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Impacts of continuous cover forestry and clear-cutting on water quality and the biodegradability of dissolved organic carbon in a drained boreal peatland

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Boreal peatlands are major sources of nitrogen (N), phosphorus (P) and dissolved organic carbon (DOC) to downstream aquatic ecosystems, and peatland forest harvesting further increases the export of DOC and nutrients. Increased DOC and nutrient loading affects biogeochemical processes and food webs of surface waters, and may cause eutrophication and hypoxia. Furthermore, lateral carbon (C) flux from terrestrial to aquatic ecosystems is an important but often ignored component of the global C cycle, because DOC mineralization to CO_2 in inland waters markedly contributes to the total C emissions to the atmosphere. Continuous cover forestry (CCF) is proposed to be an environmentally more sustainable management option for peatland forests than clear-cutting. However, the environmental effects of CCF are poorly known. We studied ground water and ditch water N, P and DOC concentrations in clear-cut, partially harvested, i.e. CCF, and uncut drained peatland forests in Finland. We also investigated the effects of harvesting intensity on DOC quality and DOC biodegradation to CO_2. Groundwater nutrient and DOC concentrations were lower in CCF and uncut forest than in the clear-cut forest. Groundwater DOC aromaticity was higher in the uncut forest than in the clear-cut and CCF, whereas ditch water aromaticity did not differ between the treatments. The biodegradation of DOC was studied by incubating water (at 15 °C for 24 h) 1, 3, 7 and 21 days after the sampling. The results indicated that the majority of the CO_2 production took place during the first three days, and CO_2 fluxes were considerably higher from the ditch water than from the groundwater. Biodegradability of DOC was lower in summer than in the other seasons. Ditch water and groundwater CO_2 production were generally significantly higher in the clear-cut than in the uncut forest. The results suggest that partial harvesting used in CCF reduces DOC and nutrient concentrations in watercourses, decreases DOC biodegradability, and therefore the aquatic CO_2 emissions compared to clear-cutting in drained peatland forests. Thus, CCF can cause less environmental drawbacks than the conventional clear-cutting.