LUONNONVARAKESKUS

Impact assessment of climate actions in the land use sector – what can bring in the largest emission reductions?

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Many opportunities to reduce the emissions in the land use sector

- In 2019, the GHG emissions of Finland were 53,1 Mt CO_2 equivalent in total.
- The net carbon sink of the land-use sector was 14,7 Mt CO_2 equivalent.
- The biggest emission sources in the land-use sector
  - ✓ Croplands on peat soils 8,7 Mt CO_2 eq.
  - ✓ Soils in drained peatland forests approximately 7 Mt CO_2 eq.

Figure. Potential implementation area and impact estimates of emission reductions.

Climate smart practises in land-use sector

Measure	Land area by measure (kha/v)	Time period needed for effects	Emission reductions 2035 (Mt CO eq./v)
Agriculture on peatland	4	Fast effect	0,91
Rewetting	5,8	Slow effect	0,24
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Conservation areas	6	Fast effect	0,17
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Drained peatland soils	75	Fast effect	2,40
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Agricultrural upland soils	1 000	Fast effect	0,69
Wood products	22 000	*	1,50
Decaying wood	22 000	Fast effect	1,26

*emissions reduction from wood products are driven by global demand.

Fast effect · Slow effect

Peatland fields and emission reductions

In total, an increase of 0,91 Mt CO_2 eq. in emission reductions could be obtained IF all options would be implemented simultaneusly

– will the 50 000 ha field area needed for this be released?

- Assumptions: half of the area needed for the new action is taken from cultivation of annual crops and half from cultivation of perennial crops.
- It is uncertain if the actions can be carried out in the indicated extent, especially after 2050. Moreover, in the calculations it has been assumed that the speed of clearing new peatland fields and the speed with which long-time cultivated peatland fields turn into mineral soils would be equal (500 ha/year) i.e., the total area of peatland fields would not change during the coming 45 years.
- The effect of climate change on the emissions has not been taken into account.

Measure/Year	2020	Emissions 2035	Emission reduction 2035
Grassland with water level -30 cm 633 ha y^{-1}	8,42	8,27 (-2 %)	0,145
Abandonment 1900 ha y^{-1}	8,42	8,00 (-5 %)	0,419
Paludiculture 333 ha y^{-1}	8,42	8,28 (-2 %)	0,137
Rewetting 500 ha v^{-1}	8,42	8,21 (-2 %)	0,205
TOTAL			**0,906**

Deforestation - methods

- In emission reduction assessment the reference scenario of the MISA project (Kärkkäinen et al. 2019. Potential actions of land use sector to achieve the climate objectives) is used as background material.
- For areas where forest was cleared for agricultural land or construction areas (deforestation) three alternative scenarios were calculated:

1. **ILMAVA 2035**: Annual deforestation areas were halved in 2021-2035 compared to the areas in the MISA scenario.
2. **ILMAVA 2050**: Annual deforestation areas were halved in 2021-2050 compared to the areas in the MISA scenario.
3. **ILMAVA peat 2050**: Annual deforestation areas were halved in 2021-2035 compared to the areas in the MISA scenario in a way that in agricultural areas peatland clearing was reduced by 75 % while total area remained the same as in scenario 2.

Deforestation - results

- Emission reduction potential means the emission savings reached through reduced deforestation including, besides the emission reduction due to land-use change, also the sink of the forest area that remains forest.

	2025	2030	2035	2040	2045	2050
ILMAVA 2035	-1,03	-1,18	-1,26	-0,46	-0,34	-0,22
ILMAVA 2050	-1,03	-1,18	-1,27	-1,36	-1,33	-1,30
ILMAVA peat 2050	-1,06	-1,25	-1,37	-1,50	-1,47	-1,44

Annual emission reduction potential (million ton CO_2 eq.) in different calculation alternatives.

Afforestation as climate measure

Scenario, afforestation 6 000 ha/year, 90 000 ha in total

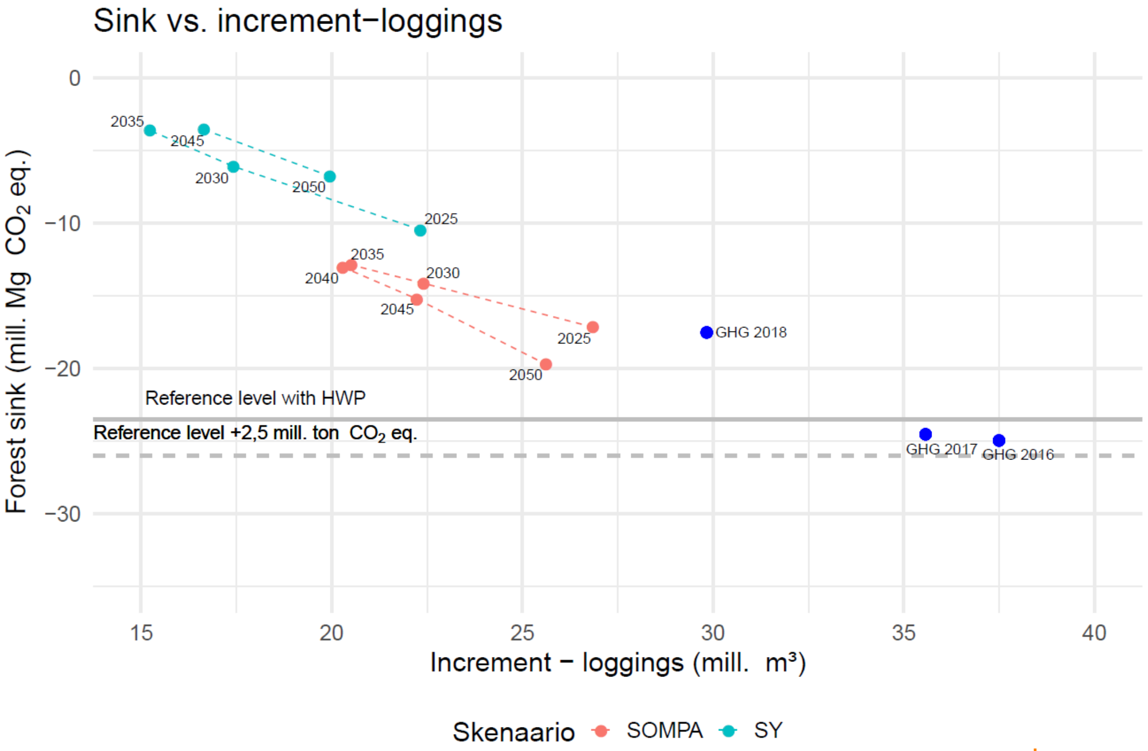
Year	Soil+trees, Mt CO_2 eq./year			
	Agricultural land		Peat production	
	Mineral soil	Peatland	Peatland	Total
2021-2035	0,09	0,07	0,03	0,19
2036-2050	0,14	0,15	0,05	0,35
2051-2065	0,16	0,21	0,07	0,44

Reduction of soil emissions in peatland forests

SOMPA scenario: Continuous cover forestry applied on nutrient-rich drained peatland forests i.e. clear-cuttings replaced by selection harvesting.

Results:

- 70000 – 80000 ha annually into continuous cover forestry
- The sink of both the trees and the soil increases in total ~5 Mt CO_2 (preliminary results)
- Trade-off: maximum sustained (SY) compared to the SOMPA scenario cuttings ↓ 3Mm^3, soil sink of mineral soils ↓ 0,3 Mt CO_2



Carbon stock of wood products

Emission reduction potential describes how much the carbon sink of the wood products could be increased if the product portfolio would be similar to that in 2000-2009, compared to the product portfolio of 2014-2018.

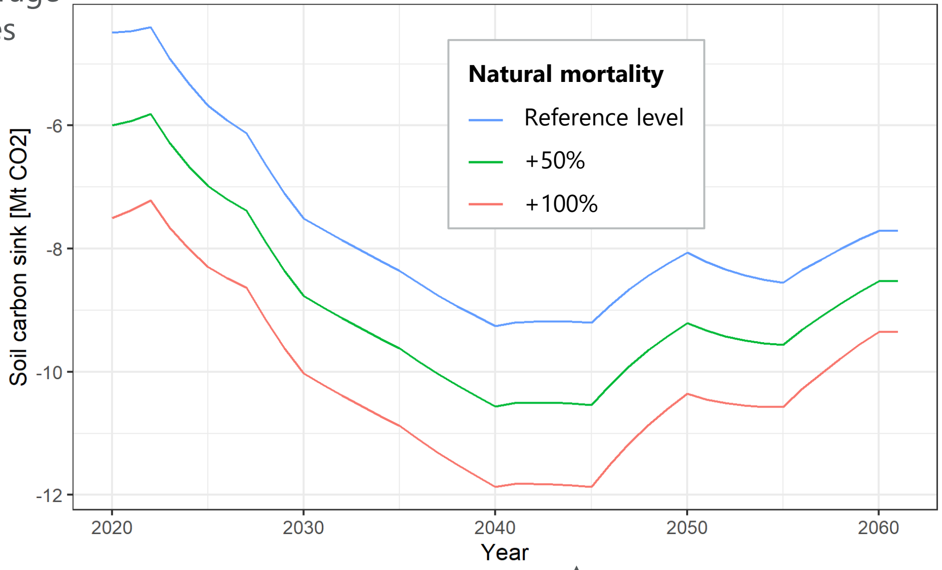
	2020	2025	2030	2035	2040	2045	2050
ILMAVA current level	-4,1	-4,5	-5,1	-5,4	-5,3	-5,2	-4,5
Comparison level	-6,4	-6,1	-6,6	-6,9	-6,7	-6,6	-5,8
Emission reduction potential	-2,3	-1,5	-1,5	-1,5	-1,4	-1,4	-1,2

Increasing the carbon sink of dead wood *

When natural mortality of trees increased from current level about 50 %, the carbon stock of dead wood and soil increased . Thus, the annual forest C sink grew **1,26 Mt CO_2** by year 2035.

Respectively, if tree mortality was doubled it led to an increase in the sink of the forests of about 2,52 Mt CO_2 by the year 2035.

Carbon storage increases



Other factors can cause a decrease in the carbon stock

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* Scenario based on Mela calculations…

Forest fertilization

Ash fertilization in peatland forests:

Annual increase in fertilized area, ha	Total 2021–2035	Additional growth 2035
30 000	3 164 773	524 000 m^3
30 000 / 60 000	4 414 899	764 000 m^3
30 000 / 100 000	6 081 733	1 070 000 m^3

→ c.a. **1.2 Mt CO_2**

Nitrogen fertilization on mineral soils :

Additional fertilization area 30 000 ha per year→2025 + 60 000 ha per year 2026–2035 → 2035 growth addition 0.54 milj. m^3, which increases the annual carbon sink by **0.62 Mt CO_2**.

Climate smart management of croplands on mineral soils

Development of farming by year 2050	Effect on total emissions in 2035 (Mt CO_2 equivalent)
Catch crop farming increases by 300 000 ha from current	-0,20
Biomass production of annuals increases 10 %	-0,19
Of the area of annuals, 10 % is replaced by green-fertilized grass	-0,09
Of the area of annuals, 10 % is replaced by biogas grass	-0,09
Carbon farming of grass (increase in profitability 10 % and raised cutting hight)	-0,13
All of the above simultaneously	-0,69

Emissions reduce about 0,69 Mt CO_2 by year 2035

Steering the early-stage development of trees

- Timely tending of seedling stands (treshold reduced from the hight of 6 meters to the height of 3 meters seedling stand) will increase the stem volume or amount of industrial harvest by 10-25 % by the time of first thinning.
- Timely tending of seedling stands on an area of 30 000 ha annually will in Finland lead to an approximate increase of **0,25 milj. m^3** in forest growth in 2035. This equals to an increase of about **0,31 Mt CO_2** in the carbon sink for year 2035.

Strengthening the forest carbon sink of mineral soils

- Reduction of cuttings in Finland by 6 – 22 million m^3 per year affects the soil carbon storage on mineral soils **0–6,4 Mt CO_2** depending on the starting point.

(Reference: https://jukuri.luke.fi/handle/10024/543898 Lehtonen et al. 2019)

- Decreasing the harvest of logging residues by a million cubic meters annually will increase the sink of the soil by **0,22 Mt CO_2** (based on earlier simulations).

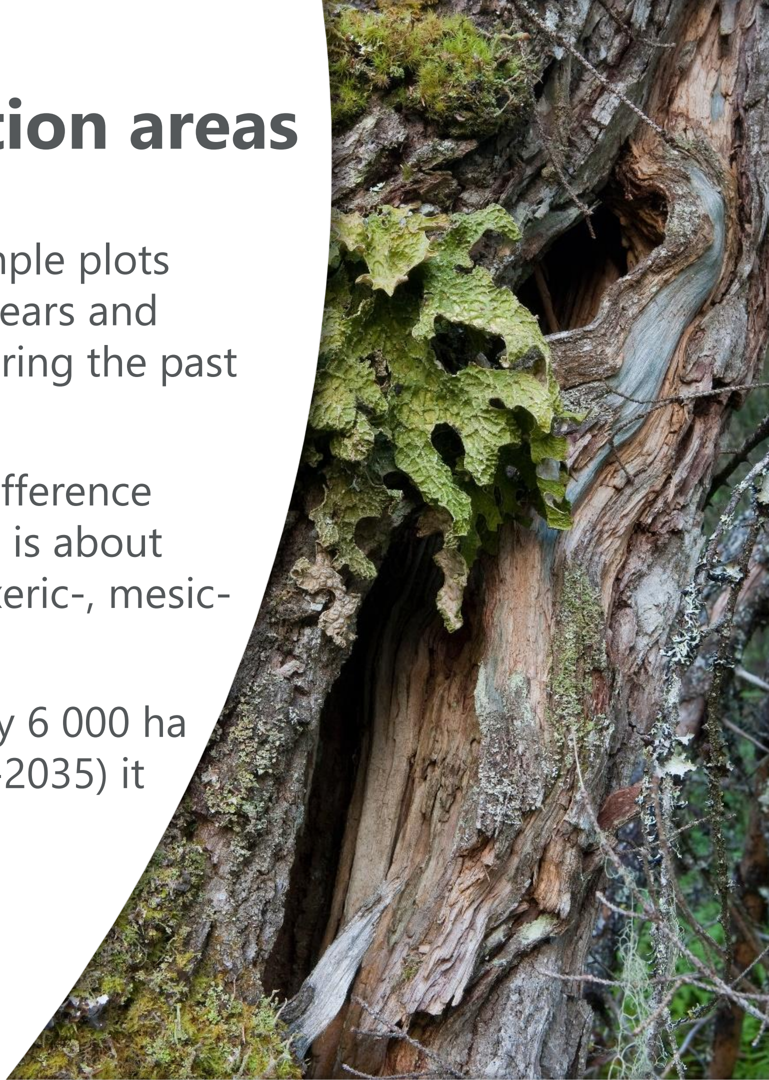
(References: Sievänen ym. 2014, Repo ym. 2015)

Climate effects of new conservation areas

VMI12: average biomass of the trees based on both sample plots where the stands have been treated during the past 30 years and sample plots that had not had silvicultural treatments during the past 30 years.

Result: in age groups 61–80, 81–100 and 101–120 the difference between untreated and treated plots in average biomass is about 16–20 Mg ha^{-1}, 24–34 Mg ha^{-1} ja 23–34 Mg ha^{-1} on sub-xeric-, mesic- & herb rich soils in Southern Finland.

If the quantity of protected areas were to be increased by 6 000 ha annually in productive forests in Southern Finland (2021-2035) it would amount to **0,17 Mt CO_2** additional sink by 2035.



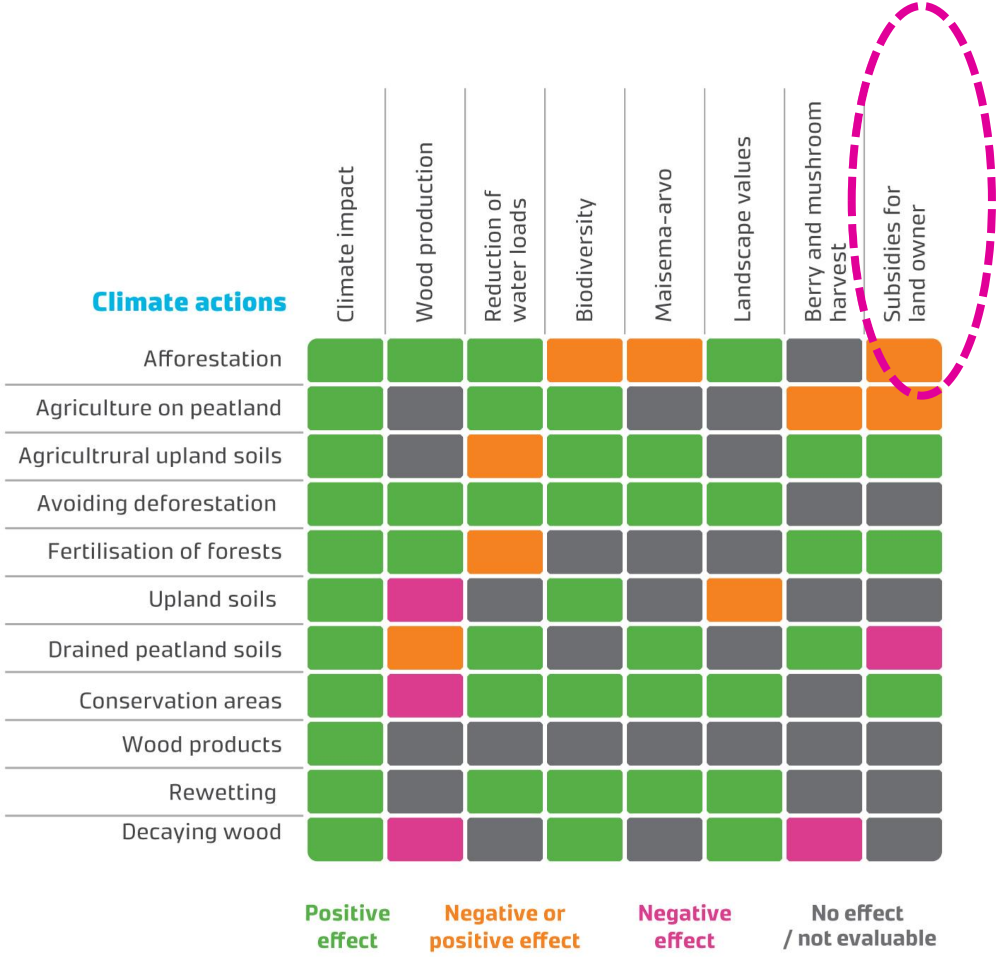
Conclusions 1/3

Rapid emission reductions in a relatively small scale actions

1) Croplands on peat soils ➡ removed from farming/afforested/transferred into paludiculture
2) Preventig deforestation

But current subsidies do not encourage to reduce emissions.

We need a reform of the farm subsidy system and/or a domestic incentive/emission trading in order to remove peatland fields from farming. Emission permission payment to control deforestation.



Conclusions 2/3

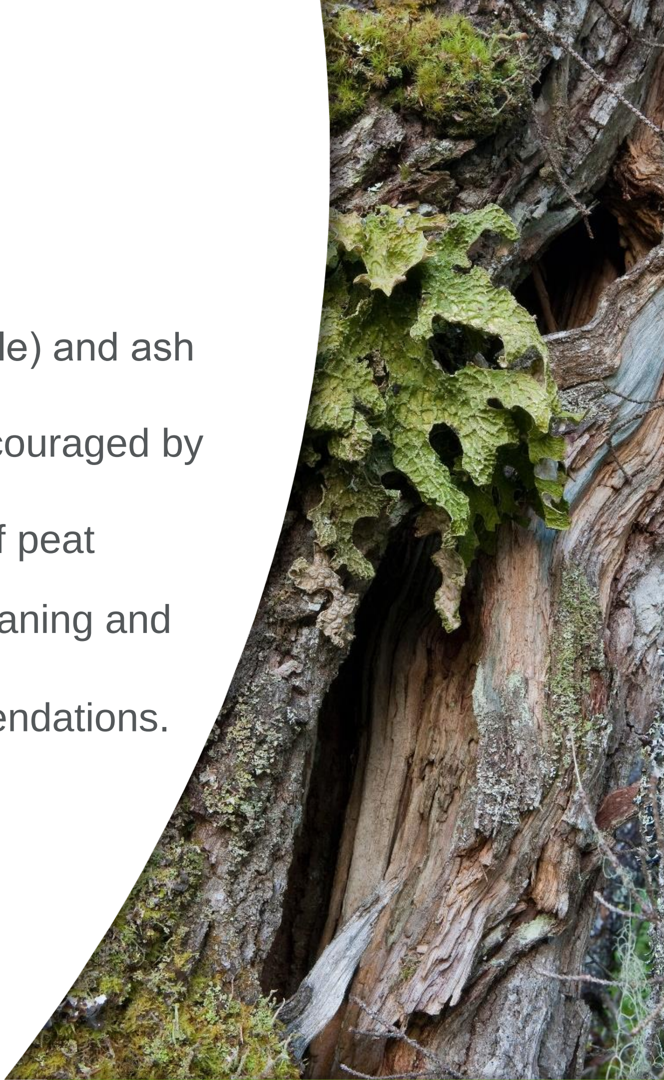
Large scale actions result in large emission reductions/additional carbon sinks

1) Nitrogen fertilization on upland soils (is economically profitable) and ash fertilization peatland forests (with KEMERA subsidy)
2) Climate smart managemet of croplands on mineral soils (encouraged by current subsidies and improves soil fertility of the fields)
3) Drained peatland forests, slowing down the decomposition of peat

But current subsidies and recommendations encourage ditch cleaning and rotation period forestry (incl. clear-cutting).
We need to update the subsidy system and silvicultural recommendations.

Positive effects on biodiversity and watercourses

1) Retention trees and increased carbon storage in dead trees
2) Restoration into wetlands
3) New conservation areas



Conclusions 3/3

- Land-use sector has large potential for emission reductions
- Realization requires big changes in subsidy systems of agriculture and forestry, investments, and improvements on farming and silvicultural methods.
- Reliable monitoring of emission reductions requires elaboration of calculation methods.
- Next the techno-economic feasibility and acceptability should be evaluated and the cost-effectiveness of climate actions compared within the land use sector and between the sectors.

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Thank you!

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