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The contribution of soil organic matter to soil health. Soil Health for Climate

Claire Chenu

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Claire Chenu. The contribution of soil organic matter to soil health. Soil Health for Climate. Soil Mission Week, European Commission - Soil Mission Secretariat, Nov 2023, Madrid, Spain. hal-04537938

HAL Id: hal-04537938

<https://hal.inrae.fr/hal-04537938>

Submitted on 9 Apr 2024

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WEEK

Breakout Session

Soil health for climate

21 November 2023, 14:00-16:00

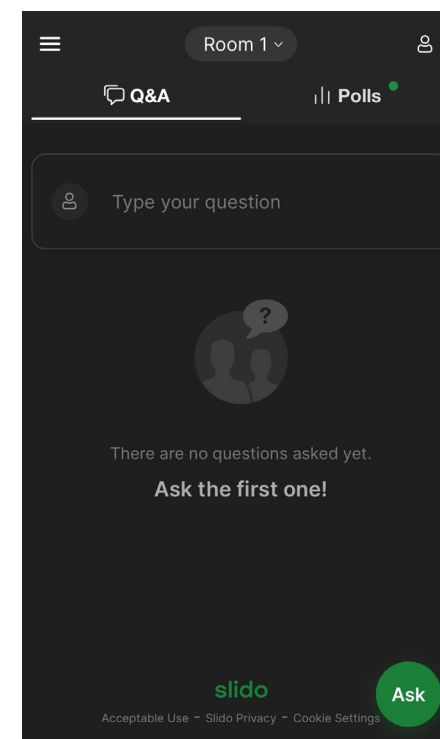
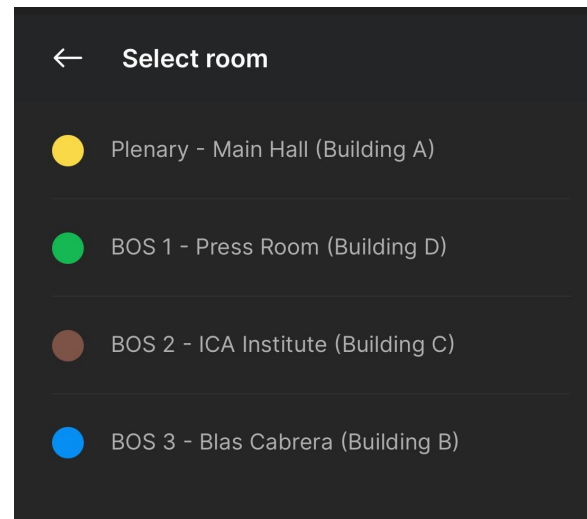
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Housekeeping rules

- **WIFI**
 - Network : EMSW
 - Password : np9dpL9Y\$8CS7v%
- **Questions**
 - Go to www.sli.do and enter event code **#ESMW2023** (or scan the QR code)
 - Select the 'room' of the session
 - Submit your questions



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Moderator

EUROPEAN MISSION SOIL WEEK



Anna Besse-Lototskaya

Co-coordinator of the EU-co-funded
programme EJP SOIL

Wageningen University & Research

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Agenda

Presentations (moderator: Anna Besse-Lototskaya)

- Claire Chenu: *The contribution of soil organic matter to soil health*
- Marta Goberna: *Trade-offs between carbon sequestration, greenhouse gas emissions and nutrient losses*
- Martin H. Thorsøe: *How do existing carbon farming schemes account for synergies and trade-offs?*
- Input from the audience: *Slido*
- Saskia Visser: *Diversifying incomes through a comprehensive carbon farming/nature credit framework*

Panel discussion (moderator: Claire Chenu)

- Tristano Bacchetti De Gregoris, Cristiano Ballabio, Christian Holzleitner, Saskia Visser: *How to develop carbon farming schemes that account for synergies and trade-offs*
- Summary of inputs



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Our speakers

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Martin Thorsøe

Coordinator of the EU-co-funded project Road4schemes

Aarhus University



Saskia Visser

Cluster manager

Resilient and climate neutral regions at Climate - KIC



Marta Goberna

Coordinator

EU-co-funded project TRACE-Soils



Claire Chenu

Senior scientist and Coordinator of the EU co-funded programme EJP SOIL

INRAE (French National Research Institute for Agriculture, Food and Environment)

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The contribution of soil organic
matter to soil health

Claire Chenu

INRAE, France



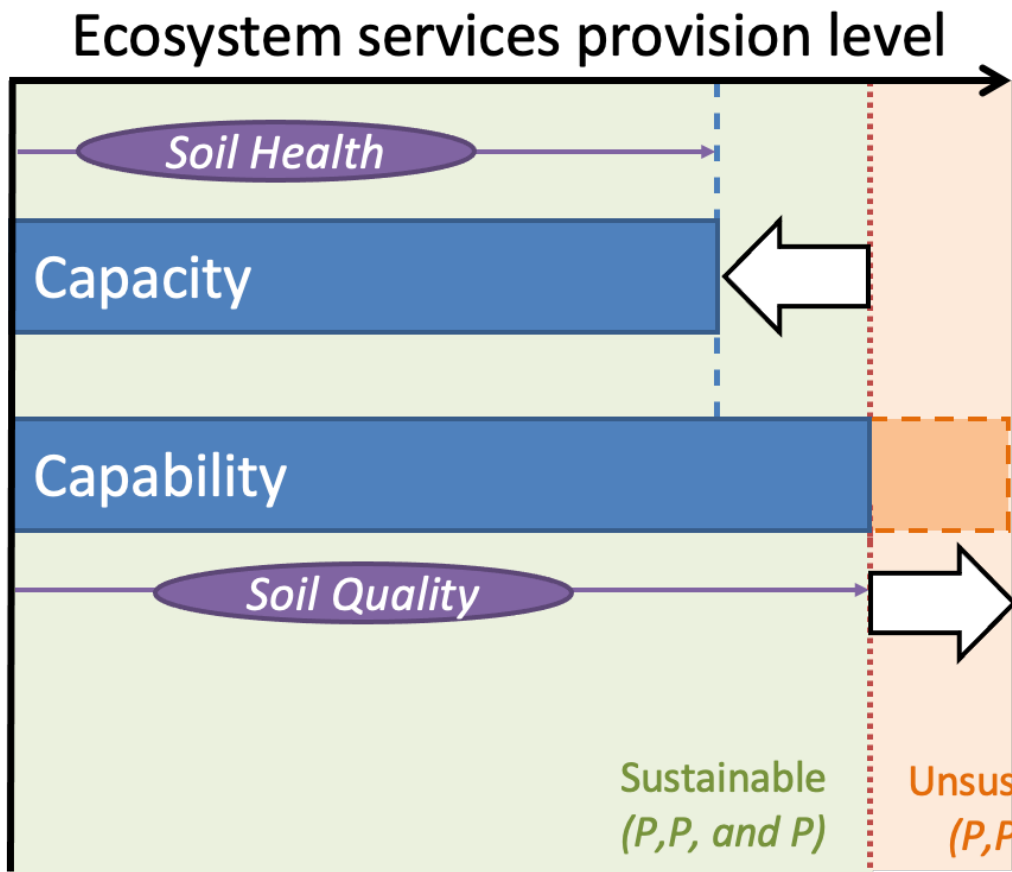
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Soil health is the actual capacity of soils to provide ecosystem services



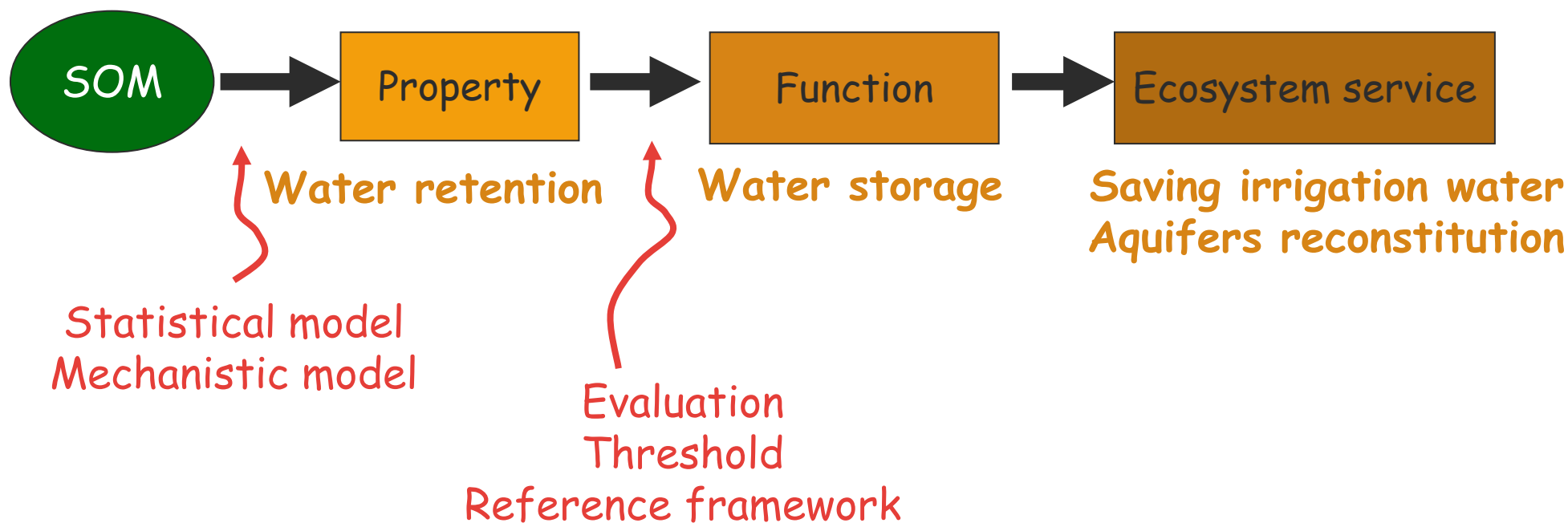
Current soil status and ecosystem management limits provision of ecosystem services

Context properties (e.g., soil type and land use) define potential at sustainable use

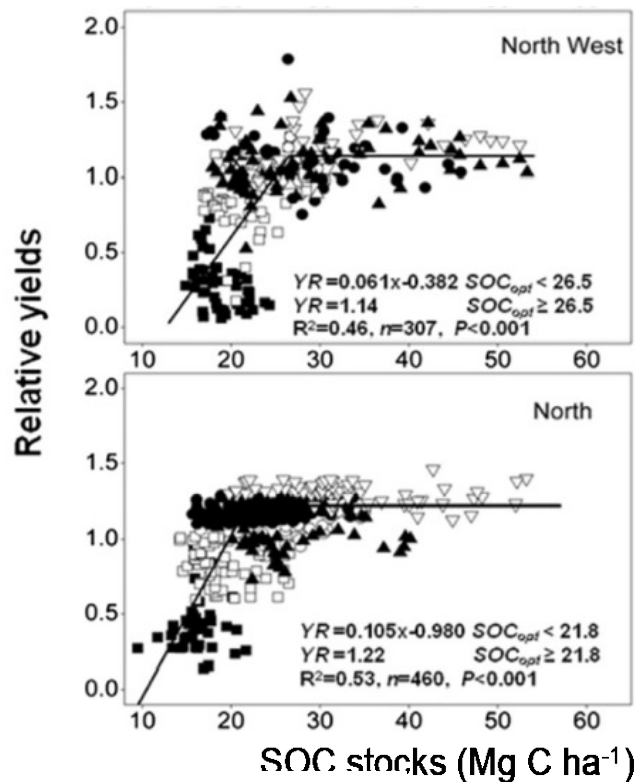
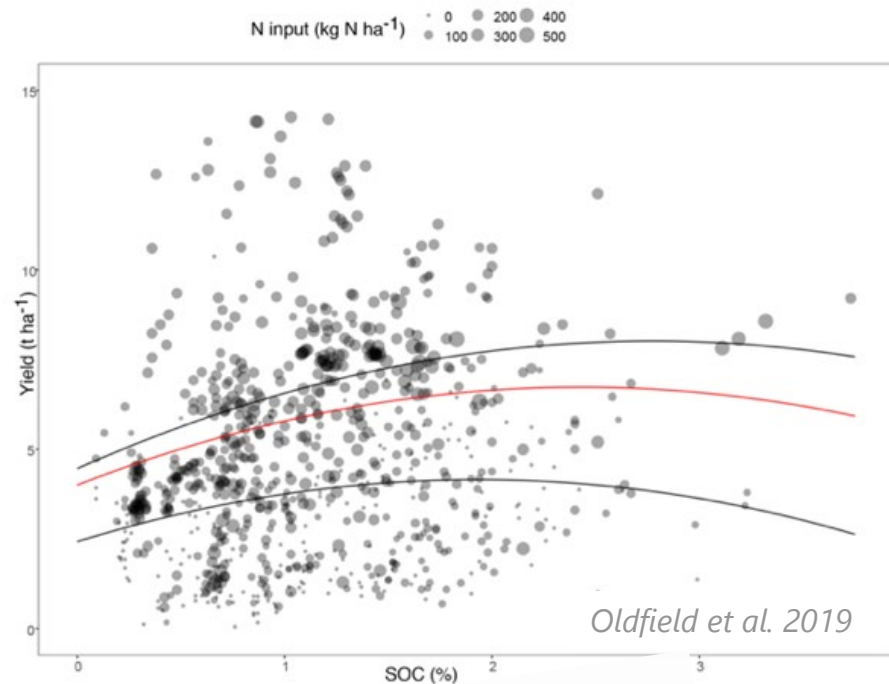
Land use sustainability in terms of people, planet, profit (P,P,P)

*Doran et al. 1994
Veerman et al. 2020
Faber et al. 2021*

Quantitative relationships : from properties to functions and ecosystem services



Supporting primary productivity: yields



Zhang et al. 2016

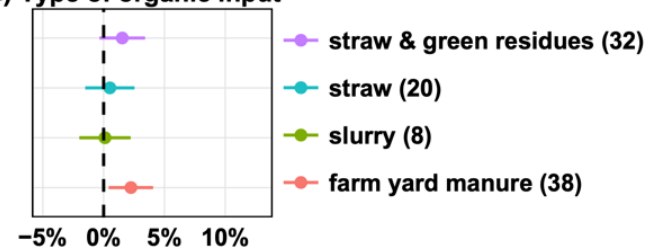
Plant Soil (2017) 411:293–303
DOI 10.1007/s11104-016-3031-x

REGULAR ARTICLE

Do organic inputs matter – a meta-analysis of additional yield effects for arable crops in Europe

R. Hijbeek · M.K. van Ittersum · H.F.M. ten Berge · G. Gort · H. Spiegel · A.P. Whitmore

(a) Type of organic input



Nutr Cycl Agroecosyst (2020) 118:325–334
https://doi.org/10.1007/s10705-020-10098-2

ORIGINAL ARTICLE

European survey shows poor association between soil organic matter and crop yields

Wytse J. Vonk · Martin K. van Ittersum · Pytrik Reidsma · Laura Zavattaro · Luca Bechini · Gema Guzmán · Annette Pronk · Heide Spiegel · Horst H. Steinmann · Greet Ruyschaert · Renske Hijbeek

Soil organic matter effects and associated benefits

Property or process	Static (S) or dynamic (D) effect	Effect on soil properties	Benefit	predictive tool for property?	Soils most concerned
<i>Chemical properties</i>					
Increase in CEC	S	↗ NH ₄ ⁺ , K, Ca, Mg, Fe retention	↗ plant mineral nutrition	PTF	Sandy soils

$$CEC = 0.037 \text{ clay}_{g/kg} + 0.273 \text{ Corg}_{g/kg}$$

$$CEC = 1.24 + 0.058 \text{ clay}_{g/kg} + 0.466 \text{ Corg}_{g/kg}$$

$$CEC = 0.062 \text{ clay}_{g/kg} + 0.295 \text{ Corg}_{g/kg} + \Delta OC \text{ charge}(pH8.1\text{-soil pH})$$

Bigorre et al. 2000

Krogh et al. 2000

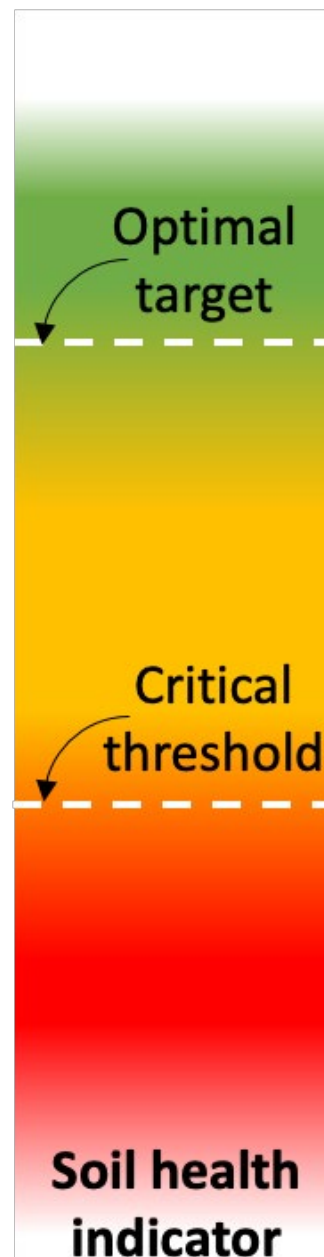
Van Erp et al. 2001

		↗ resistance to erosion	↘ erosion	model	
Porosity increase	S	↗ available water	↗ water available for plants	PTF	Sandy, stony and thin soils
		↗ water infiltration	↘ runoff and P and pesticide losses ↘ erosion ↗ water available for plants ↗ respresinment or water reserves (blue water)	PTF	Silty crusting soils, clayey soils
		↘ penetration resistance	↘ mechanical energy to work soils		Clayey soils
Mulch at the soil surface	S	↘ evaporation	↗ water available for plants ↗ respresinment or water reserves (blue water)		Sandy soils
		↘ runoff	↘ erosion	model	Silty crusting soils, slope soils
Darker color of soil	S	↗ rapid soil warming	earlier seedling emergence	model	
<i>Biological properties and processes</i>					
Mineralisation of N, P, S	D	↗ available nutrients	↗ plant mineral nutrition	model	All soils
		↗ nitrates in solution	↘ water quality	model	All soils
Mineralisation of C and N	D	↗ SOM stabilisation	↗ C storage	model	All soils
		↗ N ₂ O and methane emissions	↗ GHG emissions	model	Hydromorphic soils
Trophic resource for organisms. Increased abundance and diversity of soil biota	D	↗ abundance and biodiversity of soil biota	↗ soil resilience	-	All soils
		↗ symbiots and PGPR	↗ crop growth	-	All soils
		↗ regulating pathogens and pests	↗ crop sanitary quality	-	All soils
		↗ biodegradation of organic contaminants	↗ water quality, food quality	-	All soils

*Chenu et al. in
Pellerin & Bamière,
2017. INRAE 4p1000
expert assessment*



Setting SOM critical values



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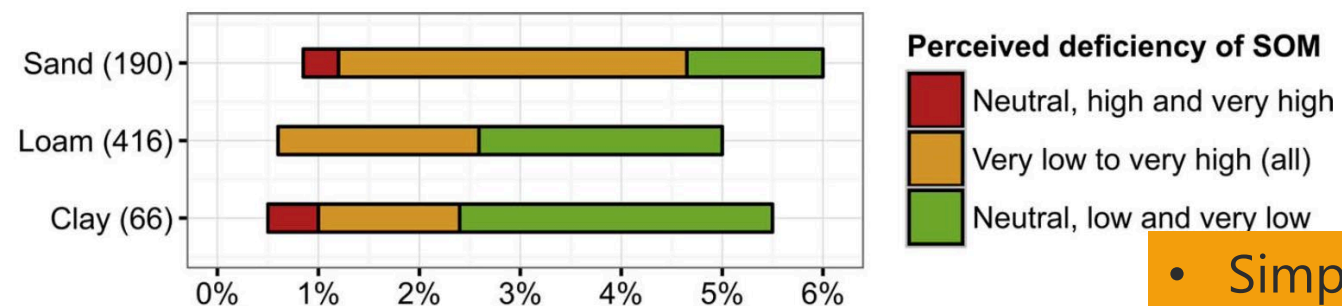
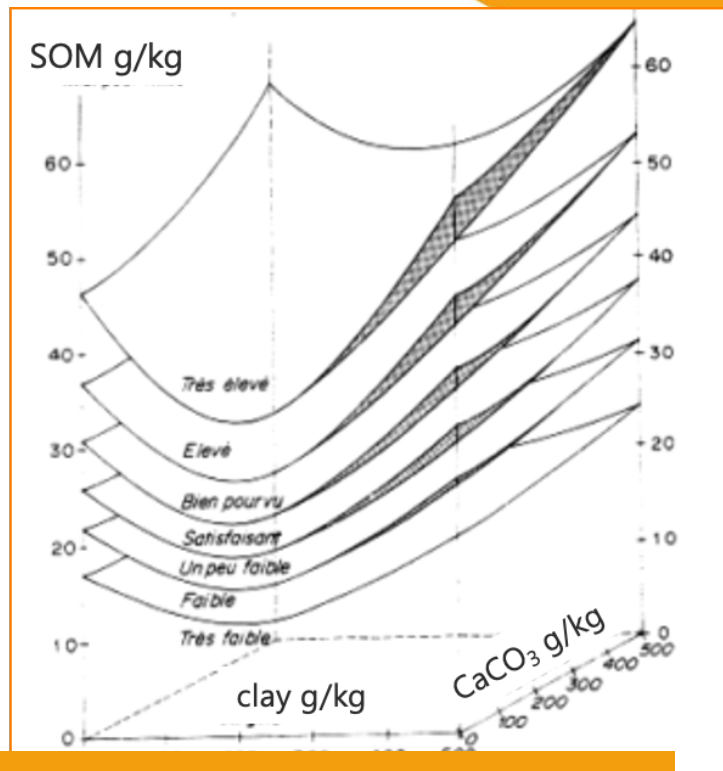
1- Fixed critical values

Table 2.5 Matrix of mean SOC minimum and maximum thresholds for cropland soils (% soil mass)

Soil texture class	Climatic water balance (mm) summer					
	Less than -100		-100 to 0		More than 0	
	Min.	Max.	Min.	Max.	Min.	Max.
Sand	0.5	1.23	0.9	1.73	1.2	2.23
Silt	1.5	2.53	1.0	2.07	0.8	1.59
Loam and clay	0.6	1.47	0.9	1.92	1.9	3.23

Source: Compiled from Wessolek et al. (2008).

Wessolek et al. 2008 in Baritz et al. EEA report 2023



Hijbeek et al. 2017 Reported SOM content

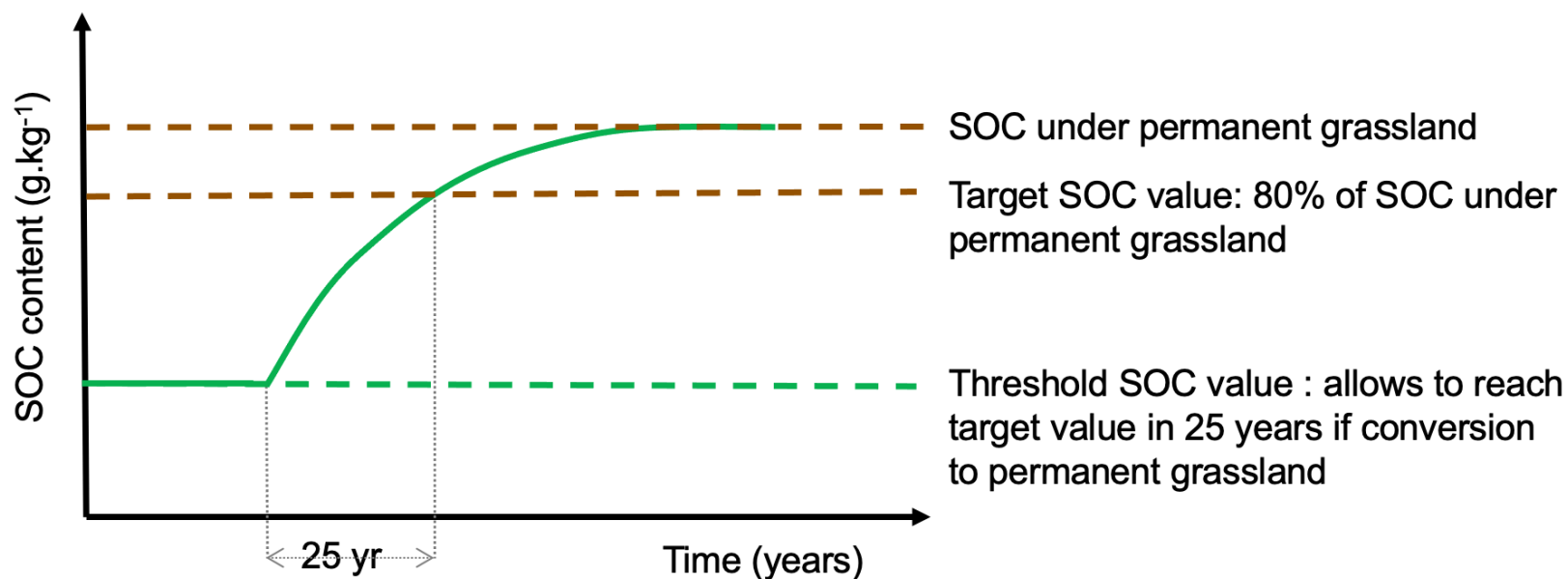
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- Simple
- Can be linked to functions
- Requires context specific references
- Available knowledge?

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2- Critical values relative to “natural” land uses

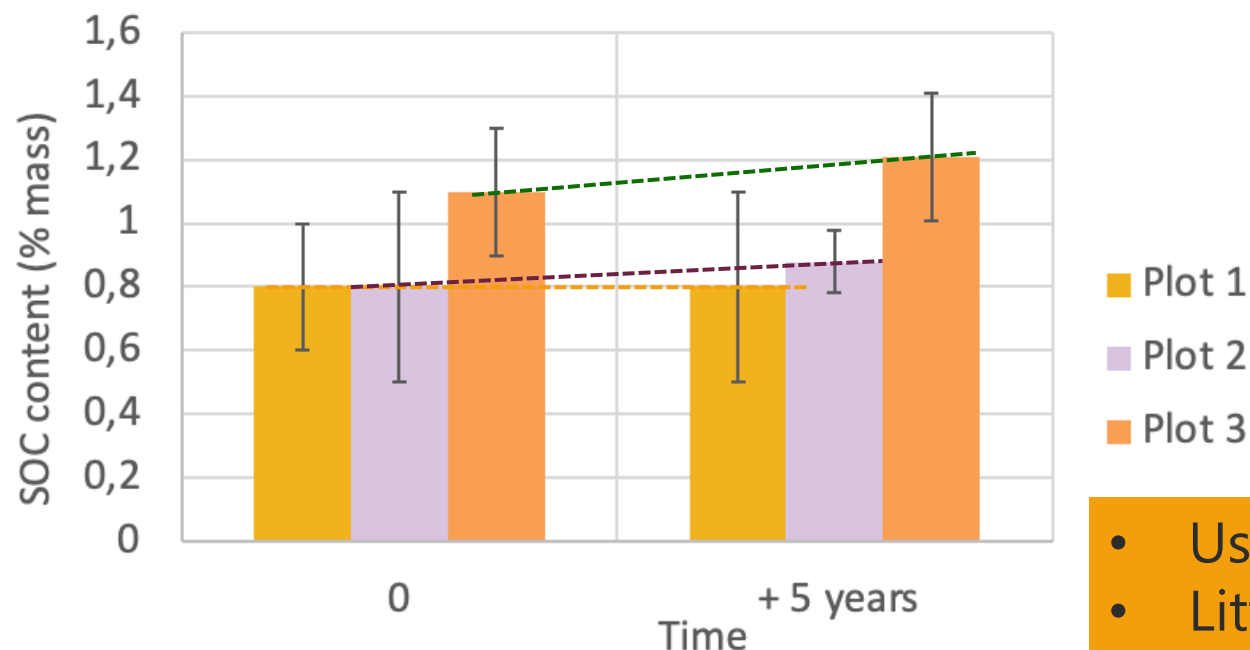


Adapted from *Sparling et al. 2003*

- Simple
- Not linked to functions
- Needs to be context specific
- “Natural” references available?

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3- Critical values based on relative changes



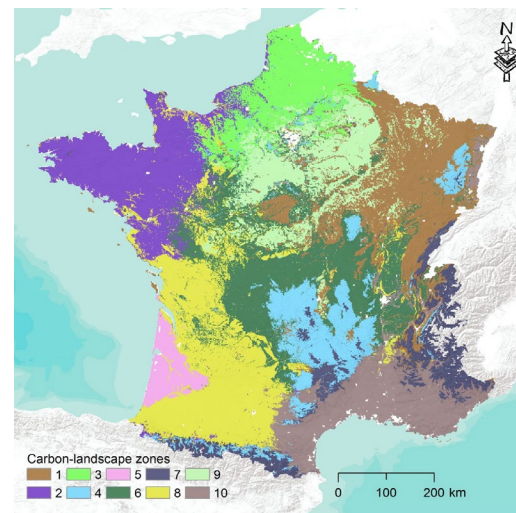
- Uses current values
- Little knowledge & stratification required
- Not linked to soil functions
- Which desired/measurable % improvement
- What about pioneers ?

4- Critical values based on existing distribution of the indicator values

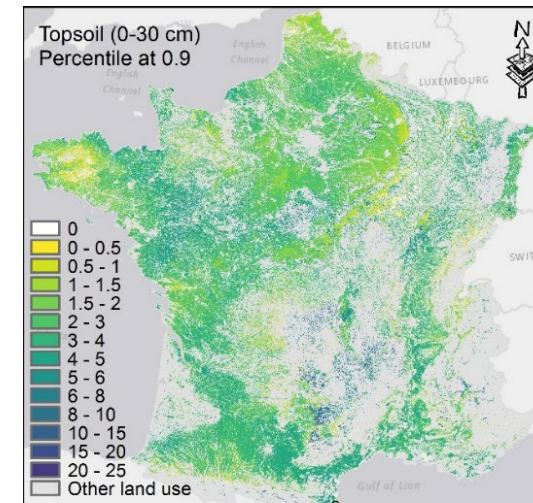
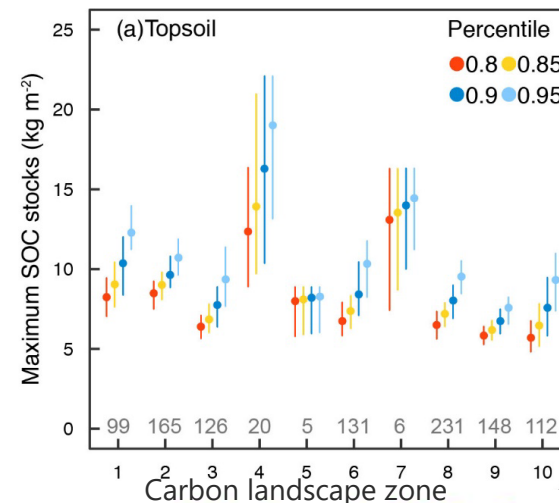
SOC stocks for 0-20 cm layer (Mg C. ha ⁻¹)		
	Target value	Threshold value
Soil order	Median C content long term pasture	Lower quartile
Recent	72	54
Granular	88	78
Melanic	98	74
Allophanic	132	103

Sparling et al. 2003

- Not linked to functions
- Requires extensive data
- How to set critical values?



Chen et al. 2019 Stoten



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Conclusion: The contribution of soil organic matter to soil health

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- Central role of soil organic matter.
- Soil health: several ecosystem services. Tradeoffs.
- Need for quantitative information to sustain decision- support tools. Context-specific. Synthesis.
- Different approaches are available to set SOM critical values.

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EJP SOIL work on critical values for indicators: A. Bispo, C. Calzolari, I. Cousin, J. Faber, M. Fantappie, R. Hessel, S. Mocalli, A. Matson, F. van Egmond et al.

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Thank you!

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EJP SOIL has received funding from the European Union's Horizon 2020 research and innovation programme: Grant agreement No 862695



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