Continuous cover forestry and novel water protection methods to mitigate environmental effects of forest management in peatlands

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Water JPI

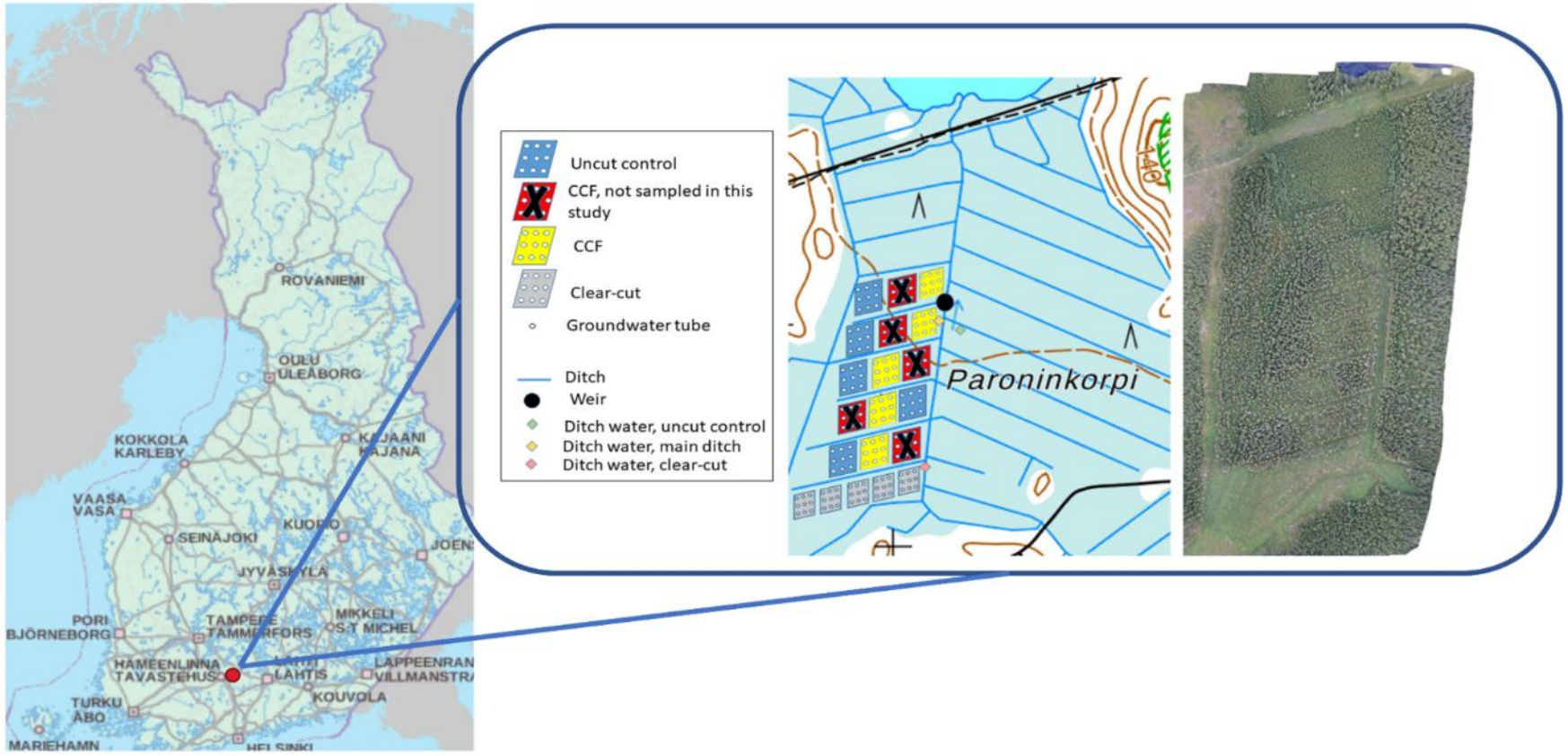
Continuous cover forestry and water quality

CCF has been suggested to cause less nutrient export to watercourses than clear-cutting:

- Reduces the need for ditch network maintenance and soil preparation
- Diminishes the amount of logging residues
- Maintains higher nutrient uptake and evapotranspiration
- Water table is lower
- Runoff and flow peaks are smaller

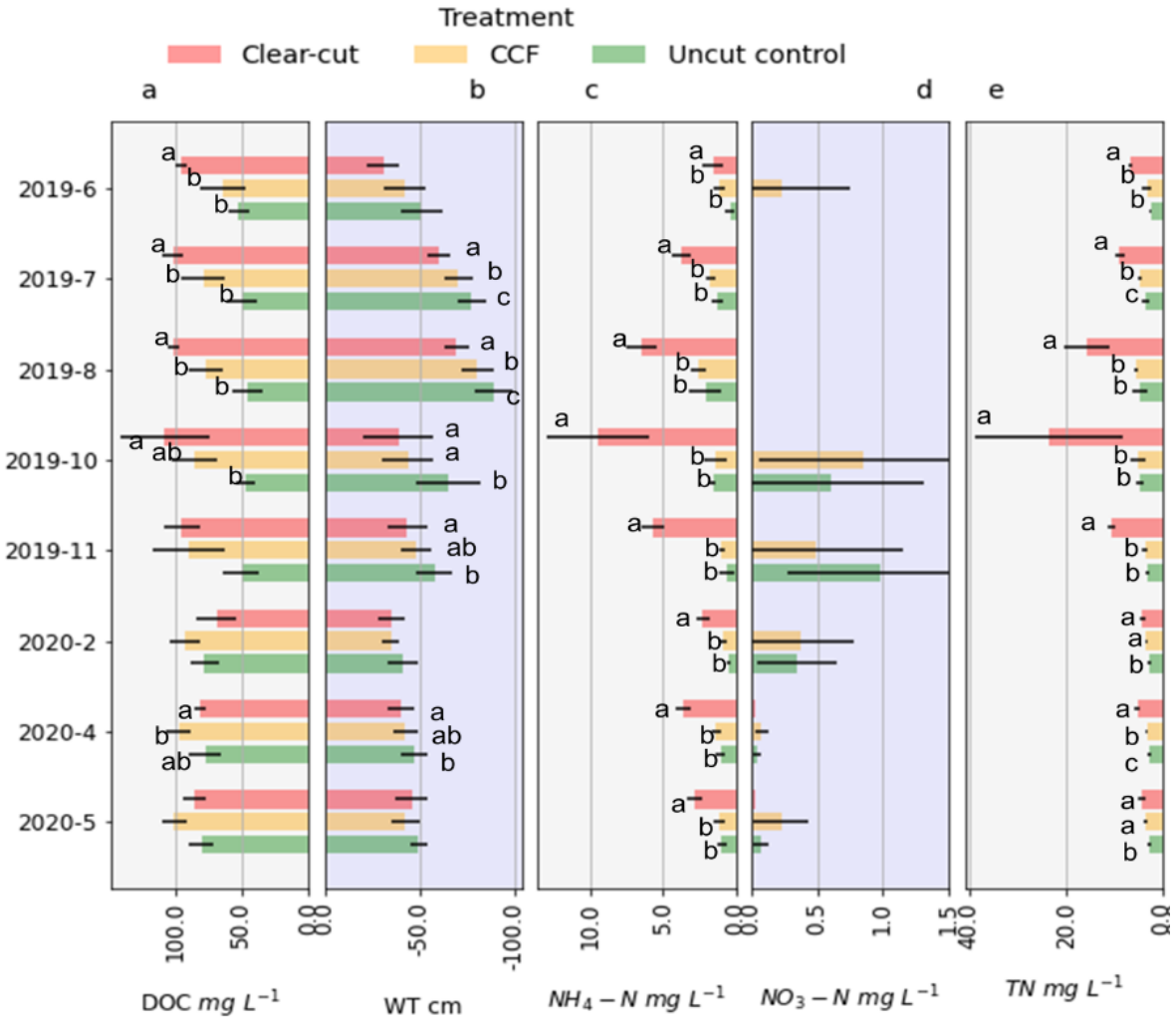
We studied the effects of harvesting intensity on 1) ground water and ditch water nutrient concentrations and 2) DOC quality and biodegradation to CO_2.

Study area: a drained, herb-rich type Norway spruce dominated forest in southern Finland
Treatments: clear-cutting, CCF (basal area 12 m^2), uncut forest (basal area 25 m^2). Harvesting in February 2017.
Ground water: 9 tubes/plot, **Ditch water:** i) from the main ditch flowing through the study area, ii) next to the clear-cut area and iii) from an uncut control forest next to the study site. Sampling during June 2019-May 2020.



Water quality

- Ground water level and DOC concentrations often higher in the clear-cut area than CCF and uncut forest
- Ground water total N, NH_4-N and PO_4-P concentrations were generally lower in CCF and uncut plots than in clear-cut plots
- Ditch water: no difference in NH_4-N, NO_3-N and PO_4-P concentrations. Total N and DOC concentrations highest in the main ditch

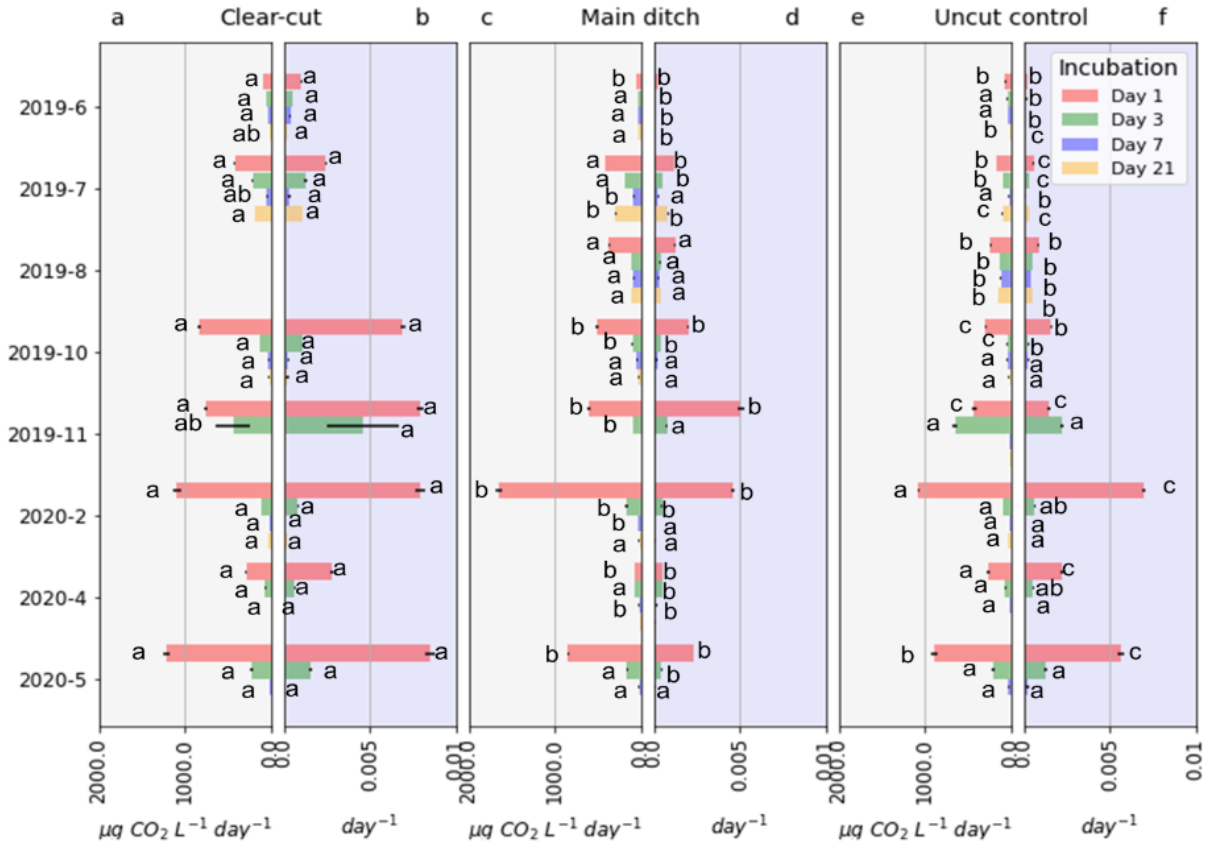


Palviainen et al., unpublished data

DOC biodegradation – CO_2 fluxes

- Water was incubated (at 15°C for 24 h) and produced CO_2 was measured 1, 3, 7 and 21 days after sampling.
- The CO_2 emissions were lower in summer than in the other seasons.
- CO_2 fluxes were considerably higher from the ditch water (50-1000 µg L^{-1} day^{-1}) than from the groundwater (10-120 µg L^{-1} day^{-1}).
- Ditch water and groundwater CO_2 production were generally significantly higher in the clear-cut than in the uncut forest and CCF.
- Higher DOC aromaticity in the uncut forest than in the clear-cut or CCF

Ditch water



Biochar in runoff water purification

- Biochar is formed when organic material is heated under limited oxygen concentration in the pyrolysis process.
- Biochar is an effective adsorbent which is based on high porosity, large specific surface area and surface charges
- We studied the capacity of spruce and birch biochar to adsorb N from the runoff water collected from clear-cut drained peatland.

Results

- Biochar adsorbs both organic and inorganic N
- Birch biochar has higher adsorption capacity than spruce biochar
- Fine biochar particles (< 4 mm) have higher adsorption capacity than coarse particles (4-6 mm)
- N adsorption capacity of biochar increases with an increase in the initial N concentration in the water. No adsorption if N concentration is < 0.4 mg L^{-1}.
- Only a small fraction of the adsorbed N was released through desorption when the biochar was exposed to water with low TN concentration.

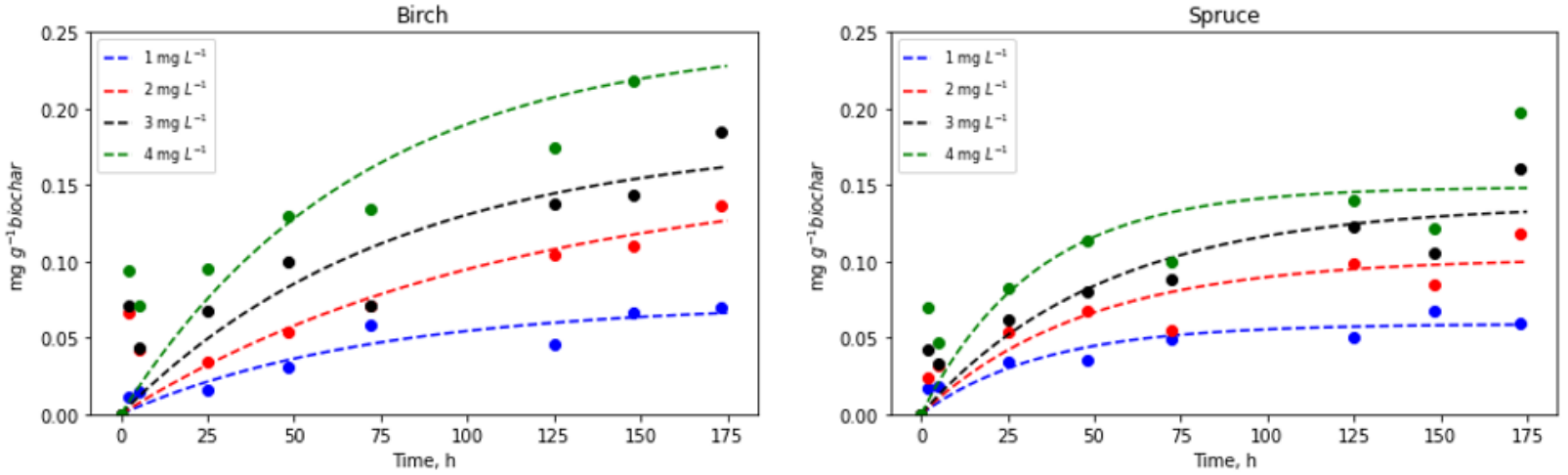


Fig. Adsorption of total N for birch and spruce biochars with different initial N concentrations in water. The dash lines represent pseudo-first order adsorption model.

Saarela et al. 2020, Kakaei Lafdani et al. 2020, 2021

Conclusions

- The results suggest that partial harvesting used in CCF reduces the concentrations of DOC and nutrients 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 conventional clear-cutting.
- Biochar can be a complementary method supporting water protection in peatlands, and deserves further studies.

Thank you

Comments, questions?