

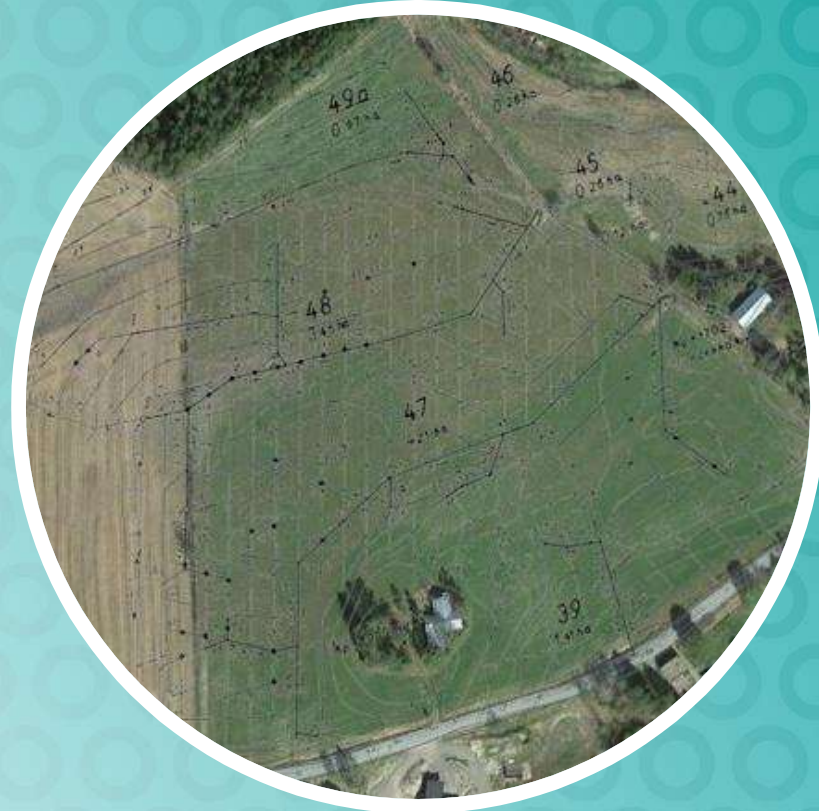
Managing soils for more C gain and less P loss

Tuomas Mattila

Suomen ympäristökeskus SYKE

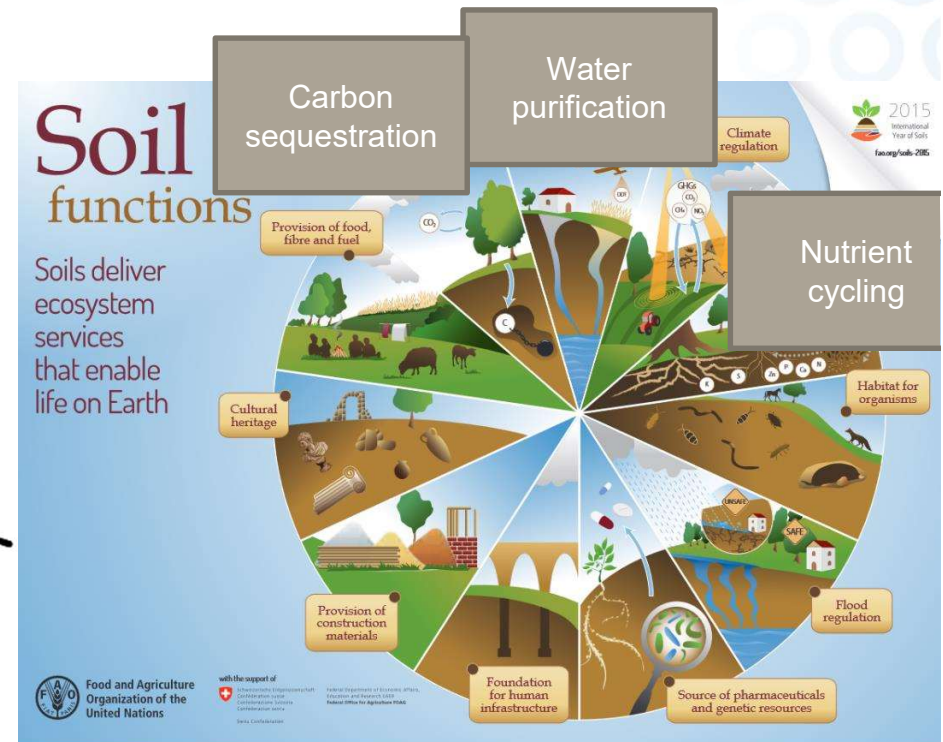
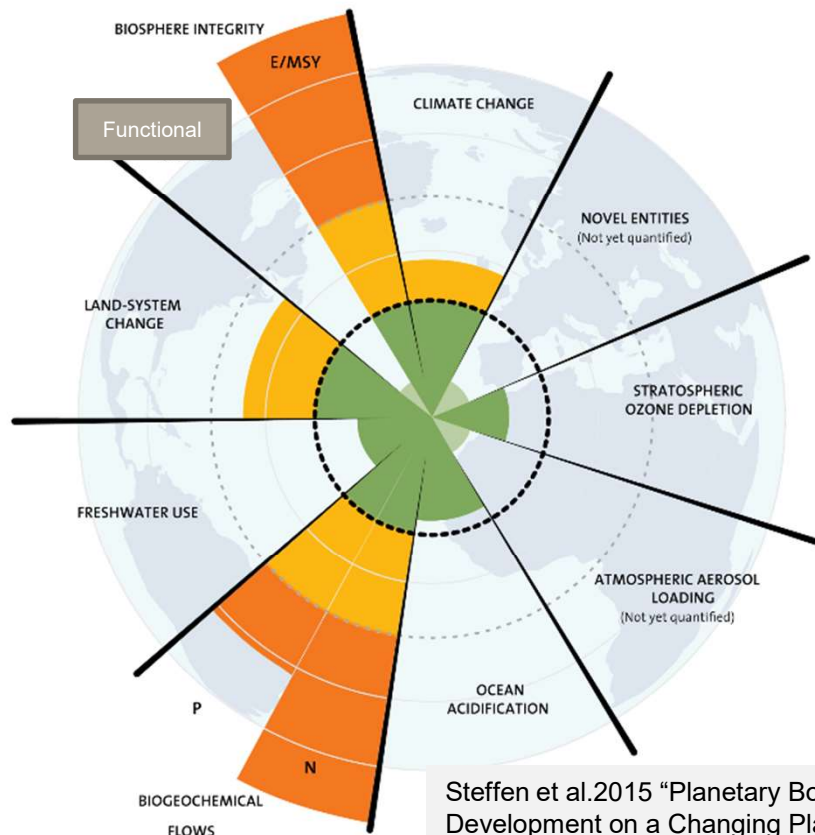
8.3.2021

... based on a manuscript by
Mattila T., Soinne H., Ekholm P.,
Heinonsalo J. and Uusitalo R.



Kilpiän tila

Two round shapes



Steffen et al.2015 "Planetary Boundaries: Guiding Human Development on a Changing Planet." *Science* 347, no. 6223.
<https://doi.org/10.1126/science.1259855>.

More round shapes... soil aggregate structure and resistance to dispersion



What is gluing sand particles together?



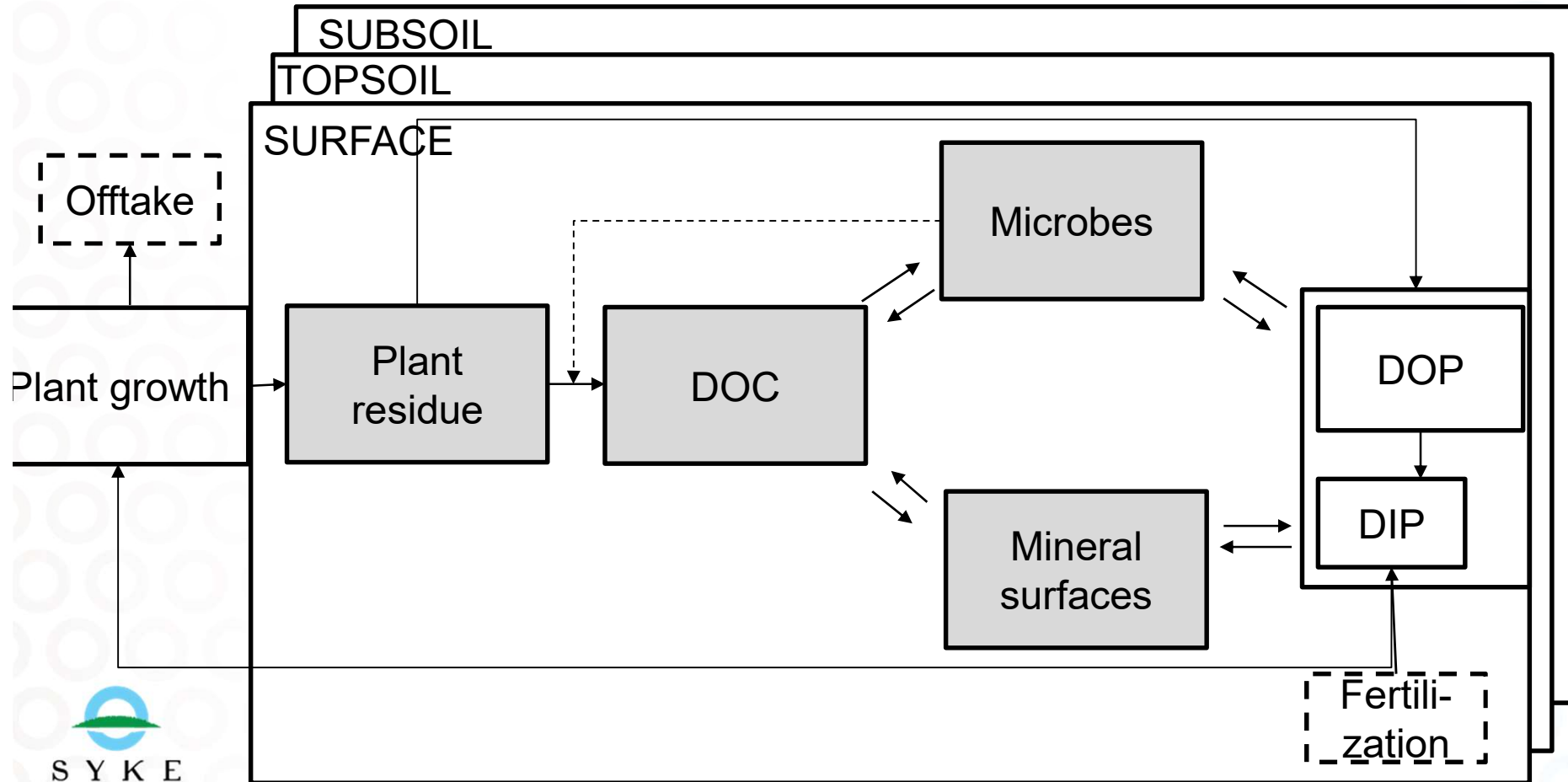
Carbon farming

TABLE 1 | Examples of agricultural management actions that can increase organic carbon storage and promote a net removal of CO₂ from the atmosphere and the main mode of action on the soil C balance (from Paustian, 2014).

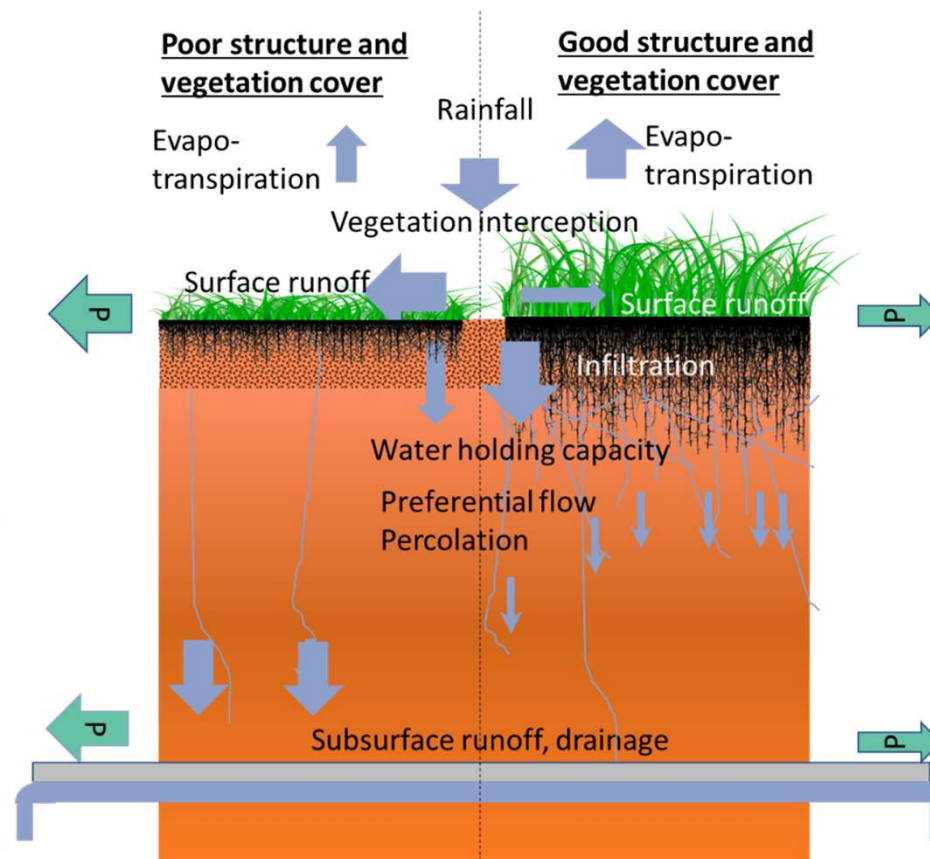
Management practice	Increased C inputs	Reduced C losses
Improved crop rotations and increased crop residues	✓	
Cover crops	✓	
Conversion to perennial grasses and legumes	✓	✓
Manure and compost addition	✓	
No-tillage and other conservation tillage		✓
Rewetting organic (i.e., peat and muck) soils		✓
Improved grazing land management	✓	

Paustian, Keith, Eric Larson, Jeffrey Kent, Ernie Marx, and Amy Swan. “Soil C Sequestration as a Biological Negative Emission Strategy.” *Frontiers in Climate* 1 (2019).
<https://doi.org/10.3389/fclim.2019.00008>.

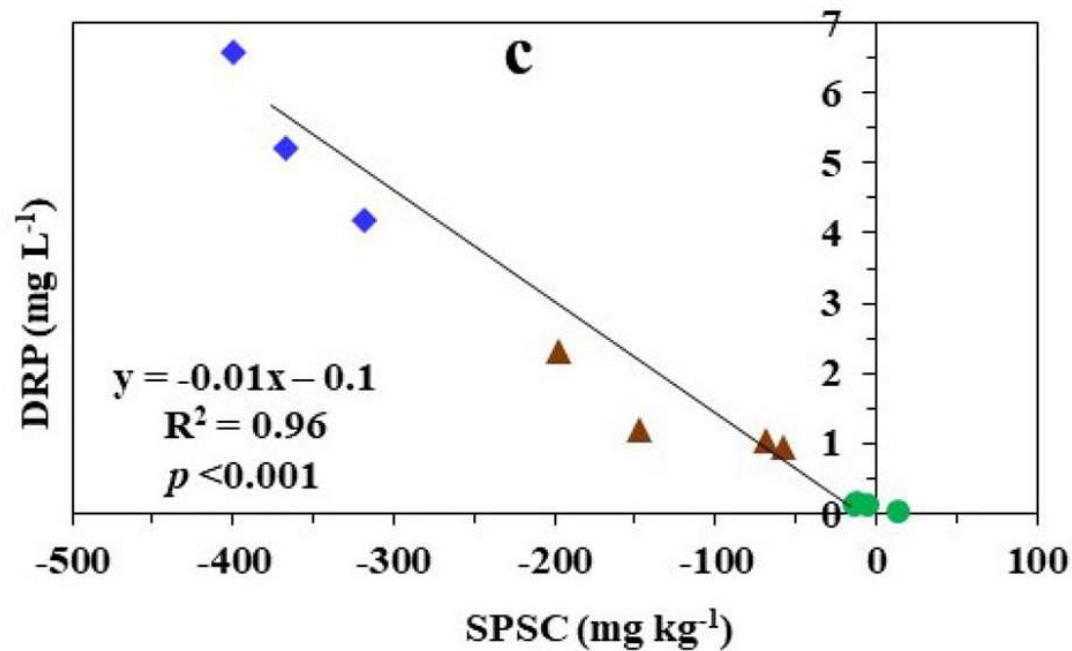
A coupled C and P cycle



P loss is site specific... depends on soil texture and hydrology



Soil has a long memory... legacy P



0-600 kg
P/ha extra
in CA test
fields...

5-20 years
of negative
P balance
needed to
control



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Dari, Biswanath, Vimala D. Nair, Andrew N. Sharpley, Peter Kleinman, Dorcas Franklin, and Willie G. Harris. "Consistency of the Threshold Phosphorus Saturation Ratio across a Wide Geographic Range of Acid Soils." *Agrosystems, Geosciences & Environment* 1, no. 1 (September 1, 2018): 180028. <https://doi.org/10.2134/age2018.08.0028>.

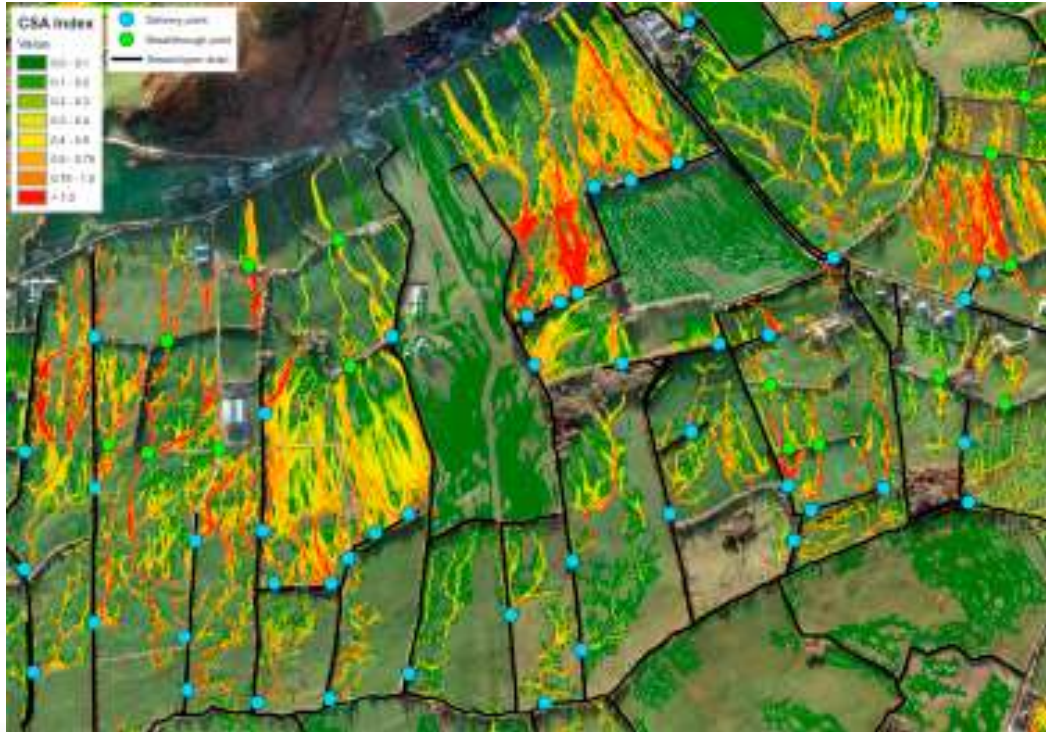
What could possibly go to s... wrong with carbon farming and P?

- **S**olubilization: cover crops transform legacy P to DRP
- **S**tratification: Plant residues accumulate P to soil surface and root channels → high local P saturation
- **S**orption: carbon competes with Fe and Al, desorbing accumulated P
- C:N:P:**S** = 100:10:2:1.4. Soil organic matter contains P, if carbon sequestration is done by adding manures, increased P budget.

What could possibly go right with carbon farming and P?

- Soil cover → Less erosion, more aggregate stability
- Living Roots → More evapotranspiration
- Deeper roots → Better hydrology
- Cover crops → more P to crops, less P fertilizer, negative P balance
- Higher yields → negative P balance

Does carbon farming and emission reduction overlap?



“-- the CSA approach identified **1.1–5.6%** of catchment areas at highest risk of legacy soil P transfers, --“

Target for hydrology intervention or agroforestry?

Thomas, I. A., P. -E. Mellander, P. N. C. Murphy, O. Fenton, O. Shine, F. Djodjic, P. Dunlop, and P. Jordan. “A Sub-Field Scale Critical Source Area Index for Legacy Phosphorus Management Using High Resolution Data.” *Agriculture, Ecosystems & Environment* 233 (October 3, 2016): 238–52. <https://doi.org/10.1016/j.agee.2016.09.012>.

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Target for hydrology intervention or agroforestry?



Thomas, I. A., P. -E. Mellander, P. N. C. Murphy, O. Fenton, O. Shine, F. Djodjic, P. Dunlop, and P. Jordan. "A Sub-Field Scale Critical Source Area Index for Legacy Phosphorus Management Using High Resolution Data." *Agriculture, Ecosystems & Environment* 233 (October 3, 2016): 238–52. <https://doi.org/10.1016/j.agee.2016.09.012>.

Integrate

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Also more:

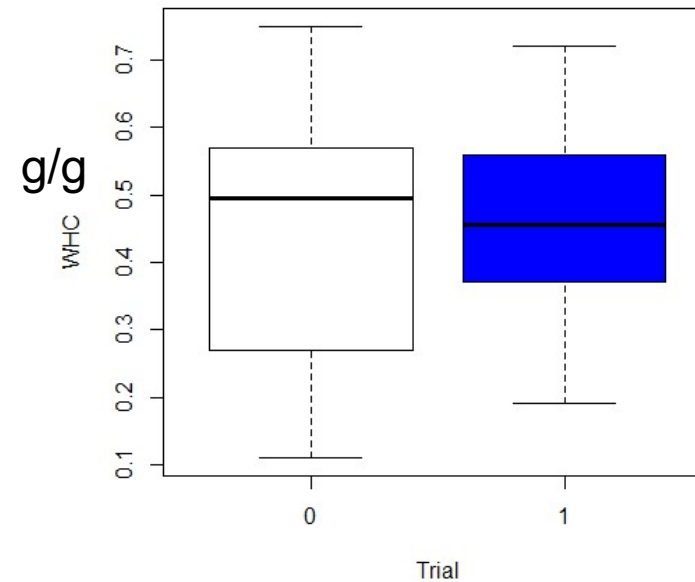
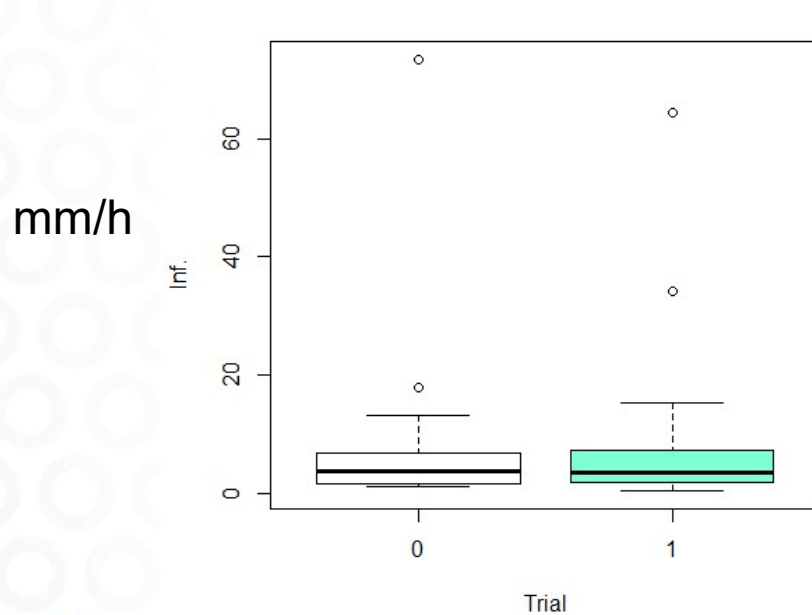
- ET
- T stability
- Infiltration
- Aggregates
- Earthworms
- P availability



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Range of observed values in water cycle... leverage points

Carbon Action monitoring sites 2019 <https://zenodo.org/record/3670654>



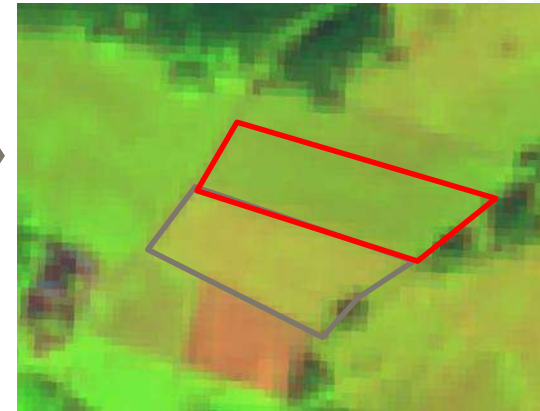
0,5 g/g = 100-150 mm water in topsoil

Carbon action experiment = 108 farms

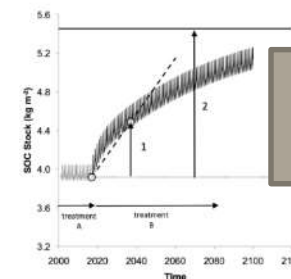
- Cover crops
- Grass diversity
- Subsoiling
- Soil amendments
- Grazing
- "All-in"



216 fields
= site specific



20 intensive sites
3-4 flux meas. sites



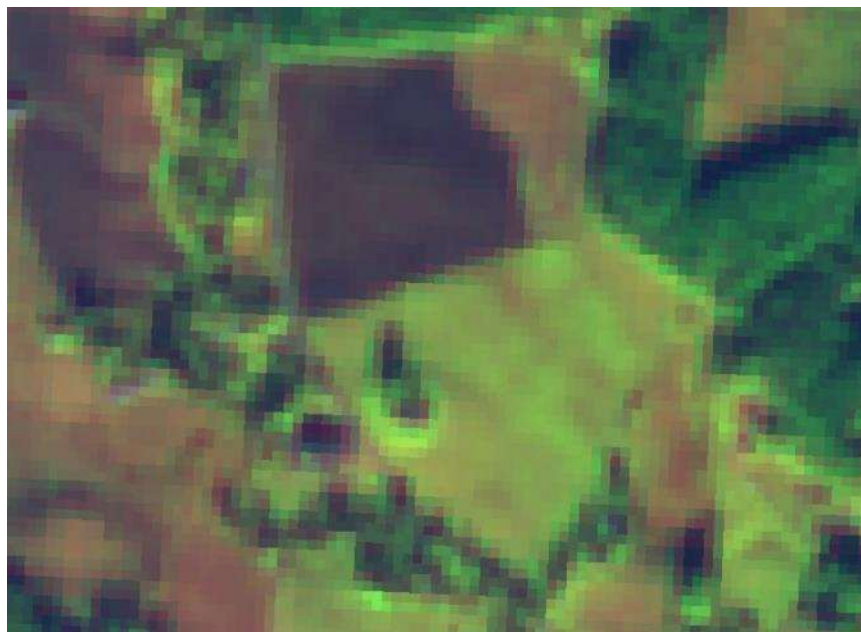
Field observatory

Thank you!


- More info:

www.fieldobservatory.org

tuomas.mattila@syke.fi



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Questions?

- Do you know where the P hotspots are in your region? How could you find out?
- Do people use cover crops in your region? Has that influenced P fertilizer rates?