Impact of forest machinery on soil physical properties and microbiology of forestry-drained peatlands

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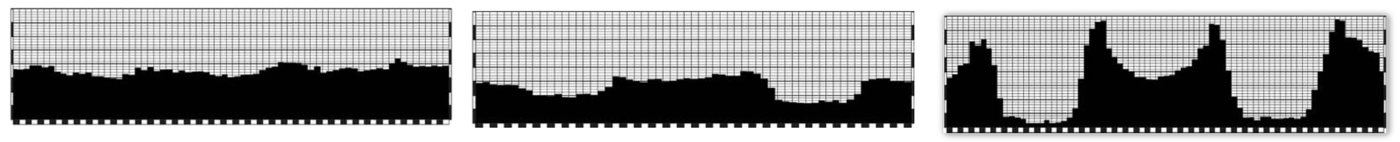
Introduction

Forestry-drained peatlands occupy approximately 5.7 million ha and represent almost one fourth of the total forest surface in Finland. They are subjected to the same silvicultural harvesting operations as upland forests. However, although the potential of timber harvesting to cause detrimental effects on soil is well documented in upland forests, the knowledge on environmental impact of harvesting machinery on peat soils is still lacking.

Materials and methods

To assess the impact of harvesting machines on peat physical properties and biology we collected soil samples from six peatland forests that were harvested by commonly employed Harvester and Forwarder. Samples were taken from trails formed by harvesting machinery (treatment plots) and outside of trails (control plots unaffected by machinery traffic) to a depth of 15 cm.



Treatment 1 (Control) **Treatment 2** **Treatment 3**

To adders the recovery of soil properties after disturbance we sampled sites that form a chronosequence in respect to time since harvesting:

1 month (Age class I)
3-4 years (Age class II)
14-15 years (Age class III)

The physical and microbiological properties of soil samples were analyzed in laboratory.

Methods used:

- Pressure-plate extraction method
- Chloroform fumigation–extraction method
- PLFA and quantitative PCR

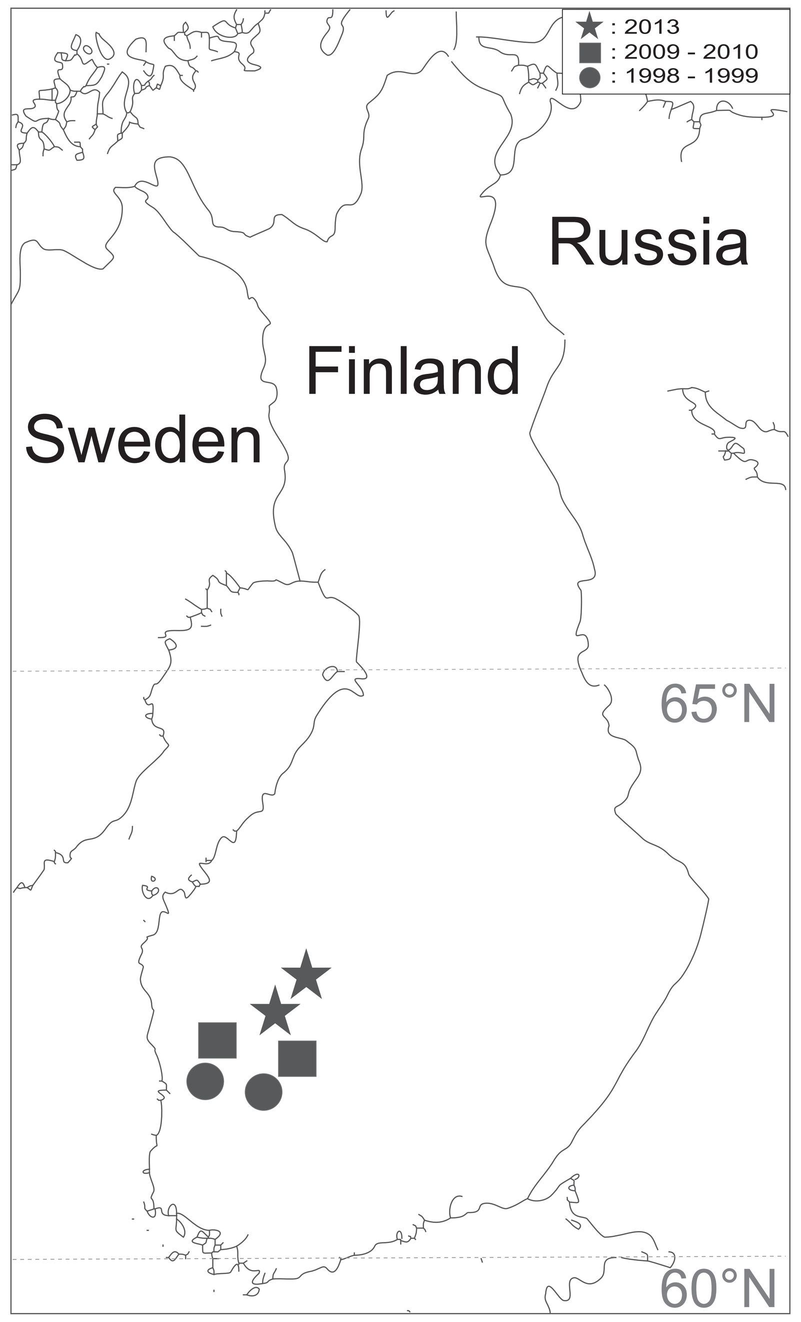


Figure 1. Location of Study sites.

Although peat significantly differs from mineral soil a research done by Chow et al. (1992) on sphagnum peat material showed that under compaction pressures higher than 13 kPa peat reaction is similar to reaction of mineral soils.

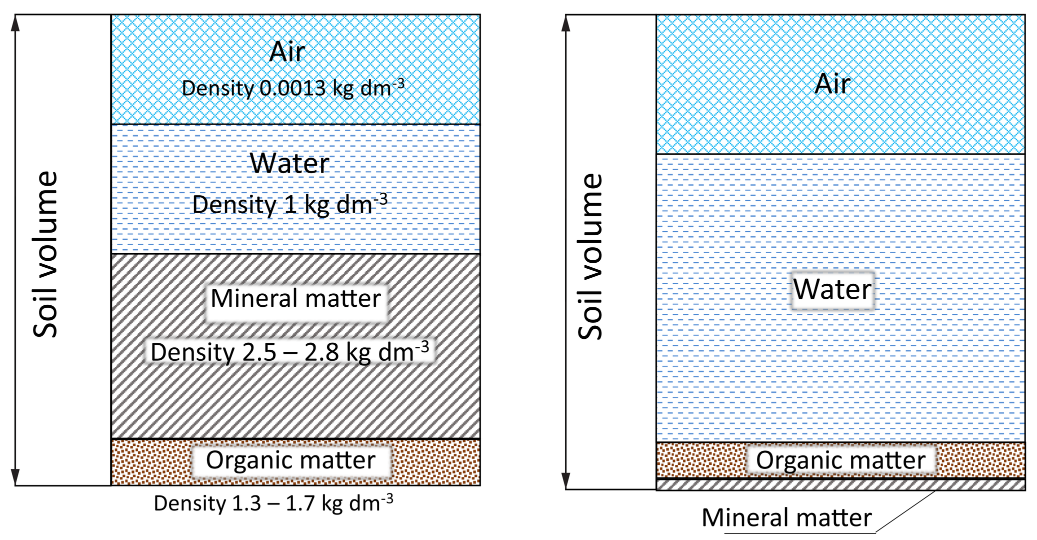


Figure 2. Mineral soil VS Peat soil.
(Päivänen and Hånell 2012)

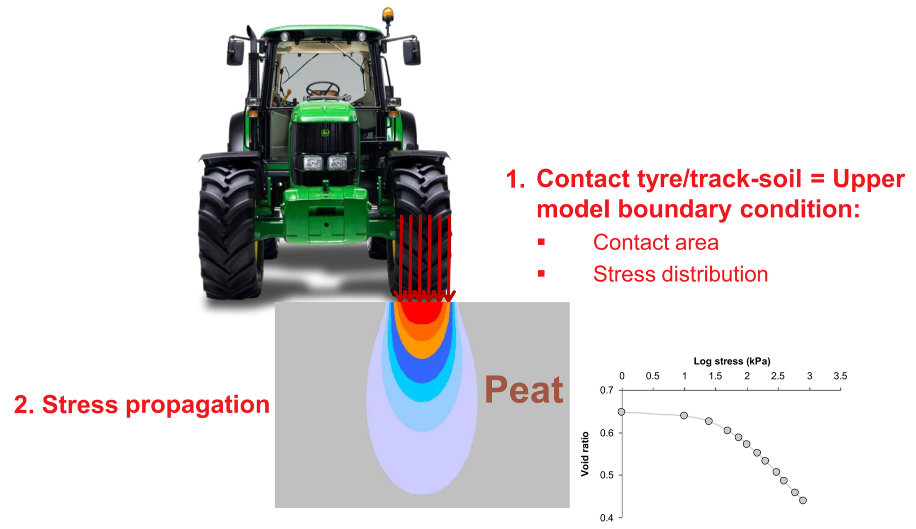


Figure 3. Machine - soil interaction

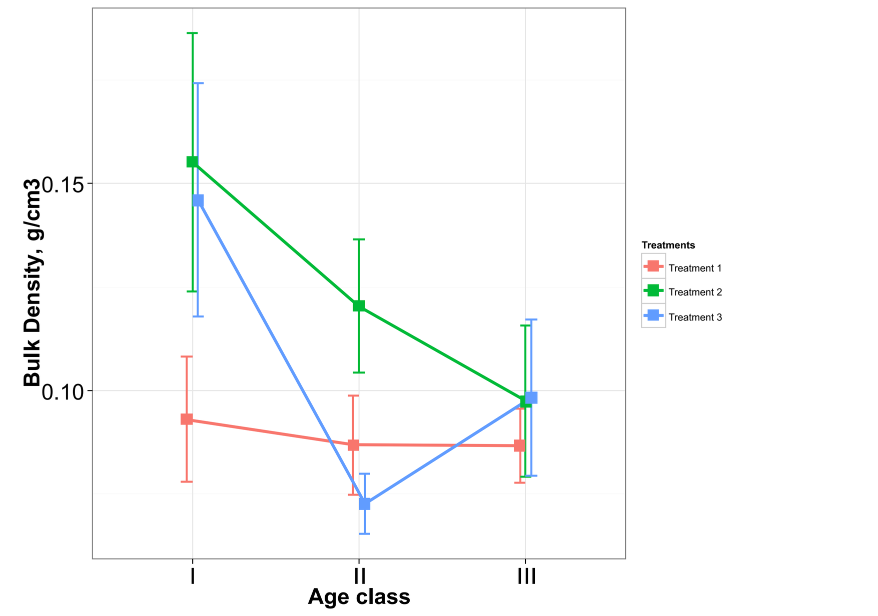


Figure 4. Mean Bulk densities with 95% CI
n = 12 (T_1)
n = 6 (T_2 and T_3)

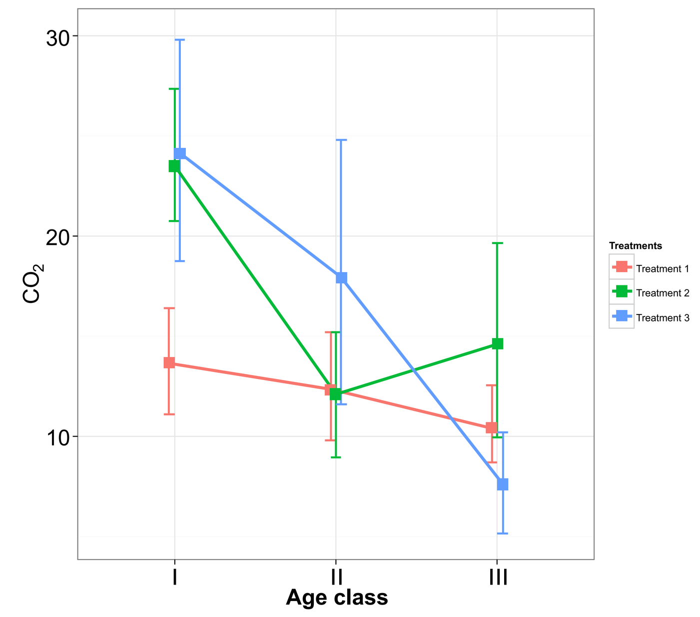


Figure 5. Mean CO_2 evolution with 95% CI
n = 12 (T_1)
n = 6 (T_2 and T_3)

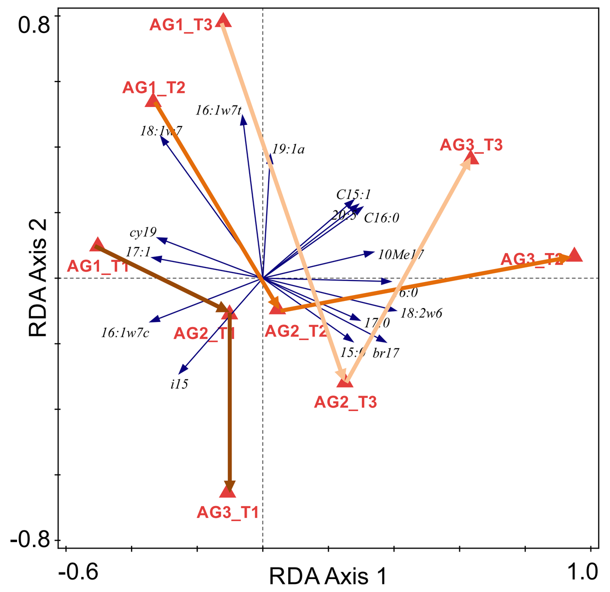


Figure 6. RDA of PLFA community.
Tot. variation = 108.68324
explanatory variables account for 15.5%
(adjusted explained variation is 4.8%).

Conclusions

Harvesting operations with heavy machinery appeared to significantly increase the bulk density of peat in the machines' trails at recently harvested sites in comparison to control plots. Following change in bulk density there was change of pore size distribution with decreasing macrospores quantity. This led to slight decrease of total porosity and decrease of air filled porosity. Water retention capacity increased with increasing bulk density. CO_2 evolution increased in the trails of class I site with where dissolved organic carbon concurrently decreased. While there was not impact of harvesting on microbial biomass or carbon, PLFA analysis indicated that machinery traffic caused a shift in microbial community structure. Results of class II and class III sites showed a recovery of physical properties within 16 years: treatment plots and control plots started to resemble each other in their soil properties. The results imply that peat soil have high recovery potential.