1–12 Radiocesium Behavior from Forest to Stream Water and River

—Understanding How Dissolved Radiocesium is Discharged from Upstream—

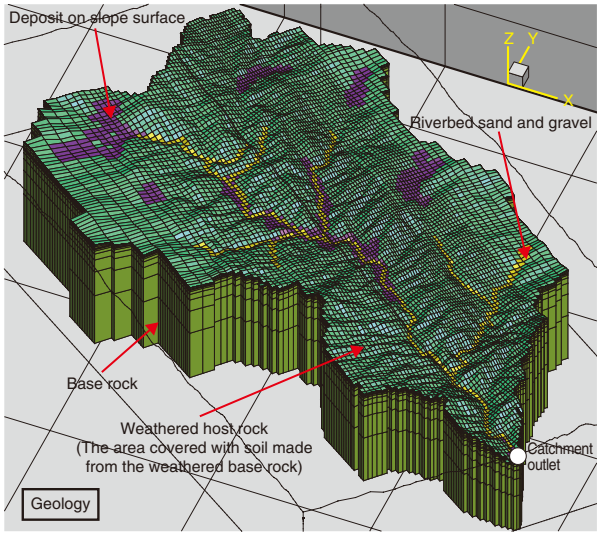

Fig.1-28 3-D-structure of the studied area
Watershed hydrological modeling (GETFLOWS) simultaneously simulates the surface and subsurface water using a 3D model based on the hydrogeological data and a 2D model based on digital elevation data. The radiocesium behavior in the environment was predicted by calculating sediment and radiocesium transport based on the obtained water velocity of the studied area.

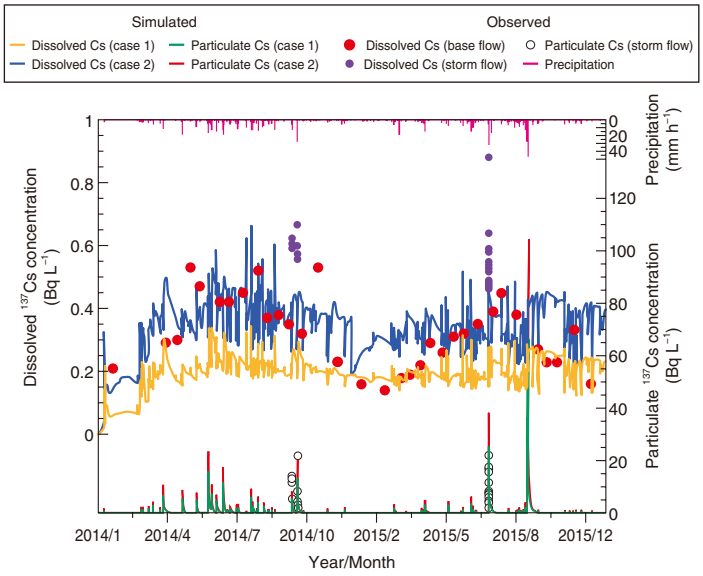

Fig.1-29 Simulated dissolved and particulate ^{137}Cs concentration in river water
Six particle sizes, including clay, silt, fine sand, sand, coarse sand, and gravel, were modeled using GETFLOWS. The distribution coefficients (K_d) for the four fine fractions of particle sizes (case 1) were set at 200000 L/kg and, the K_d value (case 2) were set at 200000 L/kg for clay and silt and 50000 L/kg for fine sand and sand.

Approximately 70% of the radiocesium (hereafter ^{137}Cs) fallout to terrestrial area from the TEPCO's Fukushima Daiichi NPS accident occurred in forest areas where decontamination work has not yet been done. Studying the behavior of ^{137}Cs from the forest to stream and river waters is thus required to understand how the ^{137}Cs concentration in agricultural products and freshwater ecosystems have changed. This includes understanding the discharge of ^{137}Cs adsorbed by soil particles (i.e., particulate ^{137}Cs) but also bio-available ^{137}Cs in water (i.e., dissolved ^{137}Cs). Therefore, water, sediment, and ^{137}Cs transport were simulated using a watershed model of the 99% forest area (in Minamisoma city and Namie town, Fig.1-28), upstream of the Ohta River catchment, in GETFLOWS. The simulated results were then compared with observed dissolved ^{137}Cs upstream discharge behavior.

The reproducibility of models related to water and sediment discharge at the discharge point were first confirmed, as shown in Fig.1-28. The partitioning of the ^{137}Cs inventory between the particulate and aqueous phases occured instantaneously and was modeled with the distribution coefficients (K_d). In the first simulation (case 1), the K_d was based on the partitioning between the dissolved and particulate ^{137}Cs measured from river water samples taken at simulation area. In the second simulation (case 2), the K_d dataset was more realistic in its modeling ^{137}Cs absorption to the particulates, as absorption occurs more readily to the finer than coarser grades.

The simulated dissolved and particulate ^{137}Cs in the river water from January 2014 to December 2015 at the discharge point is shown in Fig.1-29. The case 1 simulation results (—) underestimated the observed dissolved ^{137}Cs concentration under base flow conditions (0.14–0.53 Bq L^{-1}, mean: 0.32 Bq L^{-1}); however, the case 2 simulation results (—) matched the observations more closely (mean: 0.36 Bq L^{-1}). Thus, this model was determined to accurately reproduce the mean dissolved ^{137}Cs concentration under base flow conditions.

However, neither the seasonal variability in the base flow of the dissolved ^{137}Cs concentration (●), nor the peaks in concentration that occurred during storms (●), could be reproduced with the simulation parameters used. As well as the results of field monitoring in river, these discrepancies may have been caused an additional input of ^{137}Cs to rivers by the leaching of organic matter in forest litter, i.e., its process is considered to be other mechanism except for the equilibrium between dissolved and particulate ^{137}Cs.

Future work will aim to verify and improve this simulation method by further field monitoring and experimental work to reveal the mechanisms of the dissolved ^{137}Cs leaching process from forest litter to stream and river waters.

Reference

Sakuma, K. et al., Applicability of K_d for Modelling Dissolved ^{137}Cs Concentrations in Fukushima River Water: Case Study of the Upstream Ota River, Journal of Environmental Radioactivity, vols.184–185, 2018, p.53–62.