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Soil nitrous oxide and methane fluxes from drained peatlands under grasslands in the hemiboreal zone

Hanna Vahter[1], Muhammad Kamil Sardar Ali[1], Thomas Schindler[1], Andis Lazdiņš[2], Arta Bardule[2], Ain Kull[1], Ieva Līcīte[2], Ülo Mander[1], Aldis Butlers[2], Jyrki Jauhiainen[3], Dovilė Čiuldienė[4], and Kaido Soosaar[1]

[1]University of Tartu, Tartu, Estonia (hanna.vahter@ut.ee)
[2]Latvian State Forest Research Institute "Silava", Salaspils, Latvia (ieva.licite@silava.lv)
[3]Natural Resources Institute Finland (Luke), Helsinki, Finland (jyrki.jauhiainen@luke.fi)
[4]Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry, Girionys, Lithuania (Dovile.Ciuldiene@lammc.lt)

Organic peat soils, common in boreal, temperate, and tropical wet climate zones, represent one of the largest natural terrestrial carbon reservoirs. Europe has approximately 33 million hectares of organic soils, with 4.2% managed and 3.7% unmanaged. Grasslands, constituting 17.8% of managed organic soils (1.1% in Baltic countries), are often subjected to drainage, a common practice transforming these carbon-rich environments into significant greenhouse gas (GHG) sources. The drainage process alters nutrient cycling, impacting microbial activities that control nitrous oxide (N_2O), methane (CH_4), and other GHG production and consumption.

Our research aims to quantify CH_4 and N_2O emissions from grasslands on organic soils in the hemiboreal zone and evaluate to which extent they are regulated by drainage depth. Furthermore, this research contributes to the broader goal of sustainable agriculture and effective climate change mitigation strategies by updating and addressing the pressing need for updated region-specific emission factors (EF). The default IPCC (2014) Tier 1 EFs for grasslands on drained organic soils in the temperate zone are based on values from only seven sites presented in two publications. So far, there is no information from the hemiboreal zone in which the Baltic countries are located.

To address these objectives, we conducted continuous field measurements in different periods in the years 2016–2023 in 14 sites in the Baltic Countries (Estonia, Latvia, Lithuania). The full-year study periods cover the winter and growing seasons to capture seasonal dynamics. We divided the grasslands into groups: deep drained and shallow drained grasslands, and, as a reference, two undrained grasslands. We have taken the IPCC distribution as a basis, where deep drained sites have a mean groundwater level (GWL) of more than -30 cm and shallow drained sites with a mean GWL of less than -30 cm.

Soil N_2O and CH_4 fluxes from the soil were measured using the manual dark static chamber technique, with the number of measurement subplots ranging from 5 to 9. The frequency of

measurements varied, being conducted biweekly (Estonia) and monthly (Latvia, Lithuania). During each gas sampling session, soil water content (SWC) and soil temperature (Tsoil) were measured manually at each monitoring point close to the GHG measurement subplots. Additionally, GWL parameters such as pH, electrical conductivity, and oxygen concentration were manually measured during each sampling session. Water samples for chemical analysis were taken once a month from the sampling wells to analyze.

At the conference, updated EFs for Baltic countries, the soil N_2O and CH_4 flux dynamics, and their relation to the GWL will be presented.