Soil monitoring: digging into the data

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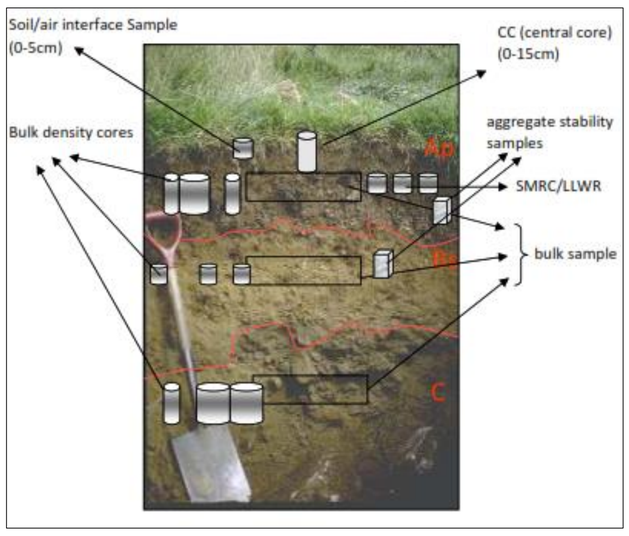
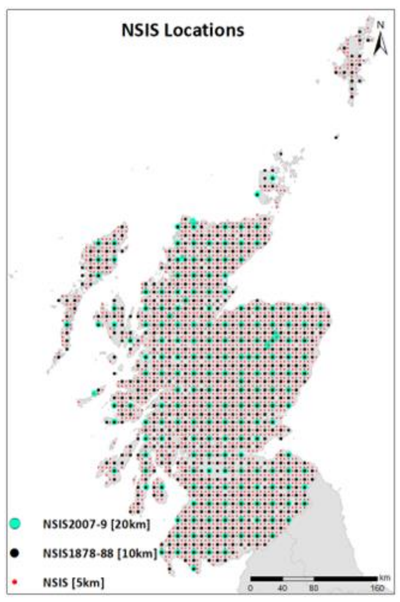
Introduction

- Soils should be considered to be a finite resource and there is a need to monitor changes to protect soil for future generations.
- Soils contribute to different policy areas including food security, climate change, biodiversity, water quality and flood resilience.
- Drivers of changes in soil processes and properties range from field management to those operating at a national scale such as climate change.
- Soil monitoring requires a framework that combines field to national scale data sets.

NSIS soil sampling data

- NSIS is a systematic 10 km grid resampled at 20 km after a period of 25 years
- One of the objectives of the NSIS2 resampling programme was to compare sampling methods currently in use in the UK
- Sampling in the central pit was carried out by pedogenic layers (the most robust way of capturing change) to 80-100cm depth. Samples were taken from a band of approximately 10 cm depth at the centre of the layer.
- A composite auger sample from 0-15 cm was taken across a 20x20 m grid.
- A central 0-15cm core was taken.
- To explore spatial variability samples were taken from four variability pits at a distance of 4, 8 or 16m from the central pit.





Lilly A, Bell JS, Hudson G, Nolan AJ, Towers W. 2011. National Soil Inventory of Scotland 2007-2009: Profile description and soil sampling protocols. (NSIS_2). Technical Bulletin, James Hutton Institute. DOI: 10.5281/zenodo.7688040.

Understanding the number of sampling points

We have estimated the sample size required based on the variance of observed differences between NSIS2 and NSIS1. In doing this we have explored different scenarios for the magnitude of change to be detected.

The analysis has shown that the sample size needed depends on the objectives of the monitoring. For example, is the objective to report the results as a national average, regionally, by land cover or land management class?

❖ The more reporting classes are used, the greater the overall sample size required.

We can design a sampling framework that can be optimal in addressing different objectives.

The objectives of a sampling scheme that would determine the intensity of points include:

❖ The magnitude of change to be detected

❖ The precision at which a variable needs to be reported

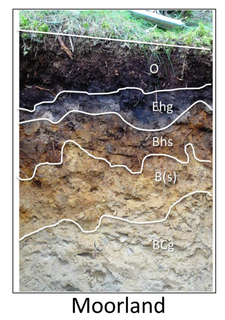
❖ Whether the objective is to benchmark soil properties against threshold values

❖ Assessing whether management interventions have been effective

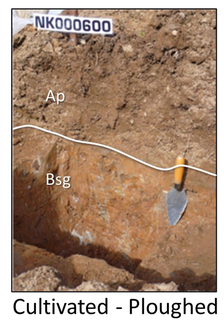
Comparing different sampling depths

Soil carbon content (%) and pH estimated from a weighted average of layers in the top 15 cm were compared with values measured in the central 0-15cm core.

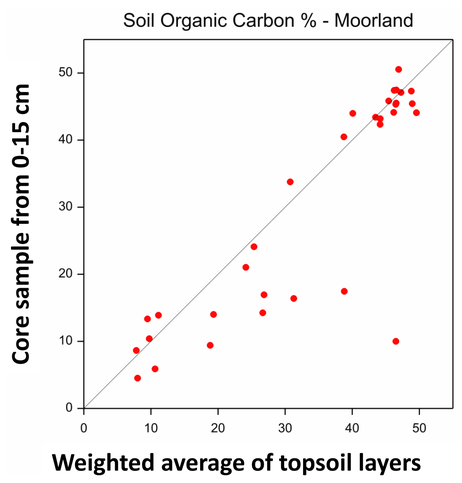
- For cultivated soils estimates were reasonably consistent between methods due to the impacts of ploughing.
- However, for organic soils (e.g. moorland soils) there were large differences in some cases .

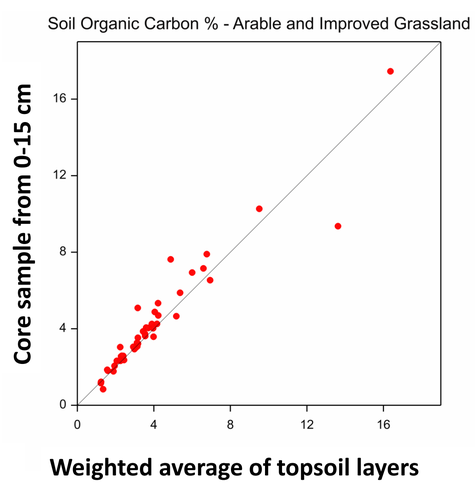


Moorland



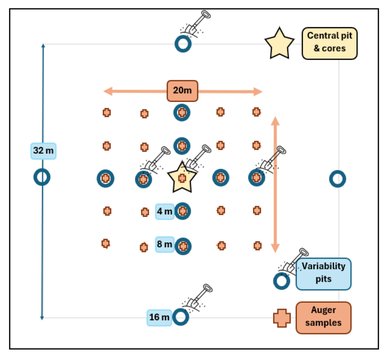
Cultivated - Ploughed

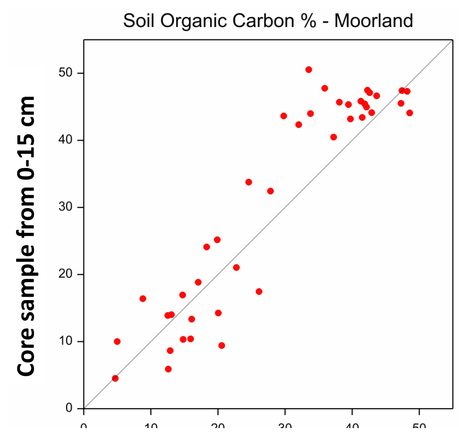


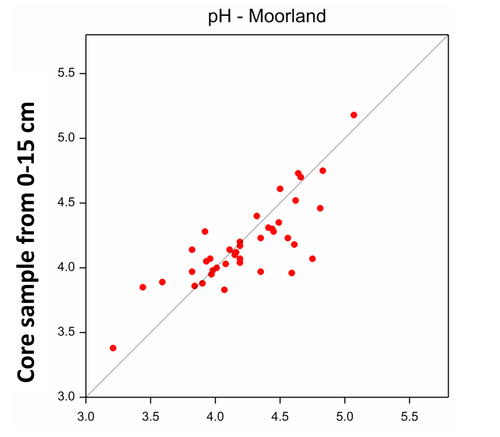


Accounting for local Spatial variability

- Analysis of the local variability pit data shows considerable local spatial variability in organic soils at distances up to 32m.
- This variability is also reflected in the differences between the between the central core and the composite auger samples.







Outcomes

- Legacy data, including the NSIS, can form a baseline for future soil monitoring.
- Data collected by different methods and at different spatial scales have different uncertainties associated with them.
- The analysis of these data sets and the development of novel statistical methods within the SRP can enable the integration of data sets to provide a baseline and assess change.
- To be able to finalise a robust statistical design this work now needs discussions with policy groups to finalise the issues that need to be addressed by a sampling framework.
- This work will inform methods to align sampling across the 4 nations as part of the LUNZ Hub 4 nations soil monitoring project

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