

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 finished its final testing using actual spent nuclear fuels and it is now preparing for full operation. The advanced environmental transfer and dose assessment model (AdvETDAM) was developed to estimate areal and temporal distributions of 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 (^3H , ^{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 2020 were similar to the background ones before the plant test operation, except for several samples. Iodine-129 deposited on soil and lake sediment surfaces around the plant has still remained at a higher level than each background level. The mean ^{129}I deposition fluxes observed at the IES site, Futamata and Hirosaki from FYs 2016 to 2020 were approximately the same level: $2.0 \pm 2.9 \text{E-}6$, $1.9 \pm 3.3 \text{E-}6$ and $2.1 \pm 3.9 \text{E-}6 \text{ Bq m}^{-2} \text{ d}^{-1}$, respectively. In addition, the temporal variations of ^{129}I deposition fluxes at the IES site, Futamata and Hirosaki have shown similar patterns: high in winter and low in other seasons. These observed facts can be reasonably explained by assuming that the ^{129}I discharged from commercial reprocessing plants in Europe was transported long distances by winter monsoons.

To improve the accuracy of the model prediction in AdvETDAM, we have investigated the distributions and transfer of radionuclides in a terrestrial environment in Fukushima Prefecture after the accident at the Fukushima Dai-ichi Nuclear Power Plant. In FY 2020, we continuously studied two subjects: the re-suspension rate of radiocesium; and the discharge rate of radiocesium via rivers. The atmospheric concentrations and fluxes of ^{137}Cs gradually decreased during FYs 2012 to 2015 with different effective half-lives, however, both values after 2015 have become nearly constant. The clear seasonality with high atmospheric ^{137}Cs concentration in summer and low concentration in winter that we reported in our previous studies was not found. The estimated discharge rate of ^{137}Cs from the river catchments of the two small rivers in Iitate Village since 2011 was less than 2% of ^{137}Cs deposited in the catchments, showing that most of the ^{137}Cs has still remained on the soil surface in the catchments.

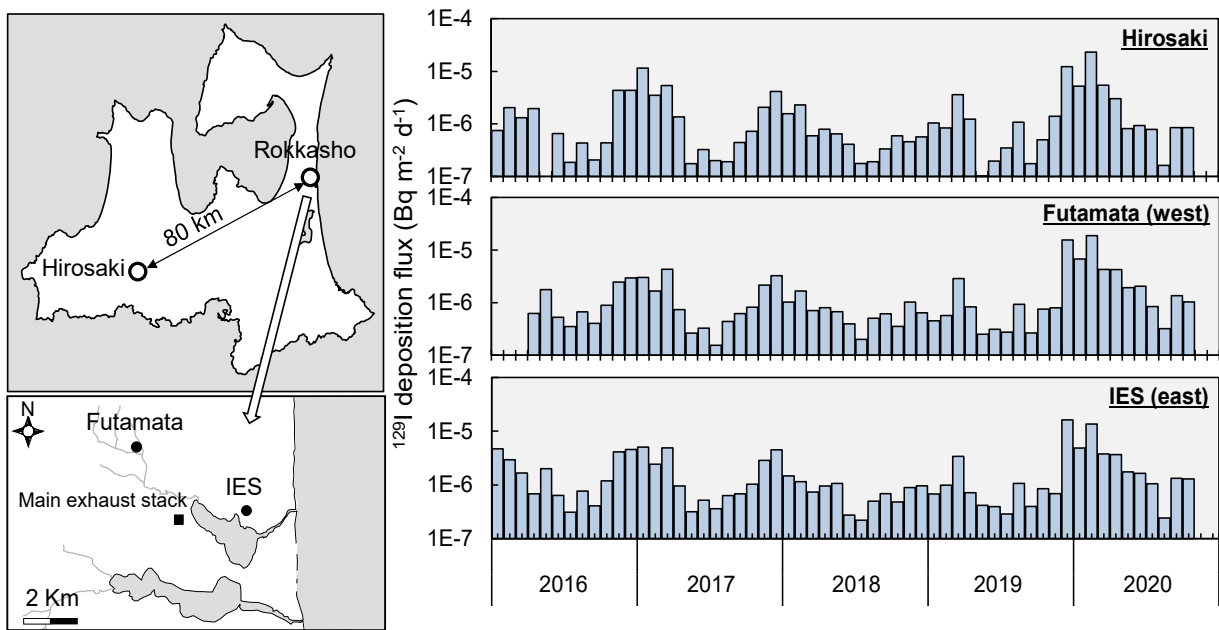


Fig. 1 Temporal variations of ^{129}I deposition flux at the IES site, Futamata and Hirosaki.