EU LIFE Programme project
"Demonstration of climate change mitigation potential
of nutrients rich organic soils in Baltic States and Finland"

REPORT

ON IMPLEMENTATION OF THE PROJECT

DEMONSTRATION OF CLIMATE CHANGE MITIGATION MEASURES IN NUTRIENTS RICH DRAINED ORGANIC SOILS IN BALTIC STATES AND FINLAND

WORK PACKAGE

REPLICABILITY TOOLS (C5)

ACTIONS

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"LIFE OrgBalt compiled the first regional Baltic/ Finnish GHG emission factors for managed nutrient-rich organic soils (current and former peatlands), which have been made available for the customary scientific review and further verification for national GHG inventories in the hemiboreal region in Finland and the Baltic countries. While the project analysed selected CCM measures for drained organic soils in agriculture and forestry and developed spatial models and tools, it also identified remaining knowledge gaps. To bridge the remaining limitations and fill the gaps, it is essential to continue GHG measurements and model development, as well to broaden and complete the scope of the evaluated CCM measures in the after-LIFE-project period, notably by including rewetting and restoration of peatlands that are currently considered to be among the most recommended CCM measures on drained peatlands in the EU. In addition, the developed Simulation and PPC models still include limited macroeconomic considerations and lack assessment of all environmental impacts. For all these reasons, these models should be used carefully in CCM strategy development for identification of gaps in climate neutrality transition policy and funding frameworks and need further optimization for broader applicability as decision-making tools."

SUMMARY

The main objective of the work package "Replicability tools" (C5) is to ensure the replicability and transferability of the LIFE OrgBalt results in the temperate cool moist climate region in Europe, particularly in the Baltic states, Finland and Germany. This will be achieved by providing applicable support tools and enabling their application on regulatory, as well as end-user level. The support tools include the Simulation model (SM) for a single field and regional level projections of GHG emissions and socio-economic outputs developed at the Latvia University of Life Sciences and Technologies, the PPC model developed at the Baltic Coasts, and the SUSI simulator developed at our collaborator institution the University of Helsinki. The data collected in LIFE OrgBalt should be made as useful as feasible for the tool development work, and should fulfill all criteria set for scientific work, including transparency and peer evaluation. For these purposes, the data should be publicly presented in scientific papers and presentations. This document lists such papers and presentations.

ABBREVIATIONS

C = carbon

CH$_4$ = methane

CO$_2$ = carbon dioxide

CCM = climate change mitigation

EF = emission factor

EU = the European Union

GHG = greenhouse gas

N$_2$O = nitrous oxide

LIFE OrgBalt = EU LIFE program project "Demostration of climate change mitigation measures in nutrient rich drained organic soils in Baltic states and Finland"

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1 MAIN REPLICABILITY TOOLS DEVELOPED, OR CONTRIBUTED TO, IN LIFE ORGBALT

The main objective of the work package "Replicability tools" (C5) is to ensure the replicability and transferability of the LIFE OrgBalt results in the temperate cool moist climate region in Europe, particularly in the Baltic states, Finland and Germany. This will be achieved by providing applicable support tools and enabling their application on regulatory, as well as end-user level. These support tools include 1) the Simulation model (SM) for single field and regional level projections of GHG emissions and socio-economic outputs, developed at the LULSaT, 2) the PPC model for economic analysis of climate change mitigation costs and benefits, developed at the Baltic Coasts, and 3) the SUSI peatland simulator, which describes hydrology, tree stand growth and nutrient availability under different management, site types, and weather conditions, developed by LIFE OrgBalt collaborator prof. Annamari Laurén, initially at Luke and currently at the University of Helsinki. Of these, the SM has been developed under C5, while development of the PPC model and the SUSI-related work has been done in C2. While the models other than SM currently still have only limited value as replicability tools, we wish to list them here for their potential value for this as well as their planned purposes.

1.1 Simulation model

The Simulation tool is a policy planning and decision support tool for simulation of the impact of different management options at a regional or national level. It allows projections of GHG emissions and socio-economic (profit, employment) effect of the selected management options within the LIFE OrgBalt project. The Simulation tool is designed by pulling together activity data, emission factors and socio-economic estimates. It integrates spatial information, projections of GHG emissions and socio-economic analysis for 15 scenarios developed within LIFE OrgBalt project. It is presented in detail in deliverables C5/1 and C5/2.

1.2 PPC model

The PPC model can be used for assessing the costs and impact on GHG emissions and CO_2 sequestration of the CCM measures implemented within the LIFE OrgBalt project. It is a microeconomic model to be used for business planning on a farm level and guidance on optimal public funding amount. PPC provides a tool to landowners/managers to help understand the implementation costs of the chosen measures, required loan amount, period for reaching return of investment, and the necessary amount of public investments. The model is designed to allow the user to assess the performance of organic soils depending on the planned land use type (scenario), based on the following land use performance criteria:
• Financial return of organic soil use scenarios from the implementation of CCM measures;
• Economic returns of organic soil use scenarios (based on GHG emission reductions and other factors such as employment);
• Financial deficit and the optimal amount of public funding for land use scenarios that give a positive economic return, but the implementation of which is not economically profitable for businesses; and
• Reduction of GHG emissions, incl. CO2 sequestration indicators.
PPC model is applicable in the Baltic states. We explored the potential to extend its applicability to Finland, but despite its great potential and interest from the Finnish actors, this turned out not to be feasible under LIFE OrgBalt. Main reasons were that compatible agricultural data was not available (only forests included in LIFE OrgBalt from Finland), and for corresponding assessment for forest land only Finland already has SUSI.

1.3 SUSI peatland simulator

Peatland simulator SUSI is a mechanistic simulation model, which describes drained peatland forest

hydrology, productivity and emerging growth limiting factors, and the resulting tree stand growth under different management schemes at different site types and under different weather conditions. SUSI is described in detail in Laurén et al. (2021).

SUSI has been developed by Prof. Annamari Laurén, who was affiliated to Luke at the planning stage of LIFE OrgBalt and was planned to work herself on modifying SUSI for Baltic conditions. SUSI has so far been developed using Finnish data only, and the drainage conditions among other things differ between Finland and the Baltic states to the extent that SUSI cannot be directly applied to Baltic peatland forests. Substantial work towards making SUSI more generally applicable was done in LIFE OrgBalt, but due to resource constraints it was eventually decided that SUSI will only be used in the Finnish context, while another solution was used for the Baltic conditions.

2 DATA TYPES COLLECTED IN LIFE ORGBALT AND THEIR USE IN THE REPLICABILITY TOOLS

Data collection under C1 in LIFE OrgBalt was designed to yield emission factors (EF) for nutrient-rich organic soils under agriculture or forestry in the Baltic states, and to provide information on how emissions of CO_2 and CH_4 evolve in longer term in forests managed in different ways on nutrient-rich organic soils in Finland. Data types include soil or forest floor GHG exchange data, environmental data (e.g., soil water-table level, temperature and nutrient concentrations), and auxiliary measurement data (e.g., biomass, biomass production, litterfall) for constructing annual soil C balance.

The EFs formulated based on the data are applied as such in the SM and PPC, while the process-based SUSI utilizes instead data constraining the soil emissions, i.e., the environmental and auxiliary data.

3 DATA PRESENTATION IN SCIENTIFIC PAPERS AND PRESENTATIONS

3.1 Scientific papers

LIFE OrgBalt has by May 31, 2024 resulted in 25 scientific papers. While papers presenting GHG exchange data from the measurement sites of LIFE OrgBalt are, self evidently, either just submitted for review (Butlers et al. 2024, Tyystjärvi et al. 2024) or will be submitted shortly, e.g., the following papers present data used or usable for EFs, which can be applied in SM and PPC:

Butlers et al. (2022)
Jauhiainen et al. (2023)
Purvina et al. (2024)
Vigricas et al. (2024)

The following papers present data that can be used in process-based models, such as SUSI:

He et al. (2023)
Lampela et al. (2023)
Leppä et al. (2020)

Papers presenting data from LIFE OrgBalt measurements sites that either have been submitted or will be submitted during June/July 2024:

Butlers et al. (2024)
Tyystjärvi et al. (2024)
Bārdule, A., et al. Net soil-to-atmosphere CO_2 fluxes from drained organic soils used for agriculture in the hemiboreal region of Europe.

Kamil-Sardar, M., Schindler, T., Vahter, H., Butlers, A., Vigricas, E., Kull, A., Līcīte, I., Bārdule, A., Čiuldienė, D., Lazdiņš, A., Jauhiainen, J., Mander, Ü., Laiho, R. & Soosaar, K. Emission factors of soil CH_4 and N_2O from drained and undrained hemiboreal peatland forests.

Samariks, V. et al. Initial impact of forest management on soil greenhouse gas emissions in drained hemiboreal coniferous peatland forests.

Papers presenting data from LIFE OrgBalt measurement sites that will be published during autumn 2024:

Ojanen, P., et al. Soil CH_4 and N_2O emissions from peatland forests managed with different types of cuttings

Korrensalo, A., et al. Soil heterotrophic respiration from peatland forests managed with different types of cuttings

Bārdule, A., et al. CH_4 and N_2O emission factors for croplands on nutrient-rich organic soils

Vahter, H. et al. CH_4 and N_2O emission factors for grasslands on nutrient-rich organic soils

3.2 **Scientific presentations**

LIFE OrgBalt partners have presented the data used in the models in several scientific meetings. Data used in the papers listed above have been presented in, e.g., the following scientific presentations:

Oral presentations

Mäkiranta, P. et al. 2023. Impacts of partial harvest and clearcut on methane and nitrous oxide emissions of forestry-drained boreal peatlands. Nordic-Baltic Workshop on Greenhouse Gas Exchanges and Carbon Cycling in Managed Peatlands, Vindeln, Sweden, June 13, 2023.

Butlers, A. et al. 2023. Greenhouse gas (CO_2, CH_4, N_2O) emissions of undrained and drained nutrient-rich organic forest soil. Nordic-Baltic Workshop on Greenhouse Gas Exchanges and Carbon Cycling in Managed Peatlands, Vindeln, Sweden, June 13, 2023.

Ali, M. K.-S. et al. 2023. Greenhouse gas emissions from drained nutrient-rich organic forest soils in Estonia. Nordic-Baltic Workshop on Greenhouse Gas Exchanges and Carbon Cycling in Managed Peatlands, Vindeln, Sweden, June 13, 2023.

Korrensalo, A. et al. 2023. Peat respiration in drained peatland forests under varying tree harvest regimes. Nordic-Baltic Workshop on Greenhouse Gas Exchanges and Carbon Cycling in Managed Peatlands, Vindeln, Sweden, June 13, 2023.

Korrensalo, A. et al. 2023. Peat respiration in drained peatland forests under varying tree harvest regimes. EGU General Assembly 2023, Vienna, Austria, 24 April 2023.

Poster presentations

Muhammad Kamil Sardar Ali et al. 2024. Soil CH_4 and N_2O fluxes from drained and undrained peatland forests in the Baltic region. EGU General Assembly 2024, Vienna, Austria, 18 April 2024.

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