

Soil organic matter thermal pools as influenced by depth, tillage, and soil texture : A Rock-Eval® analysis study on the cropland soils of the Swiss Plateau



Deluz et al. under revision (*Geoderma*)

from the master thesis of :

Cédric Deluz

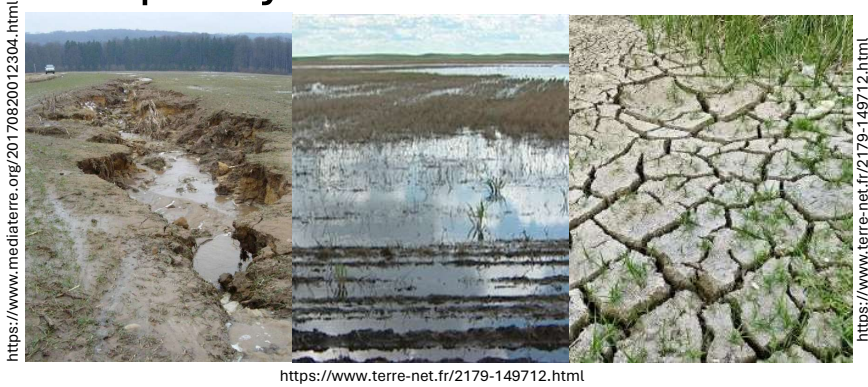
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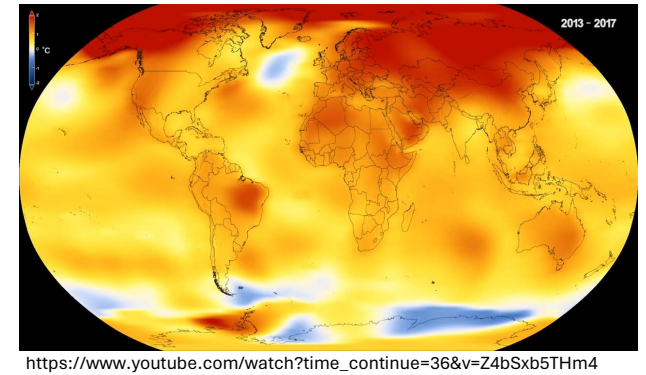
External expert : Dr. David Sebag (IFPne)

Context

Soil quality in critical condition



Global warming



Carbon

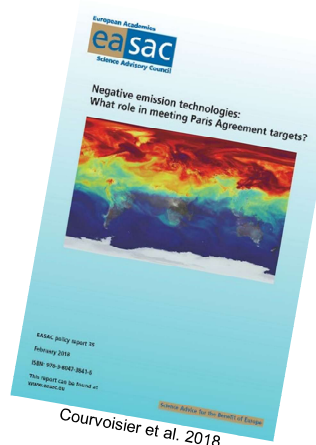


Photosynthesis



 **Lack of organic carbon**

Excess CO₂ 



Solution with **conservation agriculture (CA)**?

1 minimum soil disturbance



2 permanent soil cover: crop residue or live mulch

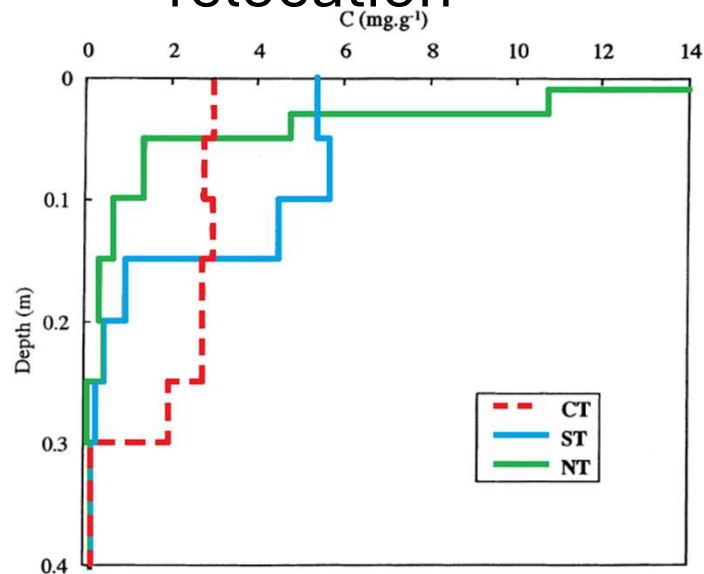


3 crop rotation and or intercropping



Effect of CA on soil organic matter

Profile relocation



Based on figure by Balesdent et al. (2000)

recolored

Soil quality



well established

Carbone sequestration



still debated

Initiative 4 per 1000 and the practice of CA are controversial

What about the quality of the stored SOC

Labile pools?

Stable pools?

What about the clay saturation?

ARTICLE INFO

Handling Editor: Dr. Jan Willem van Groenigen

Introduction

We thank the authors for their thought-provoking comments on our paper. Most of the commentators agree that soil organic carbon (SOC) sequestration is important for improving the quality of soil and the environment (Schlesinger, 2000). We shall welcome the comments and appreciate that the issue has been addressed. However, they argue that we have overstated the potential of soil carbon sequestration. We clarify that our paper (Minasny et al., 2017) mainly deals with potentials for the 20 countries and regions, where SOC requirements. We believe that in some parts of the world where food security is threatened, the benefit of soil carbon management for adaptation should be stressed more than for mitigation. This is the reason why the 4 per mille explicitly includes food security (Chabbi et al., 2017; Soussana et al., 2015). We need to add that the "4 per mille Soils for Food Security Initiatives" initiative is just one of many national and global initiatives on SOC sequestration for mitigating climate change. The Intergovernmental Technical Panel on Soils (ITPS) of the Global Soil Partnership (GSP) discussed incorporating the topic of SOC in the IPCC Assessment Report (ARs), from Arto onwards. The IPCC has also put a focus on soil in their upcoming special report "Climate Change and Land" (<http://www.ipcc.ch/report/sr2/>). The report of the Global Symposium (GSOC17) assembled experts engaged in FAO, GSP and its ITPS, IPCC, UNCCD-SPI and WMO activities to work together for climate change mitigation and adaptation (see <http://www.who.int/news-room/feature-stories/story/4-per-1000-initiative>). The Global Research Alliance on Agricultural Greenhouse Gases (GRA) focused on opportunities to reduce agricultural greenhouse gas emissions and increase soil carbon sequestration while still helping to meet food security objectives (<http://globalresearchalliance.org/about/>). The Common Agriculture Policy in the EU is currently being revised to include the potential use of SOC as a major actors in the search for a solution rather than a big component of the fossil fuels could be compensated by agriculture, and that there is therefore no need to urge manufacturers, industrialists, and oil or gas producers off the hook, since it suggests that green technologies do not necessarily make sense scientifically or politically. An idea that is brilliant politically does not necessarily make sense scientifically or popularly known as the "Star Wars" program) in the 1980s is a textbook example in this respect. From a pragmatic perspective, one of the key questions with the "4 per 1000" initiative matter stocks by 0.4% per year on average around the world. A recent collective article (Minasny et al., 2017) also consider the top 1 m of soil globally representing the remaining 35% (or about 17 Gt CO₂ eq. yr⁻¹) (Lal et al., 2011). Indeed, most differences in soil organic carbon stocks tend to 23% of total emissions. Minasny et al. (2017) also consider the top 20 to 30 cm of the soil profile can be effectively managed (Bygaard et al., 2011). Considering that typically > 50% of soil organic carbon stocks tend to be stored in the top 30 cm depth. The proportion of carbon that is stored in the top 30 cm depth. The proportion of carbon that is stored in the top 30 cm depth.

SOC = soil organic carbon

ABSTRACT

The Paris Agreement reached at the COP 21 signals the new centrality of carbon sinks, including soils, means of enabling a net zero carbon global balance through the development of "negative emission technologies". This article focuses on the 4 per 1000 Initiative, which the French government launched to foster soil sequestration with an international scope. We present and discuss the multidisciplinary design of our consideration of soil agency and vulnerability. Drawing on an in-depth qualitative investigation, we consider the methodological tensions that it entailed and the assets that it eventually represented for a carbon sequestration promises in light of the broader politics of soil knowledge. We argue that the promise may have failed to give adequate attention to soil's vulnerability (e.g. its capacity to both store carbon and other greenhouse gases) and soil's vulnerability (e.g. to urbanisation and intensification, soil degradation, including carbon loss). Committing to a carbon sink and other greenhouse gases and soil's vulnerability, including carbon loss). Committing to a carbon sink and other greenhouse gases and soil's vulnerability, including carbon loss).

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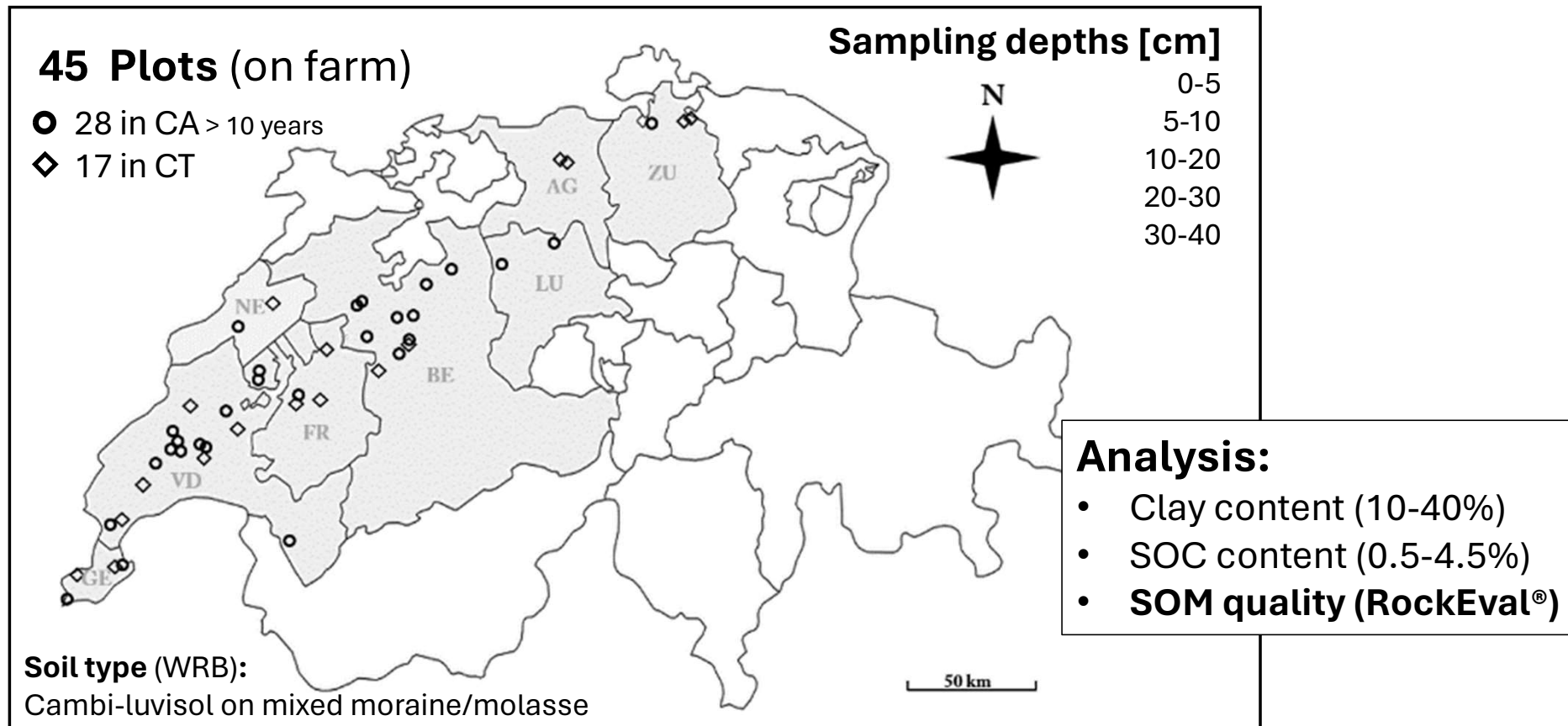
Keywords: Soil carbon sequestration, Climate change, Negative emission technology, Multidisciplinary

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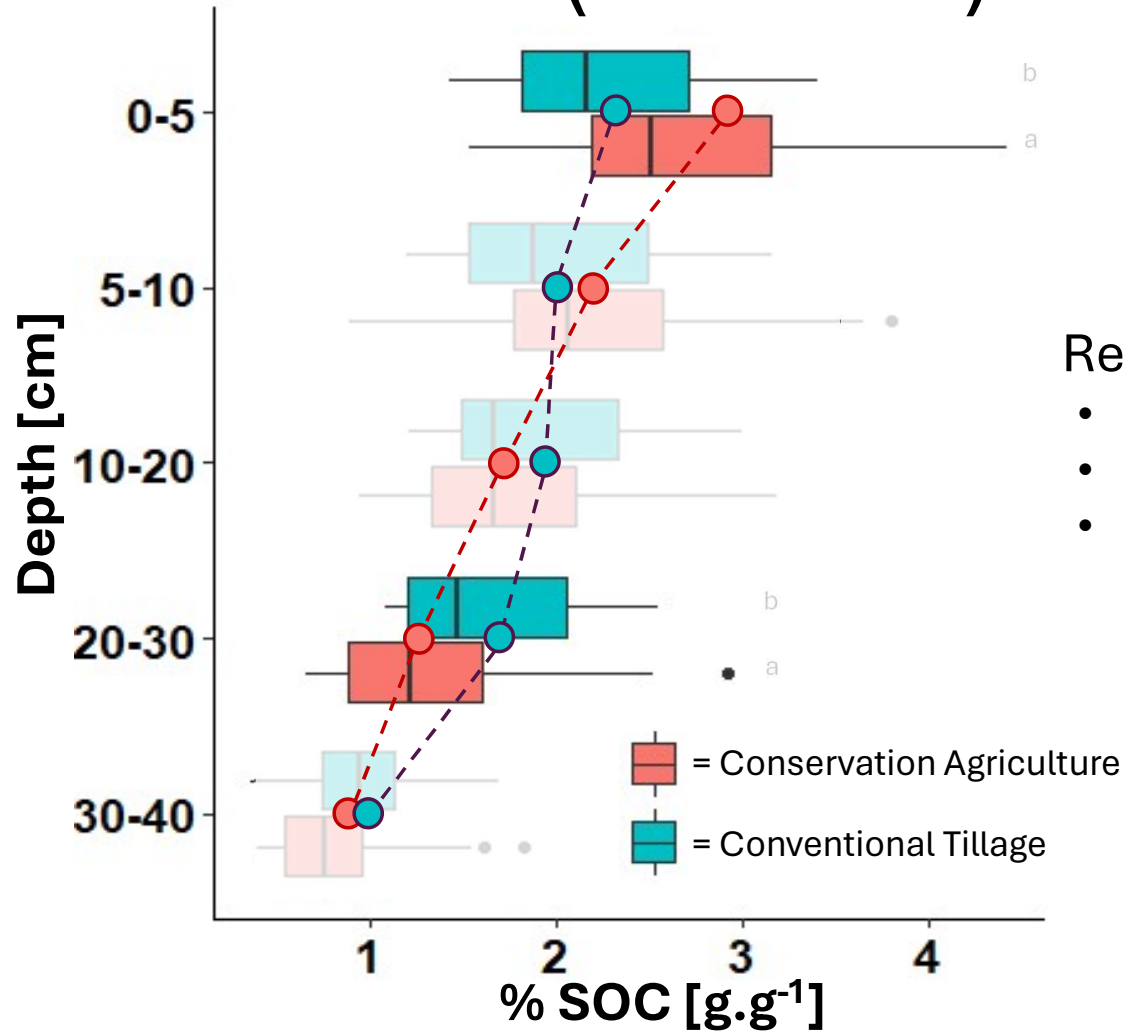
Main objectives of the study:

- 1) Compare the quality of organic carbon under CA and CT
- 2) Study the equilibrium of OM pools according to the degree of clay saturation

M&M : data collected




Results : SOC (CA vs CT)



Relocation of OM in the soil profile

- More SOC for CA at 0-5cm depth range
- More SOC for CT at 20-30cm depth range
- No difference for other depth range

 Not a paired experiment

M&M: Rock-Eval[®] analysis

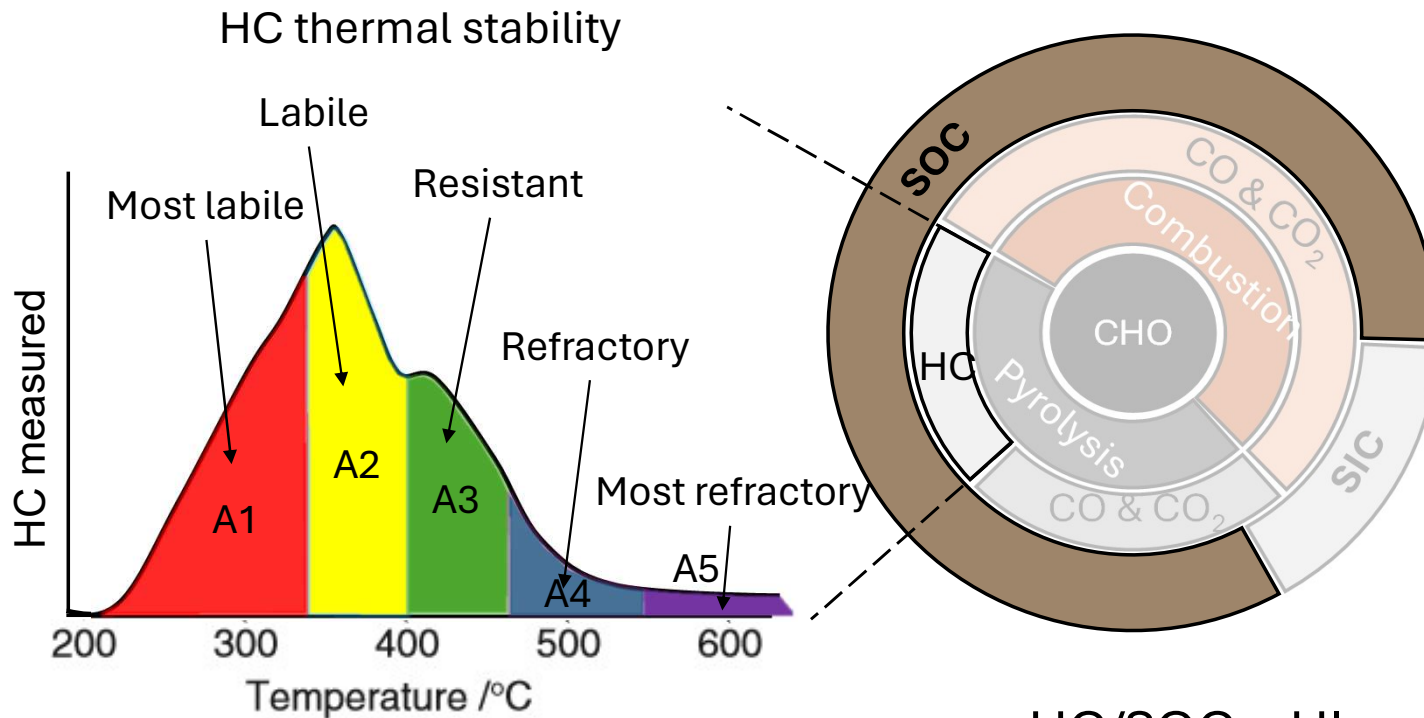


Diagram based on the diagram of Sebag et al. 2006 with the information of Sebag et al. 2016

$$\text{HC/SOC} = \text{HI}$$

HI_x

x = 1, 2, 3, 4 or 5

HC = hydrocarbon compound

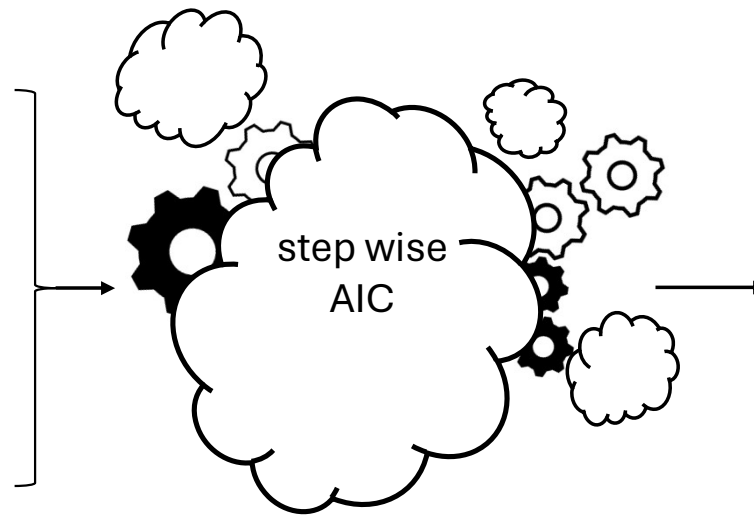
Data analysis : variable selection

Dependent variables

HIAX

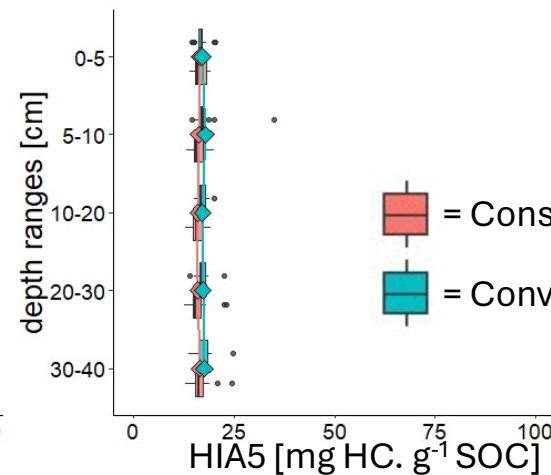
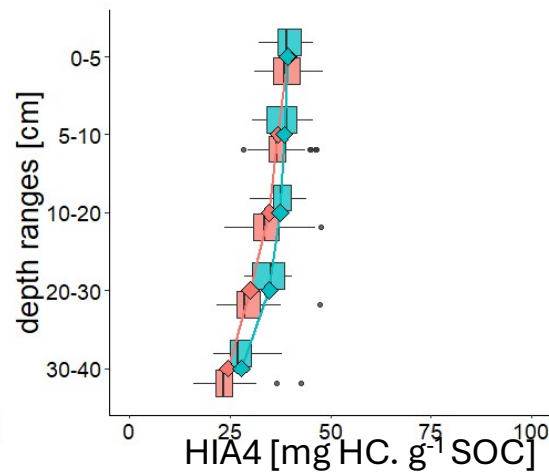
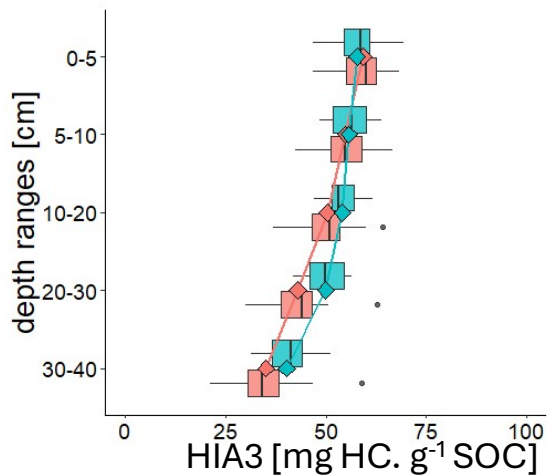
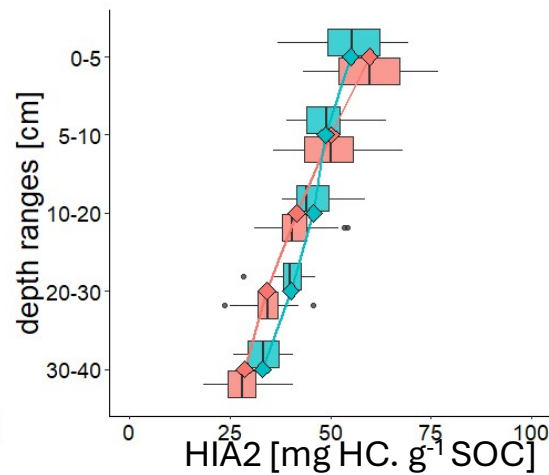
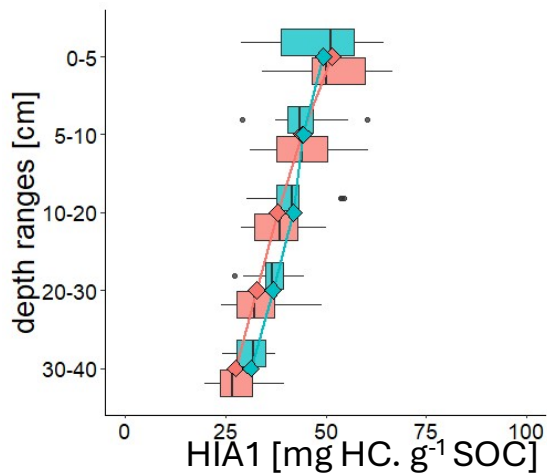
Independent variables

texture fractions (clay, silt, sand)
SOC
SOC:clay ratio
soil tillage
Depth
pH
Rock-Eval® analytical serie °n
Altitude
cumulated rainfall (mm) during the 2 weeks before sampling
....



- **SOC:clay ratio**
- **Depth**

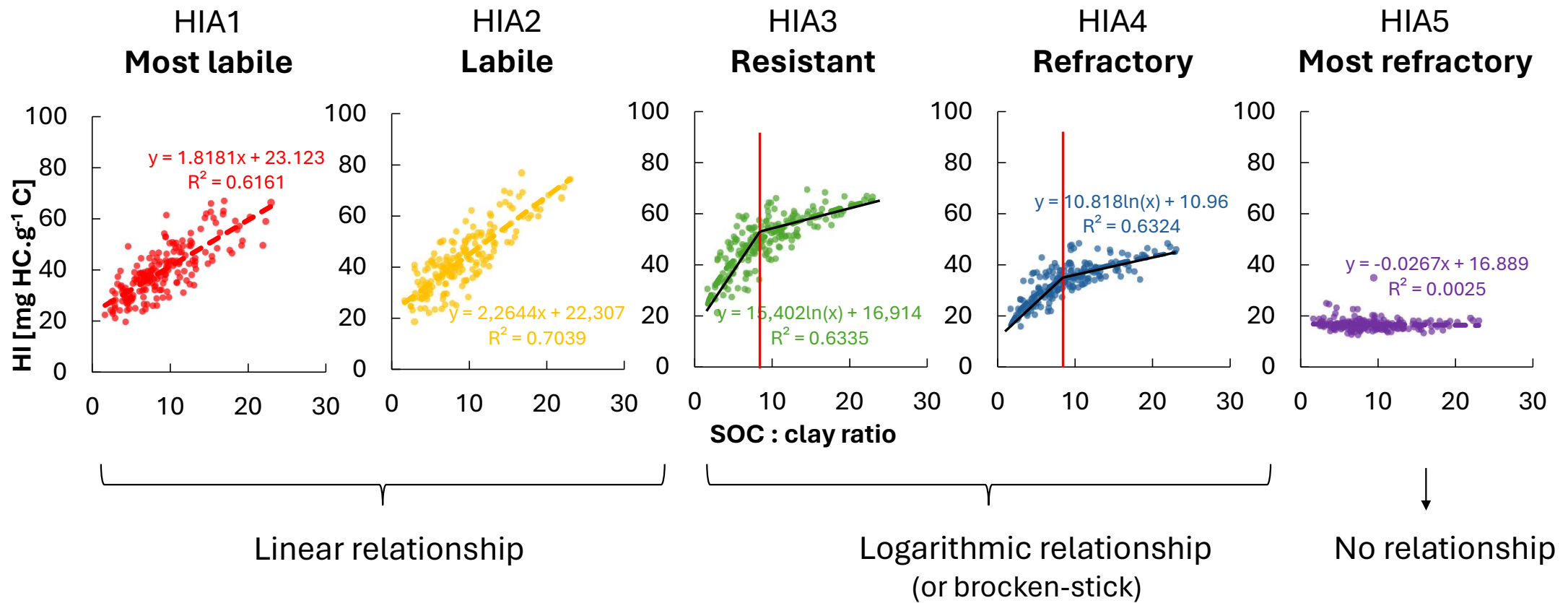
Result: SOM thermal pools (CA vs CT)



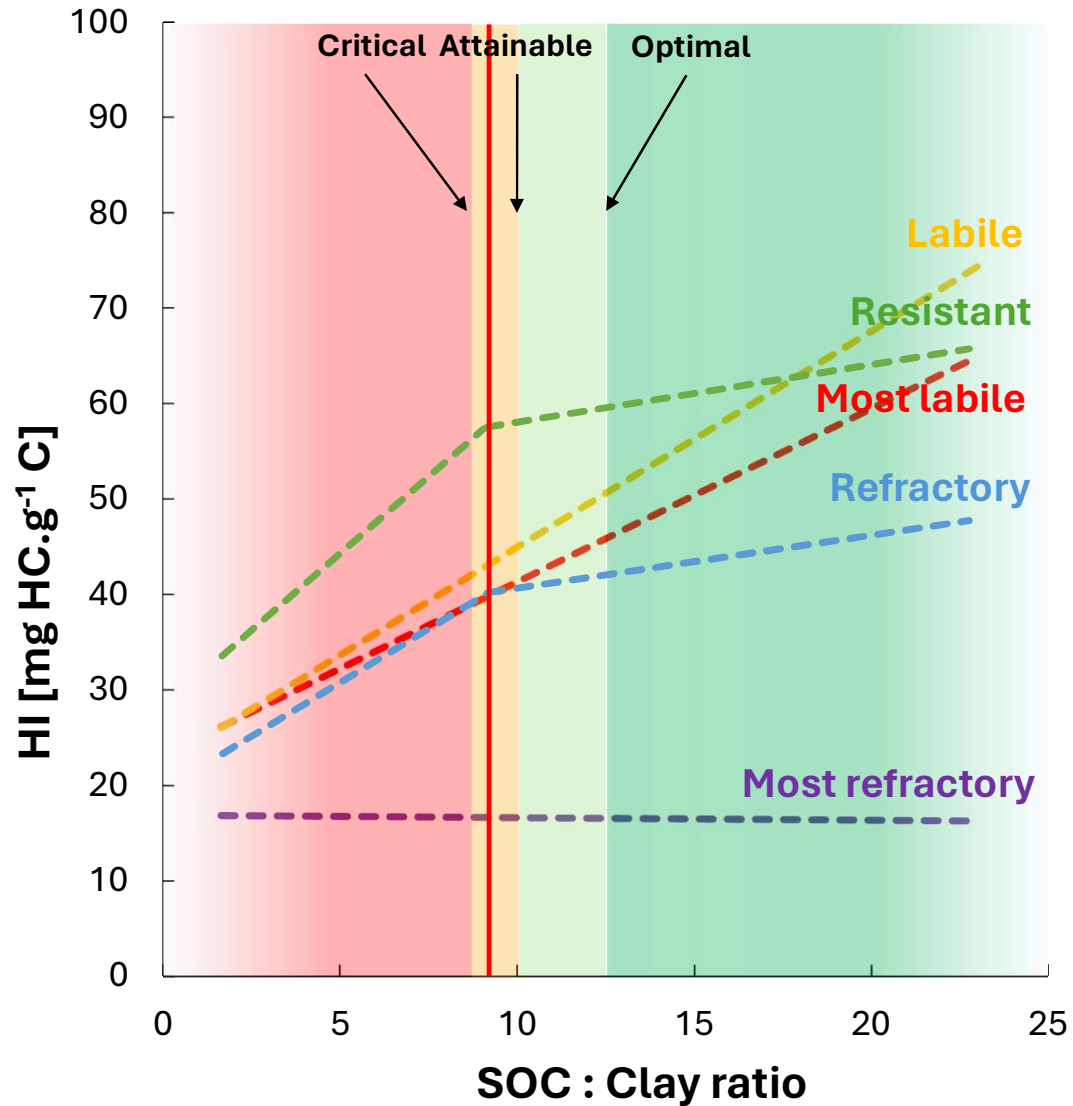
■ = Conservation Agriculture
■ = Conventional Tillage

- Almost no major difference between CA and CT for OM thermal pools
- The remaining differences are driven by the SOC, not practices
- Practices play only an indirect role via the relocation of OM in the profile

Result: Proportion of different HC pools



Structure Vulnerability Index (Johannes et al. 2017)



Structure high vulnerability:
low proportion of resistant and refractory thermal pools

Structure low vulnerability:
big proportion of labile and most labile thermal pools

Conclusion

- No direct differences on OM thermal pools between CA & CT
→ CA & CT are categories too large : need to study practices in more detail
- No clay saturation by OM from quantitative point of view... BUT :
- For OM thermal pools equilibrium : yes !
- Saturation limit point of the SOC:clay ratio correspond to the threshold of the soil structure vulnerability index

Importance to considering both, stable AND labile pools for soil quality



Thank you for your attention

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