Distribution and deposition rate of $^{137}$Cs and $^{134}$Cs from litter to forest soil
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1. Introduction
The mega earthquake that rampaged north-east Japan on March 11, 2011 has triggered tsunami in Pacific Ocean. This powerful tsunami hit and destroyed the Fukushima Daiichi Nuclear power plant. As a result about 70,000 terabecquerel radionuclide materials were believed to be discharged to the atmosphere (NISA, June 2011). When the cloud of radionuclide material pass over the forest ecosystem (as radiodust-sinker), radionuclides are trapped by canopy and deposited to the forest floor through dry, litter, and wet depositions. Litter-fall, as a key process of nutrient cycling in forest ecosystem, plays a great role in transferring canopy-trapped radionuclides to the forest soil (Bunzl et al, 1989; Livens et al., 1992; Strebl et al 1999). Information on transfer mechanism is therefore vital for understanding the behavior of the radionuclides, to make uses out of them and to devise decontamination mechanisms. We are therefore monitoring the of Fukushima derived $^{137}$Cs and $^{134}$Cs deposition rate to forest soil via litter in Japanese cypress ($Chamaecyparis obtusa$ Sieb.et Zucc.) plantation forests located approximately 160 km from the crippled nuclear power plant.

2. Methods
Soil was sampled using core sampler (internal diameter of 5cm and length 30cm) over the watershed by percussion manually to the ground. For better representation of each sampling point, three replicate core samples were taken and were merged at each respective soil depth in post sampling process. Litter is being collected since November 2010 with four litter (1m x1m each) traps at one meter above the ground. The soils and litters samples were oven-dried at 110°C for 24 h, disaggregated by gentle grinding, and passed through a 2-mm sieve. A soil fraction of < 2 mm was placed in a plastic bin and the radionuclide activities were quantified by using gamma ray spectrometry ($^{137}$Cs at 662keV and $^{134}$Cs at 604keV).

3. Results
The ratio of $^{134}$Cs to $^{137}$Cs in litter was 1.007 and the contribution of Fukushima nuclear accident to $^{137}$Cs soil inventory can therefore estimated according to the following formula:

$$^{137}Cs\ \text{Fukushima contribution} = \frac{^{134}Cs\ \text{in soil}}{^{134}Cs\ \text{ratio in litter}}$$

In absence of soil erosion scenario, litter has contributed 71% of $^{137}$Cs and 97.8% of $^{134}$Cs to their respective total soil inventories. This makes litter the main conveyor of atmospheric radionulides to forest soil.

The downward velocity ($D_{av}$) of the two radionuclide in the soil has been evaluated based on the relaxation depth as follow: $D_{av}$ (cm y$^{-1}$) = $\tilde{z}$/$\tau$ = $\tilde{z}$/$\lambda$
(Dorr and Munnich, 1991); Where: $\tilde{z}$: relaxation depth (where the activity decreased to 1/e of the activity in surface soil $\lambda$: decaying constant (y$^{-1}$). Since $^{137}$Cs has Chernobyl remnant in the soil, it has been detected up to 30 cm soil depth and has shown relatively faster downward velocity. Whereas $^{134}$Cs is total originated from Fukushima accident and its depth is limited to upper10 cm soil layer at 1.6 cm y$^{-1}$ downward velocity.

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