Effect of tree thinning and litter removal on the radiocesium (Cs-134, 137) discharge rates in the Kawauchi forest plantation (Fukushima Prefecture, northern Japan)

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On 11 March 2011 a 9.0 earthquake and the resulting tsunami occurred in central-eastern Japan triggering, one day after, the Fukushima Dai-ichi nuclear power plant (DNPP) accident. Despite the bulk of radionuclides (ca. 80%) were transported offshore and out over the Pacific Ocean, significant wet and dry deposits of those radionuclides occurred mainly in the Fukushima Prefecture and in a minor way in the Miyagi, Tochigi, Gunma and Ibaraki Prefectures. As a consequence and among other radionuclides, a total of 511,000 TBq of I-131, 13,500 TBq of Cs-134 and 13,600 TBq of Cs-137 were released into the atmosphere and the ocean, contaminating cultivated soils, rivers, settlements and forested areas. This accident caused severe environmental and economic damages. Several decontamination practices have done, including tree thinning and litter removal within the forests and tree plantations. In this study we analysed the effect of eight different management practices on the radiocesium (Cs-134 and Cs-137) discharge rates during 20 months (May'2013 - Dec'2014) in a Japanese cedar (Cryptomeria japonica) plantation (stand age of 57 years), located in a hillslope near the Kawauchi village, Fukushima Prefecture, northern Japan. This study area (37^0 20' 04" N, 140^0 53' 13.5" E) is located 16 km southwestern from the DNPP and within the evacuation area. The soils are Andosols. Ten runoff plots (5 x 2 meters) were installed and measurements started on May 2013. Two plots remained without any treatment as control plots and the other eight plots represented the following management practices: Mng1) Litter removal + clear-cutting (no sheet); Mng2) Litter removal + clear-cutting (no sheet); Mng3) Litter removal + clear-cutting (no sheet); Mng4) Litter removal; Mng5) Thinning (logged area); Mng6) Thinning (under remnant trees); Mng7) Litter removal + thinning (logged area); Mng8) Litter removal + thinning (under remnant trees). Each plot had a gauging station and sediment samples were collected every three weeks. Litter removal and tree thinning were done twice. The minimum of ground and vegetation coverages occurred in May and June 2013 and between February and April 2014. The maximum coverages appeared in September-October 2013 and between July and September 2014. The radioactivities of Cs-134 and Cs-137 were determined in the soil and litter fractions by gamma-ray spectrometry. Emissions were measured using a high purity n-type Ge coaxial detector coupled to an amplified and multichannel analyser at the CRiED laboratory of the University of Tsukuba. The activity concentration (Bq / kg) of Cs-134 and Cs-137 were calculated as well as the inventory (Bq / m2) and daily inventory (Bq / m2 day) of Cs-137. A total of 70 correlations were analysed: between the dry weight of the leaf and soil and the corresponding activity of Cs-134 and Cs-137 as well as between the total movement and total daily movement of leaf and soil and the inventory and daily inventory of Cs-137. The amount of soil and caesium movement in the experimental slopes was considerably decreased in the year 2014 than in 2013 due to the vegetation recovery after the operations in each plot.