Distribution of radiocesium in Japanese cedar and Japanese konara oak forests of the Abukuma Mountains, Fukushima

*Tadafumi Niizato[1], Yoshito Sasaki[1], Takayoshi Watanabe[1], Satomi Ito[1], Hiroki Amamiya[2]

1. Japan Atomic Energy Agency, 2. QJ Science

An understanding of long-term environmental dynamics of radiocesium in forested area, which is released by the TEPCO' s Fukushima Dai-ichi Nuclear Power Plant accident, is a key issue for predicting the future radiocesium distribution and forest products radioactivity, especially for Cs-137 (hereinafter, radiocesium) with long half-life of 30 years. In this paper we present the radiocesium distribution in an evergreen Japanese cedar and a deciduous Japanese konara oak forests of the Abukuma Mountains, Fukushima.

An investigation was conducted in October 2015 and September 2017 at Japanese cedar stand and in October 2018 at Japanese konara oak stand adjacent to the living area. The average annual rainfall (1981–2010) is 1,221 mm and 1,465 mm in the konara oak and the cedar stands, and tree density is 791 trees ha^{-1} and 740 trees ha^{-1}, respectively. The breast height diameter has mode value of 10–14 cm and 25–30 cm in the konara oak and the cedar stands, respectively. Radioactive contamination in both stands is approximately 500 kBq m^{-2} via airborne monitoring results as of December 28, 2012. We estimated the radiocesium distribution in both stands using the forest floor litter and mineral soil layers as a belowground part and the tree as an aboveground part.
Aboveground tree samples were collected by cut-down of 3 konara oak and 5 cedar trees with representative breast height diameter base on the every-tree measurement of each stand. After the biomass measurement of each tree components (leave, twig, bark, sapwood, and heartwood), radiocesium activities of the dried and pulverized tree samples were measured using Ge semiconductor detector. The aboveground radiocesium inventory (Bq m^{-2}) was calculated by multiplying the radiocesium amount per tree by the tree density. The radiocesium amount per tree was calculated by multiplying the tree biomass per tree by the radiocesium activities of each tree component.
For underground litter layer and soil samples until a depth of 20 cm were collected using a scraper plate with 450 cm^2 area. Soil samples in a depth of 20 cm or more were collected using cylinder sampler with 100 cm^3 volume by 10 cm depth interval up to 1 m depth. Radiocesium activities for the litter and soil samples were measured using Ge semiconductor detector after drying and crushing the samples. The belowground radiocesium inventory (Bq m^{-2}) was calculated using the dry sample weight, radiocesium activity, and soil bulk density.

Approximately 80% and 90% of radiocesium existed in the belowground litter and soil layers of the konara oak and the cedar stands, respectively. The radiocesium inventory of the litter layer in both stands has decreased with time, whereas the inventory of topsoil increased. The rate of cedar needleleaf radiocesium inventory to the total inventory of the stand has decreased from 2.2% in October 2015 to 0.6% in September 2017. This annual decline of the needleleaf radiocesium inventory is almost equal amount to the reduction of total radiocesium inventory of the aboveground cedar tree from 4.8% to 3.0%. Annual change of radiocesium inventory in the konara oak tree is not capable of identification by a single survey, but the rate of radiocesium inventory in the konara oak wood (sapwood plus heartwood) is 1.7%, while that in the cedar wood is relatively low as 0.3%.

These results indicate that the distribution of radiocesium in the forest is similar to the distribution of tree

fine root responsible for absorption of inorganic elements, nutrients, and water. On the other hand, the investigation results show that total radiocesium inventory of the cedar tree has decreased with time due to removal process of radiocesium from tree such as litterfall, even if radiocesium has transferred from the soil to the tree via fine roots. A monitoring survey is needed to reveal whether the decreasing trend of the cedar tree is applicable to the konara oak tree.

Keywords: TEPCO’s Fukushima Dai-ichi Nuclear Power Plant accident, radiocesium, Japanese konara oak, Japanese cedar

