31.10.2023, No. 9

Research project "Evaluation of factors affecting greenhouse gas (GHG) emissions reduction potential in cropland and grassland with organic soils" (No. 1.1.1.1/21/A/031)

Policy brief

The project's goal was to develop a model-based approach for the accounting and forecasting of greenhouse gas (GHG) emissions (CO_2, N_2O, and CH_4) from organic soils. This involved creating and refining a methodology for gathering and updating the activity data needed for these calculations. Additionally, the project aimed to devise land management strategies to lower GHG emissions through the adoption of better management practices on both rewetted and drained soils. The achievement of this goal has resulted in more accurate emission estimates compared to those derived from previously used formulas.

The primary outcomes of the project include a system for the accounting and projection of GHG emissions emanating from organic soils and drainage systems in croplands and grasslands. It also encompasses forecasts of the impacts of various climate change mitigation strategies, such as reduced tillage (transitioning to grassland), afforestation, and paludiculture (management of rewetted and drained afforested areas), as well as the management of groundwater levels in grasslands (an additional approach for converting cropland to grassland), and the cultivation of fast-growing trees. Furthermore, the project assessed the impact of wood ash application on GHG emissions and developed biomass expansion factors for farm crops, drawing upon both national and international studies. The findings offer unique insights into the GHG dynamics within the hemi-boreal climate zone, enhancing our understanding of these processes significantly. The project's scientific discoveries have been documented in various scientific publications and presented at international conferences. The publication of these results will continue after the study concludes, given their substantial scientific value and the potential to synergize with other research efforts in the hemi-boreal region.

Jauhiainen et al. (2019) provide a comprehensive summary of the latest advancements in reporting GHG emissions from organic soils. The Intergovernmental Panel on Climate Change (IPCC) offers foundational definitions and guidelines for establishing Emission Factors (EFs) for GHG inventories related to organic soils, yet it lacks specific instructions for data content and its reporting. The availability of uniform data could enhance the creation of more refined Tier 2 EFs and aid in comprehensive assessments. There's a recognized demand for more thorough reporting on various site attributes and conditions, such as the effects of daily and long-term variations in soil temperature, water table dynamics, and rates of litter production and decay. Future research should also aim to measure the indirect effects of forestry management on GHG emissions, assess CH_4 and N_2O emissions from the surfaces of plants and drainage channels, and gather information on carbon flows in water from drained organic soils. Recent research has greatly enriched our comprehension of carbon storage and sequestration, GHG emissions, management strategies, modelling techniques, and the policy ramifications for organic soils in agriculture and grasslands. This underscores the importance of cross-disciplinary studies, accurate accounting practices, and well-informed policy making for the effective control and reduction of GHG emissions from these soils. Ongoing research is essential to further refine our understanding of the intricate biogeochemical processes and interactions responsible for GHG emissions from organic soils and to discover new methods for their sustainable management. Integrating scientific insights into policy and practical management can enhance the restoration of vital ecosystems, combat climate change, and protect the crucial carbon sequestration services offered by organic soils.

The primary result of the project is a detailed methodology for the calculation and forecasting of greenhouse gas (GHG) emissions from organic soils in croplands and grasslands. This includes a system for the development and periodic update of activity data relevant to GHG calculations and for estimating the impact of climate change mitigation strategies, such as turning cropland into grassland, rehydrating grasslands, tree planting, and developing wetland cultures with species like black alder or birch. Experimental work in greenhouses has yielded important insights into how wood ash application and changes in groundwater levels affect GHG emissions from organic soils, thereby enhancing the precision of emission forecasts across various management practices. These findings are particularly relevant to the hemi-boreal climate of the Baltic region and are expected to greatly enrich our comprehension of GHG dynamics in organic soils within these countries.

The project provided scientific validation for the methodologies used in calculating and forecasting GHG fluxes and carbon movement under various management approaches. For aspects not directly studied within the project, data from existing literature was utilized. While some carbon transactions, such as litter production and biomass transfer from ground vegetation in areas undergoing afforestation, still rely on literature for their estimates and require further refinement, the project has adequately addressed soil carbon transfers and GHG emissions in degraded peatlands. This ensures a comprehensive foundation for incorporating tier 3 methodologies into mitigation strategies and tools for projecting GHG emissions.

The project significantly enhanced understanding of carbon incorporation into soil from plant residues in cropland and grassland, by disseminating findings based on its own data collection and materials gathered from previous research. This information paves the way for modelling carbon turnover in both organic and mineral soils, a capability that was previously hindered by the lack of comprehensive data sets. This breakthrough removes barriers to modelling soil carbon dynamics and implementing mitigation strategies related to the removal of CO_2 from the soil.

The outputs of the project are aligned with the National GHG inventory and the objectives of the Rural Development Program 2023-2027, aimed at climate change mitigation measures, to ensure the seamless and effective application of the project’s findings. In addition to facilitating integration with the LIFE OrgBalt GHG flux measurement data, the project will support these goals through over 10 publications that validate the project’s outcomes for inclusion in the GHG inventory system. Combined with the developed modelling approach and activity data derived from the project’s outputs, these efforts lay a robust foundation for the adoption of GHG mitigation strategies in croplands and grasslands with organic soil. The availability of comprehensive activity data allows for the expansion of the project’s impacts not only in Latvia but also across other Baltic nations.

Organic soils in croplands and grasslands are currently the most significant source of GHG emissions in Latvia, playing a major role in the GHG dynamics of the boreal and hemi-boreal regions. This situation is anticipated to persist as air temperatures rise. However, the reliability of existing methods to quantify these emissions is questionable, with most European countries still depending on the default emission factors provided by the IPCC, as noted by Jauhiainen et al. (2019). In 2021, GHG emissions from Latvia's grasslands and croplands were reported to be 2.0 million tons of CO_2 equivalent annually, accounting for 20% of the country's total emissions, according to the Ministry of Environmental Protection and Regional Development (2022). Prior research, such as the LIFE REstore project, has shown that different management practices can significantly alter emission levels, with afforestation, despite lowering groundwater levels, being recognized as an effective mitigation strategy that can transform these areas from emission sources to net CO_2 sinks (Priede & Gancone, 2019). The estimated annual cost of emissions from grasslands and croplands could reach €1 billion annually. Our findings suggest that these costs could be mitigated by implementing climate change mitigation strategies, especially through the afforestation of organic soils.

Having comprehensive, country-specific data on GHG fluxes from organic soils, without overlooking any potential sources, is crucial for formulating policies and managing initiatives aimed at building resilient systems that both mitigate climate change and offer a variety of ecosystem services. This approach is expected to enhance the Land Use, Land-Use Change, and Forestry (LULUCF) sector's contribution to the economy and climate change efforts, aiming for net-zero emissions from croplands and grasslands in the latter half of the 21st century. The adoption of a decision support system for reforesting organic soils and rejuvenating forest ecosystems native to nutrient-rich organic terrains through optimal methods could offset up to 100% of Latvia's agricultural emissions in the latter half of the 21st century, if fully applied. This transformation of organic soils through afforestation not only shifts croplands and grasslands from being major GHG emission sources to significant CO2 sinks but also minimizes net emissions from food production to almost zero. The potential revenue from selling CO2 removal credits on voluntary carbon markets could amount to €2-6 million annually, depending on unit prices, with full afforestation of organic soils.

The findings from this research are intended for long-term use and will be routinely updated within the national GHG inventory framework. Efforts have also been made to prepare for future projects and collaborations, such as the LIFE OrgBalt project, which focuses on managing nutrient-rich organic soils, to ensure ongoing work and information sharing. Such sustained initiatives are vital, given the current low levels of awareness and implementation of climate mitigation actions in the LULUCF sector, despite available restoration measures and financial mechanisms to meet national climate neutrality objectives. While immediate changes are not anticipated, the team is confident that persistent efforts will lead to significant outcomes, particularly the inclusion of afforestation, rewetting, and restoration of wet forest ecosystems in Latvia's National Climate and Energy Plan, a progress significantly bolstered by this project. The next phase involves deploying financial instruments to support the implementation of these mitigation measures in organic soils.

Further information may be provided by the project team members. Contact information and publications involving project results are available on the project web site.