The contribution of coarse woody debris to DOC flux in an old-growth forest on the east slope of Mount Hakusan

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INTRODUCTION

Coarse woody debris (CWD) is a significant component of forest ecosystems, often accounting for 7% to 20% of the total forest carbon(C) in mature forests (Harmon et al., 1990; Delaney et al., 1998; Alberti et al., 2008). It affects soil cycling through the dissolution of organic C (Spears et al., 2003; Hafner and Groffman, 2005). Accurate estimates of CWD quantity and quality is crucial for the assessment of the multiple functions of CWD in forest ecosystems. DOC's crucial function in the belowground carbon cycle is also being recognized (Jandl and Sollins, 1997 ; Moore, 1997). Numerous studies have shown that the largest increase in the flux of DOM occurs when percolating water passes through the forest floor (McDowell and Likens, 1988; Qualls et al., 1991;Currie et al., 1996;Michalzik et al., 2001).This research is to estimate CWD quantity and quality and explore whether leaching DOC from CWD may strongly effect the soil carbon sequestration.

MATERIALS AND METHODS

The study area is located in the Hakusan National Park around the area of Ohshirakawa river basin. The fixed-area sampling method (study plot was divided into 100 plots of sized 10x10 m^2) was used for the quantification of volume of aboveground CWD. We measured the length plus two diameters of each piece of CWD in 1ha plot, distributed it for different decay classes from I to IV under visible conditions, and mapped them. Throughfall was collected using a precipitation collector in nineteen replicates. Stemflow was collected by stemflow collection bin, set in different kinds of DBH of two dominated tree species. In each litter and CWD leachate plot, a zero-tension lysimeter was placed in the center just below, and in contact with, the litter layer and the log. The leached solution samples from CWD, with 500mL throughfall irrigated CWD within 2 minutes. The concentrations of DOC in solution were determined using a total organic carbon analyzer (TOC-V, Shimadzu, Japan).Solution pH and EC were determined with a glass electrode.

RESULTS AND DISCUSSION

From this study the CWD map was made in 1ha plot and biomass of CWD was estimated for 30.3 Mg C ha^{-1}, accord with biomass of logs in the coniferous old-growth forest range 16-38 Mg C ha^{-1} (Harmon et al., 1986), which is equivalent to 11% of the living wood biomass, distributed in 355 pieces with a total volume of 75.8 m^3 ha^{-1}.The area covered of CWD was 602.5 m^2 ha^{-1}. It is an important C pool and cannot be ignored. In our study the carbon distribution almost in decay class Ⅱ and decay class Ⅲ occupied 81% of the total carbon in CWD.

DOC concentration from litter and CWD is much higher than from precipitation, throughfall and stemflow (small DBH), while DOC concentration from litter, different decay classes and stemflow(large DBH) didn't show significant difference. The results of our study clearly demonstrate the effect that litter and CWD have on DOC concentration of throughfall percolating through them, showing that CWD has a same effect on solution carbon with litter. Concentrations of DOC in litter leachate range from 0.9 to 7 mM, for temperate forests (McDowell et al. 1998; Fitzhugh et al. 2001; Solinger et al. 2001; and see reviews by Michalzik et al. 2001, and Neff and Asner 2001). The concentrations from our study in CWD and litter leachate were within these values.

The DOC concentration in precipitation is similar with other temperate forests (Edmonds et al. 1995 and Inagaki et al. 1995) ,while DOC concentration in throughfall was lower than concentration range in throughfall of temperate forests (DOC concentrations for 3–35 mg C L^{-1}), (Michalzik *et al.* 2001), maybe attributable to the different structure of the vegetation canopy(Guo et al. 2005).

The concentration of DOC in stemflow at the study site was lower than mean DOC concentrations in the stemflow of forests in temperate and cold climates (23–356 mg C L^{-1} ,Hinton *et al*. 1998), probably because of different forest structure, climatic conditions and different bark morphology (Inagaki et al. 1995)(Fig.1).

Mean wood density apparently decreased from decay class Ⅰ to Ⅳ, while the DOC concentration from decay class Ⅱ is higher than decay class Ⅲ, probably because decay class Ⅱ has decayed barks while decay class Ⅲ without any barks on the surface . From the relationship between DOC concentrations and mean wood density of different decay classes of CWD (Fig.2) when we know the density of CWD we can estimate leaching DOC concentration from it. Leaching of DOC from CWD would be expected to contribute to the pool of soil organic matter (SOM) below it, and some fieldwork has shown a higher concentration of humic acids beneath CWD than in soil without CWD in British Columbia (Klinka et al. 1995). Our study site due to a large mass of CWD, contributions over a large time scale will be significant.

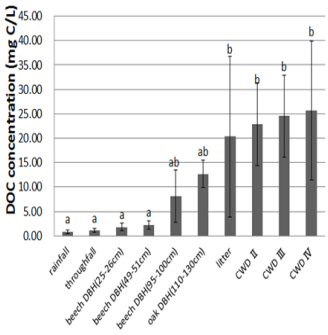

Fig. 1: Mean DOC concentration in three months from precipitation, throughfall, stemflow(different tree species and DBH), litter and different CWD decay classes. The bars showed standard deviations.

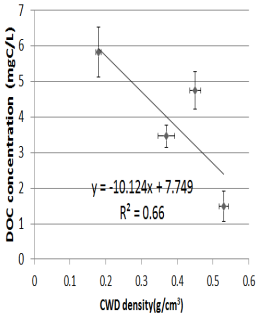

Fig. 2: The relationship between doc concentration and CWD density.