Forest SOC monitoring in Latvia – challenges and needs for the future/situation update

SNS Annual Network
Integrating Soil Monitoring in Nordic Forests – data harmonization, future designs and studies to examine soil function at different scales
NorForSoil Kick-off meeting

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February, 8-9th, 2023
Ås, Norway

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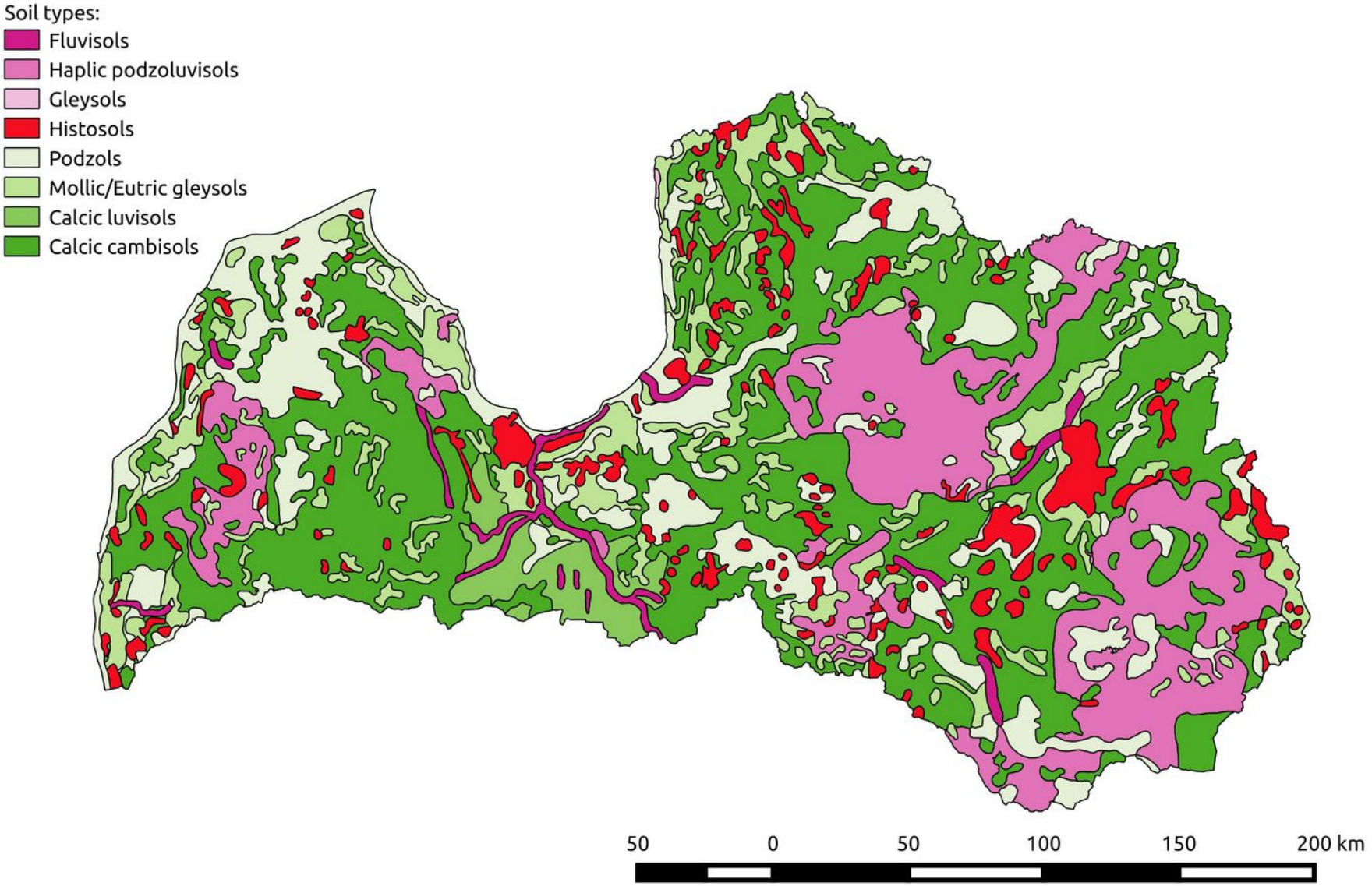
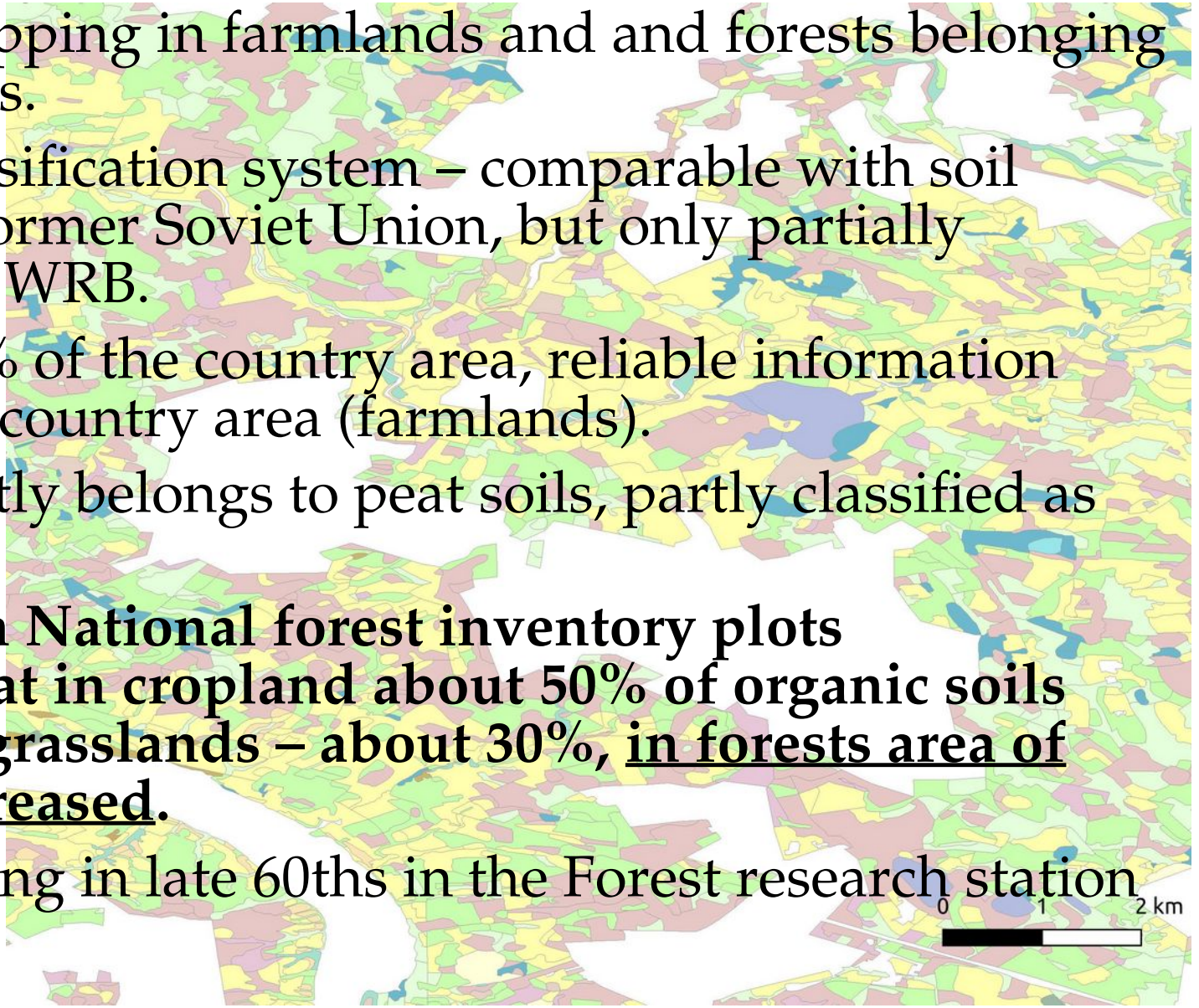
The most common soil map of Latvia in public data sources (1920^{ths})



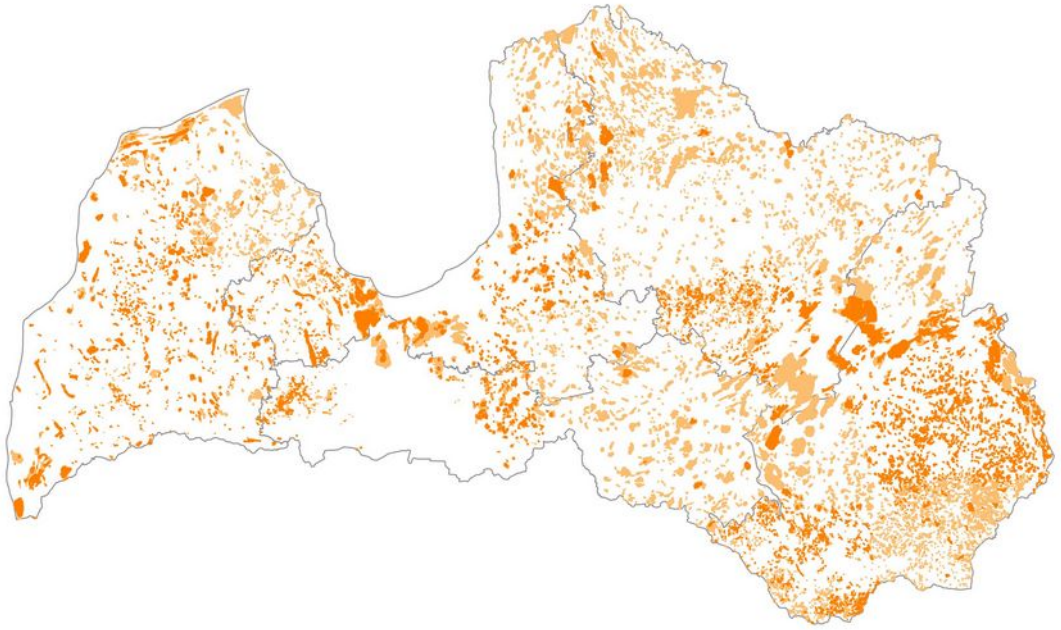
Soil inventory and mapping ~ 1968-1986

- Plot wise soil mapping in farmlands and and forests belonging to collective farms.
- National soil classification system – comparable with soil classification in former Soviet Union, but only partially comparable with WRB.
- Covers about 60% of the country area, reliable information about 40% of the country area (farmlands).
- Organic soils partly belongs to peat soils, partly classified as mineral soils.
- **Recent studies in National forest inventory plots demonstrated that in cropland about 50% of organic soils disappeared, in grasslands – about 30%, <u>in forests area of organic soils increased</u>.**
- Forest soil mapping in late 60ths in the Forest research station (about 5 kha).



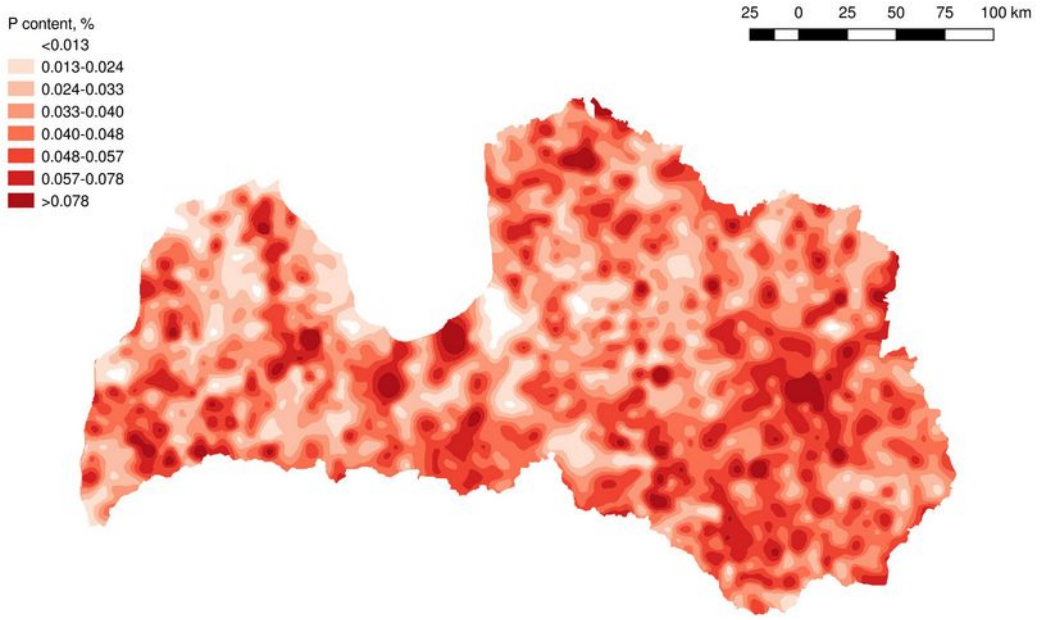
Peatland mapping - 2nd half of 20th century

- Based on information acquired during the 1st half of 20th century.
- Repeated inventory in early 80ths in western part of the country.
- Digitized in 2003 separating industrially valuable and other peatlands.
- Significantly overestimates area of peat soils, limited correlation with soil mapping data.



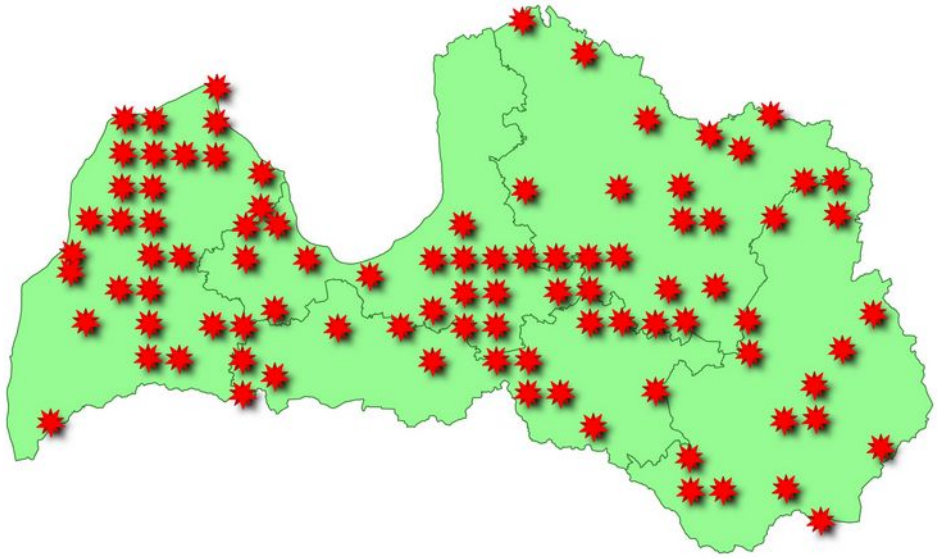
Soil geochemical mapping 1997-2000

- International project, scale 1:500000.
- Published in 2002, however, not available to public.
- Limited information on methodologies is available.
- Elements covered – Zn, V, U, Ti, Th, Sr, Se, Sb, P, Pb, Ni, Na Mo, Mn, Mg, Ls, K, Hg, Ga, Fe, Cu, Cr, Co, Cd, Ca, B, Bi, Ba, As, Al, Ag.



BioSoil – forest soil monitoring demonstration project

- 95 plots in forest lands, 1st inventory in 2006-2008, including carbon stock in soil.
- The most expensive soil monitoring program to that time.
- Repeated measurements (carbon stock, N and pH) in 2012. Ten times smaller costs than in 2006, implemented in 5 months instead of 36 months.
- Plots abandoned now, soil inventory in new Level I plots (115 in state forests) is not done up to now.

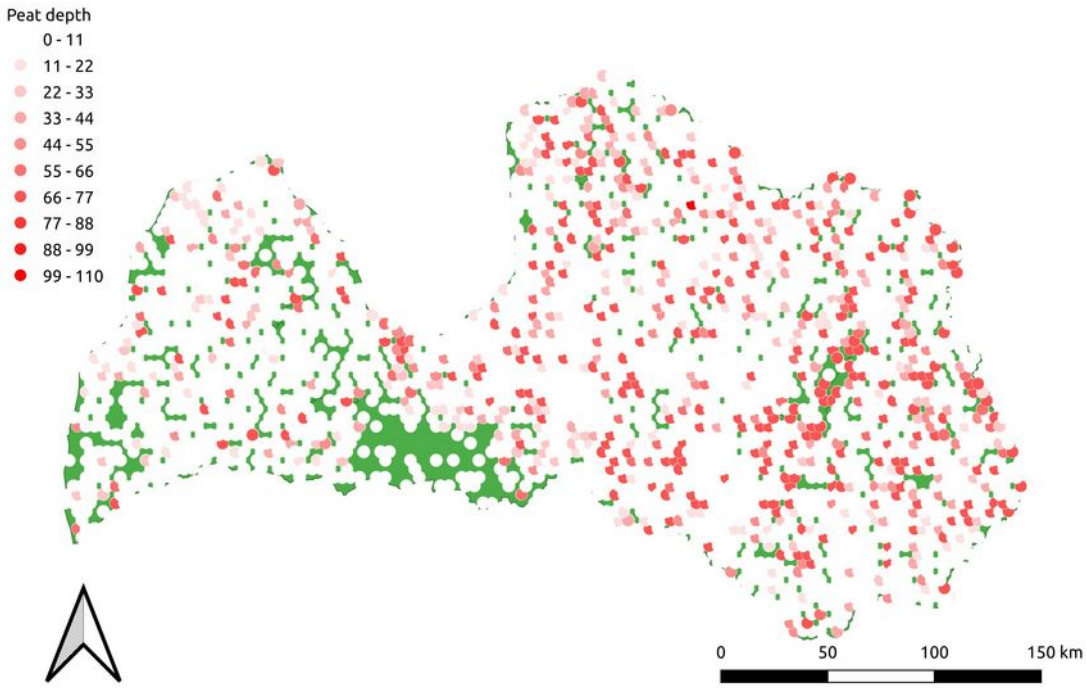


Temporal actions within the scope of National forest inventory (NFI)

- Identification of organic soils using historical soil maps (in total about 400 plots between 2012 and 2015) **in farmlands**, determination of carbon stock (C content and soil density).
- Evaluation of area of **alluvial soils** with high carbon content using information on biodiversity related payments (support to retaining alluvial grasslands) in 2013-2014. <u>One plot with alluvial soil found</u>. 
- Mapping of carbon stock in **farmlands** (0-40 cm depth) in about 200 plots in mineral soils. Currently used to demonstrate that conversion of cropland to grassland and vice versa is not a source of CO_2 emissions.

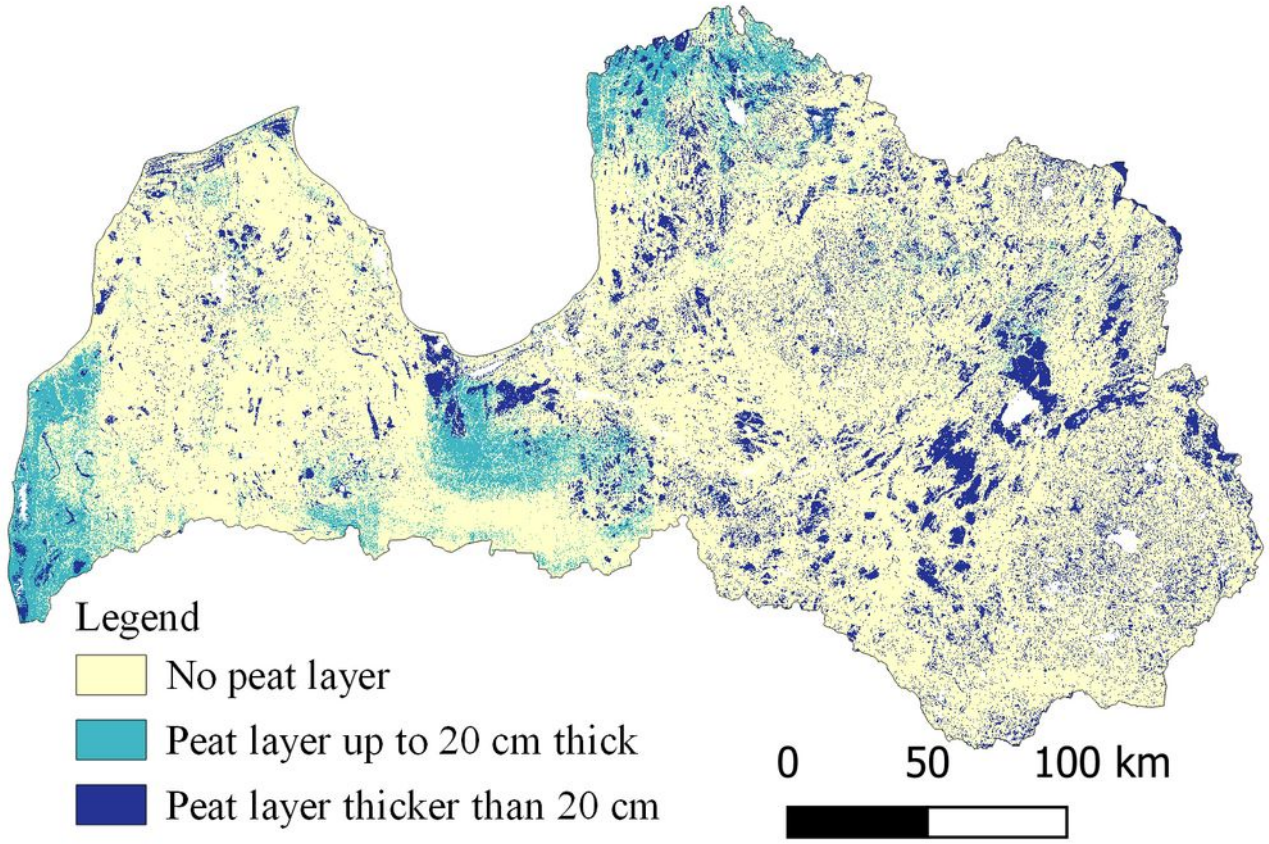
Determination of depth of litter and peat layer in forest lands within the National forest inventory

- About 11778 plots measured, 47112 unique measurements (2017-2021).
- Depth of peat layer (to 70 cm) and litter is measured in forest soils in all NFI plots.
- In combination with Biosoil data the information is used to model carbon stock in organic soils and to update equations characterizing carbon stock in litter.



- Bārdule, A., Butlers, A., Lazdiņš, A., Līcīte, I., Zvirbulis, U., Putniņš, R., Jansons, A., Adamovičš, A., & Razma, Ģ. (2021). Evaluation of Soil Organic Layers Thickness and Soil Organic Carbon Stock in Hemiboreal Forests in Latvia. *Forests*, 12(7), 1–15. https://doi.org/10.3390/f12070840.

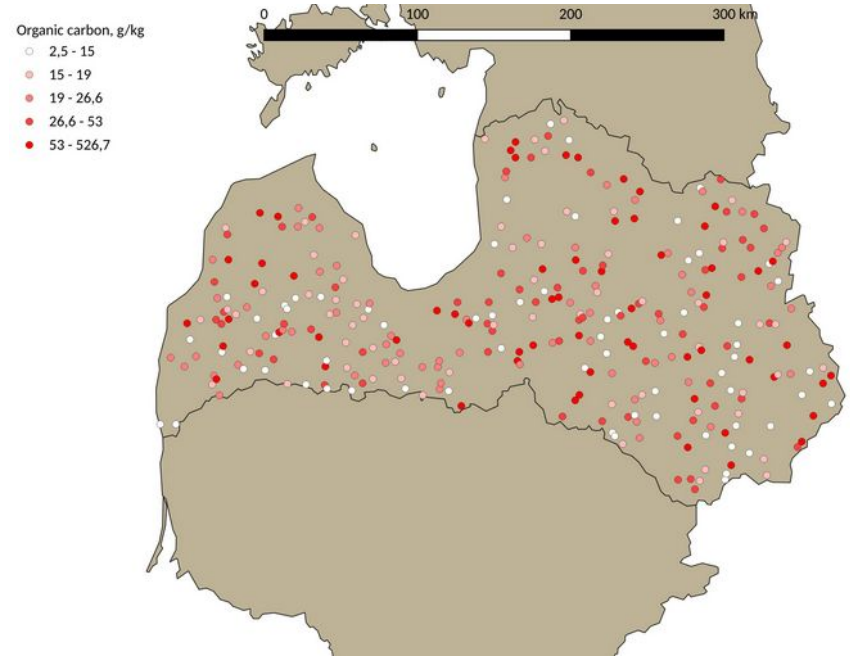
Machine learning based assessment of distribution of organic soils



- Soils where the thickness of the peat layer exceeds 20 cm is covering 15.6% (9760 km^2) of the area, while another 7.6% (4799 km^2) of the territory is covered with peat layer that is thinner than 20 cm.
- The accuracy of the reaches 0.76, while the kappa value is 0.39.

LUCAS soil monitoring program

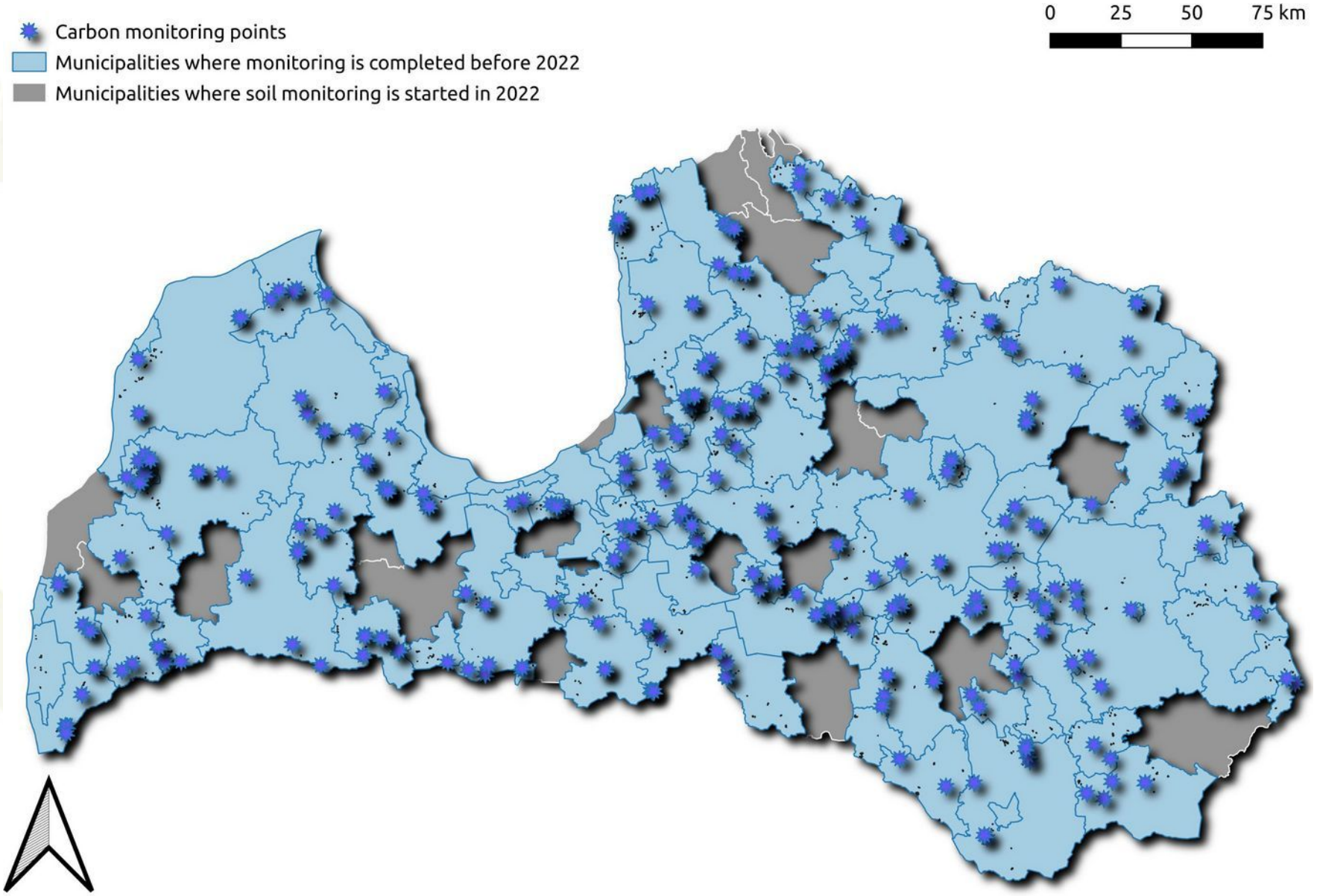
- About 300 plots with soil data including carbon content in topsoil.
- Data from 2 cycles are available, no regular changes in carbon content found.
- Data use is limited by missing information on soil density and topsoil only coverage. In forest lands litter is collected together with topsoil resulting in significantly bigger area of organic soils.
- Next Lucas cycle promises to use Level 1 forest soil monitoring methodology for sampling and analyses, which can make Lucas data useful in carbon modelling.
- Limited access to data and internal non-transparent QA procedures makes doubtful value of the data.



Soil carbon monitoring within the scope of E2SOILAGRI project

- Soil carbon monitoring program assuming repeated – once per 10 years – returning to the same plots.
- 200 plots in **croplands and grasslands** will be visited in 2021-2023. Only mineral soils will be covered.
- Additionally information on management activities (crops, yields, application of fertilizers) will be acquired.
- The acquired data will be used to verify soil carbon modelling results (Yasso).
- In parallel historical soil maps are adopted to WRB classification, and area of organic soils is updated in 2 pilot areas; however, 50 cm depth threshold is used for organic soils and these data will have limited applicability in GHG inventory.
- ***The project is funded by Norwegian government.***

E2SOILAGRI monitoring points



Field works in the E2SOILAGRI project

Yasso model – application experience

- Several attempts to implement since 2012 in forest land, cropland and grassland.
- Works in forest lands (forests with mineral soils represented as a single average stand). Carbon stock in average fits to actual Biosoil data. Due to large uncertainty used to demonstrate “not a source” assumption.
- In cropland and grassland underestimates soil carbon stock. Grasslands and organic farming areas – net source of CO_2 emissions, conventional farming – net sink.
- Significant problem in cropland – doubtful historical information on crops and application of organic fertilizers.
- Further improvements – biomass expansion factors for farm crops, carbon content in biomass and better activity data on soil type and water regime.

Susi peatland simulator (organic soils) progress up to now

- LIFE OrgBalt project activity to report CO_2 and, potentially, N_2O and CH_4 emissions from organic soils in forest land, cropland and grassland.
- **Up to now – only forest land with drained organic soils seems to be realistic, therefore, national model (temperature and groundwater level sensitive model in spreadsheet) is under development.**
- Primary function – extrapolation of groundwater level – will be developed further to improve multi-purpose activity data.

General needs for international cooperation

- Soil monitoring activities should be integrated with NFI.
- Methodology and QA/QC procedures implemented in Level I and II forest monitoring plots should be applied.
- Role of national institutions should be increased and certified according to forest soil monitoring program rules.
- Data should be openly and instantly accessible *(not like BioSoil – not accessible at all, or Lucas – accessible with up to 10 years delay)*.
- **Things to be done in Latvia –** restoration of forest soil monitoring program including information characterizing GHG fluxes *(water regime, vegetation coverage and structure, carbon input, particularly historical data outside forest lands, e.g. horticultural use of peat)*.

Additional development needs for organic soils

- **Water regime** mapping for GHG modelling using climate sensitive equations *(LIFE OrgBalt project)*.
- Implementation of **dynamic evapotranspoiration and water transfer model** applicable at local scale.
- Improvement of **GHG flux modelling tools** for drained and wet organic soils *(LIFE OrgBalt and other studies)*.
- Improvement of **soil carbon input** data *(ground vegetation, litter, roots; LIFE OrgBalt and other studies)*.
- Improvement of **activity data in cropland and grassland** *(E2SOILAGRI project)*.
- Improvement of modelling tools for accounting of **stem fluxes** and GHG soil fluxes in **wet and drained mineral forest soils**.
- Improvement of **GHG accounting system for wetlands** – activity data, peat production projections, data sources.

Thank you for attention!

Pre-defined project "Integration of climate change policy in sectorial and regional policies" LV-CLIMATE-0001 funded under the Norwegian Financial Mechanism 2014-2021 Programme "Climate Change Mitigation, Adaptation and Environment"

Photo by Andris Turks