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Sediment dynamics and associated radiocesium wash-off in Niida river basin after the accident at the Fukushima Dai-ichi Nuclear Power Plant

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Redistribution of Fukushima-derived radiocesium through river system poses potential risks for residents in the downstream area of river basin. Niida river basin (265 km^2) on north eastern part of Fukushima prefecture is indeed a case in point. The river basin has highly contaminated area on its upstream part and urban area on its downstream part. The upstream area of the basin had been subject to decontamination works, such as scraping surface soil and reversal tillage and so on, since 2012. Quantitative evaluation of ^{137}Cs wash-off associated with sediment dynamics is required for mitigating radiological risk for the residents and for understanding the influences of decontamination works. This study presents results of the long-term observation of radiocesium wash-off within the catchment and water sampling during flooding events triggered by a typhoon. Based on the results, we try to unveil processes of ^{137}Cs wash-off of catchment scale.

In the Niida river basin, we installed an integrated suspended sediment sampler, turbidity sensor and water level sensor at three sites, Sakegawa-bashi (SK), Notegami-kita (NT) and Warabi-daira (WR) in July 2014. We have collected suspended sediments trapped in the samplers every month and ^{137}Cs concentrations in the sediment samples were measured. Also, we performed X-ray fluorescence (XRF) analyses of the suspended sediment samples for investigating the influence of decontamination works on sediment dynamics. Additionally, we took approximately 20 L water samples at NT site six times from 22nd to 23rd October 2017 during a rainfall event associated with the typhoon Lan. Suspended sediments were extracted by centrifuge and measured for ^{137}Cs concentration.

The mean ^{137}Cs concentration of SK, NT and WR was 11 $\pm$ 6.0 kBq kg^{-1} (n =23), 11 $\pm$ 4.7 kBq kg^{-1} (n = 24) and 20 $\pm$ 17 kBq kg^{-1}(n =24), respectively. The decreasing trend of ^{137}Cs concentrations of suspended sediment was found for all the sites. The temporal trend in ^{137}Cs concentration of suspended sediment was fitted to exponential equation and the decreasing rate constants on SK, NT and WR were 0.30, 0.27 and 0.27 $year^{-1}$, respectively. By comparing with XRF analyses data, negative correlation was found between ^{137}Cs concentration and Fe_2O_3 contents for samples of WR. This relation suggests that the change of sediment sources due to decontamination works was reflected in the sediment properties. During the typhoon Lan with 230 mm of rainfall, the mean ^{137}Cs concentration of suspended sediment was 6.7 $\pm$ 0.92 kBq kg^{-1} (n =6) at NT site. The ^{137}Cs concentrations of samples collected during water level increasing were higher than those of samples collected during water level decreasing. This result implies that a sediment source temporally changed during the flood. Further analyses of sediment properties, such as particle size distribution and clay mineral components, can provide a basis for further discussion on dynamics of sediment and ^{137}Cs during flood events.