Practicalities and policy for soil carbon

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Dr Senani Karunaratne |

Why is SOC quantified?

1. Potential indicator of decline or improvement in soil condition

2. Source of nutrients, particularly nitrogen

3. Partake in carbon sequestration schemes or offset own emissions

SOC…. or SOM?

- Soil organic matter contains carbon, but is more than just the carbon

  SOC is *just* the carbon

- SOC is also usually what's measured

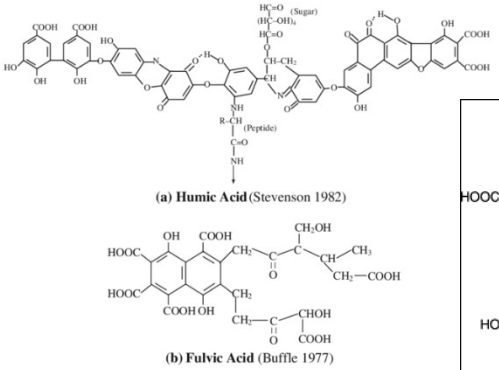
- There are discrete fractions of SOC that behave very differently

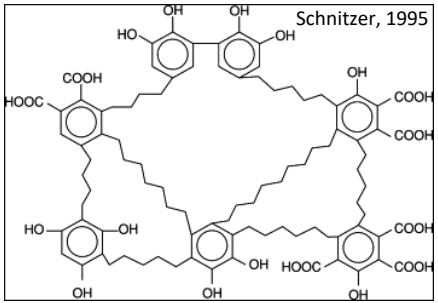
- There is also inorganic carbon

So what is it?

Old view

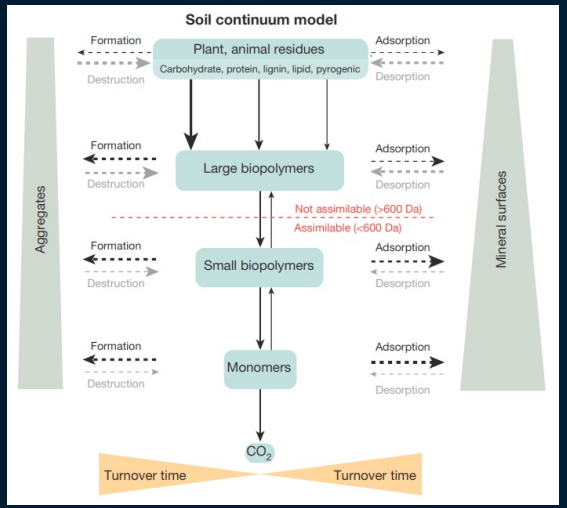
- Defined by its presumptive chemistry and condensation





New view

- Defined by the soil environment and biological reactions



Lehmann & Kleber, 2015

Calculating SOC stocks - volumetrically

$$\text{Soil carbon stocks (Mg C/ha)} = \left[\text{Carbon concentration (g C/kg AD soil)} \times (1 + \theta_m)\right] \times \text{Depth (cm)} \times \text{Bulk density (Mg/m}^3\text{)} \times \left[1 - \text{Proportion of gravel (>2mm)}\right] \times 0.10$$

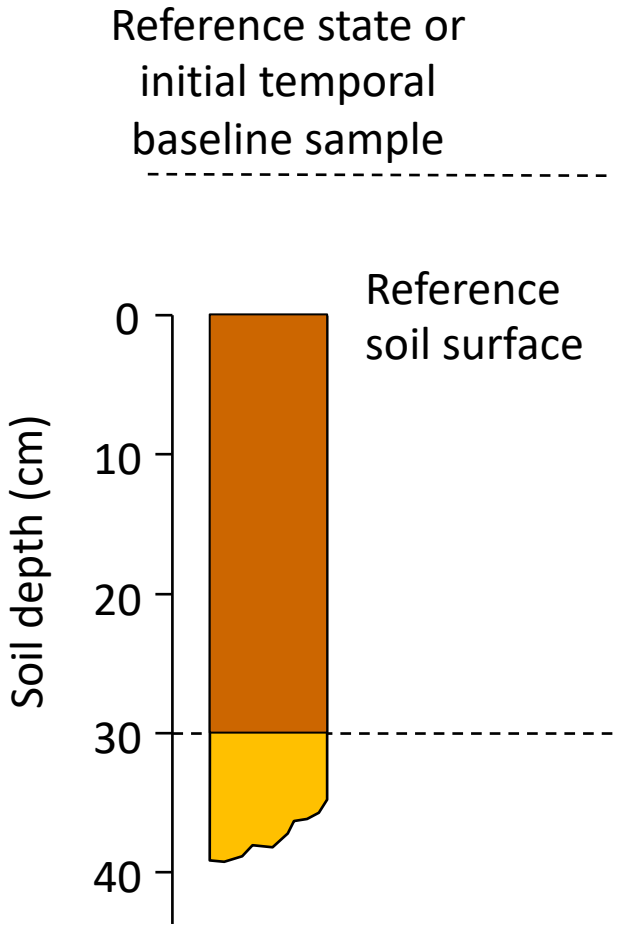
Carbon stocks do not depend on just measurements of C concentration

	Actual	Measured
OC (g OC/kg soil)	25.4	25.4
θ_m (g water/g soil)	0.12	0.14
Depth (cm)	30.0	30.2
Bulk density (Mg soil/m^3 soil)	1.25	1.30
Gravel (g gravel/g soil)	0.12	0.10
Soil carbon stock (Mg C/ha)	92.9	102.3

Error of approximately 10%

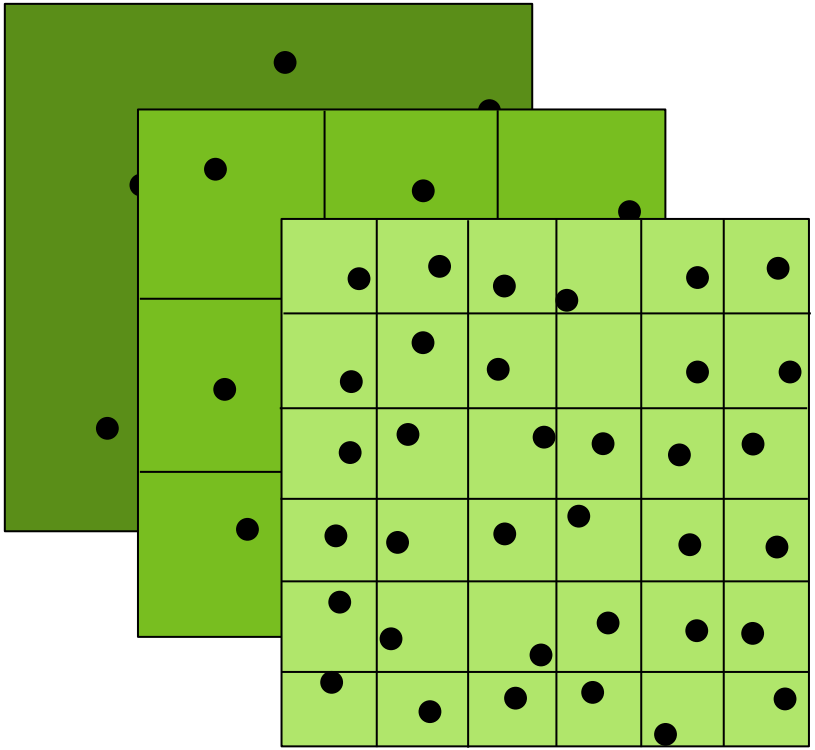
The manner in which soil samples are collected and processed is very important

Equivalent soil mass

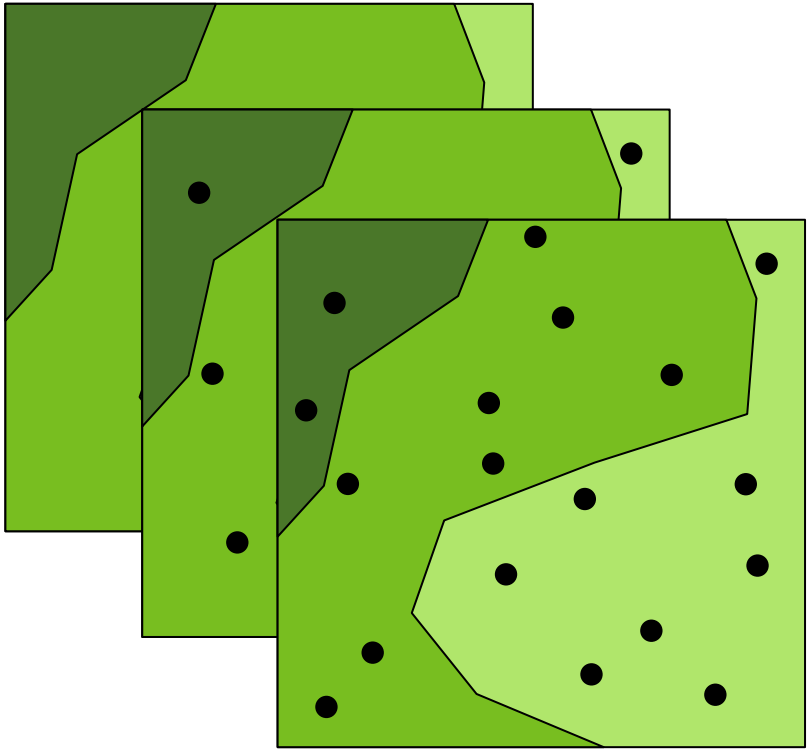


Sampling strategies

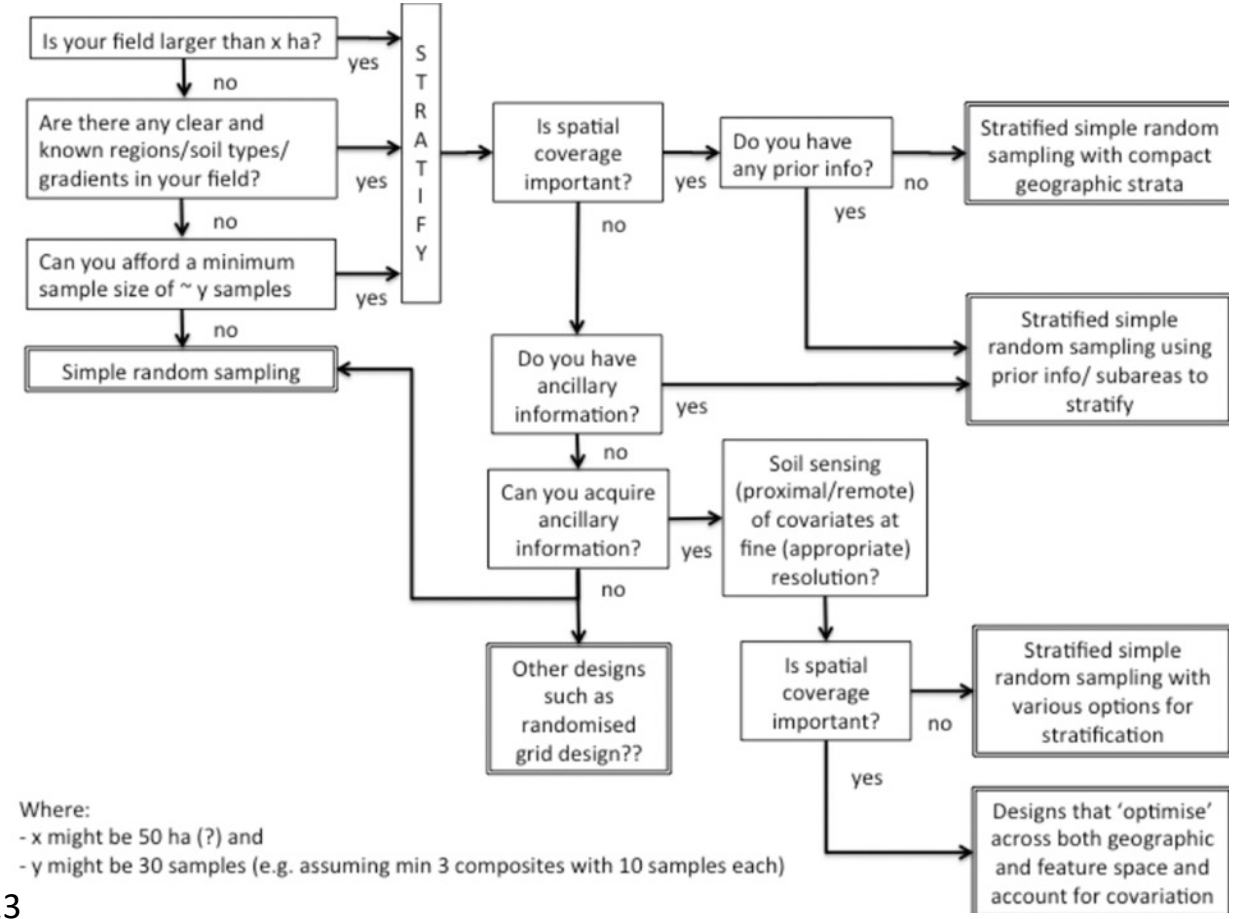
No prior information



Spatial distribution known



What strategy is appropriate?



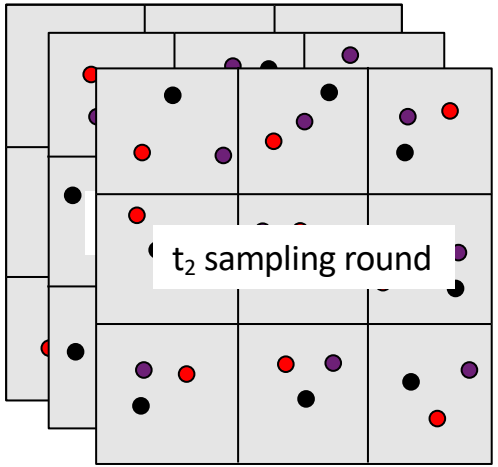
Chappell *et al*. 2013

Direct measurement soil carbon ERF methodology

Method prerequisites:

- based on direct measurement
- no prior knowledge of SOC spatial variability
- allow two depth layers, and
- conservative in its estimate of stock change

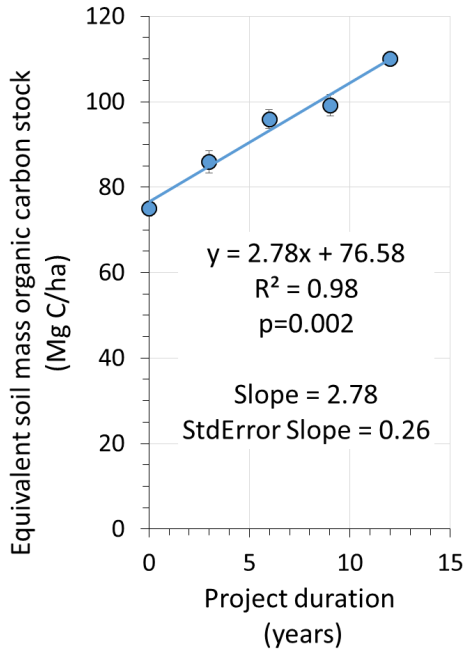
Baseline sampling round (t_0)

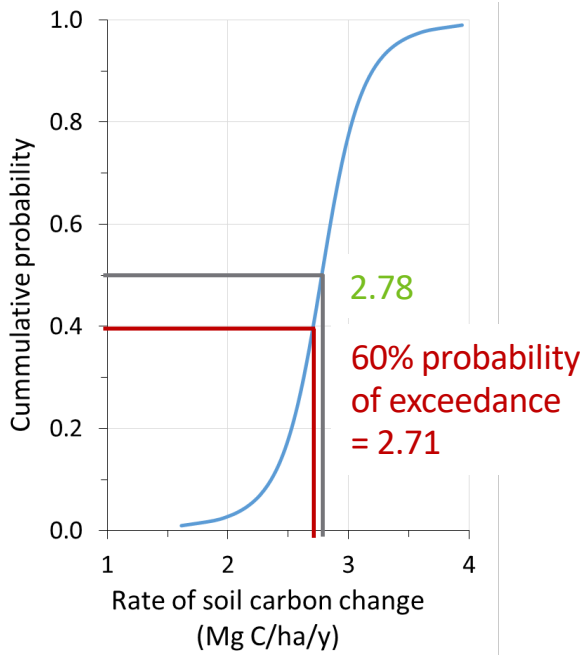


- Stratified random sampling within equal area strata
- Create composite samples by acquiring a soil core from each stratum
- Each composite sample encompasses spatial variability
- Variability between samples sent for analysis is reduced
- Improved ability to detect temporal change

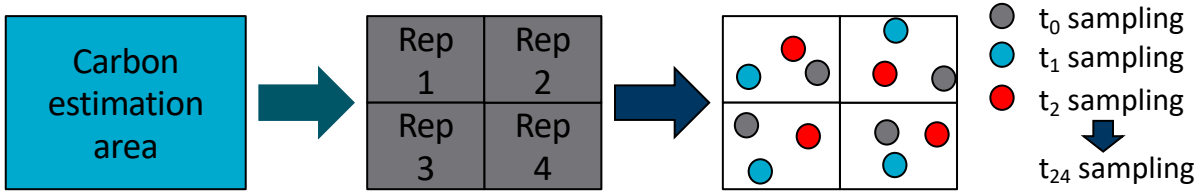
Quantifying the temporal change in ESM soil carbon stock

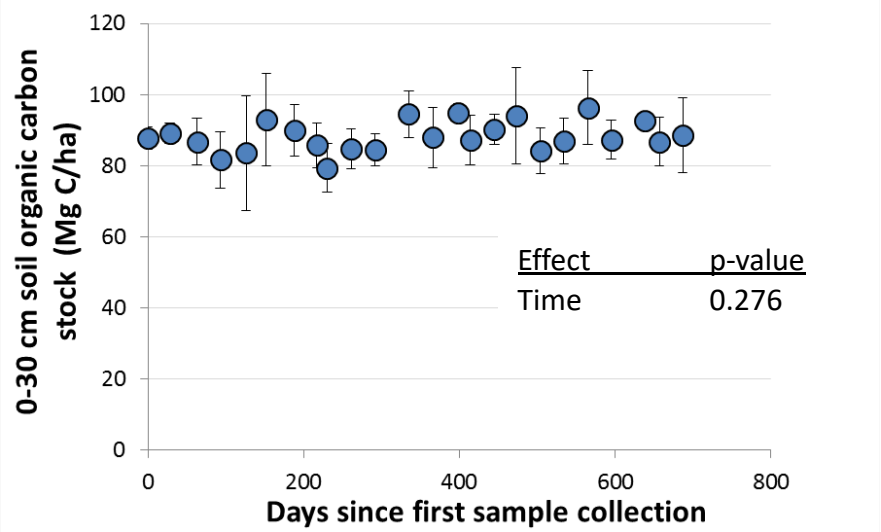
Statistics	t_0	t_1	t_2	t_3	t_4
Project duration (y)	0.00	2.98	5.98	9.02	11.99
Average (Mg C/ha/y)	75.01	85.94	95.96	99.12	110.15
Stdev (Mg C/ha/y)	1.84	2.61	2.15	2.52	1.17
Sample size (n)	4	4	4	4	4





Temporal changes in 0-30 cm soil organic carbon stock at Armidale (grazed tall fescue pasture)

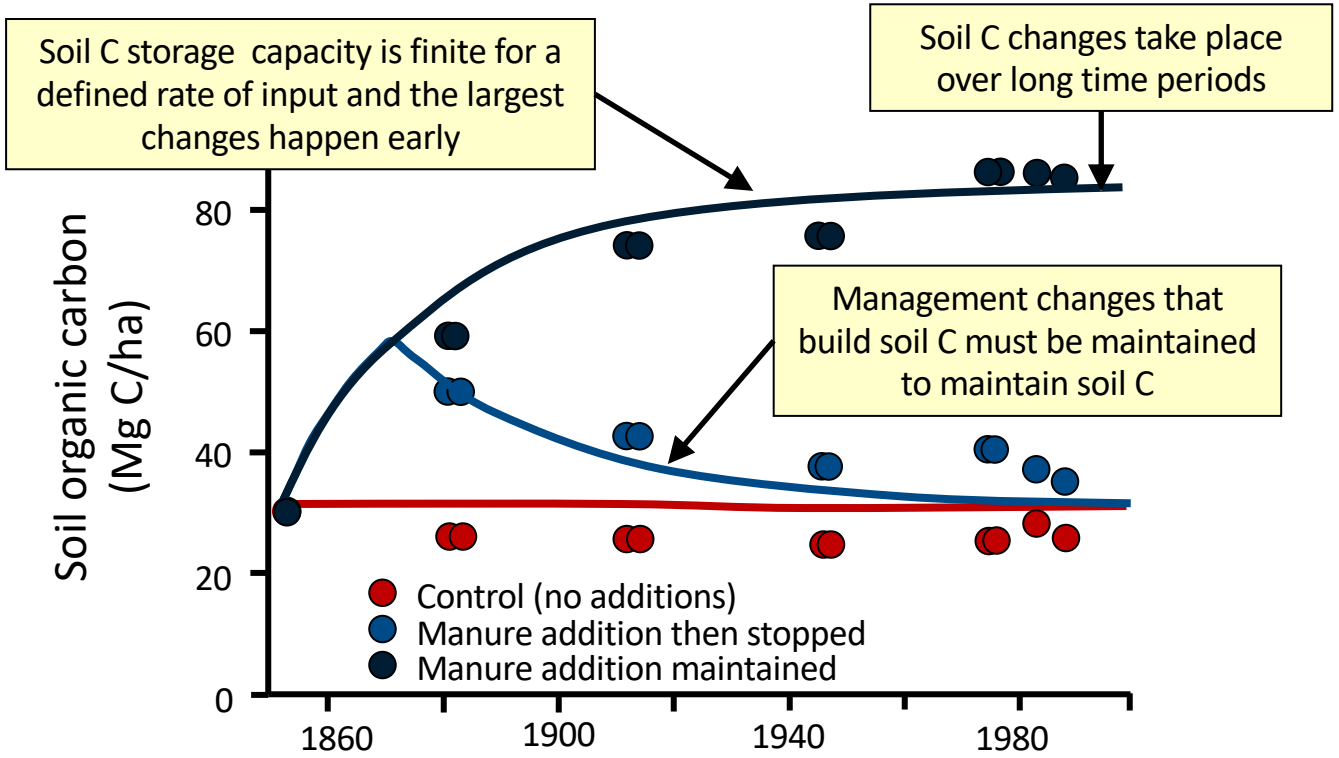




Potential sources of variation

- Spatial
- Temporal
- Sampling
- Preparation
- Analytical

Permanence of changes in soil carbon stocks



Petersen et al. (2005) Soil Biol Biochem 37: 359

Conclusions

- There are many reasons to want to build SOC
- Gains can be more rapid in degraded areas
- Spatial and temporal variability key issues – discounting is applied in the ERF to limit exposure to adverse outcomes
- Additionality a key consideration

Thank you

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Acknowledgements:

Jeff Baldock & SCaRP team

Australian Government
Department of Agriculture, Water and the Environment

Australian Government
Department of Industry, Science, Energy and Resources

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Australia's National Science Agency