FACULTY OF SCIENCE
Charles University

Akumulace uhlíku ve výsypkových půdách: potenciál, dynamika, stabilita a optimální cílový stav

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Carbon accumulation in post-mining soils: potential, dynamics, stability and optimal target state

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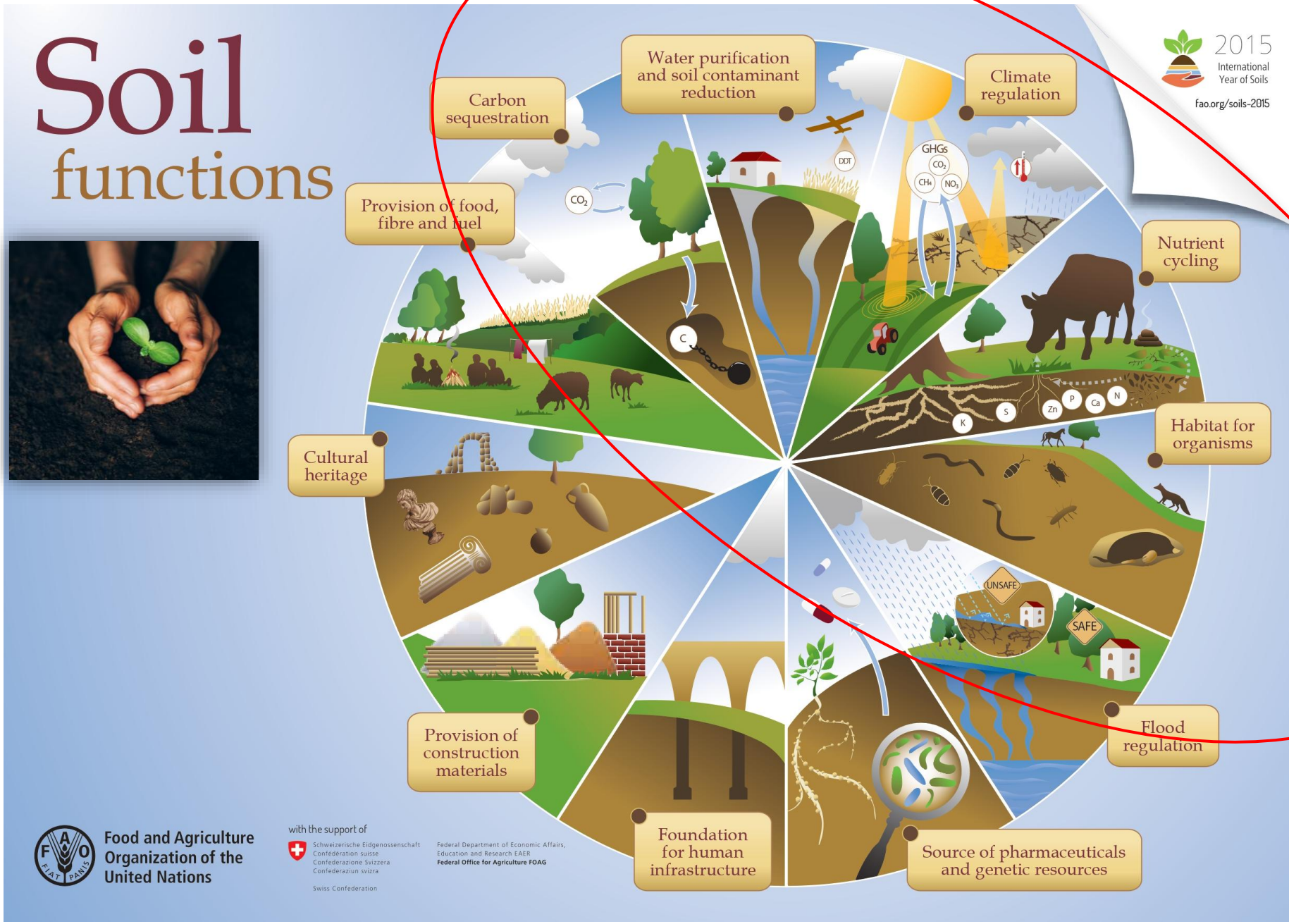
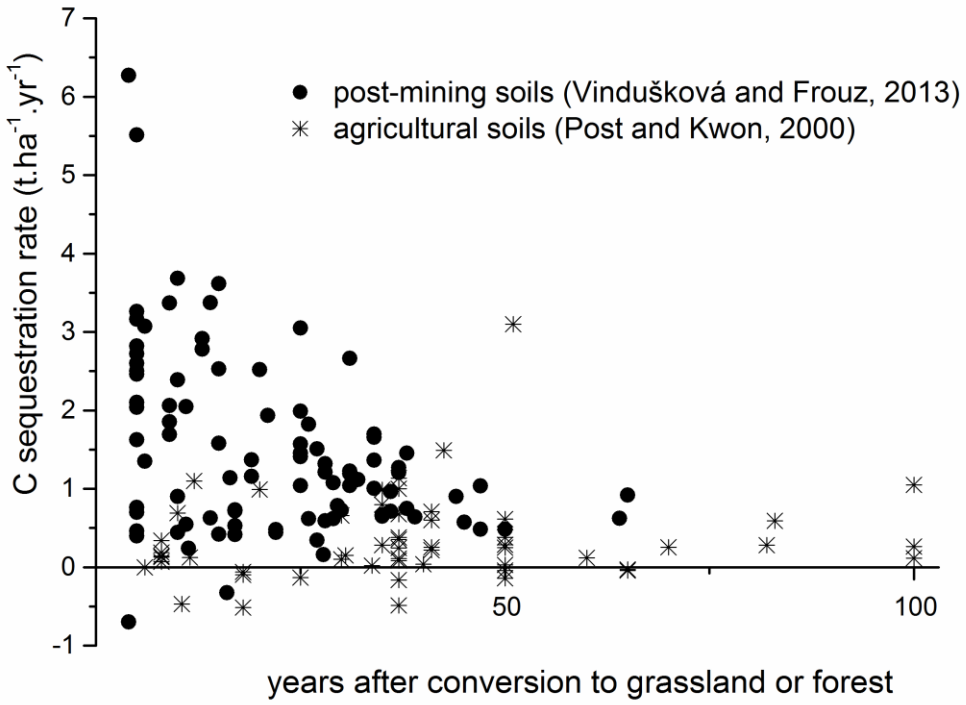
Soil organic carbon

- SOC contributes to several soil functions

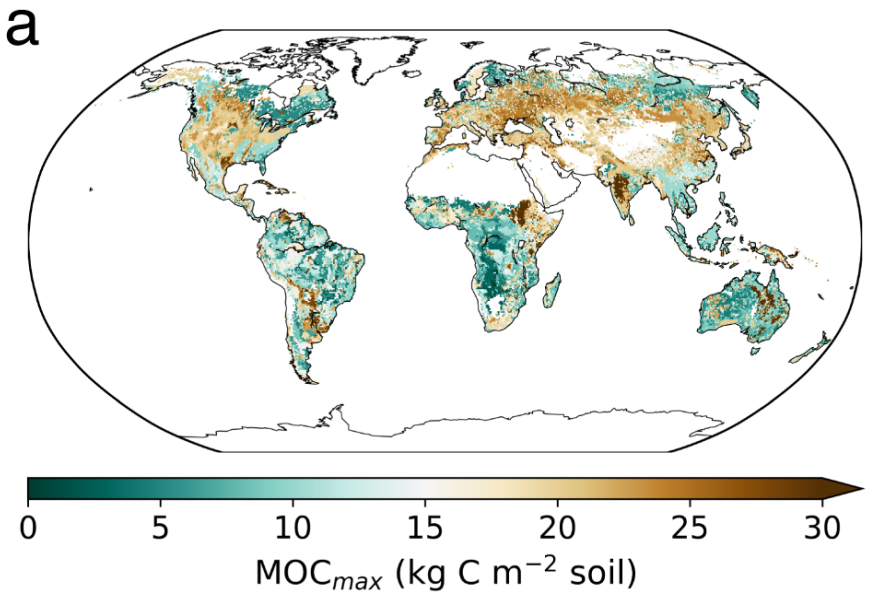


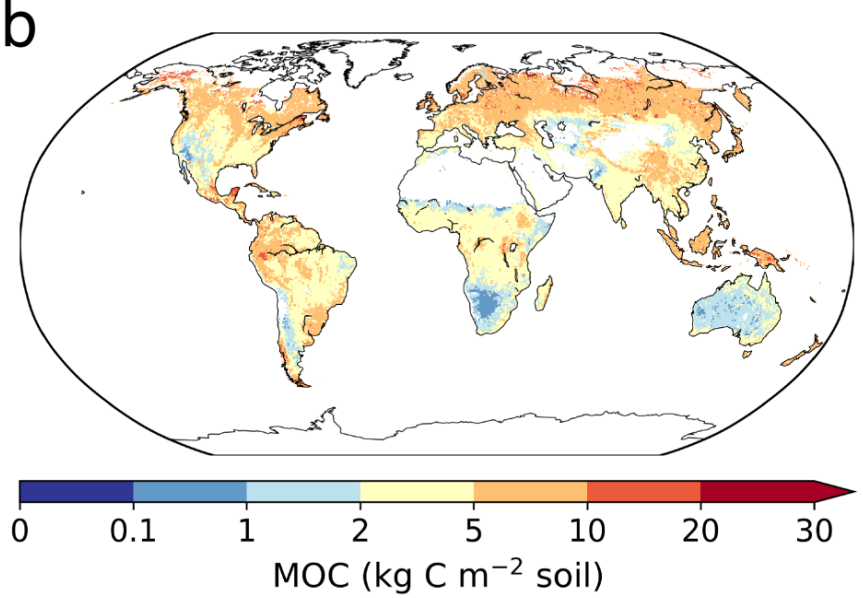


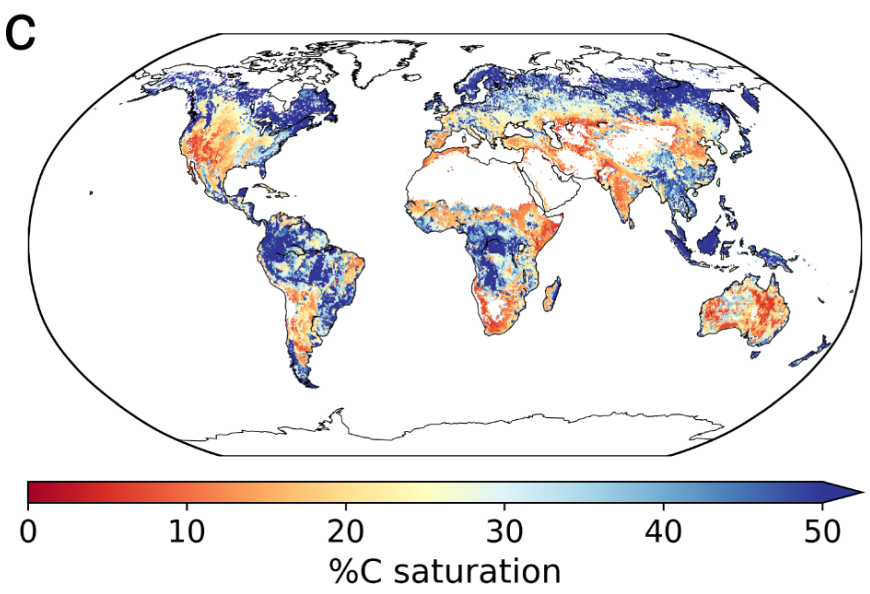
Mine soils can sequester more C than abandoned agricultural soils.

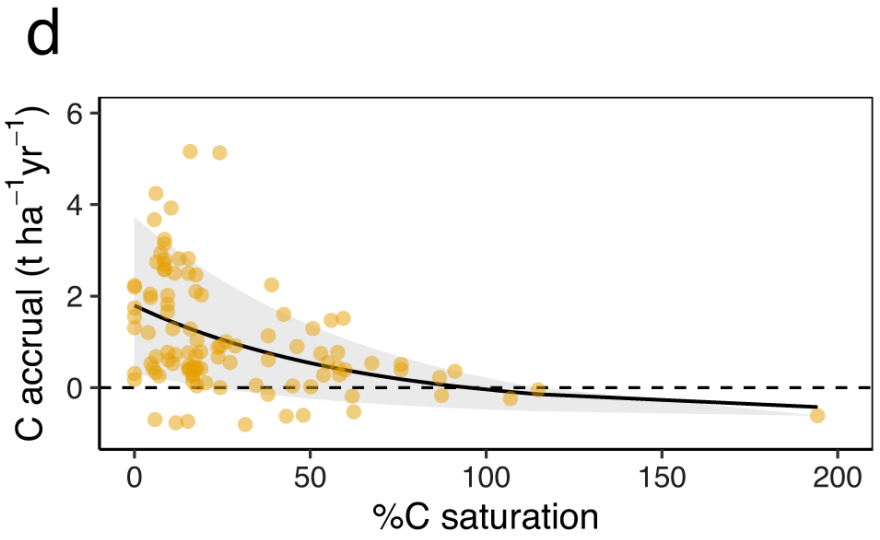
- **fossil (geogenic) organic C**
- **no recent SOC**
- **lack of nutrients, biological activity and soil structure**

Vindušková & Frouz, 2013. Environ. Earth Sci.
Frouz & Vindušková, 2018. In: Munoz, M., Zornoza, R. (Eds.) Academic Press





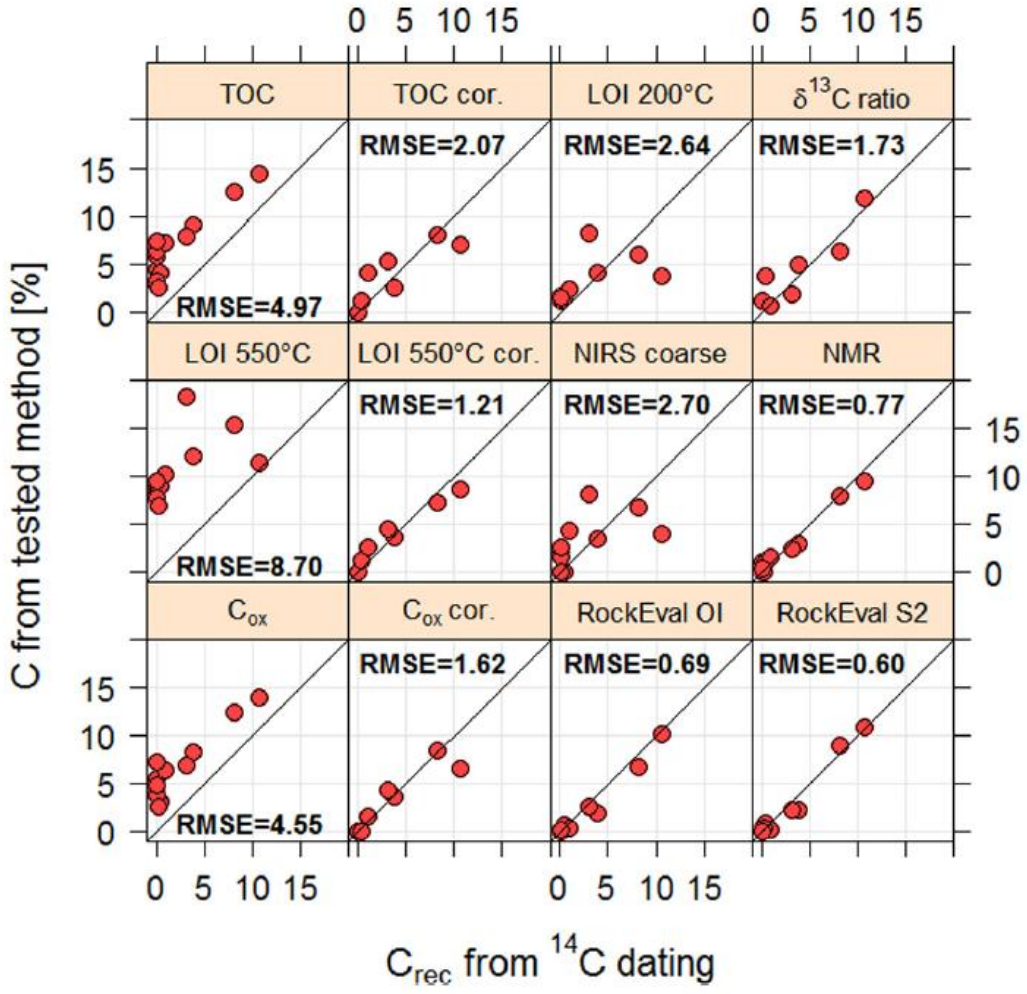




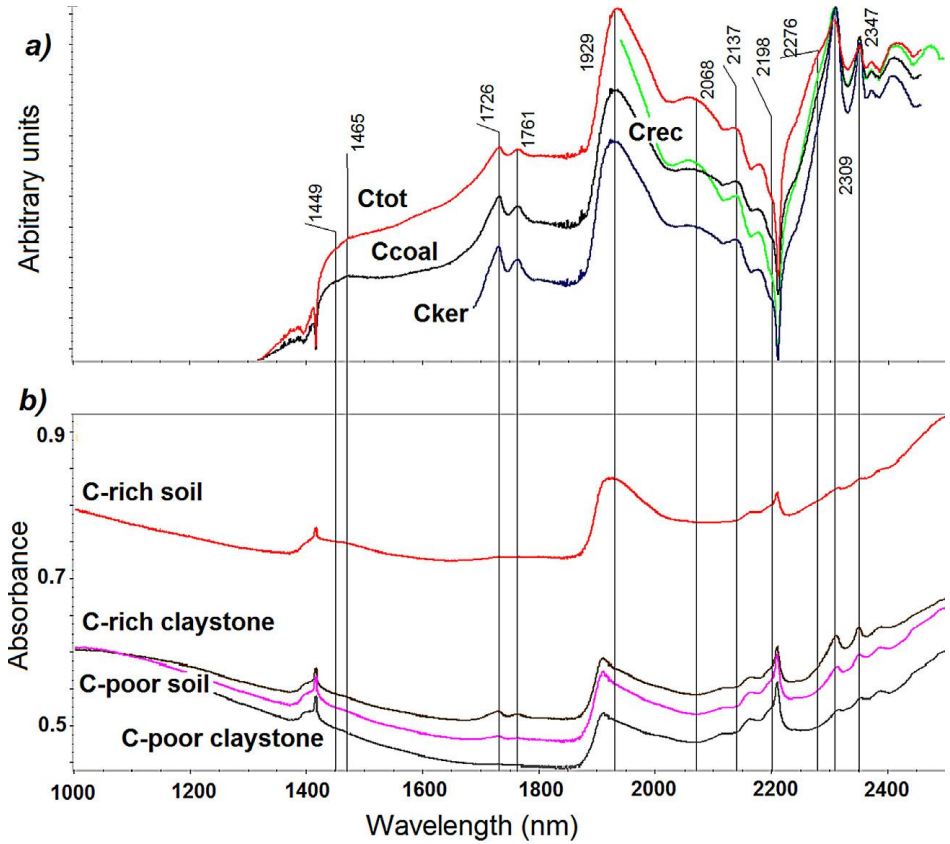
Less (MAOM-)saturated soils store C faster.

Georgiou et al. 2022

Distinguishing recent SOC from geogenic C…



Vindušková et al. 2015



Vindušková et al. 2014

...and also from inorganic carbon

- less common carbonates, such as dolomite or siderite
- little or no effervescence upon dripping of HCl (XRD needed)
- reaction with acid is slower => different pre-treatment required

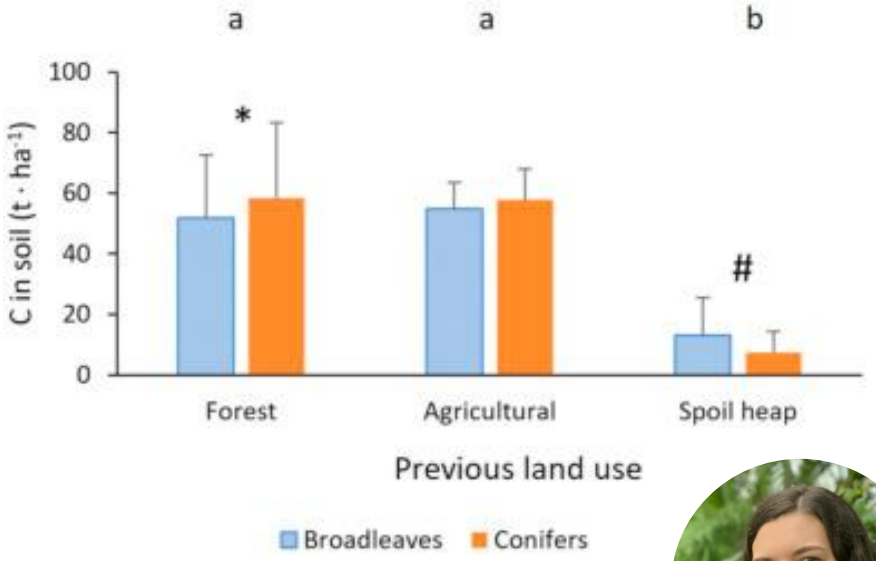
Vindušková et al. 2019. J. Plant Nutr. Soil Sci.

Role of vegetation may be time-dependent

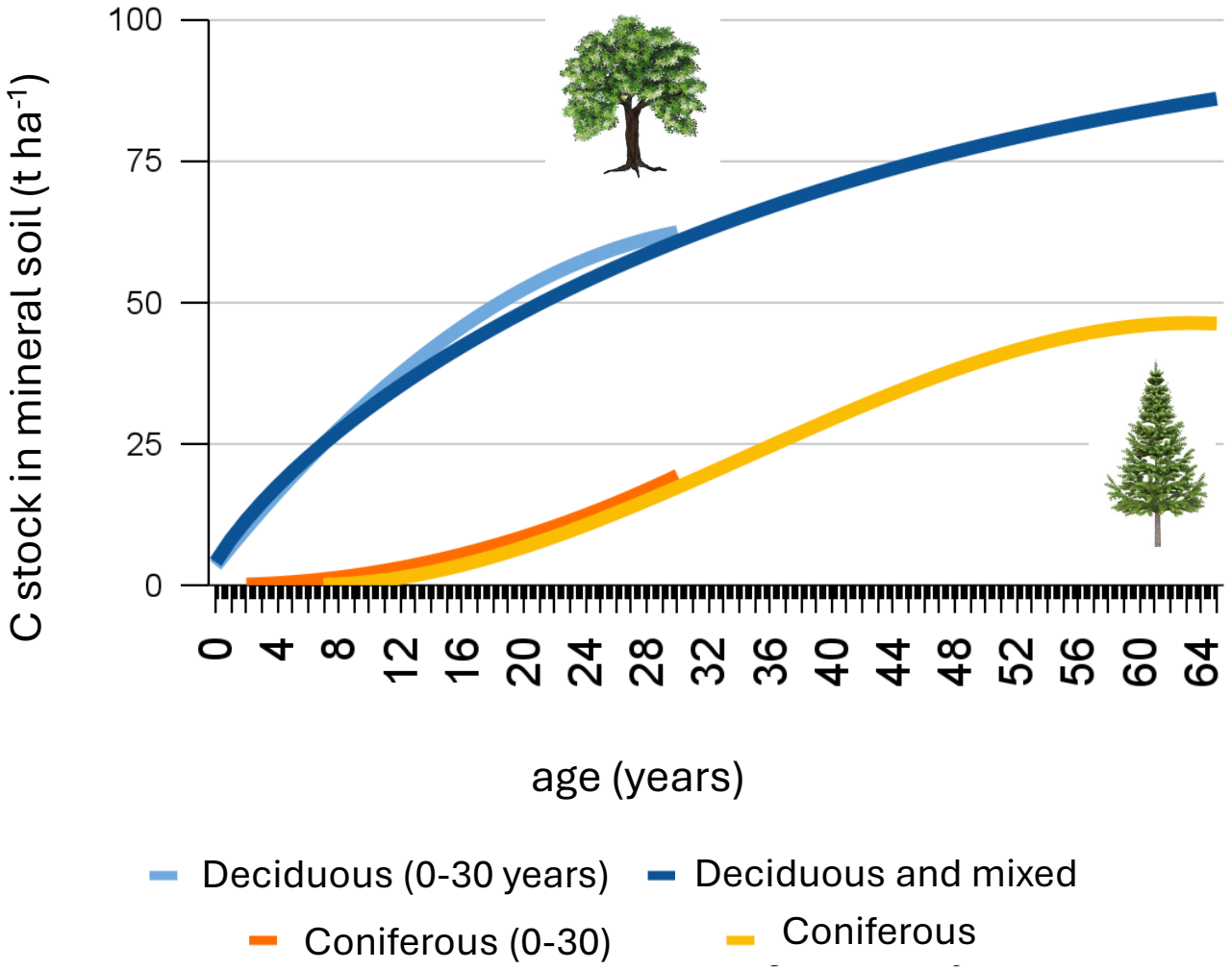
20-30 year old soils, Sokolov:

deciduous trees > conifers

Frouz et al., 2009. Biogeochem.

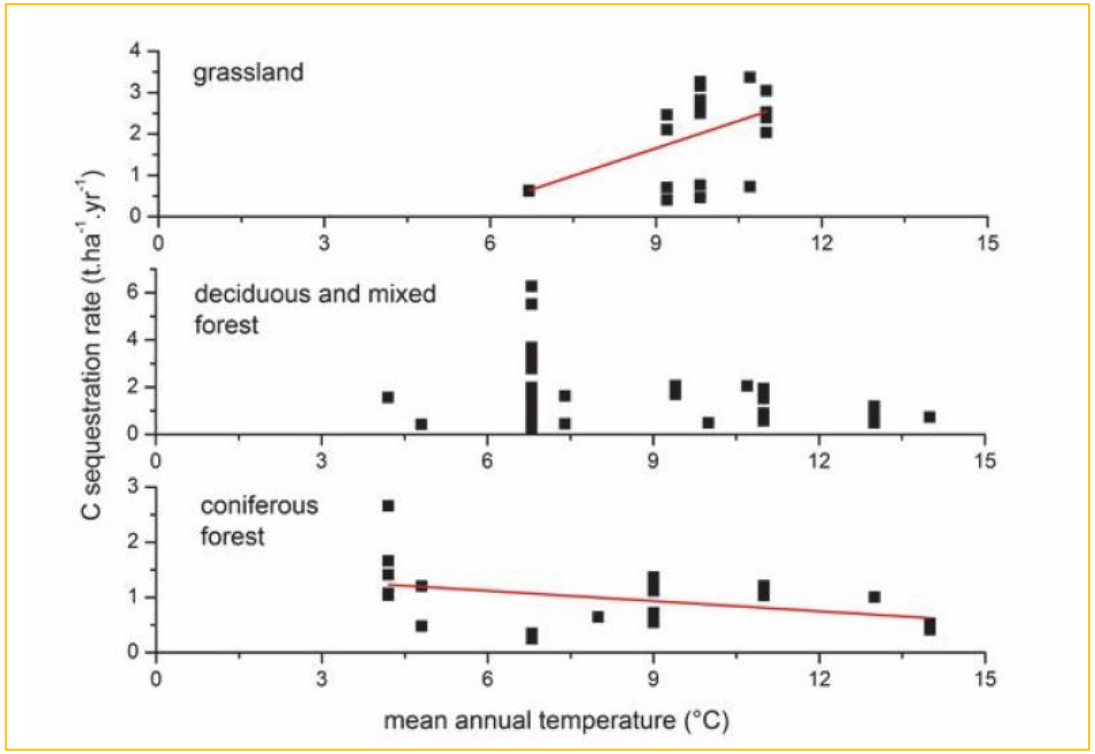


Hüblová a Frouz, 2021. J. Env. Manag.



Based on data from Vindušková & Frouz, 2013. Environ. Earth Sci.

Also climate may play a role…

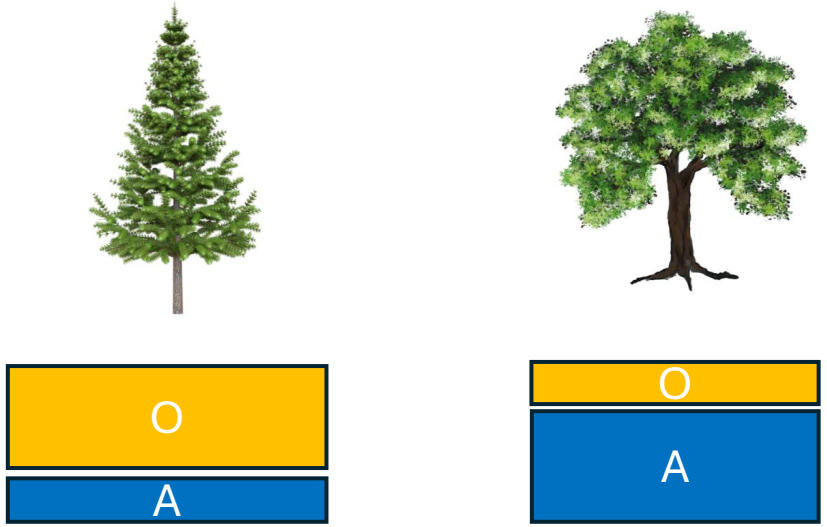


Higher C accrual under potential natural vegetation?

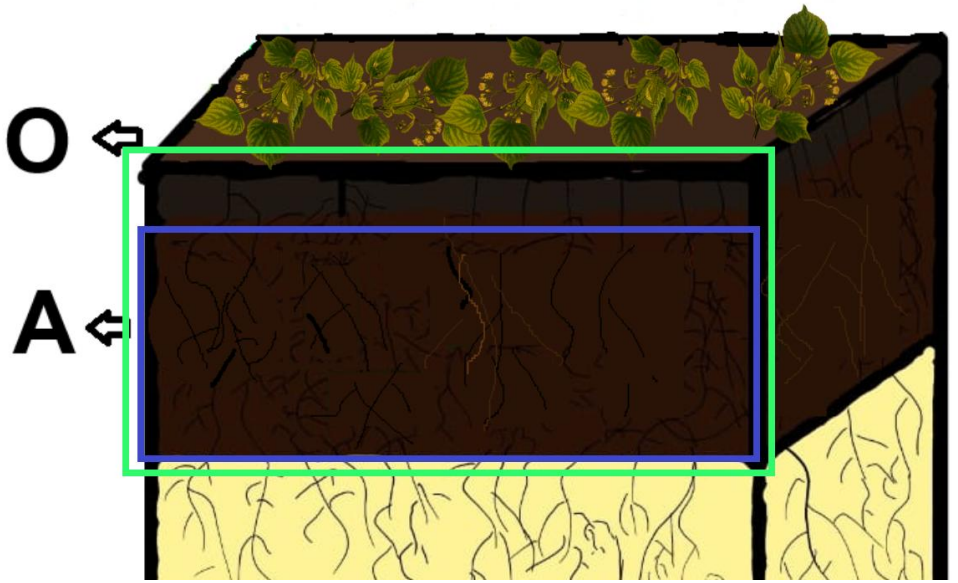
Vindušková & Frouz, 2013. Environ. Earth Sci.
Frouz & Vindušková, 2018. In: Munoz, M., Zornoza, R. (Eds.) Academic Press

SOC stability: vertical distribution

- C in O horizons less stable against disturbances (erosion, fire, clearcut) (Jandl et al. 2007)



Higher stability (MinC:TOC) under deciduous trees

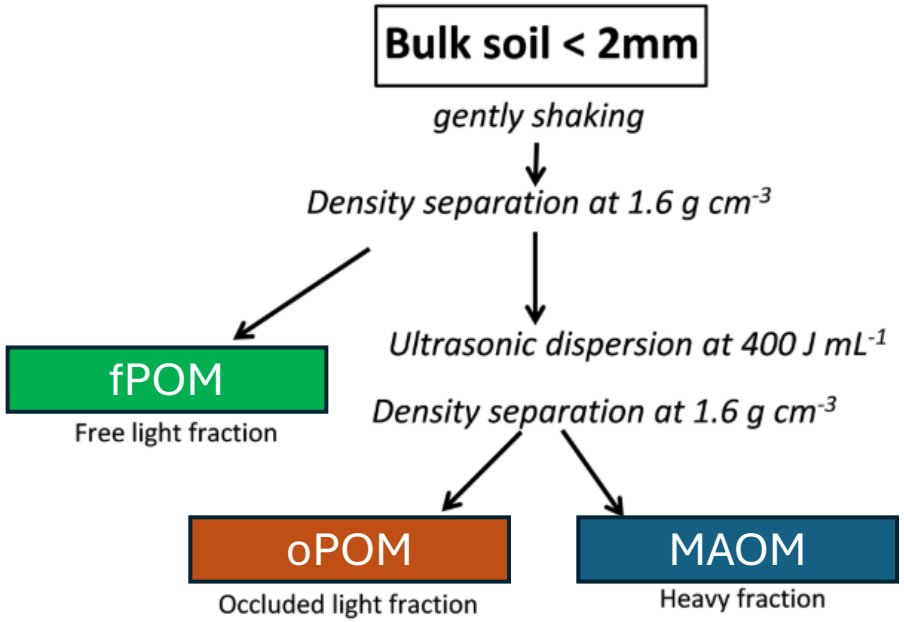


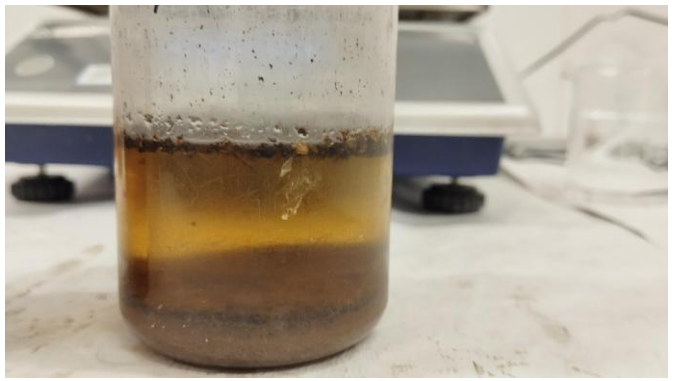
Credit: J. Haurová

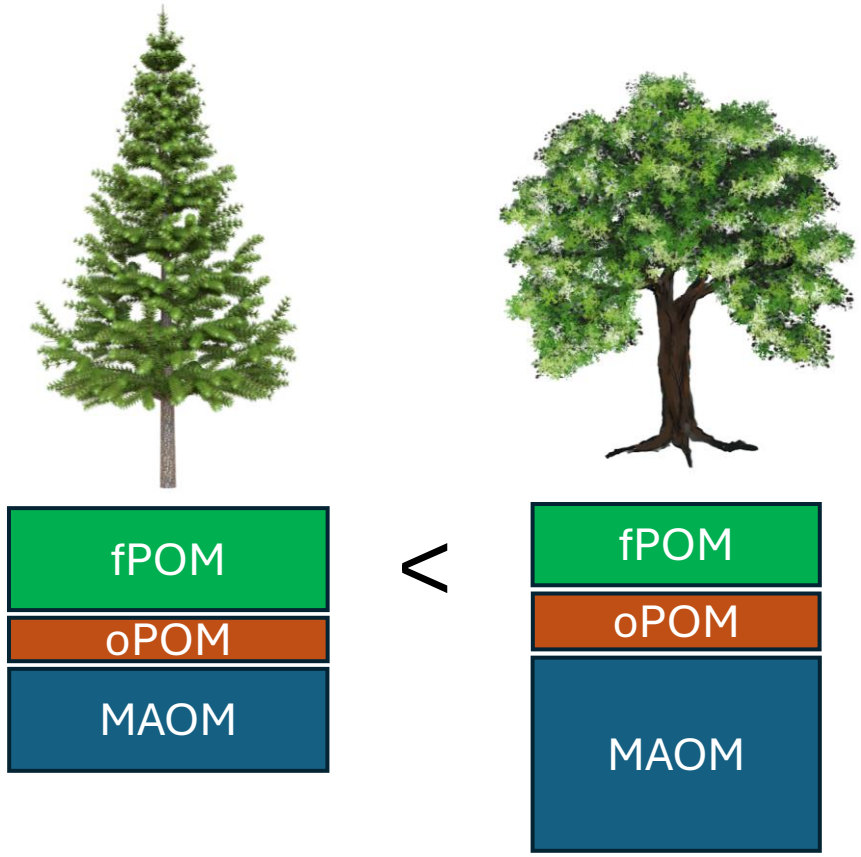
MinC:TOC = A/Total

Frouz et al. 2009, Vesterdal et al. 2013, Haurová (2015) MS Thesis

SOC stability: fractions in mineral soil

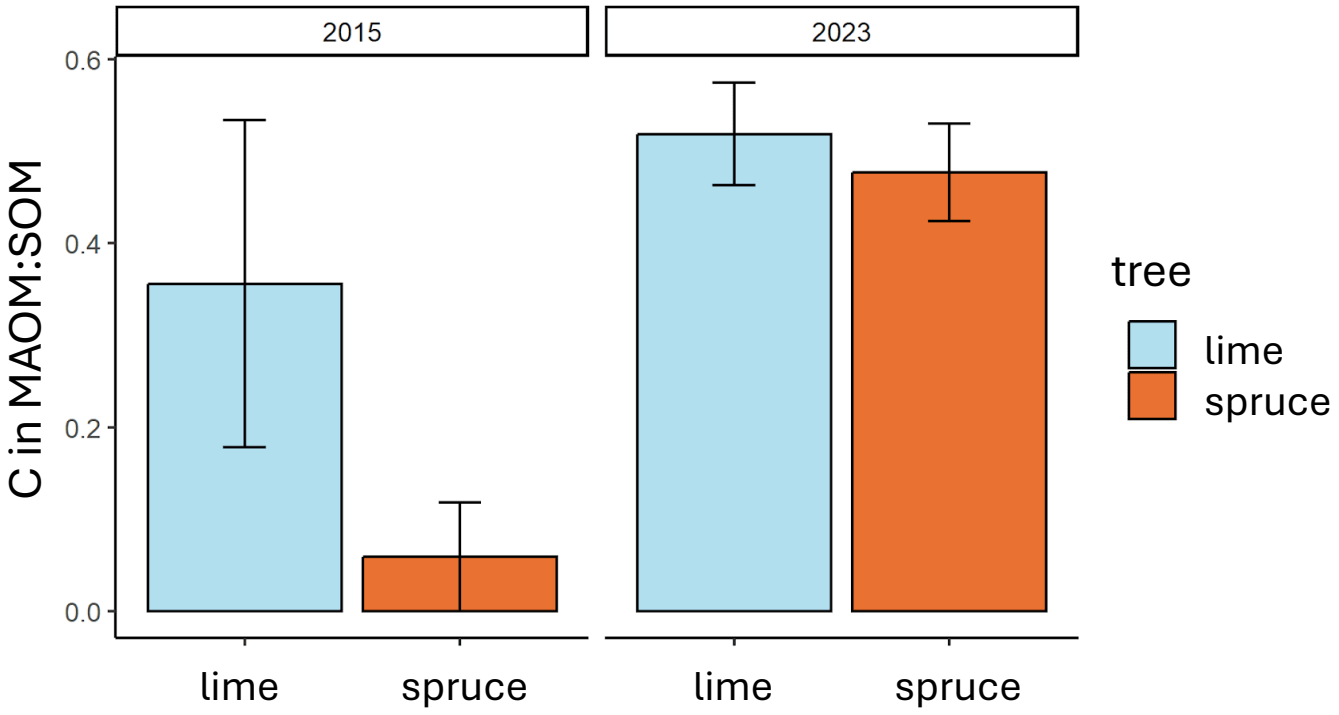


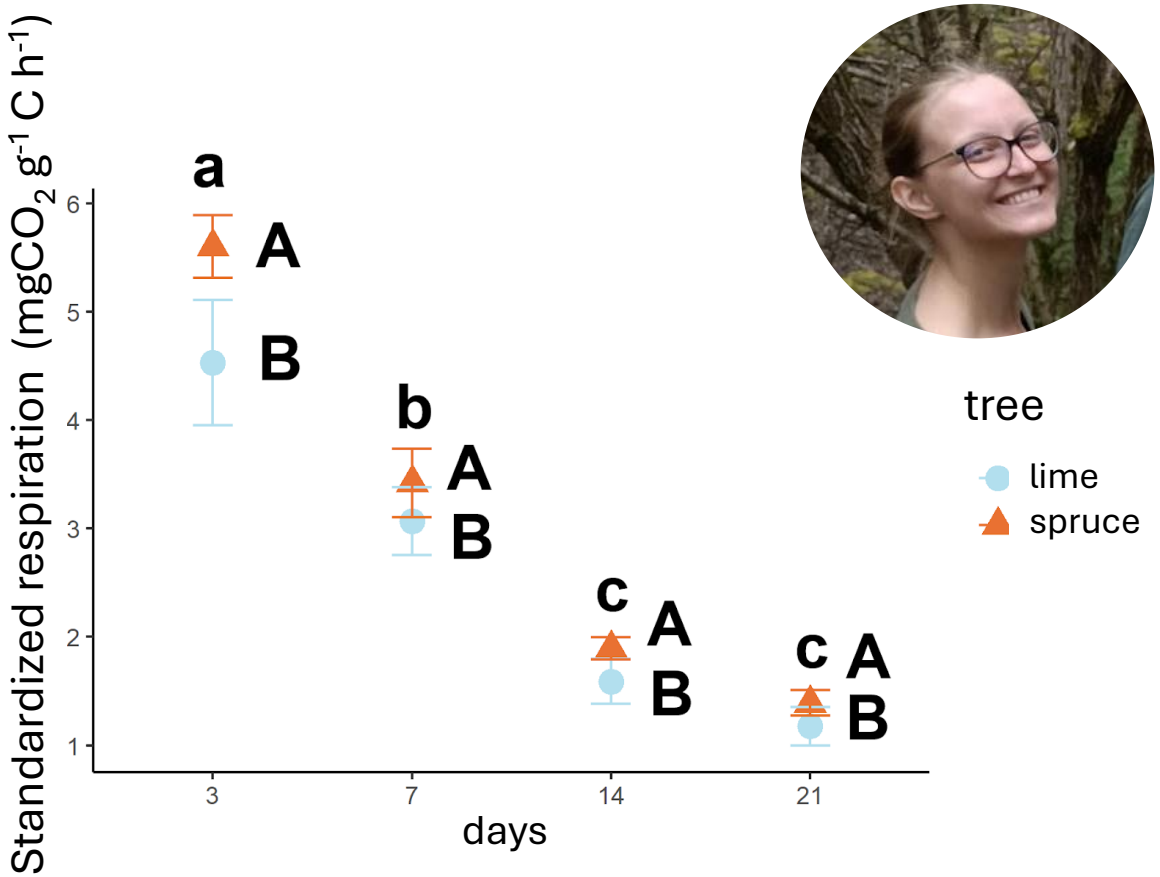




H: Deciduous trees store support higher MAOM:SOM ratio = higher C stability.

SOC stability: fractions vs. direct measurement





No effect of trees on MAOM:SOM ratio, but lower stability (higher basal respiration) under spruce.

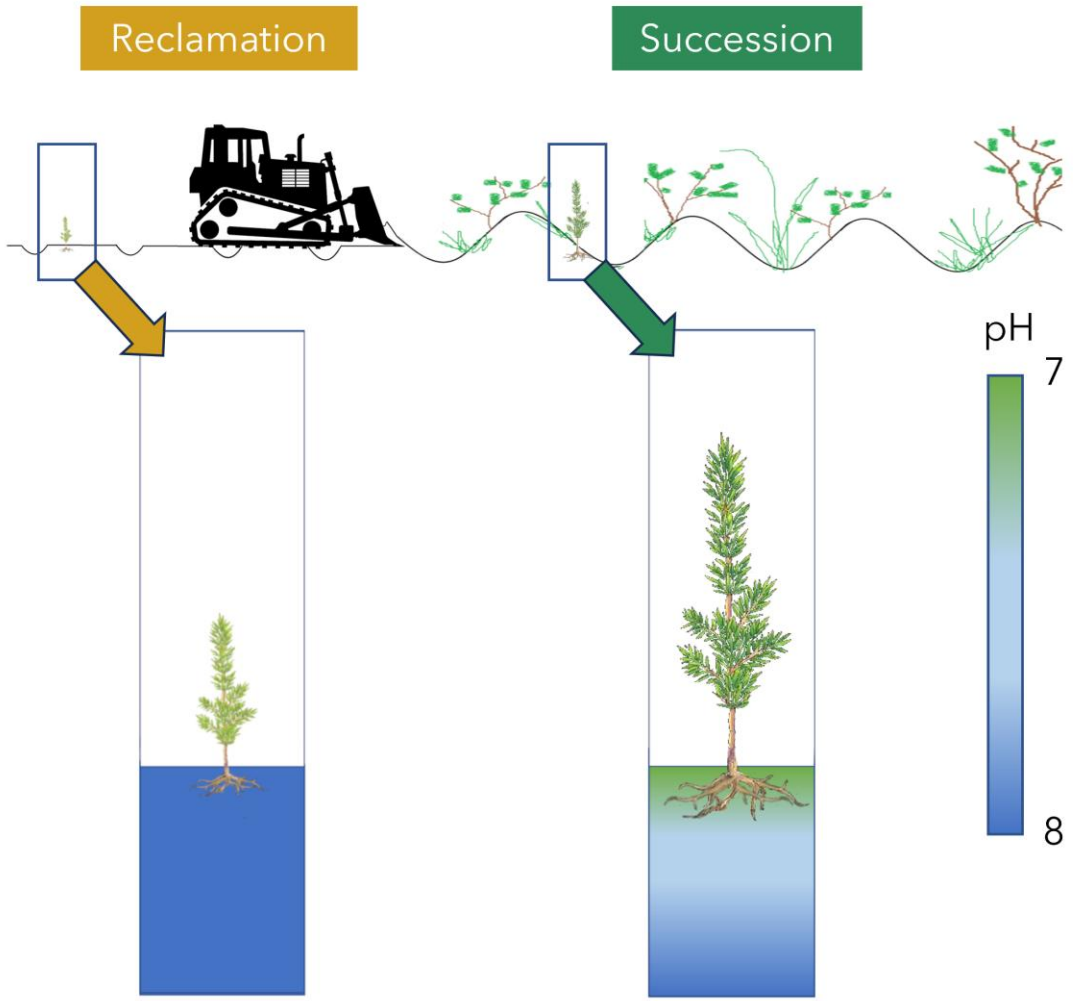
Haurová (2025) MS Thesis

What is the optimal target state?

Target for C sequestration:
highest stock of highest stability

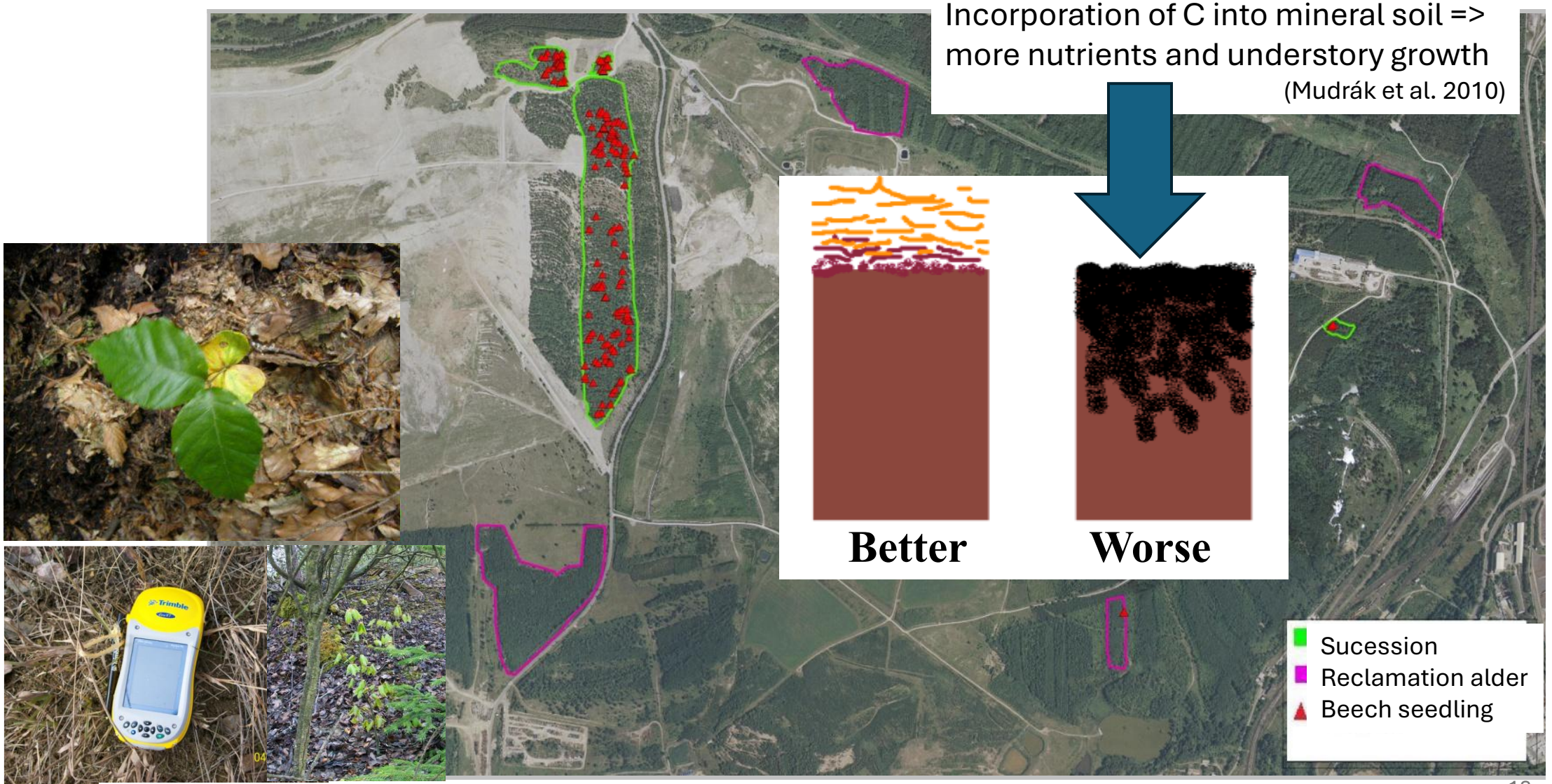
But is that true for other soil functions?

Some C accrual is useful…



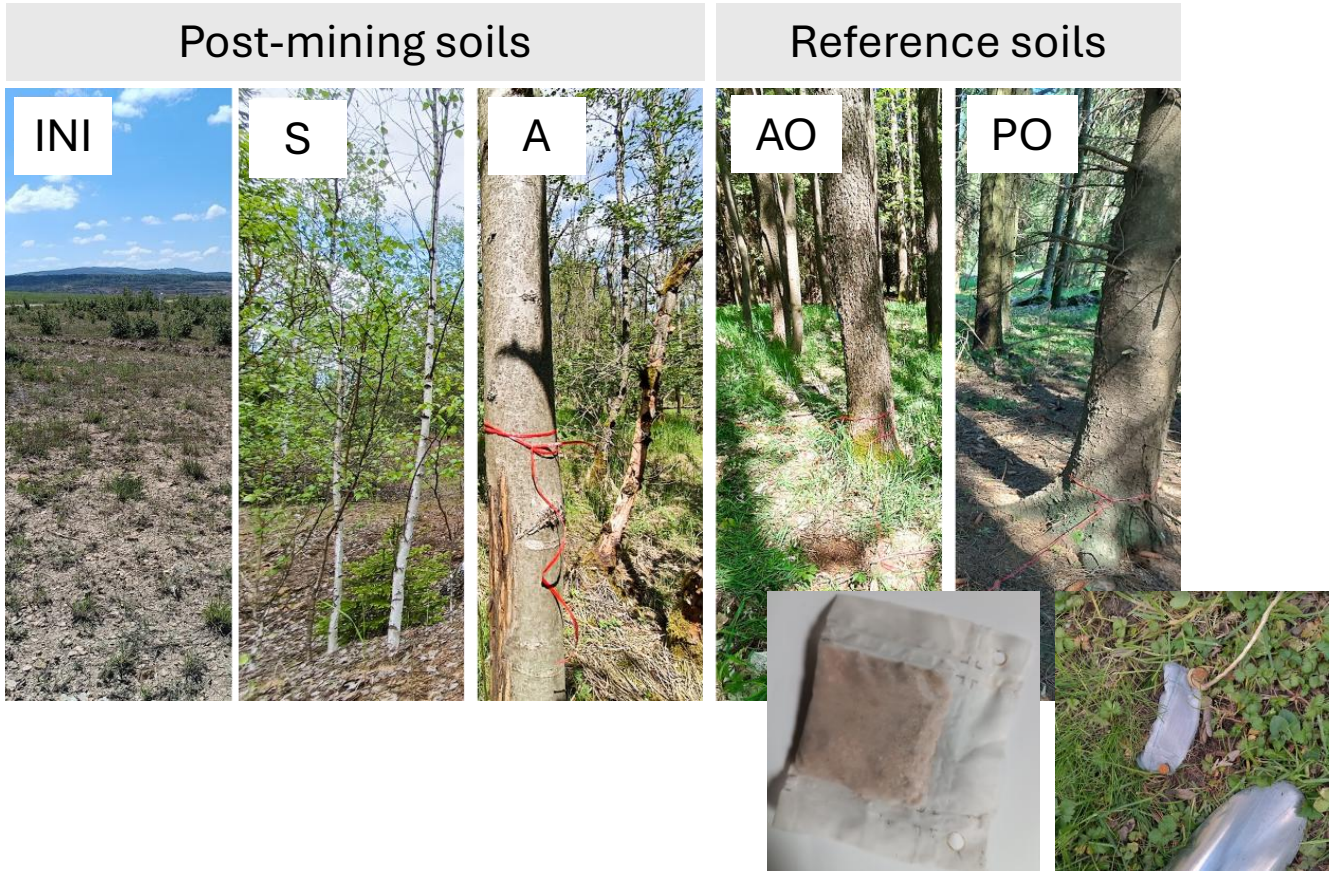
Vindušková (…) Frouz. Ecol. Eng. in revision

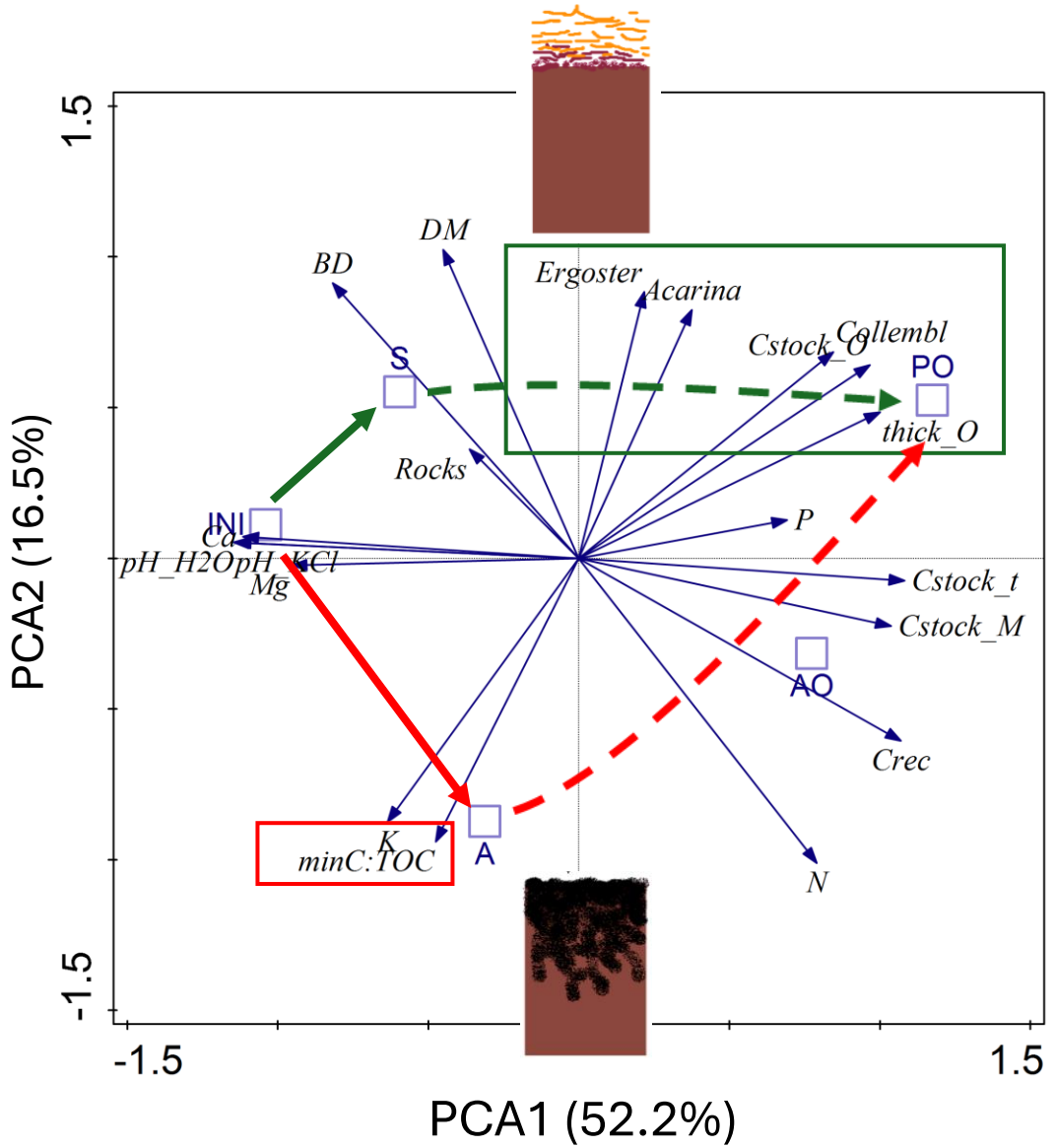
Late successional species establish better in sites with “mor/moder” humus



Frouz et al. (2015) Ecol. Eng.

Considering the target





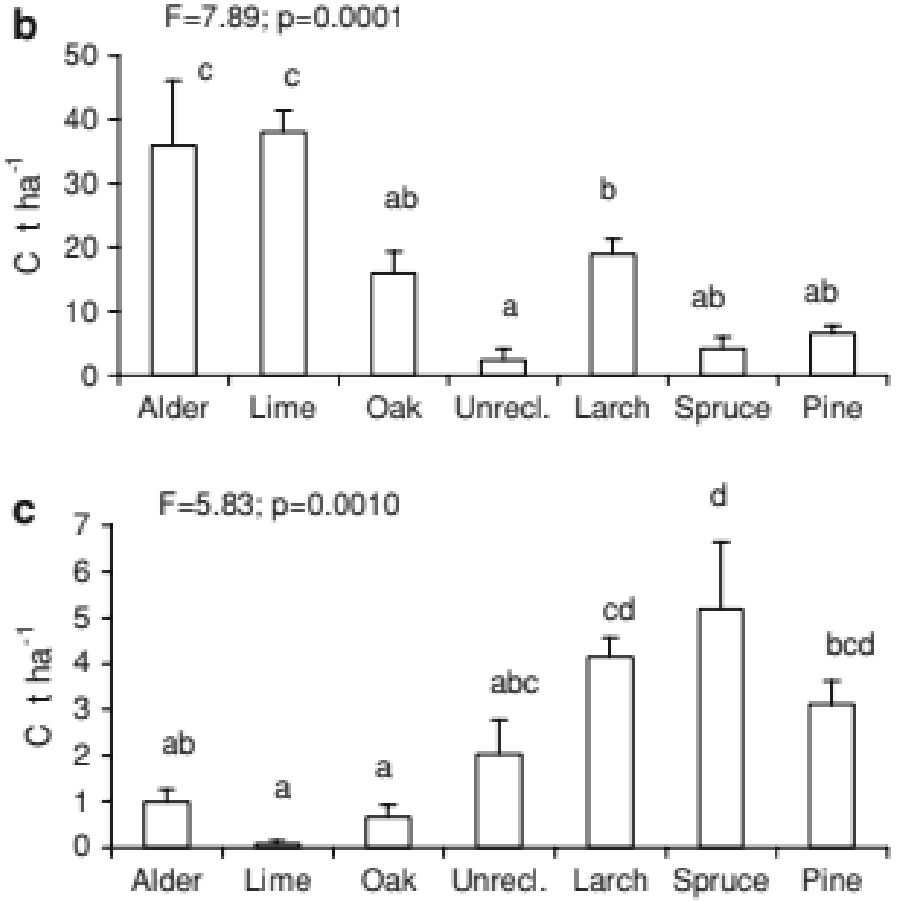
Successional soils match the spruce soils better in:

- O horizon thickness, mycorrhizal abundance, mesofauna abundance, and the proportion of C stored in mineral soil minC:TOC

Conclusions

- Post-mining soils can initially store more C than abandoned agricultural soils because they are unsaturated
- C accrual generally slows down over time
- in young soils, deciduous trees store C faster than conifers, which may later „catch up“ and even store more C in well-developed soils
- stability
  - O horizons vs. mineral soil – higher stability under deciduous
  - In mineral soil itself: no difference in MAOM:SOM but higher stability under deciduous trees in terms of basal respiration
- optimal target value?
  - Supporting C accrual but in „mor/moder“ type humus (~lower minC:TOC stability) may be more optimal for climax tree species

Thank you for your attention!


b
F=7.89; p=0.0001
C t ha-1
50
40
30
20
10
0
c
c
ab
a
b
ab
ab
Alder
Lime
Oak
Unrecl.
Larch
Spruce
Pine
c
F=5.83; p=0.0010
C t ha-1
7
6
5
4
3
2
1
0
ab
a
a
abc
cd
d
bcd
Alder
Lime
Oak
Unrecl.
Larch
Spruce
Pine