18th Baltic Peat Producers Forum, 10-12.10.2018

Abandoned peat extraction sites – will future be wetter and better?

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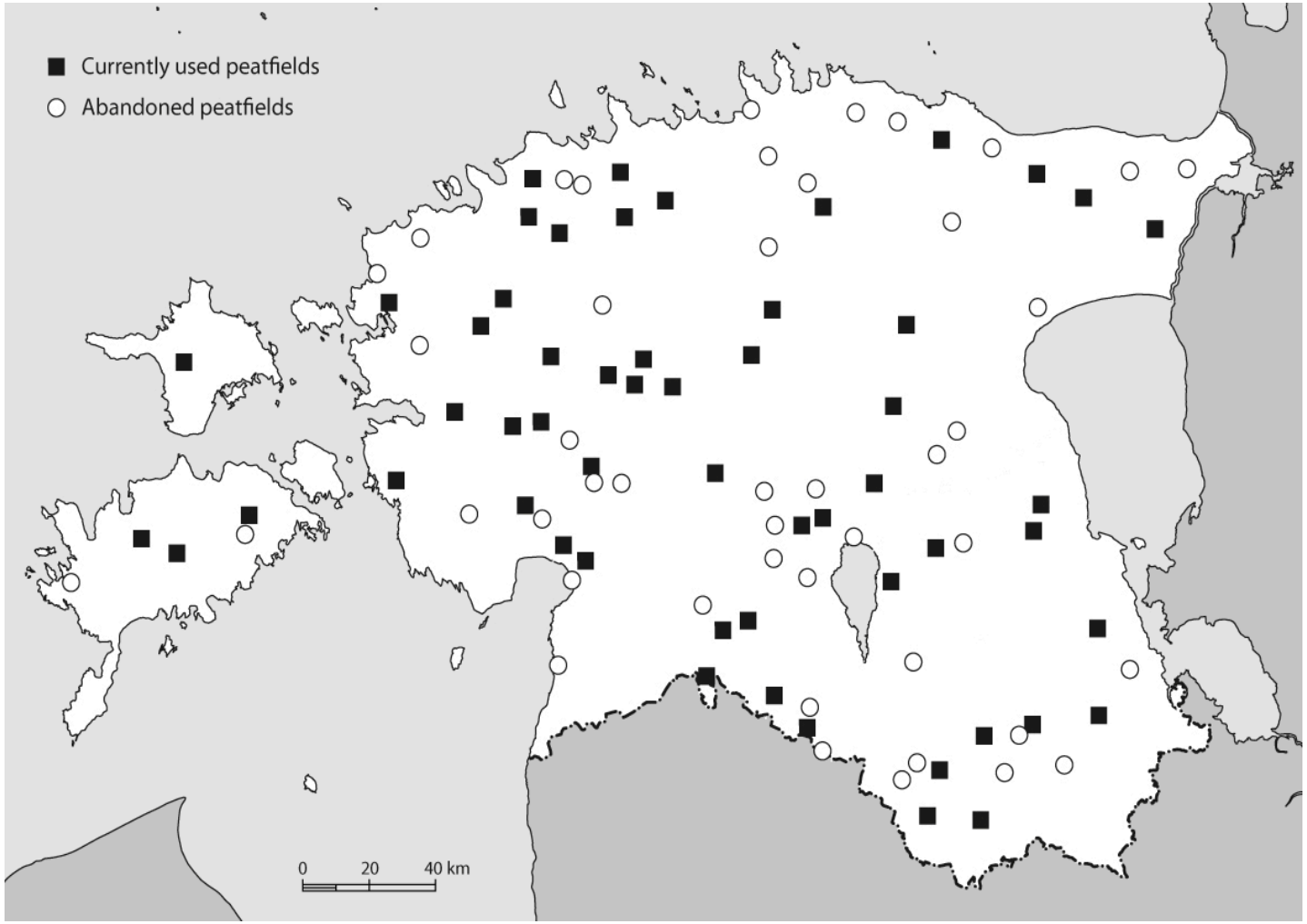
Introduction

- **Peatlands cover 1,009,101 ha (22,3%) in Estonia; open mires in natural state 255,000 ha (5.6%) and mire forests ca 6%**
- **Annual peat extraction reached the highest amounts in the 1960s–1980s at 2.9 million t yr^{-1}, currently at level: 0.7–1.2 million t yr^{-1} in Estonia**
- **Peat extraction has caused mire degradation in the Baltics, drainage and usage of peatlands for forestry and agriculture are the main reasons for the decline of mire areas.**
- **Almost all currently existing abandoned extracted peatlands in Estonia were abandoned in 1990s without any restoration measures.**
- **Small amount of extracted areas were mostly afforested, converted into agricultural lands, berry plantations or waterbodies.**

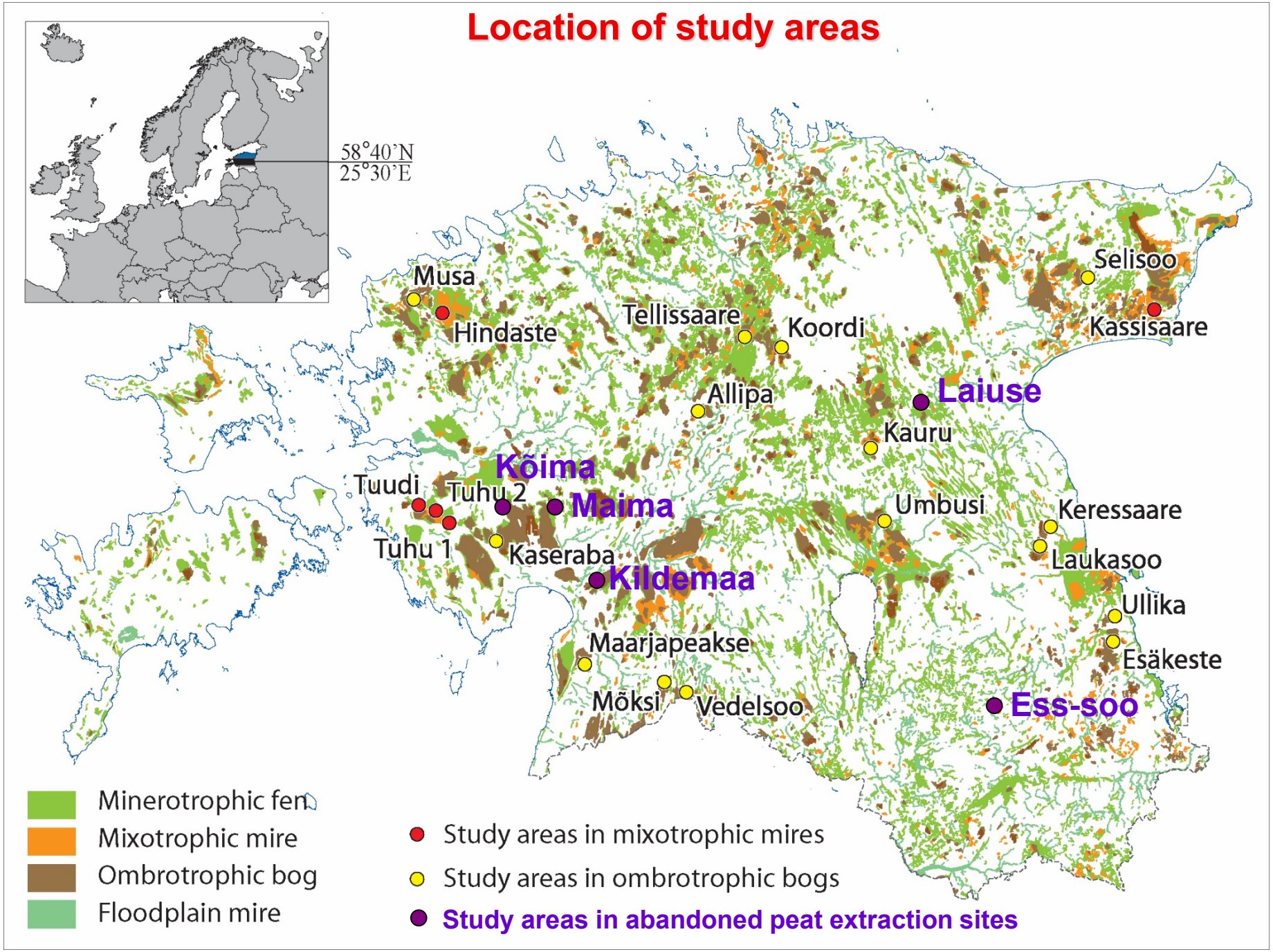
Distribution of abandoned peat extraction sites



Area of abandoned peat extraxtion sites amounts ca 9400 ha

Timeline

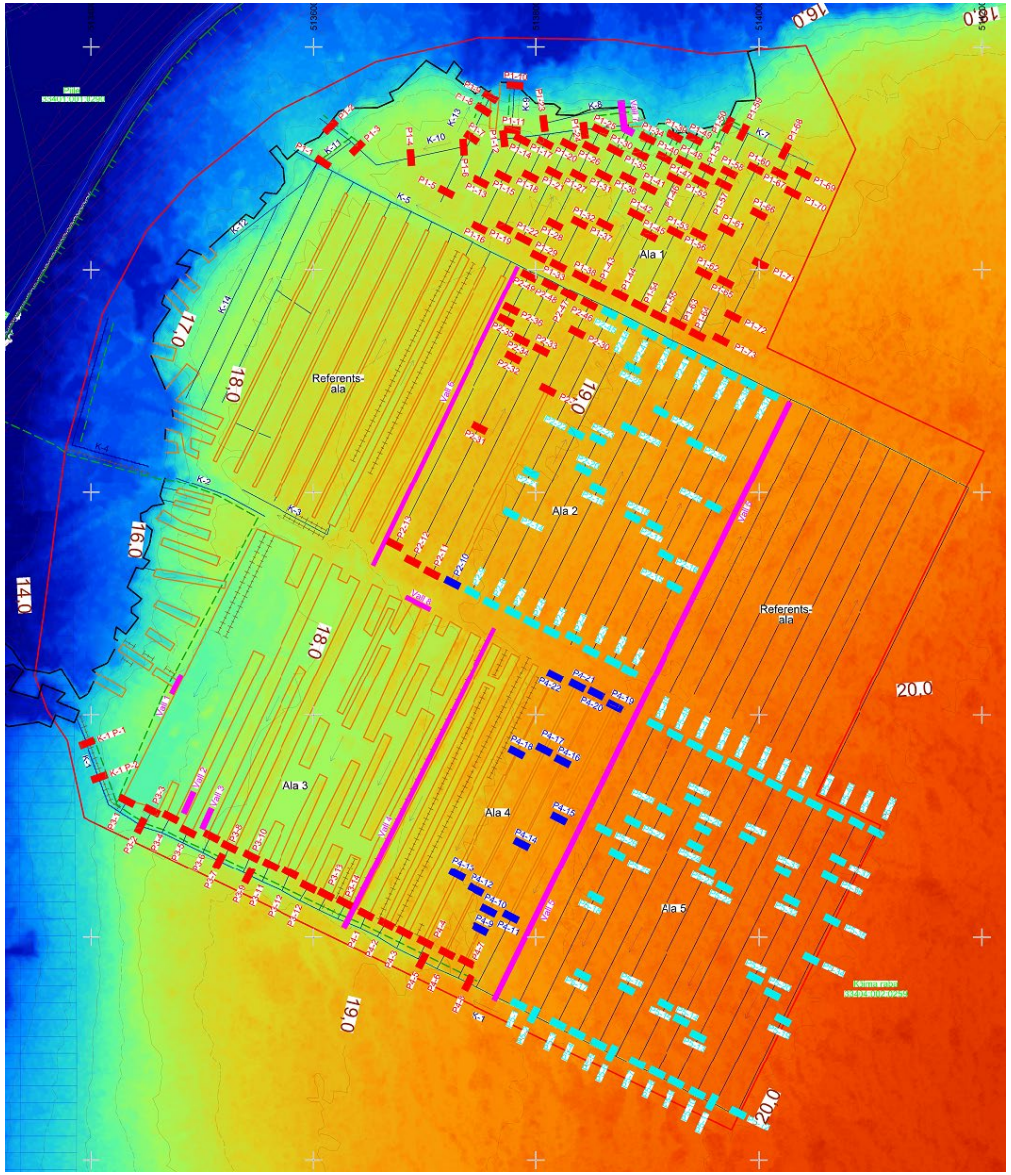
- **In period 2014-2023, Estonia is commited to rehabilitate 2000 ha abandoned peatlands. The main responsible institution is State Forest Management Centre.**
  - **In 2014, methodical guidelines for selection of abandoned peatlands for rehabilitation were compiled.**
  - **In 2015 the list of abandoned peatlands for rehabilitation was ratified by the Ministry of the Environment.**
  - **In 2016 compiling technical projects and the work has been started in preselected peatlands.**
  - **In 2017 monitoring of current state started in selected abandoned peatlands.**


Location of study areas
58°40'N
25°30'E
Musa
Hindaste
Tellissaare
Koordi
Selisoo
Kassisaare
Allipa
Laiuse
Kauru
Kõima
Tuudi
Tuhu 2
Maima
Tuhu 1
Kaseraba
Kildemaa
Umbusi
Keressaare
Laukasoo
Ullika
Esäkeste
Maarjapeakse
Mõksi
Vedelsoo
Ess-soo
Minerotrophic fen
Mixotrophic mire
Ombrotrophic bog
Floodplain mire
Study areas in mixotrophic mires
Study areas in ombrotrophic bogs
Study areas in abandoned peat extraction sites

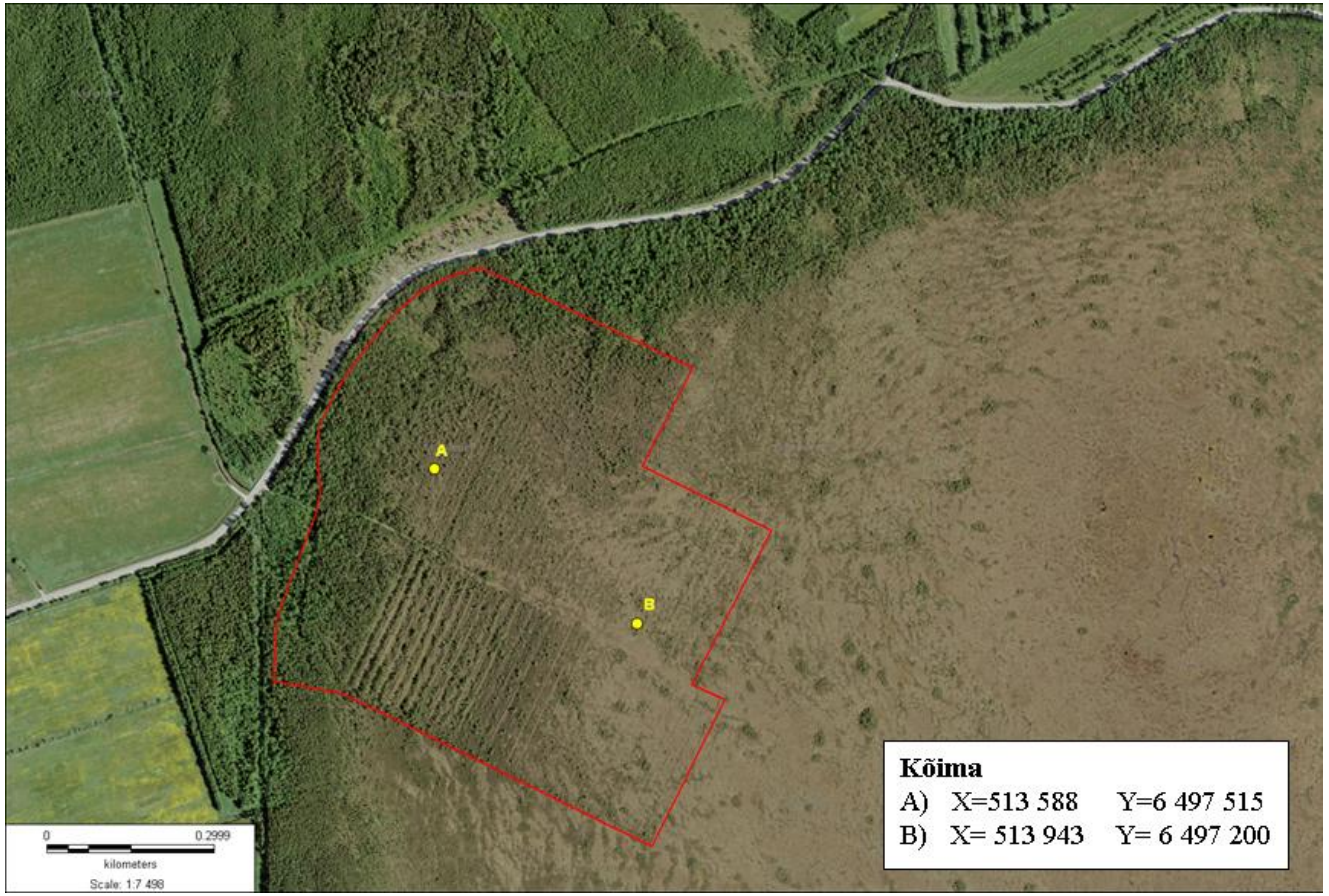
What to do?

- Natural regeneration has been very slow in milled peat production areas.
  - Annual water level fluctuation is high (80 cm)
  - Soil surface temperatures high (>50 C at top, >25 C at 10 cm depth)
- In smaller peat excavation sites natural regeneration is moderate, still water level fluctuation significant (45 cm), overgrowing with trees.
- Blocking water flow in ditches, filling ditches with peat, establishing shallow waterbodies, partial removal trees to reduce evapotranspiration, spreading sphagnum fragments in abandoned milled peat production sites (Canadian method)
- Should be cost-effective and applicable on large areas

Kõima, Pärnu County



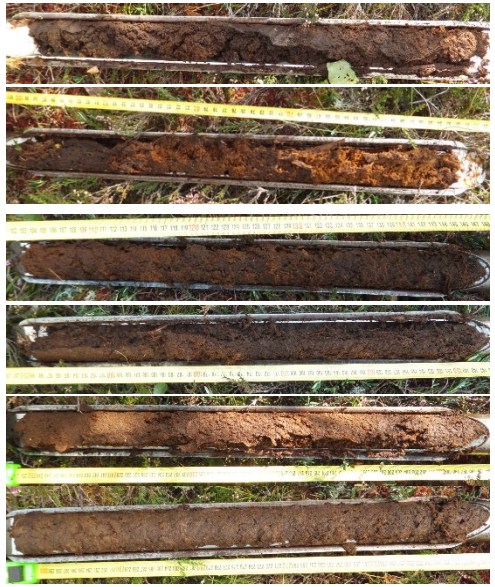
Technical project: Steiger OÜ



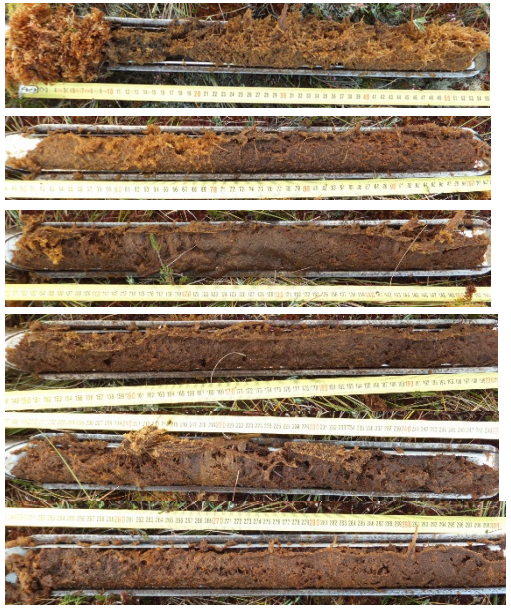
Peat excavation site

Bog specific species are still present but ecosystem strongly degraded, water level fluctuation moderate-strong, tree-covered area expanding

Kõima, reference sites

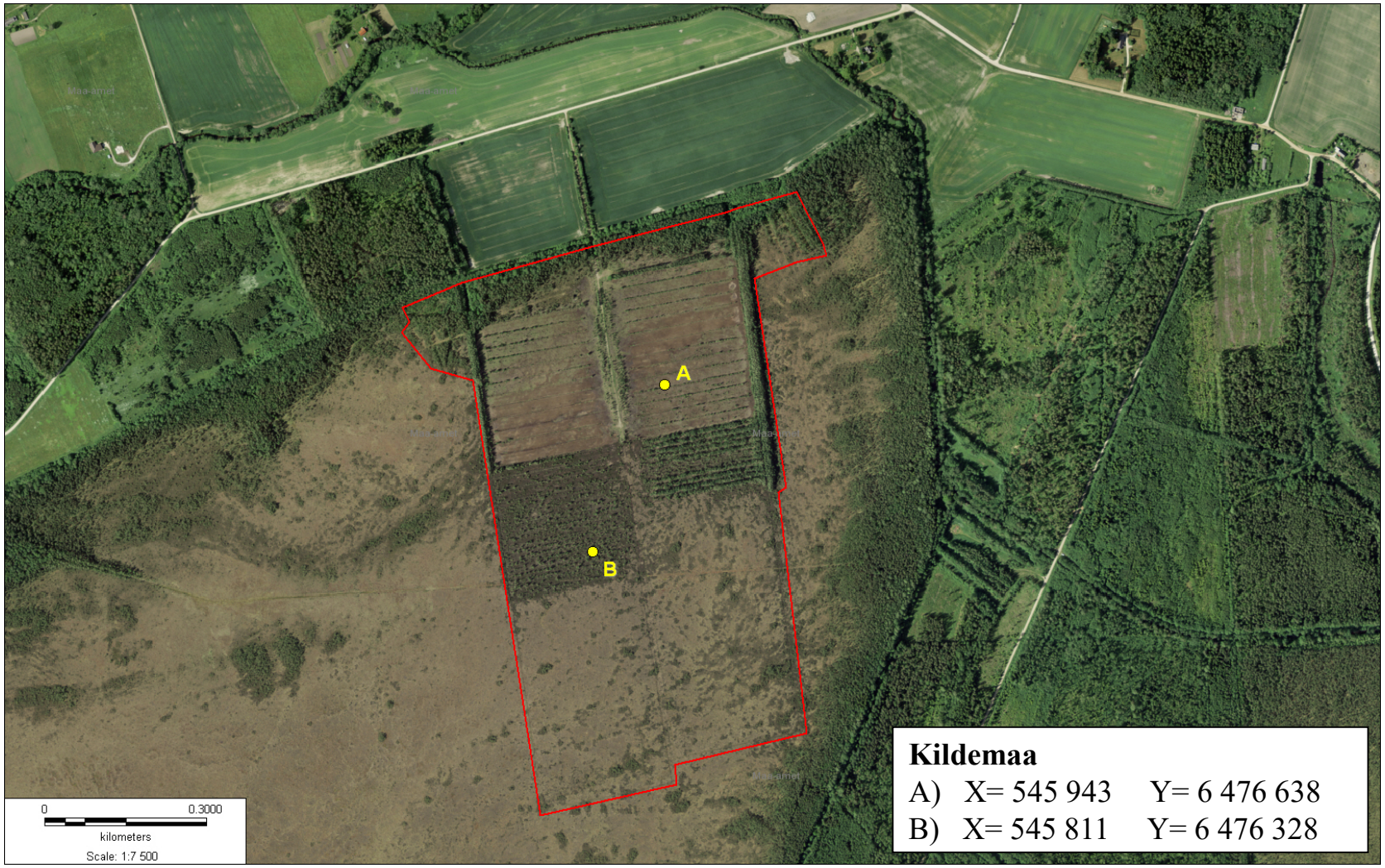


A



B

Kildemaa, Pärnu County



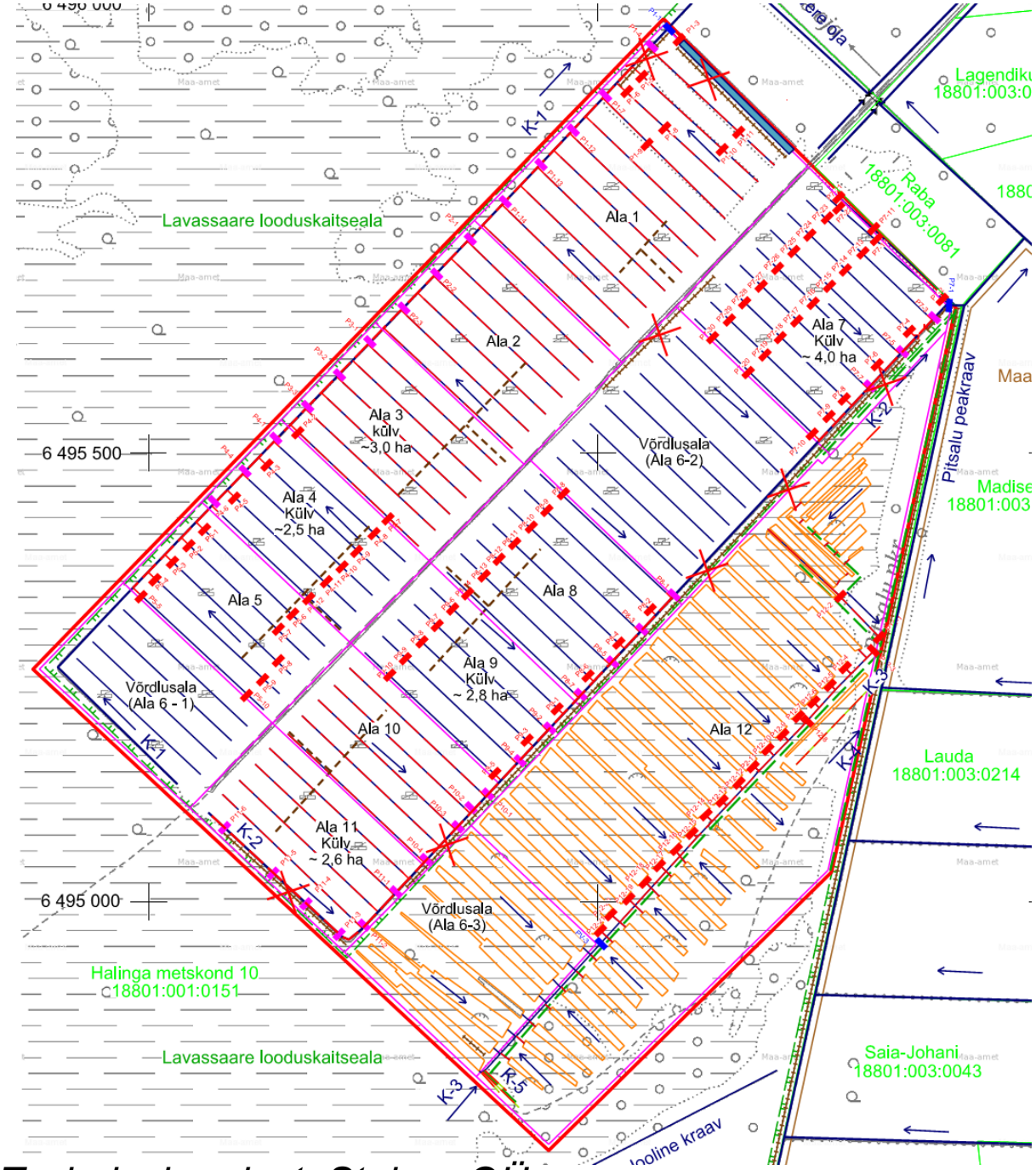
Northern part abandoned milled peat production area, in central part fully developed deep drainage without removal of upper peat layer, in southern part only shallow preliminary drainage

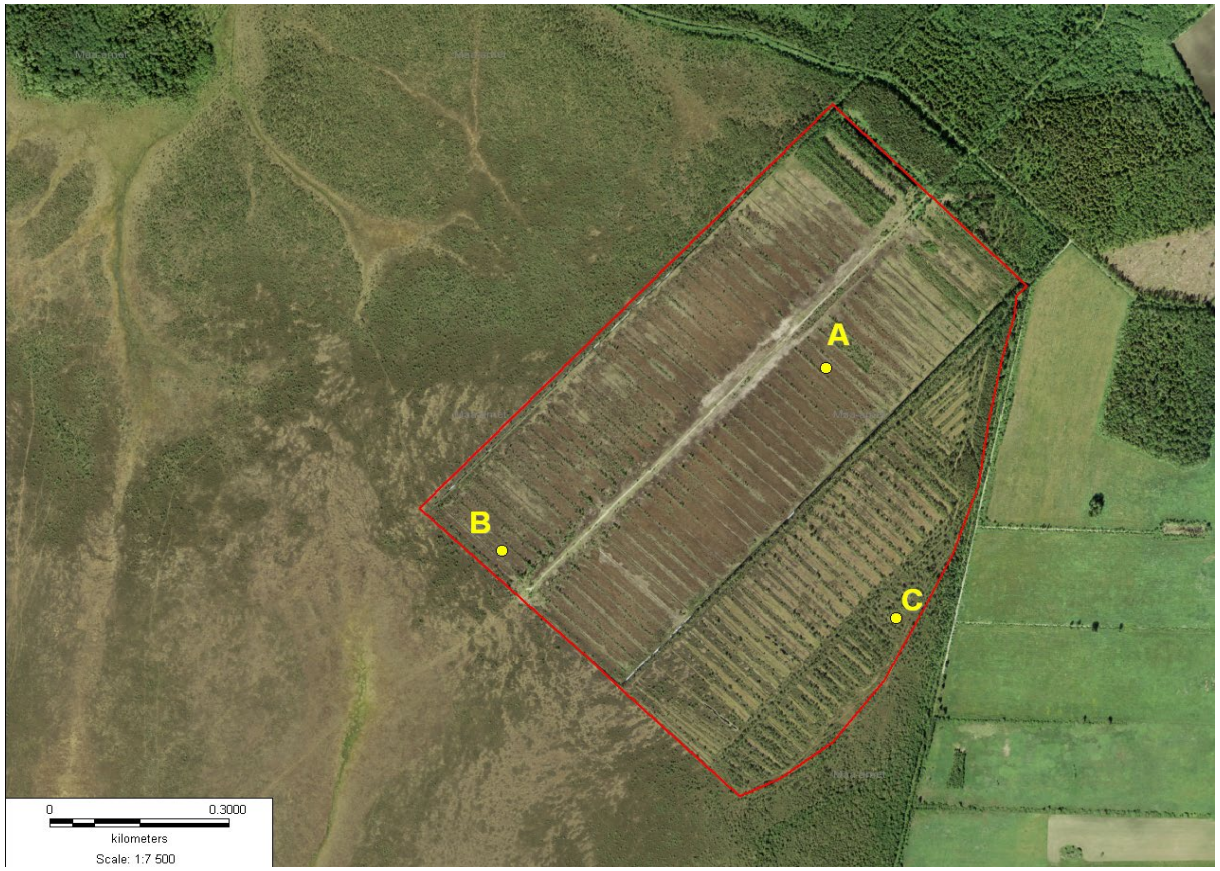
Kildemaa

A

B

Maima, Pärnu County



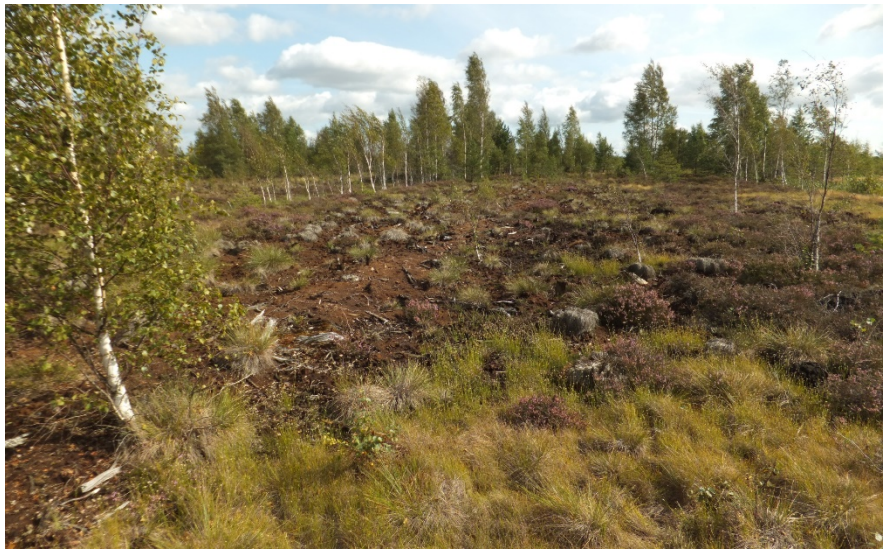


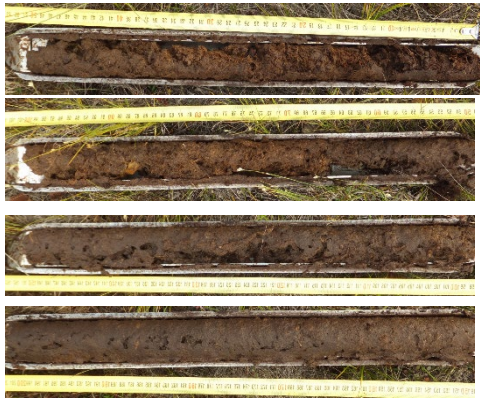
Mainly milled peat extraction, in SW part excavated peat production area

Bog specific species present only in strongly degraded SW area, water level fluctuation high, in milled peat production area natural regeneration very limited

Technical project: Steiger OÜ

Maima, reference sites





A

B

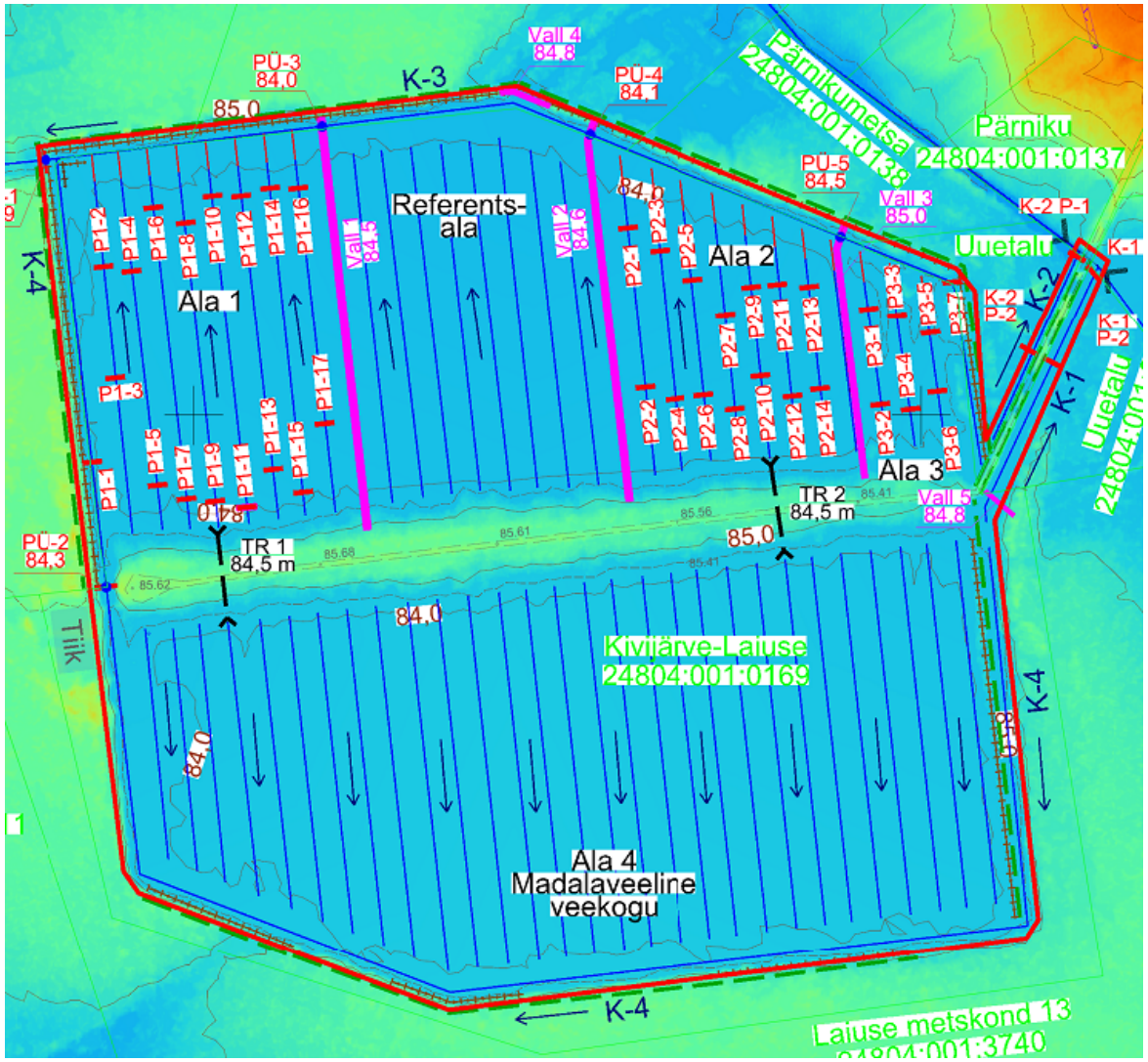
Ess-soo, Võru County

Ess-soo, reference sites

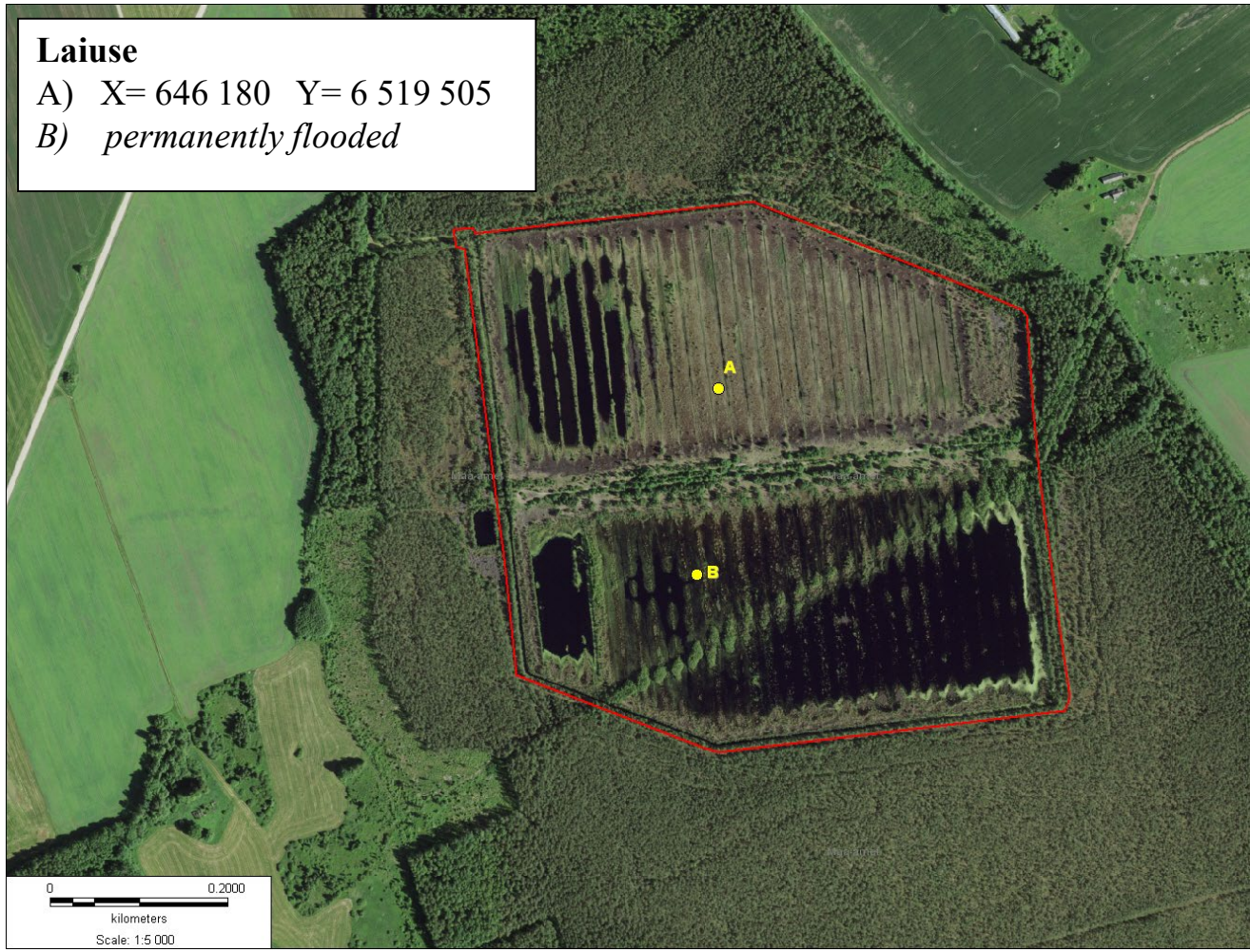
A

B

Laiuse, Jõgeva County



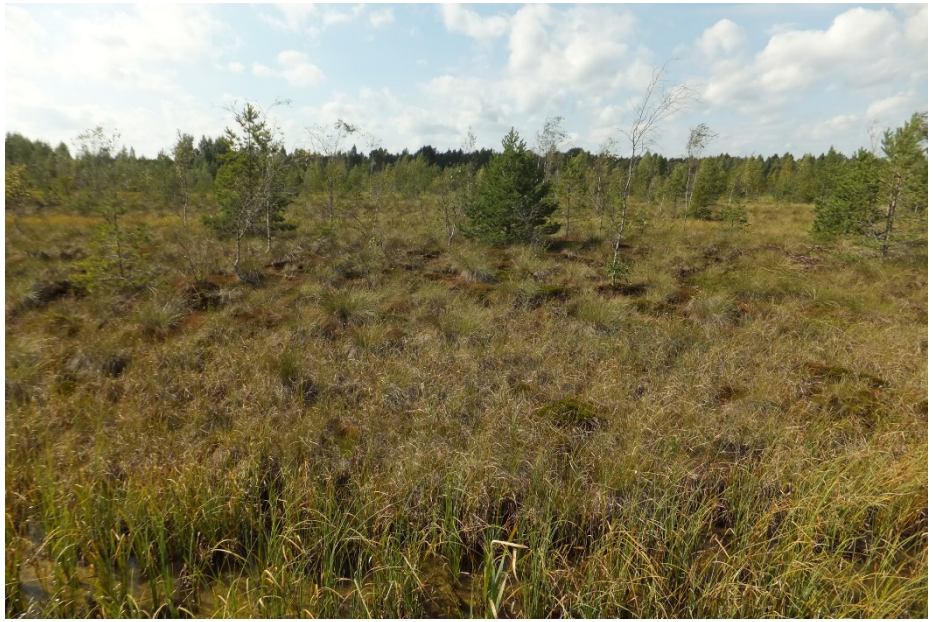
Technical project: Steiger OÜ



Abandoned milled peat production area

Natural revegetation rate good, in dry areas still limited

Laiuse, reference sites



A

B

Monitoring
Situation before rehabilitation

- Monitoring started in August, 2017
  - Water sampling wells and gas sampling collars installed, sampling frequency monthly

  Water level (automatic measurements with hourly interval, manual measurements monthly)

  O_2, ORP, pH, conductivity

  Water chemistry: TC, TOC, TN, DC, DOC, DIC, DN (monthly)

  Ca, Mg, K, P, Fe, SO4 (seasonally)

  Soil temperature at ground,10cm, 20cm, 30cm, 40cm; soil humidity m^3/m^3, soil conductivity

  Gases: CO_2, CH_4, N_2O

  Soil chemistry: in 2018 (before rehabilitation), 1 year after rehabilitation, in 2022; soil mineralisation sampling annually

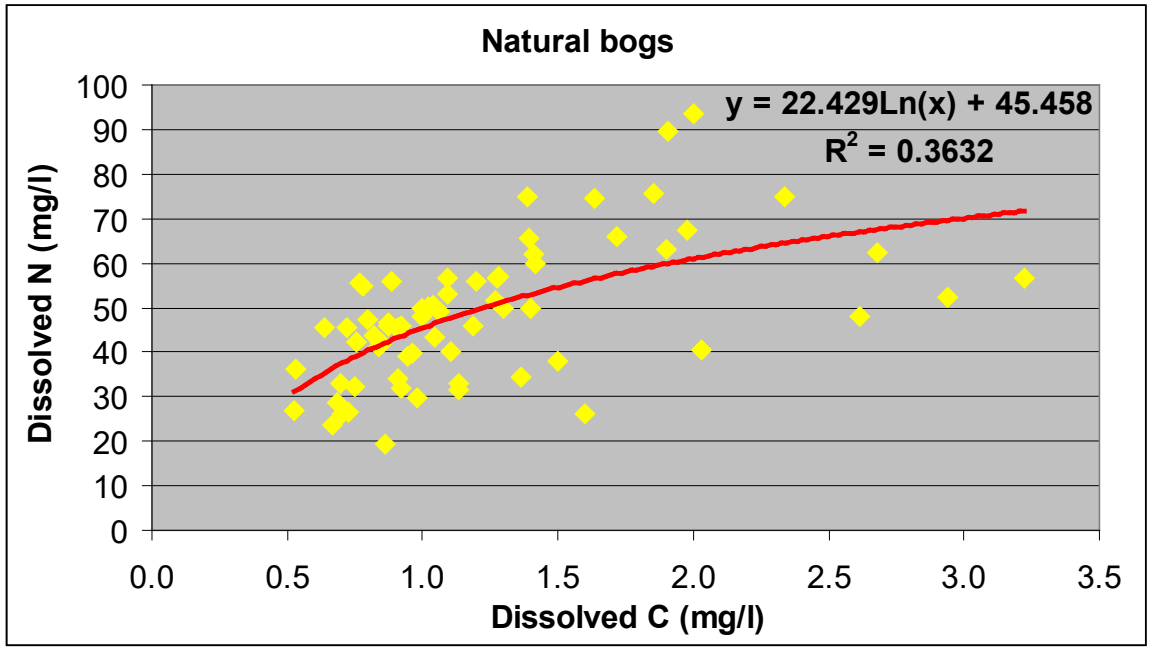
  Vegetation: geobotanical analysis shyncronous with soil sampling, twice per year in plots with sphagnum fragments spreading, annual drone based and monthly satellite based vegetation coverage monitoring.

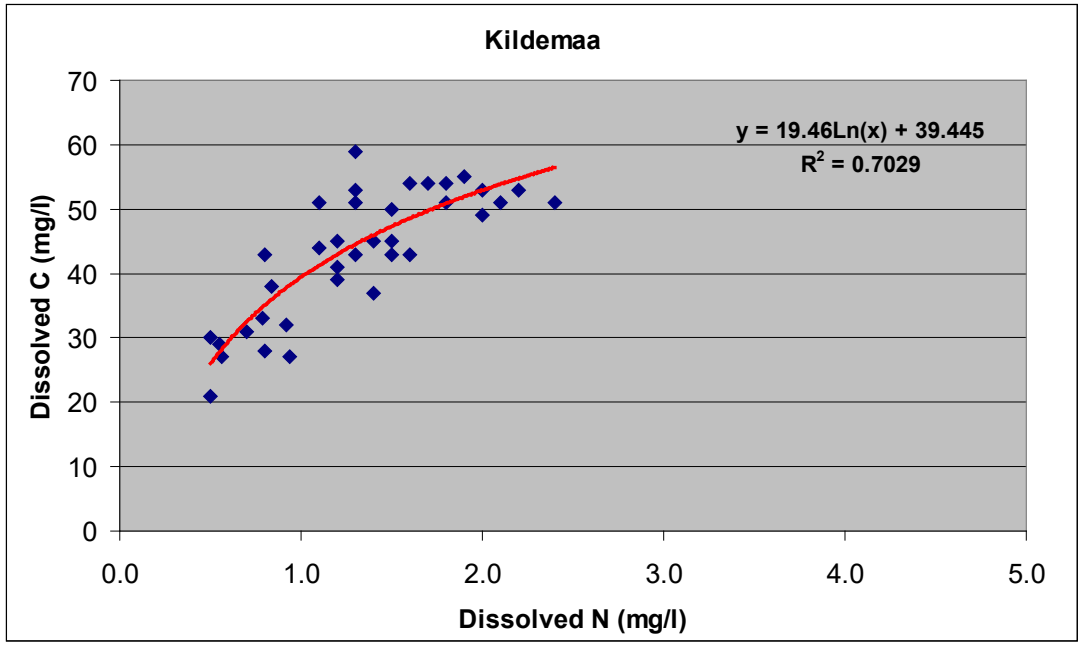
Monitoring results, 2017-2018

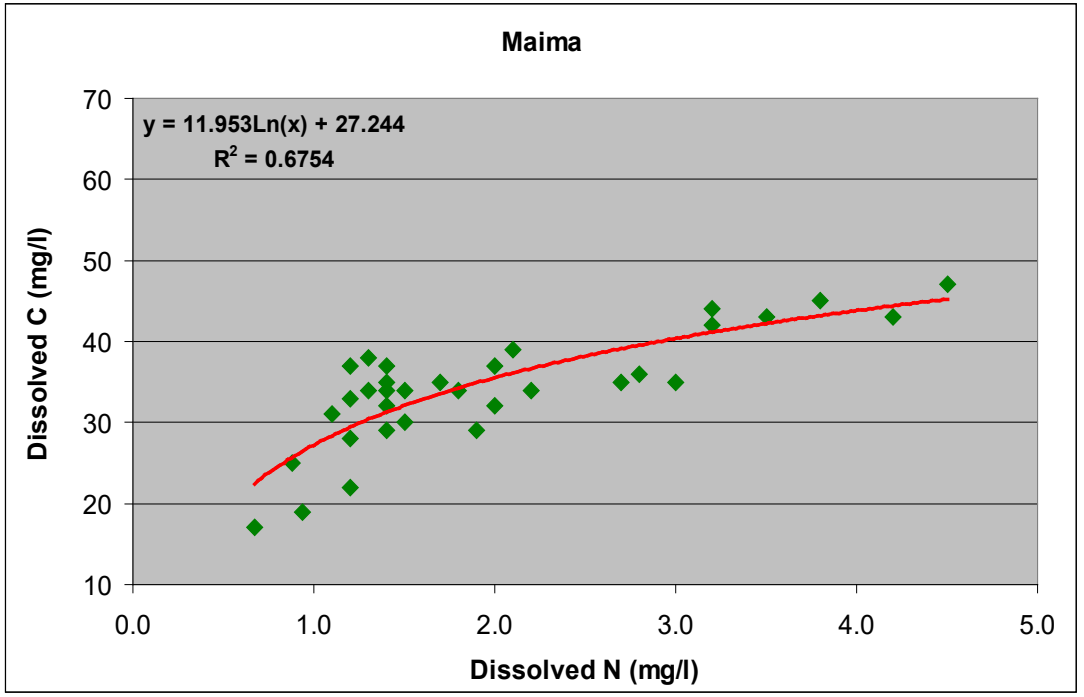
Discharge of dissolved N (DN) and C (DC) from peatland ditches are strongly related.

Milled peat areas have significantly higher C and N discharge than peat excavation sites.

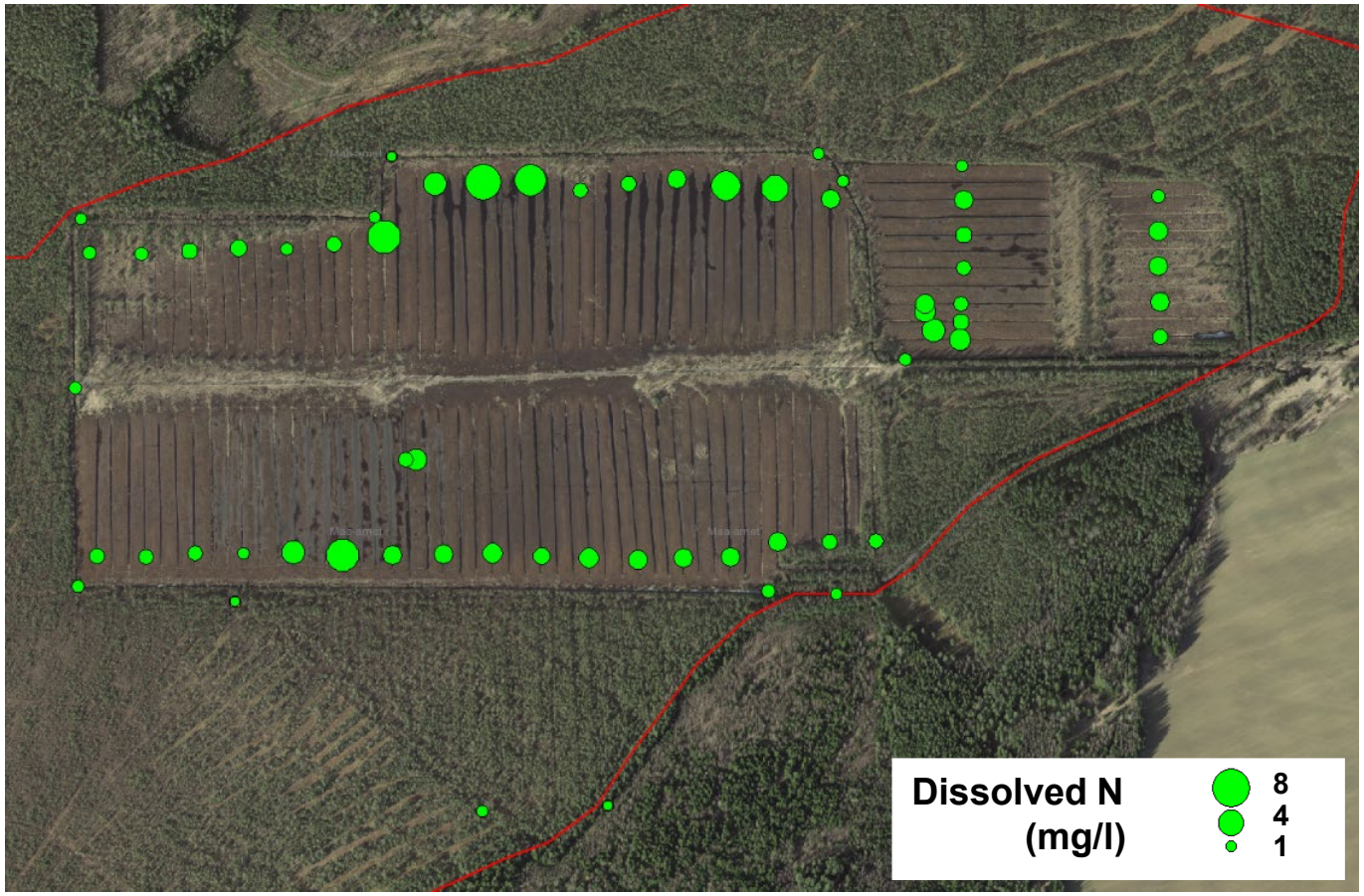
In natural bogs DN and DC discharge is weakly correlated.

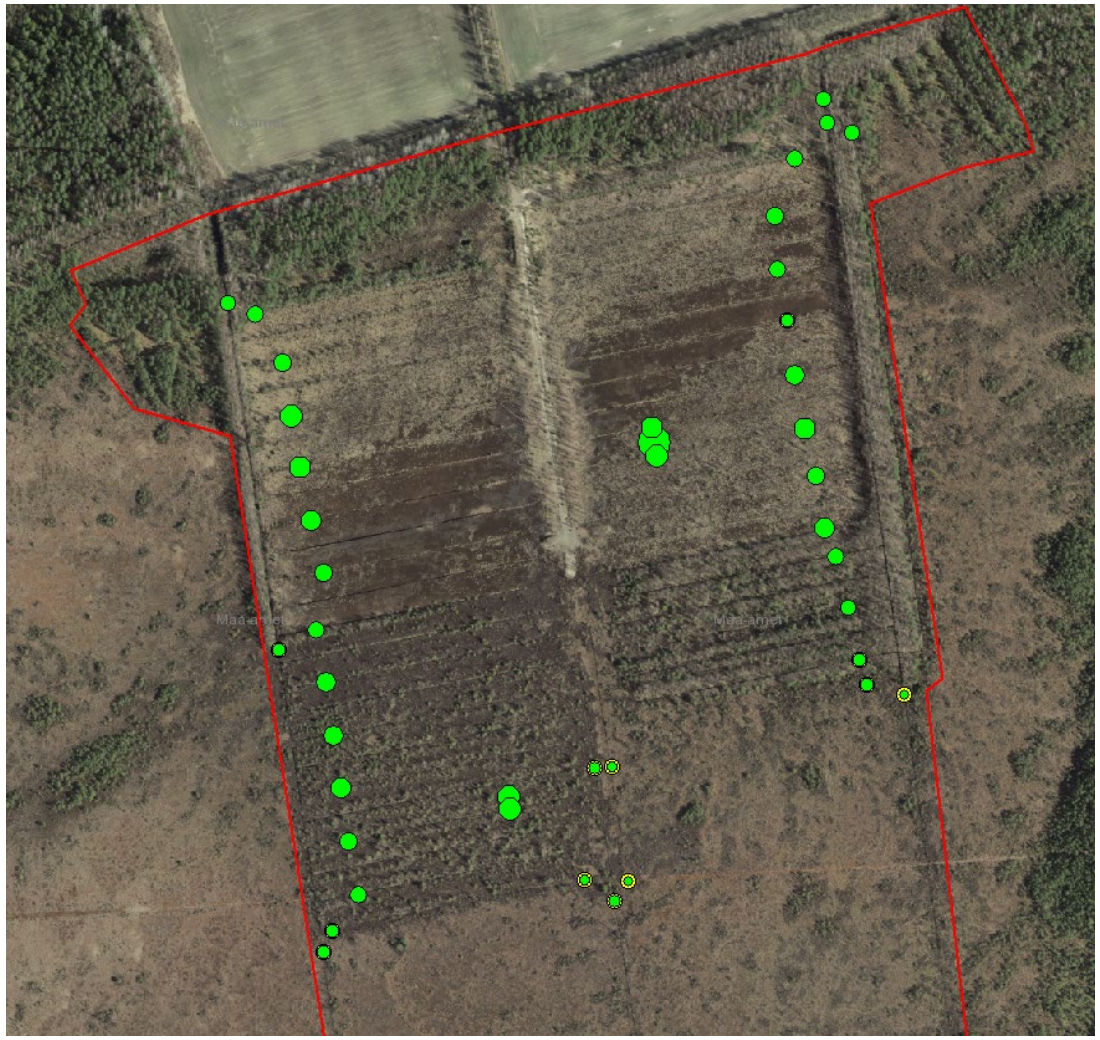






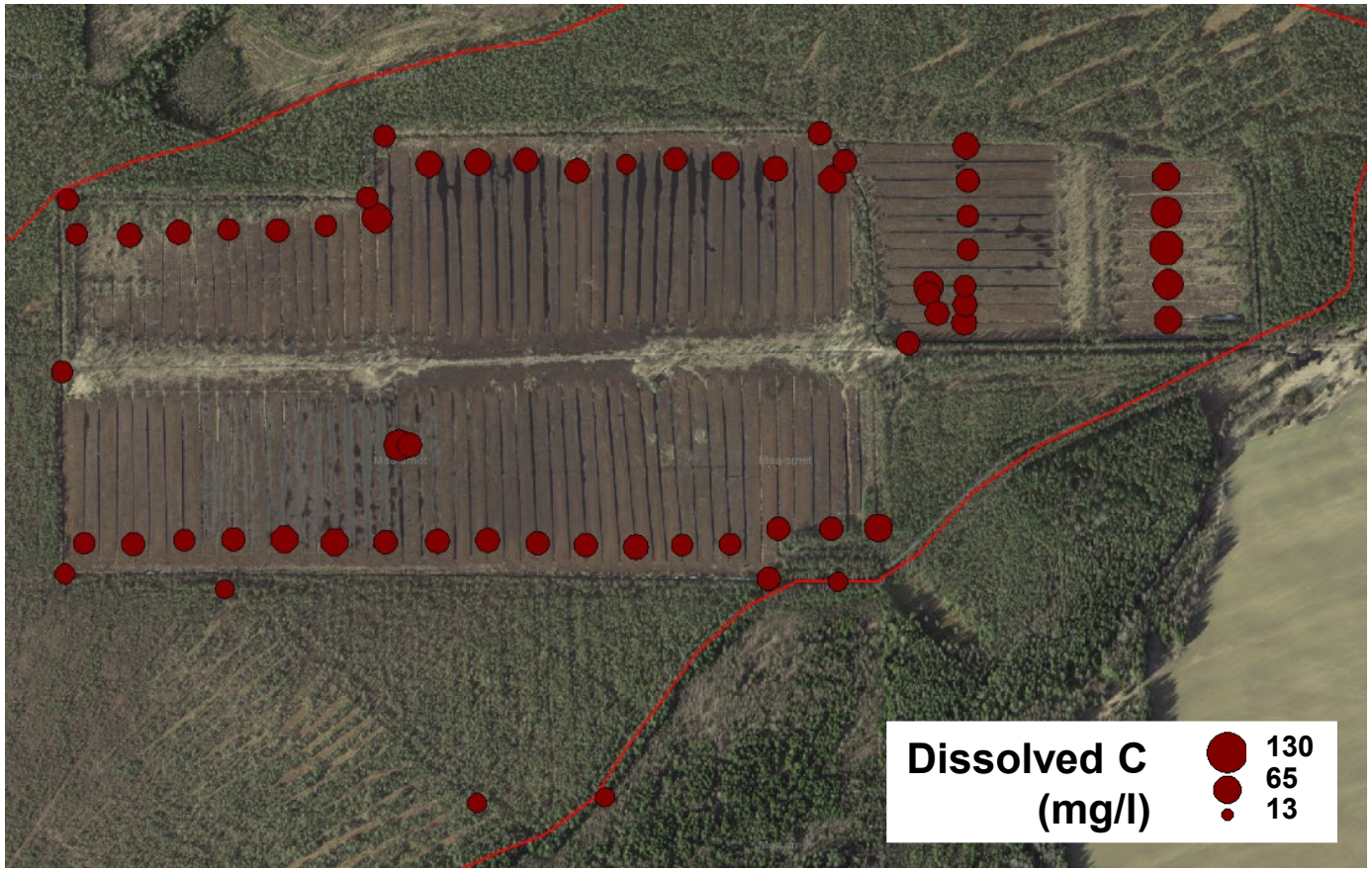
Dissolved nitrogen discharge in abandoned peatland ditches

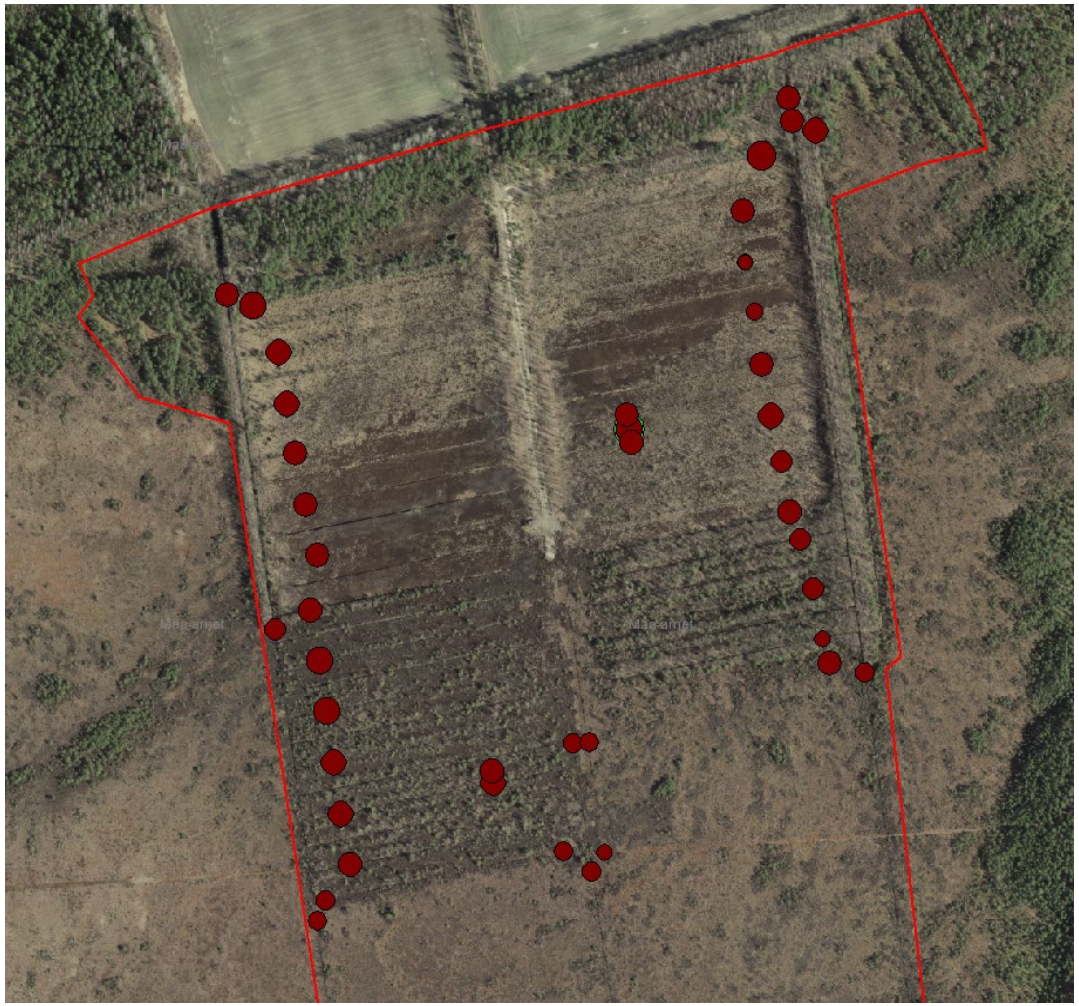




Most of discharged dissolved N is consumed and denitrified in main collector ditches

Dissolved carbon discharge in abandoned peatland ditches

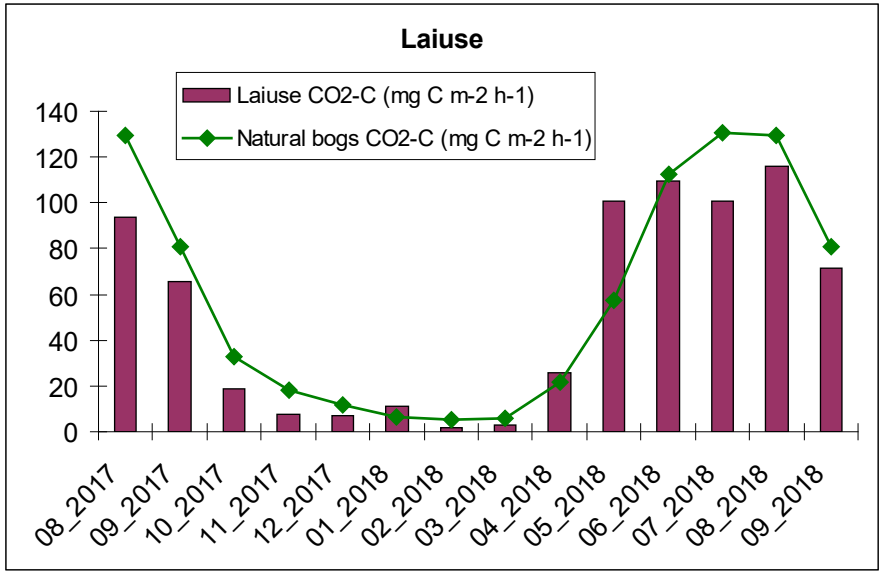


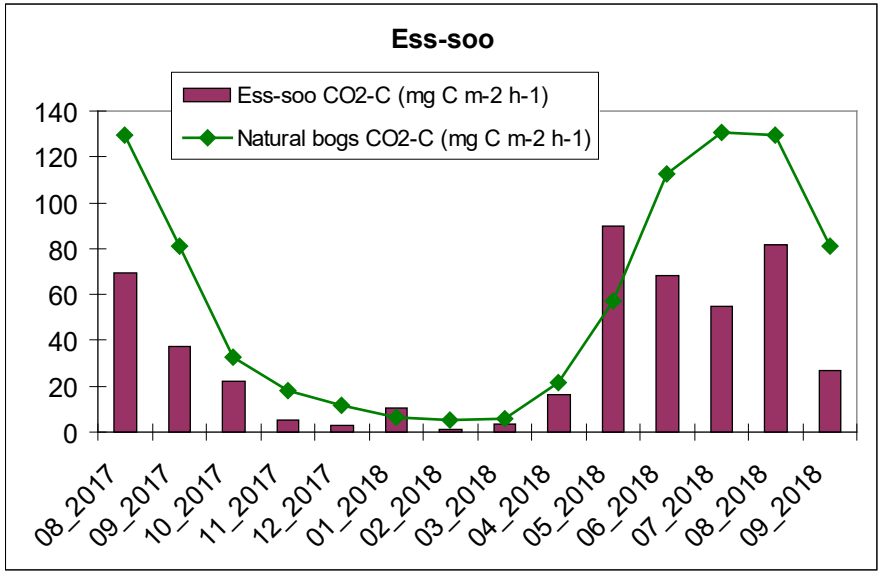


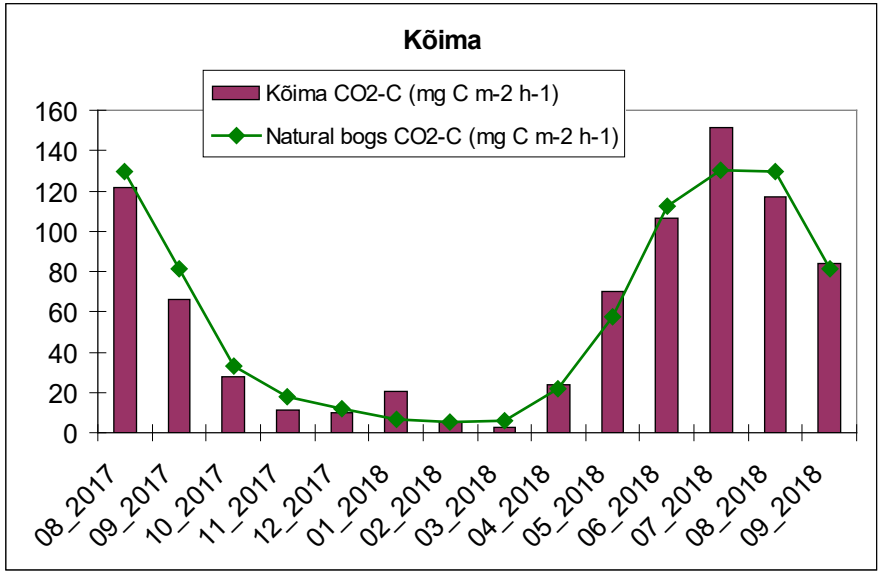
Milled peat areas have significantly higher C and N discharge than peat excavation sites.

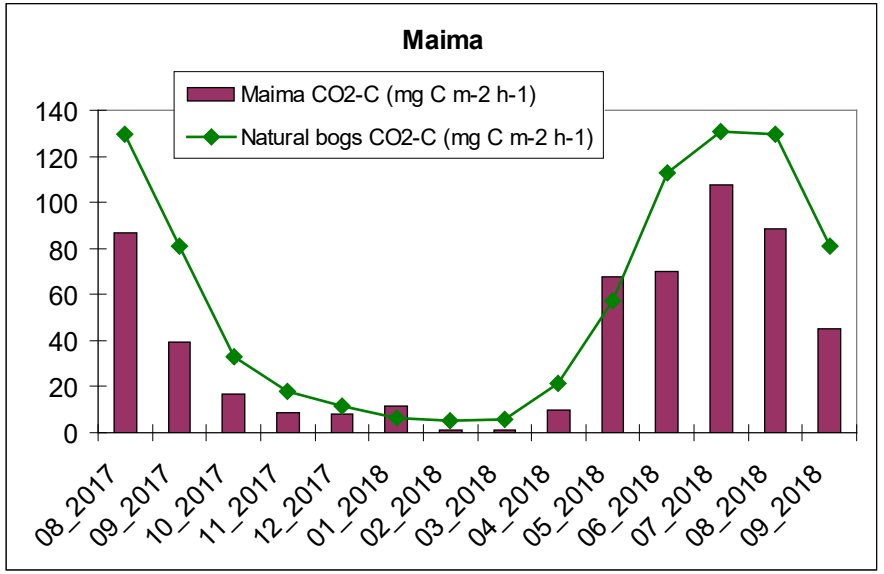
However, deeply drained peatland prepared for milled peat production has also high dissolved C runoff.

Ecosystem respiration (CO_2)



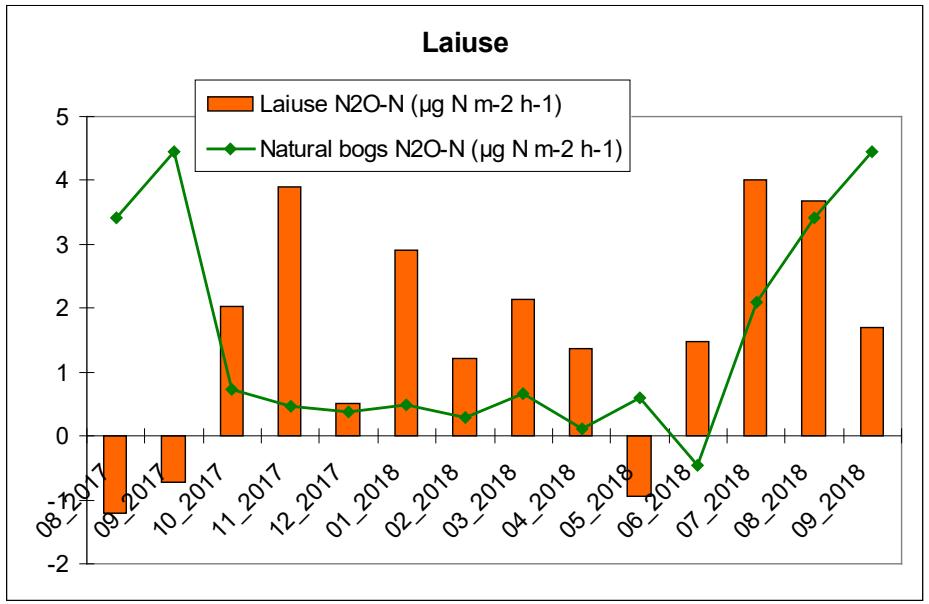


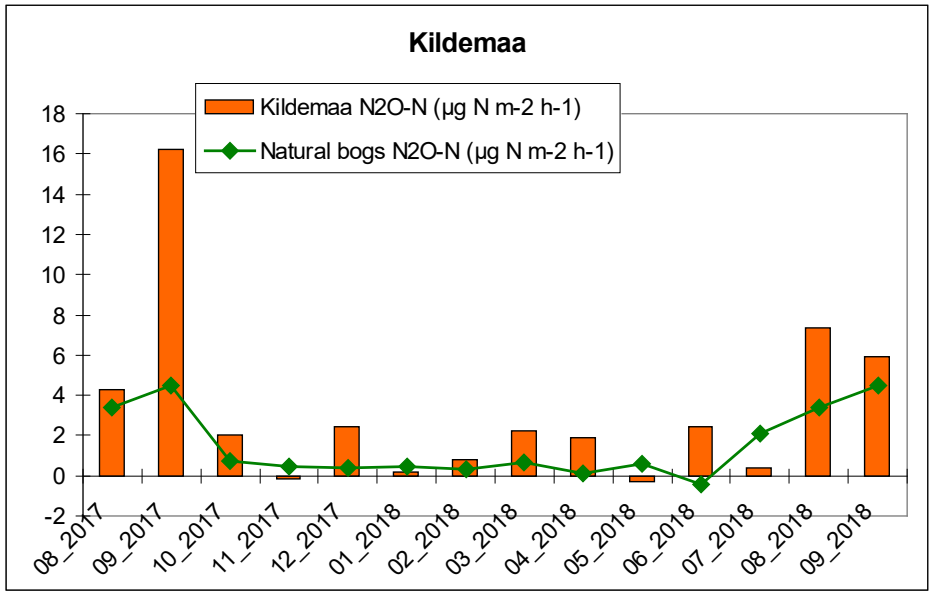


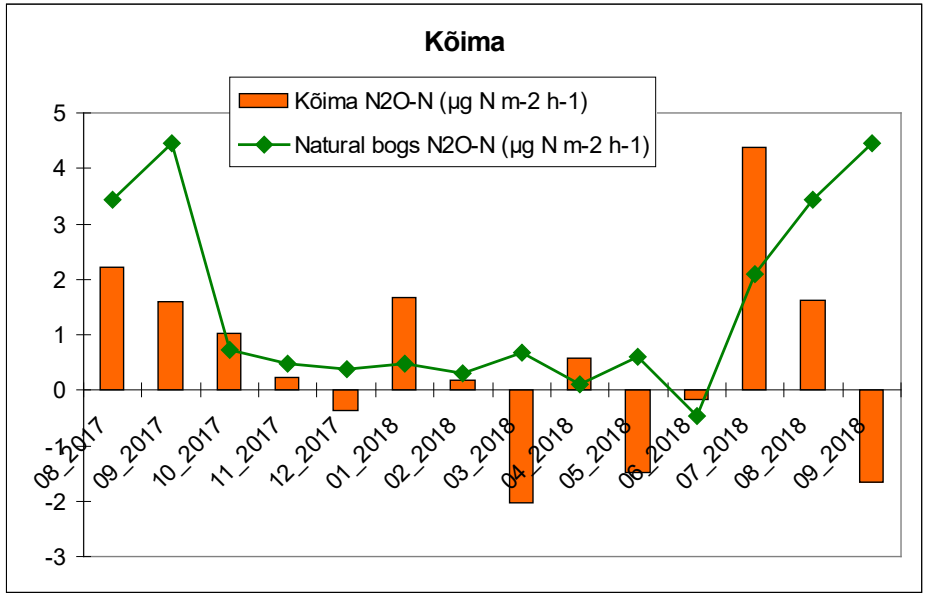


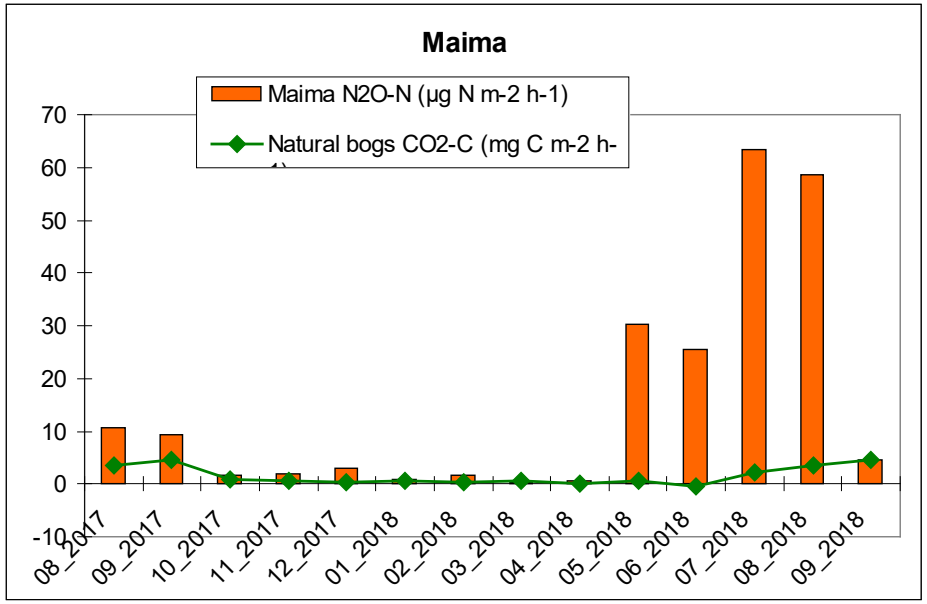
In abandoned peatlands CO_2 emission from soil only is almost as high as ecosystem respiration in natural bogs!

N_2O emission







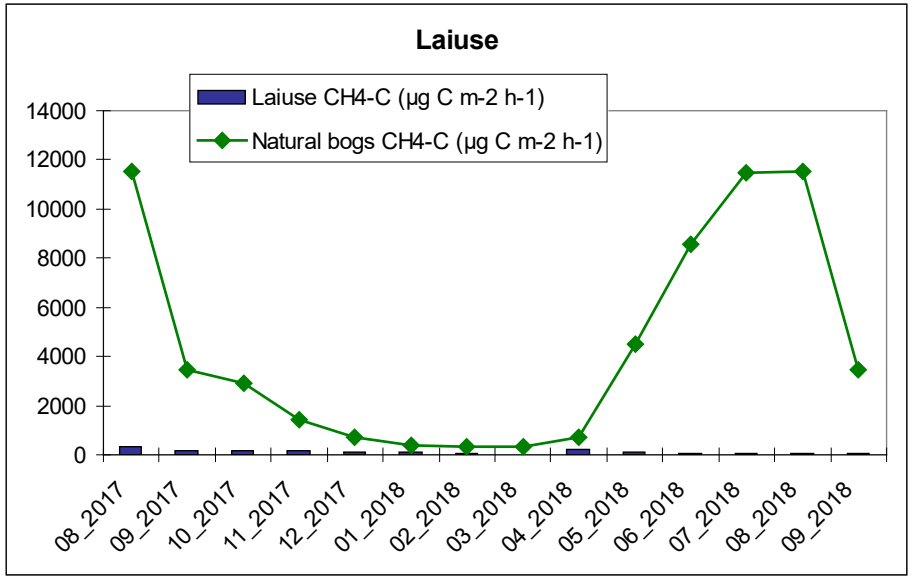


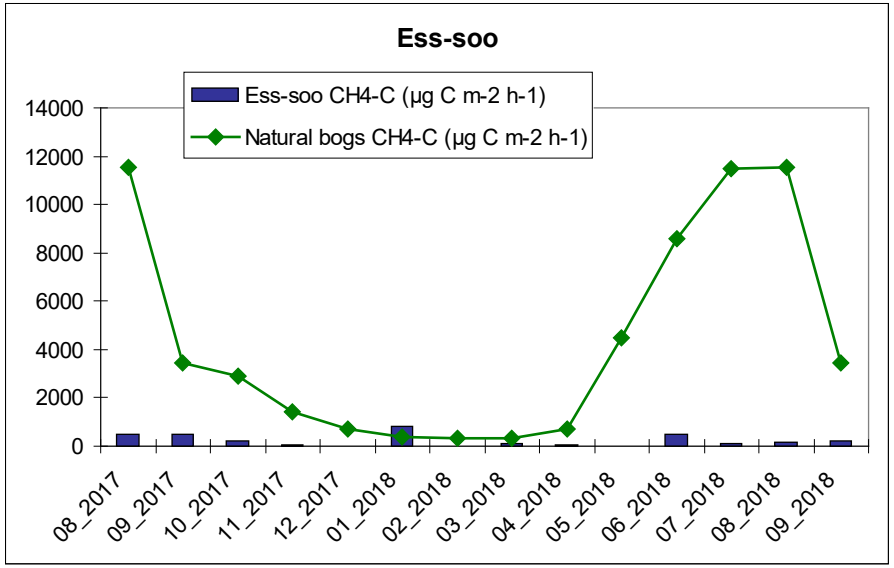
Nitrous Oxide (N_2O) has a GWP 265–298 times that of CO_2 for a 100-year timescale.

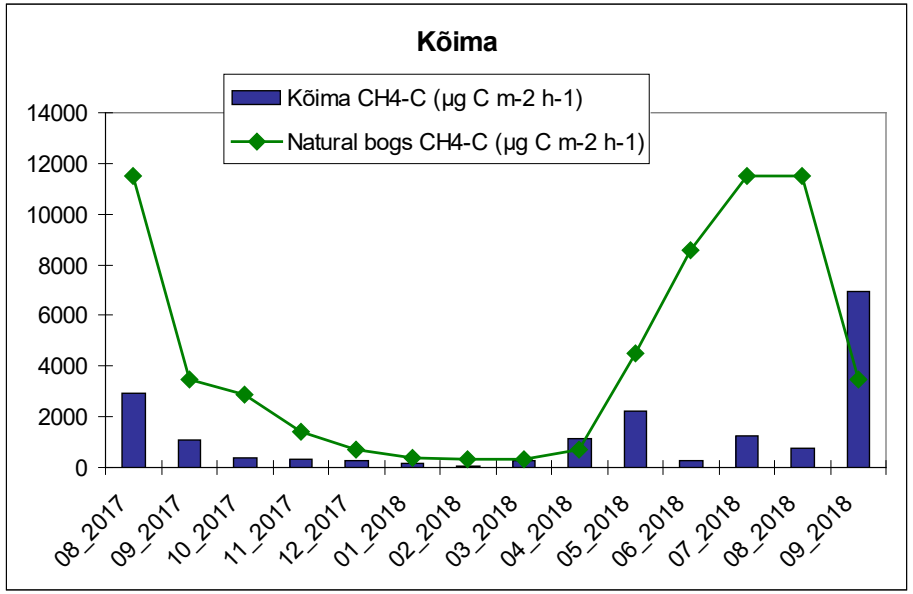
N_2O emitted today remains in the atmosphere for more than 100 years, on average.

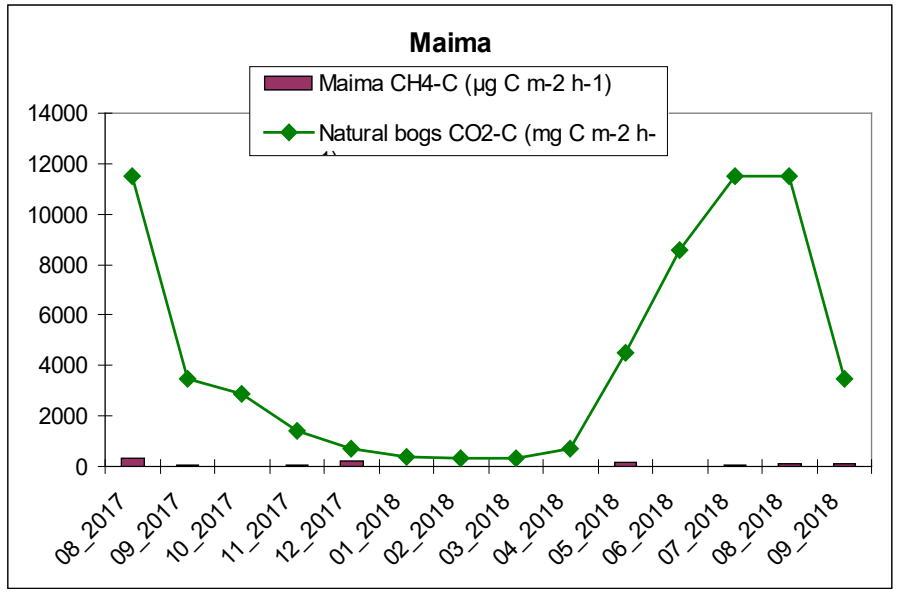
In abandoned peatlands N_2O emissions are significantly higher than in natural bogs

Methane (CH_4) emission





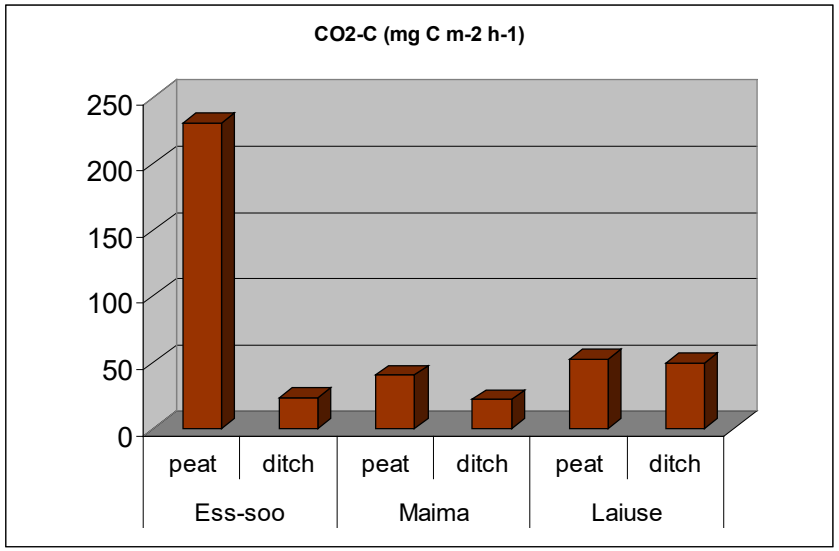


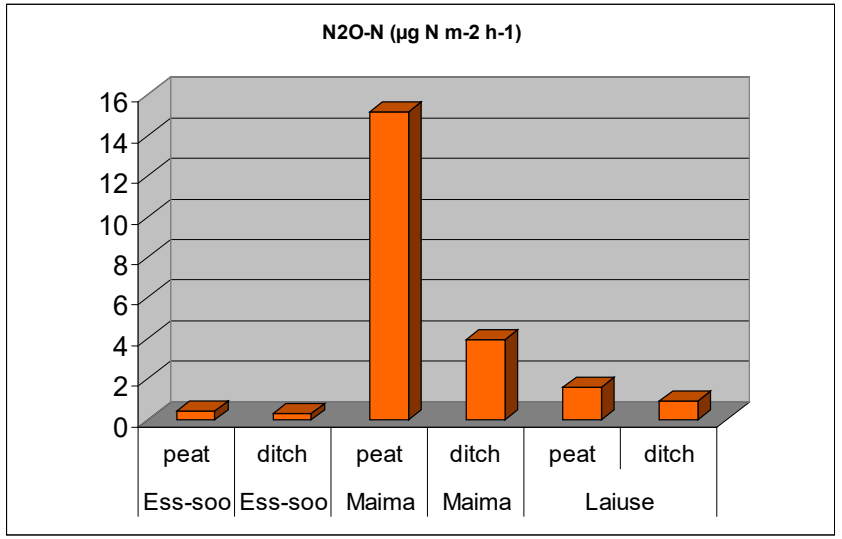


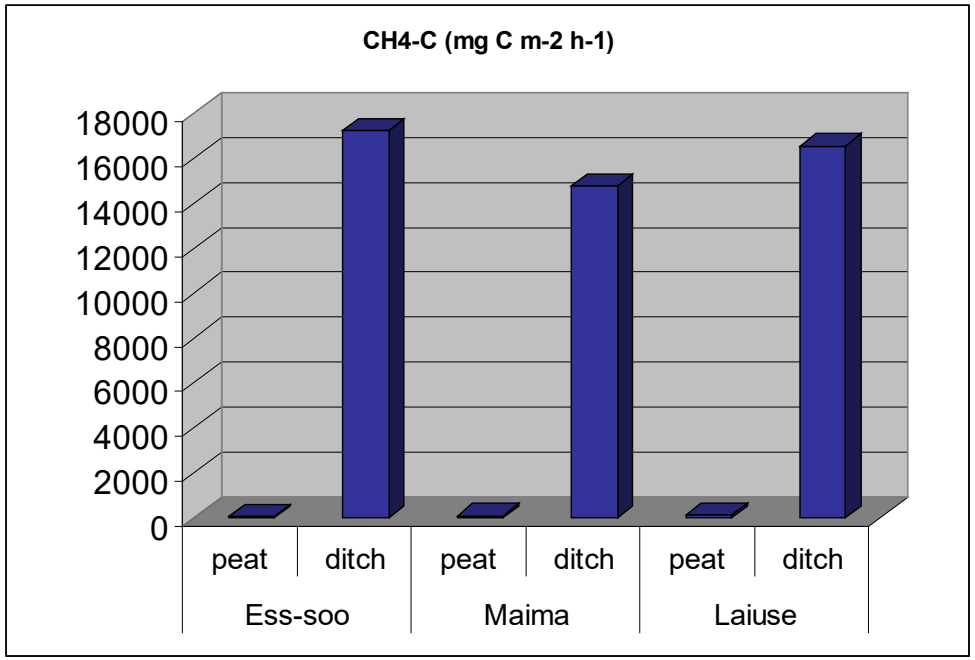
Low water level in abandoned peatlands keeps **methane emissions from soil 10-15x lower** than in natural bogs

But that's not all ... !

Emissions from land or water?

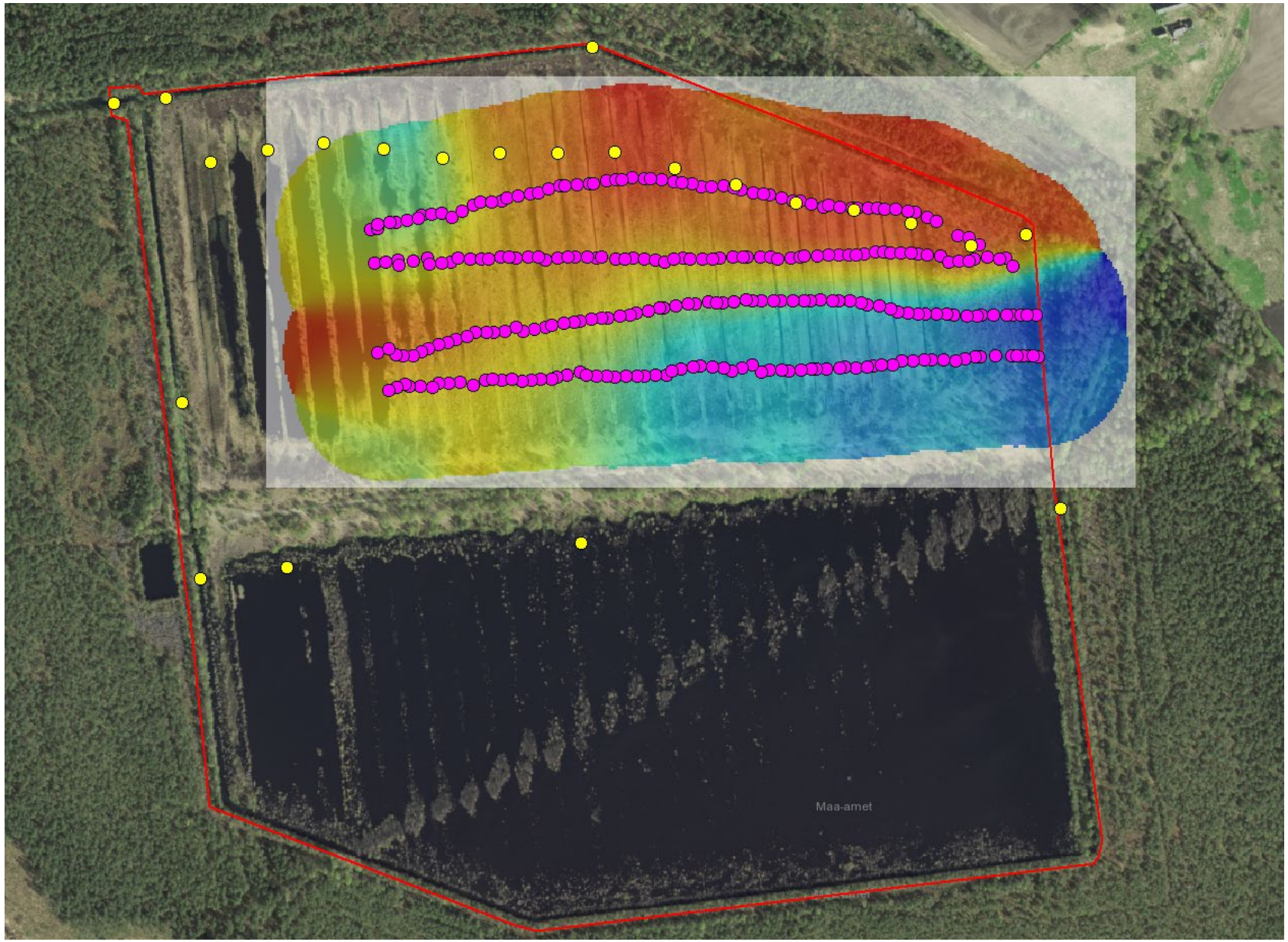




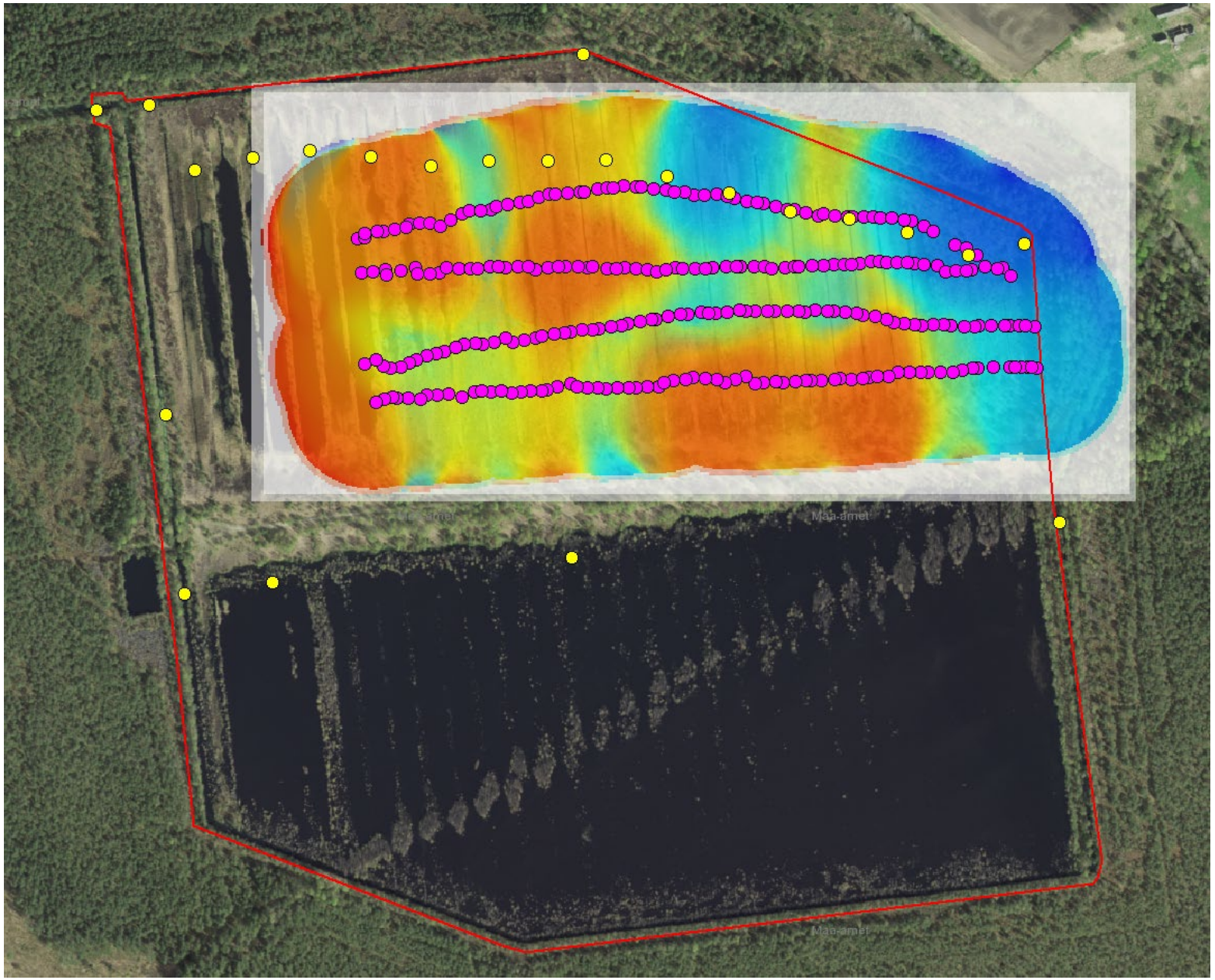


... the drawback is that methane emissions from ditches, ponds and other stagnant waterbodies of abandoned peatlands is **15-20x higher than from soil!**

Laiuse, August 23, 2018. Manually measured surface temperature (C at 0-5 cm)



Laiuse soil water content



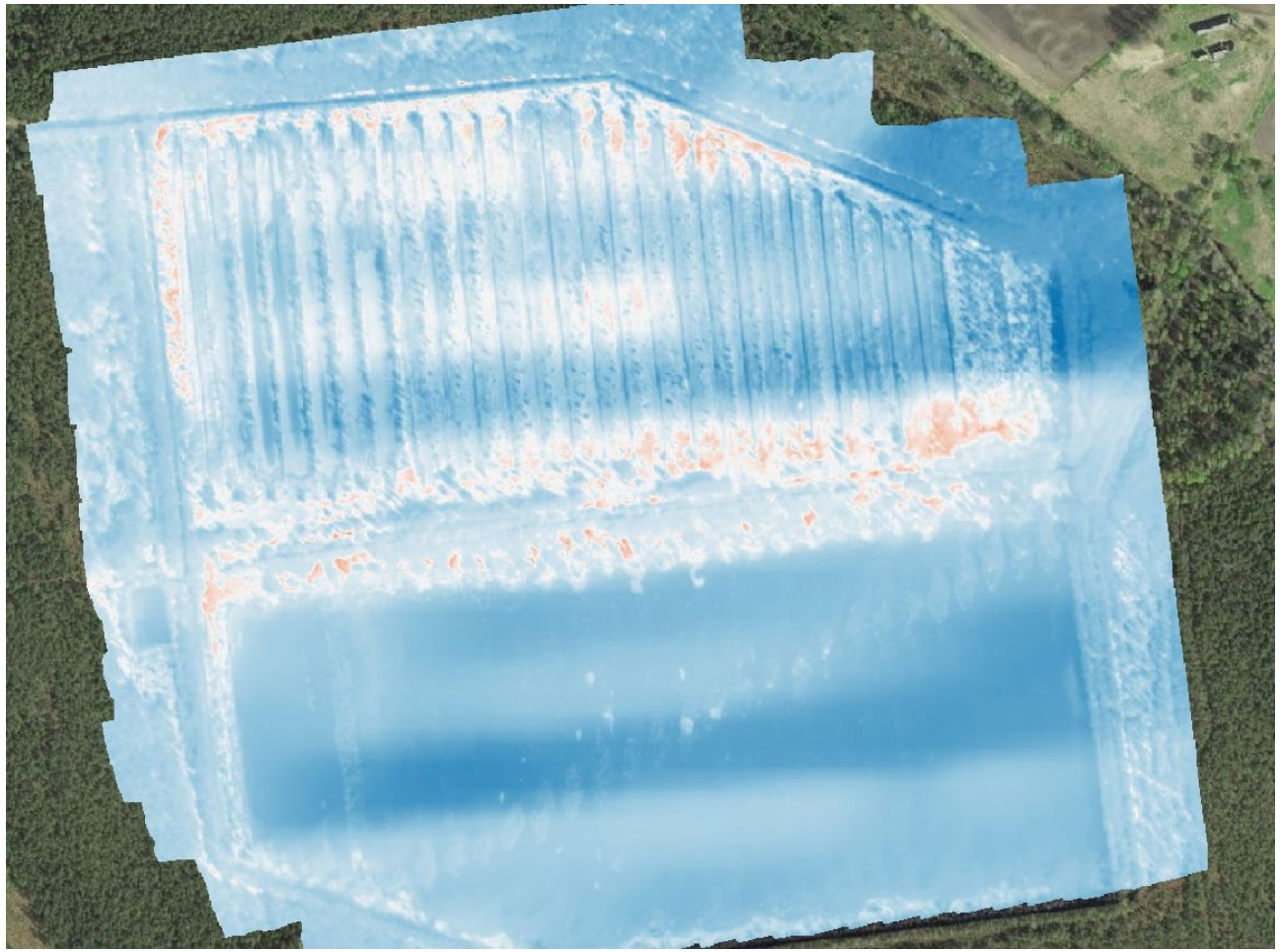
Color scale

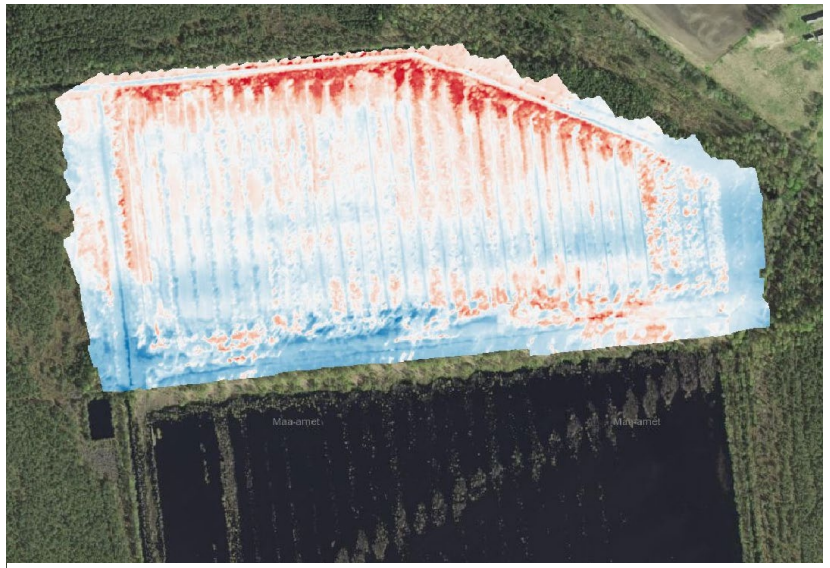
Red = 0.118

Blue = 0.94 m^3/m^3

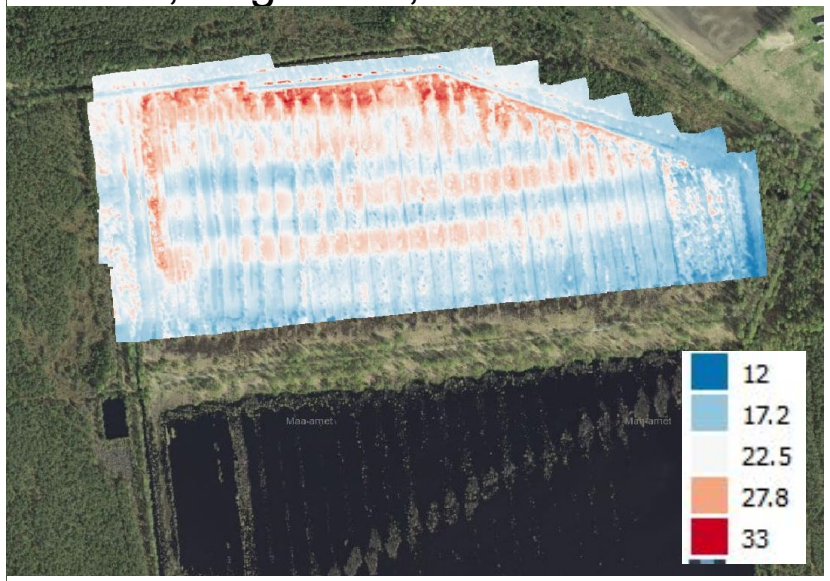
Surface temperature mapped by thermal camera

Laiuse, August 23, 2018 at 10:00, partly cloudy



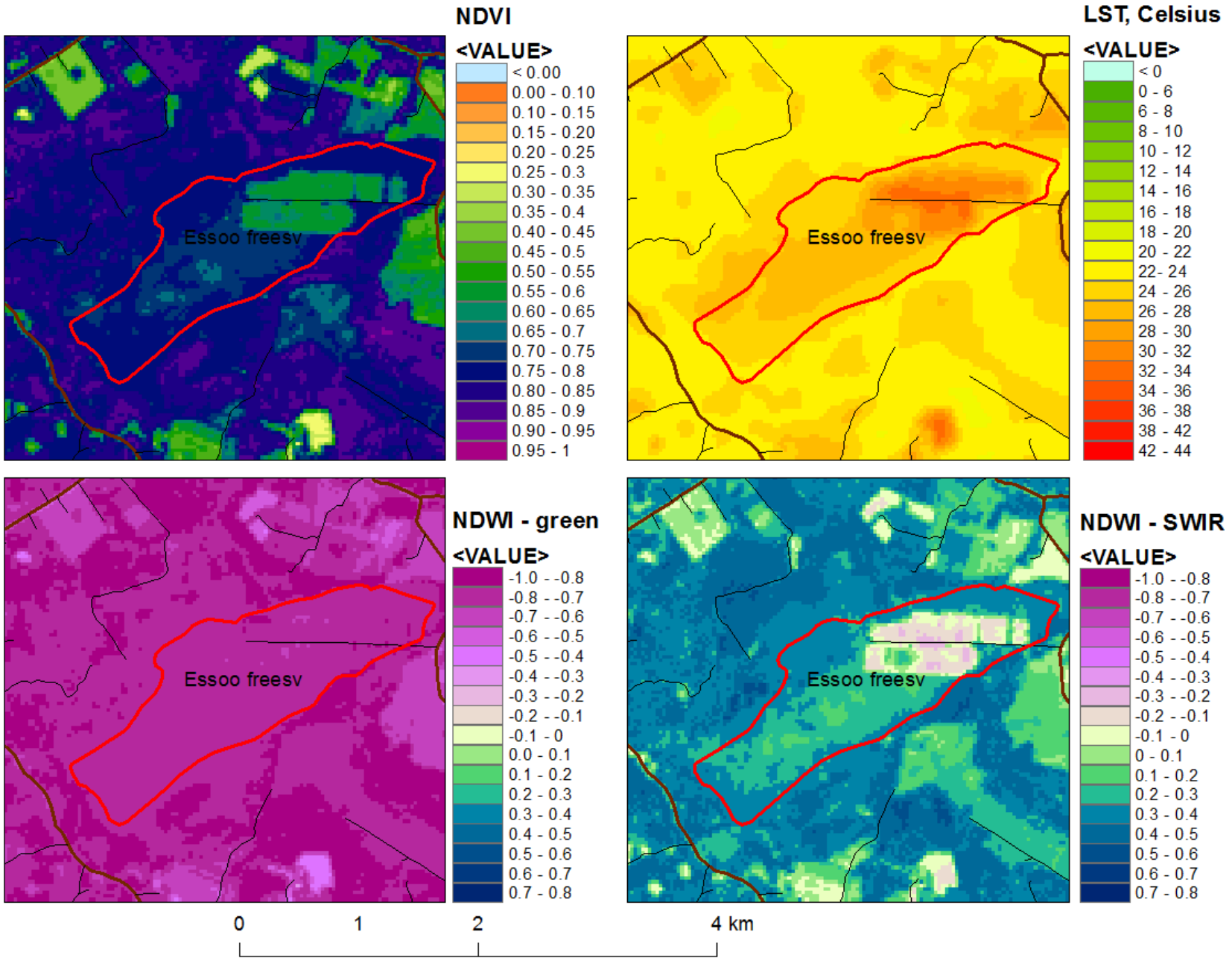


Laiuse, August 23, 2018 at 15:00



Laiuse, August 23, 2018 at 11:00

03. august 2014 **Essoo**



Satellite based survey of abandoned peatlands

Vegetation development (NDVI), surface temperature (LST), wetness indexes (NDWI)