Application of multi objective regression models to map the resilience characteristics of soil

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The Problem
- Policy makers use risk-based maps to make soil decisions.
- Producing maps confounded if data extrapolation not possible with pedotransfer functions.
- Study of soil biological and physical resilience to stress found no clear relationship with other soil properties.
- How then to produce risk based maps of soil resilience?

Soil Measurements
- Wide range of soils sampled across Scotland
- Biological resilience measured as changes in substrate mineralisation over time following a transient (heat) or persistent (copper) stress.
- Physical resilience measured from the resistance and recovery of pore structure following either compaction or water-logging.
- Soil characteristics measured – taxonomy, pH, texture, carbon & nitrogen

The Solution
- A machine learning technique of multiple regression tree induction used.
- Enabled simultaneous prediction of interdependent resilience variables.
- Models with highest Root Mean Squared Error and Correlation Coefficient selected.
- GIS techniques coupled with an existing soil dataset used to up-scale the results of the models to map resilience at a national level (Scotland).

The Maps
- The maps produced defined remarkably distinct areas in terms of physical and biological resilience.
- Sandy arable soils were less biologically stable to copper than were the organic matter rich upland soils.
- Clay based arable soils were less physically stable to an overburden stress than were the organic matter rich and coarse textured soils.

Conclusions
- Multi objective regression modelling confirmed as an advanced technique to overcome problems of single attribute modelling.
- Models induced with data mining can be easily linked with techniques for analysing spatially related data by GIS.
- Even with limited data, the maps corresponded to expected behaviour based on expert knowledge. Greater data would improve the resolution of the maps.
- Resistance and resilience characteristics defined on maps, aiding potential decision making for soil protection.

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Reference