Greenhouse gas balances in low-productive drained boreal peatlands – is climate-friendly management possible?

LONG TERM

The effect of fertilization

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http://www.metla.fi/hanke/8547/index-en.htm

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Background

- 10 million ha of peatlands in Finland (30 % of land area)
- 5 million ha have been drained for forestry (50 % of peatlands)
- 0.5–1 million ha low-productive (10–20 % of drainage areas)
    - Poorest bogs (overal lack of nutrients)
    - Very wet fens (fertile, but lacking some mineral nutrients)
    - Currently wasteland

- Could their greenhouse gas balance be improved by fertilization
    - => improved tree growth => improved CO_2 sink **+++**
        - Soil CO_2 balance **???**
        - N_2O emissions **???**
        - CH_4 emissions **???**

Eutrophy – nutrient imbalance

Not fertilized

Fertilized 1985

eutrophic birch fen
drained in 1936

Extreme ombrotrophy – lack of nutrients

Not fertilized

Fertilized
1967&75&91

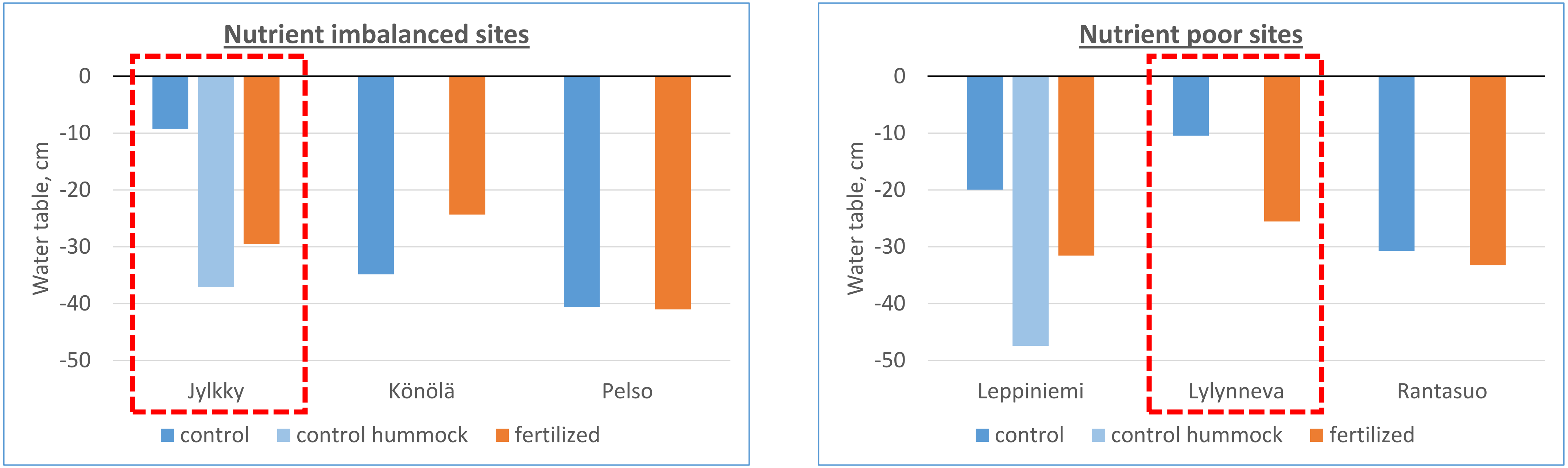
***Sphagnum fuscum* bog**
drained in 1967

6 study sites

	Site name	Site type before drainage	Drained (year)	basic fertilization (year/fertilizer/dose[kg/ha])	Fertilization treatment years	fertilizers	doses[kg/ha]
				Nutrient imbalanced sites			
eutrophic	Könölä	Eutrophic birch fen	1936	1969/PK/450	1985	PK+Ksalt	450+170
Meso-oligo-trophic	Jylkky	Flark fen	1939	unknown	1967/73/84	PK/PK/PK	600/400/400
	Pelso	Flark fen	1950-1960's	unknown	1997	wood ash	15 000
				Poor sites			
Oligo-trophic	Rantasuo	Low sedge fen/bog	1970s	1970s/PK/500	1998	wood ash	6 500
	Leppiniemi	Cottongrass fen/bog	1932	no	1947	wood ash	16 000
ombrotrophic	Lylynneva	*Sphagnum fuscum* bog	1967	no	1967/75/91	PK/PK+amm.nitr./ PK+amm.nitr.	2 000/400+400/ 500+330

The following slides contain preliminary results!

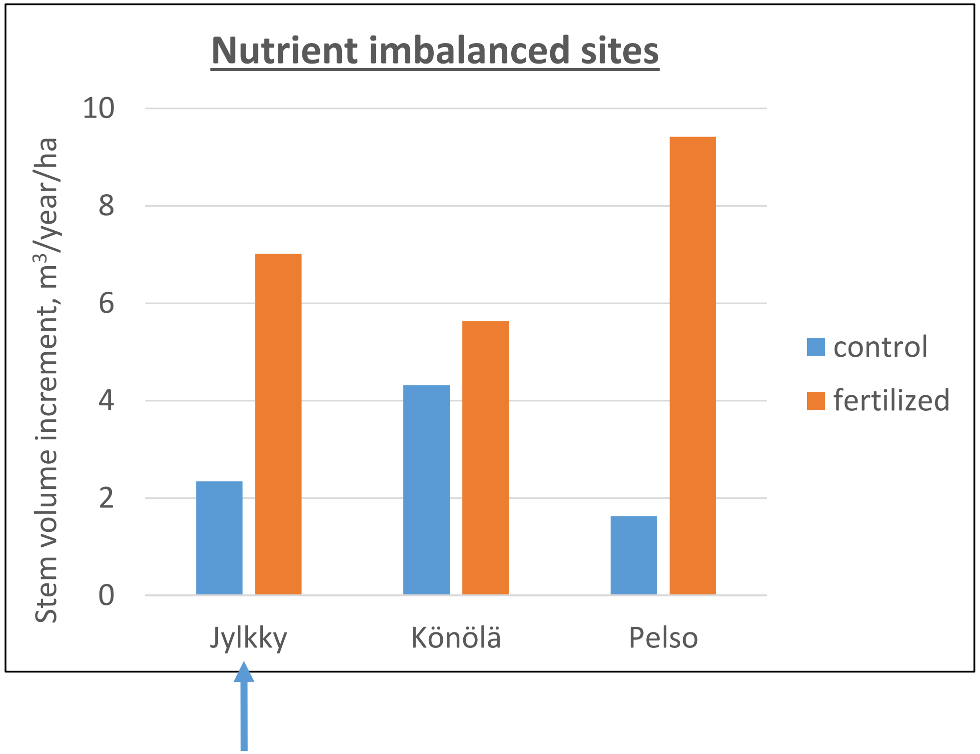
June–September water table

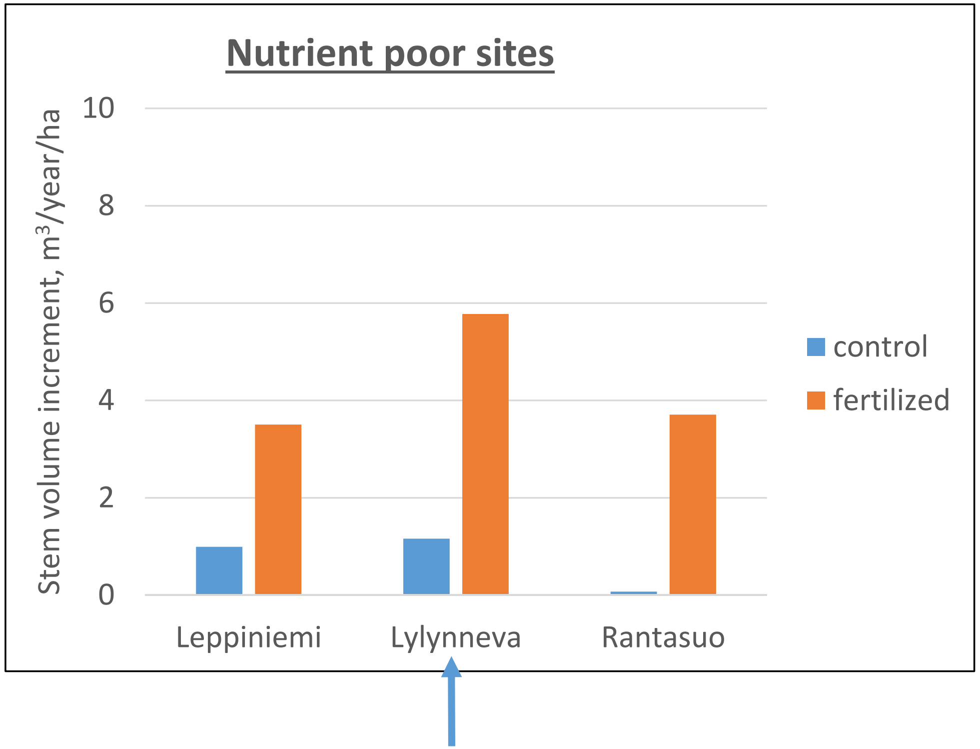


Clear WT lowering only at two sites

Method: tree stand measurements + increment coring

Stem volume growth



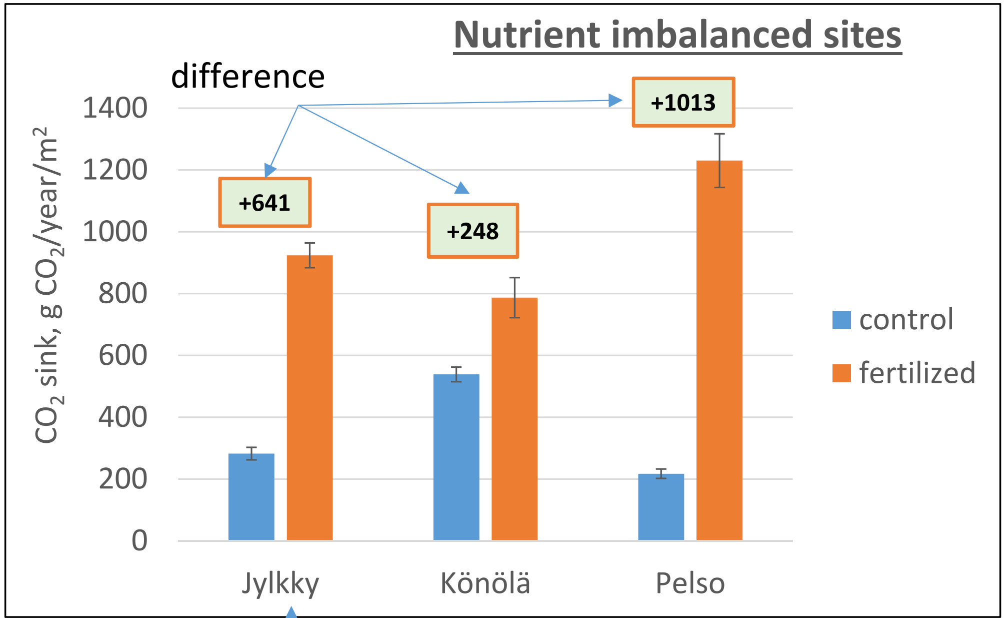


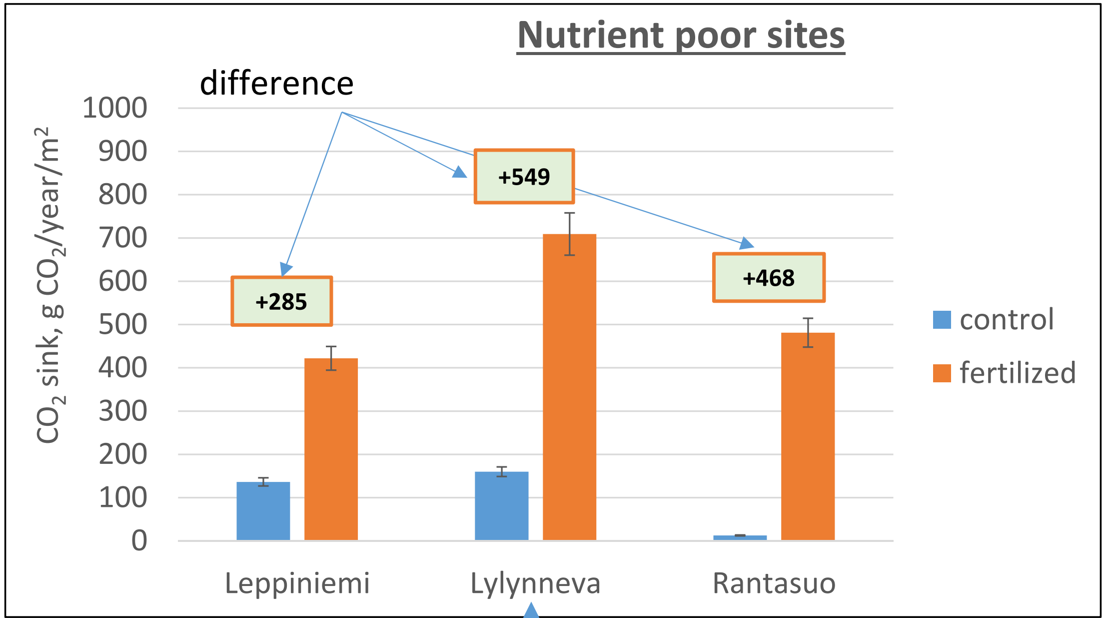
WT lowering

N fertilized
WT lowering

Method: tree stand measurements + increment coring + biomass equations

CO_2 sink of the growing tree stand biomass





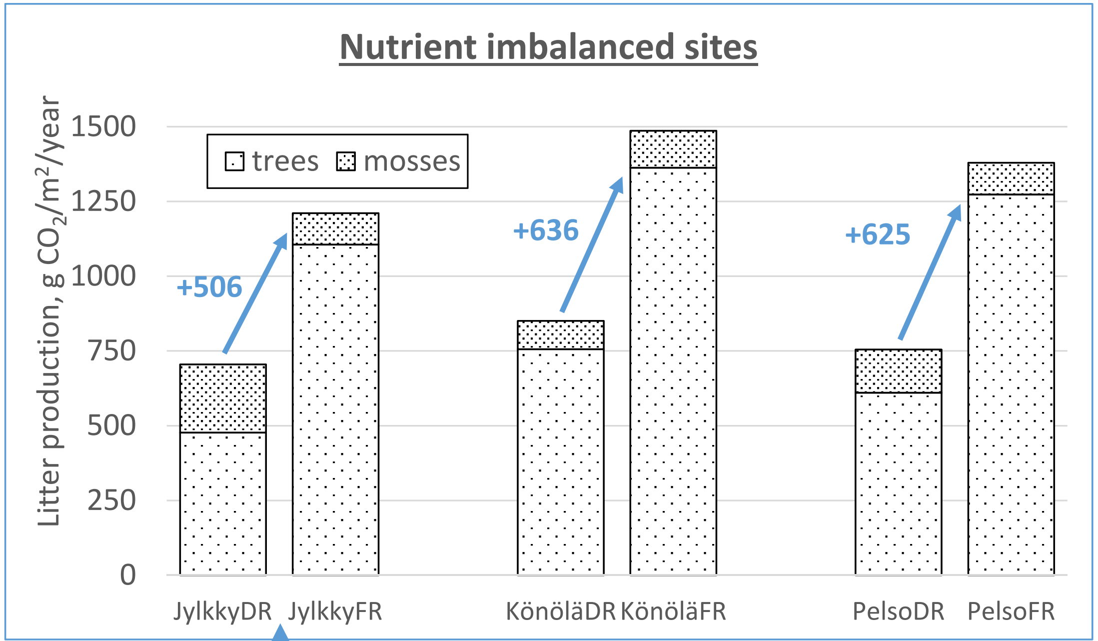
WT lowering

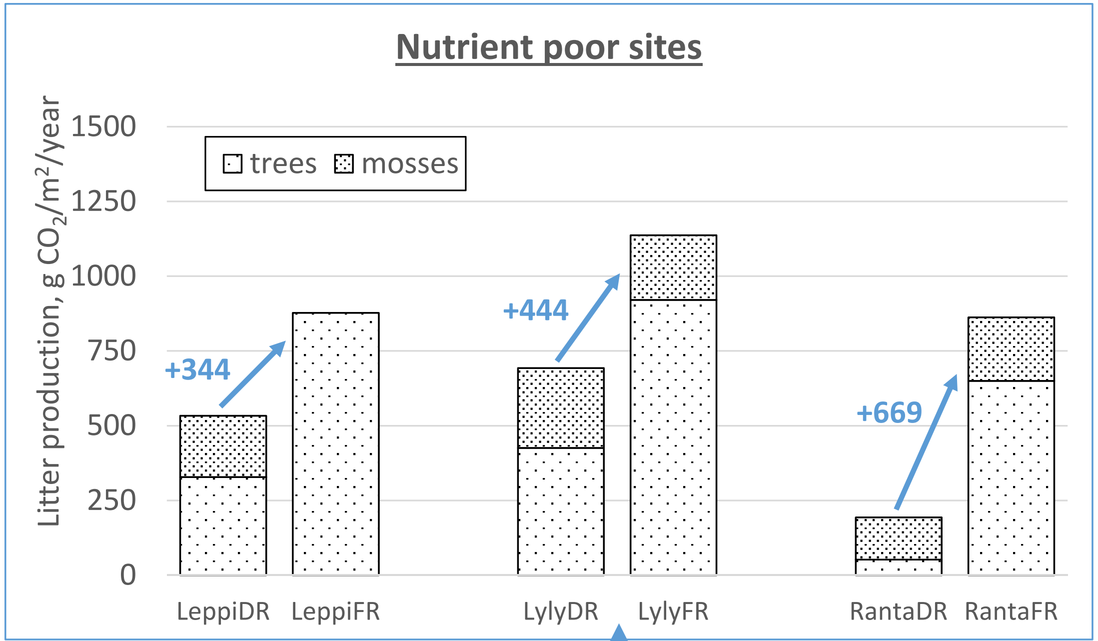
N fertilized
WT lowering

Method: 10 litter traps/site (d = 28 cm) for tree stand, one-year biomass production through nets (10/site, d = 12.5 cm) for mosses

Litter production

(trees above&belowground + mosses)



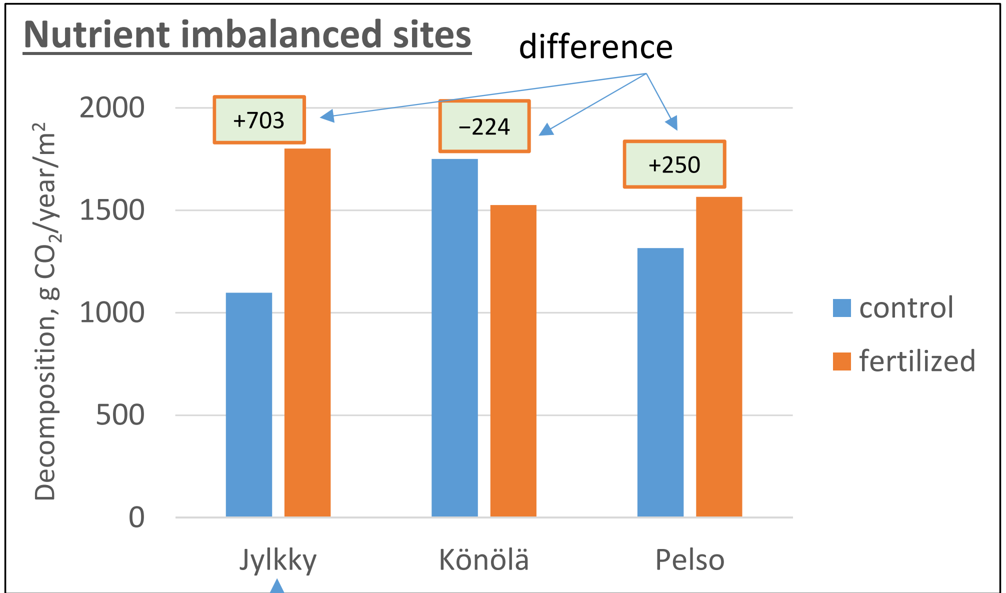


WT lowering

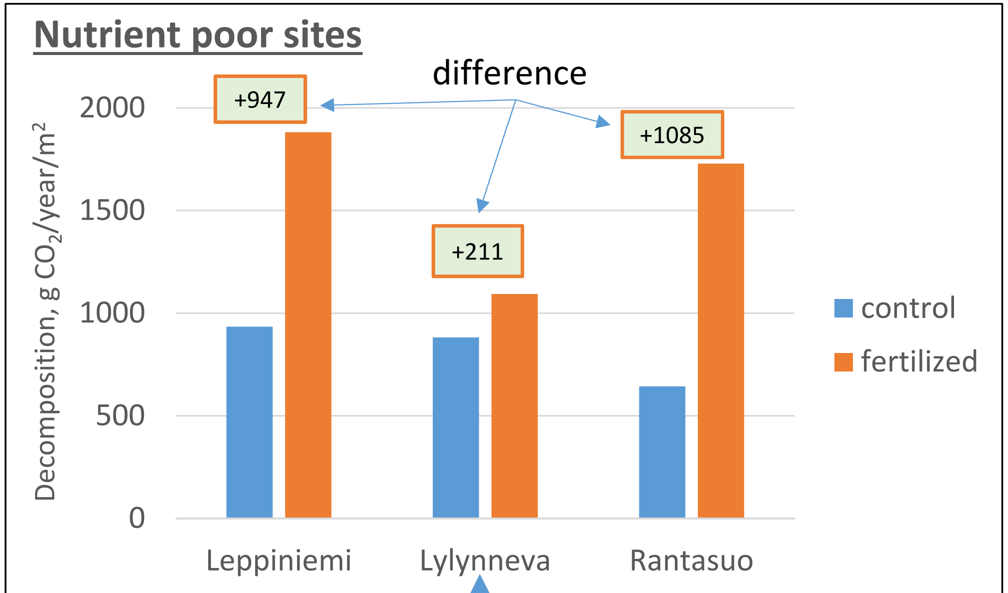
N fertilized
WT lowering

Method: closed chamber measurements, 6 measurement points/site (d = 30 cm), roots cuts + aboveground vegetation removed

Soil CO_2 efflux (heterotrophic soil respiration)



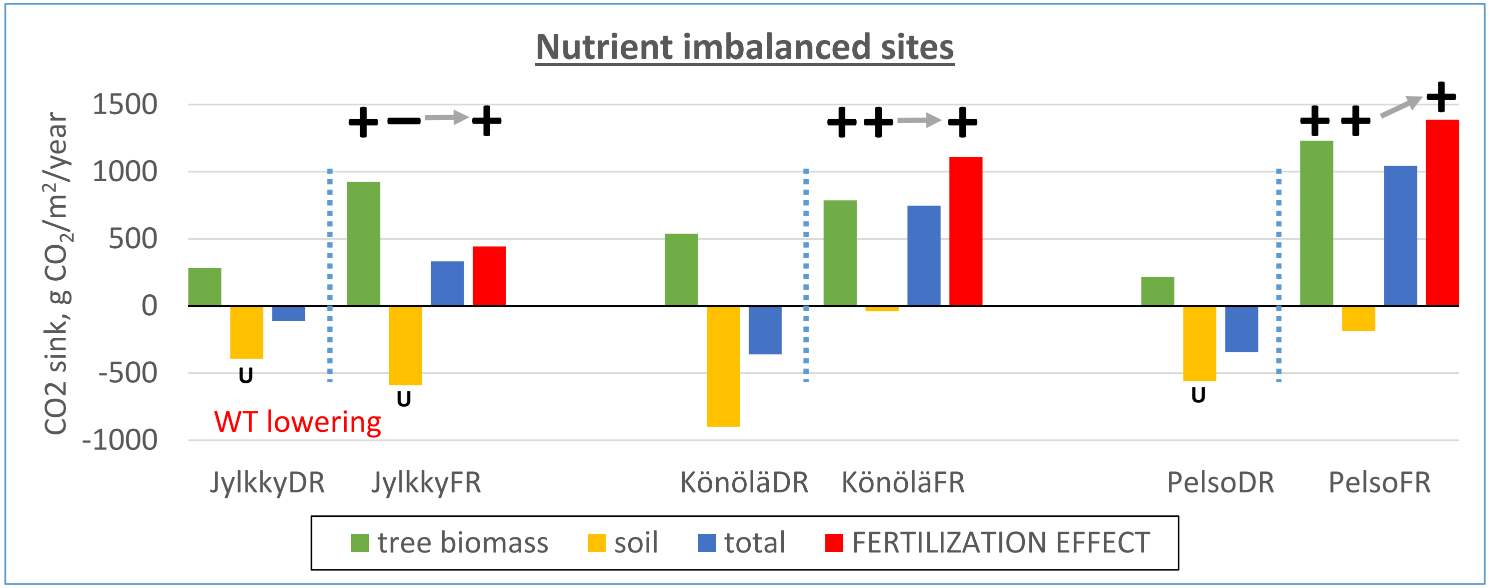
WT lowering

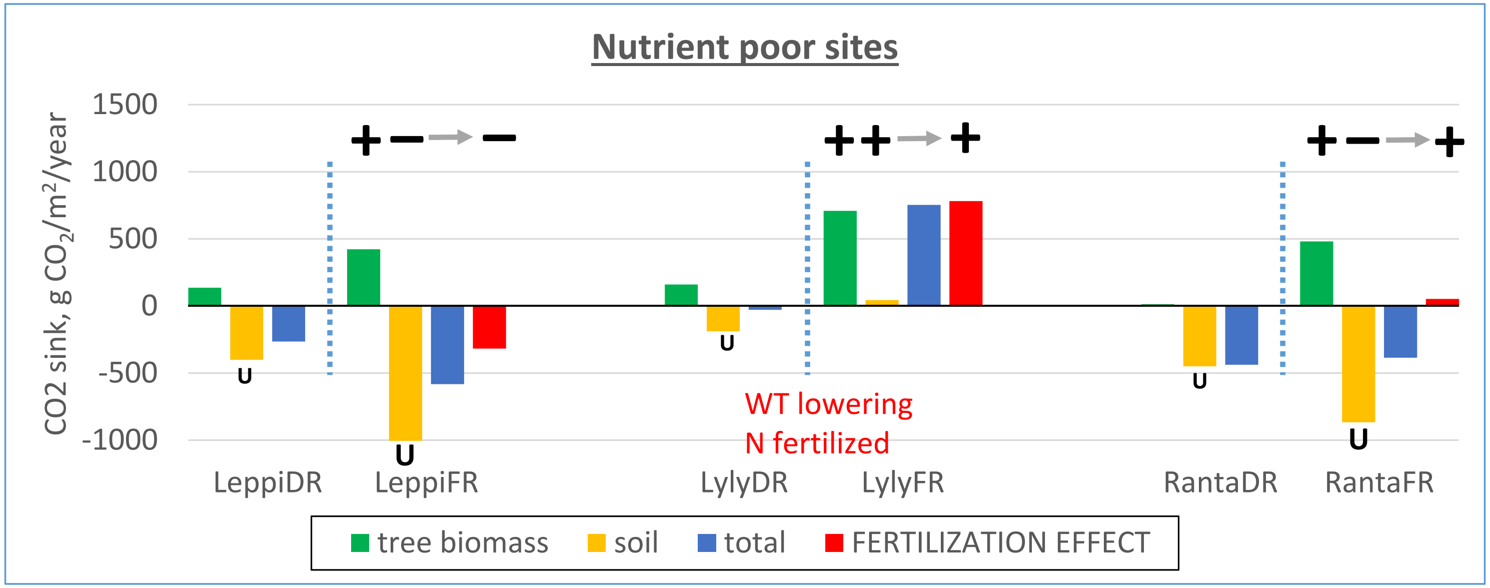


N fertilized
WT lowering

Total CO_2 effect

5/6: increasing CO_2 sink
3/6: even soil CO_2 source decreases

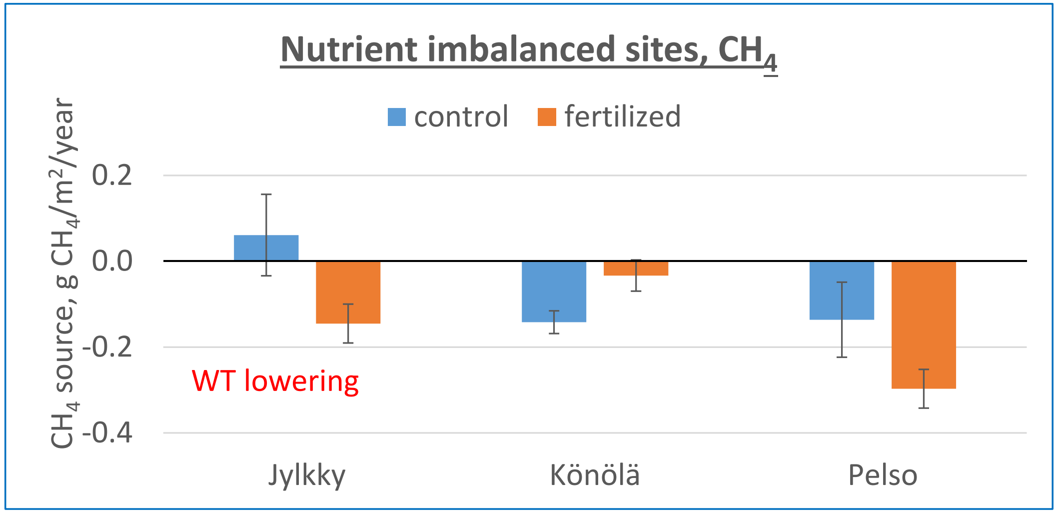


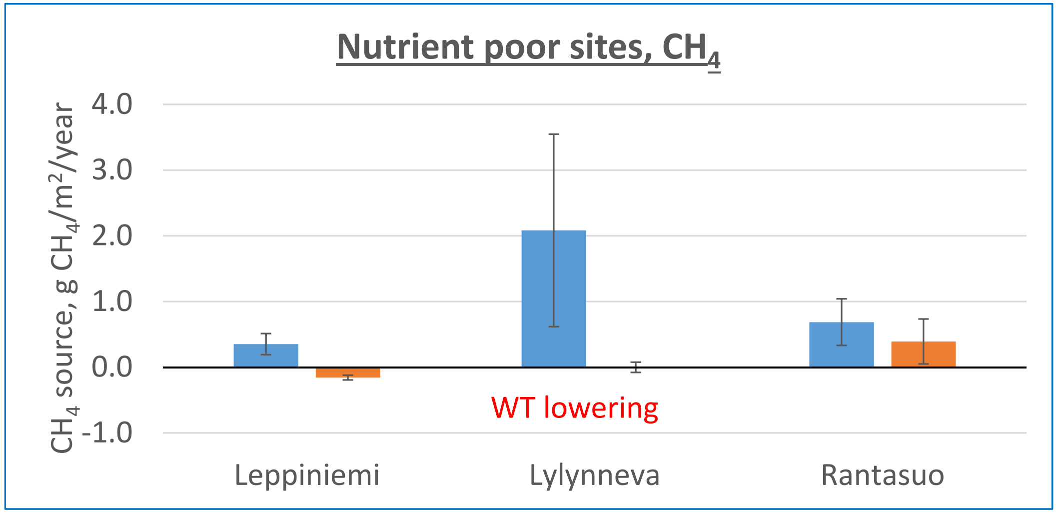


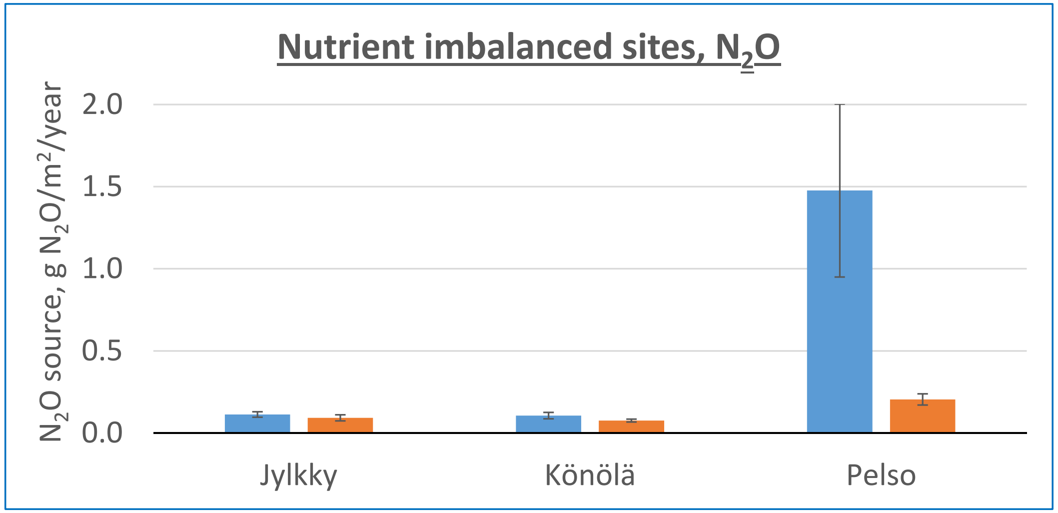
U = some underestimation due to missing litter production of vascular ground vegetion

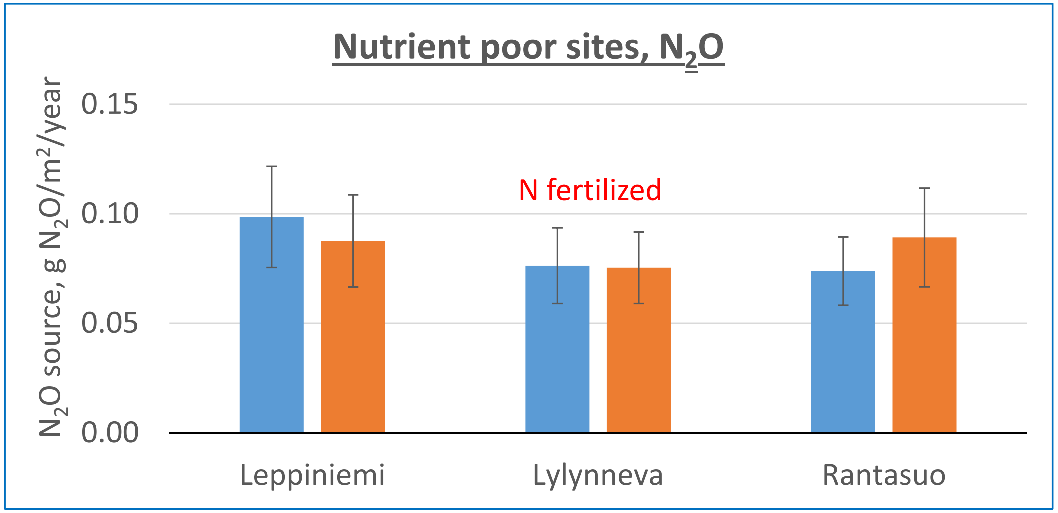
Method: closed chamber measurements, 6 measurement points/site (d = 30 cm), vegetation intact

CH_4 and N_2O

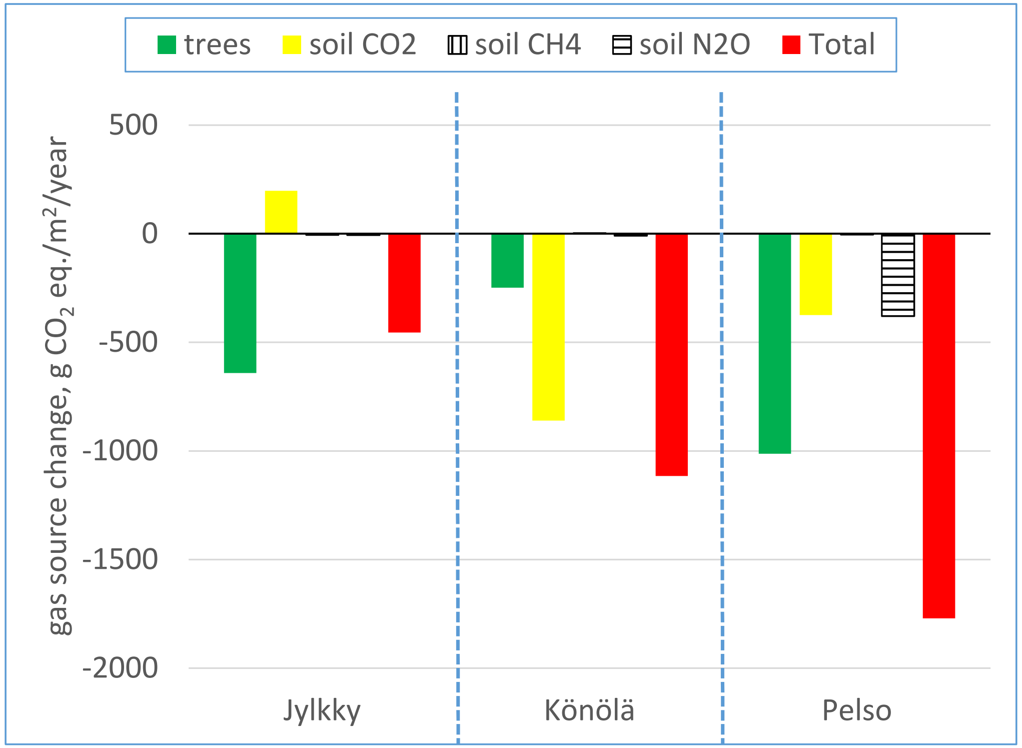


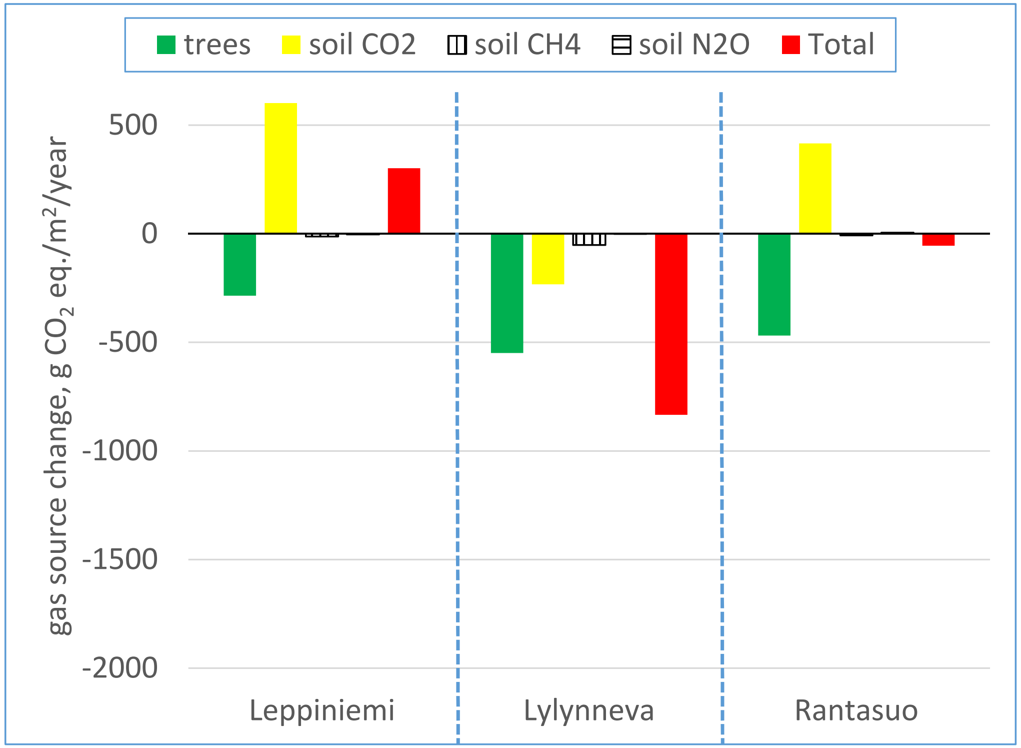






Total everything (GWP100, CO2 equivalents)





Conclusions – long term effects of fertilization

- N_2O emissions did not increase
- At originally wet sites, CH_4 emissions can decrease

- Improved tree growth causes a considerabe CO_2 sink
  - This can be offset by increase in soil CO_2 source
    nutrient poor sites at risk?
    N fertilization inhibits decomposition?

- Fertilization has potential for climate-friendly management option
  - **RISK OF SOIL CARBON LOSS**