Temporal changes of Cs-137 concentration and its flux (dissolved fraction, suspended sediment, and coarse organic matter) at small Headwater Catchment in Fukushima after Fukushima Dai-ichi Nuclear Power Plant Accident

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Radiocesium migration from headwater forested catchment is important perception as output from the forest which is also input to the subsequent various land use and downstream rivers. In this study, dissolved Cs-137 concentration of stream water, subsurface water, suspended sediment (SS) and coarse organic matter (Org) were measured. Observations were conducted from 2011 at four headwater catchments in Yamakiya district, located 35 km northwest of Fukushima Dai-ichi Nuclear Power Plant (FDNPP).
Stream water discharge was monitored by combination of parshallflume and water level recorder. Stream water was sampled manually at steady state condition in 2-4 month interval. Also intense few hours interval sampling of stream water was conducted during rainfall events using automated water sampler. Suction lysimeters were installed for sampling the soil water. Boreholes were installed for the groundwater sampling. Stream water and groundwater samples were collected for 40 L each. All the water samples were filtered through 0.45 μm pore-size membrane. Water samples with less than few L were concentrated by evaporative concentration. Water samples with more than few L were concentrated using the ammonium molybdophosphate (AMP)/Cs compound method. The SS was sampled using time-integrated SS sampler. Turbidity sensor was set in the streambed. The output of the turbidity (mV) was converted to SS concentration (mg/L). A 15 mm mesh net was placed in the stream channel to trap Org sample carried by the stream flow. The SS and Org samples were dried at 105 degree in an oven for 24 h and then finely crushed. The radioactivity of the samples was measured using gamma-ray spectroscopy.
The fast decline of first phase and secondary comparatively gradual decline were observed in time series of dissolved Cs-137 concentration in stream water and therefore fitted to two-component exponential line. During the rainfall events, the concentration of dissolved Cs-137 in stream water increased temporarily. Also the declining trend of Cs-137 concentration in SS and Org were fitted to exponential line however, those components were started to collect from August 2012 and the fast declining phase were not observed therefor fitted to single-exponential line. After 5 years passed from the accident, the difference of declining trend between catchments are shown.
In conjunction with Cs-137 concentration results, Cs-137 discharge flux were calculated for three components (dissolved fraction, SS, and Org). As a result, it is shown that more than 96% of the Cs-137 discharge was due to the discharge by SS. The total discharge ratio of Cs-137 to its deposition amount at each catchment was ranged 0.002–0.3% per year.

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