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Plot-scale wash-off of Cesium-137 and Strontium-90 after three decades since the Chernobyl accident

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Long-term behaviors of Cesium-137 (^{137}Cs) and Strontium-90 (^{90}Sr) have been of great interest in Chernobyl and its downstream area. This study presents plot-scale observations of ^{137}Cs and ^{90}Sr wash-off in the Chernobyl exclusion zone since 2018 to date. Runoff plots were established on a pine forest in the Kopachi area (PF-KP), an abandoned farmland in the Korogod area (AF-KR) and a post wild fire territory in the Red Forest (WF-RF) in December 2017. Each runoff plot consists of eroding surface of 22.13 m length and 5 m width, a 30° V-notch weir with water level sensor for monitoring surface runoff and tanks for collecting runoff water and sediments. Since February 2018, runoff water and sediment samples trapped in the weir and tanks have been collected after rainfall events and analyzed for particulate ^{137}Cs concentration, dissolved ^{137}Cs concentration, and dissolved ^{90}Sr concentration. Analyses of samples in 2, 4, and 3 wash-off events were completed for PF-KP, AF-KR, and WF-RF, respectively. The ash/litter on soil surface, soil of 0-1 cm depth, soil of 1-2 cm depth, and soil of 2-3 cm depth were sampled with a scraper plate and subject to measurements of ^{137}Cs and ^{90}Sr concentrations. Total volume of surface runoff from PF-KP, AF-KR, and WF-RF were 0.97, 0.73, and 3.2 mm, respectively. Total sediment discharge from PF-KP, AF-KR, and WF-RF were 0.29, 0.015, 1.7 g m^{-2}, respectively. The runoff and sediment discharge from PF-KP and WF-RF were mainly observed in summer and attributed to severe water repellency of the surface soils. Total particulate ^{137}Cs wash-off from PF-KP, AF-KR, and WF-RF were 51, 0.082, 270 Bq m^{-2}, respectively. Total dissolved ^{137}Cs wash-off from PF-KP, AF-KR, and WF-RF were 7.4, 0.024, 9.8 Bq m^{-2}, respectively. Total dissolved ^{90}Sr wash-off from PF-KP, AF-KR, and WF-RF were 55, 0.31, 230 Bq m^{-2}, respectively. These results indicate that wild fire enhances surface runoff and sediment yield and result in greater wash-off of ^{137}Cs and ^{90}Sr. In comparisons between PF-KP and WF-RF, apparent Kd value for ^{137}Cs at WF-RF was higher than at PF-KP. Ratio of dissolved ^{137}Cs and ^{90}Sr concentration to those in ash/litter layer at PF-KP was lower than those of WF-RF. The dissolution of these radionuclides into runoff water appeared to be restrained in the post wild-fire site.