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Impact of soil sampling on results of laboratory analysis

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Introduction

Sampling

- Is of particular importance during soil analysis
- Is essential in making the right assessment and decision making
- Sampling method should fit to the purpose of the study
- Different sampling strategies can change final results

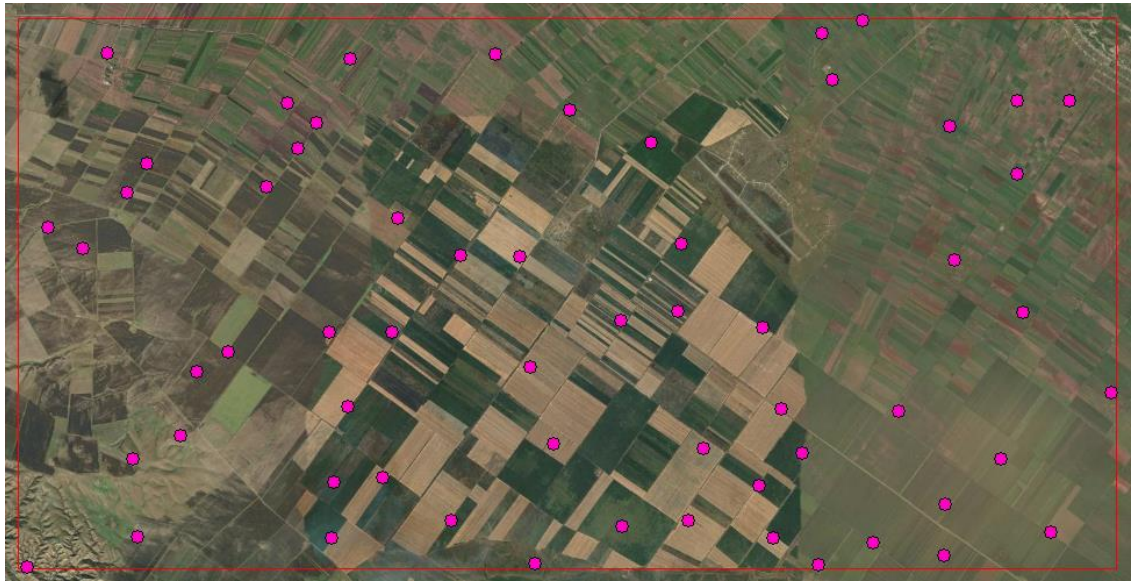
Introduction

Main challenges in soil sampling

- Soil heterogeneity due to diverse soil taxonomic units
- High degree of variability in the soil-forming factors
- Variability in soil properties (spatial, seasonal, in depth)
- Specificity of soils under different land use

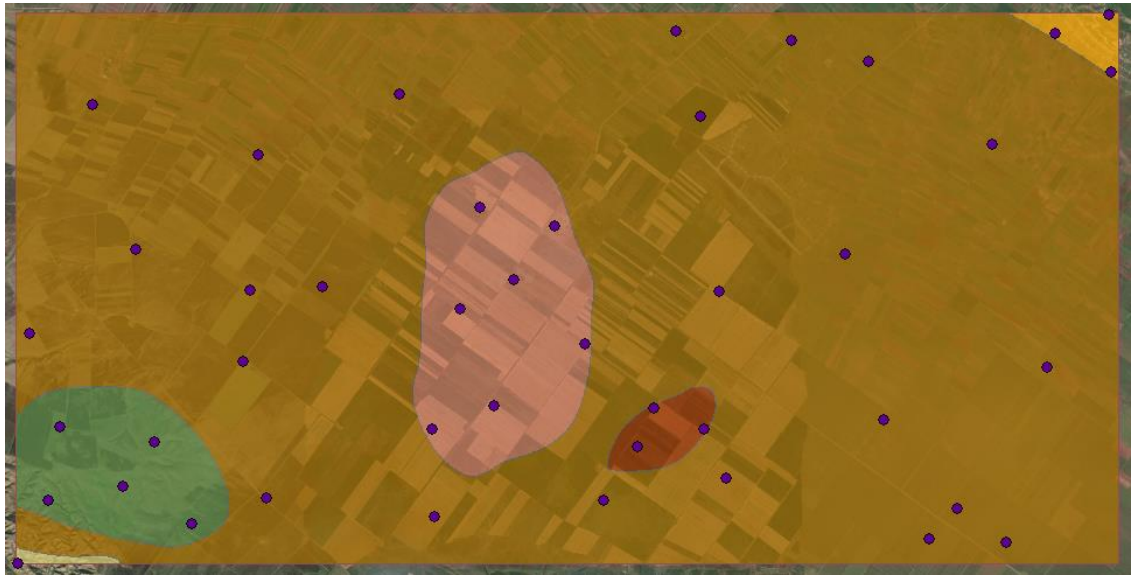
Soil sampling design

- Simple Random Sampling
  - the area to sample is relatively homogeneous
  - there is no prior information or professional knowledge available



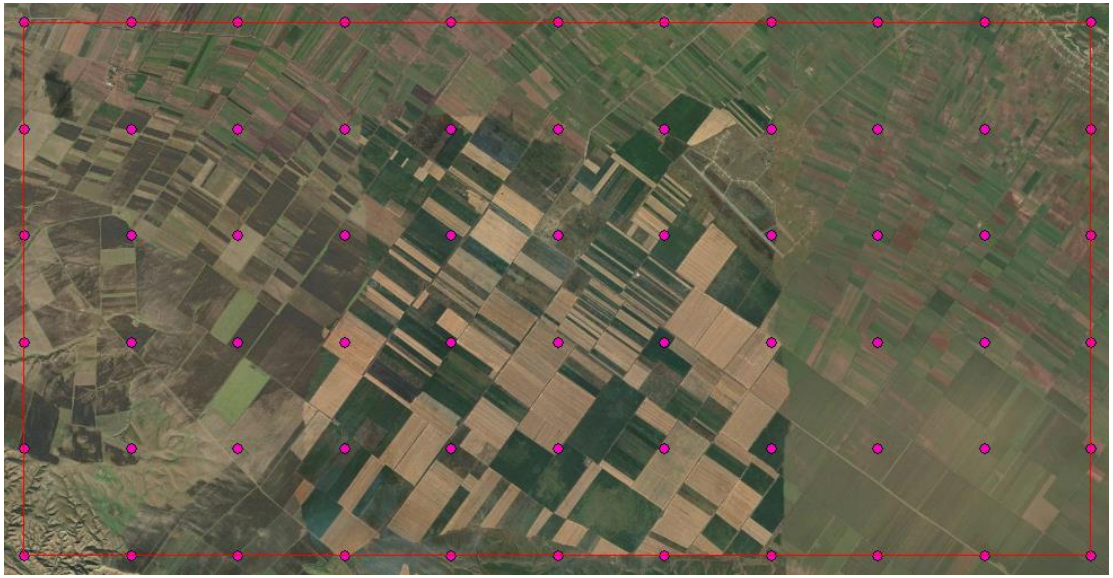
Soil sampling design

- Stratified Random Sampling
  - the area can be divided based on prior knowledge
  - the target area is heterogeneous



Soil sampling design

- Systematic Sampling
  - uniform coverage of an area is necessary
  - little to no prior information is available



Study area

- Georgia is located at the crossroad of Europe and Asia
- Total area equals to 69,700 km^2
- Population: 3.7 million

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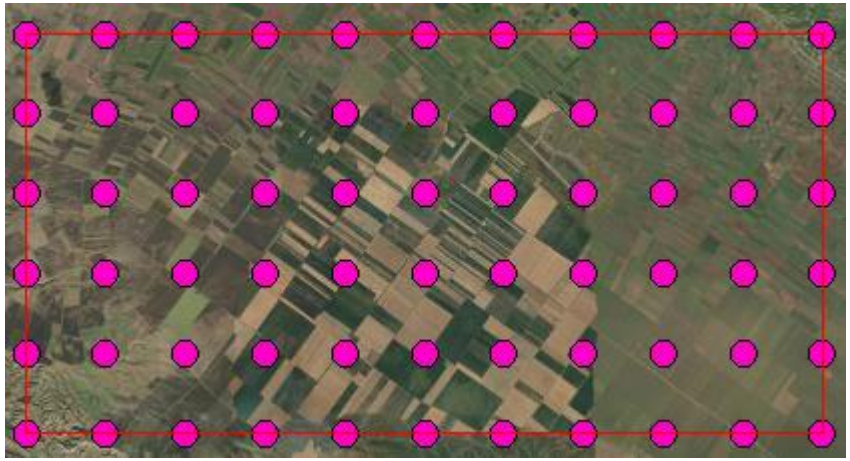
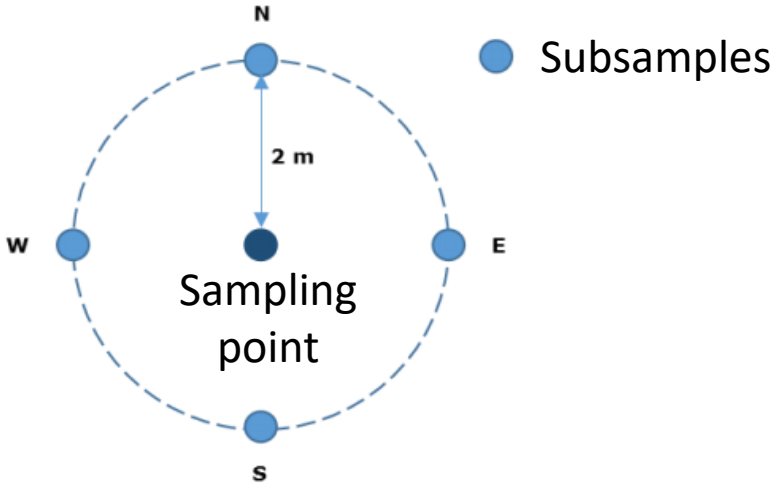
Aim of the study

To evaluate organic carbon stock in top 0-30 cm layer of soil

Methodology – Sampling design

- Soil survey using 2x2 km grid*;
- Stratification of sampling points using GIS (Geographic Information Systems) based on topographic maps and satellite imagery;
- Sampling depth 0-30 cm





*Fernández-Ugalde O., Orgiazzi A., Jones A., Lugato E., Panagos P., LUCAS 2018 – SOIL COMPONENT: Sampling Instructions for Surveyors, EUR 28501 EN, doi 10.2760/023673

Methodology – Laboratory analysis

- Organic carbon in soil determined using Walkley-Black method*
  - Digestion by potassium dichromate in the presence of sulfuric acid
  - Colorimetric determination on spectrophotometer at 600 nm wavelength

*Standard operating procedure for soil organic carbon. Walkley-Black method: titration and colorimetric method. FAO, Rome, 2019.

Results

- In total 57 soil samples were analysed
- Additional 10 duplicate samples were taken to estimate measurement uncertainty from sampling

Results

Organic carbon concertation (%) in duplicate soil samples used for uncertainty estimation

#	S1A1	S1A2	S2A1	S2A2
1	3.71	3.71	3.71	3.60
2	2.67	2.90	2.73	2.84
3	2.90	2.73	2.67	2.67
4	3.02	3.36	3.42	3.48
5	2.38	2.61	2.67	2.78
6	3.65	3.83	2.78	2.96
7	3.36	3.36	4.00	3.89
8	3.48	3.48	2.84	3.13
9	3.42	3.13	3.02	2.90
10	2.55	2.26	2.84	2.67

Results

Measurement uncertainty using robust analysis of variance (RANOVA)*

Robust ANOVA

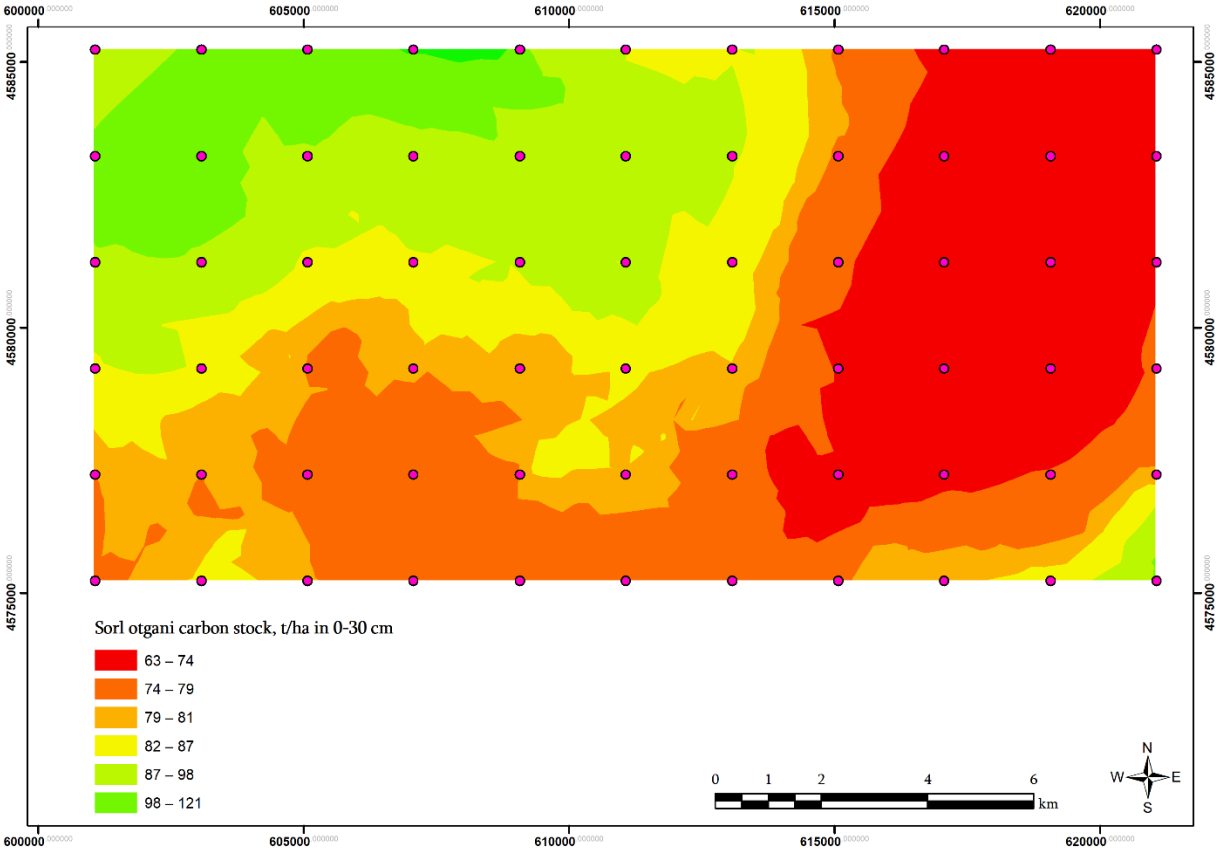
Mean	***3.1032***			
Total SD (std dev)	***0.51628***			
	Btn Target	Sampling	Analysis	Measure
SD (or *u*)	***0.41289***	***0.2745***	***0.14392***	***0.30994***
% of total variance	***63.96***	***28.27***	***7.77***	***36.04***
U' (Exp relative uncertainty) (95%)		***17.69***	***9.28***	***19.98***

u = standard uncertainty

*Eurachem/EUROLAB/CITAC/Nordtest/ AMC Guide: Measurement uncertainty arising from sampling: a guide to methods and approaches, M. H. Ramsey, S. L. R. Ellison and P. Rostron, Eurachem, Second edn, 2019, ISBN (978-0-948926-35-8), available from http://www.eurachem.org.

Results

Soil organic carbon stock, t/ha in 0-30 cm soil layer



Conclusions

- ✓The study showed that sampling has a considerable contribution to the measurement uncertainty despite relatively homogenous area we had in our study;
- ✓ It is recommended to include duplicate samples in each set of soil samples to perform estimation of a measurement uncertainty arising from sampling on permanent basis;
- ✓To work towards reduction of uncertainty from sampling, as well as from analysis

*Eurachem/EUROLAB/CITAC/Nordtest/ AMC Guide: Measurement uncertainty arising from sampling: a guide to methods and approaches, M. H. Ramsey, S. L. R. Ellison and P. Rostron, Eurachem, Second edn, 2019, ISBN (978-0-948926-35-8), available from http://www.eurachem.org.

Thank you
for your attention!