ELS2014 –The Earth Living Skin: Soil, Life and Climate Changes
EGU – SSS Conference
Bari | Italy | 22 – 25 September 2014
ELS2014-150-1

Modelling 200 years of soil carbon nitrogen and phosphorus change across the United Kingdom's semi-natural ecosystems

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The last 200 years have witnessed vast changes to the fluxes of nitrogen (N) and phosphorus (P) entering the United Kingdom's landscape. Industrialisation has resulted in N deposition, agricultural intensification has seen widespread use of N and P fertilizers and societal actions have resulted in extensive land use change. To understand the consequences of these anthropogenic inputs for our soils, freshwaters and ecosystems it is necessary to take an integrated long term large scale approach. Integration across the compartments of the critical zone – from atmosphere, plants to soil and stream - is necessary in order to trace the effects of deposition, fertilization, cultivation and land use change. Coherent integration of C, N and P dynamics is also crucial, as biological processes tightly couple these cycles, so that in unison C N and P control the generation of biomass and consequent production of soil organic matter, having knock on effects for dissolved and particulate fluxes and ecosystem function.

The Long-Term Large-Scale (LTLS) project is developing an integrated model that will simulate the pools and fluxes of carbon, nitrogen and phosphorus (C, N, and P) between atmospheric, vegetation, soil and aquatic systems for the whole of the United Kingdom for a period spanning from the onset of the industrial revolution up until the present day. The N14C model has been extended for use in simulating the semi-natural terrestrial plant-soil interactions within the modelling framework. It is a dynamic, mechanistic model which explicitly links C, N, and P in both plants and soils using plant element stoichiometry as the primary constraint. The recent extension of this model to incorporate P cycling is detailed, alongside efforts to calibrate and test the model against a large soil C, N and P dataset. Initial UK wide results are also shown, which suggest that topsoil C stocks in semi-natural systems have increased $\sim$50% over the past 200 years due to N enrichment.