Priority Subjects with Limited Terms — **Establishment of Optimal Risk Management**

Assessment of Radioactive Material Diffusion in the Environment and its Remediation Effectiveness

Background and Objective

In order to evaluate and continuously improve the safety of nuclear power plants, it is necessary to carry out preliminary assessments of the environmental impact of radioactive materials on the atmosphere and ocean in the case of severe accidents as well as the effectiveness of preventive measures against nuclear power plant accidents.

The target of this study is to develop techniques for predicting the dispersion of radioactive materials into the atmosphere and ocean, as well as techniques for monitoring radioactive materials and assessing the migration of radioactive materials in marine organisms and forests. Through the development of these techniques, we aim to contribute to improving the safety of nuclear power plants via the assessment of environmental impact.

Main results

1 Prediction of atmospheric dispersion of radioactive materials emitted from nuclear power plants

The research team improved the atmospheric dispersion model to evaluate the deposition amount of radioactive materials emitted to the atmosphere during severe accidents, as well as to evaluate the level of external exposure associated with their deposition on the ground surface. The applicability of the model to the prediction of the atmospheric dispersion of radioactive materials targeting the area within several ten kilometers of the power plant was verified (Fig. 1). In addition, the research team improved the resolution of a wide-area atmospheric transport model and compared the results obtained using the model with the measured values of field experiments. Reproducibility in terms of the grid resolution was also evaluated to identify any flaws in the model.

2 Developing assessment techniques for ocean diffusion of radioactive materials and transfer to marine organism

The oceanic dispersion of these radiocesium in the North Pacific was simulated by considering the direct discharge and the fallout of materials from the atmosphere. The simulation results were in good agreement with the monitoring results because the model can represent the subduction process into the intermediate layer (Fig. 2).*1 The simulation of radiocesium transfer to the marine sediment estimated that the total amount in marine sediment was less than 5% of total amount in seawater.*2 The simulation of radiocesium transfer through the food chain, using initial seawater concentration and depuration rate, clarified the relationship between decrease profiles of seawater and marine organisms. (Fig. 3).*3

3 Assessment of long-term environmental impact of radioactive material in trees

Radiocesium (134Cs + 137Cs) contamination, primarily derived from the Fukushima accident in March 2011, was observed in the leaves and twigs of 17 popular woody species in Japan at mid-growth season in the years 2011, 2012, and 2013. The general average of the radiocesium activities in leaves and twigs observed in 2012 were 64% and 110% of those observed in 2011, respectively, while those observed in 2013 were 19% and 28% of those observed in 2011, respectively (Fig. 4). Thus, the radiocesium activities decreased with time, although the variation in amounts/rates of decrease with the species, sampling part, and position in each stand was not negligible. Particularly, ratios of radiocesium activity between current leaves and 1-year old leaves increased with time, suggesting a translocation of radiocesium from old tissues to newly developed ones. (V13008)

*1 TSUMUNE DAISUKE, et al., Biogeosciences, 10, 5601-5617, 2013.
*2 MISUMI KAZUHIRO, et al., The Oceanographic Society of Japan, Fall meeting, 2013 (in Japanese)
*3 TATEDA YUTAKA, Isotope news, 719, 2014. (in Japanese)

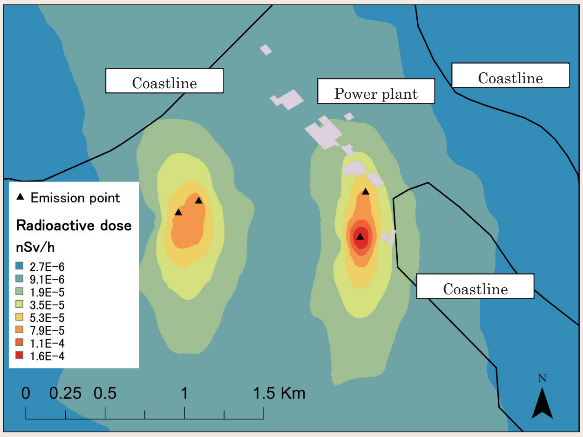

Fig. 1: Example of calculation using the atmospheric dispersion model

An experimental calculation for dispersion of radioactive plume from multiple emission sources was conducted using the data on the height of emission sources and meteorological conditions of surrounding areas in order to evaluate the level of external exposure to radioactive materials (e.g., Cs, I, and noble gas).

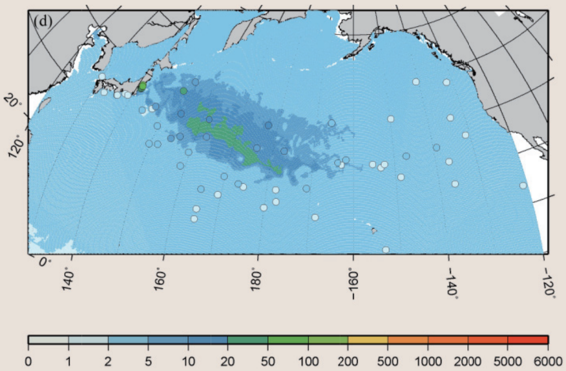

Fig. 2: ^{137}Cs concentration in surface layer of ocean in the North Pacific Ocean from Dec. 2011 to Feb. 2012

The ^{137}Cs concentrations in the ocean in the North Pacific Ocean from Dec. 2011 to Feb. 2012 obtained by simulation were in good agreement with the monitoring results. Color contours represent the simulation results, and color plots represent the monitoring positions and concentrations.

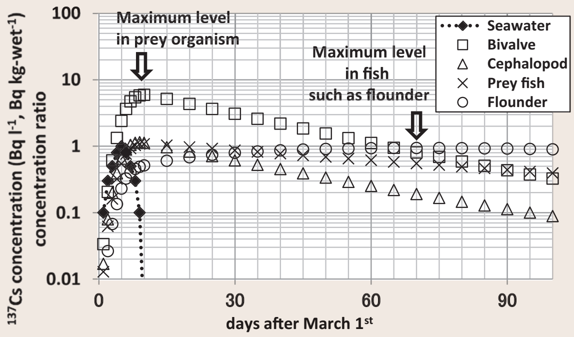

Fig. 3: Simulation of ^{137}Cs concentrations in seawater and marine organisms

The ^{137}Cs concentrations in biota (Bq kg^{-1}) were simulated under certain conditions of radioactive cesium concentration in seawater (increase during 5 days, decrease during 5 days after the 1Bq l^{-1} peak). The ratios of ^{137}Cs concentration in biota to the maximum seawater concentration (1Bq l^{-1}) are also shown on the vertical axis.

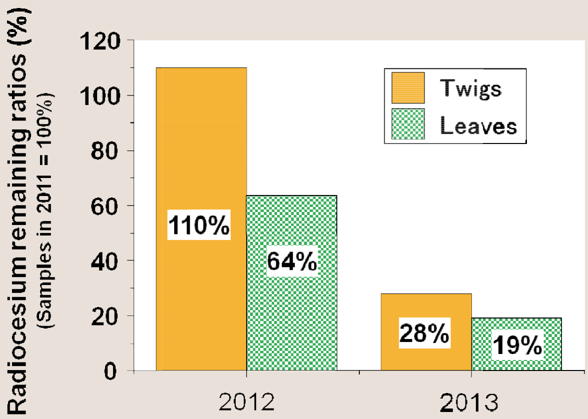

Fig. 4: Yearly transition of radiocesium activity in individual parts

Radiocesium activities in leaves (n = 54-58) and twigs (n = 42-54) of all stands/positions/species were averaged for each year samples. Then, the ratios for the averages of 2012 and 2013 against the averages of 2011 were indicated as their remaining ratios (%). Although the ratios were still high in 2012, particularly in twigs, these reduced to 20-30% in 2013. It is possible that the reduction is mainly due to washing by wind and/or rain; however, a transduction of radiocesium to newly developed tissues could also be observed.