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Assessing sediment connectivity to understand dynamics of contaminated sediment within coastal catchments of Fukushima Prefecture (Japan)

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The Fukushima Dai-ichi Nuclear Power Plant accident has led to the release of large radionuclide quantities (e.g., about 20 PBq of Cs-137 and 200 PBq of I-131) into the atmosphere. About 80% of the release was blown out and over the Pacific Ocean. The remaining 20% of emissions were deposited as wet and dry deposits on soils of Fukushima Prefecture, mainly between 15–16 March. As most radionuclides are strongly sorbed by fine particles, they are likely to be redistributed within the landscape in association with soil and sediment particles transported by runoff and erosion processes. A spatial analysis of Ag-110m:Cs-137 ratio in soils and river sediments provided a way to trace those transfers. This fingerprinting study showed that particles eroded from inland mountain ranges exposed to the highest initial radionuclide fallout were already dispersed along coastal rivers, most likely during summer typhoons and spring snowmelt. Those results suggest that hillslopes and rivers have become a perennial source of radioactive contaminants to the Pacific Ocean off Fukushima Prefecture. This study aims to specify the location and nature of the preferential sources supplying contaminated material to the main rivers draining the Fukushima contamination plume.

To this end, important parameters controlling soil erosion and sediment transfers within catchments, i.e. landscape morphology and land use characteristics, were preliminary derived from DEM data and satellite images for the River Mano, Nitta and Ota catchments (ca. 525 km^2) draining the most radioactive part of the contamination plume that formed across Fukushima Prefecture. Then, those data were used to compute indices assessing the potential sediment connectivity (i) between hillslopes and rivers and (ii) between hillslopes and catchment outlets. Finally, spatially-distributed values of connectivity indices were confronted to gamma-emitting radionuclide activities (Cs-134, Cs-137 and Ag-110m) measured in riverbed sediment samples collected in November 2011, March 2012 and November 2012 just after the main hydro-sedimentary events that occurred in this region (i.e. summer typhoon and spring snowmelt).

Preliminary results show that preferential contamination sources come from areas located near the river valleys, especially cultivated and built-up areas. However, forested zones even located on footslopes and convex settings appear to contribute significantly. Moreover, dams played a crucial role in controlling the contamination export to the Pacific Ocean. Those first results have important implications for the management of contaminated areas and dam reservoirs in the Fukushima Prefecture.