



Soil Sampling to Certify the Changes of Organic Carbon in Mineral Soils

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Introduction

Many soil functions are driven by the soil organic carbon (SOC) content, (e.g. fertility, buffering capacity, adsorption and absorption of chemicals, filtering to maintain water quality, regulation of atmospheric gas composition, etc.). The SOC is a universal soil quality indicator, which is also critical to monitor the major global environmental conventions on climate change (UNFCCC), biodiversity (CBD) and desertification (UNCCD). The detection of the SOC changes is very complicated and is mostly applicable to scientific research at present.

Objective

This study is to develop a simple, transparent, measurable and cost effective method to detect the changes in the SOC in soils.

Methods

A new Area-Frame Randomized Soil Sampling (AFRSS) combines traditional composite soil sampling with random position of the sampling sites based on randomized template (Figure 1).

The implementation of the AFRSS needs to:

1. Represent the plot/field margins in coordinates of the standard local projection used for topographic or cadastral maps (Figure 1b).
2. Define Maxis value to setup a square accordingly.
3. Overlay on the square the template with 100 points numbered from 1 to 100, as represented in Figure 1a.
4. Determine the number 'n' of sampling sites that is conditioned by the plot area (Table 1) and the need to keep the costs to a minimum.
5. Select the first 'n' points of the grid if they fall inside the plot. Otherwise select subsequent sampling point (n + 1, n + 2, etc.) until you have 'n' points inside the plot (Figure 1b).

The sampling depths (Figure 2) tend to minimize amount of samples and make sampling consistent with the European monitoring of the forest soils.

Calculations

The changes in C stock (ΔSOC_{stock}) is a difference between average reference and new measurement

$$\Delta SOC_{stock} = \overline{SOC}_{refstock} - \overline{SOC}_{new}$$

The changes are given in

$$\Delta SOC_{stock} \pm s(\Delta SOC_{stock})$$

Reproducibility (RP) is a difference in the averages resulting from two parallel samplings, which is an error of the average coming from the spatial shift of the sites positioning in the course of the repeated parallel sampling. The RP shows the minimum detectable difference in C stock.

$$RP(\%) = (\overline{SOC}_{new} / \overline{SOC}_{refstock}) * 100$$

Acknowledgements

The authors thank Mauro Piazzi and Fabio Petrella from the Soil Department of the Institute for Forestry and Environment (IPLA, Region Piemonte, Italy) for their collaboration.

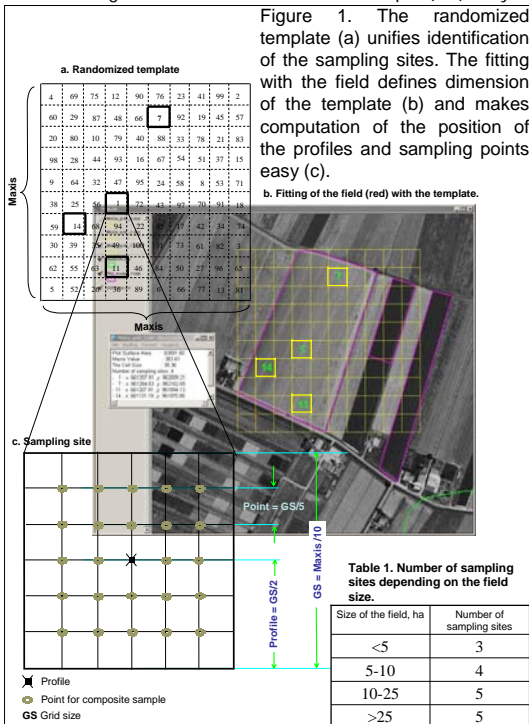
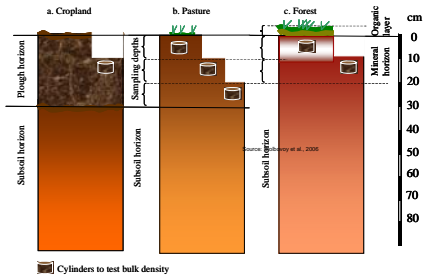


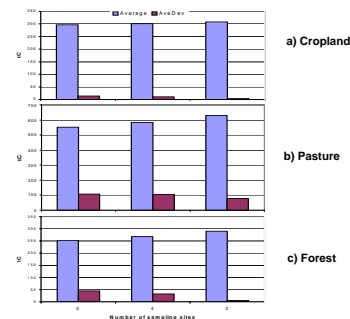
Figure 2. Sampling depths are different for: a. Cropland (homogeneous ploughed horizon), b. Pasture (gradual change of the SOC content) and c. Forest (litter and mineral soil). This substantialization avoids over sampling and links the AFRSS with the monitoring of the forest soils in Europe.



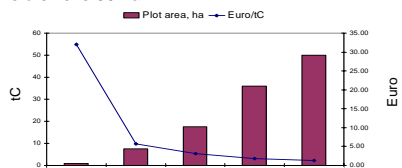
Results & Conclusions

The test of the RP of the AFRSS method in the cropland (region Piemonte, Italy) shows that changes greater than 3 % of initial C stock can be verified. For example, for the cropland (Skeletal Cambisol) with the SOC stock 70-80 tC/ha only measures having potential to accumulate more than 2.1-2.4 tC/ha can be applied.

Average deviation (AveDev) declines with the higher average (Average) SOC content. This illustrates that the uncertainty of the verification is less where the soil approaches the SOC saturation.



Laboratory costs of the analysis per unit of carbon (tC) is less for the fields with the bigger size. For example, for the average carbon sink about 1.5 tC/ha and prize of the analysis 16 euro per sample the analysis cost is as much as 33 Euro in one tC. This cost will be less than 1 Euro if the field size is 50 ha.



The conventional sampling (IPCC, 2003) requests detecting the changes in carbon stock with the 95% confidential level. At an observed variability of carbon content in the test fields the laboratory analysis results in 576 (cropland) and 800 (pasture) Euro per one tC. The AFRSS ignores soil variability, which reduces the laboratory costs to the practical level (e.g. 8 and 24 Euro per tC for cropland and pasture respectively).

Land cover	Conventional (IPCC, 2003)			This study (AFRSS)		
	Variability %	Number of samples	Cost per tC	Variability %	Number of samples	Cost per tC
Cropland	9	216	576	n.a.	3	8
Pasture	15	300	800	n.a.	9	24

References

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Stolbovoy, V., L. Montanarella, N. Filippi, S. Selvaradjou, P. Panagos and J. Gallego, 2005. Soil Sampling Protocol to Certify the Changes of Organic Carbon Stock in Mineral Soils of European Union. EUR 21576 EN, 12 pp. Office for Official Publications of the European Communities, Luxembourg.

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