Validation of the Advanced Environmental Transfer and Dose Assessment Model for Radionuclides Released from the Nuclear Fuel Reprocessing Plant in Rokkasho

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Abstract

The first commercial nuclear fuel reprocessing plant in Japan, located in Rokkasho, Aomori Prefecture is now undergoing its final testing using actual spent nuclear fuels. The advanced environmental transfer and dose assessment model (AdvETDAM) was developed for estimating areal and temporal distributions of the radionuclides around the plant and the radiation doses resulting from these radionuclides. To validate the model using actual field data, we measured the concentrations of radionuclides (^{3}H, ^{14}C, and ^{129}I, etc.) in various environmental samples collected at various points around the plant and the environmental γ-ray dose at IES. Because no nuclear fuel rods have been sheared or dissolved at the plant since October 2008, concentration levels of the radionuclides in most environmental samples collected in FY 2012 were similar to the background ones before the plant test operation, excluding several samples of soil and sediment.

Now, we have studied the distribution and transfer of several radionuclides in Fukushima Prefecture to clarify their movement in the terrestrial environment. The obtained results will be used to improve the accuracy of the model prediction in AdvETDAM. We studied: 1) the re-suspension rate of radiocesium in Koriyama City and Namie Town; 2) the radiocesium interception potential (RIP) of farmland soil in Fukushima Prefecture; 3) the transfer rate of radiocesium via two small rivers (the Hiso River and Wariki River) in a mountainous area in Iitate Village, Fukushima Prefecture; and 4) the distribution of ^{3}H in plant and soil samples collected around the Fukushima Dai-ichi Nuclear Power Station (FDNPS).

The re-suspension rate of radiocesium ranged from 10^{-9} to 10^{-11}, which was comparable to other values reported in the literature. Soil-to-plant transfer factor for soybean samples observed in 2011 was negatively correlated with the RIP value in soil. RIP and exchangeable K content in soil were useful indexes for predicting the transfer factor. The discharge rate of radiocesium from the river catchments during 2012 was less than during 2011. We considered that the most of the radiocesium deposited in the catchments has remained on the soil surface.

We collected various plant samples around the FDNPS in March, April, July and August 2011, and measured their free-water tritium (FWT) concentrations. Considerably higher FWT concentrations than the background ^{3}H concentration were observed, and that showed that HTO was released from the FDNPS in the nuclear accident. The committed effective dose from HTO inhalation was roughly estimated by using the FWT concentration obtained. The HTO concentration in the air was estimated from the FWT concentration in plants by using the relationship between the atmospheric HTO and plant FWT concentration through the relative humidity in air. Although the FWT concentration decreased from March to August, we assumed that the value in March continued until the end of July, and the August value continued until the end of December. The HTO inhalation dose about 20 km from the FDNPS was estimated to be roughly 3μSv.

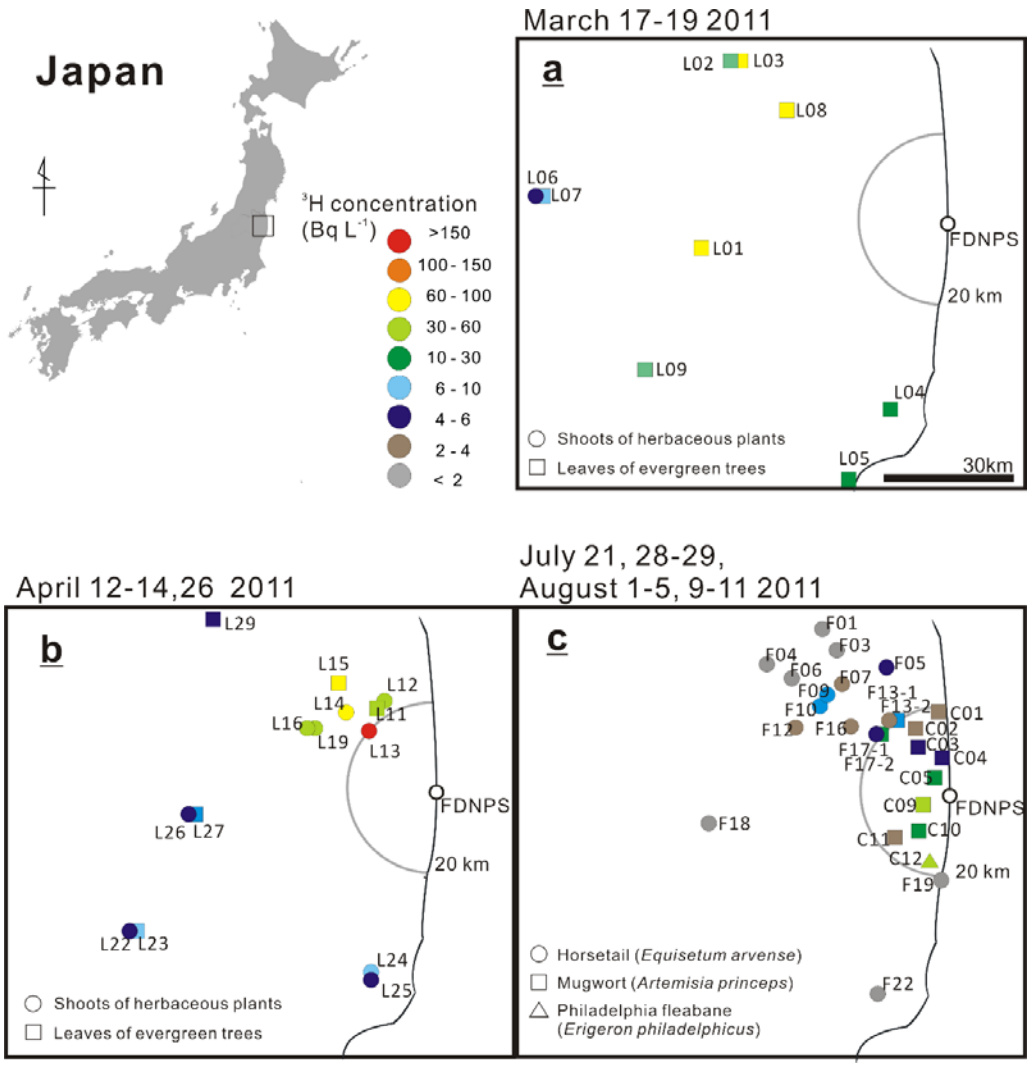

Fig. 1 Free-water tritium (FWT) concentrations in herbaceous plant shoots and evergreen tree leaves collected around Fukushima Dai-ichi Nuclear Power Station (FDNPS).