Proposing a methodology for a soil typology classification using simple indicators utilising data collected by the public

MSc Thesis Summary by Victoria Butler: September 2009

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Objectives

This project attempts to classify soil types depending on parameters observed using the OPAL Soil and Earthworm guide, and its suitability for the type of use it is intended. Three main objectives were identified:

- to assess how data on soil and earthworms collected by members of the public can be used to provide valuable information about the condition of soils in England
- to develop a soil classification system using indicators from the Open Air Laboratories (OPAL) soil and earthworms survey
- to evaluate the effectiveness of the classification system as a screening tool to identify sites where further investigation into soil conditions should be prioritised.

Introduction

Soil is a non-renewable resource which faces increasing levels of degradation. The extent of soil degradation in the UK is not yet fully understood, due to limited available data. There are several soil classification systems in use in England, for example, the Soil Classification of England and Wales and the British Soil Classification System. However, none of these are concerned specifically with the role of soil in supporting biodiversity and how this is impacted by anthropogenic activities. Existing classification systems usually rely on the results of soil surveys and laboratory analyses of soil samples, which can be costly, thus limiting the amount of data collected.

The OPAL soil and earthworms survey was designed so that soil sampling may be carried out by members of the public with no prior knowledge or experience. This allows a large number of samples to be taken across England, whilst at the same time raising awareness of the importance of soil protection. The survey comprises a number of tests and observations, which are carried out in the field. The results are then submitted to OPAL via the website (http://www.opalexplorenature.org).

The regulatory drivers for this research are chiefly the EU Thematic Strategy for Soil Protection (COM(2006)231) and the Soil Strategy for England, the first draft of which is currently out for public consultation. The main objective of these strategies is the protection and sustainable use of soil. This involves the prevention of further soil degradation and restoration of degraded soils to a standard according to their current function or intended use.

Methodology

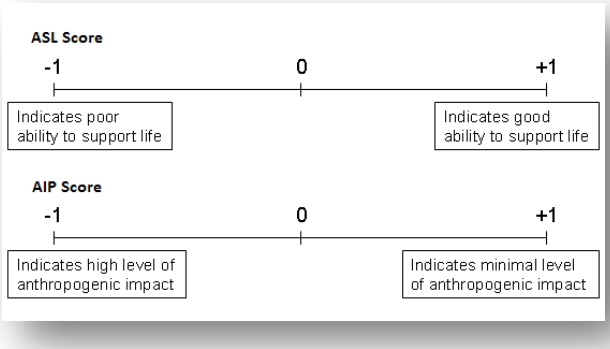
The methodology for developing the classification system took a number of stages;

- assessment of OPAL survey indicators;
- selection of criteria by which the samples are classified;

- development of a scoring system;
- grouping the samples according to their scores.

Indicators of soil properties can be physical, chemical or biological. Ideal indicators are simple and inexpensive to obtain and interpret. The OPAL survey results provide indicators of soil characteristics such as water retention capacity, soil particle size, soil pH, contamination and compaction.

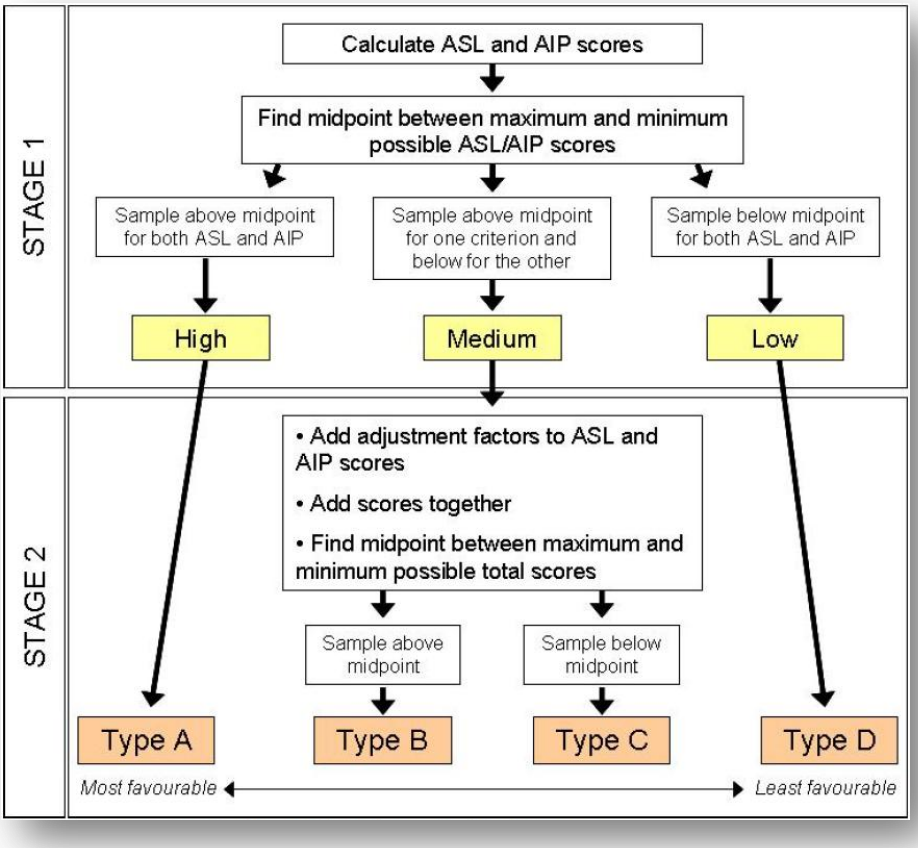
There are many potential criteria by which soils can be classified. It was decided that the most useful classification system, which makes best use of the indicators from the OPAL survey, is one that gives an indication of the soil's ability to support life, along with its level of anthropogenic impact. This could help to fulfil the objective of the protection and sustainable use of soil as set out in the EU Soil Thematic Strategy. The selection of these two criteria means that the resulting soil types are not related to a specific soil function, but could be useful in the context of many different land uses. The two criteria are referred to as ASL (Ability to Support Life) and AIP (Anthropogenic Impact and Pollution).



Principles of scoring for the soil classification system

Each relevant indicator was given a positive, negative or neutral score, depending on the extent to which the soil fulfils the function of supporting life or how severely it has been impacted by human activity. Although an individual observation or test result might indicate more than one possible soil characteristic, each sample is an aggregation of many indicators. This allows an evaluation to be made of the soil's condition as a whole. It is likely that the total scores for both ASL and AIP are influenced by factors such as the weather, time of year, type of land use and underlying geology. Therefore, adjustment factors were added to samples which achieved a high score for one of the criteria, but scored poorly in the other. This provides an extra level of detail and reduces uncertainty in the score. The adjustment factors are used to exclude as far as possible any variation due to variables that are not directly related to soil properties. They are also used to add weight to a score if non-soil variables increase the level of certainty.

The transformation of the scores into soil types is a two-stage process, which requires the calculation of the midpoint between the maximum and minimum possible scores. Each set of OPAL survey results was transformed into the two scores and the samples grouped according to their scores (Figure 1). Next, the samples falling into the "medium" group were split into two. This was achieved by applying the adjustment factors to the respective scores, then summing the total scores. The maximum and minimum possible scores were calculated and the midpoint determined. Samples scoring higher than the midpoint were classed as Type B and those scoring below, Type C (Figure 1). The "high" group became Type A and the "low" group became Type D.



Tests were carried out to assess the effectiveness of the classification system;

- Soil types were compared with known concentrations of mercury (150 samples);
- To determine whether soil properties had an effect on earthworm numbers, scores for earthworms found were removed from the ASL scores and the two were compared;
- The proportions of different soil types were compared for London and England overall;
- The distribution of soil types was mapped using GIS.

Results

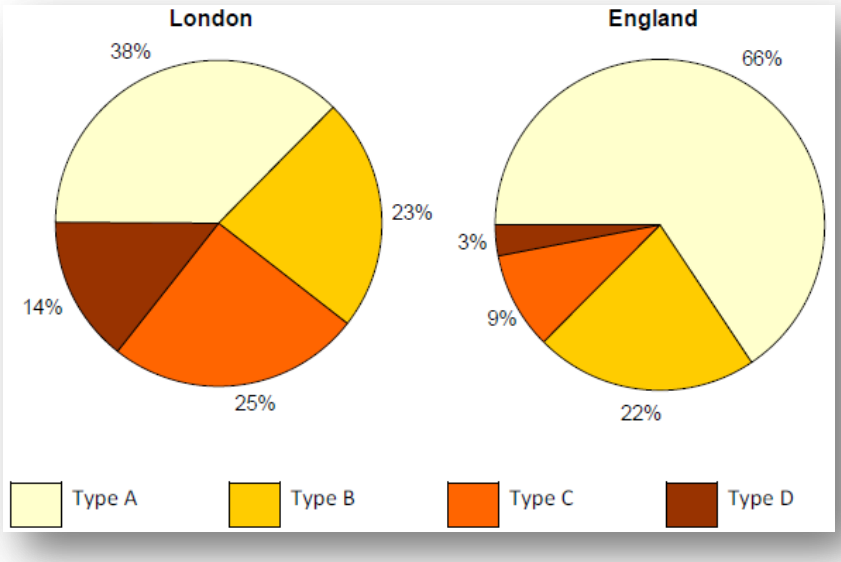
The classification system was applied to the results of 2,708 samples. The numbers of samples falling into each type are as follows:

Type A – 1779

Type B – 591

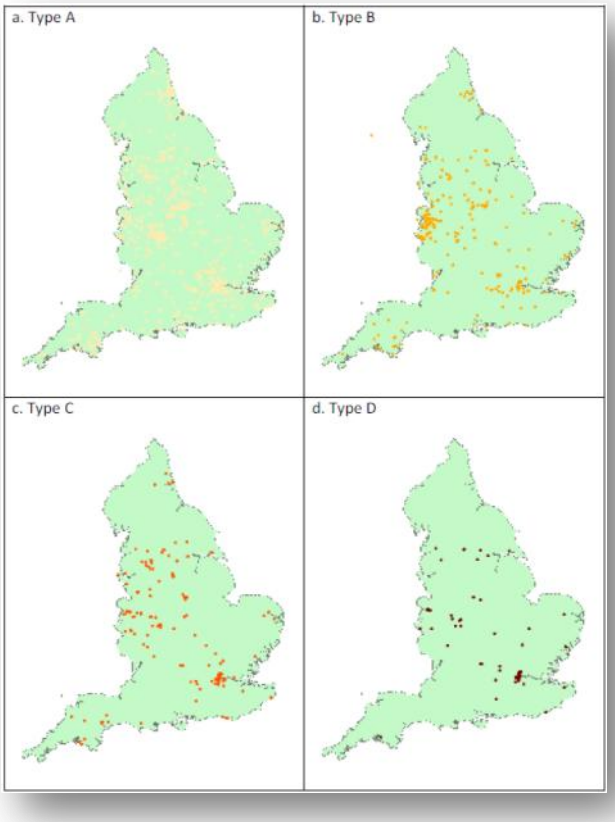
Type C – 255

Type D – 83



Results for the tests are as follows;

- no relationship was found between mercury concentrations and ASL score, AIP score or soil type;
- no significant relationship was found between earthworm numbers and ASL score;
- there was a marked increase in the proportion of unfavourable soil types in London and a reduction in Type A soils, compared to England overall;
- maps of soil type distributions did not show any discernable patterns.



Maps showing the distribution of soil type by sample point in England. Maps created using ArcGIS 9.2.

Discussion and conclusions

From the mercury comparison test conducted, the classification system appears to be limited as a screening tool. However, the low concentrations of mercury for the majority of sample points mean that this test is inconclusive. At levels of contaminants sufficient to trigger a decline in plant growth or soil fauna, the classification system may prove more effective.

As a tool for comparing the state of soils over a large area, the classification system was relatively successful. Further examination of geographical distributions of soil types may give valuable information on levels of soil degradation in different regions or cities. In order to map soil types effectively, a greater number of samples is required.

The scoring system may benefit from some refinement, using scoring based on more precisely defined combinations of indicators. Adjustment factors could be applied separately to individual indicators rather than the entire set of scores. This would ensure that adjustment to scores only occurs where it is needed.

The issue of soil degradation and the impact of human activity is highly complex, because of the huge number of variables involved. It appears that data collected by the public can provide a great deal of important information about the status of soils in England. With modification to this classification methodology, it could become a valuable tool to broaden our understanding of soil degradation and to assist in finding solutions towards soil protection.