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Assessing the impact of soil decontamination on radiocesium and sediment transfers in a catchment affected by Fukushima nuclear accident, Japan, using a reservoir sediment core.

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Significant quantities of radionuclides including a majority of ^{137}Cs have been deposited onto Fukushima landscapes following the accident of Fukushima Dai-ichi Power Plant in March 2011. Starting from late 2013, the Japanese government initiated a large-scale decontamination programme for cropland, residential areas, grassland and forest borders, which was conducted on 12% of the catchment area (8.2 km^2) while forest, which is the dominant land use (88%), was not decontaminated. The surface layer of cropland and residential soils (~5 cm) concentrating radiocesium (^{134}Cs, ^{137}Cs) was removed and substituted with a fresh soil -composed of saprolite layer mined at local quarries- which represent 3% of the catchment area (1.8 km^2). Thirteen years after the accident, questions remain regarding the fate of residual particle-bound ^{137}Cs across terrestrial environments in response to extreme precipitation (e.g. tropical storm, typhoon, extra-tropical cyclone) and associated erosion events. In particular, there is a need to identify and quantify the sources delivering sediment and associated ^{137}Cs to the water bodies, to reconstruct and evaluate the impact of decontamination on sediment and radiocesium transfers. To conduct this project, one sediment core was collected in undisturbed condition in June 2021 at a downstream location of the Mano Dam reservoir, which drains an early decontaminated catchment (67 km^2) (2014–2016). Elemental geochemistry, organic matter, visible colorimetry, particle size, and radiocesium analyses were conducted on the sediment core, with depth increments of 1 cm. These analyses were used to provide multiple lines of evidence to define and interpret the major precipitation events recorded by the sedimentary sequence. Then, the sediment source fingerprinting technique allowed, with a multiple modelling approach (MixSIAR and BMM), to identify changes in sediment sources with variable contributions from forest,

cropland, and subsoil (e.g. channel bank, fresh soil) throughout time. During abandonment (2011–2016), the contribution from cropland sharply decreased (from ~50% to 30-35%) while forest increased (from ~40% to 60-65%). Nevertheless, after the completion of decontamination, in late 2016, a significant increase of cropland contributions was observed, returning to the pre-accidental level in the most recently deposited sediment (~55%). It occurred concomitantly with that of sediment originating from the freshly-added soil (i.e. granite saprolite; from about 5% to 25%), reflecting the impact of decontamination. During abandonment, the ^{137}Cs activity in sediment was reduced by 40%, such as the ^{137}Cs flux per extreme event, which was reduced by 20%. After the completion of decontamination, although a strong decrease in ^{137}Cs activity in sediment was observed (up to -60%), it was not associated with such a significant decrease as ^{137}Cs flux per extreme event (0% to -20%). This suggests that the reduction in ^{137}Cs activity in the sediment following decontamination may result from a dilution of contaminated sediments originating from forest with sediment originating from decontaminated cropland fresh soil rather than the removal of contaminated soil in designated areas. To understand the impact of natural soil protection against erosion through revegetation on ^{137}Cs flux over a longer abandonment time, studying sediment cores from lately decontaminated catchment would be useful.