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Detailed monitoring of transfer of 137Cs at the hillslope scale by in situ HPGe spectrometry and landsurvey

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This study takes place after the Fukushima Daiichi Nuclear Power Plant disaster of March 2011, which was triggered by the Tohoku earthquake and the tsunami that followed. A large amount of radionuclides was released in the environment and settled in the form of fallout that contaminated the underlying soil. To provide a rapid assessment of the soil contamination and its potential redistribution, intensive scientific monitoring has been conducted since July 2011 in our study site, located in the Yamakiya district of Kawamata town, in the Fukushima prefecture, 37 km North-West from the crippled power plant.

At the hillslope scale, the main radiocesium movements are expected to occur via the redistribution of soil, namely erosion and deposition. As such, understanding erosion processes at the highest possible resolution allows for a better understanding of the fate of radiocesium.

Inside a 5 m x 22 m bounded hillslope plot, we deployed multiple innovative monitoring methods in addition to the measurements of runoff volumes and sediments radiocesium concentrations. Each major rainfall event was followed by a large number of spatially-distributed in situ gamma spectrometry measurements. The method is calibrated outside of the study plot using manual, high resolution, depth sampling (slices of 2 mm) of the soil and laboratory gamma spectrometry. From this calibration, maps of the radioactivity and soil redistribution can be constructed at the meter resolution.
In 2011 and 2012, several high resolutions Digital Elevation Models were acquired with a terrestrial laser scanner to assess the surface topography changes. After processing, and although the precision of the final DEMs (˜2mm) is not enough to precisely identify and quantify the soil losses for a short interval of time, these DEMs do provide some information about the potential erosion and deposition sites.

Finally both methods permitted to observe physical processes of soil redistribution at the (big) rainfall event scale, including interrill and rill erosion, as well as local deposition and remobilization phenomenon. They provide information on the erosion spatio-temporal variability and the associated radionuclides transfers.

Keywords: 137Cs, Erosion, HPGe spectroscopy, Laser scanner, radiocesium, Fukushima