Managing forest peat soils for carbon and water

Tuula Larmola 28 Aug 2025

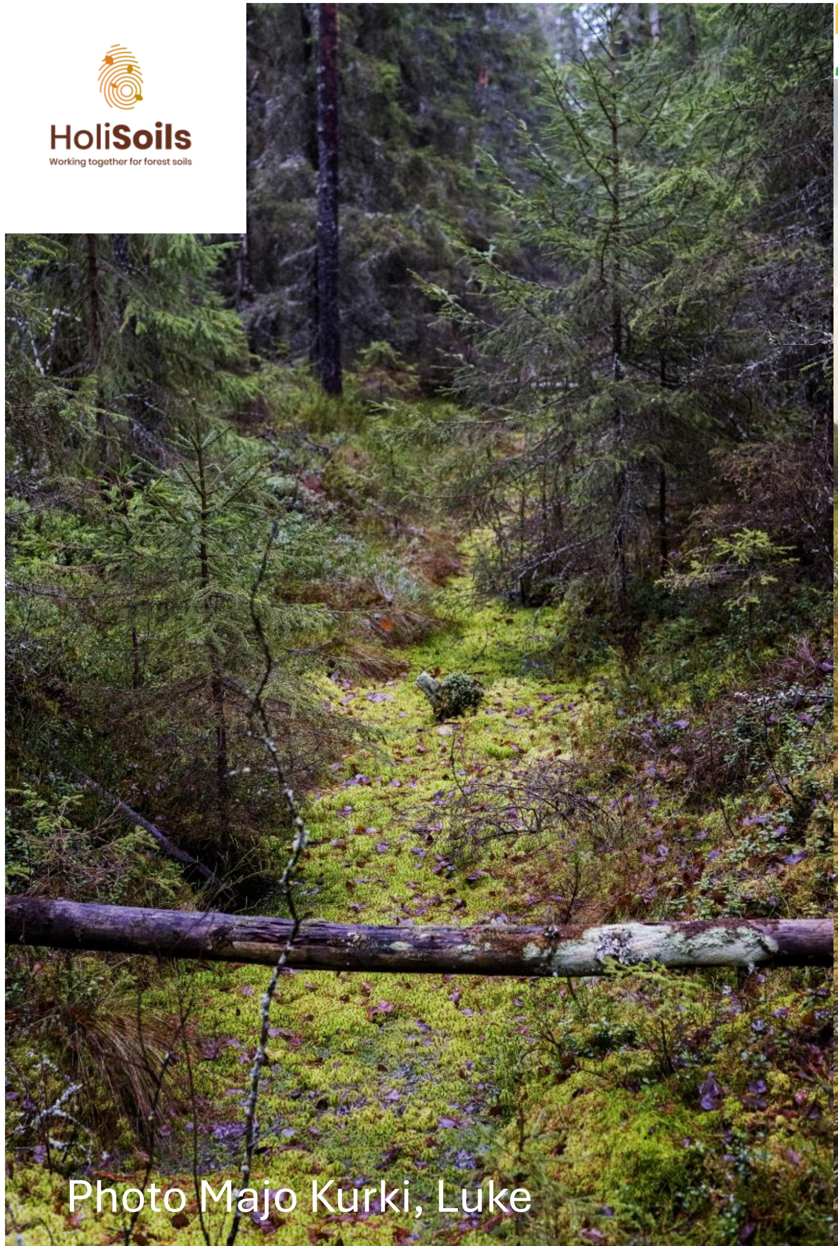
Photo T. Larmola, Luke

Luke

Environmental impacts of rewetting and restoration

Mitigation of greenhouse gas emissions from managed peat soils in agriculture and forestry

HoliSoils
Working together for forest soils



PaluWise

Wetland Restoration for the Future

Coordinators L. Ukonmaanaho, T. Larmola

Climate change mitigation which supports biodiversity and is socially just and rewarding

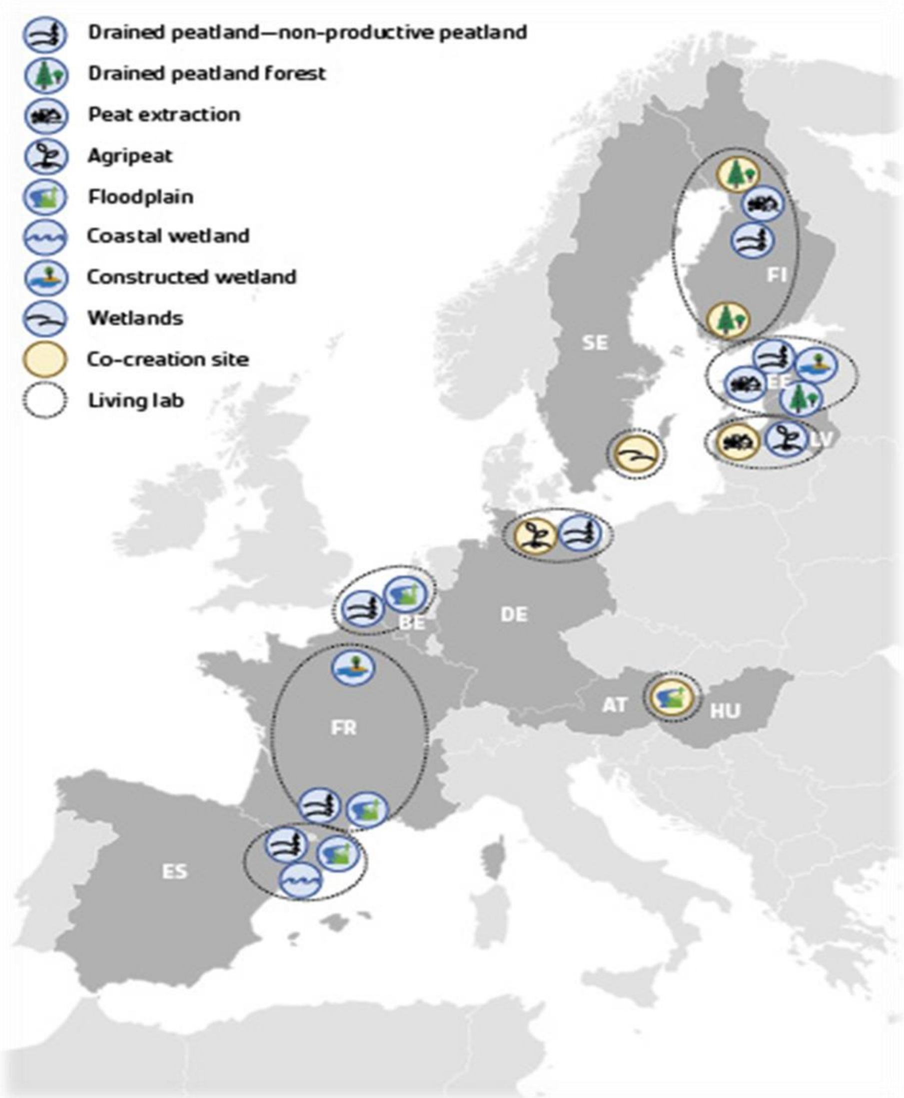
- ALFAwetlands (Horizon Europe 2022-2026) will
    - Advance the geospatial knowledge base of wetlands
    - Evaluate pathways of wetland restoration that incorporate a co-creation process
    - Provide information to maximize climate change, biodiversity and other ecosystem benefits

Luke
NATURAL RESOURCES INSTITUTE FINLAND

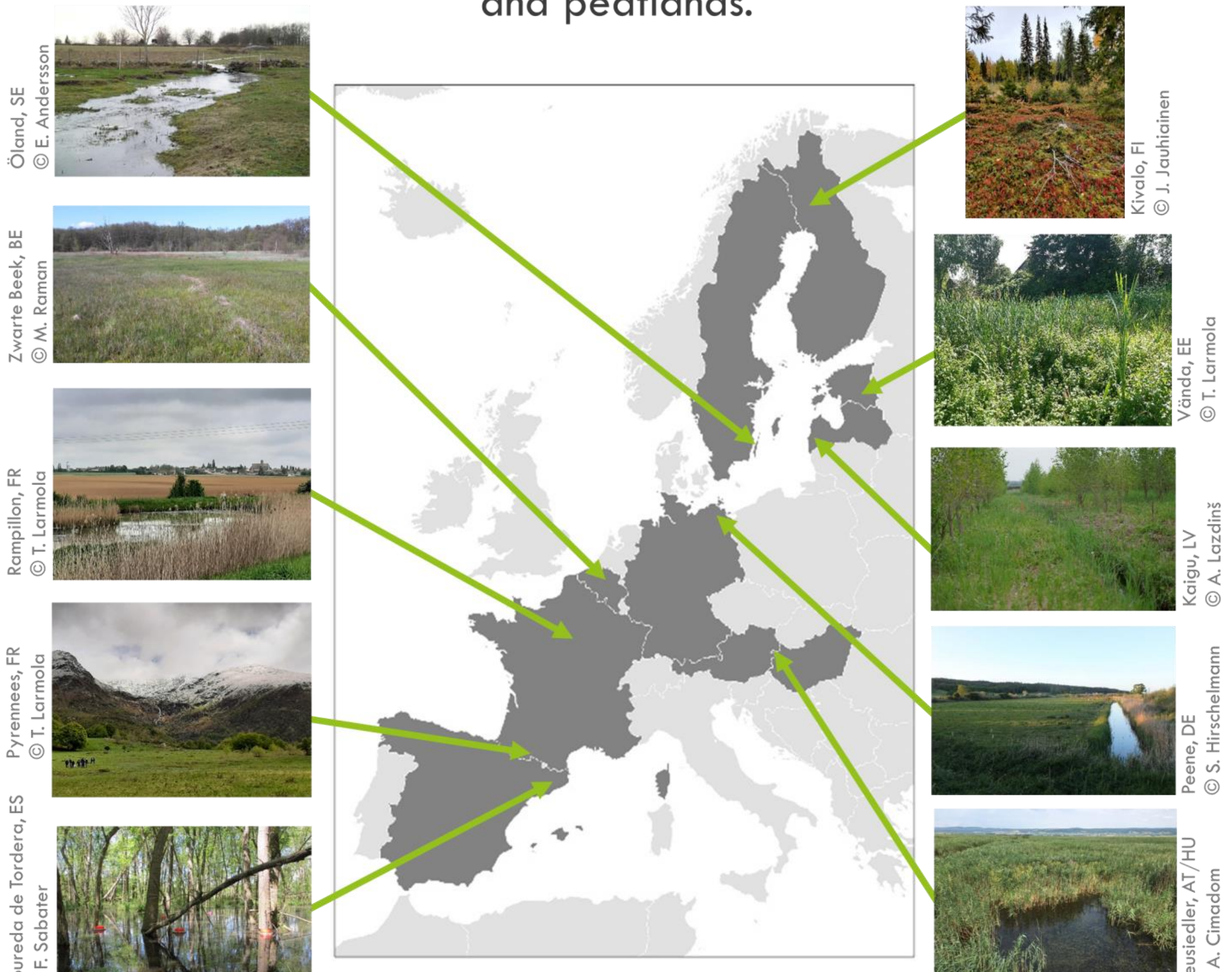
ALFAwetlands Living Labs

- Living Labs support interdisciplinary and multi-actor research on ecological, environmental, economic, and social issues at the local level.
- **Longer time series** of GHG exchange and water impacts under different management options
- **Co-creation sites** for socially fair and rewarding pathways for wetland restoration
- **Landowners' perceptions**, acceptability & compensation requests of wetland policies
- **Indicators** to maximise climate change mitigation and biodiversity

https://alfawetlands.eu/living-labs/



A wide range of wetlands and their land uses across Europe will be covered, including floodplains, coastal and artificial wetlands and peatlands.



Examples of wetlands in Living Labs.

Peatland management options studied incl.

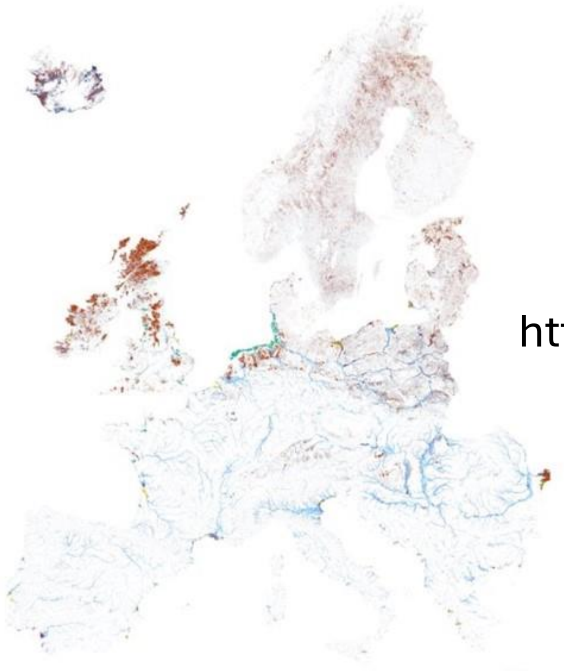
Water level manipulations
Continuous cover forestry
Flood-tolerant crops
Sphagnum sowing
Mowing fen meadow, periodic flooding
Rewetting, (partial) tree removal
Restoring hydrology
Berry cultivation
Ash fertilization
Agroforestry
Afforestation
Fenching to prevent livestock grazing

Efficiency of wetland restoration compared to other AFOLU mitigation options

Follow ALFAwetlands

Restoration for the future
WETLANDS
www.alfawetlands.eu

- info@alfawetlands.eu
- https://alfawetlands.eu
- https://twitter.com/ALFAwetlands
- https://www.facebook.com/ALFAwetland
- Newsletter https://alfawetlands.eu/alfawetland/newsletter/
- @alfawetlandsproject



https://zenodo.org/records/15302184

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

RESEARCH INSTITUTE
NATURE AND FOREST

UNIVERSITAS TARTUENSIS 1632 TARTU ÜLIKOOL

UNIVERSITAT DE BARCELONA

Luke
NATURAL RESOURCES INSTITUTE FINLAND

IIASA
International Institute for Applied Systems Analysis

EUROPEAN WILDERNESS SOCIETY

UNIVERSITET STOCKHOLMS

SILAVA

Succow Stiftung

CREAF

cnrs

INRAE
science for people, life & earth

Wetlands
INTERNATIONAL

SER
SOCIETY FOR ECOLOGICAL RESTORATION

Luke
NATURAL RESOURCES INSTITUTE FINLAND

Moss vegetation impacts ditch methane emissions from boreal forestry-drained peatlands — revisions to national greenhouse gas inventory and forest management

Tuula Larmola, Antti J. Rissanen, Paavo Ojanen, Leena Stenberg, Jani Anttila, Sakari Tuominen, Kari Minkkinen, Markku Koskinen, Jyrki Jauhiainen, Lukas Kohl, Liisa Ukonmaanaho, Raisa Mäkipää

Natural Resources Institute Finland, University of Tampere, University of Helsinki, University of Eastern Finland

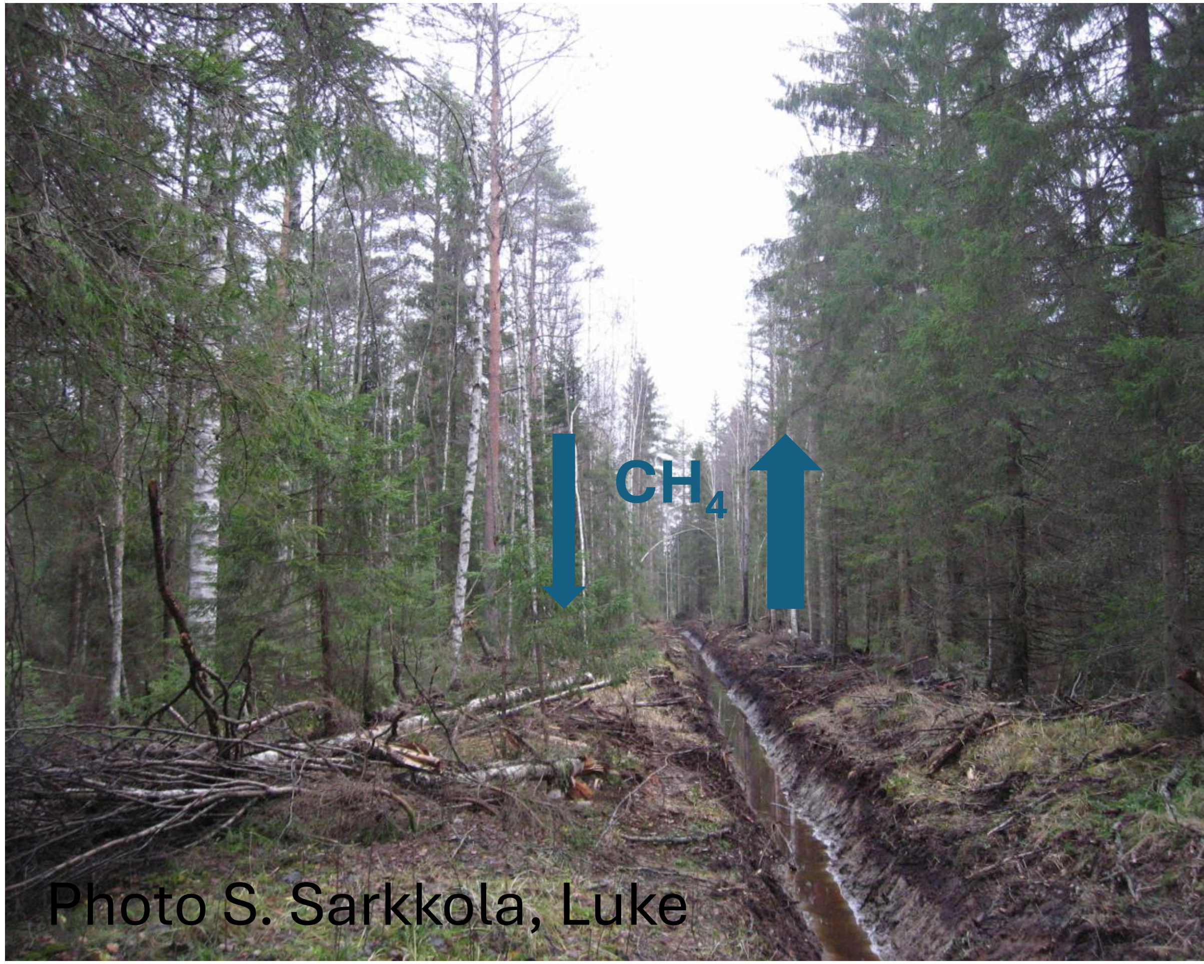
Photo Majo Kurki, Luke

Why study methane emissions from ditches?

- Ditches in forestry drained peatland
- cover ca. 2,5-3% of area
- contribute to up to 100% of CH_4 emission
- peat soil can be a CH_4 sink especially under efficient drainage

- **Emissions from ditches will impact whether a drained peatland is a net CH_4 sink or source** Emission factors for national conditions (Tier2-3) developed: the condition of ditches (depth, vegetated/not), time since drainage (Rissanen et al. 2023 Frontiers Env Sci)

- **Ditch network maintenance is changing along with new schemes in peatland forest management:** ditch network maintenance not subsidized after 2023, Continuous Cover Forestry becoming more common



How does vegetation impact ditch CH_4 emissions?

frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 05 April 2023
DOI 10.3389/fenvs.2023.1121969

Check for updates

OPEN ACCESS

EDITED BY
David Widory,
Université du Québec à Montréal, Canada

REVIEWED BY
Gerald Jurasinski,
University of Rostock, Germany
Michelle Garneau,
Université du Québec à Montréal, Canada

*CORRESPONDENCE
Antti J. Rissanen,
antti.rissanen@tuni.fi

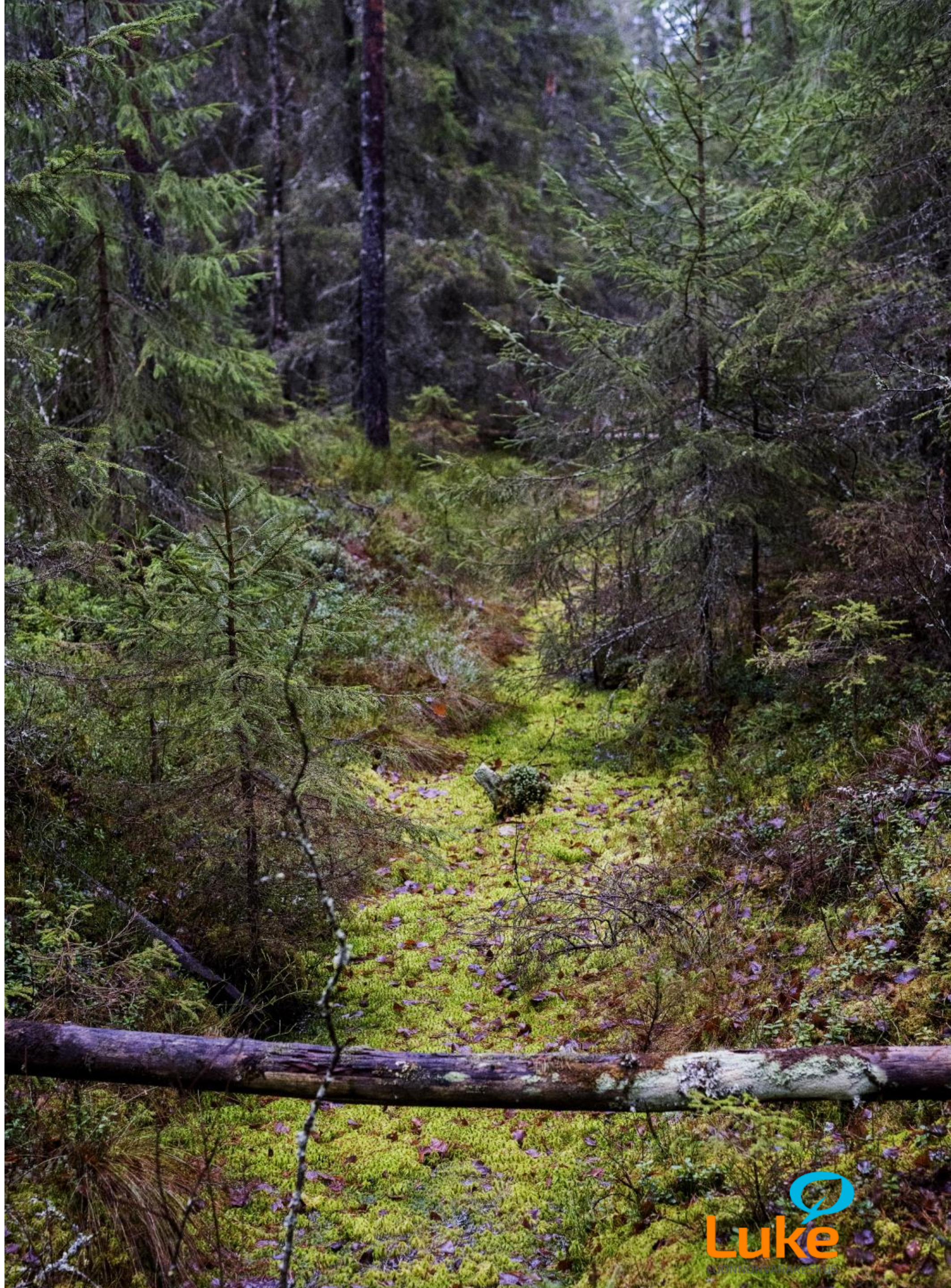
SPECIALTY SECTION
This article was submitted to Biogeochemical Dynamics, a section of the journal Frontiers in Environmental Science

RECEIVED 12 December 2022
ACCEPTED 24 March 2023
PUBLISHED 05 April 2023

Vegetation impacts ditch methane emissions from boreal forestry-drained peatlands—Moss-free ditches have an order-of-magnitude higher emissions than moss-covered ditches

Antti J. Rissanen[1,2]*, Paavo Ojanen[1,3], Leena Stenberg[1], Tuula Larmola[1], Jani Anttila[1], Sakari Tuominen[1], Kari Minkkinen[3], Markku Koskinen[4,5] and Raisa Mäkipää[1]

[1]Natural Resources Institute Finland (Luke), Helsinki, Finland, [2]Faculty of Engineering and Natural Sciences,



Luke

CH_4 fluxes from moss-dominated ditches ca. 90% lower than from open water ditches

Based on chamber measurements in 21 forestry-drained peatlands

Moss covered	2.6 g CH_4 m^{-2} y^{-1}
Moss free	20.6 g CH_4 m^{-2} y^{-1}

Rissanen et al. 2023. Frontiers in Env Sci

Currently Tier 1 emission factor 21.7 g CH_4 m^{-2} y^{-1} applied the Finnish national GHG inventory

Luke
LUONNONVARAKESKUS

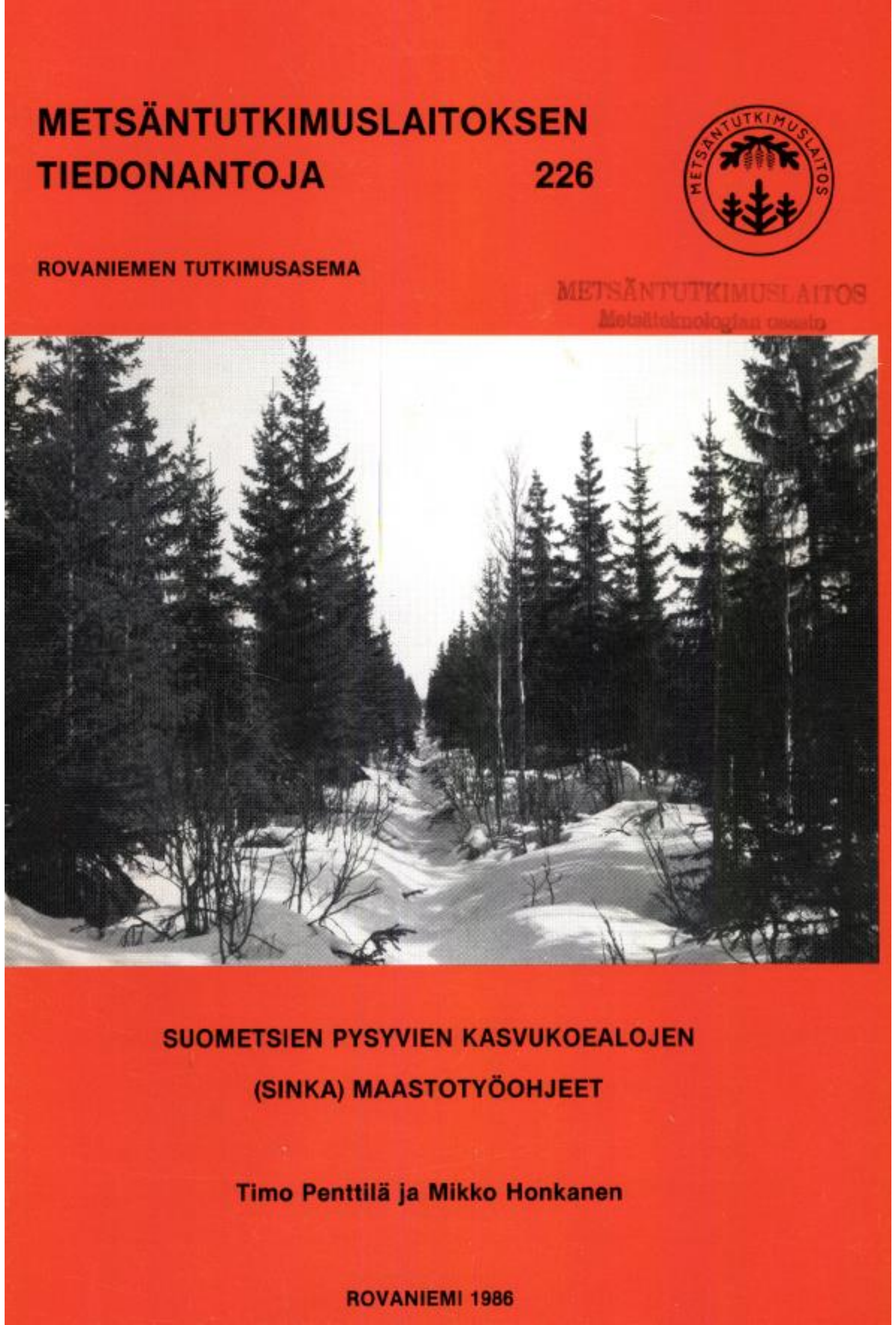
What is the area of moss-covered ditches in Finland?

- Areal extent of different types of ditches was estimated by

1) building a model to classify ditches into moss-covered and moss-free ditches

2) applying the classification model across Finland.

- SINKA database (Penttilä & Honkanen, 1986) 1984-2013
- Systematic subsample of 7th National Forest Inventory field plots on drained peatlands measured Tree stand properties, ditch depth, width, age, ditch condition incl. Sphagnum moss



Luke
LUONNONVARAKESKUS

Ditch classification

Leena Stenberg, reported in Rissanen et al. 2023

- a random forest model to classify ditches into two classes: ***moss-covered*** and ***moss-free***
- 2922 approved observations in SINKA data (46% moss-covered)
- Best model If ditch age known **RF25**
  - Moss presence explained by ditch age, North coordinate, elevation, temperature sum, nutrient poor site (*V. vitis-idaea* type or Dwarf-shrub type)
- If ditch age not known **RF42**:
  - Moss presence explained by North coordinate, elevation, temperature sum, nutrient poor site, main tree species coniferous species

Ditch age known

- **RF25**-model class errors:
  - **Moss-covered: 12%**
  - **Moss-free: 12%**
- Overestimation of moss-covered ditches in Southern Finland (ca. 2%)
- Underestimation of moss-covered ditches in Northern Finland (ca. 3 %)

Ditch age not known

- **RF42**-model class errors:
  - **Moss-covered: 17%**
  - **Moss-free: 20%**
- Overestimation of moss-covered ditches in Southern Finland (ca. 11%)
- Underestimation of moss-covered ditches in Northern Finland (ca. 13%)

Luke LUONNONVARAKESKUS

Results: New estimate for ditch CH_4 emissions from forestry- drained peatlands in Finland

Rissanen et al. 2023

Estimations for year 2022:

	North	South	All
Ditches, moss-covered	41%	79%	67%
Ditches, moss-free	59%	21%	33%

- Segmented data from drained peatlands (open data sources)
- Type of vegetation in ditches within a segment
- Ditch lengths within the classified segments summed → total ditch lengths for different vegetation classes
- 1 m ditch width assumed -> ditch areas for different vegetation classes

Areal estimates x the CH_4 emission factors for moss-covered (2.6 gm2 y-1) and moss-free ditches (20.6 g m2 y-1)

->Revised forest ditch CH_4 emissions in Finland 8,600 t yr^{-1}

63 % lower than with Tier1 estimate 23,200 t yr^{-1}

Luke

Conclusions for GHG Inventory

- Mean seasonal CH_4 emissions from moss dominated ditches 90% lower than from open water surfaces
- Tier 1 emission factor overestimates CH_4 emissions of moss-covered ditches of forestry-drained peatlands: 2/3 ditches moss-covered in Finland
- The use of ditch type-specific emission factors clearly improves the accuracy of ditch emission estimates.
- 63% lower CH_4 emission estimate for Finland than in the current GHG inventory CH_4 emissions
- Next steps Time series since of the areal extent of moss-covered ditches needed to implement new emission factors in national greenhouse gas inventory

Luke
LUONNONVARAKESKUS

Conclusions for forest management

- Ditches overgrown by mosses reduce CH_4 emissions from drained peatland forests
- Giving up Ditch maintenance

- an additional GHG mitigation measure to management practices that maintain a continuous forest cover, attenuate the changes in soil water level and thus reduce CH_4 emissions from peat soils.