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Study of the radiocesium dynamics in the Fukushima forest ecosystems

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Accident at Fukushima Dai-ichi NPP on March 11, 2011, has resulted in release into the environment of large amounts of radiocesium (134Cs and 137Cs) and in radioactive contamination of terrestrial and aquatic ecosystems. Up to 2/3 of the most contaminated territory in Fukushima prefecture is covered with forests, and efforts aimed at revitalization of this territory should include, therefore, elaboration of the forestry strategy. In particular, understanding of the radiocesium dynamics in the ecosystem compartments is necessary for the reliable long-term prognosis.

Numerous studies revealed and quantified the key processes governing radiocesium redistribution in Fukushima forests at the early stage after the accident, when initially intercepted radiocesium was gradually transported from the trees' crowns to the soil surface and profile with precipitations and litterfall, and the general trend was a decrease of the radiocesium total inventory in the forest biomass. However, at the later stage, the radiocesium activities in the biomass compartments can increase due to its root uptake from the soil profile; the two major processes, radionuclide root uptake and its return to soil, will determine the future radiocesium levels in the forest compartments.

Objectives of our study were characterization of the radiocesium distribution at the beginning of the late stage, revealing its dynamics and parameterization of the above-mentioned fluxes for prognosis of the radiocesium long-term redistribution in the typical Fukushima forest ecosystems. The study started at one experimental site (Yamakiya district, Kawamata town, Fukushima Prefecture) in the spring of 2014; to the moment, it has been continuing at several experimental sites in the Fukushima zone characterized by different species composition and soil-landscape conditions.

For the typical Japanese cedar (Cryptomeria japonica) and Japanese red pine (Pinus Densiflora) forests, we determined distributions of radiocesium in the ecosystems and in the aboveground biomass compartments by the end of 2014 or 2015. At the best studied Yamakiya site the radiocesium distributions were determined for the two consequent years. In 2014, about 74% of the total radiocesium inventory at this site was localized in soil, 20% was in the litter, and only 6% was associated with the aboveground biomass. Within the tree compartments, the largest radiocesium activity fraction, about 46%, was observed in old foliage. The aggregate soil-to-wood transfer factor was 0.0011 m2/kg d.w. Based on the radiocesium activities measured in the biomass compartments of the studied ecosystems, we derived the estimates of its main fluxes and compared to the apparent dynamics of its inventories in biomass at the Yamakiya site.