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Investigation of Factors Controlling Dissolved ^{137}Cs Concentrations in Japanese Rivers

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To predict the behavior of particulate and dissolved radiocesium (^{137}Cs) in river water, some soil and land use categories in the watershed should be considered because these may affect the dissolved ^{137}Cs concentration. This recommendation is based on measurements made after the Chernobyl accident (Smith et al., 2004). However, it is difficult to predict the dissolved ^{137}Cs concentration in Japanese rivers based only on studies after the Chernobyl accident because ^{137}Cs dynamics differ between the areas surrounding the Chernobyl and Fukushima Daiichi Nuclear power plants because of climate and soil differences (Evrard et al., 2015; Konoplev et al., 2016). In this study, to investigate the factors that affect dissolved ^{137}Cs concentrations in Japanese rivers, we measured dissolved ^{137}Cs concentrations in 67 rivers under baseflow conditions 13–280 km from the Fukushima Daiichi nuclear power plant in August and September 2017.

The watershed area of each sampling point was 3.2–3,600 km^2 and the averaged ^{137}Cs inventory for each watershed in July 2011 was 4.7–1,700 kBq/m^2(calculated from the ^{137}Cs inventory distribution map by Kato et al., under review). Land use in the watersheds varied and included forest watershed (up to 99% forest area) and urban watershed (up to 73% building area). To research the influence of water quality on the dissolved ^{137}Cs concentration, we coincidently measured the main coexisting solutes, pH value, and electric conductivity in the river water. Additionally, to research the effect of the ^{137}Cs source, the land use ratio, soil components, and watershed topographic wetness index were calculated from geographic information data published on the Internet.

The dissolved ^{137}Cs radioactivity concentrations in river water were 0.10–120 Bq/m^{3}and strongly depended on the averaged ^{137}Cs inventory in the watershed ($r = 0.70$, $p < 0.01$). Therefore, the dissolved ^{137}Cs concentration was normalized by dividing it by the averaged ^{137}Cs inventory (converted into the range 4.5×10^{-6}–2.2×10^{-3} m^{-1}) and the correlations among these values and each water quality factor and ^{137}Cs source were analyzed.

Significantly high positive and a negative correlation existed between the normalized dissolved ^{137}Cs concentration and building area ratio (r = 0.78) and forest area ratio (r = -0.60), respectively. The high concentration of coexisting ions in the water was a cause of such a high correlation because it would impede ^{137}Cs absorption in soil particles because the building area ratio has a high positive correlation with electrical conductivity (r = 0.55).