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FINNISH FOREST RESEARCH INSTITUTE

DEVELOPMENT OF SOIL CARBON STOCKS FOLLOWING CLEAR-CUTTING AND REGENERATION IN FINLAND: A CHRONOSEQUENCE STUDY

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Clear cutting and regeneration can be expected to have a major impact on carbon sequestration into forest soils. We determined changes in soil carbon stocks separately in organic horizon and from the surface to the depth of 30 cm in mineral soil in 18 clear-cuts ranging in age from 12 to 27 years old.

It seems that even after 27 years since clear-cutting there is still a substantial amount of undecomposed coarse debris in the soil which is increasing soil carbon stock. Also the litter of evolved ground vegetation seems to have an increasing effect on organic horizon carbon content. Compared to natural ecosystems, the lack of forest fires can be an important factor increasing the amount of carbon in forest soils after clear-cut, but due to the type of the material available we could not show this effect here.

Figure 1. In a clear-cut all stems are removed and the logging residue is left to the site. The amount of logging residue can be estimated by e.g. allometric functions or weighing.

Figure 2. A new tree stand starts to grow almost immediately after the clear-cut. In new light environment also the amount of ground vegetation increases.

Figure 3. The tree stand of site 608 25 years after the plantation. The tree stand is dense and almost all above-ground litter consists of spruce needles.

Figure 4. Typical podzol profile of Finnish forest soil with a separate organic (L;F;H) horizon above eluviated (grey) and illuviated (reddish) mineral soil horizons.

Figure 5. At the time of regeneration soils are often mechanically prepared either so that humus is partially removed or the soils are ploughed down to the mineral soil.

Figure 6. There is an increasing interest to harvest also branches, needles, stumps and coarse roots for bioenergy. This alters the carbon balance of the sites much more than stem harvest alone.

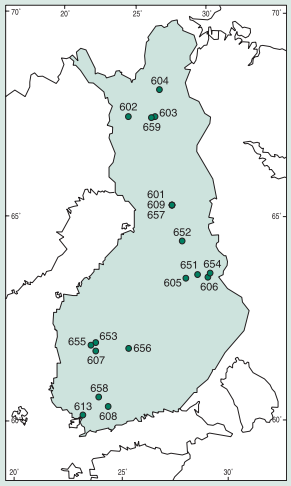

Figure 7. The sites selected for the study are distributed between the 60-70 ºN and 20-30 ºE. The annual average temperature varies from + 4 ºC in south to - 1 ºC in the north Finland. Most of Finland locates in boreal vegetation zone.

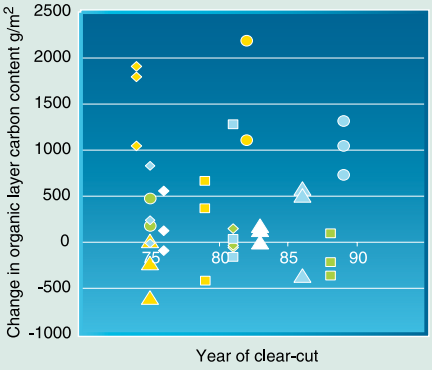

Figure 8. Both in humus and in mineral soil the average C content of all sites was slightly higher after clear-cut, but due to the large variation both within and between sites the difference was not statistically significant.

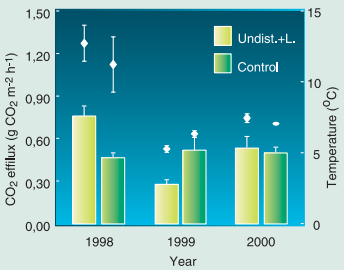

Figure 10. In the growing season following the clear-cut the soil respiration was higher at clear-cut sites, but this difference turned opposite during the following year, on third growing season the soil respiration rates were similar in control and clear-cut sites. This result may be explained by the rapid decrease of easily decomposable logging residue already during the first year and increase in root respiration when time elapsed from clear-cut increases.

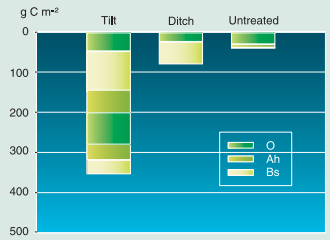

Figure 9. In the ploughed sites the carbon in organic layer had a strong spatial distribution. The carbon content on the tilt was 270 g m^{-2} and 700 g m^{-2} in the furrow. The distribution of the carbon bound to root biomass was opposite, because most of the roots were found in the tilt. Although the distribution of C was different in ploughed soil compared to untreated soil, the average C content per soil m^{-2} was almost the same.

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