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PREDICTING THE POTENTIAL FOR P-LOSS USING SOIL SAMPLES FROM THE NATIONAL SOIL ARCHIVE OF SCOTLAND

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1. OVERVIEW OF THE CONTENT OF THE NATIONAL SOIL ARCHIVE OF SCOTLAND

- The National Soil Archive of Scotland is at the Macaulay Institute in Aberdeen (Fig. 1).
- The archive contains around 40,000 soil samples collected from the late 1940s onwards and includes soil from mainland Scotland and the islands.
- The archive includes samples from 721 soil profiles (around 2,800 individual samples) taken on a 10-km grid (Fig. 2). It is part of a 5-km grid which was visited (3094 sites).
- Resampling soils on a 20-km grid to assess change, test different sampling methods and to include new soil parameters has commenced in 2007.
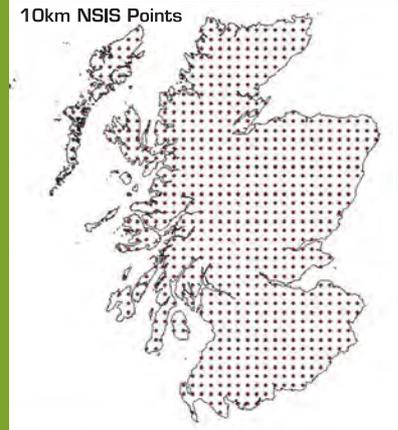

Figure 1. Archive racks

10km NSIS Points

Figure 2. Map of Scotland showing 10-km grid sampling positions.

2. PROPERTIES RECORDED

- For the 5-km grid inventory positions, where soil is present, a full description of the soil profile in terms of its morphology is available.
- For those points which occur at the 10-km intersects (Fig. 2), soil was sampled on the basis of horizons and systematic laboratory analyses are available on the samples.
- Each site is uniquely geo-referenced, and the data are held in digital form in a series of relationally linked Oracle tables (Fig. 3).
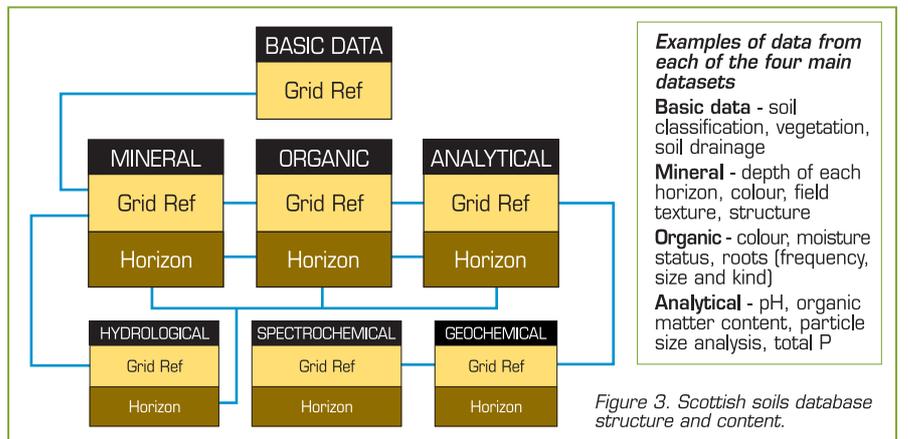

BASIC DATA — Grid Ref

MINERAL — Grid Ref, Horizon
ORGANIC — Grid Ref, Horizon
ANALYTICAL — Grid Ref, Horizon

HYDROLOGICAL — Grid Ref, Horizon
SPECTROCHEMICAL — Grid Ref, Horizon
GEOCHEMICAL — Grid Ref, Horizon

Examples of data from each of the four main datasets

Basic data - soil classification, vegetation, soil drainage

Mineral - depth of each horizon, colour, field texture, structure

Organic - colour, moisture status, roots (frequency, size and kind)

Analytical - pH, organic matter content, particle size analysis, total P

Figure 3. Scottish soils database structure and content.

3. ASSESSING POTENTIAL FOR LOSS OF PHOSPHORUS FROM LAND TO WATER

The archived samples provide a unique opportunity to assess the P-status of Scottish soils.

- The existing inventory includes the total P content of the soil: for around half of the soils the amount of P extractable by 0.43 M acetic acid (an agronomic test reagent) is available.
- To assess the potential for loss of P by leaching we are using the "change point" concept coupled with other measurements such as the degree of P saturation.
- The extractants for the determination of the "change-point" are 0.5 M $NaHCO_3$ at pH 8.5, and 0.01 M $CaCl_2$, which provide measures of the quantity (Q) and intensity (I) factors, respectively.
- In addition to the method of fitting two straight lines, the "change point" will also be determined by non-linear methods (Fig. 4) using the re-arranged Langmuir equation (Koopmans *et al.*, 2002), extraction with 0.5 M $NaHCO_3$ acting as a measure of reversibly adsorbed P and extraction with 0.01 M $CaCl_2$ acting as a measure of solution P.

To provide a more complete picture, we will also determine the potential for loss of particulate P using minimal dispersion in water. The suspended fractions will be analysed by XRD to quantify the minerals present and by ICP-MS for total element concentrations following micro-scale lithium metaborate fusion.

The soil resampling programme which commenced in 2007, will also provide information about any change in the P status of Scottish soils over the past 20-30 years.
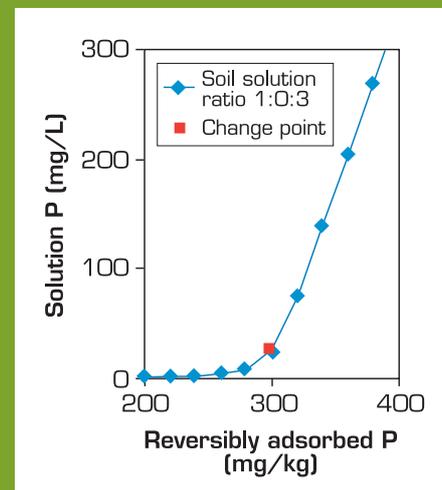

Figure 4. Idealised Langmuir equation (Q_{max} = 300 mg/kg; K = 1.5 L/mg), showing the "change point" identified as the point of maximum rate of change in slope using Microsoft Excel's solver.