LIVING LAB OF FINLAND

Restoration for the future WETLANDS
www.alfawetlands.eu

Luke NATURAL RESOURCES INSTITUTE FINLAND

FMI

Monitoring restoration in drained peatland forests

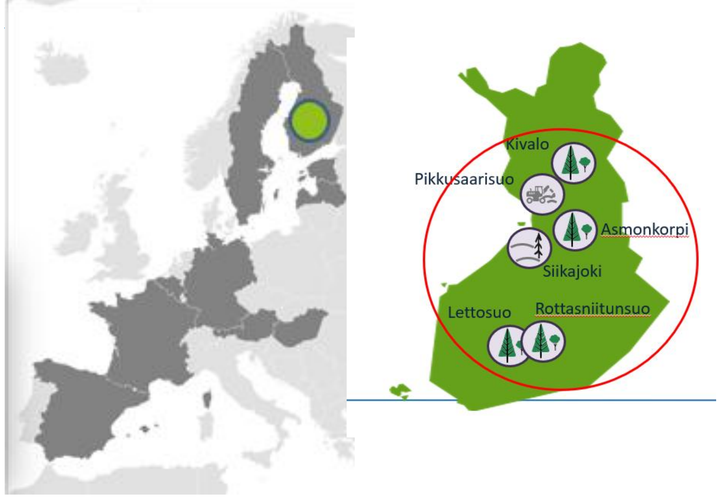


Sanginjoki

Drained peatland forest – ditch blocking will be conducted 2027 (Photo: R. Isomäki)

Restoration and improved wetland management can support climate and biodiversity goals while being socially just and rewarding

1 OUR LIVING LAB



THE CHALLENGE

Drainage has changed water-table conditions and affects greenhouse gas fluxes, biodiversity and water quality.

Nearly 50% of Finland's peatlands (4.95 Mha) have been drained for forestry, representing about 25% of the forest area. Drained peatland forests are a net carbon sink through tree growth, while their soils remain a carbon source. Conventional forestry in Nordic peatland forests is based on even-aged rotations of 60-100 years, followed by clearcutting and often ditch network maintenance (NTM) to promote regeneration. NTM lowers the soil water table for extended periods, increasing aerobic decomposition and CO_2 emissions, whereas higher water tables increase CH_4 and potentially N_2O emissions.

Drained peatland forest







Drained peatland forest in Finland and fresh ditch
(photos H. Nousiainen)

WETLAND TYPES

Drained peatland forest
Lettosuo – continuous cover forestry (CCF)
Kivalo - continuous cover forestry (CCF)
Rottasniitunsuo – rewetting+ thinning
Asmonkorpi / Sanginjoki - constructed wetlands + rewetting

Drained peatland forest – non-productive
Siikajoki

Peat extraction (afteruse)
Pikkusaarisuo



Peat subsidence under drained conditions vs. undrained site (photos: H. Nousiainen)

CONTACT: Liisa Ukonmaanaho, Natural Resources Institute Finland,Luke
liisa.ukonmaanaho@luke.fi

2 WHAT WE DID

ACTIONS - MONITORING

- Monitoring the impacts of more sustainable forest management in drained peatlands and assessing its potential as restoration measure
- Monitoring the effects of rewetting and thinning on GHG emissions in drained peatland forests
- A baseline assessment and Co-creation process was implemented
- Remote sensing-based approach for mapping biodiversity and ecosystem services.
- Modelling of CO_2 and CH_4 fluxes and soil carbon stocks
- PPGIS, a map-based survey method used to collect stakeholders' opinions, experiences and values related to specific locationss conducted
- Open days was conducted one of the Living lab sites





Set up of GHG measuring point, N2O measuring (Lettosuo),and vegetation mapping (Kivalo) (Photos: M. Kurki, L Ukonmaanaho)

WHAT WAS MEASURED?

At the Lettosuo and Kivalo monitoring focused on heterotrophic soil respiration and GHG fluxes (CO_2, CH_4, and N_2O) from strips and ditches in continuous cover forestry sites and nearby conventional peatland forestry sites as control.

Supporting measurements included groundwater depth, soil moisture, soil and air temperature, precipitation, photosynthetically active radiation, soil and groundwater chemistry, and the physical and chemical properties of peat. Carbon inputs and stocks were assessed through above- and below-ground vegetation biomass, litter production (measured under LIFE OrgBalt project) and tree growth.

At Rottasniitunsuo, monitoring followed a different approach, with continuous ecosystem-scale CO_2 and CH_4 flux measurements using the eddy covariance (EC) method. These continuous measurements provided whole-ecosystem CO_2 and CH_4 balances.

The wider project added harmonised biodiversity and ecosystem-service indicators, soil microbial sampling, infrared spectroscopy of peat (Silava analysed our samples), wetness, water quality (forms of N at Lettosuo) and surface temperature.

Remote sensing and GIS analyses, combined with field data, were used to map LULC, vegetation, biodiversity, and ecosystem services using satellite, aerial, drone, and laser-scanning data.

Scenarios assessing the impacts of wetland restoration at Living Lab sites, as well as their upscaling from site to regional level, were modelled using the process-based ecosystem model JSBACH-YASSO-HIMMELI

With the PPGIS survey, was examined stakeholders' perceptions of wetland restoration, the significance of wetlands, and willingness to pay for restoration.

CO-CREATION

Between 2024 and 2025, three co-creation workshops were held in Sanginjoki/Asmonkorpi, a forested nature reserve undergoing extensive wetland restoration. The workshops brought together local stakeholders to discuss the future development of the area and its restoration activities.



3 RESULTS & LEGACY

KEY FINDINGS

- On average in nutrient rich spruce dominated sites, such as Lettosuo and Kivalo, annual CO_2 release from peat decomposition was lower in CCF sites than in control treatments, however the raise soil water table level does not always reduce annual soil emissions.
- At the Rottasniittu rewetting site, rewetting and associated thinning temporarily turned a strong CO_2 sink into a source. CO_2 uptake recovered by year two, while CH_4 emissions increased slightly.
- Modelling: NEE (Net ecosystem change) simulations (1900–2100) showed that rewetting temporarily turned the site from a strong CO_2 sink into a source. Elevated post-rewetting fluxes were likely associated with logging residues increasing respiration and CH_4 emissions, while CO_2 uptake recovered over time.
- Remote sensing:
  - A new remote sensing-based LULC classification method achieved up to 96% accuracy across seven EU wetland and peatland sites, enabling rapid large-scale monitoring of wetland types and management practices.
  - BES was best predicted by combined canopy structure and spectral data. Sentinel-2 performed best, with the highest values in closed-canopy areas.
- PPGIS survey results showed (Sanginjoki/Asmonkorpi and surrounding region)
  - Wetland restoration was widely accepted by respondents.
  - Wetlands were valued for relaxation, nature experiences, and well-being benefits
  - Around 2/3 of respondents expressed willingness to financially support wetland restoration programmes
- The Co-creation process enhanced understanding of wetland restoration and stakeholder perspectives, resulting in jointly developed recommendations for the sustainable and inclusive management of the reserve, which were delivered to land manager.

BENEFITS & TRADE-OFFS (expected)

	Continuous cover forestry (Lettosuo, Kivalo)	Ecological restoration (Rottasniittu, Sanginjoki/Asmonkorpi)
Climate mitigation	+	+
Biodiversity	+	+
Water quality	+	+/–
Production	+/–	–
Management costs	+/–	+/–
Stakeholders acceptance	+	+

++ strong positive
+ positive positive
+/– mixed
– negative / trade-off

LESSONS LEARNT

- Having historical data available is valuable, as starting from scratch is labour-intensive, although sometimes necessary.
- Diversity of site, makes difficult to interpret results
- Long term ecological monitoring is needed
- peatland and wetland restoration must be planned and governed at landscape and catchment scales, not only at the parcel level.
- Continuous EC measurements provided integrated ecosystem-scale greenhouse gas balances, enabling the ecosystem response to rewetting.
- Long-term CO_2 and CH_4 monitoring is essential to separate treatment effects from annual weather variability and capture delayed ecosystem responses.
- Restoration outcomes are strongly influenced by local social contexts and stakeholder trust, highlighting the need for early, inclusive, and sustained co-creation processes

LEGACY AND NEXT STEPS

Legacy:
- Monitoring data from the sites are stored in the ALFAwetlands database and will be archived in Zenodo.
- Scientific publications and deliverables produced
- Monitoring and research will continue many of the sites through follow-up projects
- Improved evidence on GHG emissions from managed and restored forestry-drained peatlands. However, more long-term monitoring is needed to track emissions and functional peatland recovery.
- Enhanced stakeholder collaboration and enduring management guidance beyond the project lifetime.

Next steps
- Paludisilviculture bridges peatland restoration and forestry through rewetting, native species and ash fertilization, improving habitat quality while reducing emissions and maintaining timber revenue
- Long-term EC monitoring will continue at Rottasniitunsuo and Lettosuo.
- At Lettosuo, EC measurements will be expanded to include also ecosystem-scale CH_4 and N_2O measurements.

ONE KNOWLEDGE GAP

The effects of different restoration methods on water quality and on plant and animal communities have not been adequately studied.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.