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Effects of logging disturbance on soil organic carbon and related variables in the Coastal Range of British Columbia, Canada

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Forest soils of the coastal mountains of British Columbia have been shown to store comparatively large amounts of soil organic carbon (SOC). This study aims to determine short to medium term effects of clear-cut logging on SOC and related soil variables in coastal Podzols. For this purpose, we examined a disturbance chronosequence comprising sites logged 0 to 15 years prior to sampling. Twenty-seven soil profiles were sampled to a depth of 1 m and analyzed for loss on ignition, SOC, total nitrogen, pH, cation exchange capacity (CEC) and texture. Special attention was also paid to poorly crystalline minerals, which were investigated by transmission electron microscopy, Fourier-transform infrared spectroscopy and selective dissolution analysis including pyrophosphate, oxalate and dithionite extractions.

We found that 60% of SOC was stored below the 20 cm depth. This deep carbon pool played a key role in the response of overall SOC storage after logging, suggesting that it contains both stable and fast-cycling organic compounds. It is therefore important that subsoil horizons be sampled systematically in disturbance studies. Soil organic carbon increased by approximately a third in cleared plots (logged 1-5 years prior to sampling) and returned to levels similar to control sites in regenerating plots (logged 8-15 years prior to sampling). The increase in SOC after clearing was attributable to the gradual downward translocation of decaying logging slash. This SOC increase was limited to the sand and silt fraction, suggesting that new organic inputs did not form complexes with soil clays and were not subsequently stabilized.

Logging affected organic matter quality. The average C:N ratio and carbon concentration of organic matter decreased after logging, suggesting increased organic matter oxidation and maturation. The CEC:C ratio increased in regenerating plots. The CEC:C ratio is a useful indicator of the environmental performance of organic matter at these sites and the increase is indicative of organic matter with a higher functional group density, which could help retain nutrients on site.

Poorly crystalline minerals were widespread and represented nearly half of the clay fraction in subsoil horizons. Imogolite-type material was the most abundant poorly crystalline phase with an average concentration of 23 g/kg. We found indications that logging affected the amount of poorly crystalline phases as well as the distribution of reactive aluminum between organic and inorganic reactive phases (represented by the ratio of pyrophosphate-extractable to oxalate-extractable Al). Changes in SOC and poorly crystalline phases after logging were consistent with a disruption of the podzolization process. The implication of these findings for the potential formation of organo-mineral complexes in soils affected by transient disturbances such as logging or by long term environmental change such as global warming will be discussed.