1–8 Retention of Mobile Radiocesium in Forest Surface Soils
— Quantifying Microbial Uptake and Abiotic Adsorption —

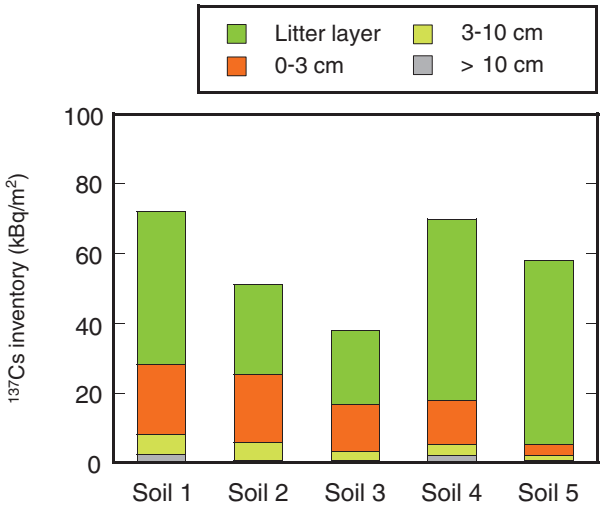

Fig.1-16 Vertical distribution of ^{137}Cs in forest soils three months after the accident
At five forest sites in Fukushima prefecture, 50%–91% and 6%–39% of the total ^{137}Cs deposition were observed in the aboveground litter layer (■) and the topmost (0–3 cm) soil layer (■), respectively.

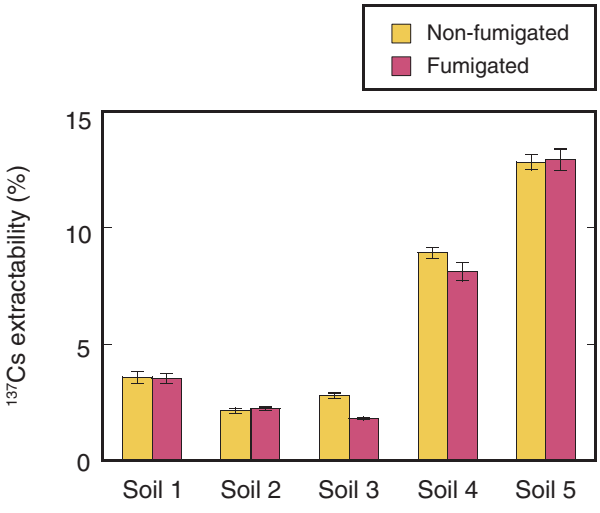

Fig.1-17 Extractability of ^{137}Cs in five forest surface (0–3 cm) soils
Cesium-137 was extracted with K_2SO_4 from soils before (non-fumigated) and after (fumigated) chloroform fumigation. No increase in the ^{137}Cs extractability was observed after the destruction of microbial biomass by chloroform fumigation.

The accident at the TEPCO's Fukushima Daiichi NPS released a huge amount of radiocesium into the environment and caused serious radioactive contamination of forest ecosystems. Our investigation, which was conducted in Fukushima Prefecture three months after the accident, revealed that >89% of the cesium-137 (^{137}Cs) deposited onto forest floors remained in the aboveground litter and topmost (0–3 cm) soil layers (Fig.1-16). In forest ecosystems affected by the accident at the Chernobyl NPS in 1986, ^{137}Cs has reportedly still been observed in surface soils and has become a major potential source for soil-to-plant transfer. Therefore, a better understanding of the mechanisms of retention and migration of ^{137}Cs in forest surface soils is urgently needed.

We focused on microbial involvement in the retention process of mobile ^{137}Cs in forest surface soils because some types of microorganisms in soils are believed to accumulate ^{137}Cs and thus influence the cycling of ^{137}Cs in forest ecosystems. Surface (0–3 cm) soil samples were collected from five forest sites in Fukushima Prefecture one year after the accident, and the following experiments were conducted.

First, soils were extracted with potassium sulfate (K_2SO_4) solution, and the extracts were analyzed for ^{137}Cs. The extraction process liberated 2.1%–12.8% of the total ^{137}Cs as easily exchangeable ions from the soils. Two soils with a higher content of clay-sized particles and organic carbon showed higher ^{137}Cs extractability (Fig.1-17, Soils 4 and 5). Next, the soils were fumigated with chloroform to destroy microbial biomass and then extracted with K_2SO_4. Microbial biomass was extracted from all of the soils; however, no increase in the ^{137}Cs extractability was observed (Fig.1-17).

The results indicate that the uptake of ^{137}Cs by soil microorganisms is less important for retention of mobile ^{137}Cs in the forest surface soils than ion-exchange adsorption by abiotic components. We are now conducting a similar experiment on litter and soil samples collected under different meteorological conditions to fully understand the role of soil microorganisms in controlling the mobility of ^{137}Cs in natural biotic systems.

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Reference

Koarashi, J. et al., Retention of Potentially Mobile Radiocesium in Forest Surface Soils Affected by the Fukushima Nuclear Accident, Scientific Reports, vol.2, no.1005, 2012, p.01005-1-01005-5.