Long-Term Large-Scale Project

LTLS CNP

NERC SCIENCE OF THE ENVIRONMENT

The Scottish Government

macronutrient cycles programme

Introduction

- The LTLS project aimed to understand and simulate changes in UK pools and fluxes of C, N and P over the last 200 years.
- To achieve this we developed an integrated model (IM) of the interacting element cycles in atmosphere, land and water.
- The LTLS IM provides plausible explanations of macronutrient cycling history. Therefore it should be useful for forecasting, at national and large catchment scale, how the pools and fluxes of C, N and P might evolve in the future, in response to drivers of change.
- The core modelling work was described in our platform presentations; the slides are available on the project website: www.ltls.org.uk
- On these posters we present the key results of supporting studies, designed to provide data to drive or test the IM or its components, and to relate model outputs to biological responses.

Centre for Ecology & Hydrology NATURAL ENVIRONMENT RESEARCH COUNCIL

ROTHAMSTED RESEARCH

Lancaster University

Keele University

UCL

The James Hutton Institute

UNIVERSITY OF LIVERPOOL

BGS 1835

NERC SCIENCE OF THE ENVIRONMENT Radiocarbon Facility (Environment)

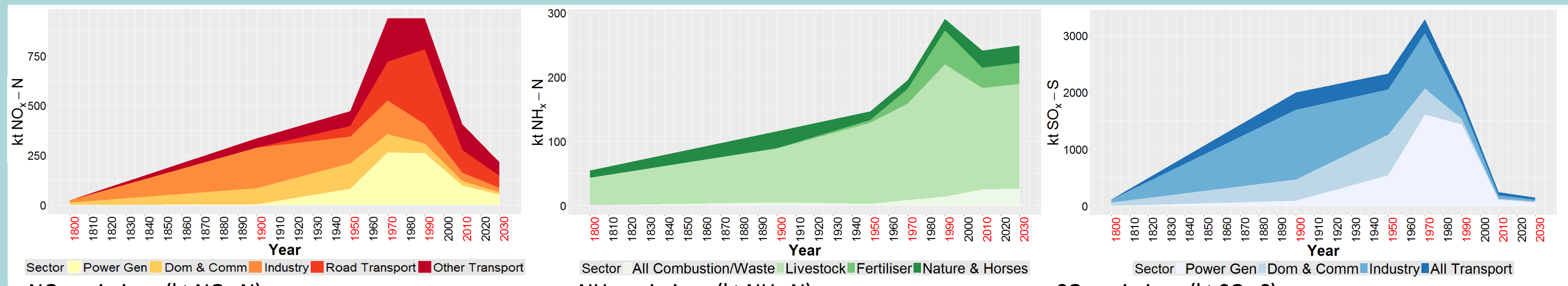
Atmospheric Modelling and Measurements

Carnell E.J.[1], Tomlinson S.J.[1], Dore A.J.[1], Simpson D.[2], Misselbrook T.[3], Nemitz E.G.[1], Langford B.[1], Mullinger N.[1], Smith T.[4], Sutton M.A.[1] & Dragosits U[1]. 1) Centre for Ecology and Hydrology 2) Norwegian Meteorological Institute 3) Rothamsted Research 4) Kings College London

Emissions

Emissions of NO_x, NH_x and SO_x were quantified and spatially reconstructed for individual source sectors over seven time slices.

SO_x emissions decreased by 92% from 1970 to 2010, while NH_x emissions only decreased by small amounts.



NO_x emissions (kt NO_2-N)
Combustion of fossil fuels (mainly industry, transport)

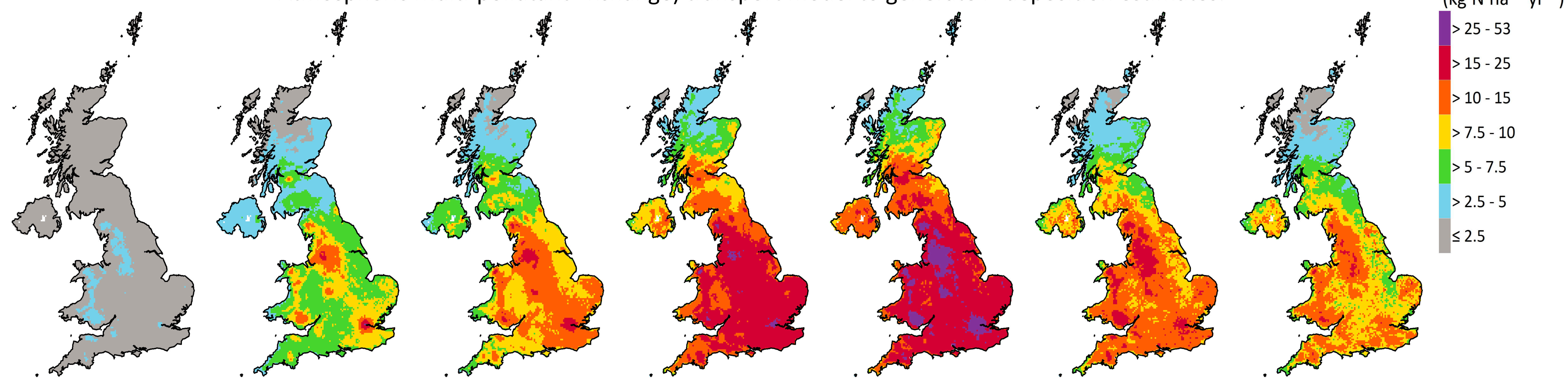
NH_x emissions (kt NH_3-N)
Agriculture (livestock manures, fertiliser application) and waste processing

SO_x emissions (kt SO_2-S)
Combustion of fossil fuels (industry, power generation) and domestic fuel combustion (mostly coal)

Figure 1 – Emission estimates for the seven modelled time slices (including 2030 projections)

N Deposition

The spatially resolved emission estimates were input into the FRAME (Fine Resolution Atmospheric Multi-pollutant Exchange) transport model to generate N deposition estimates.



1800	1900	1950	1970	1990	2010	2030
•First population census data •Industrial Revolution	•Domestic coal use peak •Board of Agriculture established	•Large scale Haber-Bosch processing •Increase in power generation	•Peak in sulphur emissions	•Peak NO_x & NH_3 emissions •Sulphur decreasing	•Present day	•2030 Projection (UEP43)

Figure 2 – Modelled N deposition estimates for the seven time slices (including 2030 projections)

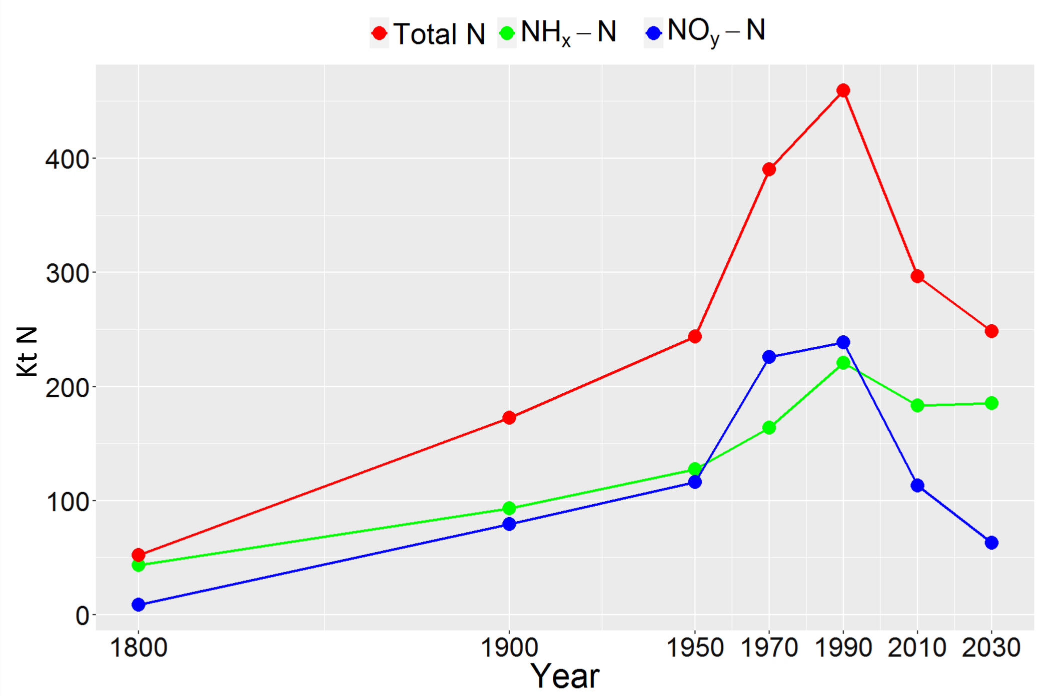


Figure 3 – Total N deposition with composition of NO_y-N and NH_x-N (including 2030 projections)

- N deposition peak ~1990: 460 kt N
- Reduced N (NH_x) constitutes 62% of all N deposition in 2010: driven by agriculture.
- Wet deposition fraction dominant in 2010 (76%), partly due to NH_3:SO_2 ratios and OH availability.
- Deposition trends are non-linear: lowland areas have larger relative decreases compared to uplands.

Conclusions

- **S & N emissions –** increased hugely from 1800 to 1990
- **Sulphur** - emission reductions a big UK & international policy success!
- **Oxidised N (NO_x)** - emissions reductions from ~1990 mainly due to international legislation (e.g. combustion and catalytic converters), but NH_x abatement is slow.
- **Reduced N (NH_x) –** now largest source of N deposition, largely unchanged & predicted to remain stable.
- **Changing spatial patterns –** composition of N deposition affected by changing emissions, changing chemistry and wet:dry deposition fractions.

Contact: ud@ceh.ac.uk, samtom@ceh.ac.uk, edcarn@ceh.ac.uk, todo@ceh.ac.uk