

Model sensitivity to future drivers of change

The Long-Term Large-Scale Project: trends of C, N and P in the UK environment

Helliwell, R.C.¹, Tipping, E.², Davies, J.³, Naden, P.², Bell, V.², Dragosits, U.², Dore, A.², Sutton, M.², Whitmore, A.⁴, Muhammed, S.⁴, Boyle, J.⁵, Quinton, J.³, Stuart, M.⁶, Rose, N.⁷, Ullah, S.⁸, Smart, S.³, Rowe, E.², Jarvis S.², Chaplow, J.², Jackson-Blake, L.¹

¹The James Hutton Institute, Aberdeen Email: rachel.helliwell@hutton.ac.uk



The James Hutton Institute



Introduction

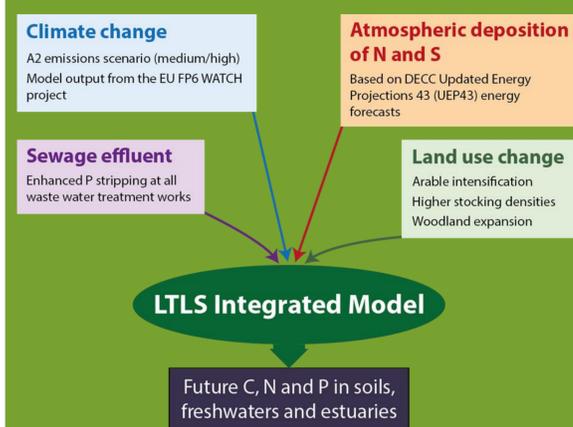
To help manage and protect the future environment, the LTLS Integrated Model will be used to provide projections of future C, N and P pools in the UK's soils and freshwaters.

The major drivers of future change to be included in the model were discussed at a stakeholder workshop in April 2014.

The four key drivers to be considered are climate change, land use change, atmospheric deposition of N and S and reductions in sewage effluent P inputs.

Details of the drivers are shown in Figure 1. Long term model projections will be made to 2100 or to key policy target years.

Figure 1: Future drivers of change



It is hoped that the research will provide new insights that stakeholders can use to evaluate and develop environmental policy, promising a major step forward in the way we manage the environment.

LTLS Integrated model

We are combining models that simulate the processes governing C, N and P in the UK environment. The models are simple and designed to exploit available data, in order to simulate land and water systems at the National Scale over the last 200 years and into the future.

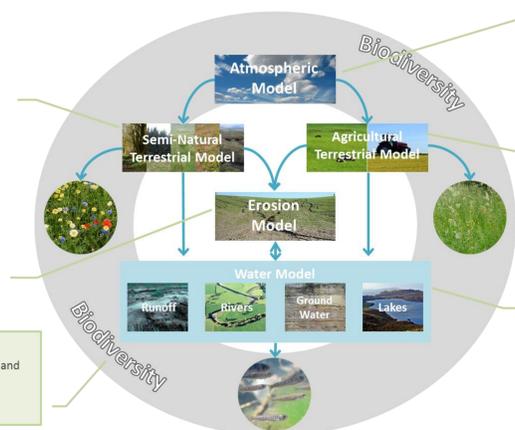
Drivers of change
Input drivers to the model include climate, geology, land use change, diffuse and point-source loads of nitrogen, phosphorus and sulphur, and changes in the application of fertiliser and animal feed.

Natural terrestrial ecosystems
Simulation of conifer and deciduous woodlands, rough grasslands, heathlands and peatbogs. Outputs include soil C, N and P stores; leaching of C, N and P; gaseous emissions of C and N.

Soil erosion
Simulates the production and yield of sediment on a large spatial and temporal scale to provide nutrient fluxes from land to water.

Biodiversity
Changes in terrestrial plant species density and freshwater biodiversity are being related to ecosystem enrichment by nitrogen and phosphorus.

Figure 2: The LTLS Integrated Model



Future scenarios
The LTLS Integrated Model is based on historical and contemporary data, but will simulate future C, N and P behaviour for different scenarios.

Precipitation chemistry
Production of nitrogen and sulphur in precipitation driven by historical and current land-use, combustion and farming activities.

Agricultural ecosystems
Simulation of arable and intensively-grazed farming systems. Outputs include soil C, N and P stores; leaching of C, N and P; gaseous emissions of C and N.

Water quantity and quality
A suite of hydrological models are connected to simulate transport and processing of C, N and P.

The sensitivity framework

Baseline projections: The baseline model run for the future is based on 1800-2010 for all drivers except climate. For climate the enhanced WATCH data for the period 1800-2001 will be used, then the control climate scenario from 2001-2100.

Future projections: The outputs from related projects or desk studies on land use, deposition and water treatment were used to drive the Integrated Model into the future.

LTLS modelling team will sequentially run their models to demonstrate the model capability and sensitivity to each driver (Figure 3).

Plan: Complete sensitivity analysis by the end of 2015.

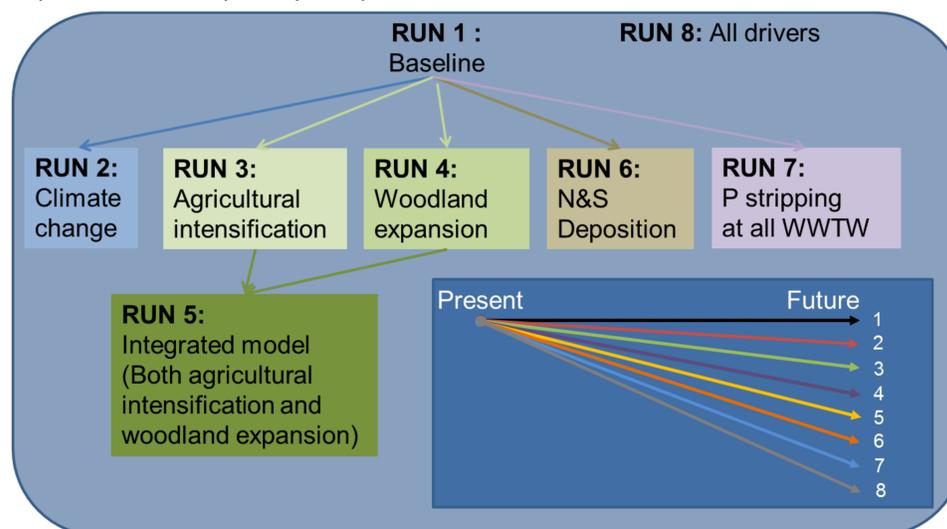


Figure 3: Sensitivity Framework (WWTW- Waste Water Treatment Works, S- Sulphur, N- Nitrogen)

Pathway to Impact Through Stakeholder Engagement

The next stakeholder workshop will be on the 2nd-3rd February 2016, and will aim to showcase results from the integrated model application for the future period.

The aims are to discuss:

- How results should best be presented to maximise their usability and uptake, and how results should be interpreted in a management and policy context
- The potential for new contracts to address the specific needs of our stakeholders

- For further information visit our project website www.ltls.org.uk

Acknowledgements

Special thanks go to the Macronutrient Cycles Programme funded by NERC (<http://macronutrient-cycles.ouce.ox.ac.uk>) and the Scottish Government's Rural and Environment Science and Analytical Services Division (RESAS).

