Soil Research Centre

University of Reading

The chemical and physical stability soil organic carbon in the top 1 m of the soil profile under different land uses in the UK



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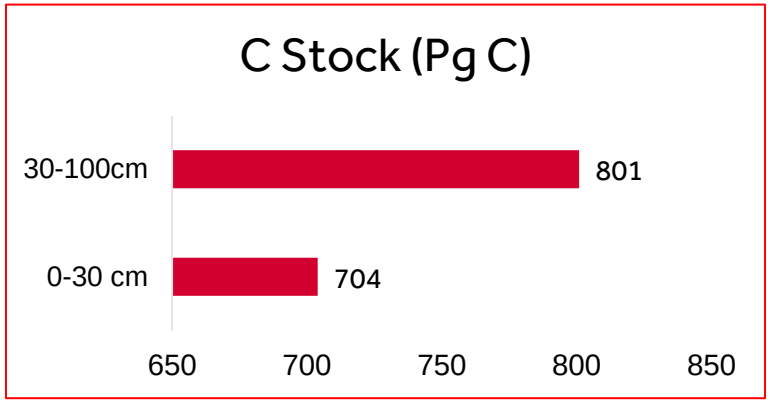
Why is deep SOC important?

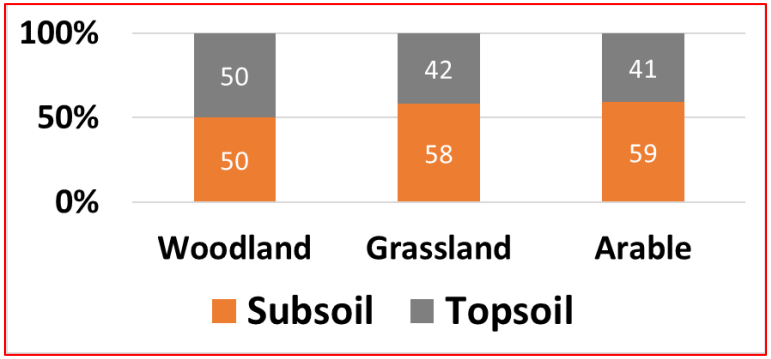
Significant amount of SOC is stored the subsoil (>30 cm)

are **stabilisation mechanisms** responsible for making subsoil carbon stable the same as the mechanisms that make the topsoil stable?

Need to examine **factors affecting** soil carbon storage at depth under different land-uses to assess their capacity to store soil C



Batjes (1996)

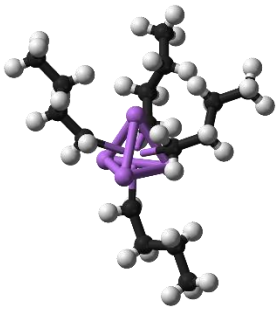


Jobbágy, E. G., & Jackson, R. B. (2000).

How does SOC become protected?

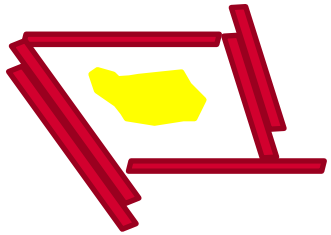
- **Intrinsic Recalcitrance**

Selective preservation and formation of SOM due to resistant molecular structure



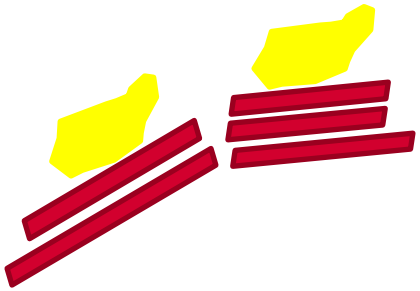
- **Spatial inaccessibility**

Occluded within soil aggregate (**intra macro and intra micro aggregates**) that limit accessibility by decomposer organisms



- **Interaction with mineral surfaces**

Adsorbed to minerals (clay, silt) and metal oxides (e.g. Al, Fe, Mn)



Lutvow et al., 2006

RESEARCH LOCATION & METHODS

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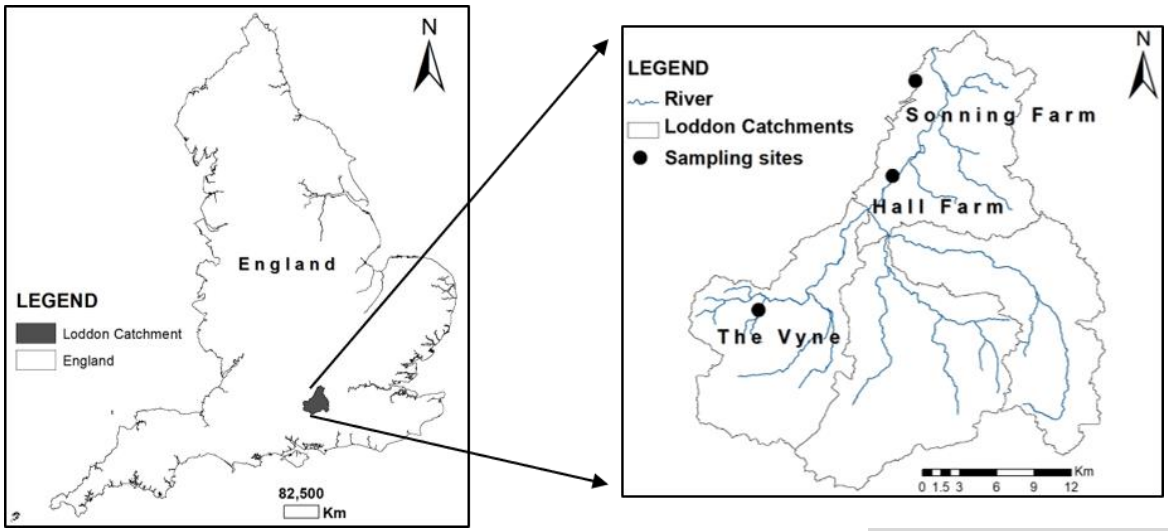
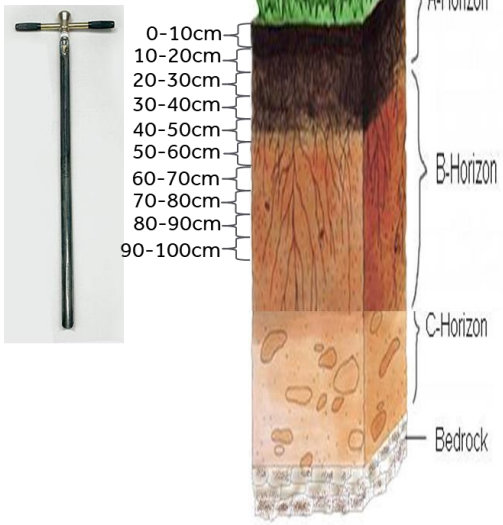


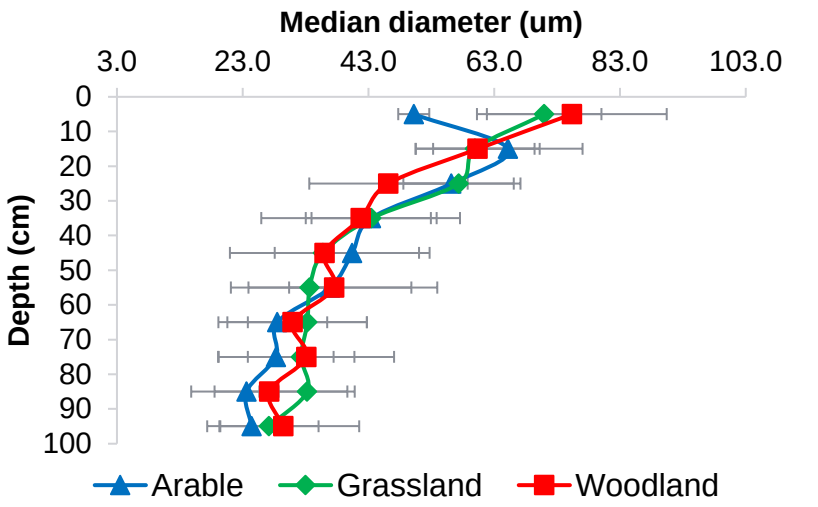
Soil samples were collected from **Arable, Grassland, Woodland** in each location



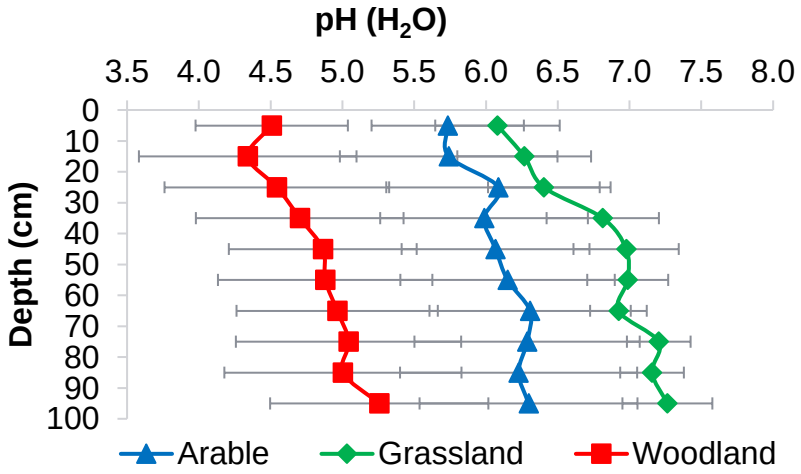
All samples were analysed for texture, pH, Carbon and Nitrogen.

selected layers (i.e. 0-20cm, 20-30cm, 50-60cm and 90-100cm) analysed for **SOM fractionation** and **Mineral availability** (ammonium oxalate extraction) analysis

Soil Properties



- Texture becomes more fine down the soil profile
- **Similar texture** under eachland use ($p>0.05$), but significantly different between with depth ($p<0.05$)



- pH increased down the soil profile
- On average, **Woodland> Grassland > Arable** ($p<0.05$)
- but not significantly different with soil depth ($p>0.05$)

TOC, Nitrogen, & C:N Ratio

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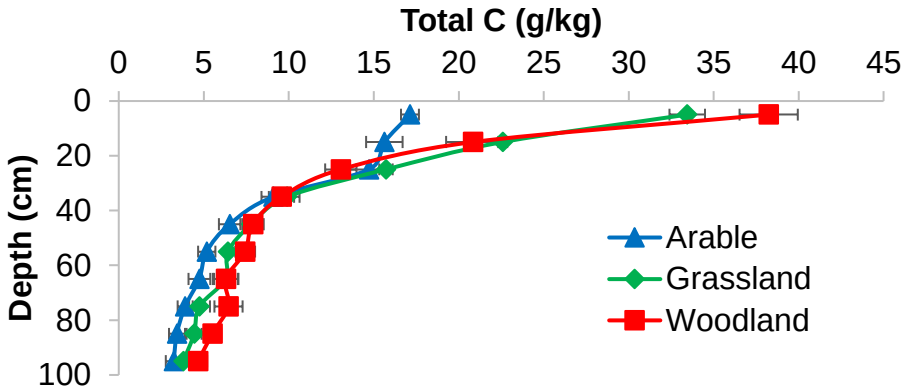
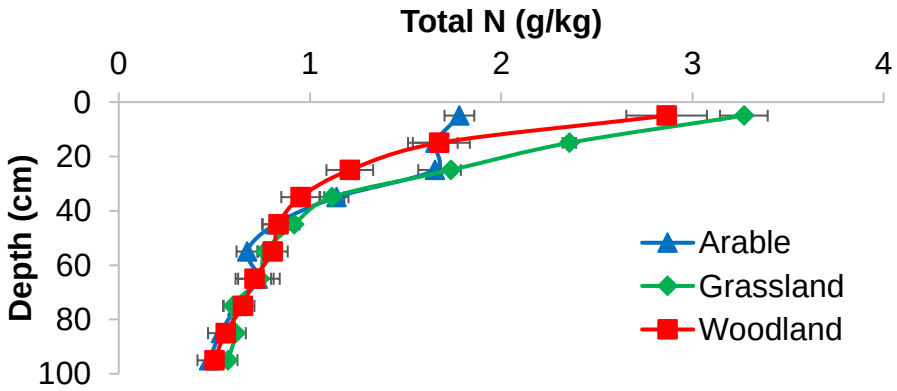
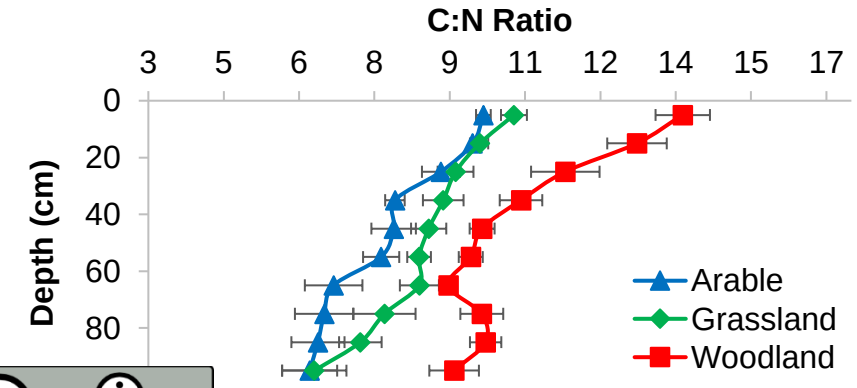


- Total C decreased down the soil profile
- On average, **Woodland> Grassland > Arable**

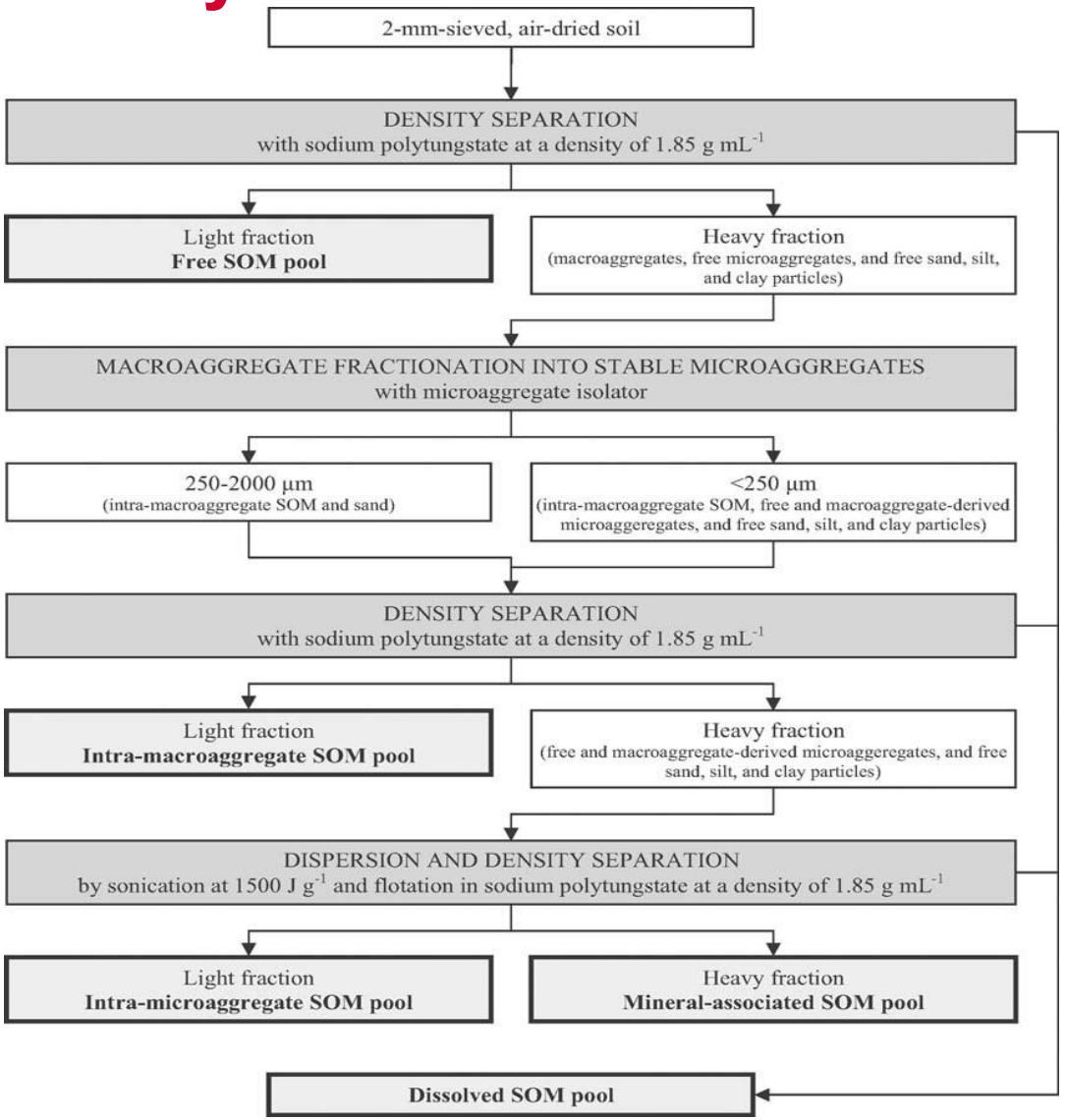


- Total N tends to decrease down the soil profile
- On average, **Grassland>Woodland > Arable**



- C:N ratio values decreased down the soil profile
- On average, significantly different ($p<0.05$) between **Woodland> Grassland> Arable**

SOC Physical Fractionation



Plaza et al. 2012

Sample used representative layer from each land use

Topsoil :
0-10cm & 20-30cm

Subsoil :
50-60cm & 90-100cm

SOC Physical Fractionation

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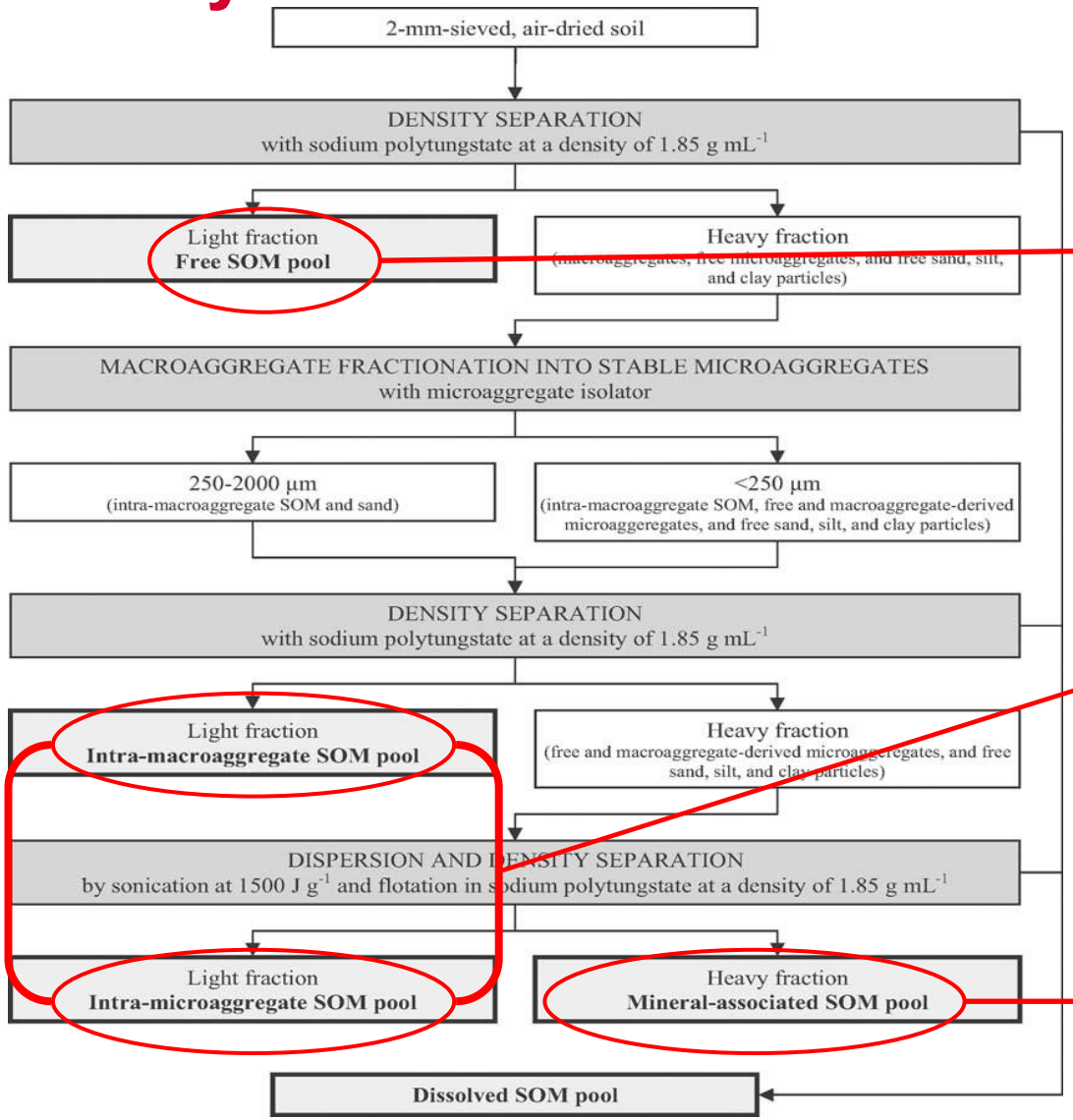

Free SOM or fPOM considered as the most **labile fraction**

Physical protection including occlusion in intra macro & intra micro aggregates

Mineral protection mechanism as a result of sorption to mineral surfaces

Plaza et al. 2012

SOC Physical Fractionation

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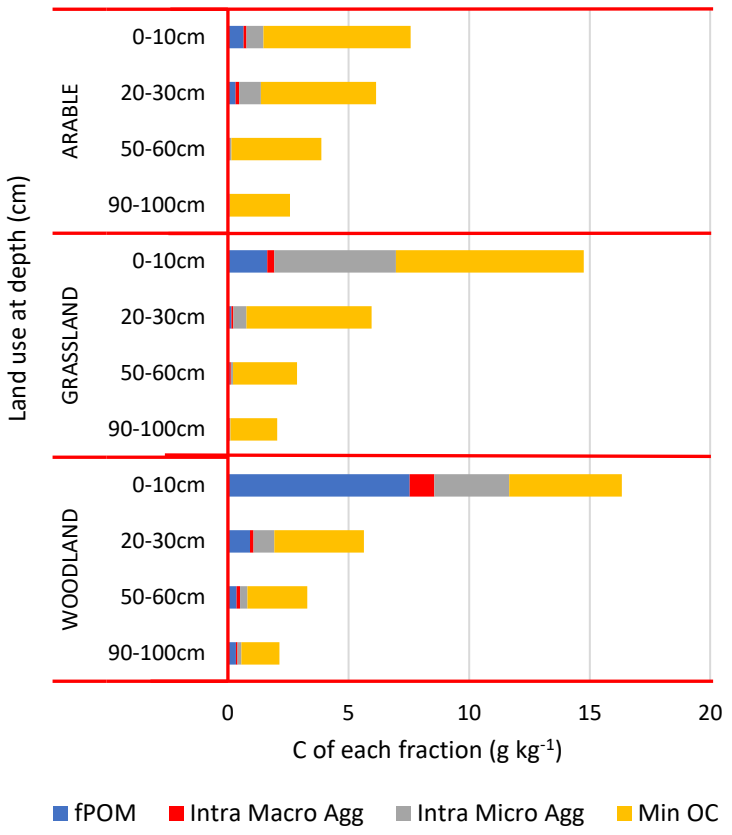
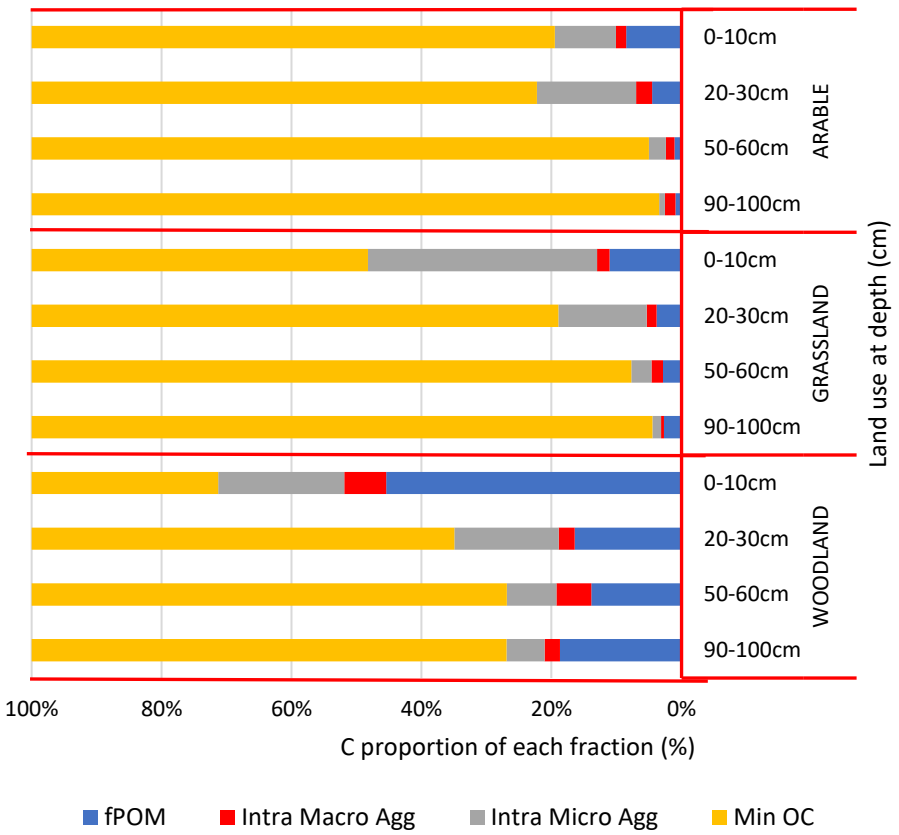
C concentration of each fraction in different pool of SOM

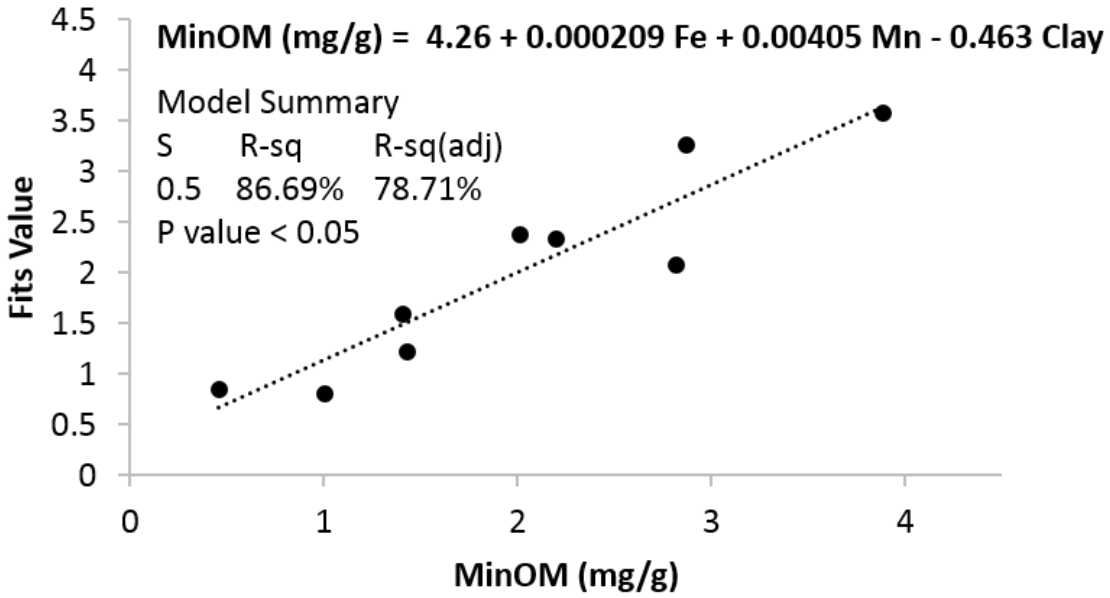


C proportion of each fraction in different pool of SOM



- Free particulate organic matter (fPOM), intra macro and micro aggregate is higher in the topsoil than subsoil and decreased down soil profile
- Mineral associated OC (Min OC) dominated subsoil fraction under all land uses

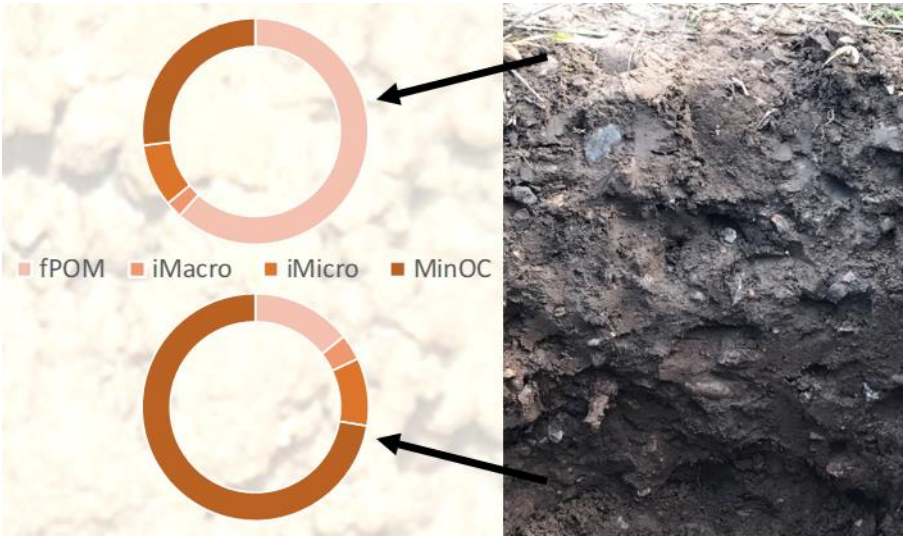
Mineral associated OM and mineral availability at 90-100 cm



Multiple linear regression model demonstrating that mineral associated organic matter content in the 90-100 cm soil layer can be predicted from % Clay (negative association), and ammonium oxalate extractable Fe and Mn (positive association)

Conclusions

- It is clear that **total C, total N and C:N ratio** decrease down the soil profile.
- **Total C and C:N ratio** were significantly different both between land uses and between topsoil and subsoil.
- SOM fractionation found that **free POM** (particulate organic matter) was dominant in the topsoil whereas **mineral associated organic carbon (minOC) fraction** was proportionally greater in the subsoil under all land uses.
- SOC protection of **mineral associated organic carbon** in subsoil layers is regulated by soil **Fe & Mn mineral availability**.
- Subsoil carbon may therefore be **susceptible to future changes in pH** and this should be considered when planning land-use changes (e.g. planting trees)



Acknowledgements

- All my supervisors
- SAGES Technician team
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