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 final testing using actual spent nuclear fuels is mostly finished for the first commercial nuclear fuel reprocessing plant in Japan, located in Rokkasho, Aomori Prefecture and the plant 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 environmental, agricultural, and livestock samples collected at points around the plant and we also measured the environmental γ-ray dose rates at IES.

Because no nuclear fuel rods have been sheared or dissolved at the plant since October 2008, we found concentration levels of the radionuclides in most environmental samples collected in FY 2017 were similar to the background ones before the plant test operation, excluding several samples. Iodine-129 deposited on soil and lake sediment surfaces around the plant has still remained at a higher level than their respective background levels. We also found that the concentrations of radionuclides (^{3}H, ^{14}C and ^{129}I) in agricultural products, which were produced in an experimental agricultural field at IES for the study of radionuclide transfer from the atmosphere to these products, were similar to their background levels.

To improve the accuracy of the model prediction in AdvETDAM, we have been investigating the distributions and transfer of radionuclides in the terrestrial environment in Fukushima Prefecture after the accident at the Fukushima Dai-ichi Nuclear Power Plant. In FY 2017, we continued to study the following subjects: 1) the re-suspension rate of ^{137}Cs and 2) the discharge rate of ^{137}Cs via rivers. The atmospheric concentrations and deposition fluxes of ^{137}Cs gradually decreased during FY2012 to 2015 with different effective half-lives, however, both half-life values after 2015 have become nearly constant. Clear seasonality was found with a high atmospheric ^{137}Cs concentration in summer and a low concentration in winter which was the same as our previous observation. The wind direction weighted mean re-suspension factor of ^{137}Cs in Namie, Fukushima Prefecture (1.0×10^{-11} - 1.0×10^{-9} in FY 2013 - 2017) has become similar to or lower than the annual mean re-suspension factor (atmospheric ^{137}Cs concentration)/(^{137}Cs deposition density), observed at Chernobyl and in European countries (1×10^{-10} - 1×10^{-6}). Concentrations of dissolved ^{137}Cs in water samples from seven small rivers in Fukushima Prefecture correlated well with the ^{137}Cs inventories in their catchments, with annually decreasing values for the (dissolved ^{137}Cs concentration)/(^{137}Cs inventory) ratio during FY2012-2017.

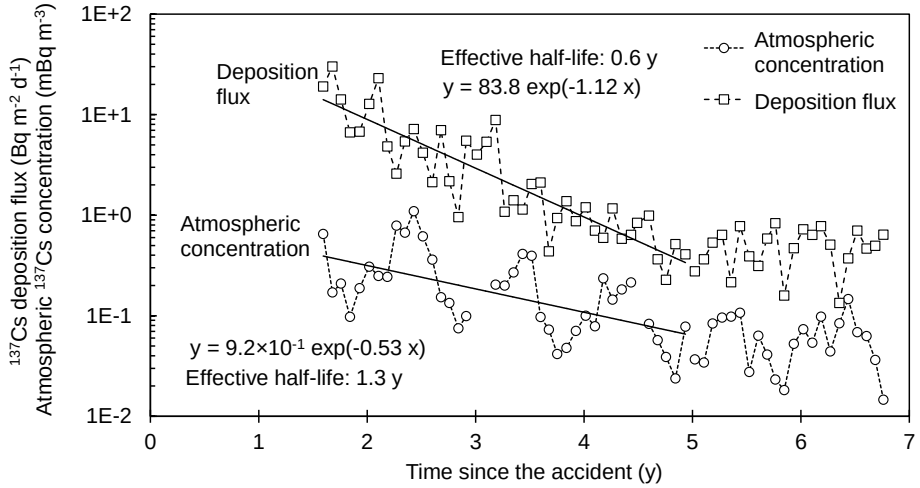

Fig. 1 Temporal variation of averaged monthly atmospheric concentration and deposition flux of ^{137}Cs observed in Namie, Fukushima Prefecture.

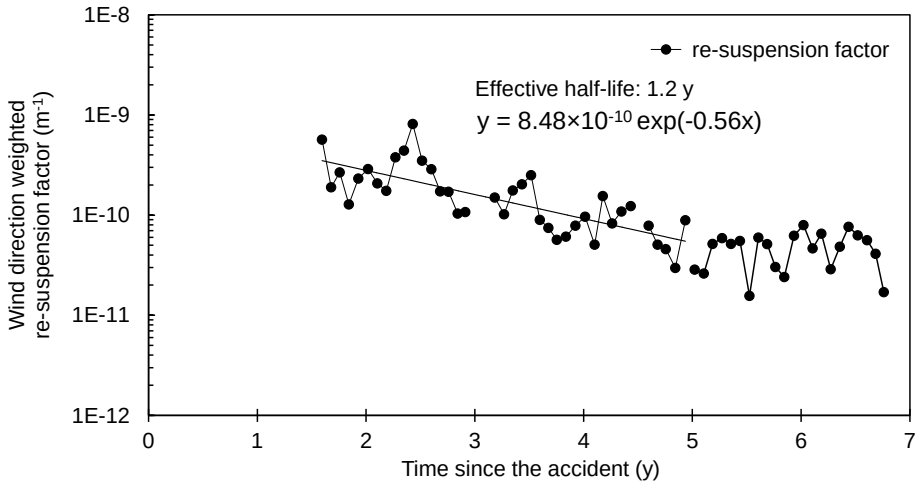

Fig. 2 Temporal variation of the wind direction weighted mean re-suspension factor of ^{137}Cs in Namie, Fukushima Prefecture.