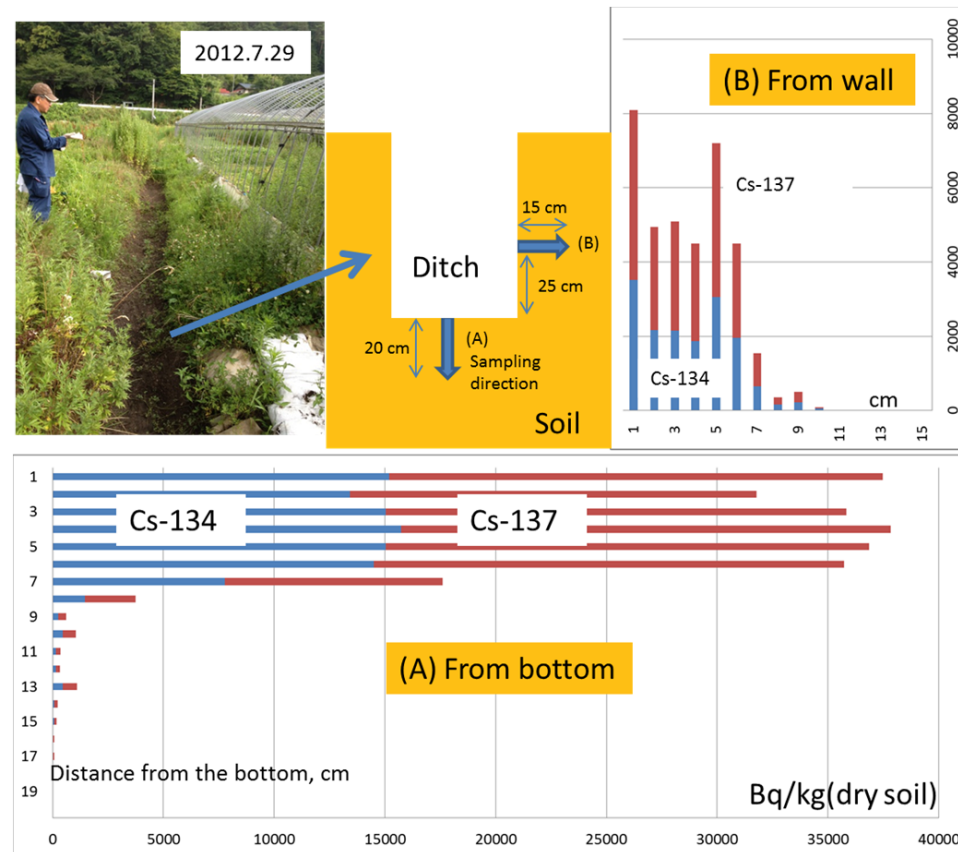
decontamination method by  
stripping frozen soil  
(2012.1.8)



Rotary weeder method  
(2012.4.1)



# Pour contaminated muddy water into the drain



A result of the radioactivity measured at each depth by sampling the soil of the bottom and sides of the groove after a dried-up Cesium is not expected to immersion in the soil!

# Why all right? – Soil Filtration function!



Fresh water comes out when muddy water is poured in the sand. When this operation is repeated, fresh water becomes slow to come out. Clay particles with radioactive cesium are also trapped in the sand by this principle.



# Made-method-1 (Komiya method)

## Soil puddling + Deep plowing method



(2013.5.18)





# Made-method-1 (Sasu method)

## Stripping topsoil + Deep plowing method



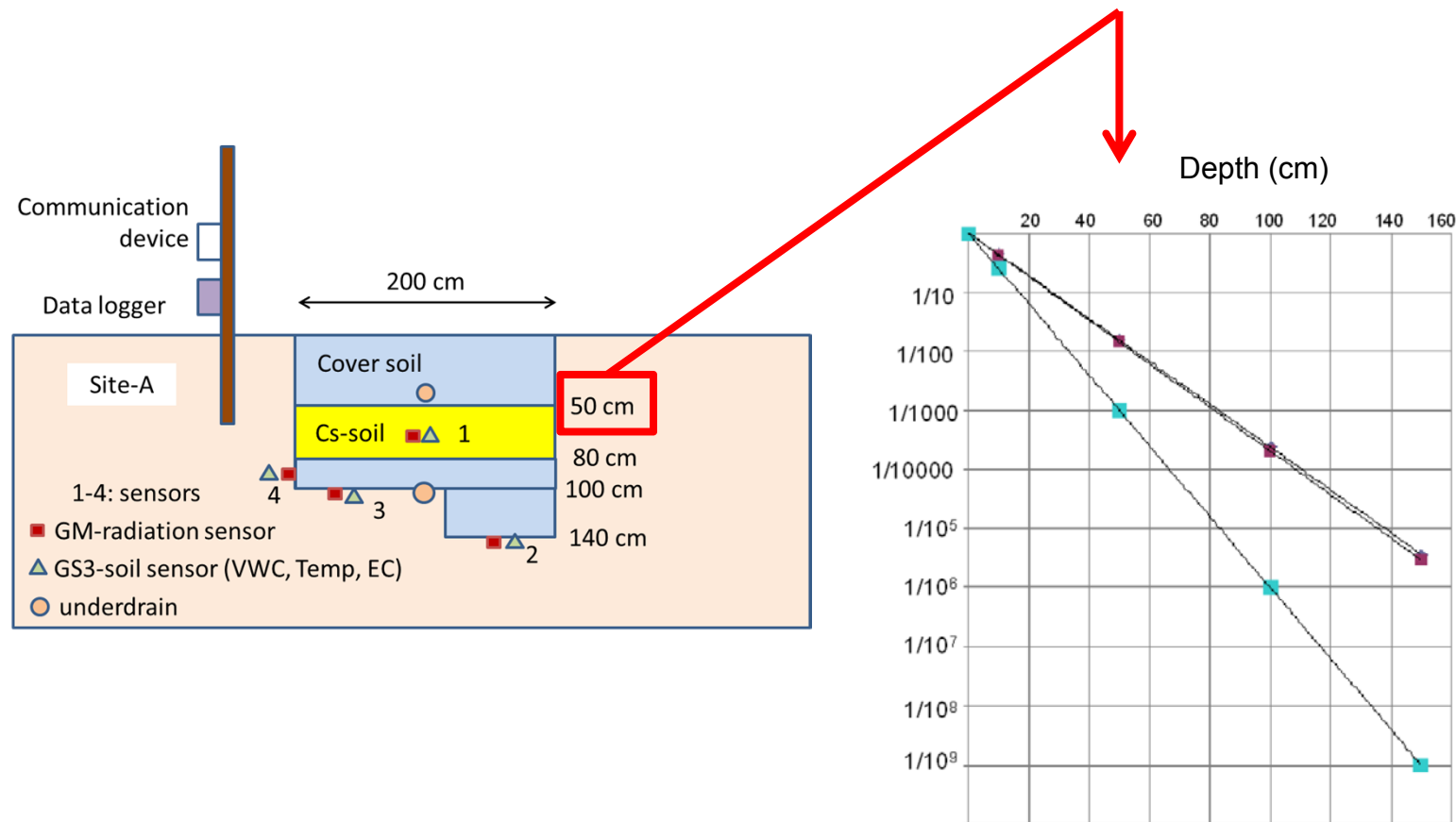
Burial of contaminated soil

Compaction of soil

2012.12.1

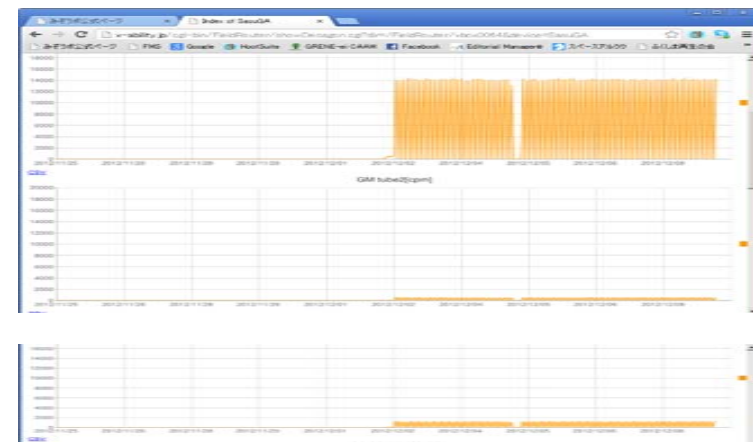
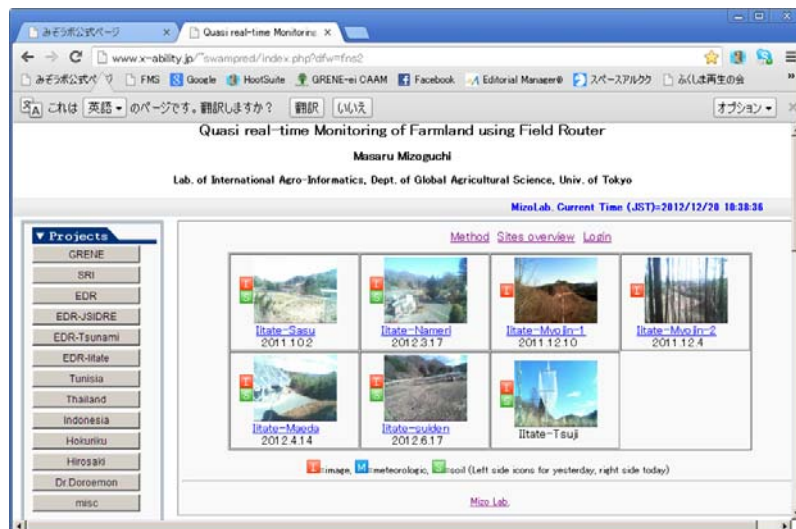
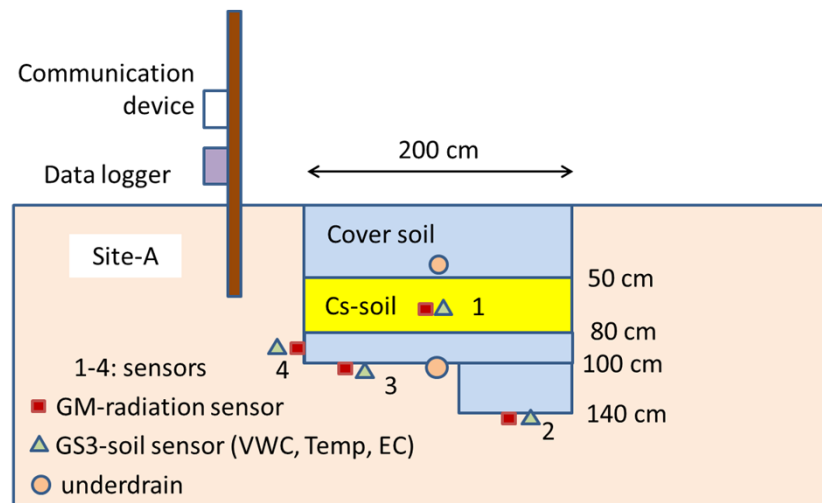
# Contaminated soil should be buried in the bare hole!

Radiation dose is 1/100 to 1/1000 just bury 50cm deep!



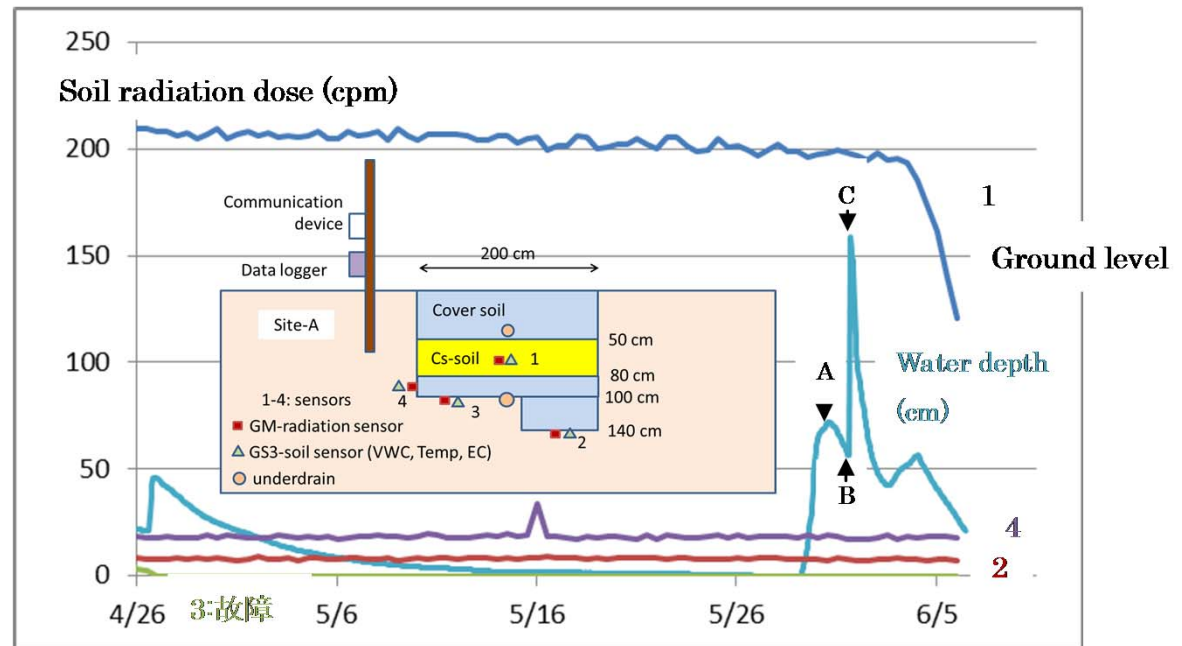
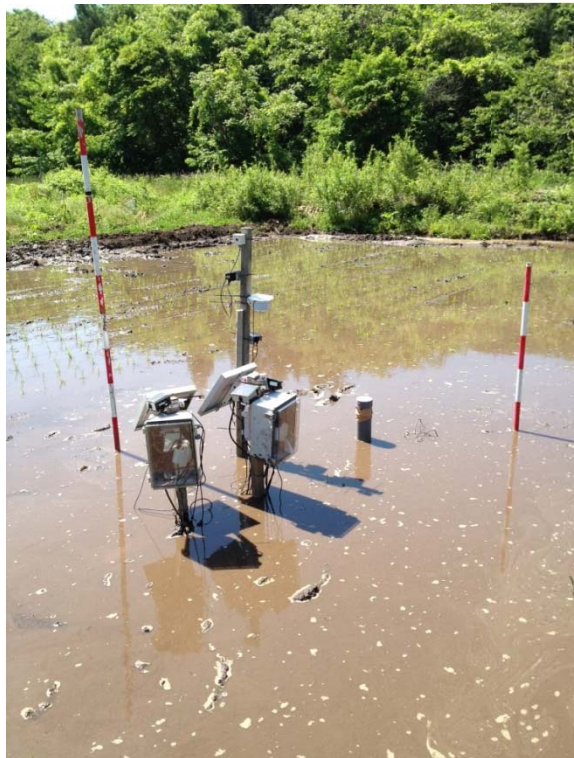


# Radiation dose monitoring of soil



Radioactive cesium is not moved even if water penetrates!

# Rice planting in paddy that contaminated soil was buried (Susu, 2013.6.8)



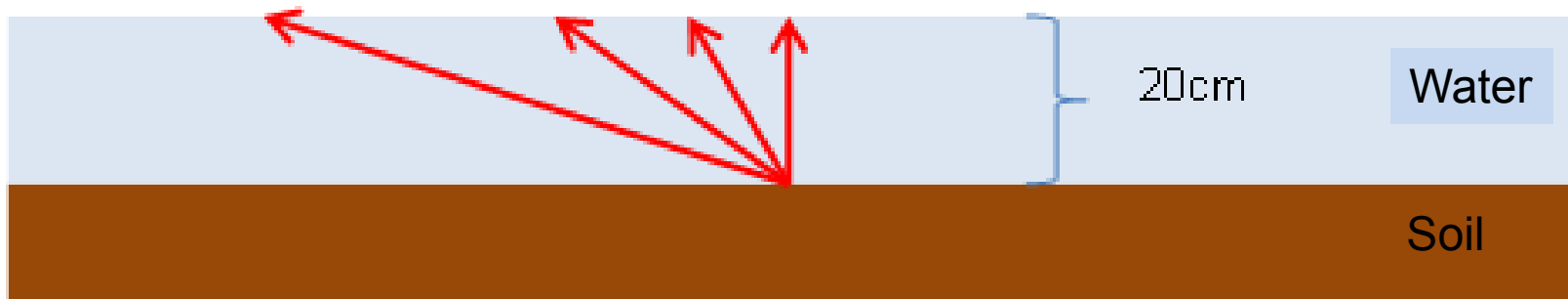
Changes in soil radiation dose (cpm) and water level in a well in flooded rice field

Radioactive cesium is not moved even if water penetrates!



# Radiation shielding effect of paddy flooding

Prof. Kubo (2012)



- Radiation reaching the roads and houses are emitted at a low angle from paddy
- Even shallow water depth, distance to the surface of the water from the soil surface is longer in the case of low angle
- Human activities height above the banks of the rice fields

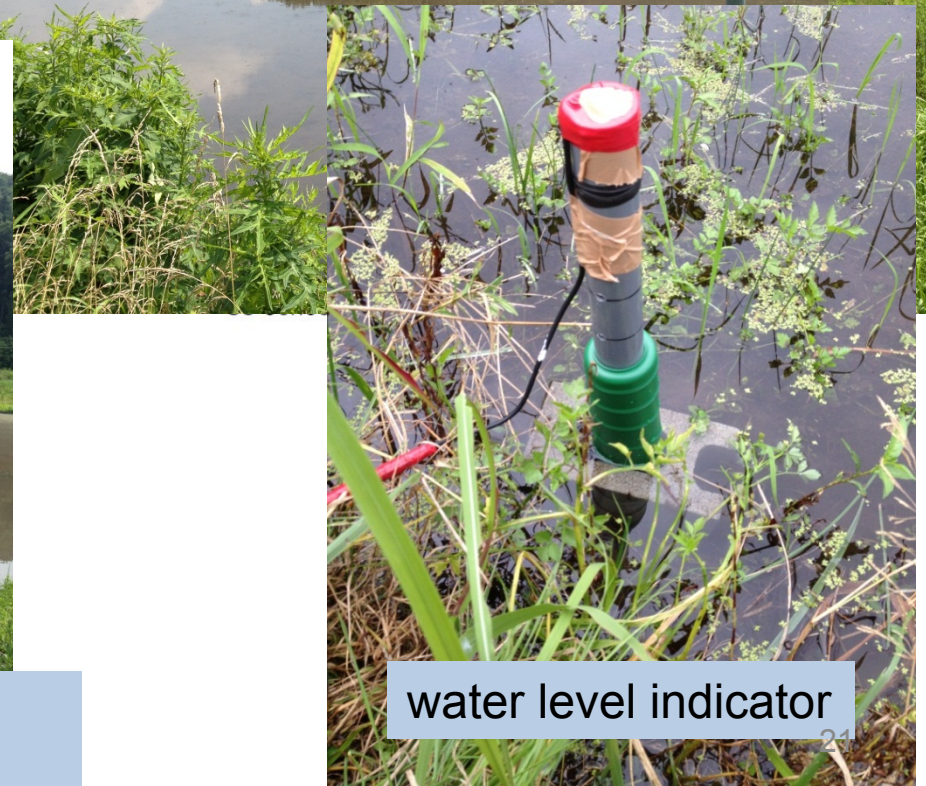
Paddy fields infested by wild boar



paddy flooding  
(July 29 2012)



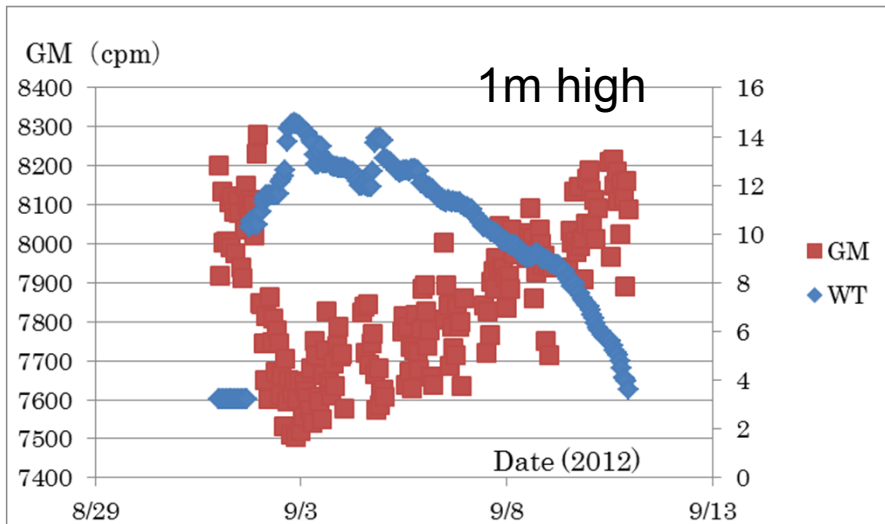
Installation of radiation meter  
(July 29)



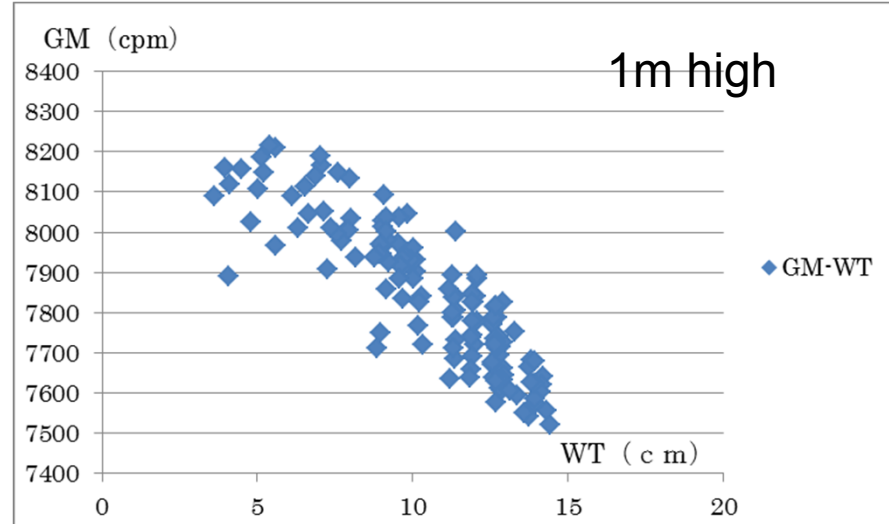
water level indicator



# Paddy field should be flooded by water



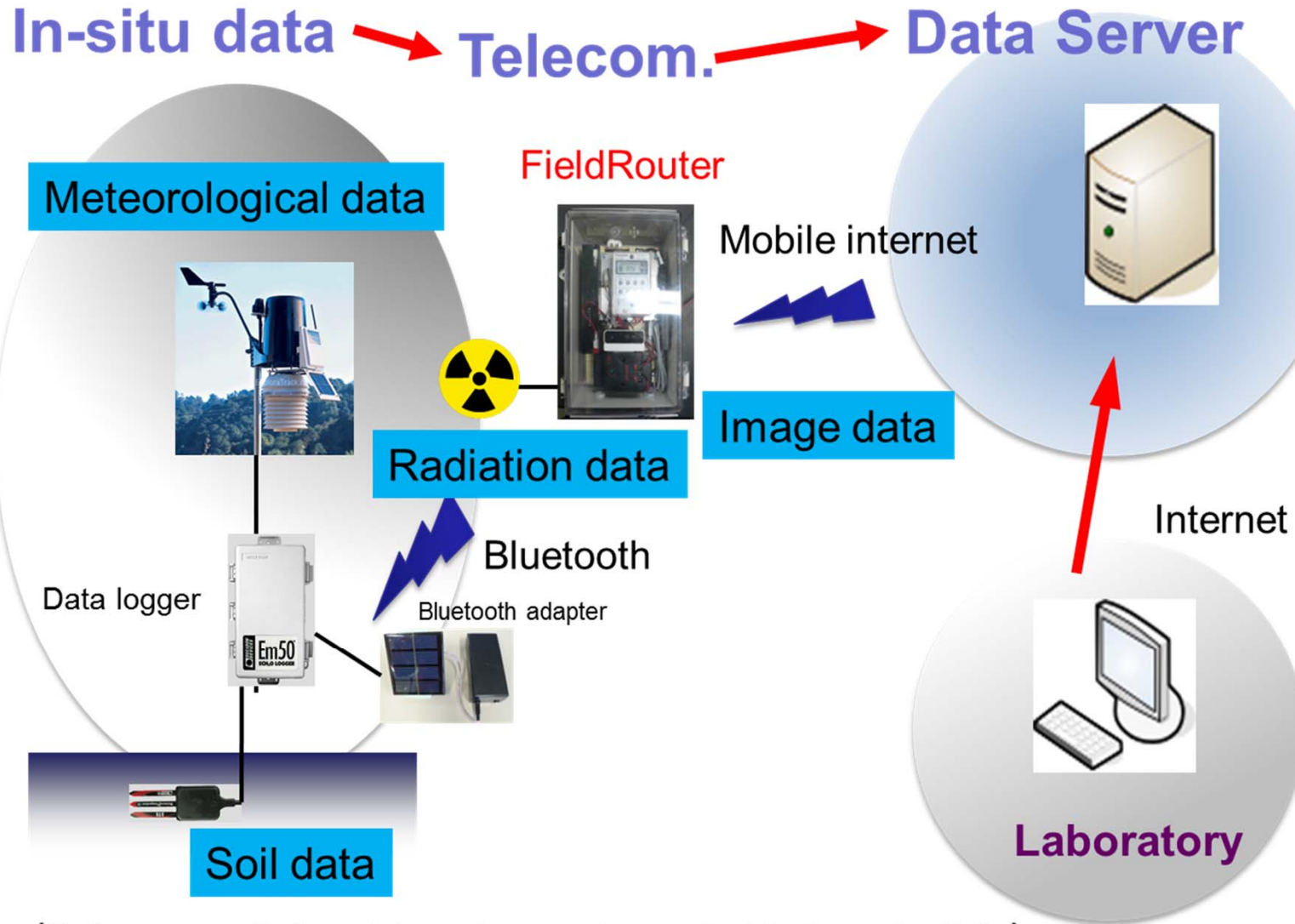
Water depth and radiation dose as a function of time



Water depth vs. radiation dose

- Radiation damping effect by water
- If rice doesn't absorb cesium, rice should be planted normally
- Prevent a wild animal and weed

# The FMS with a radiation sensor



(Soil sensor : Soil moisture, temperature, electrical conductivity)



# Environmental monitoring of litate village



Garden of a house

1.2 m high Radiation dose  
Air temperature  
Relative humidity  
Precipitation  
Solar radiation  
Wind direction, wind speed  
Soil moisture, soil temperature,  
and electrical conductivity



In Forest



Out of forest  
(deforest area)

# 6-monitoring sites in Iitate village

Quasi real-time Monitoring of Farmland using Field Router

Masaru Mizoguchi

Lab. of International Agro-Informatics, Dept. of Global Agricultural Science, Univ. of Tokyo

MizoLab. Current Time (JST)=2012/07/23 12:26:58

**▼ Projects**  
GRENE  
SRI  
EDR  
EDR-JSIDRE  
EDR-Tsunami  
EDR-Iitate  
Tunisia  
Thailand  
Indonesia  
Hokuriku  
Hirosaki  
Dr.Doroemon  
misc

[Method](#) [Sites overview](#) [Login](#)  

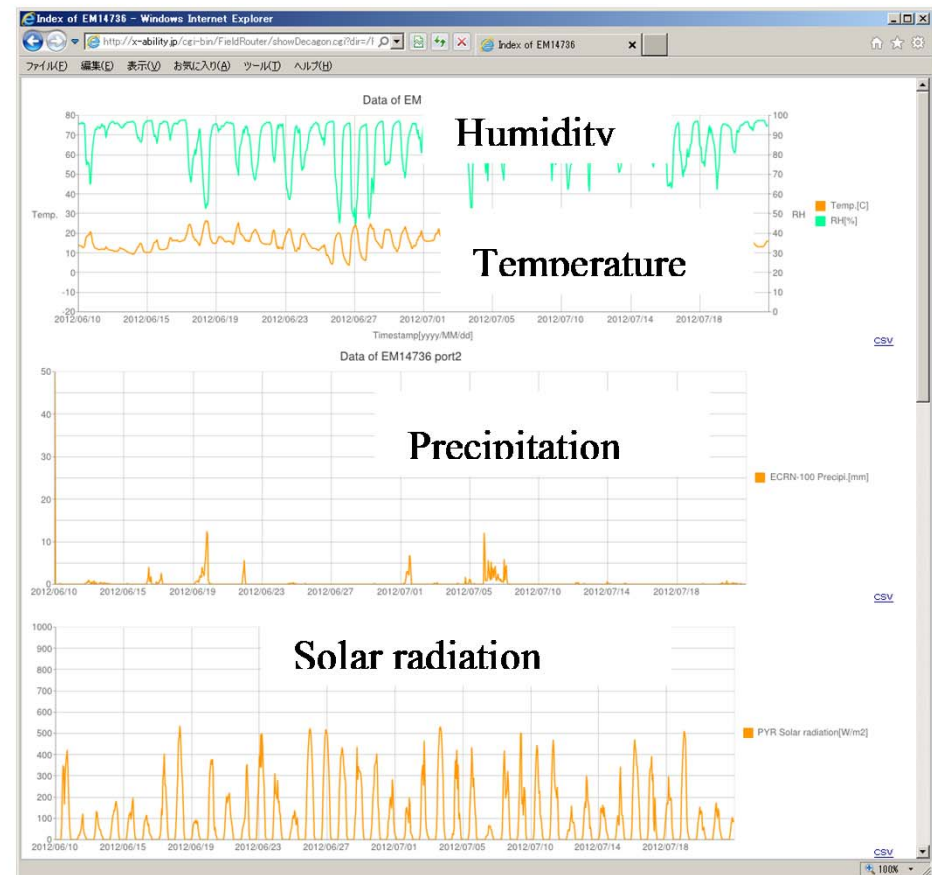
 <a href="#">Iitate-Sasu</a> 2011.10.2	 <a href="#">Iitate-Nameri</a> 2012.3.17	<b>Site Info</b>  <a href="#">Iitate-Myojin-1</a> 2011.12.10	 <a href="#">Iitate-Myojin-2</a> 2011.12.4
 <a href="#">Iitate-Maeda</a> 2012.4.14	 <a href="#">Iitate-suiden</a> 2012.6.17		

=image, =meteorologic, =soil (Left side icons for yesterday, right side today)

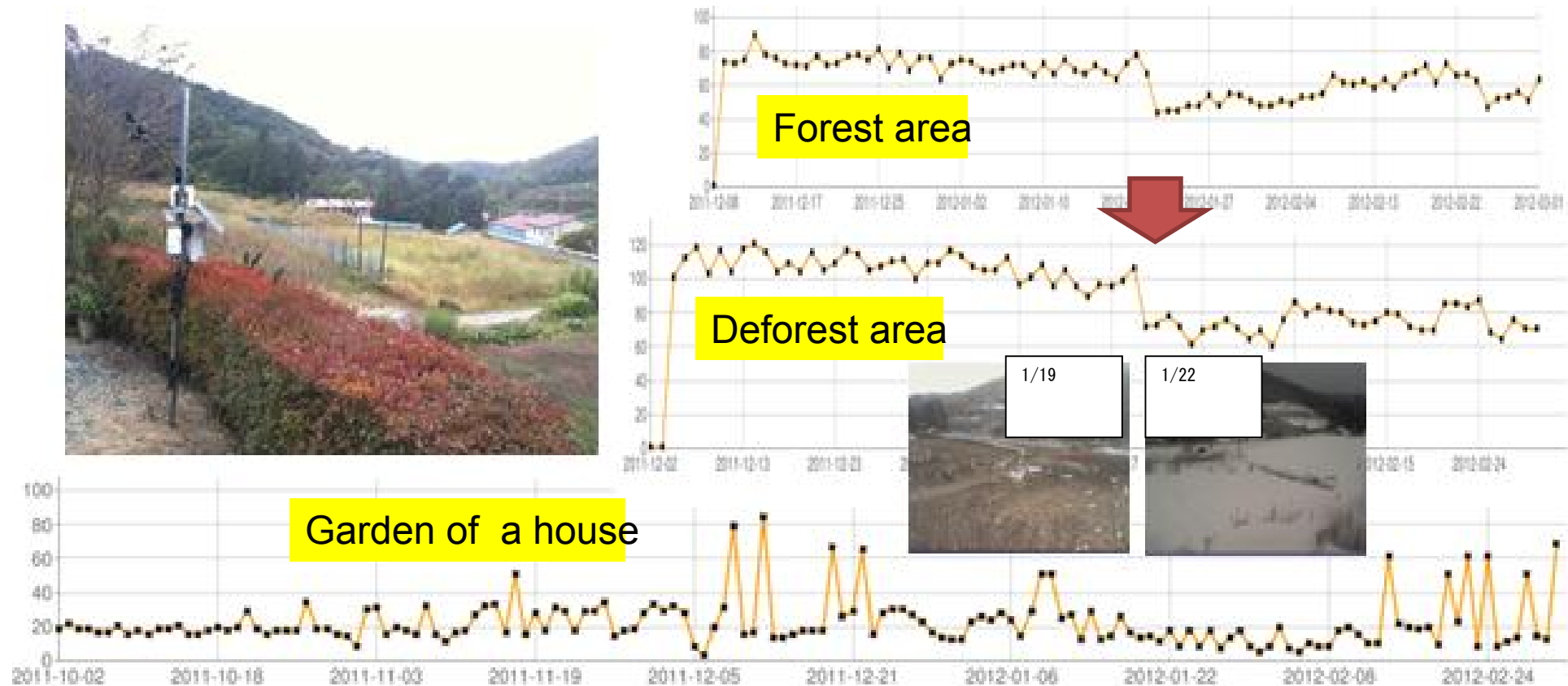
[Mizo Lab.](#)



# An example of monitoring data



# Radiation watch in the village

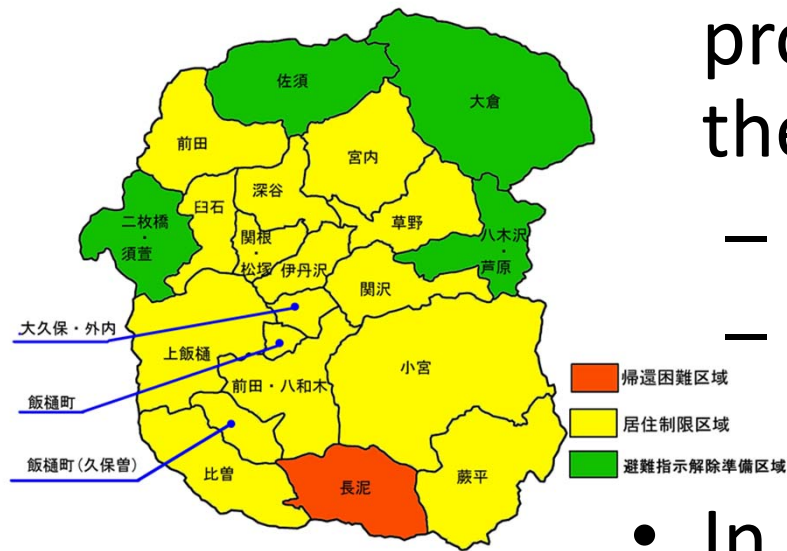


Field monitoring reveals:

1. Snow cover decreases radioactive dose of village
2. Radioactive dose is high on a fine and low humid day

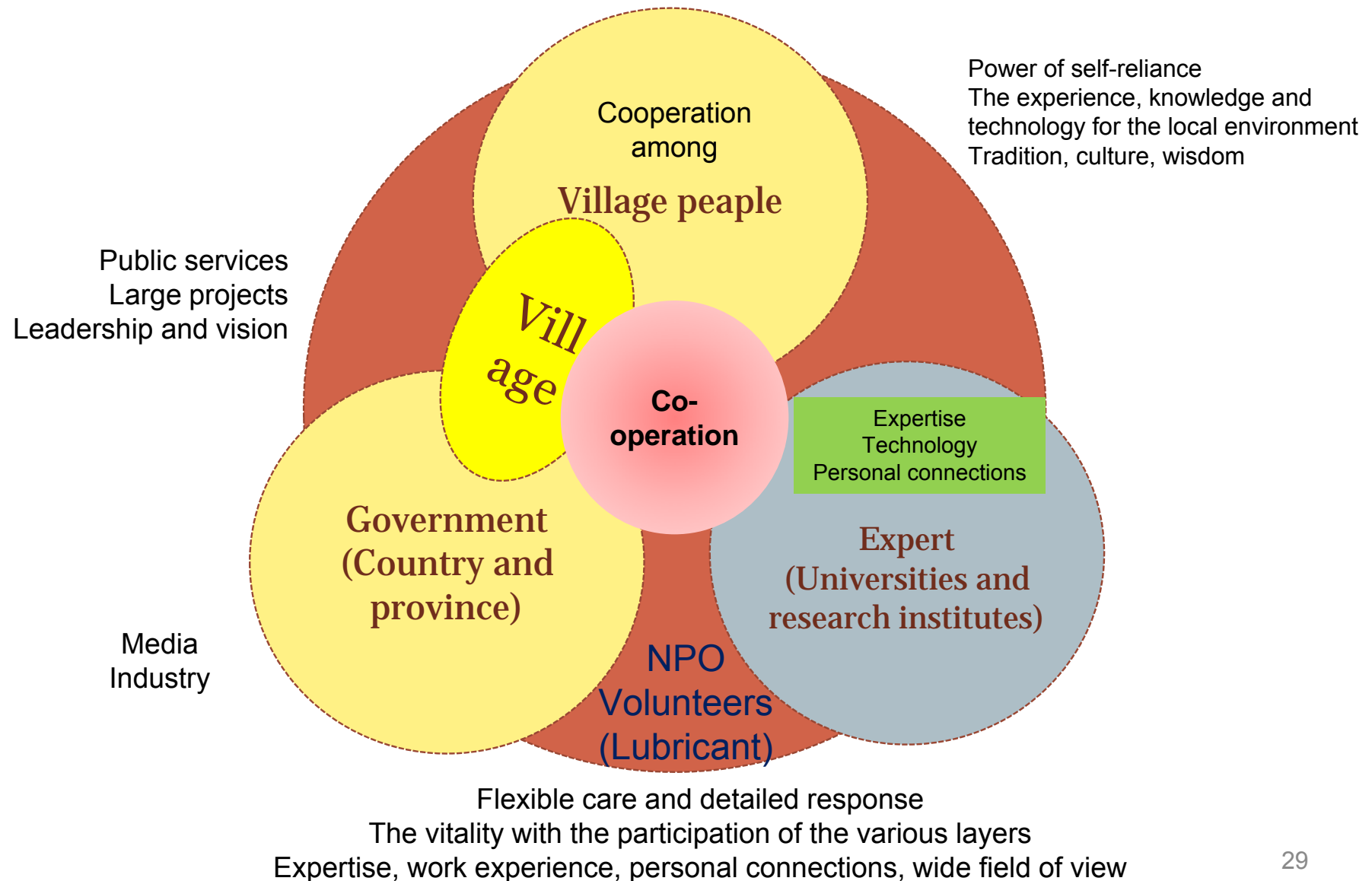


# Current status of Iitate village



- Decontamination of soil is progressing by government with the stripped topsoil method
  - Risk of missed
  - Risk of re-contamination
- In the re-decontamination
  - Re-decontamination by villagers participatory
  - Need to prepare a variety of decontamination method

# Road to recovery by cooperation





# Blind men and an elephant

Who has the responsibility to Fukushima?



# Thank you for your kind attention



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Google

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