Improvement 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

We have developed the advanced environmental transfer and dose assessment model (AdvETDAM 1.1) for radionuclides released from the first Japanese commercial nuclear fuel reprocessing plant located in Rokkasho. The computer code system was developed on personal computers to describe atmospheric dispersion, terrestrial and aquatic transfers, and dose calculations for the released radionuclides. The model consists of an atmospheric dispersion model with a meteorological model (MM5), a terrestrial transfer model, an aquatic transfer model in Lake Obuchi, which is a brackish lake neighboring the reprocessing plant, and its catchment area, and a coastal marine model for the Rokkasho coast.

In FY 2012, in order to improve accuracy of ^{3}H transfer from ground surface to river, we installed two submodels for snow accumulation and melting on the ground into the catchment area model of Lake Obuchi. The introduced submodels were based on the Noah Land-Surface Model and the SWAT model, and could be selected by users. The detailed behaviors of radionuclides on the leaf surface of vegetables, which were obtained in the research carried out at IES, were also installed into the terrestrial transfer model for more realistic estimation of radionuclide concentration in vegetables. The AdvETDAM was updated to version 1.2 by installing the submodels.

In order to improve accuracy of the meteorological model and the atmospheric dispersion model, we optimized various parameters in the models. Monthly gamma-ray dose rates at IES from ^{85}Kr were estimated by the models during April 2006 to October 2008, when significant amounts of ^{85}Kr were released from the plant. Various values were examined for the nudging coefficient used in the meteorological model and for the time-step, the emission gas temperature and the mixing layer height in the atmospheric dispersion model; then the best values for each parameters were determined. The accuracy of the model results was evaluated by using the ratio of the number of estimated values within a factor of two or five of the measured values to the total number of measured values (called the factor of two agreement ratio or the factor of five agreement ratio, hereafter). Finally, the factor of two or five agreement ratios was increased from 41% to 53% and 76% to 94%, respectively. Most effective parameters for the improvement were the emission gas temperature and the mixing layer height.

We collected basic hydrological data from Lake Takahoko for model construction, including the exchange rate of seawater and characteristics in the lake bottom environment (organic matter content, etc.). Electrical resistivity tomography in the subsurface ground was carried out in the river mouth areas of the rivers that flowed into Lake Takahoko to evaluated intrusion of seawater into it. Also, groundwater levels were measured in the catchment area of this lake.

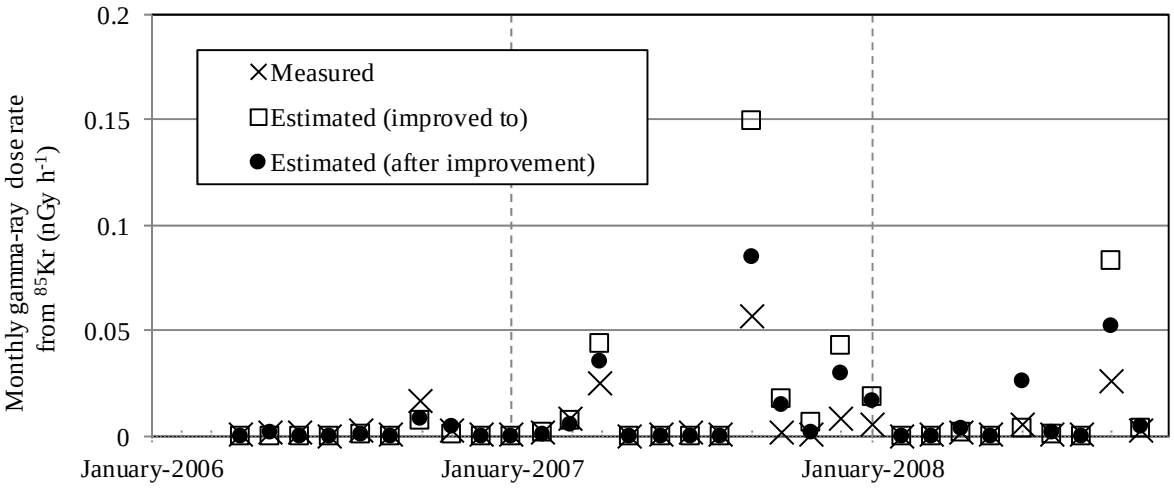

Fig. 1 Monthly gamma-ray dose rates from ^{85}Kr estimated with AdvETDAM and measured at IES during the test operation period using actual spent nuclear fuels.

AdvETDAM calculation conditions: calculation area, 50 x 50 km with a grid resolution of 500 x 500 m; 2,400 m above ground with 26 vertical intervals varying from 10 m to 175 m; calculation period, from Apr. 2006 to Oct. 2008.