

Explication the effect of thinning on suspended sediment runoff in a cypress and cedar plantation forest by end-member mixing analysis using Fukushima-derived Cs-137, Cs-134 and Pb-210ex

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Skid trail and heavy machinery for forest practice becoming more common for effective forest practices, but these causes soil disturbance in the forest, leading to a sudden increase in the amount of suspended sediment during and post thinning. The discharged sediment can flow into the river and may cause downstream water pollution. To evaluate the effect of thinning on sediment production, sediment fingerprinting techniques can be an effective tool for proper forest practices.

In Tochigi prefecture in Japan, in addition to the Cs-137 by global fallout and Pb-210ex, additional FRN, the Fukushima-derived Cs-137 and Cs-134 on March 2011 are available, but few studies area available for combining use of Fukushima-derived radiocesium and fallout Pb-210ex. Therefore, the objective of this study is to determine the transport of the fine sediment in the forest pre- and post- thinning with using fingerprinting techniques.

The study area is Mt. Karasawa, located 180 km southwest of the Fukushima nuclear power plant in Tochigi prefecture. The fallout inventory of Cs-137 and Cs-134 is 8 kBq/m²(Kato et al, 2012). The study site has two catchments which are called K2(17ha) and K3(9ha) respectively and the observation period was from August 2010 to August 2019. In K2, strip thinning was performed with heavy machines from June to October 2011 while randomly thinning without heavy machines was applied for K3 from January to March 2013.

Soil samples were collected from the slope surface, skid trail and stream bed, which are the possible sources of suspended sediment. The suspended sediment concentration was measured based on the data of the turbidity censor installed in the stream. The particle size distribution and radionuclide concentration of sediment collected from SS sampler and soil samples are also measured.

Hysteresis analysis based on suspended sediment concentration and flow rate and fingerprinting using Fukushima-derived Cs-137, Cs-134, and Pb-210ex, a natural radioactive isotope, was applied to determine the contribution of the slope surface layer and streambed to suspended sediment. By using the difference in the depth distribution of Cs-134 and Cs-137, the production source depth of suspended sediment was estimated.

In the K2 catchment where strip thinning was performed with heavy machinery, suspended sediment concentration during high flow period was rapidly increased up to 333 kg/day during thinning period. It is 30 times more than pre thinning. Then suspended sediment amount decreased down to 503 mg/L after

thinning. On the other hand, in the controlled catchment(K3), no increase in suspended sediment amount was observed during the same period.

By using hysteresis analysis, contribution from forest soil to suspended sediment increase from 0% to about 50% during thinning and that trend had continued by 3 years later of thinning. After that, contribution from stream bed increase and slope decreased.

By using End- Members Mixing analysis, contribution from streambed to suspended sediment are similar to the hysteresis analysis except for the period of midterm of thinning to immediately after thinning. In that period, contribution from the slope also decreased. It is considered to increase the sediment production from skid trails.

Then we focused on the characteristic of the soil from skid trail, which show low Pb-210ex content. In K2 catchment, Pb-210ex in suspended sediment quite decreased during thinning period to 1 month after of thinning. However, Pb-210ex in suspended sediment didn't change during thinning. It is assumed that contribution from skid trails is very high during and soon after thinning.

Keywords: thinning, Cs-137, suspended sediment, finger printing