

LTLS

www.ltls.org.uk

*NERC Macronutrient Cycles Programme
Consortium Grant*

**Website
lists all
participants**

LTLS

**Analysis and simulation of the
Long-Term / Large-Scale interactions
of C, N and P
in UK land, freshwater and atmosphere**

E Tipping *CEH*

JF Boyle *U Liverpool*

J Quinton *Lancaster U*

ME Stuart *BGS*

AP Whitmore *Roth Res*

RC Helliwell *JHI**

NL Rose *UCL*

S Ullah *U Keele*

CL Bryant *NERC RCF*

LTLS questions

- Over the last 200 years, what have been the temporal responses of soil C, N and P pools in different UK catchments to nutrient enrichment?
- What have been the spatial patterns of C, N and P transfers from land to the sea in different UK catchments and estuaries?
- How have freshwater biodiversity responded to increases in system productivity engendered by nutrient enrichment at different locations?

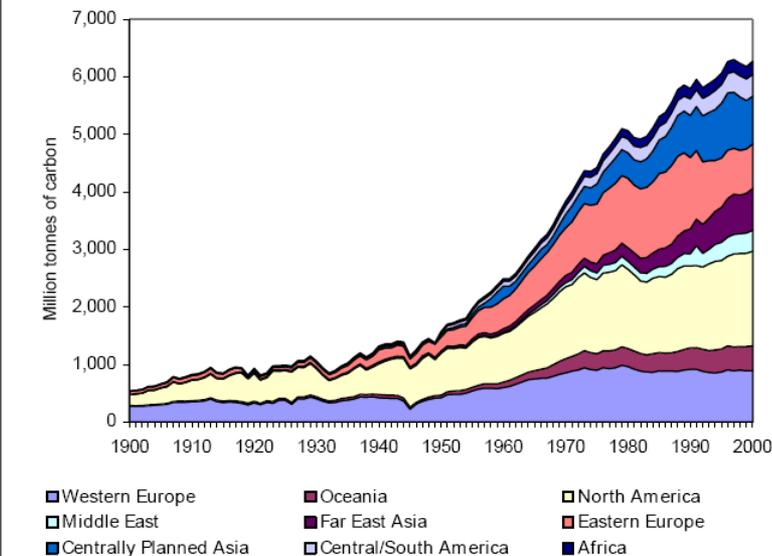
...or, how did we get to where we are today?

Answered by:

***integrated modelling analysis,
aimed at accounting for observable present element
pools and fluxes in different UK catchments
in terms of their nutrient enrichment histories***

LTLS focus period 1800-2000 (2015)

Chart 5A.1 Global emissions from fossil fuel combustion from 1990 to 2000



Source: Marland, G., T.A. Boden, and R. J. Andres, Global, Regional, and National CO₂ Emissions

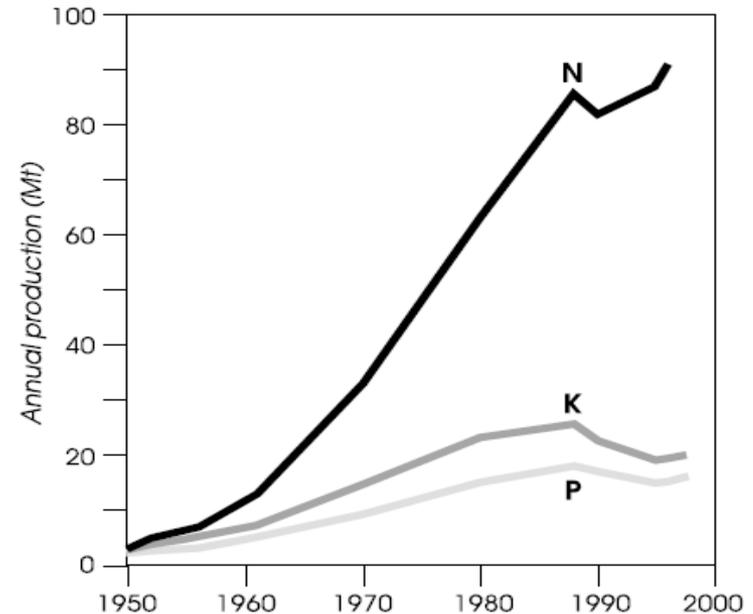


Figure 3. Global Production of Inorganic Fertilizers, 1950-2000.

“...human beings are now carrying out a large scale geophysical experiment...”

Revelle & Suess, 1956

“...the UK’s long-term, spatially-distributed, biogeochemical experiment in nutrient enrichment...”

LTLS proposal 2011

“...most soils are a kind of pedogenic paleosol...” Richter & Yaalon 2012

LTLS outputs & benefits

Integrated model - spatially distributed, long-term description of UK macronutrient pools, fluxes and *interactions*

- feasibility of joining up simple models
- large-scale / long-term implications for bioG and bioD

Platform – for incorporating more detailed / site-specific / short-term knowledge

Policy – national-scale description, multiple effects, scenario analysis

Capacity-building – upscaling, model linkage

LTLS Timetable September 2012

Date	Event / Activity
Oct 2012	Project starts
Nov 2012	Start-up meeting, Lancaster
mid-Nov 2012	All 4 PDRAs and CEH RA appointed
2013 & 2014	Fieldwork
June 2013	Prototype integrated model running
Jan 2014	Half-way meeting, Lancaster
2015	Scenario analyses with Stakeholders
~ Sep 2015	Project ends

LTLS WP1 Data collation

- Climate, deposition, soil, geology, surface and groundwater, radiocarbon, fertilisers etc, point sources, land-use
- History - written accounts
 - maps 1500-1750, 1930s, 2007
- ITE archived data
- Phosphorus deposition data, global including unpublished UK data – CEH, JHI, For Res

*Chaplow, Tipping,
Naden, Scholefield,
Helliwell, Whitmore,
Muhammed, Wu,
Davies H, Bell,
Stuart, Lapworth,
Turner, Rose,
Quinton, Crow,
Vanguelova*

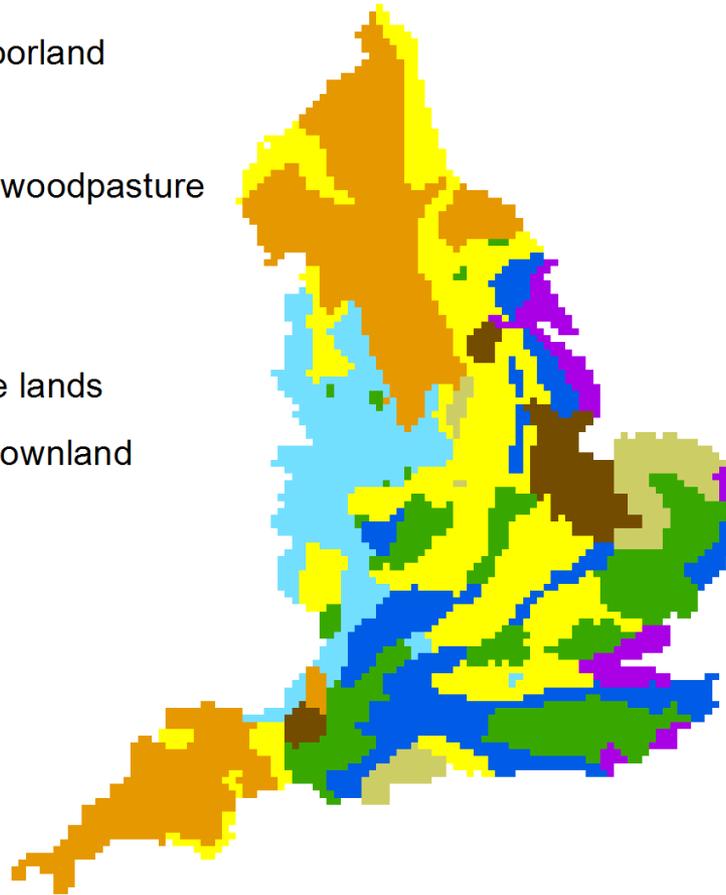
*Davies J, Toberman,
Boyle, Scholefield,
Tipping*

*Rowland, Chaplow,
Tipping R, Tipping E,
Taylor*

*Tipping, Rowe
+ 13 others*

Joan Thirsk's map of English farming regions

1500-1750



LTLS WP2 New measurements

- Atmospheric chemistry experiments

*Sutton, Braban,
Langford*

- Soil & plant elements inc NPP – test data



*Toberman, Adams,
Tipping, Smart, Helliwell,
Coull, Bryant, CEH & JHI
analysts*

- Soil denitrification



Sgouridis, Ullah

- River C-N-P, suspended sediments

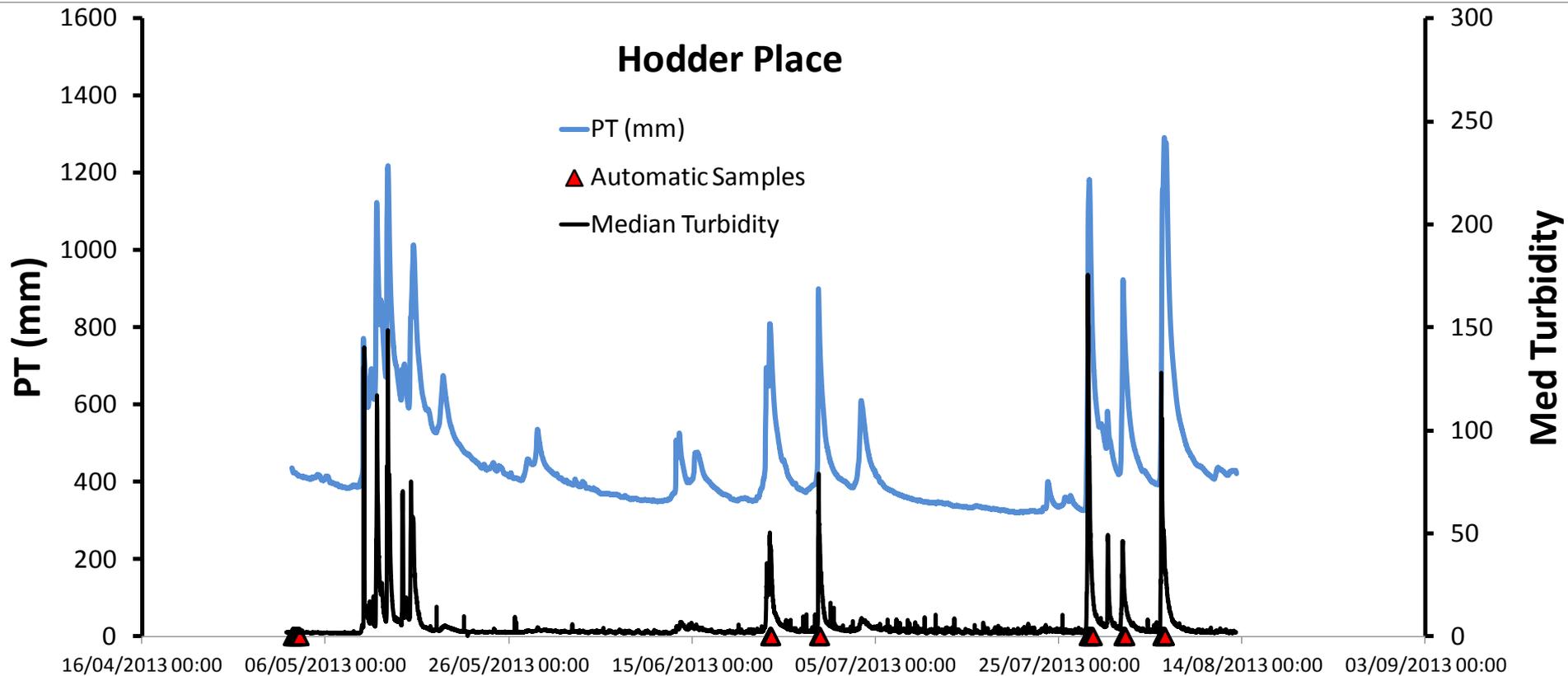
*Adams, Old, Naden, Tipping,
Helliwell, Gibbs Bryant,
Warwick, Rowe, CEH & JHI
analysts, Panton, Purdie*

- Lake sediments



*Boyle, Toberman, Turner,
Rose, Helliwell*

LTLS WP2 River sediments



Gareth Old, Jess Adams

LTLS WP3 Atmospheric model

Temporal – spatial model of N deposition for the UK from 1800

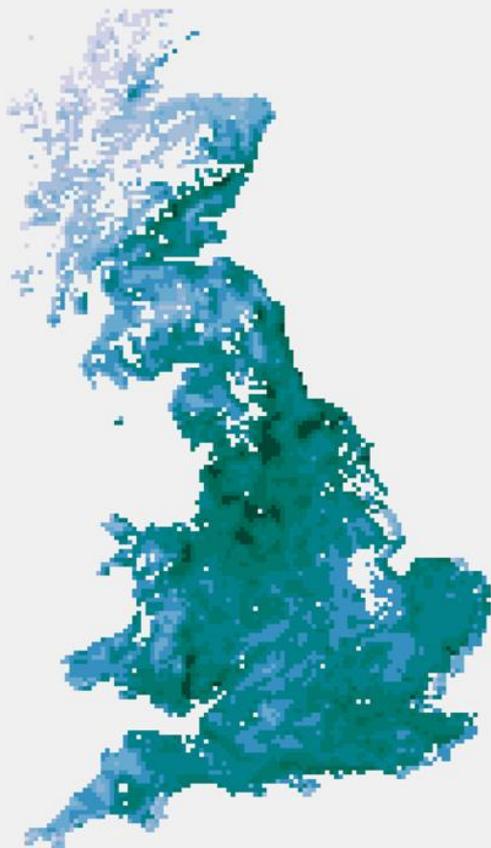
Dragosits, Sutton, May

LTLS WP4 Terrestrial ecosystem models

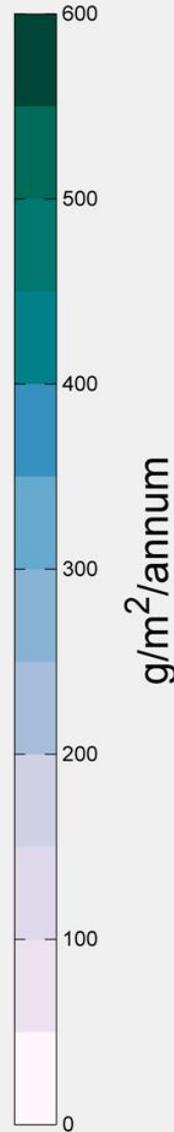
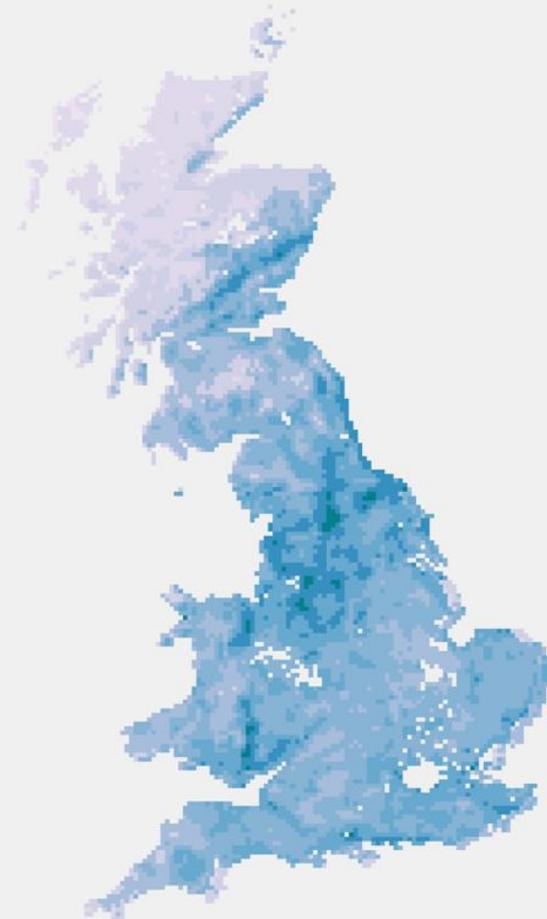
- N14C – semi-natural terrestrial ecosystems
Davies, Tipping, Rowe, Scholefield 
- Rothamsted model of agricultural terrestrial ecosystems
Muhammed, Whitmore, Wu 
- Erosion
Davies, Quinton, Bell, Naden 

N14C simulation of NPP, 2007

Broadleaf
woodland



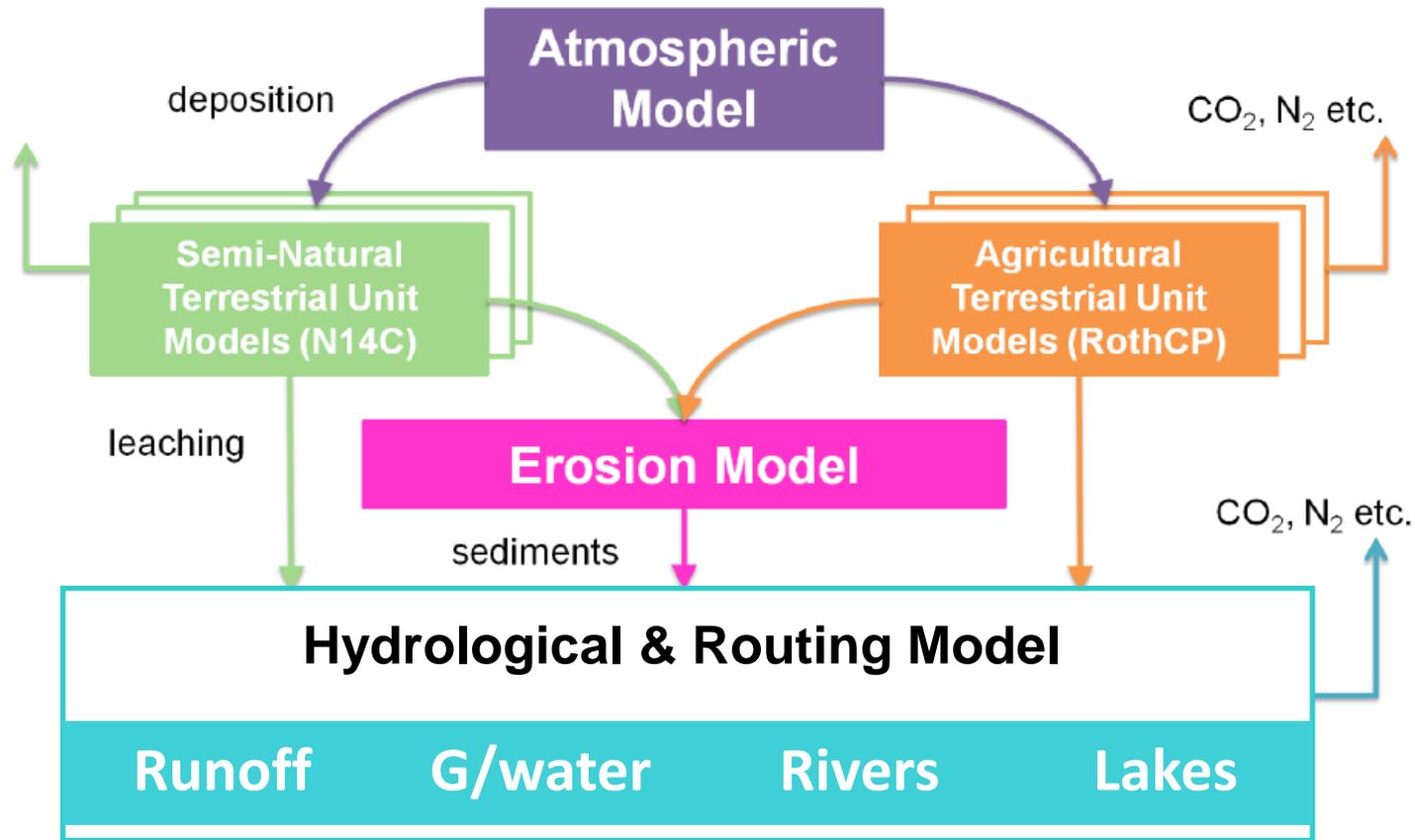
Rough
grassland



LTLS WP5 Aquatic models

- River biogeochemistry
Naden, Bell, Tipping
- River sediment transport
Naden, Old, Bell
- Lake biogeochemistry
Tipping, Naden, Monteith, Boyle
- Groundwater biogeochemistry (nitrate transport)
Stuart, Lapworth, Wang

LTLS WP6 Integrated Model (IM) land → rivers

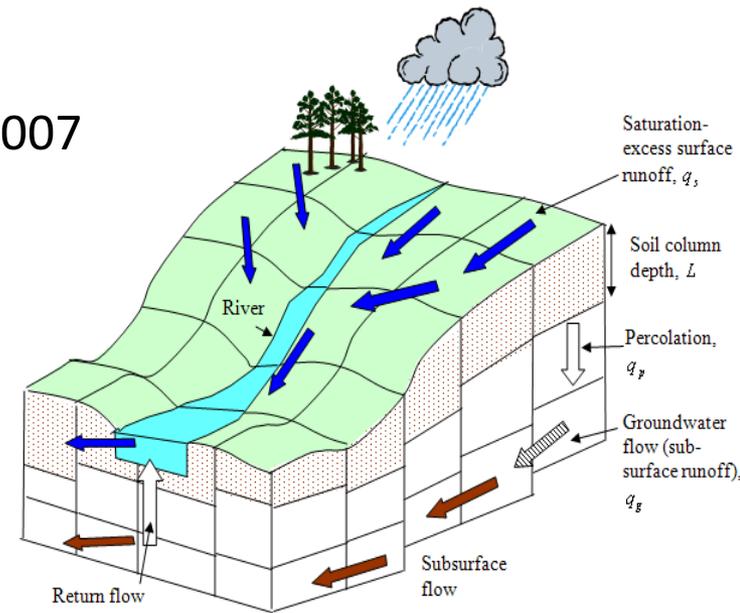


Bell, Naden, Davies H

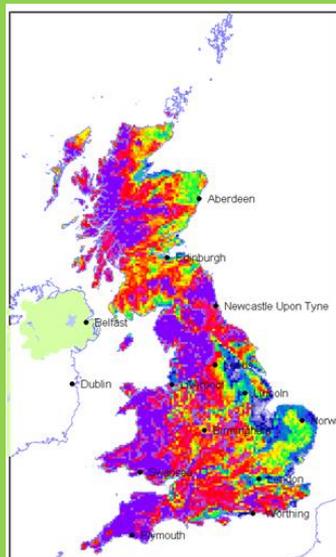
+ *Davies J, Muhammed, Quinton, Whitmore, Tipping, Rowe*

LTLS Integrated Model (IM) land → rivers

- ❑ **Spatial resolution:** $\Delta x = 5.0\text{km} \rightarrow \Delta t = 2\text{hr}$
- ❑ **Prototype** tested on observed data from 1971 – 2007
- ❑ **Modelled variables:**
 - 10 dissolved nutrients
 - 12 particulate nutrients
 - pH, O_2 , algae, macrophytes, water temperature
 - Gaseous outputs from river model



Runoff



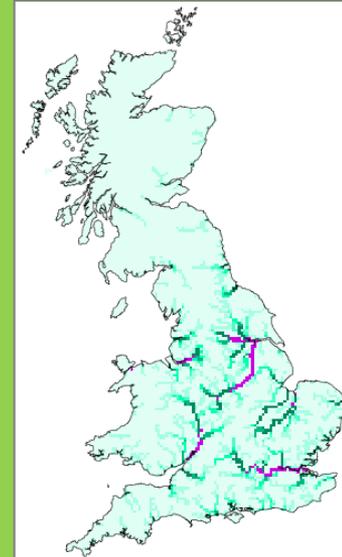
Flow



Erosion



Nitrate



**Example
model
output:**

LTLS WP7 Biodiversity - Biogeochemistry relationships

- Terrestrial plants, based on NPP
Smart, Henrys, Davies, Tipping, Toberman
- Lake diatoms
Simpson, Turner, Rose, Monteith
- River diatoms
Monteith, Kelly, Tipping

LTLS Stakeholder interactions

- Website *Chaplow, Patel, Tipping*
 - Scenario / Integrated Model workshop
Feb or Mar 2014
 - Scenario analysis with Integrated Model - 2015
- } **2-way**

Agreed: EA - For Res - SG - JNCC - NE

Awaited: NFU - Defra - ADAS - Nat Res Wales - SEPA - SNH - Water PLCs

- Scenarios for all MNC – *Rachel Helliwell* 

LTLS Project partners / larger-scale model

Dick Wright

Norwegian Institute for Water Research

Filip Moldan

Swedish Environmental Research Institute

Jan Mulder

Norwegian University of Life Sciences

Jack Cosby

CEH

Paul Whitehead

University of Oxford

Can the LTLS approach be upscaled,
e.g. to grid sizes of 50 x 50 km,
for application to larger areas?

LTLS future timetable

Date	Event / Activity
2013	Continuing fieldwork and analyses
Jan 2013	Half-way science meeting, Lancaster
Feb / Mar 2014	Meeting with Stakeholders - Integrated Model and scenarios
Mar-Sep 2014	Arable soils & peat sampling, bracken survey
Sept 2014	IM version 2 completed
2014	Larger-scale model, other countries
2015	Scenario analyses with Stakeholders
~ Sep 2015	Project ends

LTLS what have we learned so far?

Joining models together is hard work

National-scale modelling is informative

The British landscape is heterogeneous

We need to think about displaying outputs

LTLS research partners



**Centre for
Ecology & Hydrology**

NATURAL ENVIRONMENT RESEARCH COUNCIL



**Keele
University**

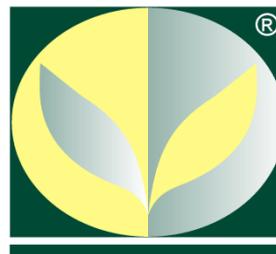
LANCASTER
UNIVERSITY



UNIVERSITY OF
LIVERPOOL



The James
**Hutton
Institute**



ROTHAMSTED
RESEARCH



NATURAL
ENVIRONMENT
RESEARCH COUNCIL

Radiocarbon Facility
(Environment)