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 km²
• 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

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

Results

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

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

<table>
<thead>
<tr>
<th>#</th>
<th>S1A1</th>
<th>S1A2</th>
<th>S2A1</th>
<th>S2A2</th>
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<td>1</td>
<td>3.71</td>
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<td>3.71</td>
<td>3.60</td>
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<tr>
<td>2</td>
<td>2.67</td>
<td>2.90</td>
<td>2.73</td>
<td>2.84</td>
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<tr>
<td>3</td>
<td>2.90</td>
<td>2.73</td>
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<td>7</td>
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<td>4.00</td>
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<tr>
<td>8</td>
<td>3.48</td>
<td>3.48</td>
<td>2.84</td>
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<tr>
<td>9</td>
<td>3.42</td>
<td>3.13</td>
<td>3.02</td>
<td>2.90</td>
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<tr>
<td>10</td>
<td>2.55</td>
<td>2.26</td>
<td>2.84</td>
<td>2.67</td>
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</tbody>
</table>
Results

Measurement uncertainty using robust analysis of variance (RANOVA)*

<table>
<thead>
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<th>Robust ANOVA</th>
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<tbody>
<tr>
<td>Mean</td>
<td>3.1032</td>
<td></td>
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</tr>
<tr>
<td>Total SD (std dev)</td>
<td>0.51628</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SD (or u)</td>
<td>0.41289</td>
<td>0.2745</td>
<td>0.14392</td>
<td>0.30994</td>
</tr>
<tr>
<td>% of total variance</td>
<td>63.96</td>
<td>28.27</td>
<td>7.77</td>
<td>36.04</td>
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<tr>
<td>$U'$(Exp relative uncertainty)</td>
<td>17.69</td>
<td>9.28</td>
<td>19.98</td>
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<tr>
<td>$u = $standard uncertainty</td>
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</tr>
</tbody>
</table>

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

Thank you for your attention!