

Discharge of suspended solids and radiocesium from a forested watershed before and after line thinning

*Yoshiki Shinomiya¹, Masahiro Kobayashi², Yoshio Tsuboyama², Shinji Sawano², Koji Shichi², Tatsuya Tsurita², Yasuhiro Ohnuki², Yuko Itoh²

1. Tohoku research center, Forestry and Forest Products Research Institute, 2. Forestry and Forest Products Research Institute

We compared suspended solids (SS) and radio cesium discharges from a forested watershed in Ibaraki Prefecture, Japan (N36° 31.1', E140° 18.7') before and after line thinning. The study watershed has a drainage area of about 59.9 ha and is around 120 km southwest of the Fukushima Daiichi Nuclear Power Station. The watershed is underlain with sedimentary rocks (sandstone and mudstone). The elevation ranges from 130 to 300 m and the lower and upper slopes are covered with plantation conifer trees (Japanese cedar) and deciduous trees, respectively. Line thinning was carried out at a thinning rate of 35% across about 20% of the northeastern part of the watershed in 2012 and across the remaining part in 2013. Spur roads, 3-m wide, were constructed along streams. According to the two times of thinning, the forest road density changed from 27 to 108 m ha⁻¹ corresponding to the two thinning periods. Logged trees were dragged and grappled by forest machinery and were transported along spur roads to timber yards by forwarder-type forestry vehicles. V-notch weir and a water level gauge were installed at the watershed outlet in 2000. Stream water was sampled twice a month during base flow. Stream water samples of 1 or 2 L were collected every hour with an automatic water sampler (ISCO, Model6712) during storm events. Water samples were filtered with glass fiber filters (0.5 μm) to obtain the SS concentrations. We collated SS concentration data for 21 floods that occurred before thinning from June 2010 to August 2012, with total rainfalls between 15 and 130 mm and maximum rainfall intensities between 3 and 39 mm h⁻¹, and for 13 floods that occurred after thinning from October 2013 to August 2015, with total rainfalls from 19 to 127 mm and maximum rainfall intensities between 5 and 39 mm h⁻¹. We installed an SS sampler (Koga et al., 2004) in the stream close to the weir and collected SS samples every 2 or 3 months and measured their Cs-137 concentrations. We compared SS concentrations before (from July 2010 to August 2012) and after thinning (from October 2013 to August 2015) under flood and base flow conditions. We found that, within the same runoff range, some of the flood flow SS concentrations were higher after thinning than before thinning. The maximum SS concentration before thinning, observed in an event with a total rainfall of 74 mm and a maximum rainfall intensity of 39 mm h⁻¹, was 211 mg L⁻¹. After thinning (October 2013), the maximum SS concentration, observed in an event that had a total rainfall of 127 mm and a maximum rainfall intensity of 19 mm h⁻¹, was 790 mg L⁻¹. In February 2014, 5 months after thinning, an SS concentration of 751 mg L⁻¹ was recorded in an event with a total rainfall of 123 mm and a maximum rainfall intensity of 22 mm h⁻¹. Some of the ΣL_{ss} (the specific cumulative load of SS in a flood event) were higher after thinning than before thinning within almost the same ΣQ (the specific cumulative runoff in a flood event). We found that SS concentrations and ΣL_{ss} increased after thinning and that thinning had an influence on the SS discharge. The newly-constructed spur roads and the land cleared along the streams to facilitate harvesting were possibly the main sources of SS. We investigated the Cs-137 concentrations of SS from February 2012 to June 2016. Cs-137 concentrations were not related to thinning and Cs-137 concentrations in SS dropped during large storms. With the exception of large storms, Cs-137 concentrations in SS did not increase during or after thinning but decreased gradually from February 2012 to June 2016. The rate of decrease in the Cs-137 concentrations of SS was greater than the decrease expected because of Cs-137 decay. After thinning, SS discharges increased but Cs-137 concentrations in SS decreased in flood events. Therefore, Cs-137

export from the forested watershed did not increase sharply because of the thinning. Also, for smaller areas of bare land, SS discharges and Cs-137 exports would decrease. The next step is to examine changes in SS and Cs-137 concentrations for the years since thinning.

Keywords: forest, thinning, radiocesium, suspended solid