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Differences and similarities between behavior of Fukushima-derived and Chernobyl-derived radiocesium in the environment

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The mobility and bioavailability of radiocesium (r-Cs) of accidental origin is governed by the ratio of its chemical forms in fallout and site-specific environmental characteristics determining the rates of leaching, fixation-remobilization, as well as sorption-desorption of the mobile fraction (its solid-liquid distribution). R-Cs in the environment is strongly bound to soil and sediment particles containing micaceous clay minerals (illite, vermiculite, etc.). This is associated with two basic processes – high selective reversible sorption and fixation.

Climate and geographical conditions for Fukushima Prefecture of Japan and Chernobyl zone differ. For example, the catchments of the Chernobyl zone are flat and characterized by low slopes, while Fukushima's watersheds are hilly with steep slopes. Annual precipitation also differs substantially, with annual average for Fukushima about 3 times higher than at Chernobyl. The soils on the north-east coast of the Honshu island that were primarily affected by the radioactive contamination from the Fukushima Daiichi nuclear power plant (FDNPP) accident differ significantly from the Chernobyl zone soils. The proportion of clays such as illite, vermiculite etc. is 20-30% at Fukushima, which is higher than in the sandy loam soils of the Chernobyl zone. In addition to the landscape differences, the speciation of r-Cs in fallout was also different between Fukushima and Chernobyl.

It is a challenge to compare r-Cs behavior in FDNPP and Chernobyl zones.

Comparative analysis has been carried out for r-Cs wash-off parameters and the distribution coefficient K_d in rivers and surface runoff on Fukushima and Chernobyl contaminated areas for the first years after the accidents. The r-Cs distribution coefficient in Fukushima rivers was 1-2 orders of magnitude higher than correspondent values for rivers and surface runoff of the Chernobyl zone. This suggests higher ability of Fukushima soils and sediments to bind r-Cs. The normalized dissolved wash-off coefficients for Fukushima river watersheds are 1-2 orders of magnitude lower than corresponding values for the Chernobyl zone. Normalized particulate wash-off coefficients are comparable for Fukushima and Chernobyl. The effective dispersion coefficients in the Fukushima soils were found to be relatively high (2-10 cm^2/year) as compared to Chernobyl values. Investigation and analysis of Fukushima-derived r-Cs distribution in soils of Niida river catchment has led to identify accumulation zones of contaminated sediments on the floodplain. Contaminated sediment accumulation is one of the most important factors for predicting r-Cs redistribution on a catchment and its fluvial transport, and is also relevant for decision making on remediation options of contaminated territories.