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Relevance and use of the Ag-110m: Cs-137 activity ratio for tracking the dispersion of radioactive sediment within Fukushima coastal catchments

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Large quantities of fallout radionuclides emitted during the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident were deposited on Japanese soils, thereby leading to the formation of a 3000 km^2 contamination plume. Because they are strongly sorbed by fine particles, those radionuclides are likely to be redistributed by hydrosedimentary processes across catchments. As Ag-110m: Cs-137 activity ratio showed a variation in soils across the main plume, we investigated the behaviour of Silver-110 metastable (Ag-110m) and compared it to the one of the more documented radiocesium (Cs-137) to check whether this ratio may be used to track the dispersion of contaminated sediment. We analysed soil and sediment drape deposits (i.e. mud drapes deposited on channel bed sand in rivers) collected in Nov 2011, April 2012, Nov 2012 and May 2013 within coastal catchments draining the main radioactive pollution plume of Fukushima Prefecture (Japan). Several field experiments were also conducted to document radiosilver behaviour in the terrestrial environment. Results show a similar and low mobility for both elements in soils and a strong affinity with the clay fraction. Measurements conducted on sediment sequences accumulated in reservoirs tend to confirm a comparable migration and deposition of both radionuclides even after their redistribution due to erosion and deposition processes. Use of a simple mixing model based on Ag-110m: Cs-137 activity ratio values in both soil and sediment demonstrated the strong reactivity of catchments to the succession of summer typhoons and spring snowmelt. We identified a two stage sediment export cycle with (1) a partial export of contaminated sediment from inland mountain ranges – exposed initially to the highest radionuclide fallout – to the coastal plains in summer and autumn after the occurrence of violent typhoons, and (2) an amplification of the sediment flush during the spring snowmelt. Our results suggest that this contamination export cycle will continue during the next years or decades as large quantities of contaminated material are being stored in reservoirs of the region.