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Combining national monitoring and novel modelling to fingerprint soil functions and contextualise services in agricultural ecosystems

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In this talk, we highlight research from the NERC Soil Security Programme which exploits a large-scale national survey of Great Britain, Countryside Survey, to better quantify the multivariate nature of soil characteristics, functions and ecosystem service indicators in different agricultural habitats and how they change across management gradients, and to assess the utility of different spectral techniques to fingerprint soil characteristics and infer functional changes. We present an example where we aimed to identify the key controls on measured aggregate stability and the conditions associated with biophysical resistance to perturbation under agricultural land management. Sampling locations were selected from arable and grassland habitats dispersed across GB, ensuring capture of spatial variation and presenting ability to disentangle potential drivers. A core subset of over 400 samples from 2007 were used to produce new data on aggregate stability, Visible-Near Infrared (Vis-NIR) and Mid-Infrared (MIR) reflectance spectra. Furthermore, a wider sample set of ∼900 samples from both 1998 and 2007 were also used to produce Vis-NIR data. These were linked to existing soil, vegetation and habitat data from the Countryside Survey, and additional spatial data were derived for sample locations on climate, topography, soil type and parent material. We firstly used an approach involving spectral fingerprinting of the soil sample using neural network calibration models to estimate soil metrics in the core subset. The predictive ability of these models is greatly improved by inclusion of site-based covariates. Aggregate stability was then predicted in the wider sample set and placed in context of the associated ecological and spatial data, and changes over time under different agricultural management. We present the results of a Structural Equation Model that represents direct and indirect relationships between the multivariate factors that were hypothesised to control resistance to perturbation. The model brings together above-ground information on plant traits and plant abundance with soil type, chemical and physical characteristics as well as land management history. This work highlights an approach that could be deployed for fingerprinting functional soil conditions and upscaling to landscapes for decision-making.