The potential of global peatland rewetting for climate change mitigation

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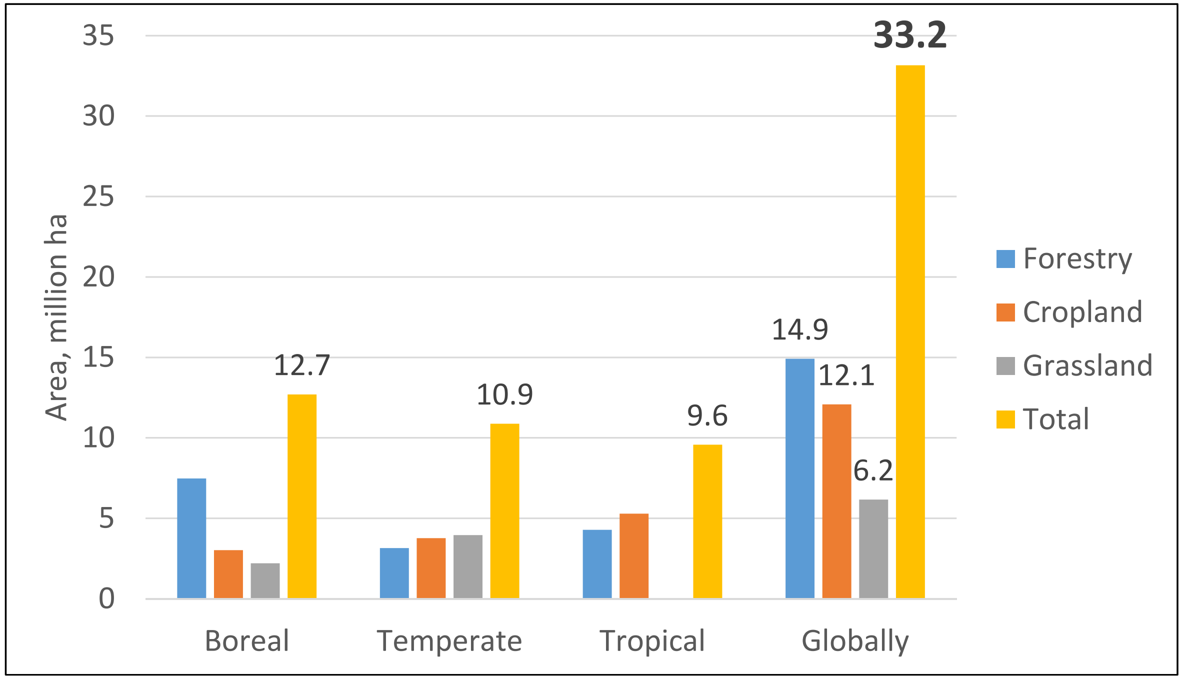
Peatlands, drainage and climate

- Peatlands have accumulated a huge carbon (C) storage as peat
  - ca. 500–600 Pg C (vs. 800 Pg C in the atmosphere)
- Peat C storage is vulnerable
  - high water table (WT) protects the C storage
  - land-use typically means lowering of WT by drainage (ditching)
    => gradual loss of peat C
- **1.** Peat C storage needs to be actively protected
  - careless land-use can lead to a big increase in the atmospheric C content
    => long-term (centennial) climate goals require peatland protection
- **2.** Greenhouse gas emissions need to be reduced
  - peatlands have been drained for agriculture and forestry
  - drainage causes CO_2 and N_2O emissions from soil to the atmosphere
    => short-term (decadal) climate goals require emissions reductions

Area **estimate** of drained peatlands



Equals to
- 2‰ of the Earths land area
- ca. 7% of the Earths peatland area

Rather conservative estimates based mainly on National Inventory Submissions 2017 for boreal (6 countries) and temperate (29 countries) climate zones.

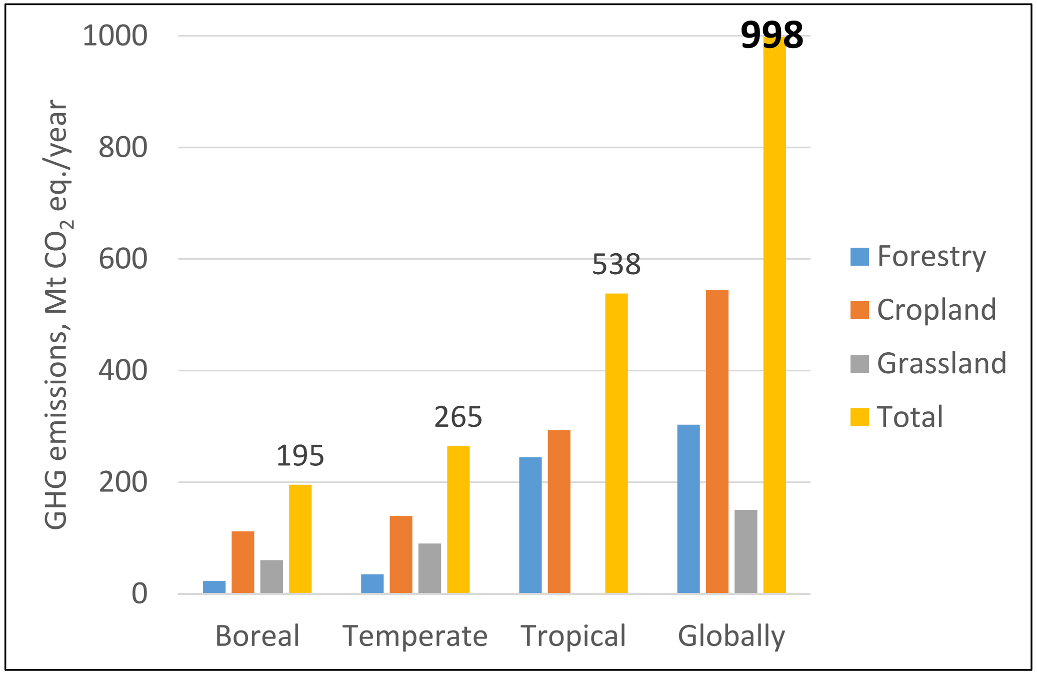
Other sources: Renou-Wilson et al. 2018 & David Wilson (Ireland), Chris Evans & Rebekka Artz (Great Britain), Andis Lazdiņš (Latvia), Björn Hånell (Sweden), Lise Dalsgaard (Norway), Kristiina Regina (Finland), Yearbook Forest 2016 (Estonia)

For the tropical zone, Malaysia, Indonesia and China are included, sources: Miettinen et al. (2016), Jyrki Jauhiainen and Strack et al. (2008)

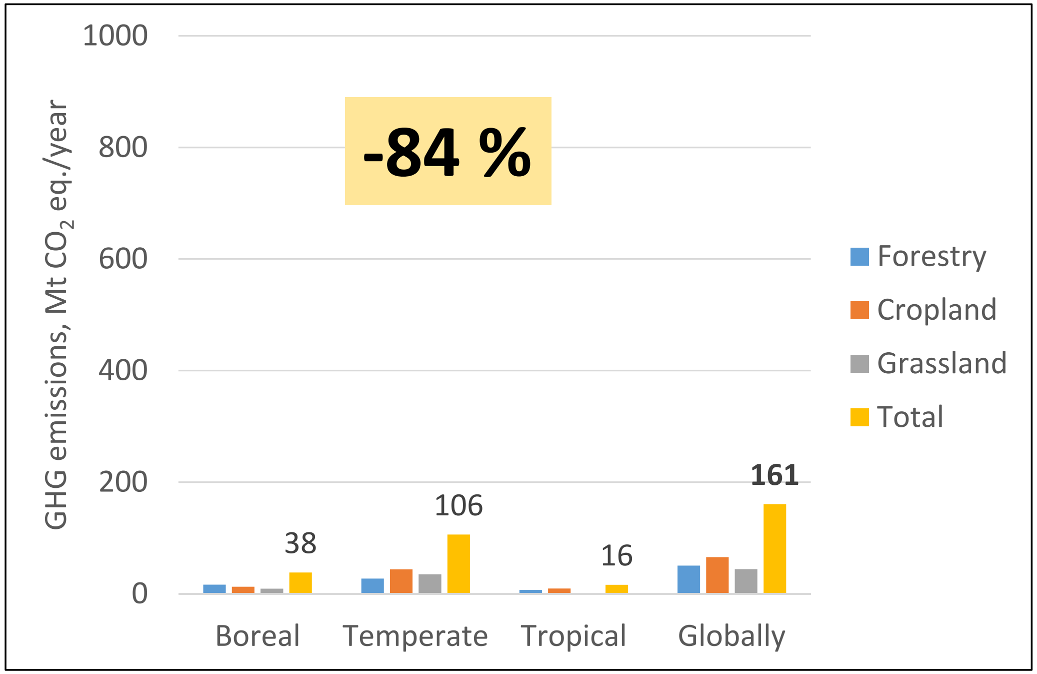
Emissions from **soil** in CO_2 equivalents (GWP_{100})

(based on IPCC (2014) emission factors for CO_2, CH_4 and N_2O updated by Wilson et al. 2016 for rewetted soils)

At the current, drained state



If rewetted



Huge emissions (ca. 25% of LULUCF) that could be greatly reduced!

Time for action?

- Let's rewet all the drained peatlands
- It's not easy, but we can do it in maybe 20 years if we really try

- Let's calculate the effect on climate!
  - instead of drained peatlands we have an increasing area
    of rewetted peatlands continuously exchanging greenhouse gases
    between soil and the atmosphere

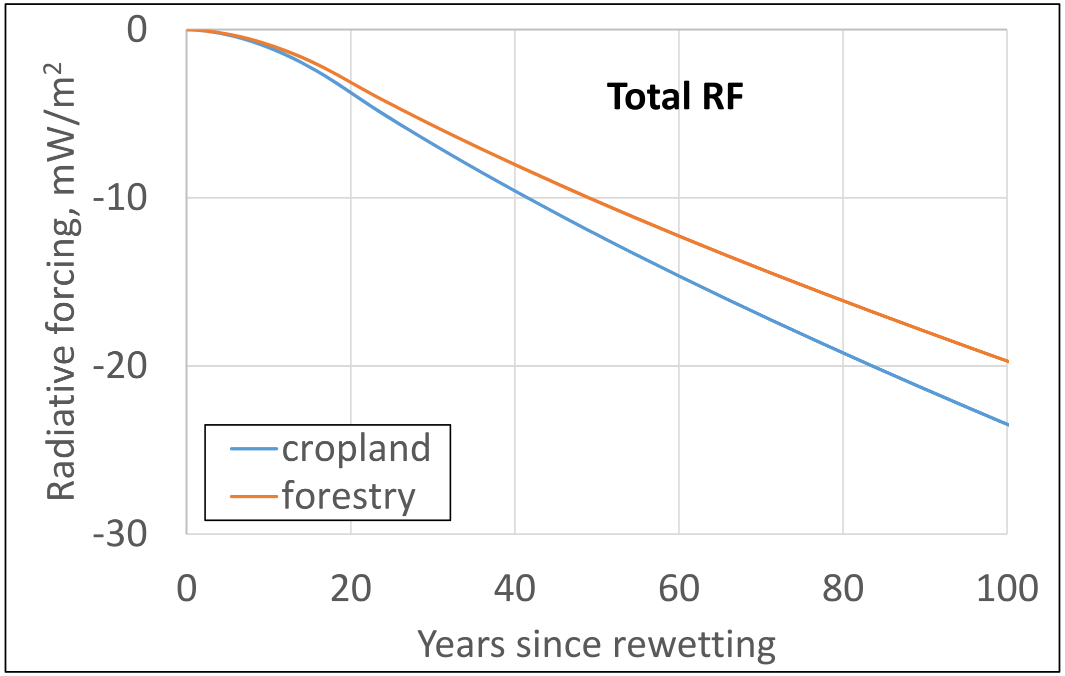
Radiative forcing scenarios for rewetting soils

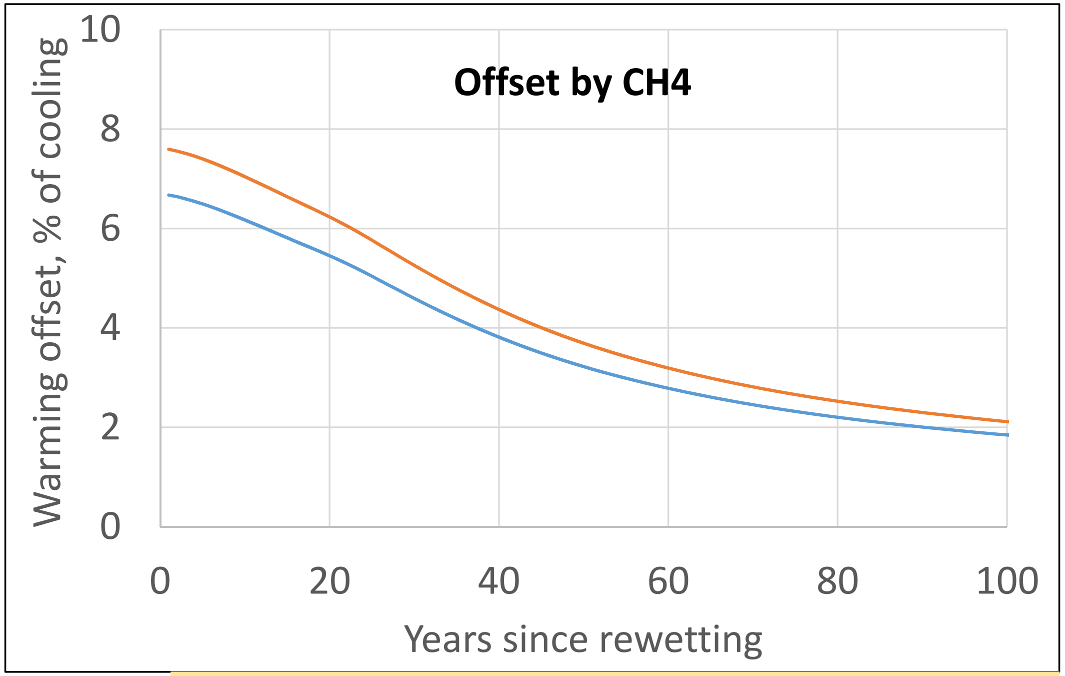
- GWP_{100} does not reveal the temporal dynamics of the effect on climate
- need to calculate radiative forcing time series
- different gases have different radiative efficacies and lifetimes (Myhre et al. 2013)
- **increasing CH_4** emissions offset part of the **decreasing CO_2 and N_2O** emissions

Gas	Total radiative efficacy 10^{-13} W m^{-2} kg^{-1}
CO2	0.0176
CH4	2.11
N2O	3.58

Atmospheric lifetime	
Gas	Half-life (years)
22% of CO2	∞
22% of CO2	273
28% of CO2	25
27% of CO2	3
CH4	9
N2O	84

Rewetting of **tropical peatlands**

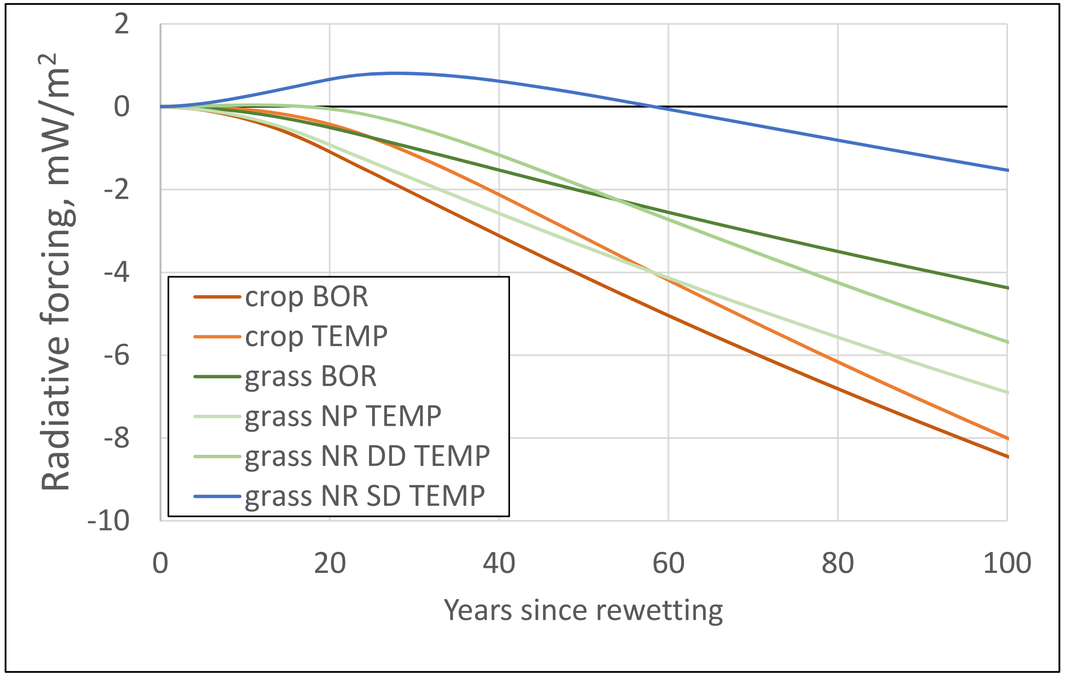


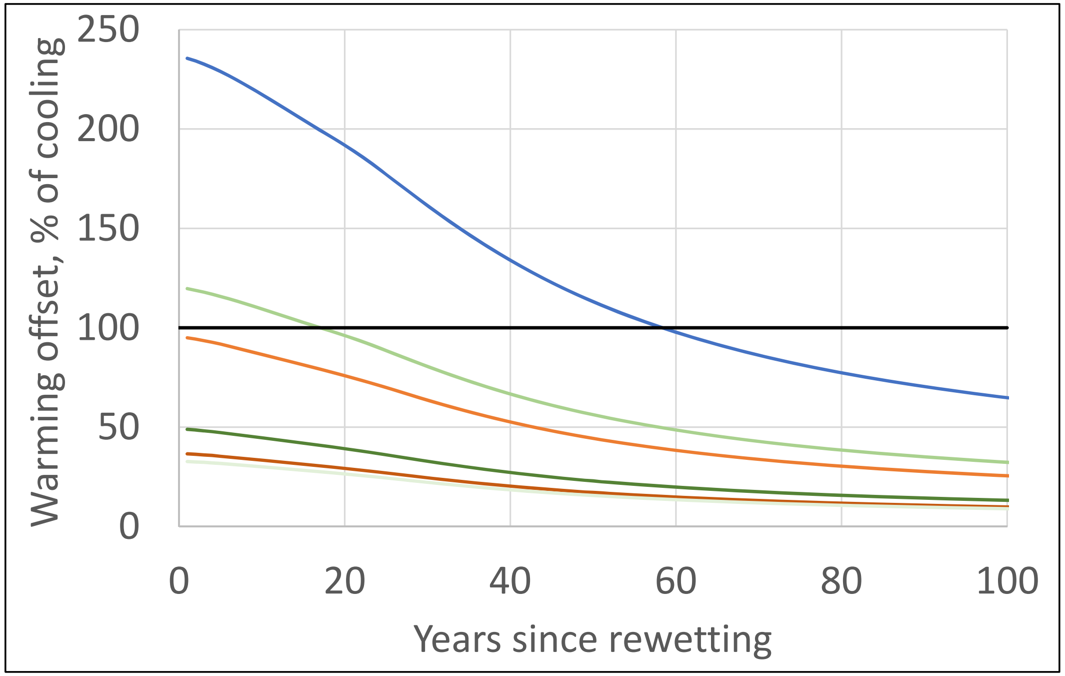


Warming offset, % = -RF(CH_4)/RF(CO_2+N_2O)×100

We can safely promise immediate climate cooling!

Boreal and temperate **grassland and cropland**

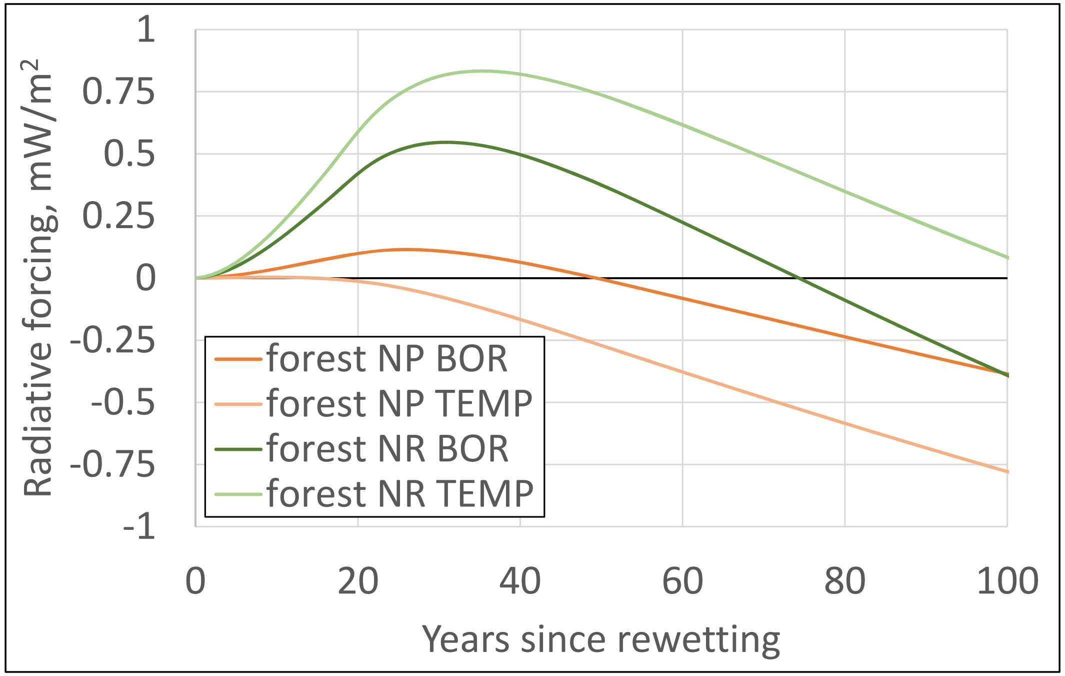


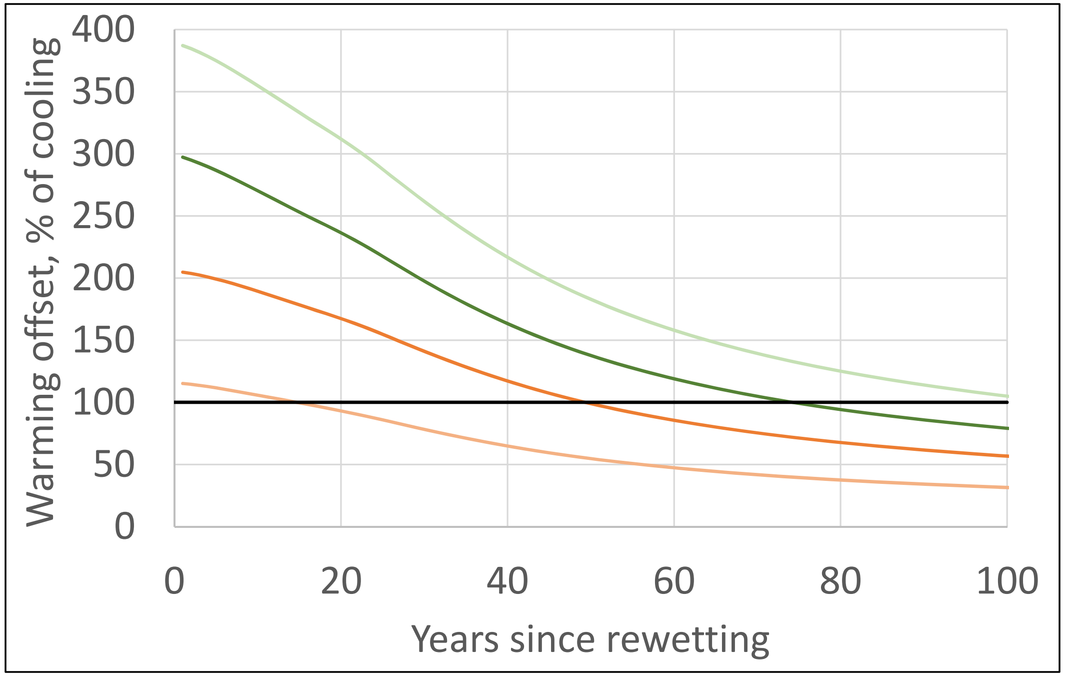


Mostly cooling or no effect in the beginning!

NP/NR = nutrient poor/rich, DD/SD = deep/shallow drainage, BOR/TEMP = boreal/temperate

Boreal and temperate **forest**

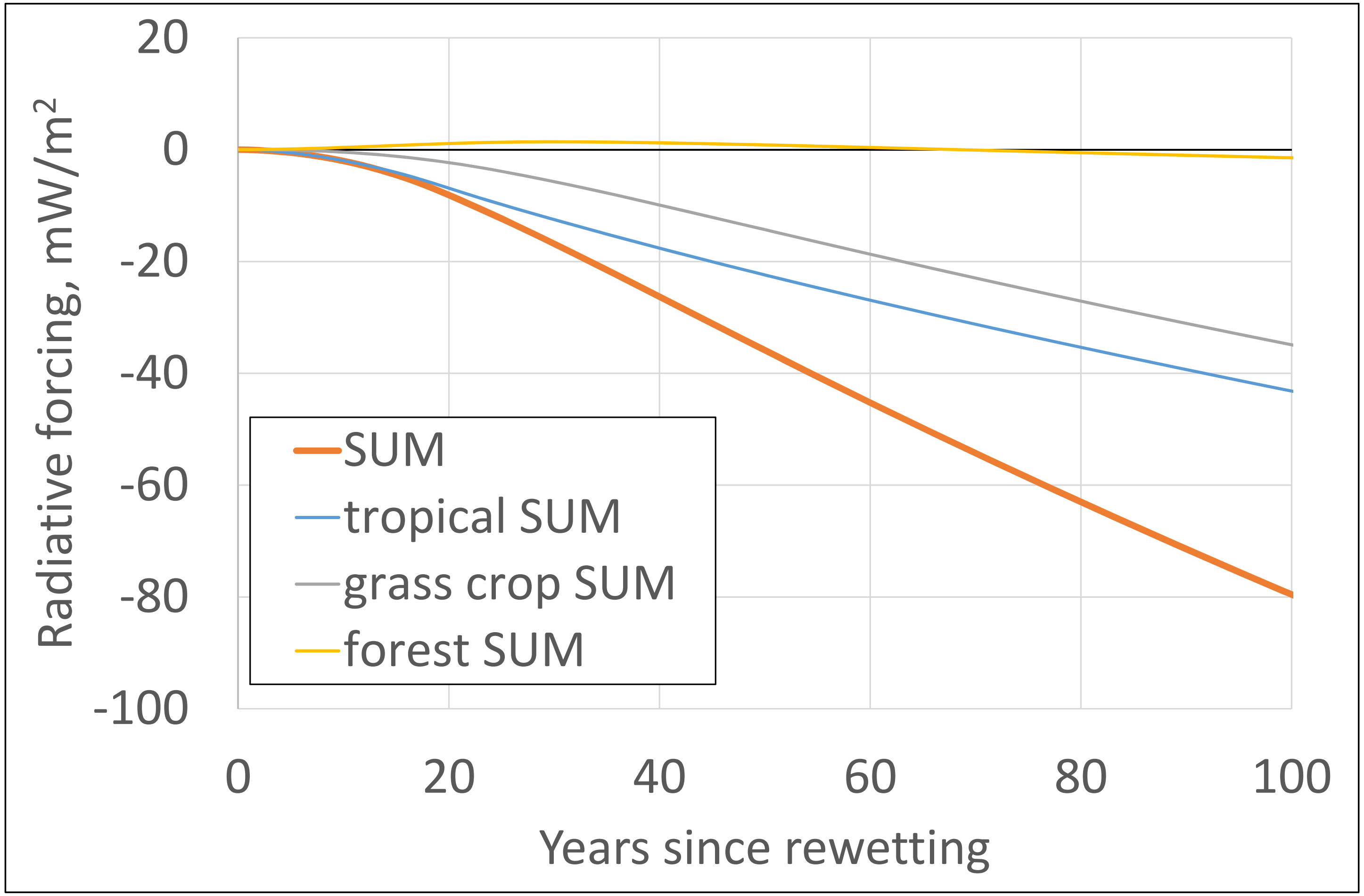




Mostly warming or no effect for the first decades!

NP/NR = nutrient poor/rich BOR/TEMP = boreal/temperate

Total effect



Tropical peatlands and cropland and grassland important goals for rewetting!
Boreal and temperate forestry-drained peatlands have negligible effect.

But not everything is negligible in the forest!

Average tree growth/standing stock at Finnish (**boreal**) forestry-drained peatlands
(National Forest Inventory, biomass expansion factor 0.7 Mg dry weight /m^3 stem volume (Lehtonen et al. 2004))

	stem volume		CO_2 sink/storage in(to) tree biomass
Tree growth	2–7.5 m^3/ha/year	=>	2.6–9.6 t/ha/year
Standing stock	70–240 m^3/ha	=>	90–307 t/ha

On the total area of boreal and temperate forestry-drained peatlands (10.6 Mha):

	CO_2 sink/storage	vs. Emission reduction (GWP_{100}) by rewetting
Tree growth	28–102 Mt CO_2/year	14 Mt CO_2/year (14–50% of tree growth)
Standing stock	740–2550 Mt CO_2	14 Mt CO_2/year (50–180 years)

Trees beat the peat in the decadal time scale!

Conclusions

- At tropical peatlands, succesful rewetting both protects peat C and causes immediate climate cooling => **go for it!**
- At boreal and temperate grasslands and croplands, succesful rewetting protects peat C and is mostly cooling or has no effect in the beginning => **reasonable!**
- At boreal and temperate forests, succesful rewetting protects peat C but is mostly warming or has no effect in the beginning => **questionable!**
    - Just letting trees to grow could be better in the decadal time scale!
    - Sacrifice the topmost peat layer for the short-term emission reduction?
    - Can we rewet and still keep a well-growing tree stand?

Literature

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