Data soon available on the climate impacts of restoring fertile peatland forests and afforesting cutaway peatlands in Finland

There is an increasing need to study the role of peatlands as part of climate change mitigation and emission reductions. The Finnish government has launched the "Catch the carbon - research and innovation programme 2021-2024" for climate change-related projects in the land use sector.

The programme provides resources for studying greenhouse gas (GHG) emission reductions and ways to strengthen carbon sinks and reservoirs also in peatlands. It is highlighted that to achieve the target of a carbon-neutral Finland by 2035, more studies are needed, especially concerning drained peatlands (Ministry of Agriculture and Forestry of Finland 2022).

TURNEE project produces data

One project funded from the programme is called "Forests on peatlands - solutions for reducing emissions and increasing of carbon sinks (TURNEE)". The project uses new measurements and modelling to investigate to what extent emissions from the land use sector could be reduced by restoring fertile peatland forests, and how far sinks could be increased by afforesting abandoned cutaway peatland areas in Finland.

The climate impact of the restoration of drained forest peatlands are important to study. Raising the ground water table level reduces the decomposition of peat and emissions of carbon dioxide (CO_2) and nitrous oxide (N_2O) (Minkkinen et al. 2020), but likely increases methane (CH_4) emissions, especially in nutrient-rich mires (Vanselow-Algan 2015), which means that the climate benefits of restoration can be offset for decades (Ojanen and Minkkinen 2020). However, the studies which show an increase in CH_4 emissions are almost all from agricultural areas and from warmer climates compared to Finland. No previous knowledge exists from fertile boreal peatland forests.

Cutaway peatlands are also a potentially significant target for emission reductions. Because of climate change mitigation policy in Finland, energy peat harvesting practically ceased in Finland in 2021,

leaving behind tens of thousands of hectares of cutaway peatlands that are in need of an after-use plan. From the perspective of climate change mitigation, the different after-use options may create very different outcomes. However, little data on the climate effects of different after-use options is available.

Afforestation is a common after-use method, which is also encouraged by the law on temporary support for afforestation (HE 150/2020). Successful afforestation creates a carbon sink from the growing tree stand. In cutaway peatlands, the residual peat is usually nutrient-poor, and thus fertilization is needed. With the help of fertilization, afforestation may even be successful naturally, at least if downy birch is accepted as a tree species to be grown (Alatalo 2020). However, as the trees need good drainage and fertile soil, carbon loss from the peat soil may well exceed the carbon sink by the tree stand. Thus, there is a risk that afforested thick-peated sites will become long-lasting C sources rather than sinks, contrary to the climate mitigation goals.

Measurements in TURNEE

In the TURNEE project, climate impacts are or will be measured at two new sites, equipped with an eddy covariance system and instruments for ancillary meteorological measurements.

In addition, small particle formation will be measured. The measurement setups are based on the SMEAR concept (station for measuring earth surface - atmosphere relations, see Hari and Kulmala 2005, Hari et al. 2016), which combines the observation of GHG exchange (Integrated Carbon Observation System, ICOS, compatible measurements) and atmospheric aerosol particle measurements (Aerosols, Clouds, and Trace gases Research Infrastructure, ACTRIS, compatible measurements).

These globally unique monitoring stations will provide information on the overall climate impact of peatlands for many years to come even after the end of the TURNEE project.

An intensive measurement station was established on a cutaway peatland, Naarasneva, Soini, western Finland, in autumn 2021. The station is measuring

1. GHG exchange between the peatland and the atmosphere,
2. aerosols formed by trees and other vegetation and the subsequent formation of small particles,
3. surface albedo and other ancillary meteorological parameters, and
4. carbon and nutrient release along with water discharge.

The site was fertilized with wood ash in January 2022, and it will be afforested by planting pine seedlings in spring 2022. Thus, we are able to monitor the changes in gas and water fluxes following afforestation. Next to the test field, we have established an experimental area where GHG emissions will be measured with the GHG

Figure 1: Instrument cabins and towers for the intensive measurements of total climate effects on afforested cutaway peatland in Naarasneva, Finland. The taller tower is for the meteorological measurements, while the shorter tower is for the eddy covariance fluxes. The cabin to the right with the long horizontal inlet includes the NAIS (neutral cluster and air ion spectrometer) analyser for small aerosol particles.
Photo: Kari Laasasenaho

flux chambers from a plain, unforested peat soil, serving as a control plot, and from areas with different fertilization treatments.

The immediate effects of the restoration of forestry-drained peatland on GHG emissions will be measured at an intensive measurement station, which will be set up in a fertile forestry-drained peatland in Tammela, southern Finland, in spring 2022. The peatland will be rewetted about a year after the start of the measurements. CO_2 and CH_4 exchanges will be measured using the eddy covariance method.

In connection with the rewetting, the tree stand in the peatland will be thinned to resemble the state of the peatland before drainage. Measurements will continue for several years after the project has ended. In addition, we will study the distribution of greenhouse gas exchange (CO_2, CH_4 and N_2O) between the soil, ground vegetation and trees, using the chamber method. Biomass measurements of different vegetation layers will also be conducted. The collection of data has begun, and the first scientific results will be published in the coming years.

The TURNEE project is a joint project together with University of Helsinki, University of Oulu, Finnish Meteorological Institute and Seinäjoki University of Applied Sciences in 2021-2023. The total project budget is ca. 1.9 million euros.

For more information on the project please contact the authors:

Kari Laasasenaho & Risto Lauhanen

Seinäjoki University of Applied Sciences
Seinäjoki, Finland
kari.laasasenaho@seamk.fi
risto.lauhanen@seamk.fi

Annalea Lohila & Olli-Pekka Siira

Institute for Atmospheric and Earth System Research, University of Helsinki, Finland
annalea.lohila@helsinki.fi
olli-pekka.siira@helsinki.fi

Kari Minkkinen & Paavo Ojanen

Department of Forest Sciences
University of Helsinki, Finland
kari.minkkinen@helsinki.fi
paavo.ojanen@helsinki.fi

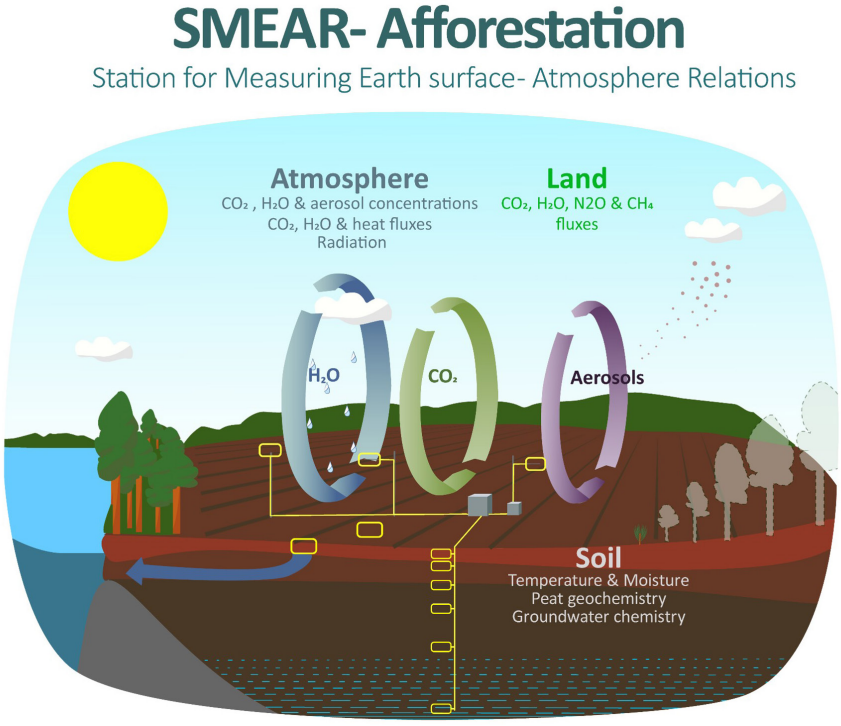

Figure 2: The SMEAR afforestation station is measuring, e.g., CO_2, water and aerosol exchange between atmosphere, land and soil. Illustration: Núria Altimir

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Figure 3: The site for the measurement station in a peatland forest that is to be restored in Tammela, southern Finland. Photo: Kari Minkkinen

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