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Hydrological response and ^{137}Cs wash-off evaluated by continuous observation with USLE plots in Chernobyl exclusion zone

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Radionuclide wash-off is a key issue for understanding its redistribution in the environments after nuclear disasters. Plot-scale radionuclide wash-off was evaluated by coupling runoff plots with artificial rainfall experiment and snowmelt runoff monitoring after the accident of Chernobyl nuclear power plant. However, there is no continuous observation of plot-scale radionuclide wash-off in Chernobyl and therefore long-term dynamics of radionuclide and hydrological response to natural rainfall remained unclear. This study shows approximately one-year observation of radionuclides wash-off from three runoff plots during 2018 in the Chernobyl exclusion zone. 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 following a standard for Universal Soil Loss Equation studies 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. Sensors were installed at depths of 5, 10, 20, 30 and 50 cm in soil around the plots to monitor soil water content and soil temperature. An interval camera was installed at each plot for evaluating soil surface condition during runoff events. Since February 2018, runoff water and sediment samples trapped in the weir and tanks have been collected after rainfall events and analyzed for their particulate and dissolved ^{137}Cs activity concentrations. The ^{137}Cs inventories around the plots were quantified by soil sampling. During winter-spring season, one runoff event for the PF-KP and three runoff events for the AF-KR were observed. Soil temperature of 5cm depth was below 0˚C during precipitation at the PF-KP and it was suggested both rain and snowmelt water ran off on frozen soil. In contrast, soil temperature were above 0˚ C at time of precipitation through winter-spring season in the AF-KR and it is suggested that snowmelt water mainly ran off from the AF-KR. During winter-spring season, particulate and dissolved ^{137}Cs activity concentration for PF-KP was 150000 Bq kg^{-1} and 4.3 Bq L^{-1}(n = 1), respectively. Those for the AF-KR was, in average (n = 4), 3300 Bq kg^{-1} and 0.29 Bq L^{-1}, respectively. During summer season, one runoff event on the PF-KP and one runoff event on the WF-RF were observed during a rainfall event on 30th June with total rainfall of 57.8 mm. Runoff coefficient for the PF-KP and the WF-RF in this event was 1.1% and 1.9%, respectively. Because no runoff was observed in the AF-KR which showed more frequent runoff during winter-spring season, surface runoff from the PF-KP and the WF-RF could be attributed to severe water-repellency. Furthermore, the image from the interval cameras for the WF-RF showed that entire surface soil within the plot was saturated during the rainfall event and it is suggested that ash resulted from wild-fire created strongly-hydrophobic layer and prevented water infiltration. These results suggest that wild fire could increase surface runoff and radionuclide wash-off.