Impact of decontamination and the occurrence of typhoons on the sources supplying sediment and radiocesium to Fukushima coastal rivers (2011–2019)

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Following the Fukushima Dai-ichi accident that occurred in March 2011, significant quantities of radionuclides, including a majority of radiocaesium (^{137}Cs and ^{134}Cs), were deposited on soils across an area of ~3000 km² located to the northwest of the power plant. Soil erosion during typhoons and spring floods led to the significant redistribution of radiocaesium-contaminated sediment into coastal rivers draining this plume. Sediment deposits were systematically collected once or twice a year at the same locations (~30) between 2011 and 2019 along the Mano and Niida Rivers to characterise their changes in radiocesium concentrations throughout space and time. Suspended matter was also collected during several floods, and sediment cores were retrieved from the Mano Dam Reservoir. These samples were analyzed by spectrocolorimetry, X-ray fluorescence and gamma spectrometry. In addition, the spectrocolorimetric and geochemical signatures of the sediments were compared to those of the potential sources delivering this material to the river systems (i.e. cultivated soils, forests, decontaminated areas, landslides) and their proportions were calculated using a mixing model. The analyses show that radiocesium sediment activities strongly decreased by 96% between 2011 (mean: 62,000 Bq kg^{-1}) and 2019 (mean: 2240 Bq kg^{-1}). In addition, the contributions of different sediment sources were also calculated. On average, cultivated soils were the main source of sediments transiting rivers (mean 43%, SD 32%). Forests were the second contributing source (mean 27%, SD 21%), followed by decontaminated land (mean 23%, SD 23%) and landslides (mean 7%, SD 8%), with significant variations in space and time. The overall impact of the decontamination programme and the occurrence of very intense typhoons in October 2019 on the redistribution of material contaminated with radiocesium through the river network will also be discussed in a context where these areas have been reopened to the local population.

Keywords: radiocesium, soil erosion, river sediment, catchment, sediment tracing, sediment fingerprinting