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

Shinya OCHIAI, Hidenao HASEGAWA, Hideki KAKIUCHI, Shinji UEDA,
Shun'ichi HISAMATSU
Department of Radioecology

Abstract

The first commercial nuclear fuel reprocessing plant in Japan, located in Rokkasho, Aomori Prefecture finished its final testing using actual spent nuclear fuels and is now under safety assessment by the Nuclear Regulation Authority. 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, ^{129}I, etc.) in various environmental samples collected at points around the plant and the environmental γ-ray dose rates 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 2014 were similar to the background ones before the plant test operation, excluding several samples. Iodine-129 deposited on soil and sediment surfaces has still remained at a higher level than each background level.

Since the accident at the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) in 2011, 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. In FY 2014, we studied the following subjects: 1) the re-suspension rate of radiocesium in Koriyama City and Namie Town; 2) the distribution of ^{3}H in plant and soil samples collected around the FDNPP; 3) the discharge rate of radiocesium via two small rivers in a mountainous area in Iitate Village; and 4) the distributions of dissolved and particulate ^{137}Cs concentrations under base-flow conditions in seven river systems in Fukushima Prefecture.

The atmospheric ^{137}Cs concentrations were found to depend on the frequency of wind direction from a higher contaminated area and the re-suspension rate of ^{137}Cs has been gradually decreasing with time. Higher free-water tritium (FWT) and organically bound tritium (OBT) concentrations than the background ^{3}H concentration were observed, reflecting HTO released from the FDNPP accident. These concentrations have been gradually decreasing from 2011 to 2014. The discharge rate of radiocesium from the river catchments of the two small rivers during 2014 was less than that during 2011 and similar to that during 2012, showing that most of the radiocesium deposited in the catchments has still remained on the soil surface. The concentration of dissolved ^{137}Cs in water samples form the seven rivers in each year was significantly correlated with the mean ^{137}Cs inventory in the catchment area above each sampling point during 2012–2014. Those results suggest that the dissolved ^{137}Cs under base-flow conditions originates from the whole area of the catchment, and its concentration is primarily determined by the mean ^{137}Cs inventory of the catchment area. On the other hand, the concentration of particulate ^{137}Cs in river water did not show a clear relationship with the mean ^{137}Cs inventory, indicating that the concentration does not simply reflect the inventory of the whole catchment area.

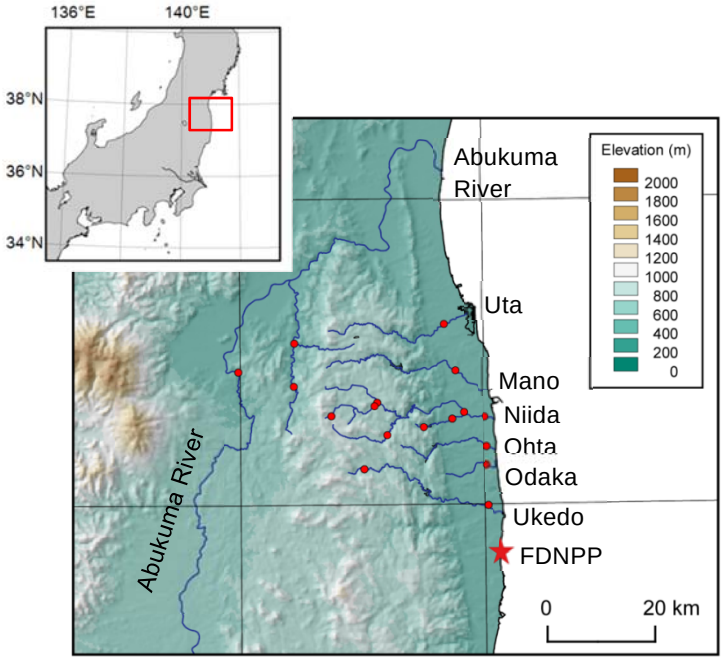

Fig. 1 Sampling points of river water. Map data were based on National Land Numerical Information (Ministry of Land, Infrastructure, Transport and Tourism).

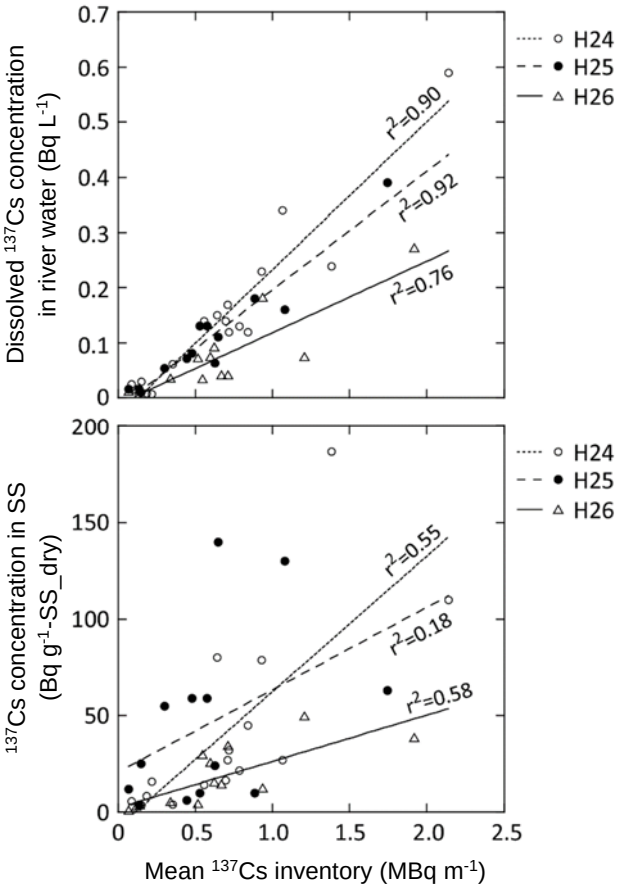

Fig. 2 Relationships between the mean ^{137}Cs inventory in the catchment and the dissolved ^{137}Cs concentration in river water, and ^{137}Cs concentration in SS.