NERC Macronutrient Cycles Programme
Consortium Grant

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

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RC Helliwell *JHI**
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CL Bryant *NERC RCF*

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* Funded by the Scottish Government

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LTLS research partners

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Biodiversity
Biogeochemistry
EIDC
Water

Keele University

LANCASTER UNIVERSITY

UNIVERSITY OF LIVERPOOL

UCL

The James Hutton Institute

BGS 1835

ROTHAMSTED RESEARCH

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Radiocarbon Facility (Environment)

LTLS questions

- Over the last 200 years, what have been the temp… responses of soil C, N and P pools in different UK cat… ent enrichment?
- What have been th… d P transfers from land to th… estuaries?
- How … water biodiversity responded to increa… tem productivity engendered by nutrient enrich… t 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

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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 Workpackages

WP1
Data

WP2
New measurements

WP3
Atmospheric model

WP4
Terrestrial models

WP5
Aquatic models

WP6
Integrated model

WP7
Biodiversity

LTLS Participants: modelling, fieldwork, analysis, data

Name	Name	Institution	Description	e-mail
Band 7 Acreman		CEH W	rivers fieldwork	
Band 7 Shore		CEH BG	soil, plant, water fieldwork	
Bell	Vicky	CEH W	integrated model	vib@ceh.ac.uk
Boyle	John	U Liverpool	history, lakes	jfb@liverpool.ac.uk
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PDRA Liverpool		U Liverpool	fieldwork, 14C	
PDRA Rothamsted		Roth Res	agricultural model	
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Scholefied	Paul	CEH BD	advice on Ribble etc	paul1@ceh.ac.uk
Sgourides	Fotis	U Keele	denitrification	
Simpson	Gavin	UCL	biodiversity	gavin.simpson@ucl.ac.uk
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Sutton	Mark	CEH BG	atmospheric	ms@ceh.ac.uk
Tipping	Ed	CEH BG	everything	et@ceh.ac.uk
Ullah	Sami	U Keele	denitrification	s.ullah@esci.keele.ac.uk
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Whitmore	Andy	Roth Res	agricultural model	andy.whitmore@rothamsted.ac.uk
Wu	Lianhai	Roth Res	agricultural model	lianhai.wu@rothamsted.ac.uk

LTLS scope & approach

Long-term processes	1800-present *20,000 BP – 1800*

All UK catchments to the tidal limit
+ water directly entering estuaries & sea

Existing data

New gap-filling data

Integrated modelling

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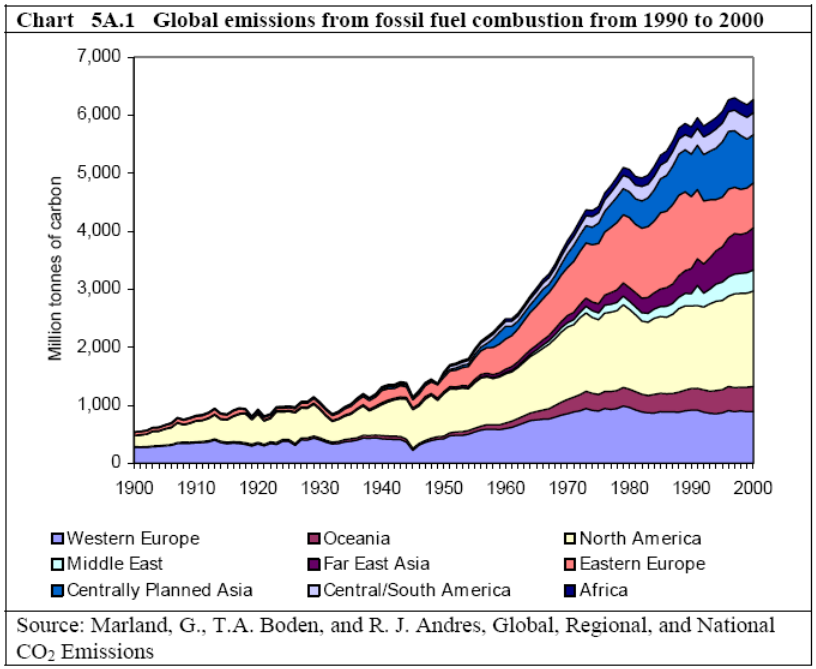
LTLS focus period 1800-2000



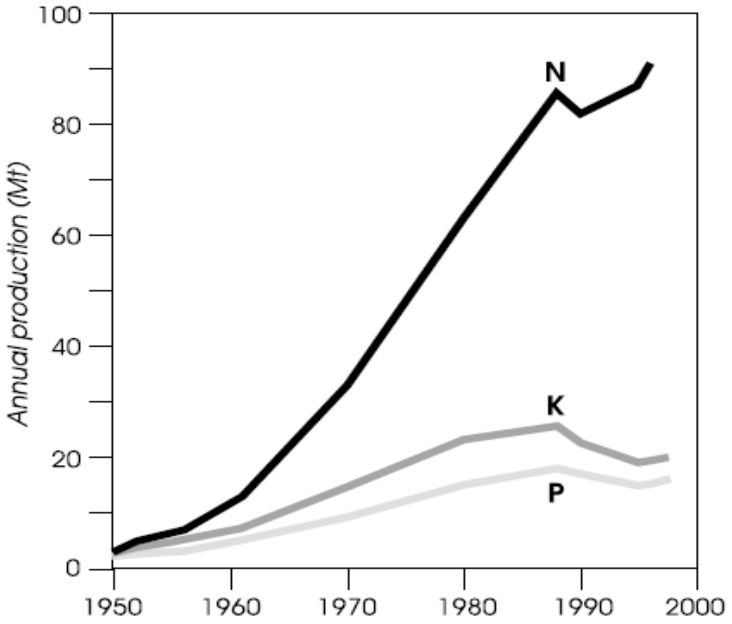


Figure 3. Global Production of Inorganic Fertilizers, 1950-2000.

"…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

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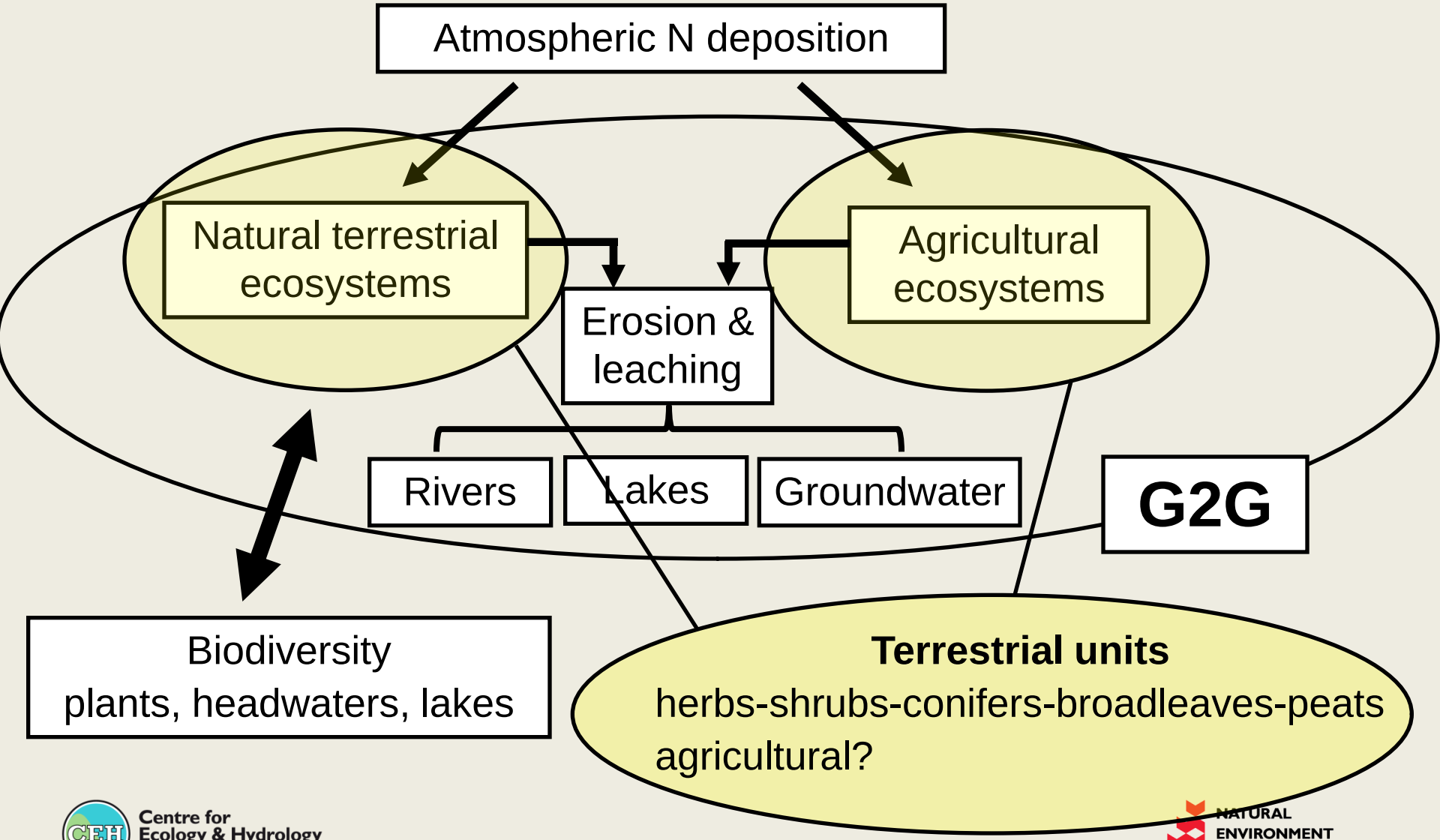
LTLS joined-up models



LTLS modelling

N deposition	Sutton
Natural terrestrial ecosystems	Tipping / Quinton
Agricultural ecosystems	Whitmore / Quinton
Riverine fine sediment, floodplains	Naden
River & lake biogeochemistry	Boyle / Monteith / Naden / Tipping
Groundwaters	Stuart
G2G	Bell
Biodiversity	Smart / Simpson / Monteith

LTLS existing data: driving

CLIMATE
Paleoclimate and Coupled Model Intercomparison Project
CMIP5 outputs from BADC

LAND USE
History
Land Cover Map
Agricultural land use data

DEPOSITION
N & S

SOLID & DRIFT GEOLOGY?

FERTILISERS ETC
British Survey of Fertiliser Practice
Nutrients in slurry and manure
Animal feed data
Farm Management Handbook
Biosolids applications

POINT SOURCES TO RIVERS

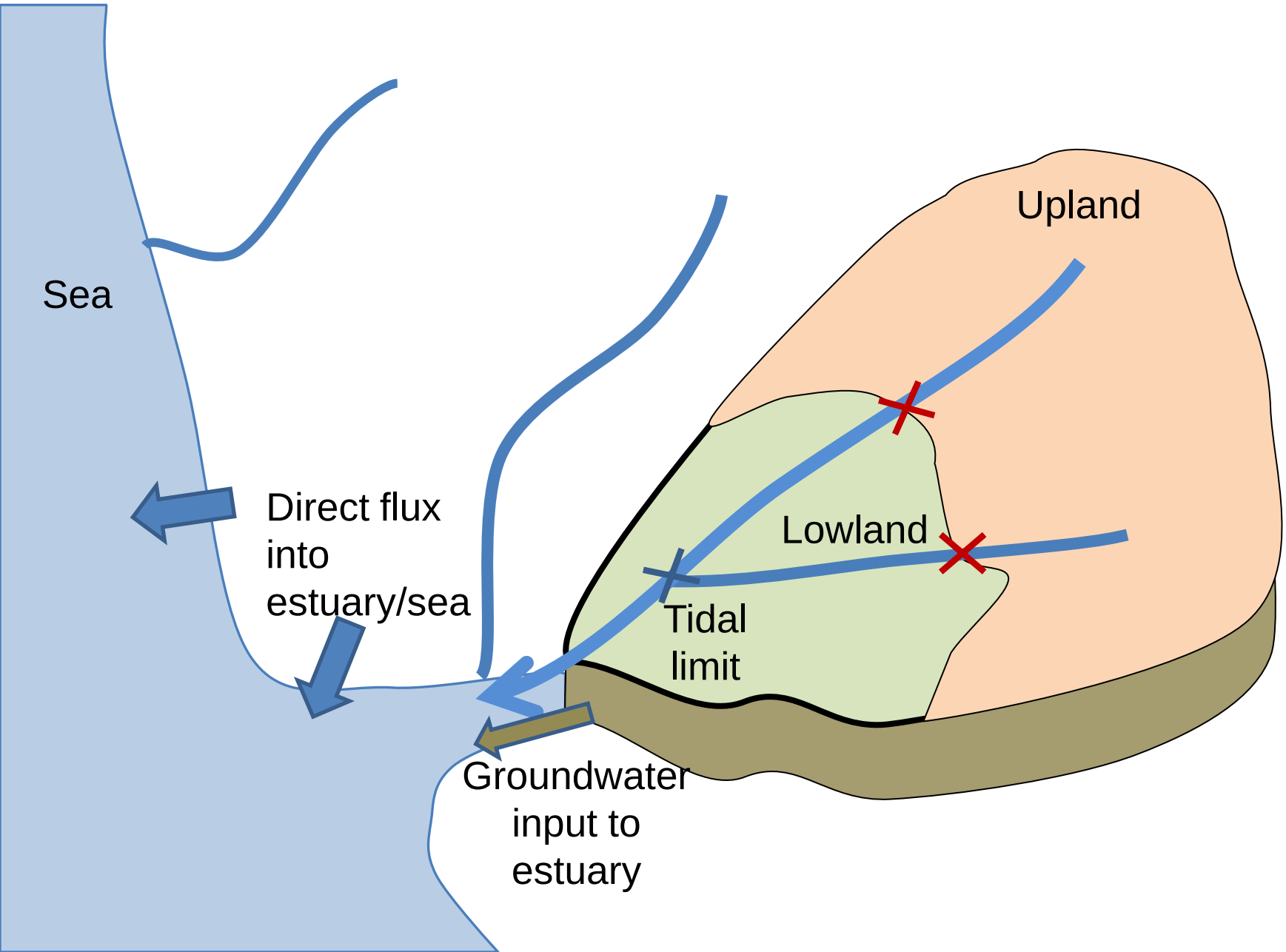
LTLS existing data: fitting & testing

Plant CNP	ITE, CS, Roth Res, literature
Soil chemistry	CS, NSRI, JHI, Roth Res, literature
Soil solutes	CEH, ECN, Forest Res, Roth Res, literature
Soil radiocarbon	Defra (TU), Roth Res, literature
Soil denitrification	Defra projects, literature
Erosion	Defra projects, river fine sediment fluxes, literature
River flows	National River Flow Archive
Freshwaters	HMS (EA), AWMN, ECN, LOIS, DTC, literature
Groundwater	BGS archives, EA national data, literature
Lake sediments	UCL database, literature
Biodiversity	CS (terrestrial & headwaters), UCL-ECRC, literature
Nutrient removal	Crop and livestock yield data, forestry data

LTLS gap-filling data

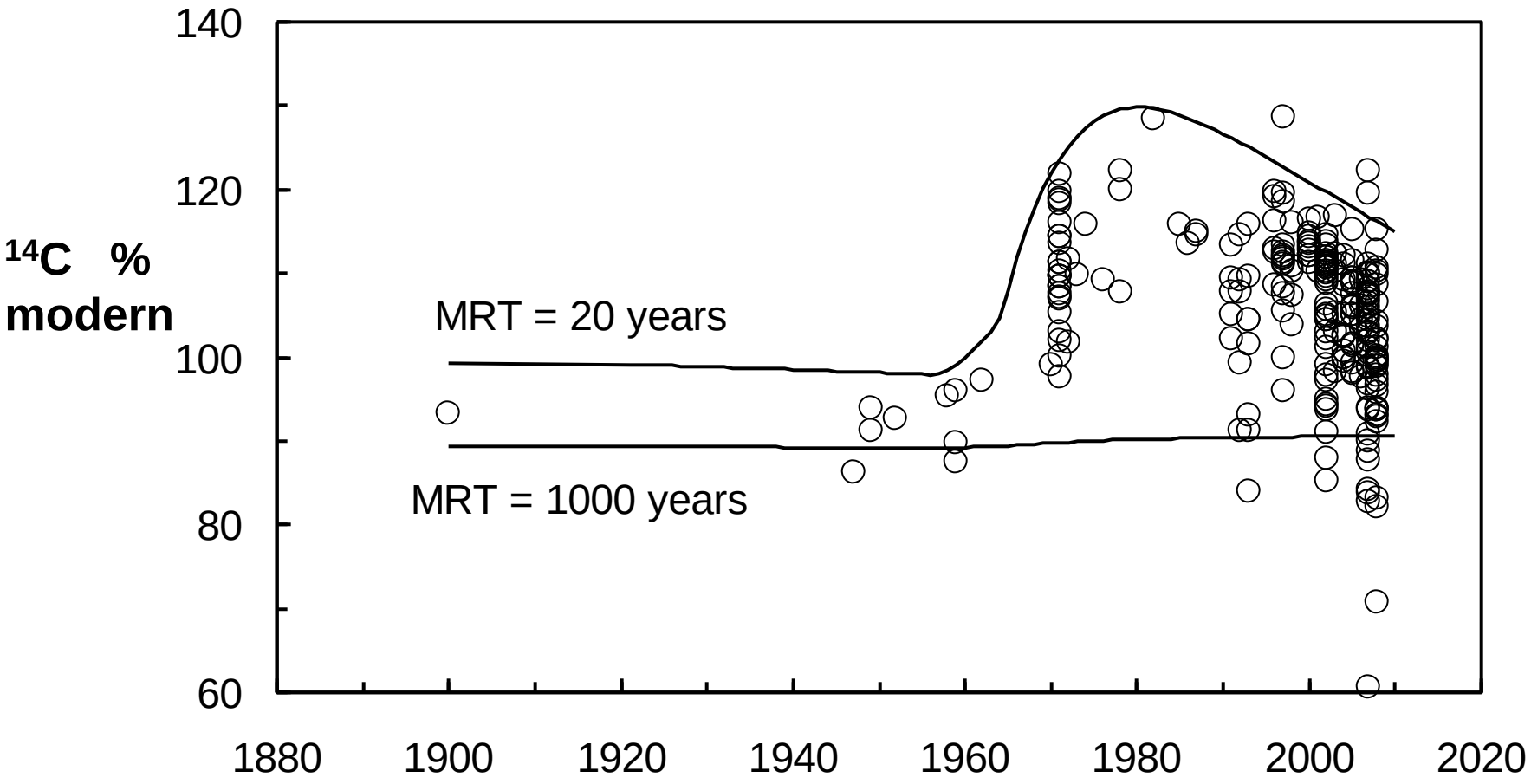
Element release from burning coal and wood, to enable atmospheric modelling	laboratory
Denitrification (N_2 + N_2O) from semi-natural soils	**Conwy, Ribble** Avon? Dee?
C N P (Porg) pools in vegetation and soils, ^{14}C	Avon, Conwy, Dee, Ribble
Agricultural soils ^{14}C	TBA
Riverine transport of dissolved & particulate C N P ^{14}C	**Ribble,** Avon, Conwy, Dee
Lake sediments – accumulation rates of C N P	Avon, Conwy, Dee, Ribble

LTLS division of catchments



LTLS radiocarbon

258 natural topsoils analysed for radiocarbon



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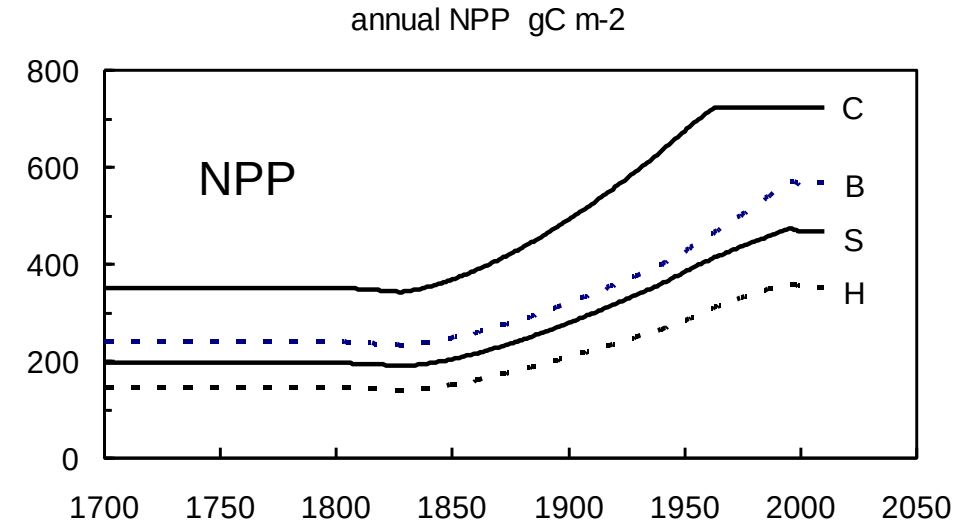
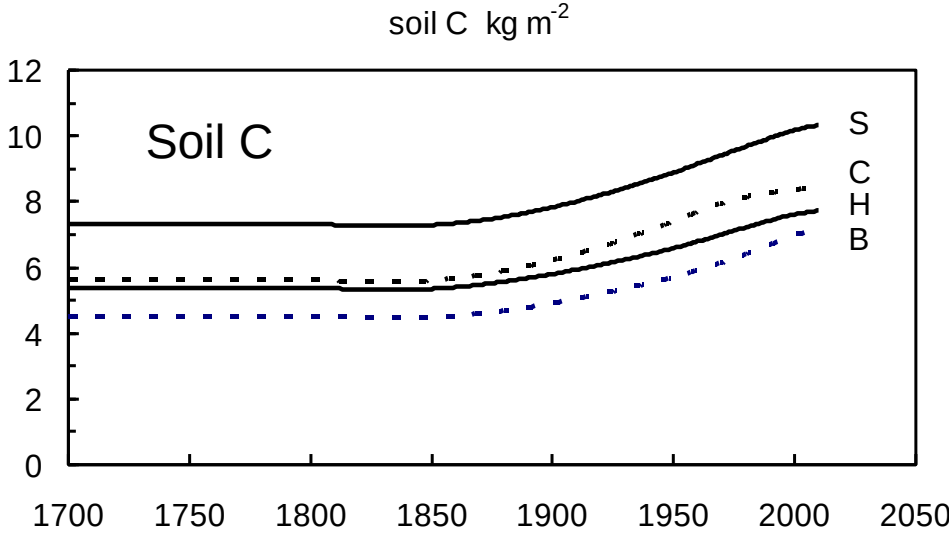
LTLS history of Britain

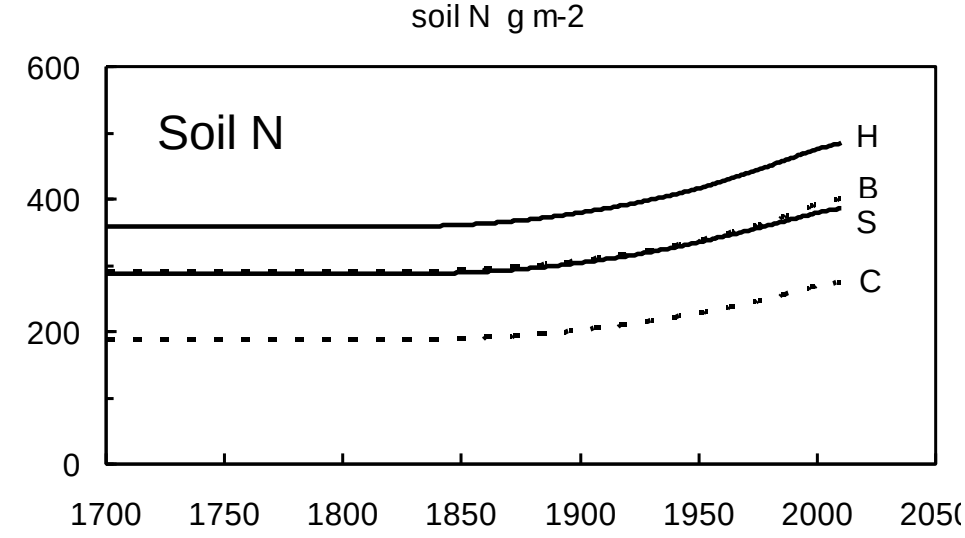
		Pop, m
-13000	tundra / glaciated	
-6000	deciduous forest	
-3000	Neolithic farming / forest clearance ongoing	0.01
-1500	ploughing begins	
0	all Britain involved in farming	1
1100	E&W 35% arable, 25% pasture, 15% forested [DB]	2
1500-1700	Joan Thirsk farming maps for E&W	5
1700-1800	transition from organic to inorganic economy	9
1800-2000	***main focus of the project***	
1930	Dudley Stamp UK land-use map	40
2000	UK Land Cover Map	60

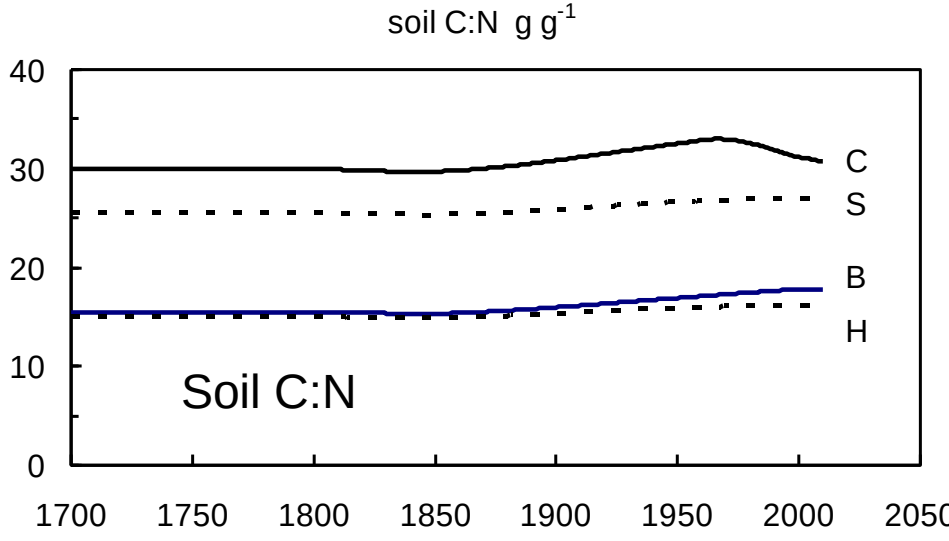
N14C simulations for Broadleaf, Conifer, Herbs, Shrubs

MAT = 8ºC , MAP = 1500 mm, Ndep(2000) = 2 g m^{-2}



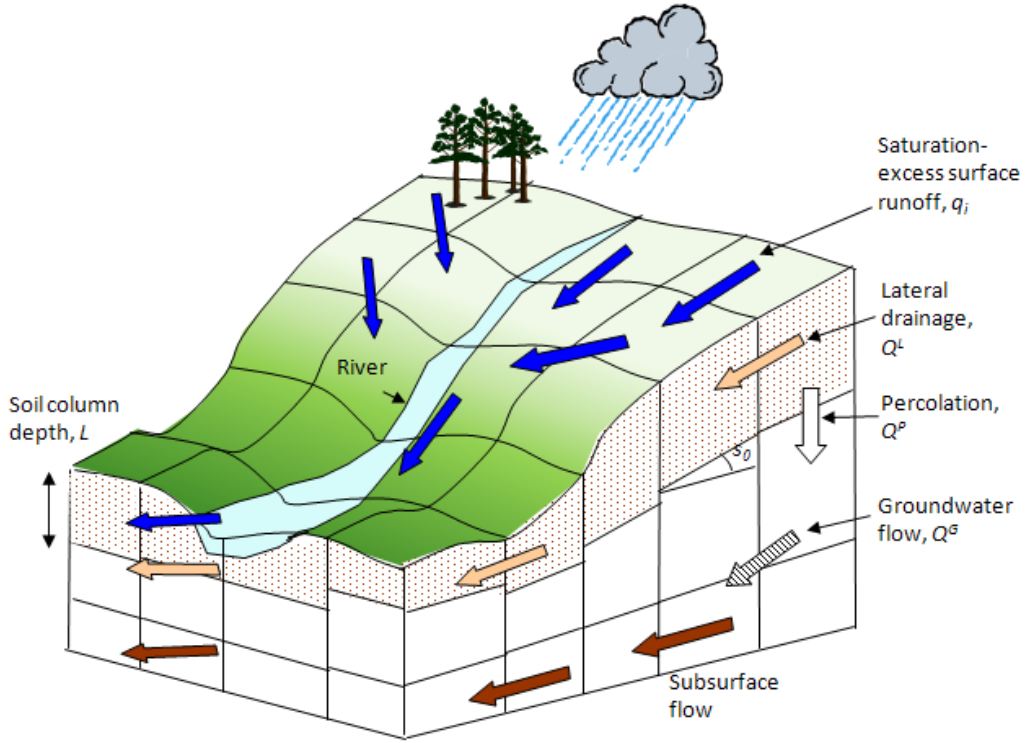






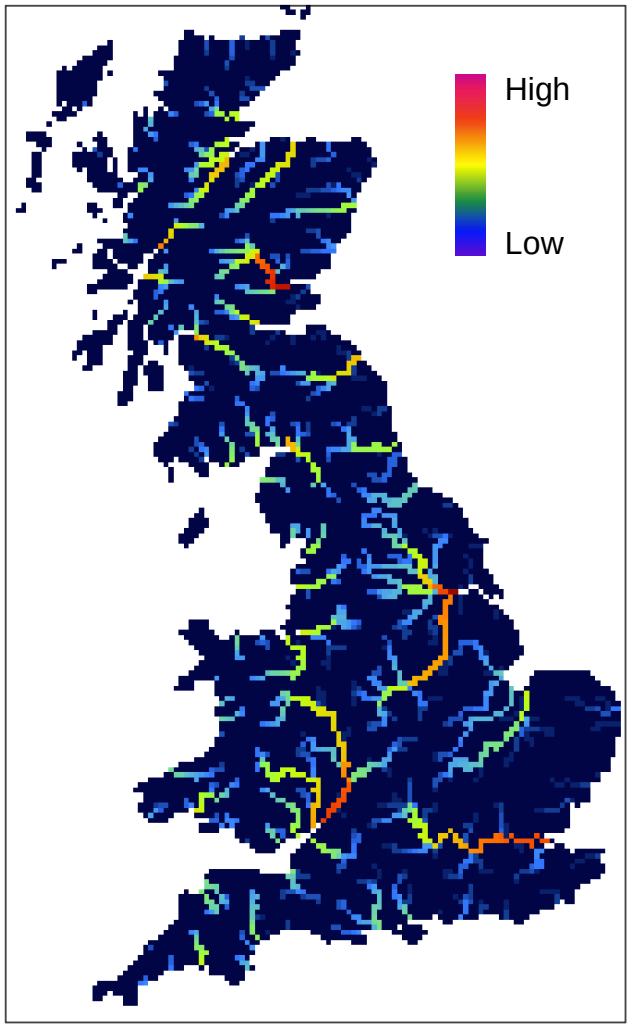
LTLS G2G

- River flows at 5km resolution
- Digital datasets of elevation, soil-type and urban land-cover ⟶ spatially-varying effects of the landscape on river flows
- Single set of parameters for the whole domain of coverage



Example model output

Monthly mean river flow (m3 s-1)



LTLS Stakeholder interactions - 1

- MC programme meetings etc.

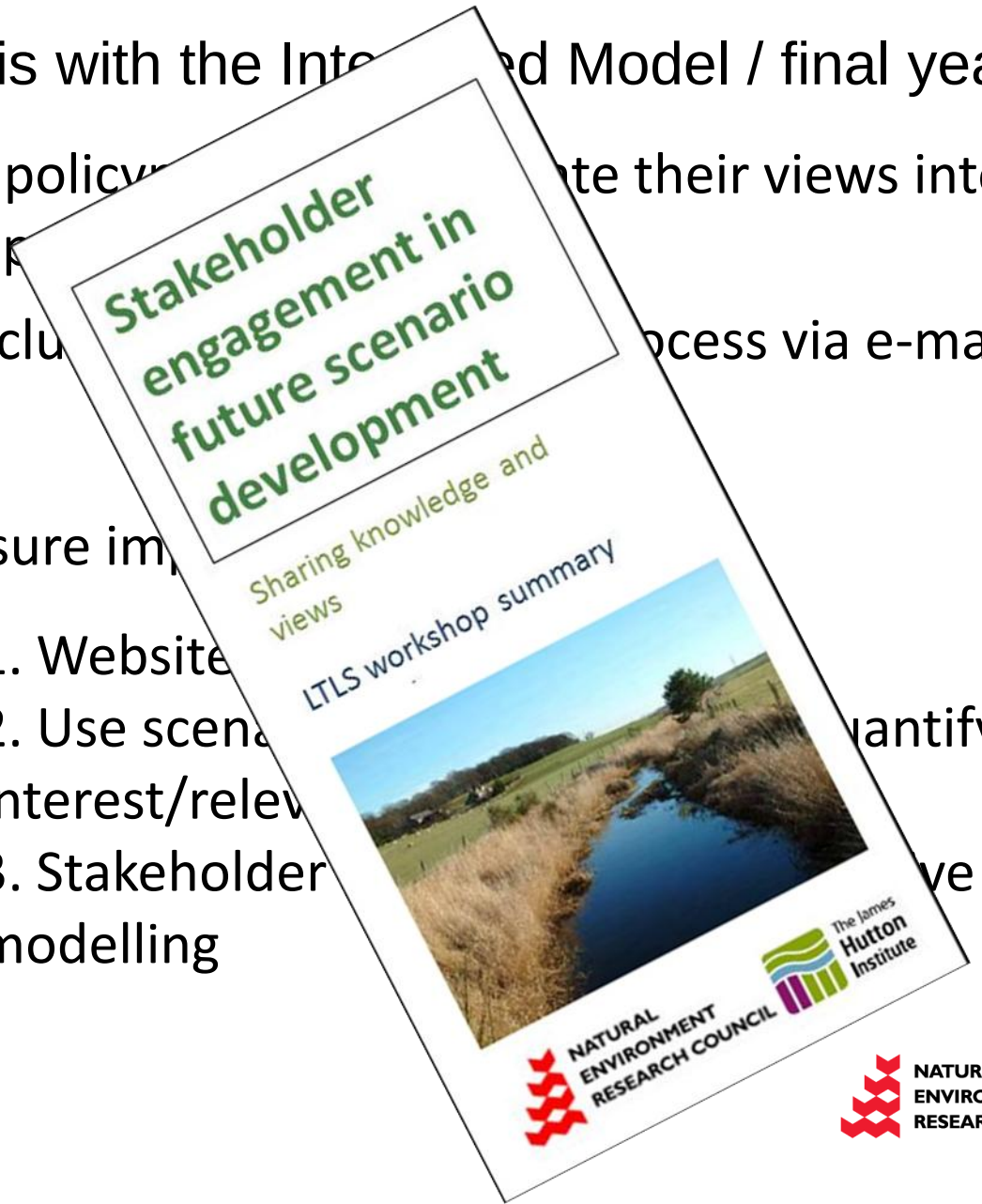
- Project website
  - To disseminate information and results to a range of audiences (Policy, Industry, Education etc.)
  - *You Tube* video clips, inc Powerpoint presentations with voice commentaries

- "Halfway" workshop to review progress and relevance with stakeholder engagement
- Prepare a stakeholder questionnaire to gauge interest in further scenario development/workshop involvement

LTLS Stakeholder interactions - 2

- Scenario analysis with the Inte ed Model / final year
  - Workshop with policy te their views into scenario develop
  - Policymakers inclu ocess via e-mail communication
- How will we measure im

1. Website
2. Use scena uantify interest/relev
3. Stakeholder ve modelling



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LTLS Project partners

NIVA

Norwegian Institute for Water Research

UMB

Norwegian University of Life Sciences

IVL

Swedish Environmental Research Institute

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LTLS Timetable

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