

M. Yoneda, Y. Shimada, D. Setouchi, R. Kato, S. Fukutani¹ and M. Ikegami¹

Faculty of Engineering, Kyoto University

¹*Institute for Integrated Radiation and Nuclear Science, Kyoto University*

INTRODUCTION: The procedure to the final disposal of the waste polluted with radioactive Cs in Fukushima is far from well established. In carrying out a middle storage of the polluted waste and its final disposal, it is necessary that behaviors of radioactive Cs in the wastes are clarified and a realistic method is suggested to estimate leakage of radioactive Cs to the environment in future to establish the safe disposal method of the waste. This study developed the theoretical equation to estimate the result of Cs elution test of incineration ash containing soil and proposed a practical method to get the parameter in the equation on site.

THEORY AND EXPERIMENT: Based on Langmuir type competitive adsorption theory, and assuming the existence of three types of adsorption sites for Cs in soil, which are So type: exchangeable adsorption site mainly on organic matter; Ss type: exchangeable adsorption site mainly in clay matrix; and Sf type: almost unchangeable adsorption site in soil called frayed edge site. Then, adsorbed Cs is expressed by the following equations:

$$[Cs-S] = [Cs-So] + [Cs-Ss] + [Cs-Sf] \quad (1)$$

$$[Cs-So] = [So_{max}] b_{Cs-So} [Cs^+] / (1 + \sum_i b_{i-So} [M_i]) \quad (2)$$

$$[Cs-Ss] = [Ss_{max}] b_{Cs-Ss} [Cs^+] / (1 + \sum_i b_{i-Ss} [M_i]) \quad (3)$$

$$[Cs-Sf] = [Sf_{max}] b_{Cs-Sf} [Cs^+] / (1 + \sum_i b_{i-Sf} [M_i]) \quad (4)$$

where,

[Cs⁺]: concentration of Cs⁺ in eluate (meq/mL)

[M_i]: concentration of cation i in eluate (meq/mL)

[Cs-S]: adsorbed Cs to solid phase in soil (meq/g)

[Cs-So], [Cs-Ss], [Cs-Sf]: adsorbed Cs to So type, Ss type, and Sf type adsorption site (meq/g)

Considering the practical situation of incineration ash containing soil, the elution ratio E_{Cs} (%) by standard heavy metal elution test of Ministry of Environment is expressed by the following equation:

$$E_{Cs} = 100 / (1 + (a/R)RIP/[K^+]) \quad (5)$$

where,

a: weight containing (or mixture) ratio of soil in incineration ash,

R: weight ratio of incineration ash and eluate,

[K⁺]: concentration of K⁺ in eluate (meq/mL).

The efficiency of Equation (5) is considered by the following experiment:

A quantity of Cs is added to Refuse Derived Fuel (RDF), then it is mixed with a certain amount of forest soil, then it is incinerated at 500 degree C for three hours, and then it is eluted by the method of elution test of Ministry of Environment.

RESULTS AND DISCUSSION: The elution ratio estimated by equation (5) is compared with observed value in Fig.1. It shows that equation (5) can well estimate the elution ratio of Cs from incineration ash containing soil, when the soil mixture ratio is not small. Equation (5) also shows that it is not necessary to measure the soil mixture ratio a and the concentration of K⁺ respectively, but it is enough to measure the value of a/[K⁺]. We also showed that the ratio of a/[K⁺] can be estimated from the ratio of Si and K measured by a portable XRF instrument:

$$a/[K^+] = (M_K R) / (1000 r_{Si} ([K/Si] - r_K / r_{Si})) \quad (6)$$

where,

M_K: atomic mass of K,

r_{Si}: weight ratio of Si in soil,

r_K: weight ratio of K in clay matrix

[K/Si]: weight ratio of K and Si measured by XRF.

It is expected that elution ratio of each sample can be estimated on site using XRF measurement and equation (5) and (6).

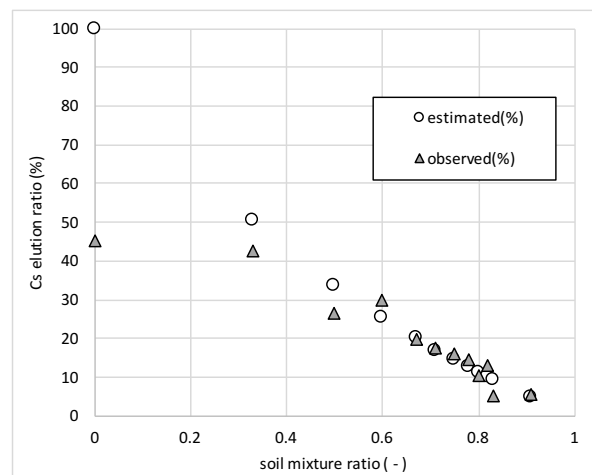


Fig.1 Comparison of estimated and observed elution ratio of Cs from incineration ash depending on its soil mixture ratio.

CO10-2 Ethnographic Study of Radiation Regulation for Victims Living in a Low Dose Radiation Field post National Decontamination Act in Fukushima

M. Takagaki, K. Uno and SI, Masunaga¹

Louis Pasteur Center for Medical Research

²Institute for Integrated Radiation and Nuclear Science, Kyoto Univ

INTRODUCTION: In FY 2017, we interviewed the scientists of IIRNS about the responsibilities of science on Fukushima nuclear accident, and heard precious opinions. We sincerely appreciate them for their many suggestive comments. In particular, the necessity of ethnography on regulation of radiation dose was discussed. Therefore, this time we analyzed the numerical values of environmental radioactivity in Fukushima Iitate village and feelings of villagers from long-term investigation and summarized it in this report as ethnography of radiation regulation.

Many of the villagers who had gone back to home in Iitate were elderly. The reason for many villagers to return home while they know that their village is still contaminated with low dose radiation was a sense of unity with previous living for agriculture. Elderly people who can only find living in the village life have returned home while they also aware of the radiation hazard after national decontamination act.

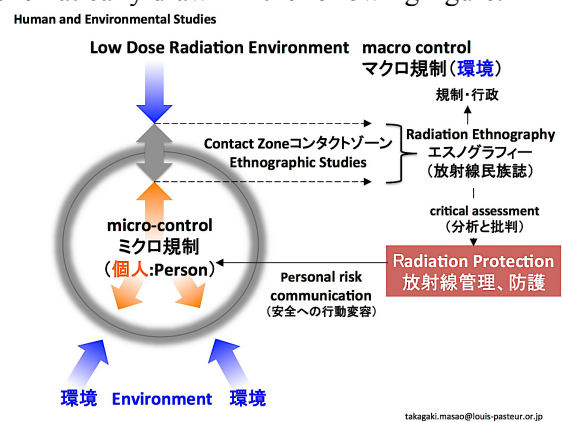
NARRATIVE: Mrs. S who came back to Sasu says that *in our refuge where my husband and I have been evacuated, even when our children and grandchildren who live outside the prefecture come to visit there are no places to sleep for a narrow floor. Because it was canceled evacuation on June 2017, we decided to return to the living home in Iitate to greet the grandchildren in a large house. Although it is not good that grandchildren stay for about two or three days in low dose radiation field but we think that 2-3 days exposure might be safe for their radiation protection. There is one other reason to return. Since I had been always listening to grandpa and grandma's narratives of hardship for building our house and keeping farm in Iitate village, we thought that it was quite natural for us to protect our homes then we decided to go back to our village.*

NARRATIVE: Mr. N who came back to Ohkura says that *after returning home, we made vegetables by putting compost in the decontaminated hothouse. There is unfortunately 100-200Bq in the vegetables experimentally grown there. But most of all that I want to do is to contact with the soil. When I am cleaning the flowerbeds and giving fertilizer and fertilizer, I forget about worries and anger, I feel very calm. It is mysterious. Fear for low dose radiation hazard does not leave from my head and the bottom of my heart. However happiness to make vegetables and flowers in Iitate that I could not do for seven years so far surpass my fear. Even after decontamination, we know radioactivity still*

remains in the soil. However, we thought that we would not be relieved at the refuge at all, we decided to return as a place to relax.

The villagers will come back to their villages by giving priority to their living although they know the risk of the low-level radiation environment. Scientist's explain to the villagers about the risk of low level radiation for the purpose of literacy for radiation protection might not be effective anymore. Many other narratives will be handed over Takagaki's second doctoral thesis due to space limitations.

DISCUSSION: A contact zone between macro control (environment) and micro control (person) is schematically drawn in the following figure.



It is difficult for villagers whose communities are damaged to act collectively (Hannah Arendt, 1906.10.14. - 1975.12.4.). Meanwhile, it seems that the bio-politics that encourages villagers to go home in the low-level radiation environment seems to have further divided the community through villagers' management and enclosure (Michel Foucault, 1926.10.15. - 1984.6.25.).

When the evacuation direction was canceled on June 2017, because the community was further divided by being left to the free will of the villagers rather than the joint return, group activities became difficult in subsequent litigation activities. As pointed out by Arendt, collective activities will be difficult unless the group becomes monolith once again.

We scientists are forced to simply restrict with numerical values of radiation when doing radiation protection, but in reality the radiation contamination should be carefully managed by taking into consideration the thought of the victims lurking in various ways in the contact-zone.

Acknowledgments: I would like to thank the scientists at IIRNS who gave us suggestive many comments on a several hours interview and also thank the villagers of Iitate Village who accepted interview willingly for more than several years. This study is financially supported by JSPS grant (No.17K18536).