GHG EMISSIONS MEASUREMENT AND SAMPLING IN AGRICULTURAL LANDS: TOWARDS DATA-DRIVEN DECISION MAKING FOR MANAGING CARBON RICH ORGANIC SOILS

The lack of data on greenhouse gas (GHG) emissions in carbon-rich organic soils in the Baltics and Finland is one of the main motives for implementing the project LIFE OrgBalt. During the project, demonstration sites on agricultural lands are used for testing and evaluation various climate change mitigation measures (CCM). These measures include agroforestry, land use change (from cropland to grassland), riparian buffer zones management, controlled water level and crop change (introduction of legumes) related activities whose CCM potential is based either on decrease of soil emissions, reduced leaching of nutrients or increase of CO_2 removals in living biomass on other carbon pools.

In this article, we review the key measurements taken in the project demonstration plots on agricultural land. The measurements of GHG emissions are not only crucial for evaluating CCM measures in agricultural lands, but also contributing to the development of national GHG inventory systems and to the implementation of national and global CCM targets.

GHG emissions in demo sites are monitored using GHG measurement methodologies developed within the project, including supplementary data on biomass production, weather conditions, soil and water properties. The long-term impact of the CCM measures will be modelled using the scenario analysis tool elaborated within the project.

For agricultural lands, 4 key types of measurements are pursued:

1.GHG flux measurement

Two dark closed chamber methods are used to monitor GHG fluxes between soil and the atmosphere in field conditions. In both chamber methods, a known area and volume of airspace on top of the monitored soil surface are closed by a chamber headspace. GHG concentration increases inside the chamber over the time of the deployment period, and the GHG flux rate is determined by combining information on the closed soil surface area, the volume of the closed airspace, and the GHG concentrations over the deployment period. In grasslands, the transparent closed dynamic chamber is also used to assess the net ecosystem exchange of CO2 during the growing period. As a result, data on CO_2, CH_4 and N_2O fluxes can be derived.

Figure 1. Taking a gas sample.

2. Aboveground biomass sampling on grassland and cropland

Aboveground biomass is sampled by harvesting, drying and weighing the aboveground vegetation of small plots at the time of peak biomass in summer. The samples are separated into plant functional types

Figure 2. Measuring GHG fluxes.

(shrubs, graminoids, forbs, and mosses, as applicable).

3. Soil screening with infrared spectroscopy

Information on soil nutrient concentrations and other soil properties, e.g., soil organic matter characteristics, are needed for various purposes. Infrared spectroscopy (IRS) is a rapid, cost-effective and relatively easy-to-use technique that has long been used for the characterisation of different sample materials, including the determination of several chemical and biological characteristics of soils (e.g., Holmgren and Nordén, 1988; Confalonieri et al. 2001; Terhoeven-Urselmans et al., 2008; Cécillon et al. 2009; Bellon-Maurel and McBratney 2011; Krumins et al., 2012; Hayes et al., 2015; Straková and Laiho, 2016).

The LIFE OrgBalt project uses IRS for peat and soil samples collected in cool temperate moist climate zone in forest land, cropland and grassland. In parallel, peat samples collected in the LIFE REstore project are used to cover the full spectrum of peat properties – from nutrient-poor Sphagnum peat to fertile peat of mesotrophic bogs. The aim of these procedures is to to start building a spectral library for organic soils (including peat) and create initial calibration models to evaluate the method's potential to predict pH value and C, N, P, K, Ca, Mg and humic acid concentration in peat samples.

4. Soil and water analyses

A comprehensive evaluation of soil properties down to 100 cm depth is done in all gas fluxes measurement plots while establishing the reference and demonstration sites. After collection, samples are transported to LSFRI Silava laboratory of Forest environment and air-dried. Then all samples will be dried at 105°C degrees, weighted to determine bulk density, milled and screened through a 1 mm sieve, and samples for elemental analyses will be milled and sieved through a 0.25 mm sieve. After the preparation of samples following parameters are dermined: bulk density, pH, N, P, K, Ca, Mg, C and ash content.

The results of the analyses are used to determine possible correlations and covariations with GHG fluxes, particularly, after the proposed actions are implemented in the project demo sites. Water properties are used as additional parameters to increase the elaborate GHG emission models' accuracy and improve the ability to predict GHG fluxes under different management scenarios and land uses.

With this set of measurements done in demonstration sites on agricultural land, a diverse and in-depth data set on GHG fluxes and other environmental variables will be obtained. This is a key step in quantifying the impacts CCM measures have on nutrient rich organic soils and transferring the results of LIFE OrgBalt to other domains, such as improvement of the national GHG inventories and long-term modelling.

Discover the measurement processes in action in this short documentary:
https://www.youtube.com/watch?v=fktSVWquuus

LIFE ORGBALT TEAM

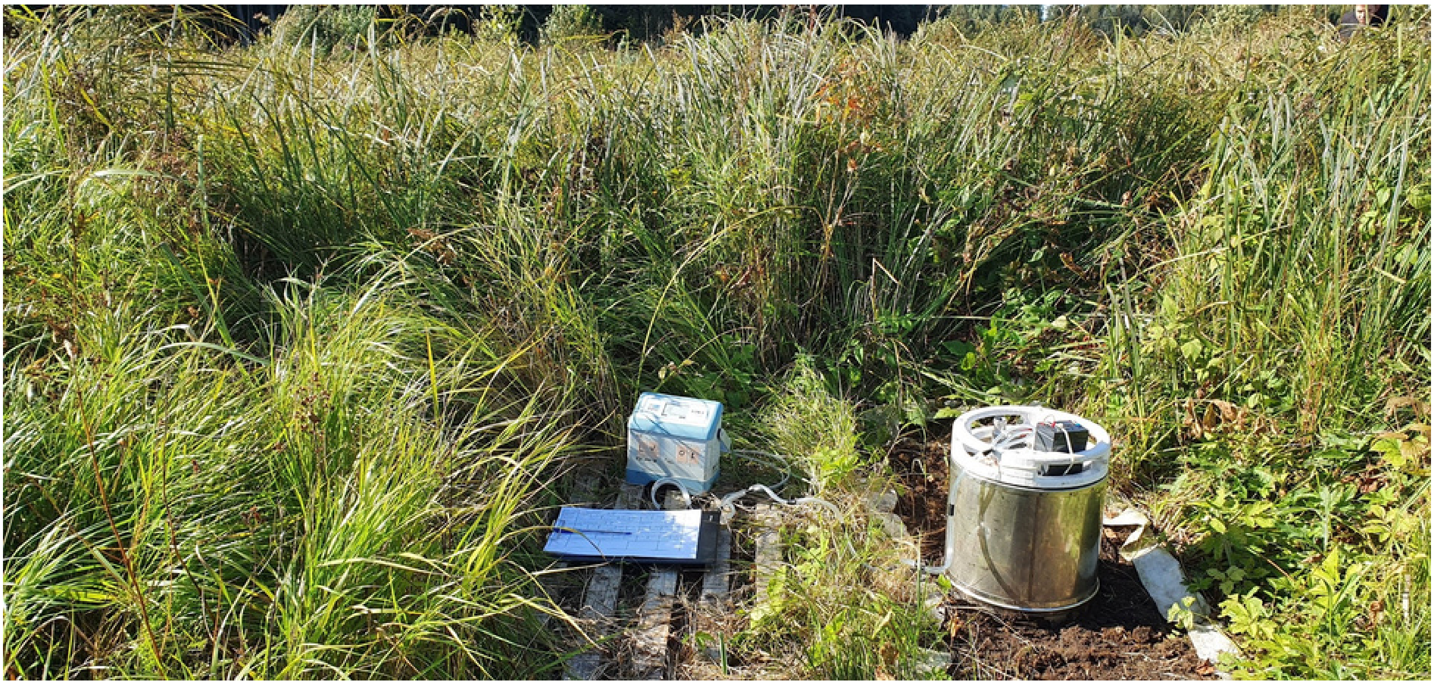

Figure 3. Measuring GHG fluxes.

References

Bellon-Maurel, V. and McBratney, A. 2011. Near-infrared (NIR) and mid-infrared (MIR) spectroscopic techniques for assessing the amount of carbon stock in soils – Critical review and research perspectives. Soil Biology and Biochemistry, 43(7), 1398-1410. https://doi.org/10.1016/j.soilbio.2011.02.019

Cécillon, L., Barthès, B.G., Gomez, C., Ertlen, D., Genot, V., Hedde, M., Stevens, A. and Brun, J.J. 2009. Assessment and monitoring of soil quality using near-infrared reflectance spectroscopy (NIRS). European Journal of Soil Science, 60, 770-784. https://doi.org/10.1111/j.1365-2389.2009.01178.x

Confalonieri, M., Fornasier, F., Ursino, A., Boccardi, F., Pintus, B., and Odoardi, M. 2001. The potential of Near Infrared Reflectance Spectroscopy as a tool for the chemical characterisation of agricultural soils. Journal of Near Infrared Spectroscopy, 9(2), 123-131. https://doi.org/10.1255/jnirs.299

Hayes, D.J.M., Hayes, M.H.B., and Leahy, J.J. (2015). Analysis of the lignocellulosic components of peat samples with development of near infrared spectroscopy models for rapid quantitative predictions. Fuel 150: 261–268. https://doi.org/10.1016/j.fuel.2015.01.094

Holmgren, A. and Norden, B. (1988). Characterisation of Peat Samples by Diffuse Reflectance FT-IR Spectroscopy. Applied Spectroscopy 42: 255–262. https://doi.org/10.1366/0003702884428284

Krumins, J., Klavins, M., Seglins, V., and Kaup, E. (2012). Comparative Study of Peat Composition by using FT-IR Spectroscopy. Material Science and Applied Chemistry 26: 106–114.
Straková, P. and Laiho, R. (2016). Application of infrared spectroscopy for assessing quality (chemical composition) of peatland plants, litter and soil. In Geophysical Research Abstracts (Vol. 18). EGU General Assembly 2016. file:///C:/Users/03093541/AppData/Local/Temp/EGU2016-17039-4.pdf
Terhoeven-Urselmans, T., Schmidt, H., Joergensen, R.G., and Ludwig, B. 2008. Usefulness of near-infrared spectroscopy to determine biological and chemical soil properties: Importance of sample pre-treatment. Soil Biology and Biochemistry, 40(5), 1178-1188. https://doi.org/10.1016/j.soilbio.2007.12.011

Figure 4. Measuring GHG fluxes.

To receive our newsletter, send us an email to info@baltijaskrasti.lv or submit a request on our project website.

FIND OUT MORE

FOLLOW US

Project "Demonstration of climate change mitigation potential of nutrient rich organic soils in Baltic States and Finland" (LIFE OrgBalt, LIFE18 CCM/LV/001158) is implemented with financial supportfrom the LIFE Programme of the EuropeanUnion and State Regional Development Agency of the Republic of Latvia. www.orgbalt.eu
The information reflects only the LIFE OrgBalt project beneficiaries view and the European Climate, Infrastructure and Environment Executive Agency is not responsible for any use that may be made of the information contained therein.
Additional information: www.orgbalt.eu