Drainage impact on greenhouse gas fluxes from drained nutrient-rich organic soils under grasslands in the hemiboreal zone

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Introduction

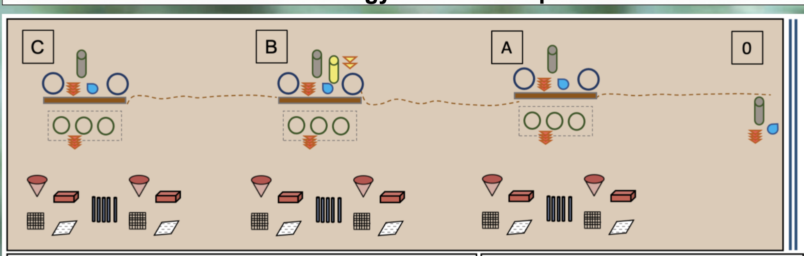
Organic soils are one of the largest natural terrestrial carbon stores, mainly in boreal, temperate and tropical wet climate zones. In Europe, organic soils account for a very small proportion of the total utilized agricultural area. However, as a common management practice, drainage turns those carbon-rich soils into a significant greenhouse gas (GHG) source. Drainage causes increased CO_2 and N_2O emissions due to increased soil mineralization. CH_4 emissions, on the other hand, are reduced compared to natural wetlands where no soil drainage and tillage are done. Land use, climate zone, soil nutrient status, and drainage status are closely linked to estimating GHG budgets from managed sites on organic soils.

Drainage impact on GHG fluxes from grasslands and forests on drained nutrient-rich organic soils throughout **two full-year is studied in hemiboreal Estonia (EE), Latvia (LV), and Lithuania from 2021.** Results of the first full-year period of N_2O and CH_4 fluxes and environmental parameters from grasslands in EE and LV will be presented. **Fluxes with different drainage statuses were determined on seven sites in four groups:**

(I) two on excessively drained fens soils;
(II) two on moderately drained fens soil;
(III) one on drained fens soil with increased groundwater levels; and for comparison **(IV)** two non-managed fens as reference sites.

The main objective of our study is to calculate a carbon (C) and nitrogen (N) budget further and adjust GHG emission factors for GHG from drained peatland grasslands in the Baltic countries.

Methodology – sites & steps

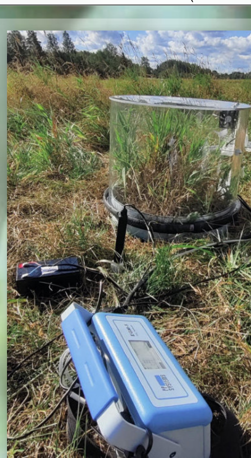


Environmental parameters and GHG measurements - EE biweekly, LV monthly
- CH_4 and N_2O monitoring point; manual dark closed chamber
- Heterotrophic CO_2 monitoring point, cluster of three trenched points; dynamic chamber
- Soil moisture monitoring; manual
- Soil T (°C) monitoring 10, 20, 30 & 40 cm; manual
- Piezometer - WT, pH, SPC, EC, ORP, O_2, BP manual monitoring, chemical analysis (once a month)
- Piezometer – WT; logger monitoring
- Soil T (°C) monitoring 10 & 40 cm; logger

Biomass sampling
- Litter collector (litter from trees and shrubs)
- Litter collector on the ground (1 m²)
- Moss biomass net (if significant moss cover)
- Ground vegetation monitoring
- Root ingrowth cores

Duckboard — Ditch — Walking path

Fig. 1. Study plot, enclosing three subplots for GHG and other data collection (modified from Jauhiainen *et al.* 2019)



Preliminary results - nitrous oxide (N_2O) & methane (CH_4)

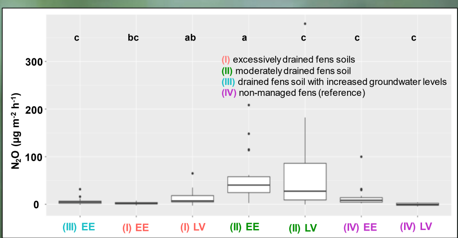


Fig. 2. N_2O variability and statistical parameters (median values, 25th & 75th percentiles, minimum and maximum values)

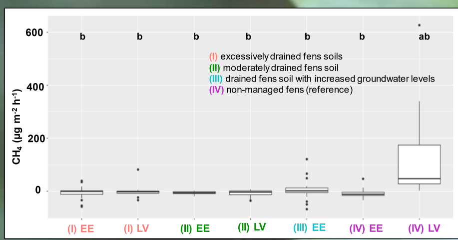


Fig. 3. CH_4 variability and statistical parameters (median values, 25th & 75th percentiles, minimum and maximum values)

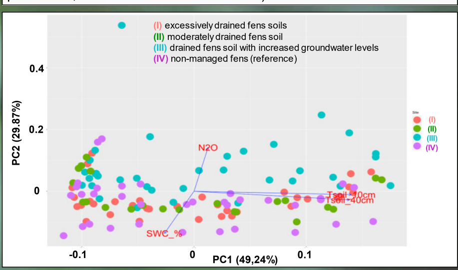


Fig. 4. Principal component analysis (PCA) of environmental variables (soil water content (%) and soil temperature in 10 & 40 cm depth (°C) and N_2O fluxes in four groups.

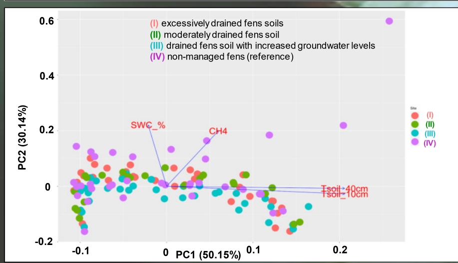


Fig. 5. Principal component analysis (PCA) of environmental variables (soil water content (%) and soil temperature in 10 & 40 cm depth (°C) and CH_4 fluxes in four groups.

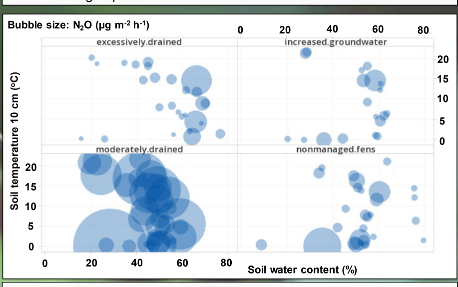


Fig. 6. Relation between soil water content (%), soil temperature in 10 & 40 cm depth (°C) and N_2O fluxes in four groups.

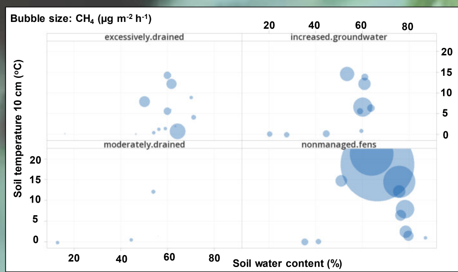


Fig. 6. Relation between soil water content (%), soil temperature in 10 & 40 cm depth (°C) and CH_4 fluxes in four groups.

Preliminary conclusions

- High N_2O and CH_4 fluxes seasonal variability;
- Drained grasslands (I, II) were annual CH_4 sinks (emissions varied from -77.7 to 108.88 µg m^{-2} h^{-1}), while fens soils with higher groundwater levels (III, IV) were a source of CH_4 (emissions varied from -90.54 to 2389.70 µg m^{-2} h^{-1});
- All studied sites were annual emitters of N_2O (emissions varied from -2.45 to 379.31 µg m^{-2} h^{-1}).
- Moderately drained soils (II) were the highest N_2O emitter (61.20 ± 12.15 µg m^{-2} h^{-1}).

Next important steps in our study are the following:
- continue with more in-depth data analysis (etc. multicriteria);
- C and N budget
  - include heterotrophic CO_2 flux;
  - C and N content in above & below ground biomass;
  - litter and biomass production.

Acknowledgements

This research is supported by the LIFE program project "Demonstration of climate change mitigation potential of nutrients rich organic soils in the Baltic States and Finland", (2019-2023, LIFE OrgBalt, LIFE18 274CCM/LV/001158).

ICOS Integrated Carbon Observation System — UNIVERSITY OF TARTU — OrgBalt LIFE project