

Clay:organic-carbon and organic-carbon as determinants of the soil physical properties

Reassessment of the Complexed Organic Carbon concept

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SOC controls most soil functions

SOC: Soil Organic Carbon



- Direct impact on soil quality
- A “hot” topic at all scales → goals for cropped land ?

Global (worldwide) scale



Local (plot) scale



Global Warming
Carbon sequestration

Eco-functions
Filtration, Water storage,
Soil stability



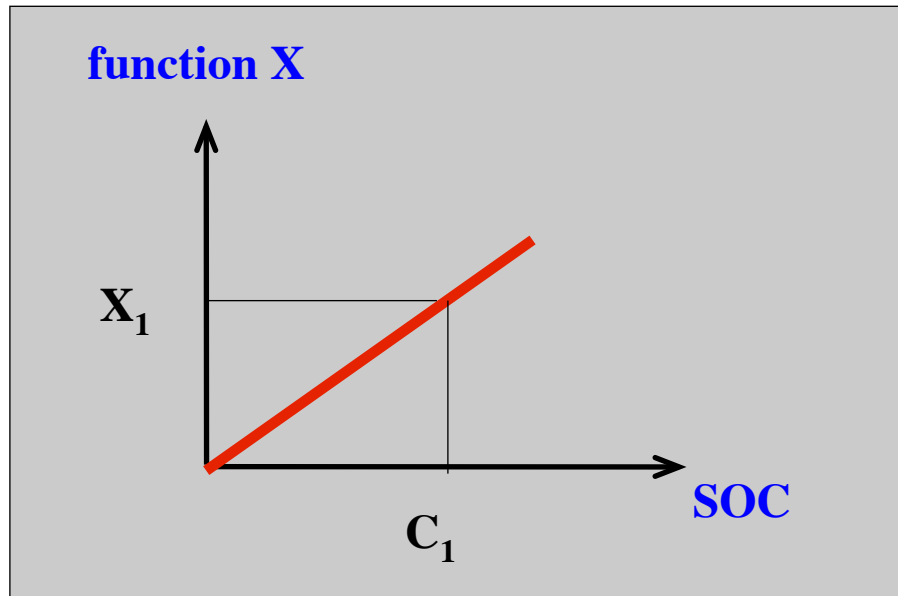
Biodiversity
Habitat and gene
reservoir

EGU - 2016

Fertility
Crops yields

Haute école du paysage, d'ingénierie
et d'architecture de Genève

SOC and Physical properties



- Porosity
- Water retention
- Plant Available Water
- Air content
- Infiltration
- Mechanical properties
- Stability
- Biological activity
- Nutrient reserve
- Depuration
- Etc.

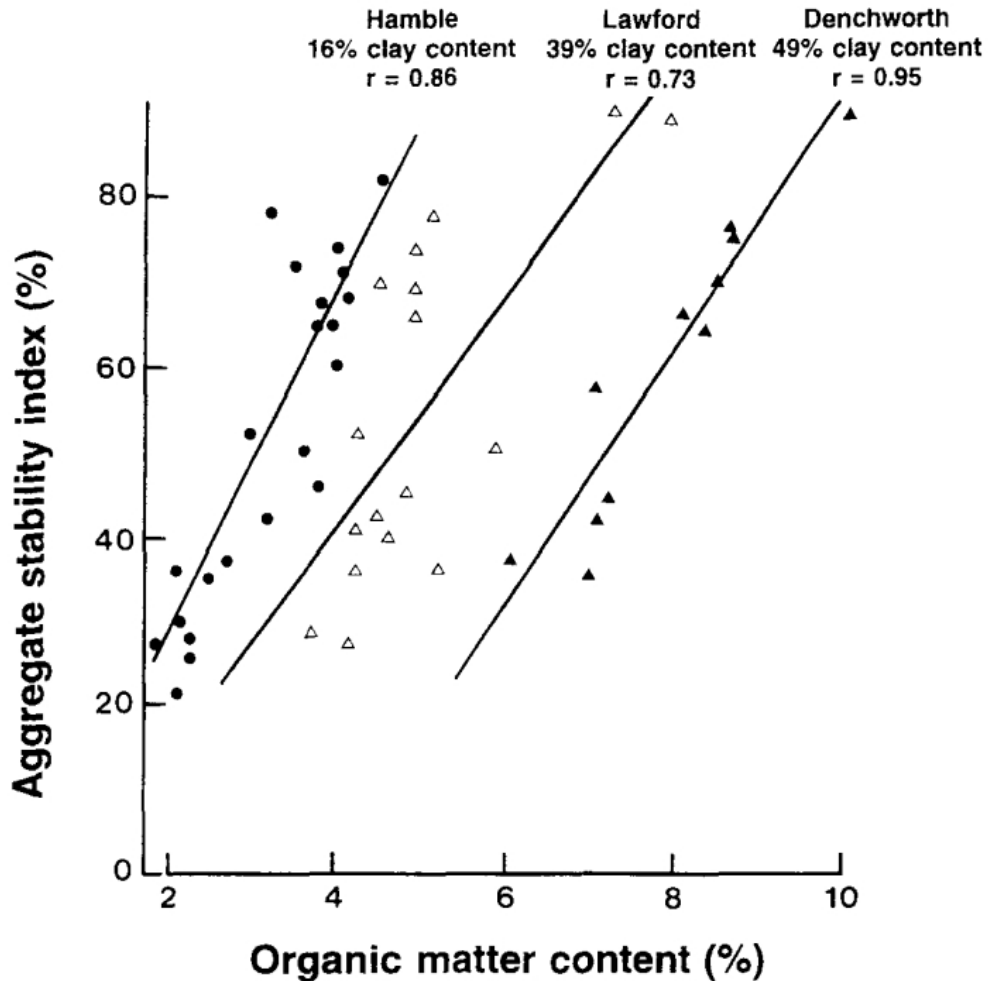
Is the relation always linear ?

More is better ?

Goals for soil management ?

Reasonable targets ?

Does clay content matter ?



«increasingly higher quantities of C were required to achieve the same level of aggregate stability in soils of increasing clay content (16-49% clay)».

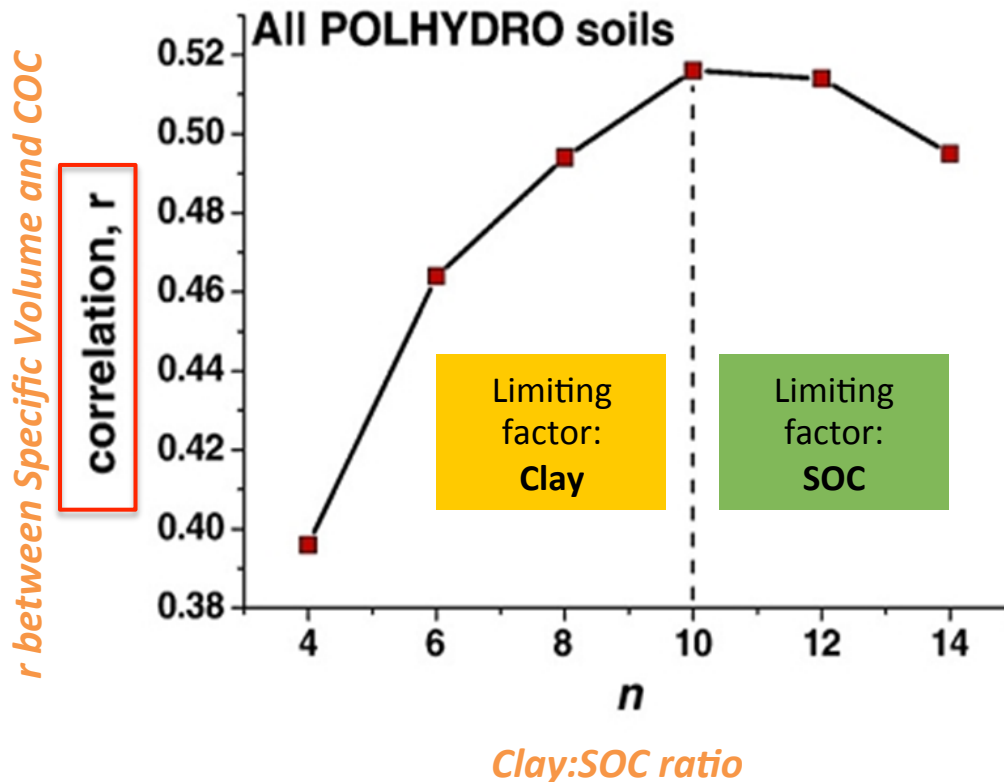
Feller and Beare 1997

Clay:SOC ratio and determination of the physical properties : “complexed” OC: **COC**



“Complexed organic matter controls soil physical properties”

Dexter et al. 2008



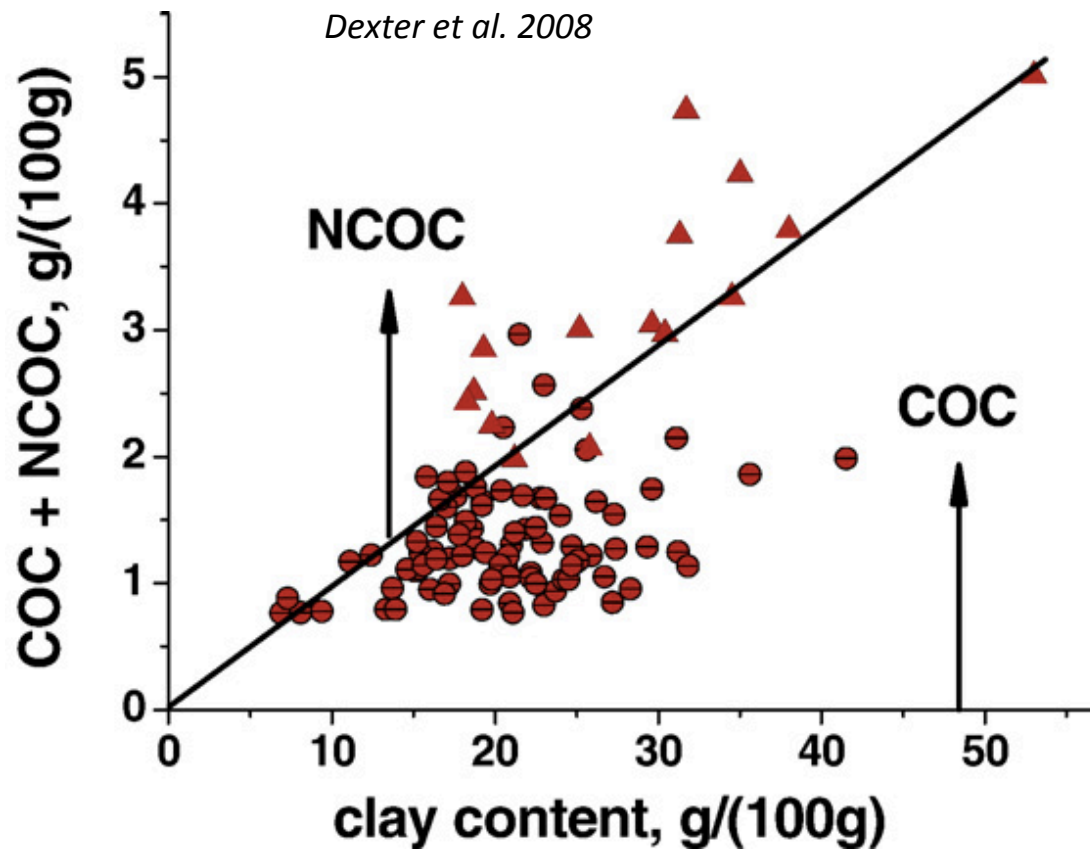
clay:SOC = 10
would be an
optimum ?



Permanent pasture



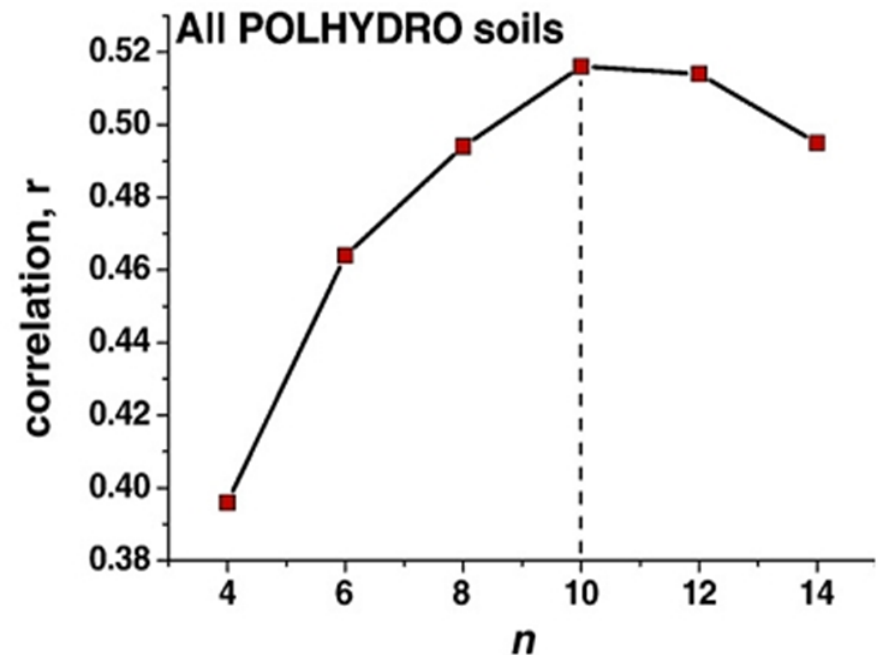
hepia - Agronomie



Many questions with the empirical COC approach



- Different databases along the study
- Different soil types (bed rock, pedogenesis)
- Decreasing $n \rightarrow$ less samples and more sandy soils along the graph
- Methods for volume measurement ? Field water content ?
- Structural state of the samples ?
- Optimum for r , but for the properties ?
- Etc.



Methods



- Large scale sampling, unique soil order and bed rock (Cambi-luvisol)
- Shrinkage analysis
- VESS scoring of the samples analysed
- Discuss SOC effect on physical properties
- Similar mineralogy, large texture and SOC ranges
- Volume at controlled matric potential
- + other physical parameters
- Classes of structural quality



Adapted from Ball et al. (2007) by Johannes et al. (in prep).

Sampling site: Swiss plateau



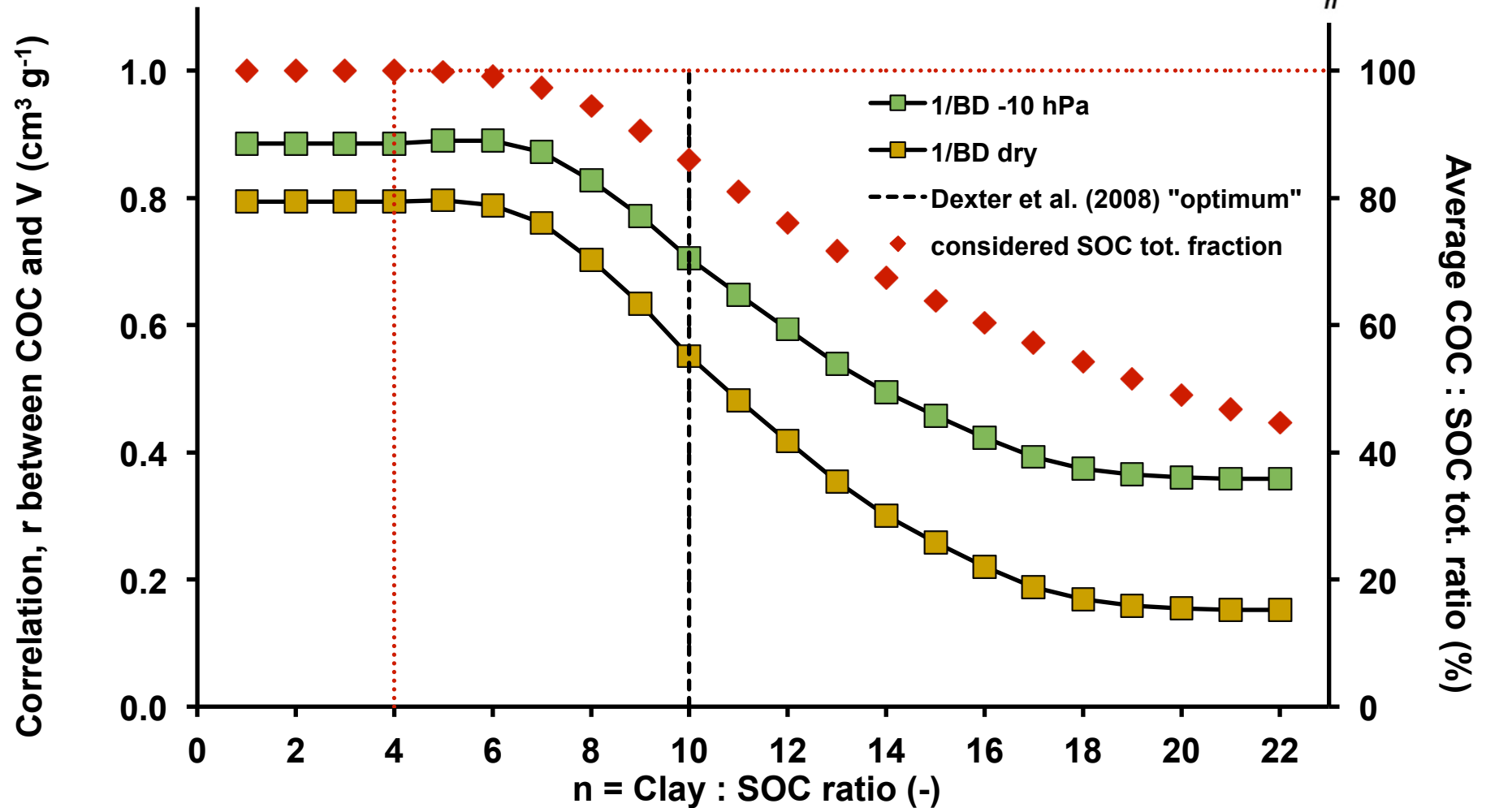
- 120 km across the Swiss plateau
- 157 undisturbed samples randomly collected
- From spring to autumn (2012 – 2014). Topsoil (5-10 cm)
- 3 different managements: No-till ; Conventional tillage ; Permanent pasture

**Cambi-Luvisol on
morain - molasse**

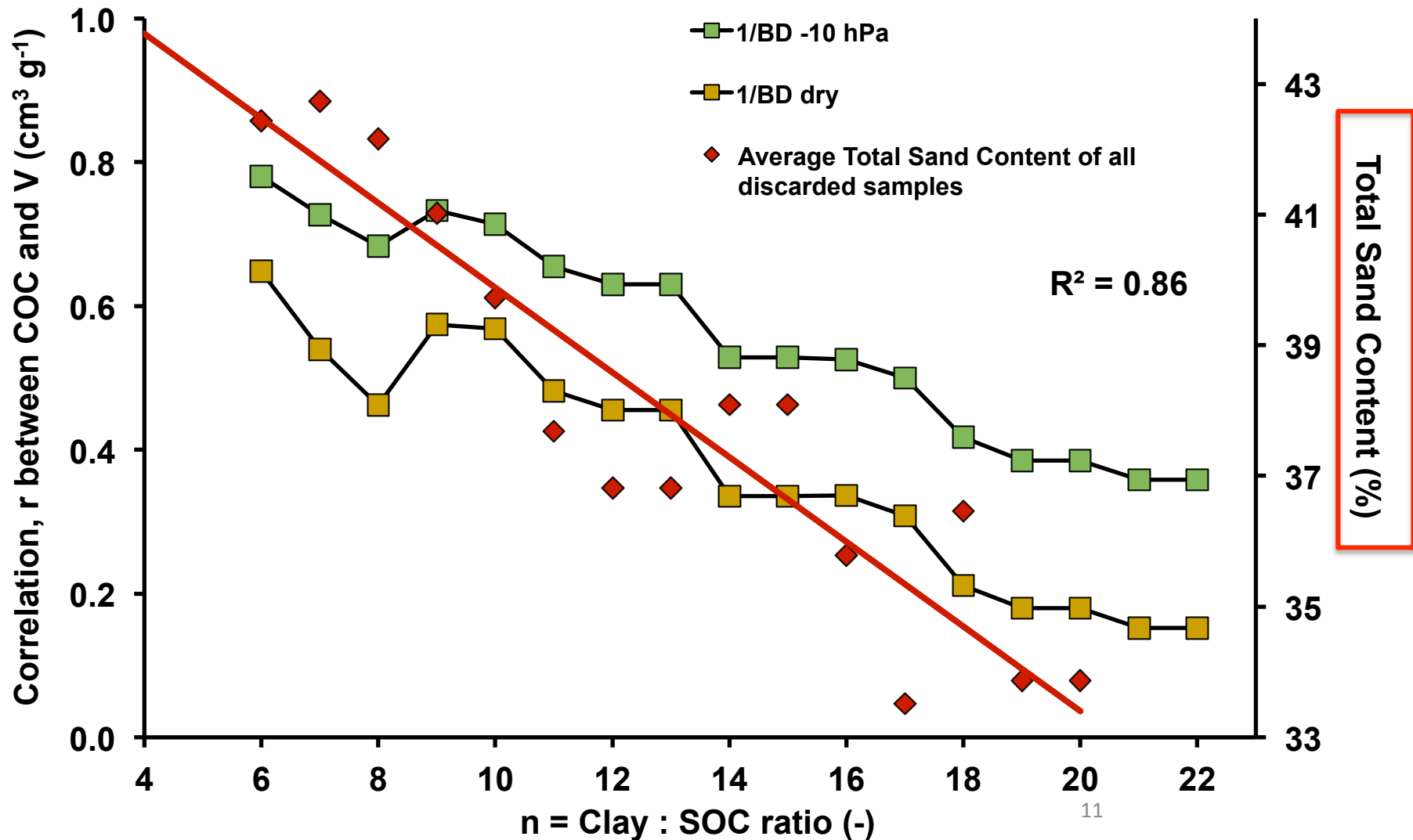


Soils with good VESS score

Volume at -10 hPa and air-dry



Modified formula (sample exclusion)

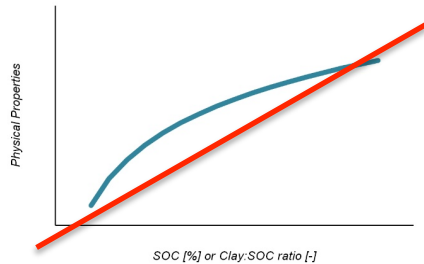
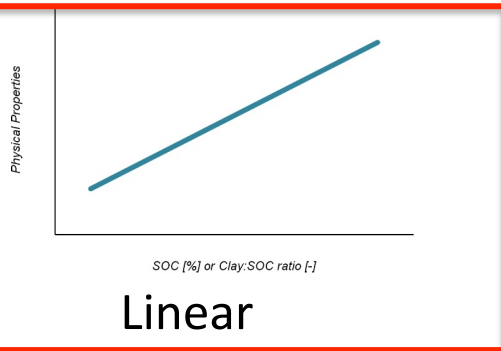


Partial conclusions

- There is no optimum of the correlation between clay:soc ratio and the physical properties
 - Also true for other parameters than bulk volume, e.g. Structural porosity
- The maximum correlation is obtained when all the SOC is taken into account $n \approx 7$
- The correlations are much larger than in *Dexter et al., 2008*
- What about the physical effect of SOC and clay:SOC ratios ?

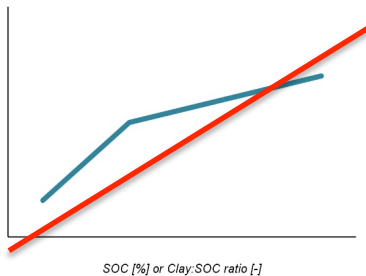
Relation with physical properties

Good VESS score (< 3)



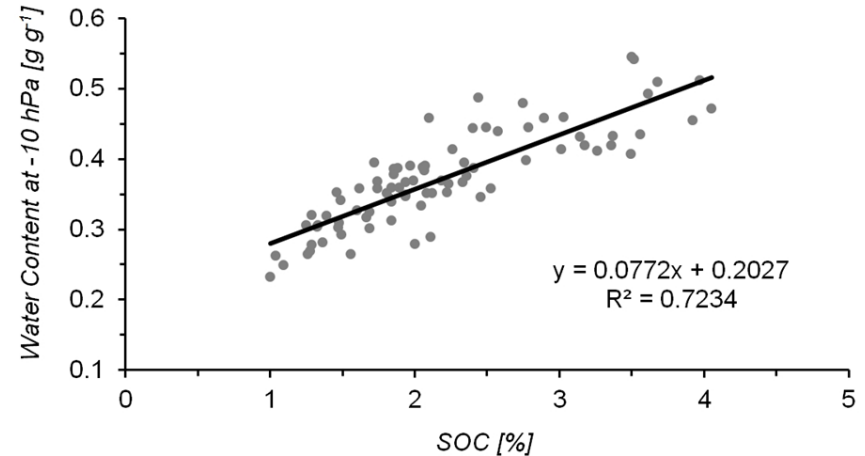
Logarithmic

R^2 is not improved



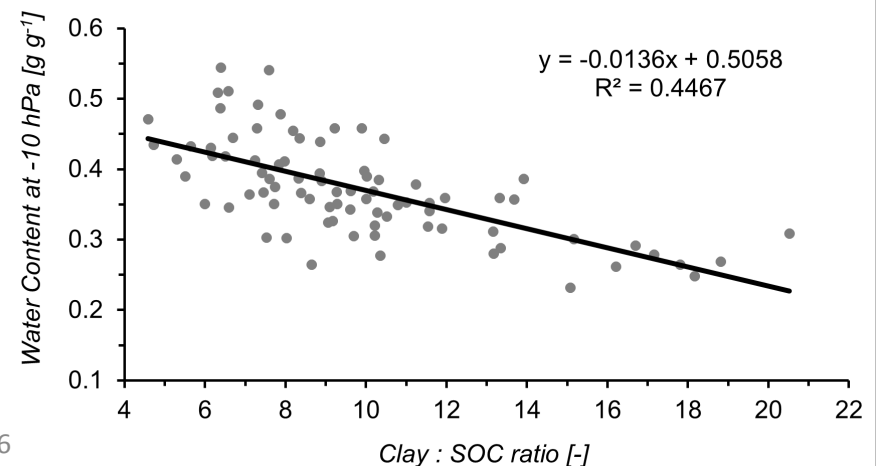
Segmented

No significant breakpoint



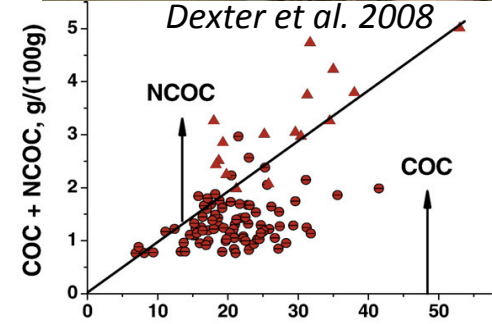
The relation between SOC or clay:SOC and physical properties is linear

R^2 always higher with SOC than with clay:SOC

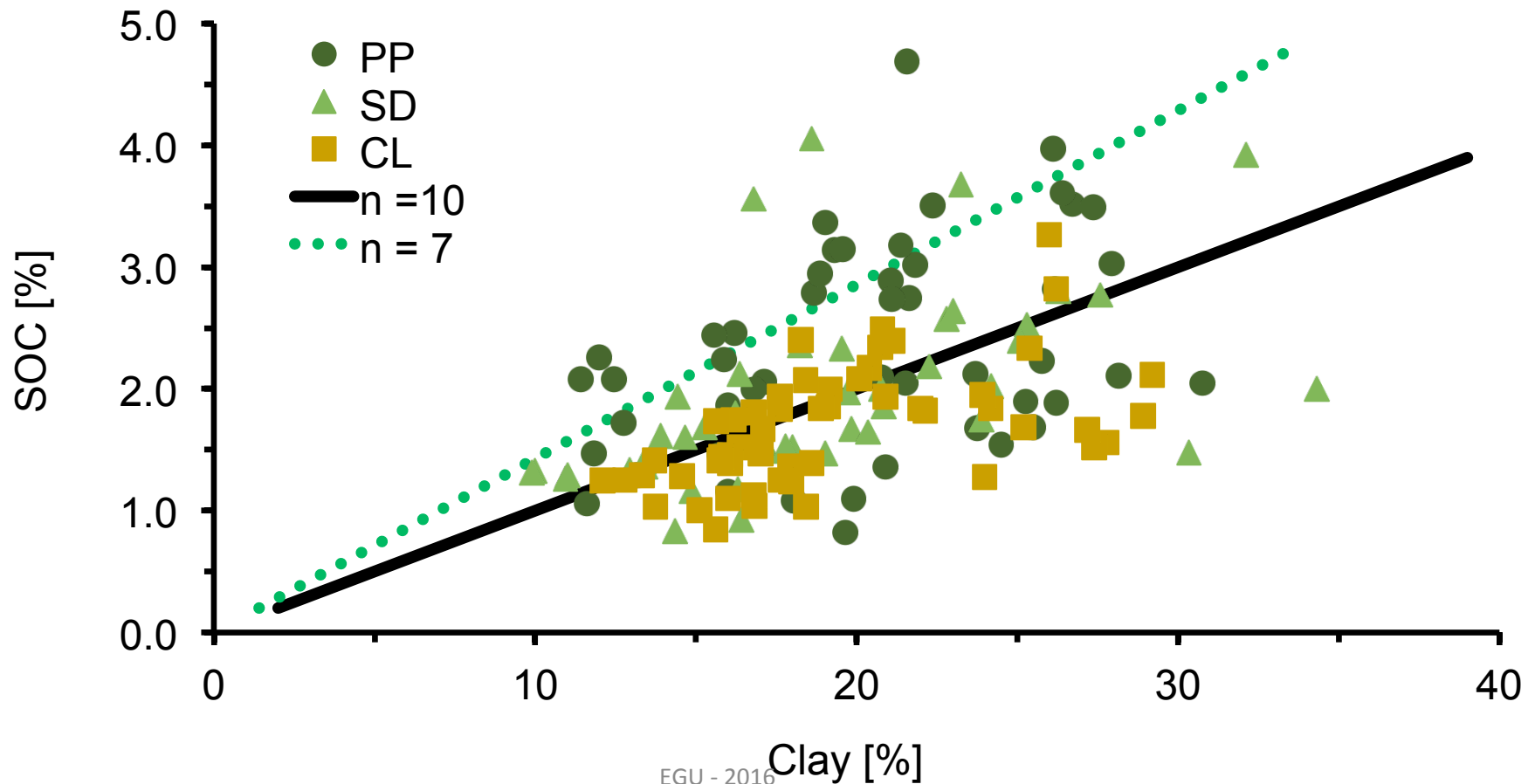


Does clay:SOC matter for soil quality ?

Optimum ratio



All samples

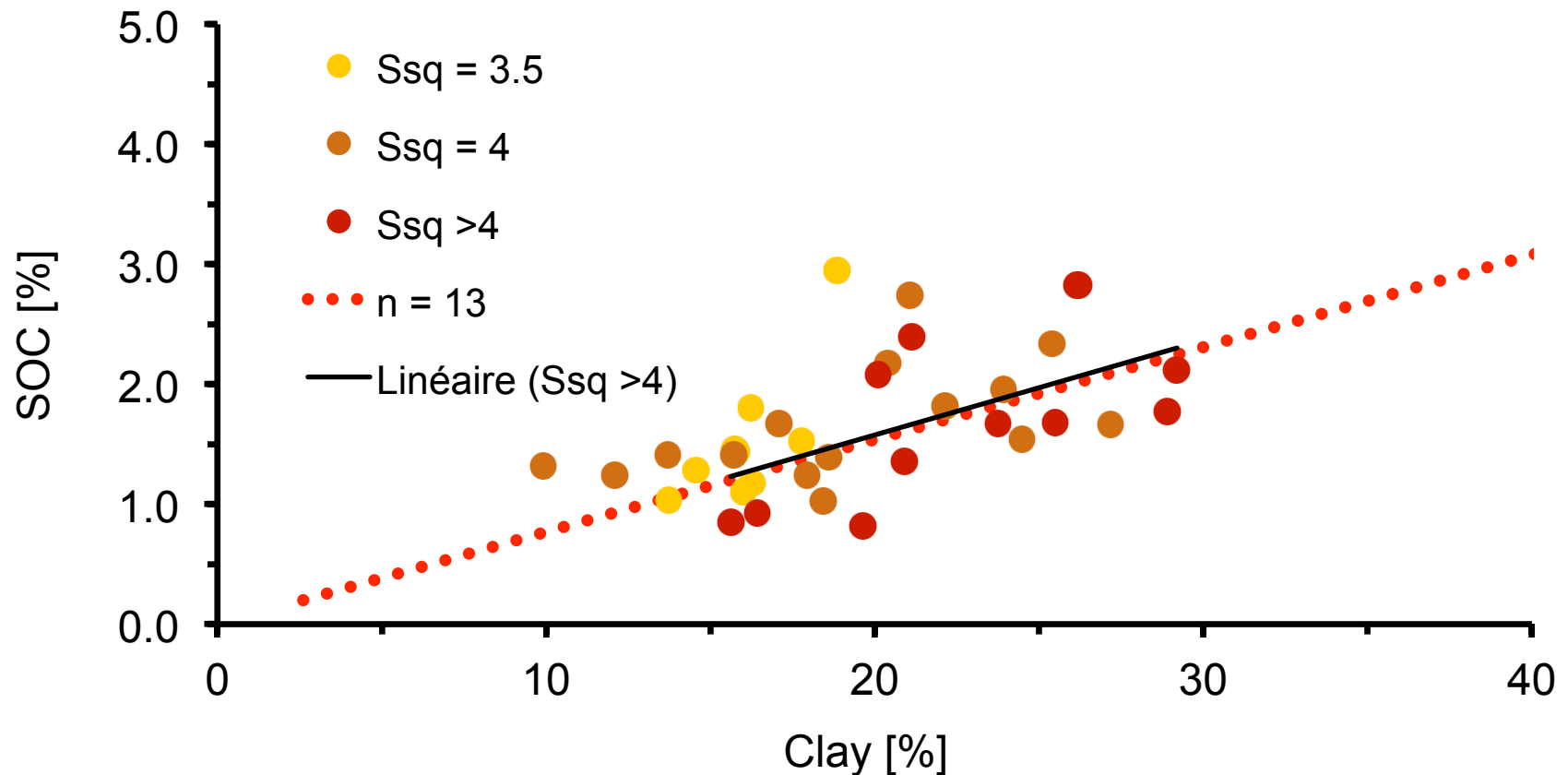


Does clay:SOC matter for soil quality ?

Minimum ratio



Bad VESS scores (> 3)



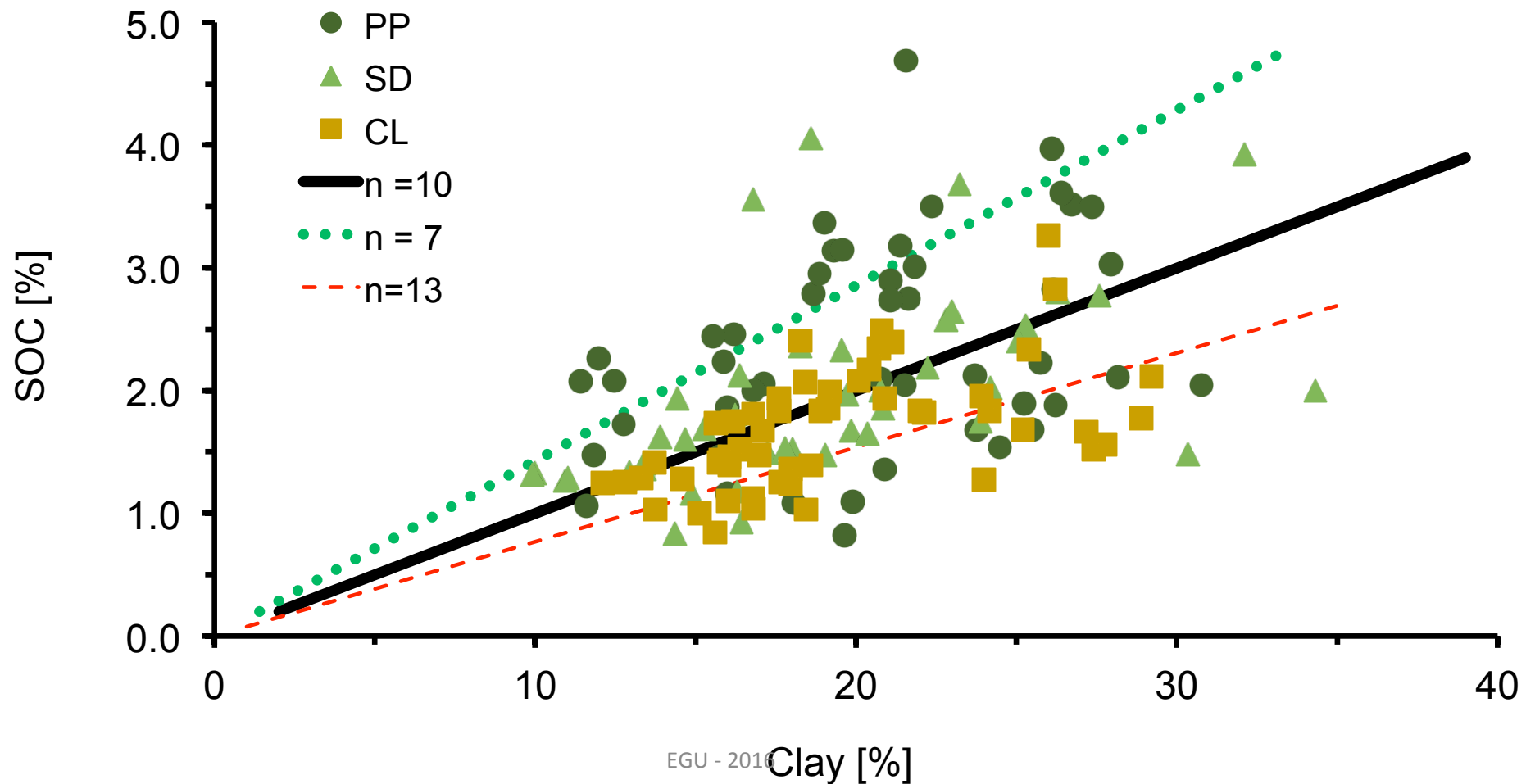
Three different limits



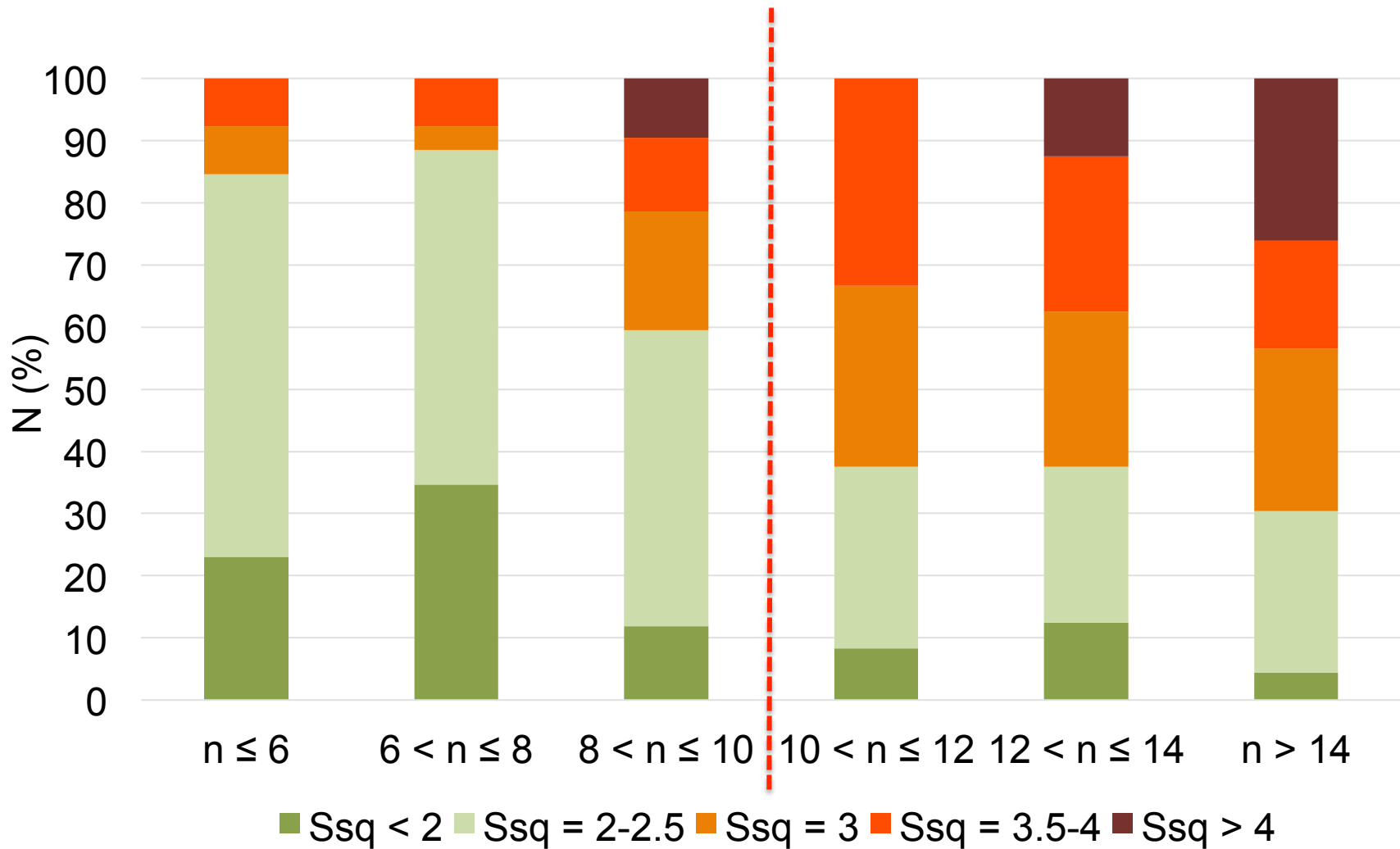
n=10 : reasonable goal

-- n=7 : top value --

n = 13: unacceptable ratio
Average VESS > 4



n=10 and VESS Score=3
(limit of acceptable)



Thank you for your attention



- SOC: for physical properties, the more is the best
- There is no clay:SOC optimum ratio
- However, $n = 10$ is a “reasonable goal” – good agreement with $VESS = 3$
- This soil shows a “Maximum possible SOC” at $n = 7$
- $n = 13$ is average value of the VESS scores > 4 : unacceptable ratio

Thanks to the Swiss Federal Office for the Environment FOEN

