

Battles of Soil Scientists in Fukushima, Japan

Monday, November 4, 2013

1:00 PM-4:00 PM

Marriott Tampa Waterside, Room 8

Additional information-2



By
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*ASA, CSSA, & SSSA International Annual Meetings
Nov. 3-6, 2013, Tampa, Florida*

Shield effects of floodwater on radiation from paddy field soil in Fukushima

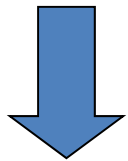
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and Taku Nishimura

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The devastating accident of the nuclear power plant occurred due to Great East Japan Earthquake in March 2011.



A lot of radioactive substances precipitated on the ground in the surrounding area.



A large number of people is still suffering prolonged evacuation to avoid the strong radioactivity.

The reduction of the radioactivity at the residential area is urgently required to realize earlier returning home of the evacuated residents.

Our proposal

- Residential zones in the stricken area are typically surrounded by paddy fields.
- Paddy fields are originally designed to store floodwater on the ground in order to grow rice plants.
- Water has a strong shield effect on radiation.



Paddy field area

Reduction of radiation by making use of shield effects of floodwater

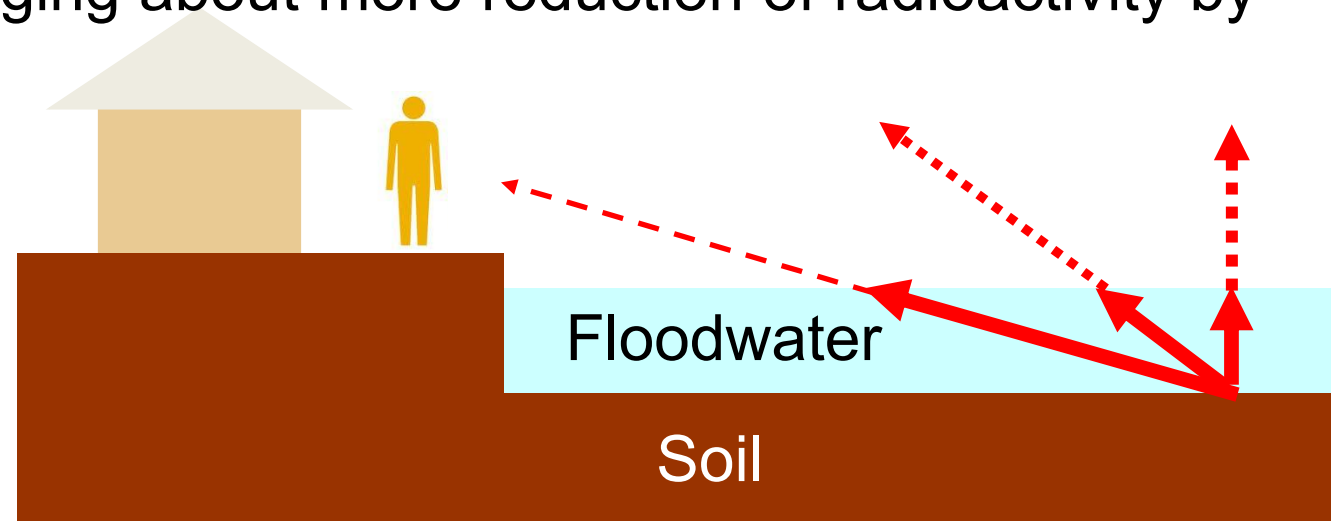
No additional cost
No waste disposal
Immediate applicability

The focus on our attention

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The radioactive ray going to the surrounding homes must emit at a smaller angle to the ground surface.

The radioactive ray with a smaller angle must travel the longer way through water, when the floodwater covers the large area, bringing about more reduction of radioactivity by the floodwater



Objectives

Evaluation of shield effects of floodwater on radiation to the surrounding zones

Step1. Measurement at the experimental field



Step2. Model development



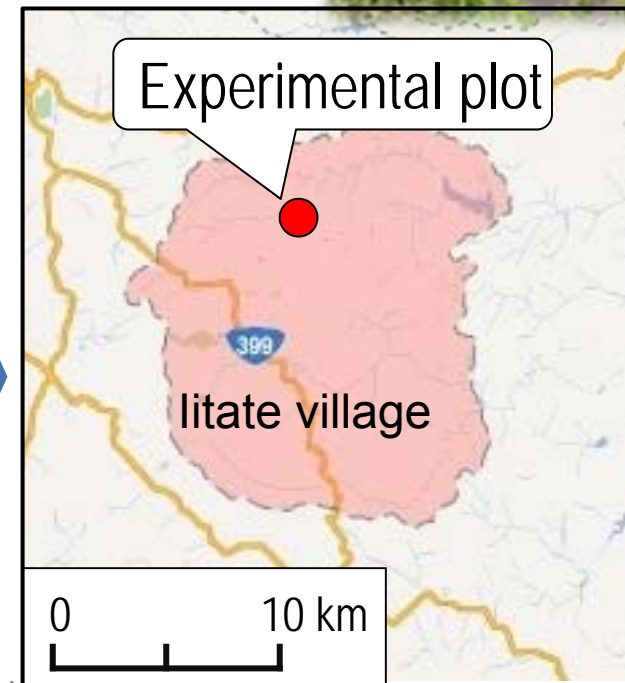
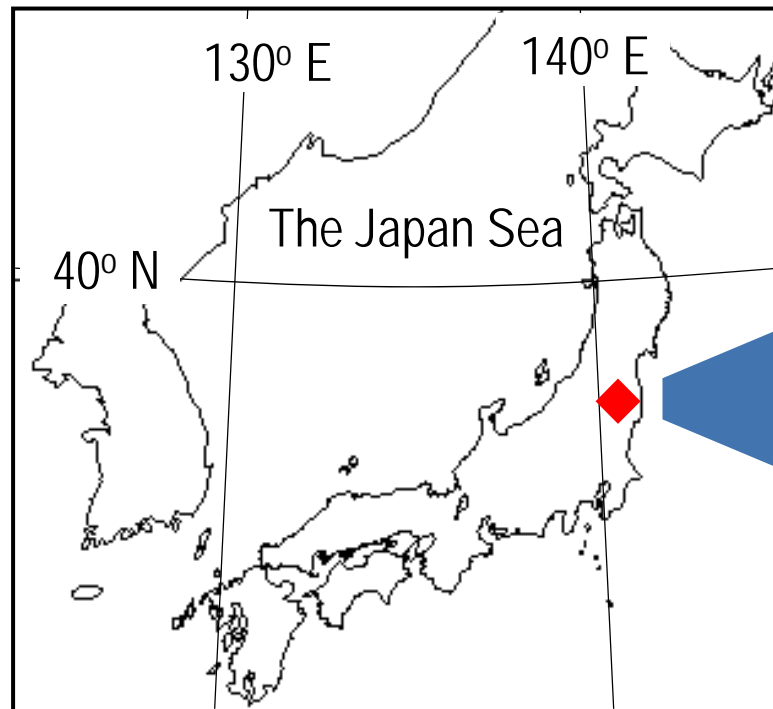
Step3. Comparison between the field observation measurements and the model calculation

Experimental plot

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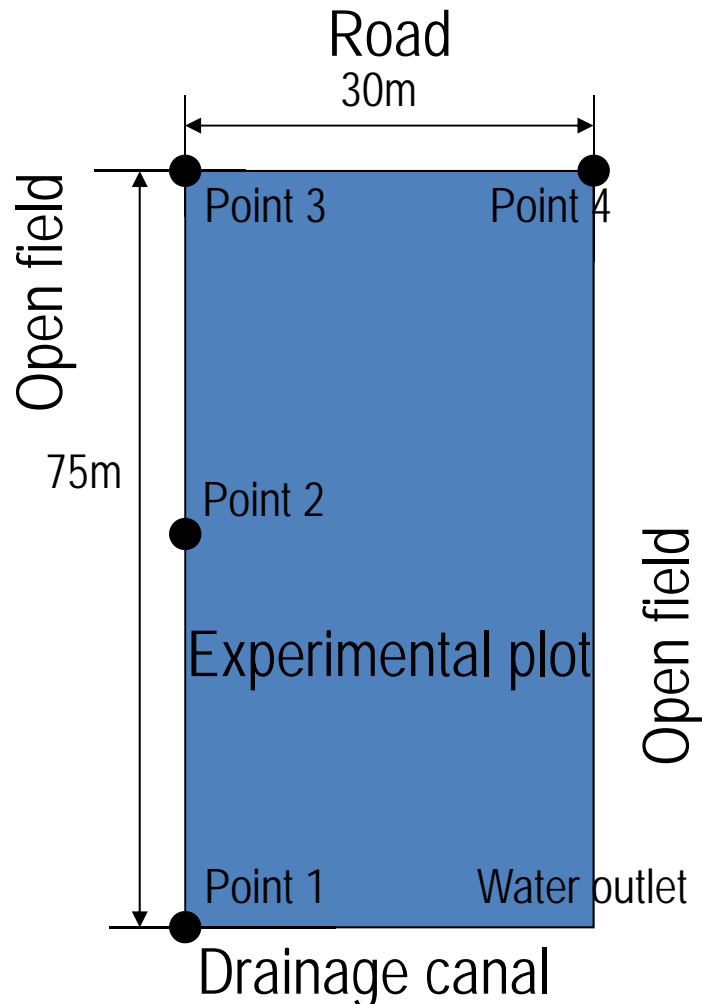
A paddy field plot was selected for the experimental plot in litate village.

- Distance from the destroyed nuclear plant: about 44.6 km
- After the accident:
 - March 2011 – April 2012: abandoned
 - May 2012: puddling



Observation methods

Plan of the experimental plot



Experimental period

from Oct. 13, 2012, 17:00
to Nov. 10, 2012, 12:00

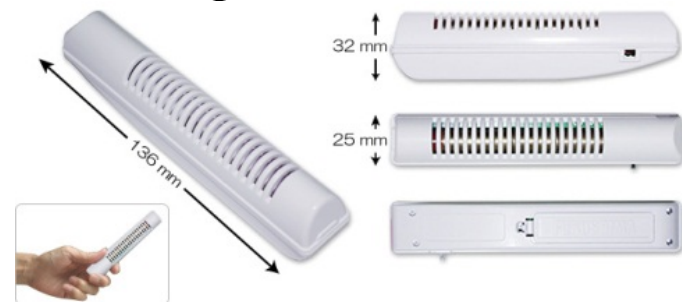
No significant rainfall during the
experimental period

Measurement

Point 1, 4: dosimeter

Point 2, 3: dosimeter,
water level sensor

Dosimeter: Geiger counter



measured for 25 min



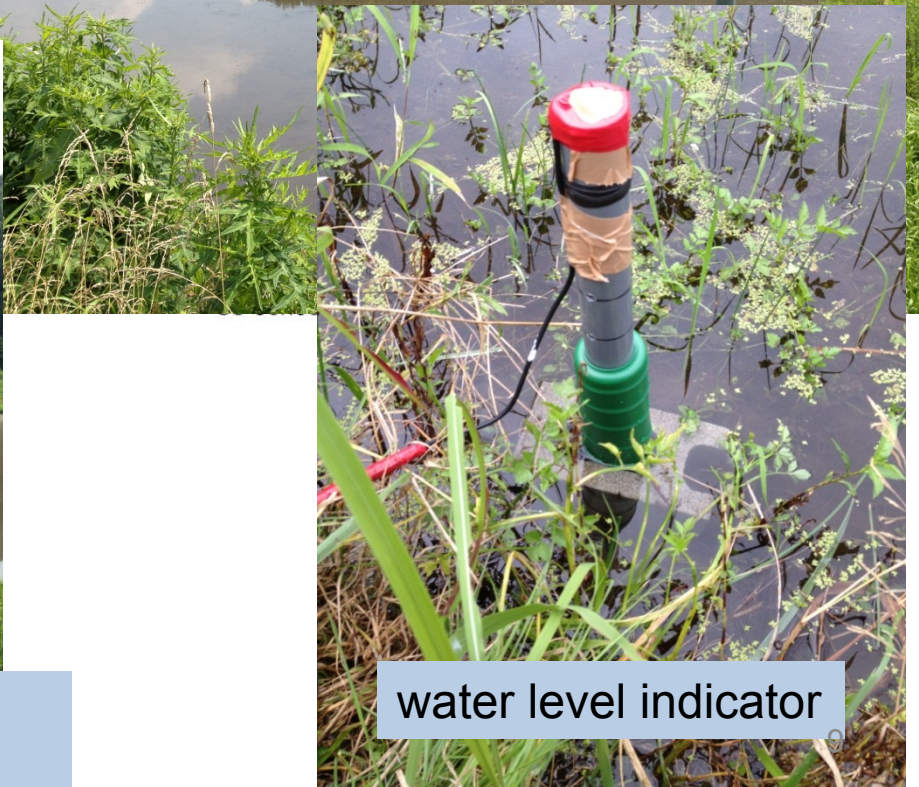
Paddy fields infested by wild boar



paddy flooding
(July 29 2012)

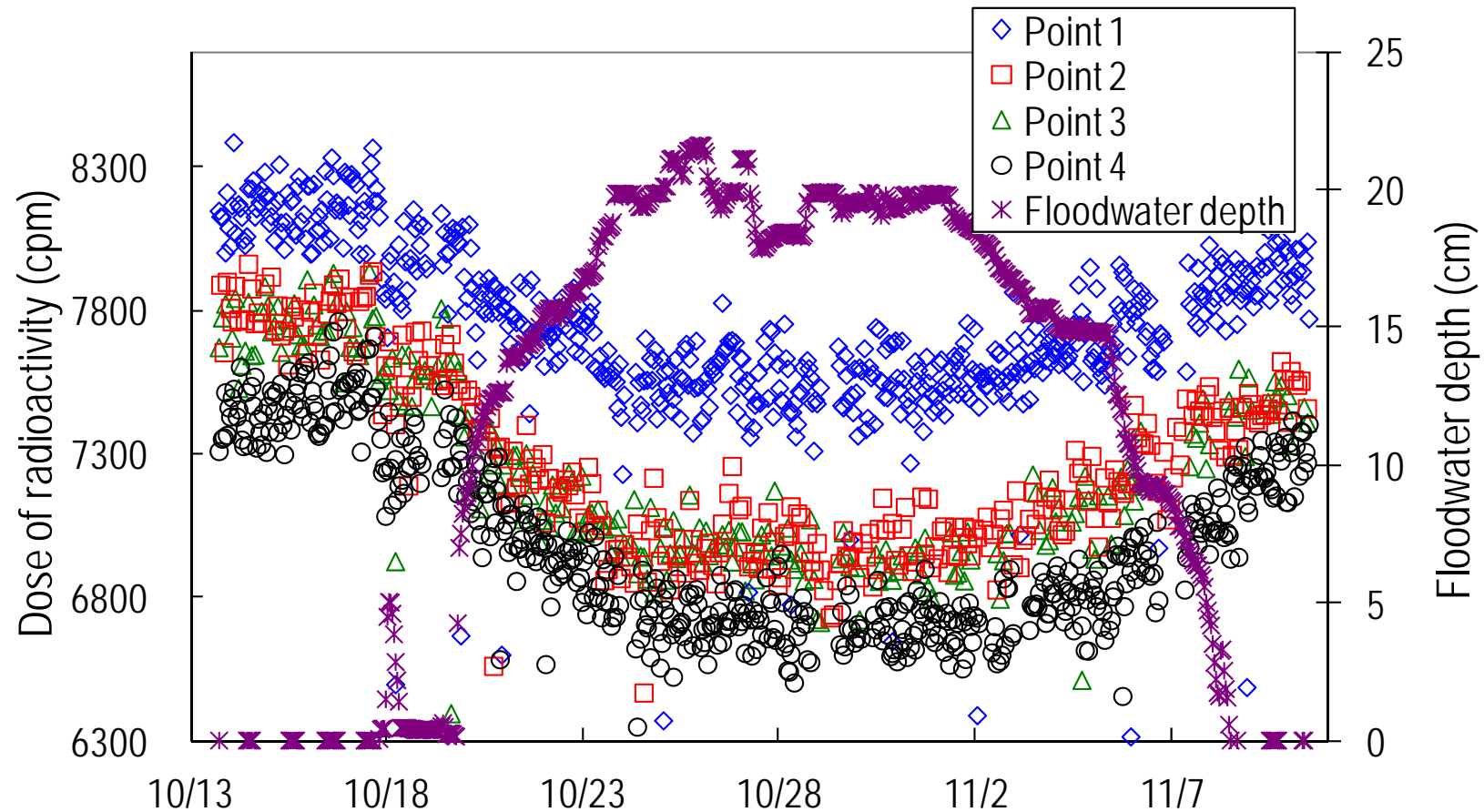


Installation of radiation meter
(July 29)



water level indicator

Observation results



Reduction of radioactivity by the floodwater was verified.
The initial radioactivity values were different among the points.

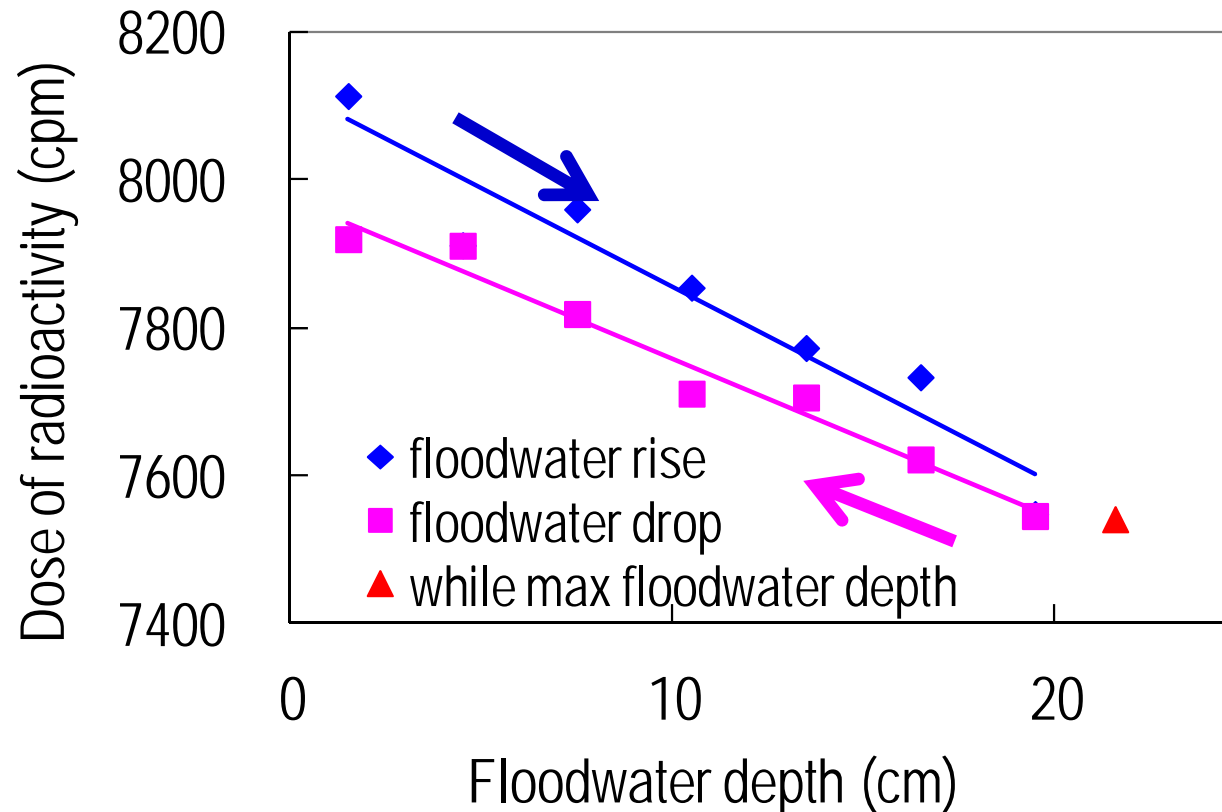
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Observation results (time variation)



Time variation of the radioactivity and the floodwater depth at Point 1 throughout the experiment period

At all the observation points, the radioactivity did not return to the initial value when the floodwater was fully drained at the end of the experiment.

Model development

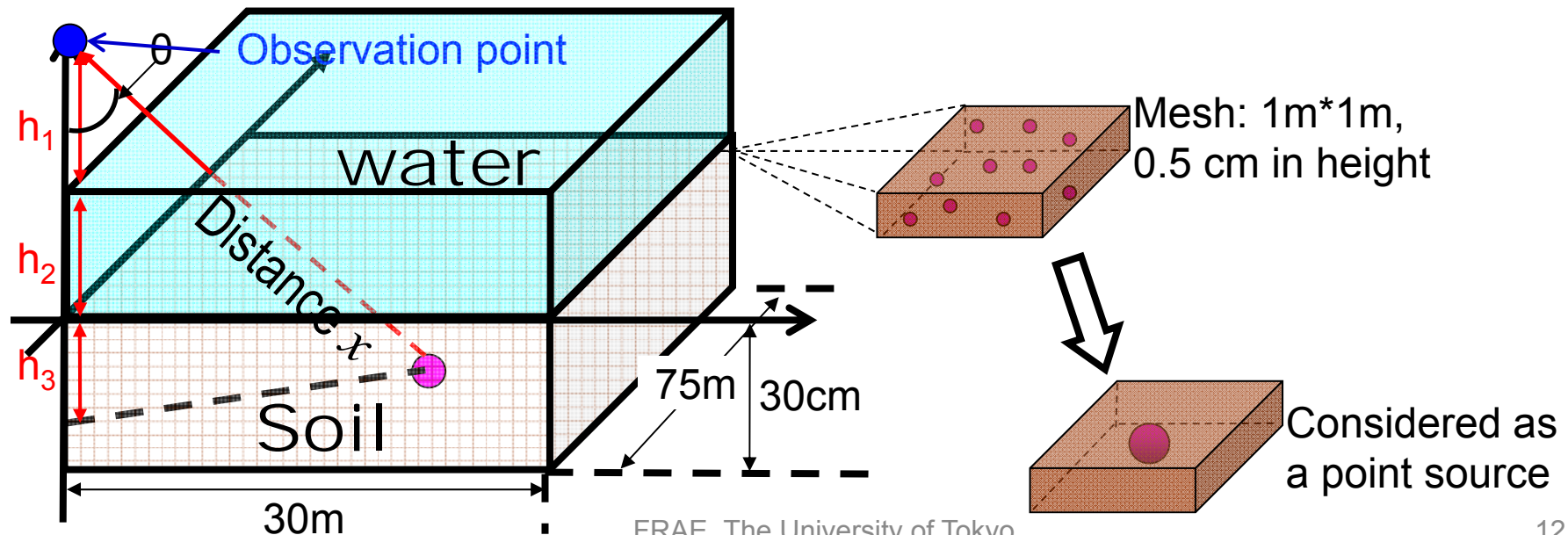
Gamma rays from 3D distributed point sources in the soil were integrated with attenuation by the three layers (soil, water, air).

$$d\phi_{n,m,l} = \frac{dQ}{4\pi x_{n,m,l}} \exp\left[(\mu_1 h_1 + \mu_2 h_2 + \mu_3 h_3) \sec \theta_{n,m,l}\right]$$

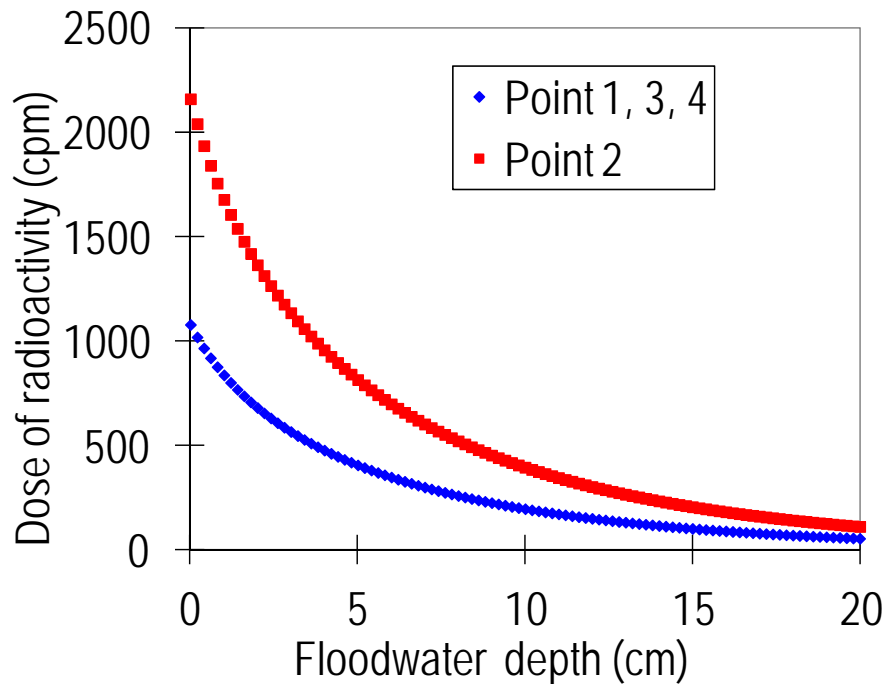
$$\phi_{all} = \sum_{n,m,l} d\phi_{n,m,l}$$

ϕ : photon flux at the observation point ($\text{count} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)
 dQ : photon flux emitted from point sources ($\text{count} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$)

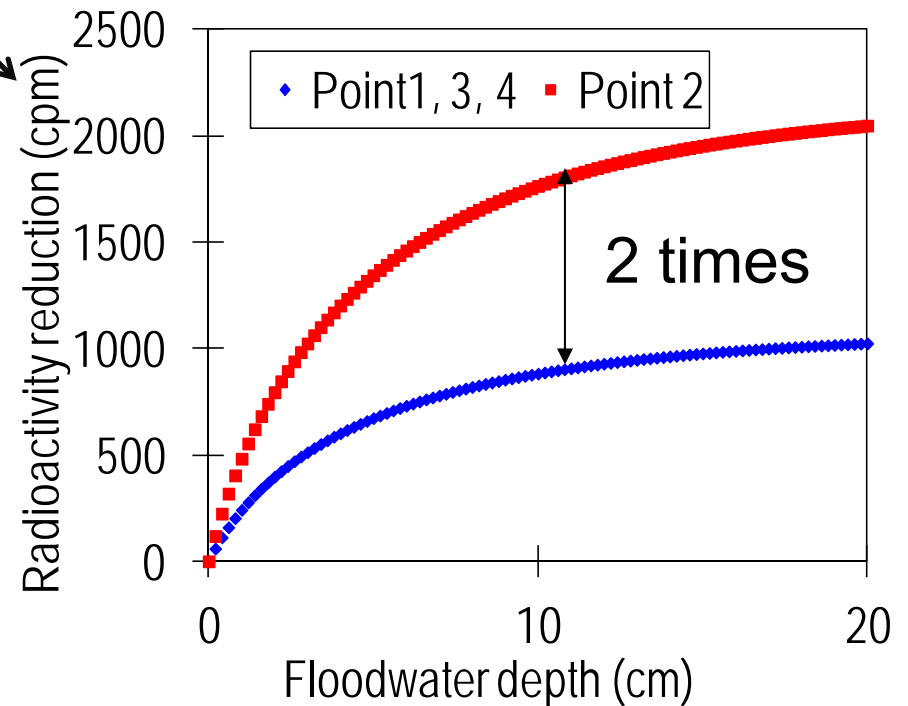
μ_1, μ_2, μ_3 : attenuation constant of air, water, soil (m^{-1})



Radioactivity difference between no floodwater and a certain depth of floodwater



Relation between the dose of radioactivity and the flood water depth



Relation between the radioactivity reduction and the floodwater depth

The reduction of radioactivity from the paddy field soil by the floodwater was reproduced by the model

Step1. Measurement at the experimental field

➤ Reduction of radioactivity by the floodwater was verified.

Step2. Model development

➤ The reduction of radioactivity from the paddy field soil by the floodwater was reproduced by the model.



We are now measuring radioactivity at a paddy field in front of a house where 93 mother and 93 son live.