

Soil GHG exchange estimates for drained peatland forests by management units

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CONTENT

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BACKGROUND

- **Paris Agreement targets** → need to find ways to reduce emissions & increase sinks in land-use sector
- Demand of roundwood continues → what other ways to reduce emissions we have ? → **continuous cover forestry (CCF)** on drained peatlands looks promising (has several benefits).
- Simultaneously, lot of activity on generating "**compensation**" markets → need to have more reliable GHG emission estimates and need to have management unit specific results.
- **Current methods with GHG inventory** are not appropriate for site specific GHG exchange estimation. According to Ojanen et al. (2014) CO₂ exchange drained peat soils in Finland may be a small sink or massive emissions
- **Water table depth** defines the amount of GHG emissions from drained peat soils

OBJECTIVE

- To estimate soil GHG exchange for each management unit on drained peat land forests in Finland
- To be able to locate most promising areas for emission reduction
- To compare existing GHG exchange estimates for drained peatlands forest soils against estimates produced here
 - GHG inventory
 - Ojanen et al. 2014 [<https://doi.org/10.1016/j.foreco.2014.03.049>]

WORK FLOW (I)

1. **Segmentation** of forest landscape in Finland → management units for forests

- Soil type (drained peatland, undrained peatland / upland soils), property borders, tree height & stem volume/proportions of main tree species

2. **LAI** (leaf area index) estimation

- Mean foliage biomass estimates by species from multisource thematic maps (year 2015)

3. **Ditch spacing** based on digital map for Finland

- Relationship between ditch meters in a management unit vs. ditch spacing

4. **Ditch depth** based on NFI12 data (2014-2018)

- Modeling ditch depth based on: time since ditching, ditch type, peat layer depth, north coordinate (Hökkä et al. in revision)

WORK FLOW (II)

6. **Site type** for estimating hydraulic properties of peat

- Based on multisource thematic maps (year 2015), place to improve

7. **Dominant height** of trees

- Based on multisource thematic maps (year 2015)

8. **Weather forcing** data from FMI grid.

- temperature, precipitation, vapor pressure deficit & global radiation

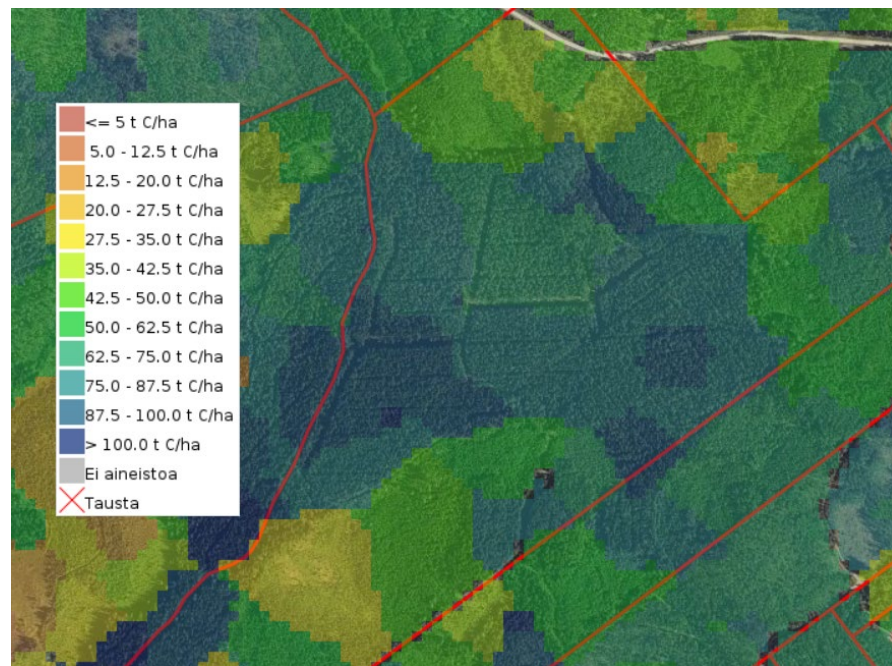
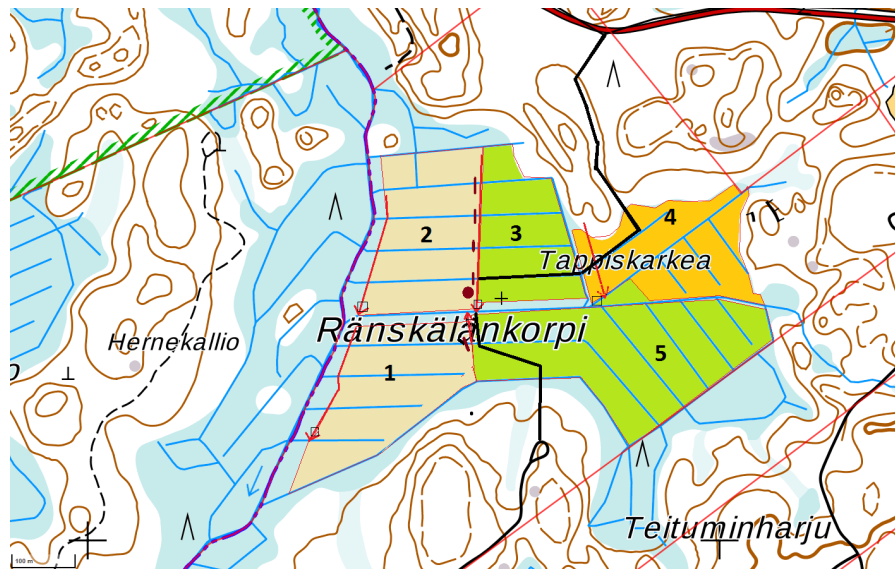
9. Running simplified **SpaFHy** (Launiainen et al. 2019) adapted for peatland forests to estimate water table depth (WTD)

10. Coupling growing season mean WTD with **GHG soil exchange**, based on Ojanen et al. 2010, 2019

Launiainen et al. 2019 [<https://doi.org/10.5194/hess-2019-45>]
Ojanen et al. 2010 [[doi:10.1016/j.foreco.2010.04.036](https://doi.org/10.1016/j.foreco.2010.04.036)]
Ojanen et al. 2019 [DOI: 10.19189/MaP.2019.OMB.StA.1751]

Segmentation & management unit based variables – case Ränskälänkorpi

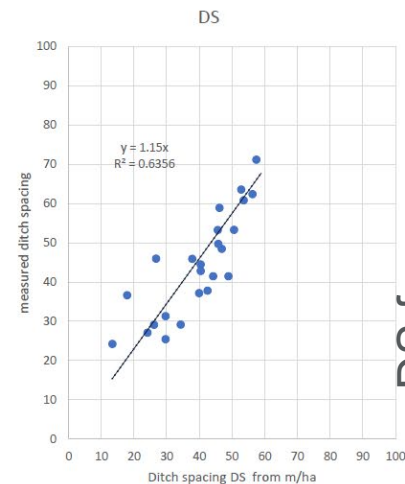
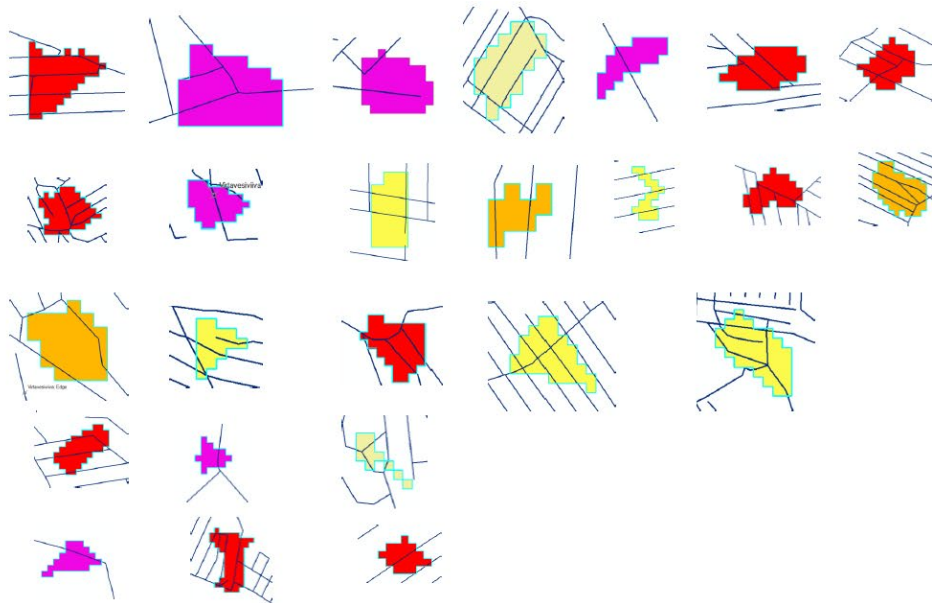
Biomass estimates for each segment



Ditch spacing (DS)

Ditch spacing
based on:

- Digital maps
- Etelä-Savo
data from
Metsäkeskus



DS from measurements

DS from ditch meters

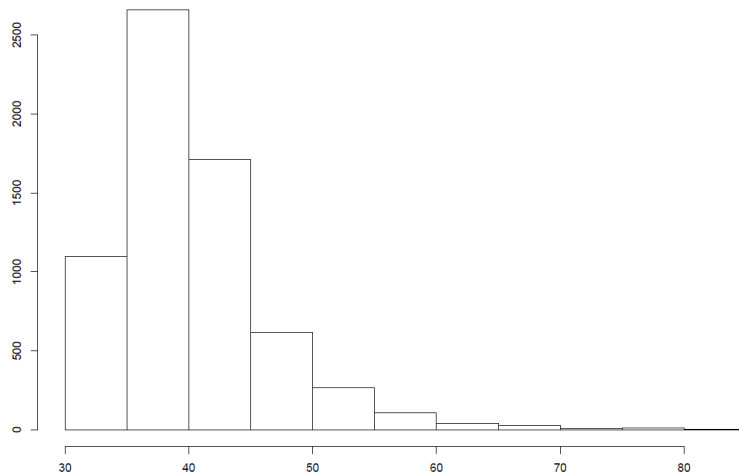
Ditch spacing for Pohjois-Pohjanmaa & Kainuu

Ditch depth

Ditch depth based on:

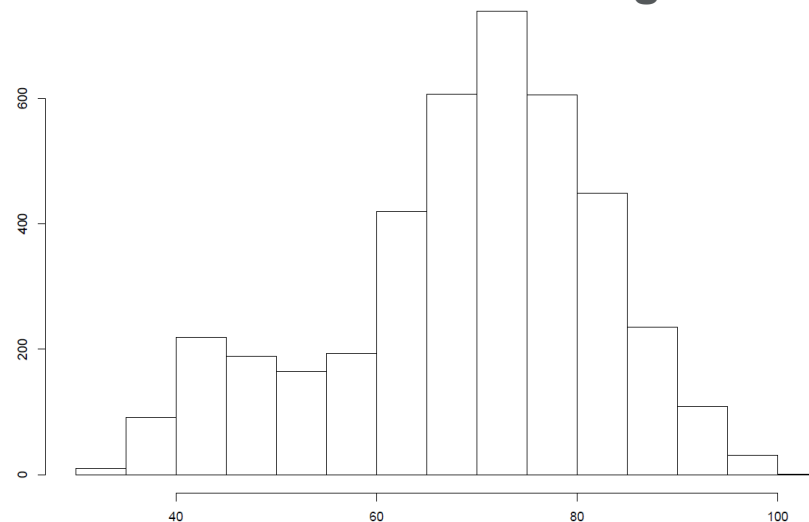
- Hökkä et al (2020) models, $f(\text{ditch age, coordinate, peat depth, type ditching})$
- NFI12 data on ditch properties

Original ditching



Ditch depth [cm]

Maintenance ditching



Ditch depth [cm]

SpaFHy – model for hydrology

- Inputs:
 - Daily weather data
 - Leaf biomass -> LAI
 - Drainage (depth & distance)
 - Soil properties (conductivity & water retention)
- Output:
 - Daily water balance
 - Daily water table depth
- Implemented with python



Estimating GHG emissions from WTD

- Based on works by Ojanen et al. (2010 & 2019), for N₂O (in review)

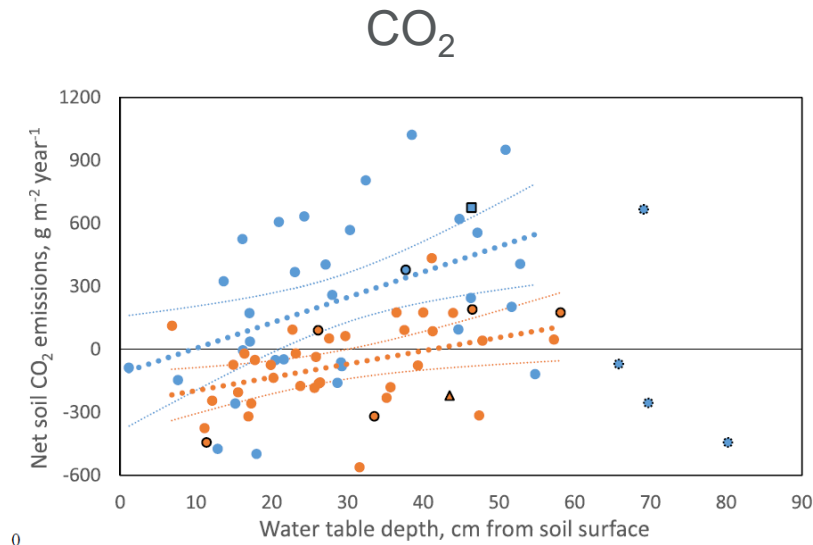
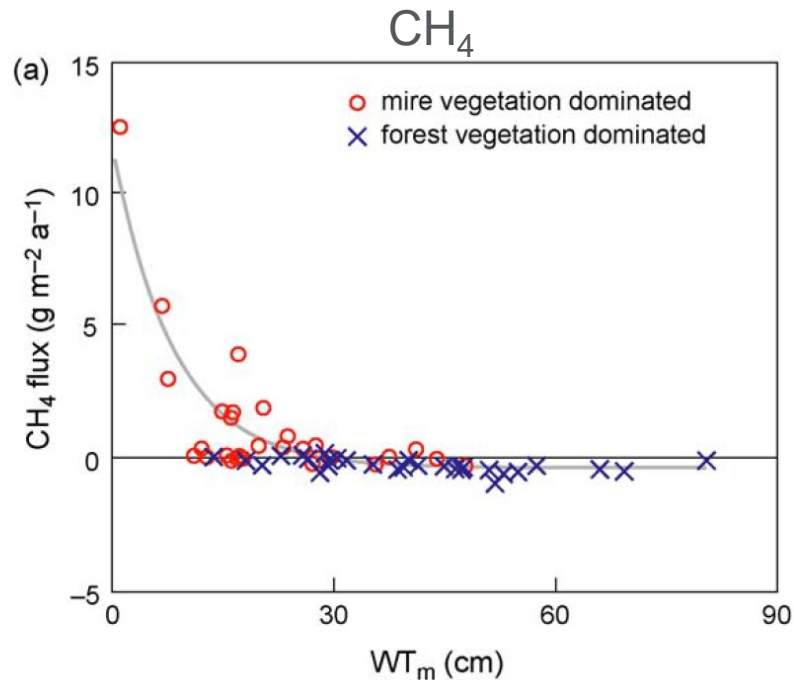
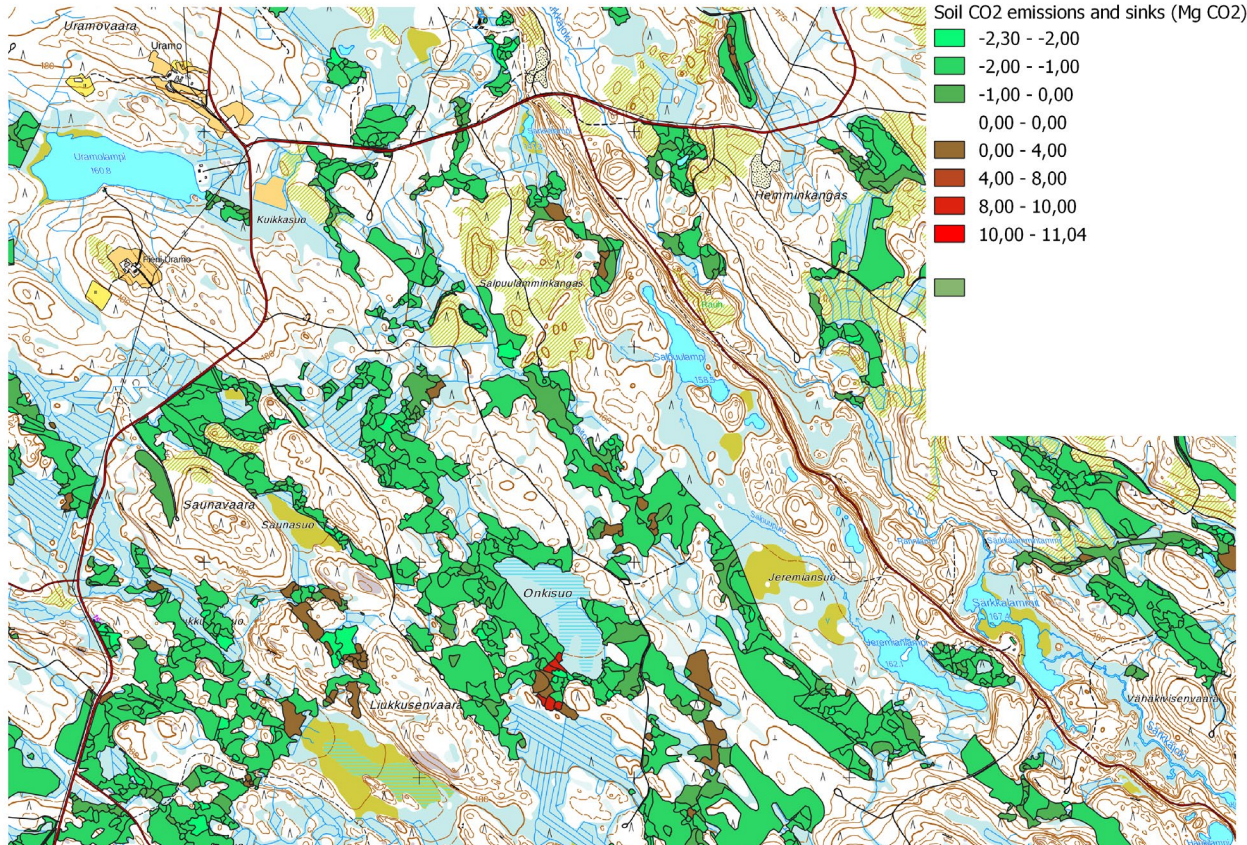


Figure 2. Linear regression, with 95 % confidence band, between mean May–October water table depth and annual soil net CO₂ emissions at nutrient rich (blue) and nutrient poor (orange) forestry-drained boreal peatlands. Data: Ojanen *et al.* (2013) (no border; those excluded from regression with dotted black border), Ojanen *et al.* (2019) (black border), Minkkinen *et al.* (2018) (triangle with black border), Korkiakoski *et al.* (2018) (square with black border). Positive values indicate emissions and negative values indicate removals.



Ojanen et al. 2010 [doi:10.1016/j.foreco.2010.04.036]
Ojanen et al. 2019 [DOI: 10.19189/MaP.2019.OMB.StA.1751]

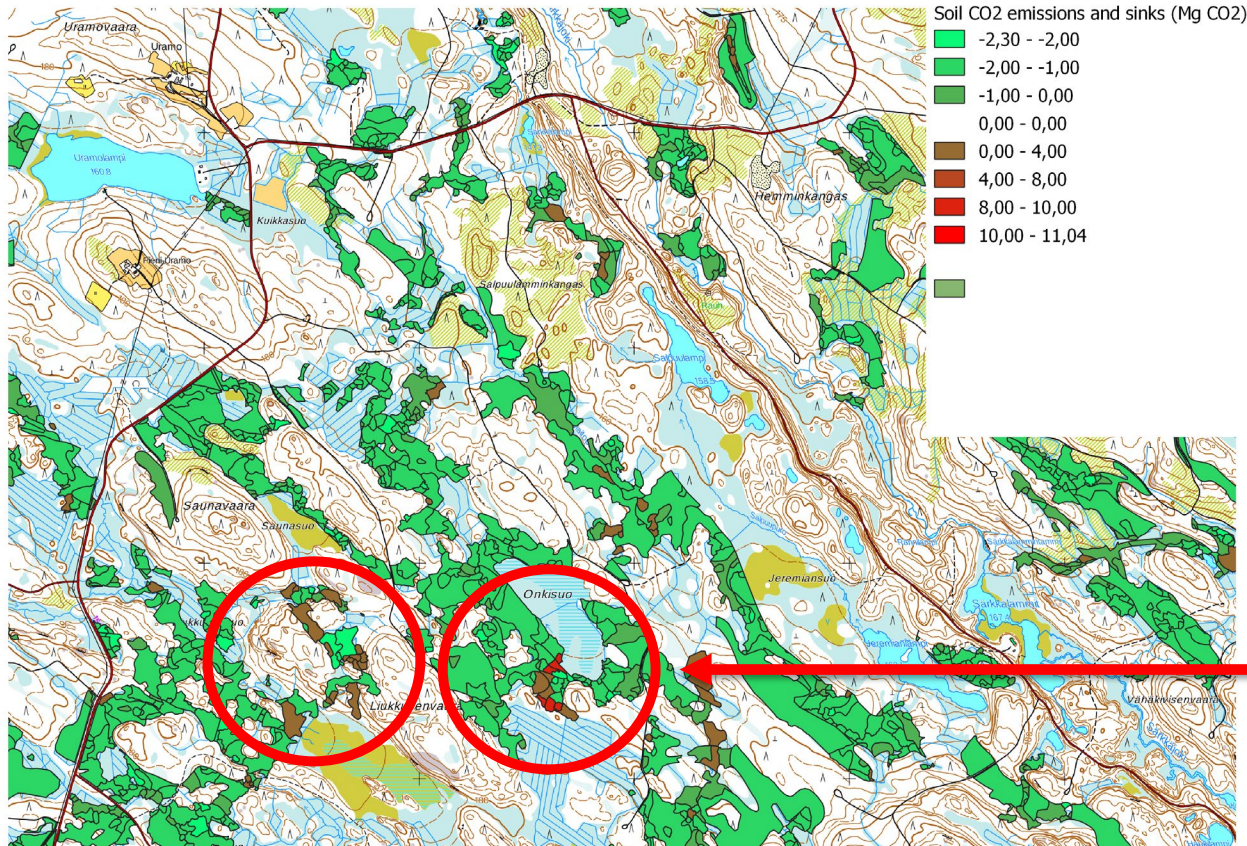
Drained peat forests in North Carelia state lands



Green → soils
accumulate carbon

Brown / Red: soils
are a emission
source

Drained peat forests in North Carelia state lands



Green → soils
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Allows to locate
potential emission
hot-spots

Comparing results with other estimated

GHG inventory results for Finland, here Tg CO₂ [2012 - 2018]

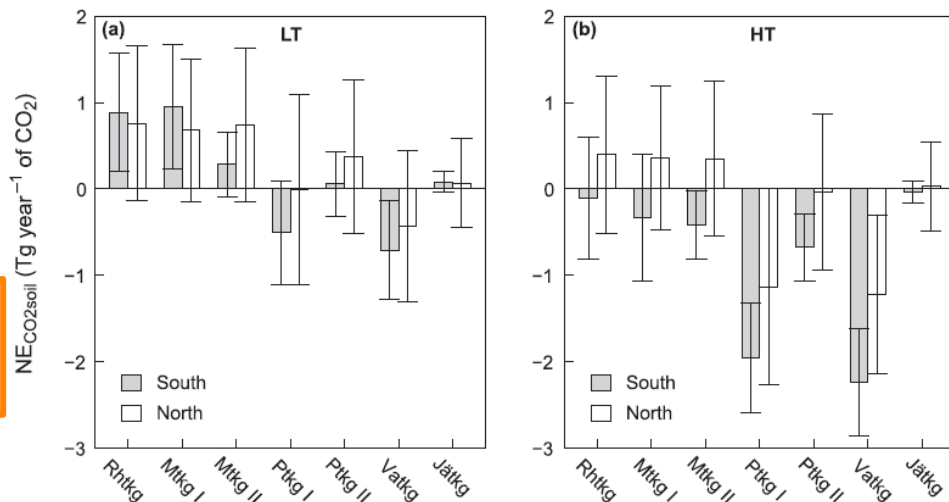
2012	2013	2014	2015	2016	2017	2018
6.7	6.1	5.9	5.4	5.1	4.8	4.3

Against estimates by Ojanen et al. 2014, where different fineroot turnover rate results very different estimates for Finland

Tilastokeskus 2020 NIR for Finland

Ojanen et al. 2014

[<http://dx.doi.org/10.1016/j.foreco.2014.03.049>]



Things to do

Peat water conductivity (more data needed)

Ditch depth (ALS data as by Arbonaut)

Soil biochemistry (LUKE SOCOS project)

LAI estimation (currently based on biomass models)



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