Landscape variability and impacts of ammonia in relation to the Habitats Directive

Mark Sutton
CEH Edinburgh

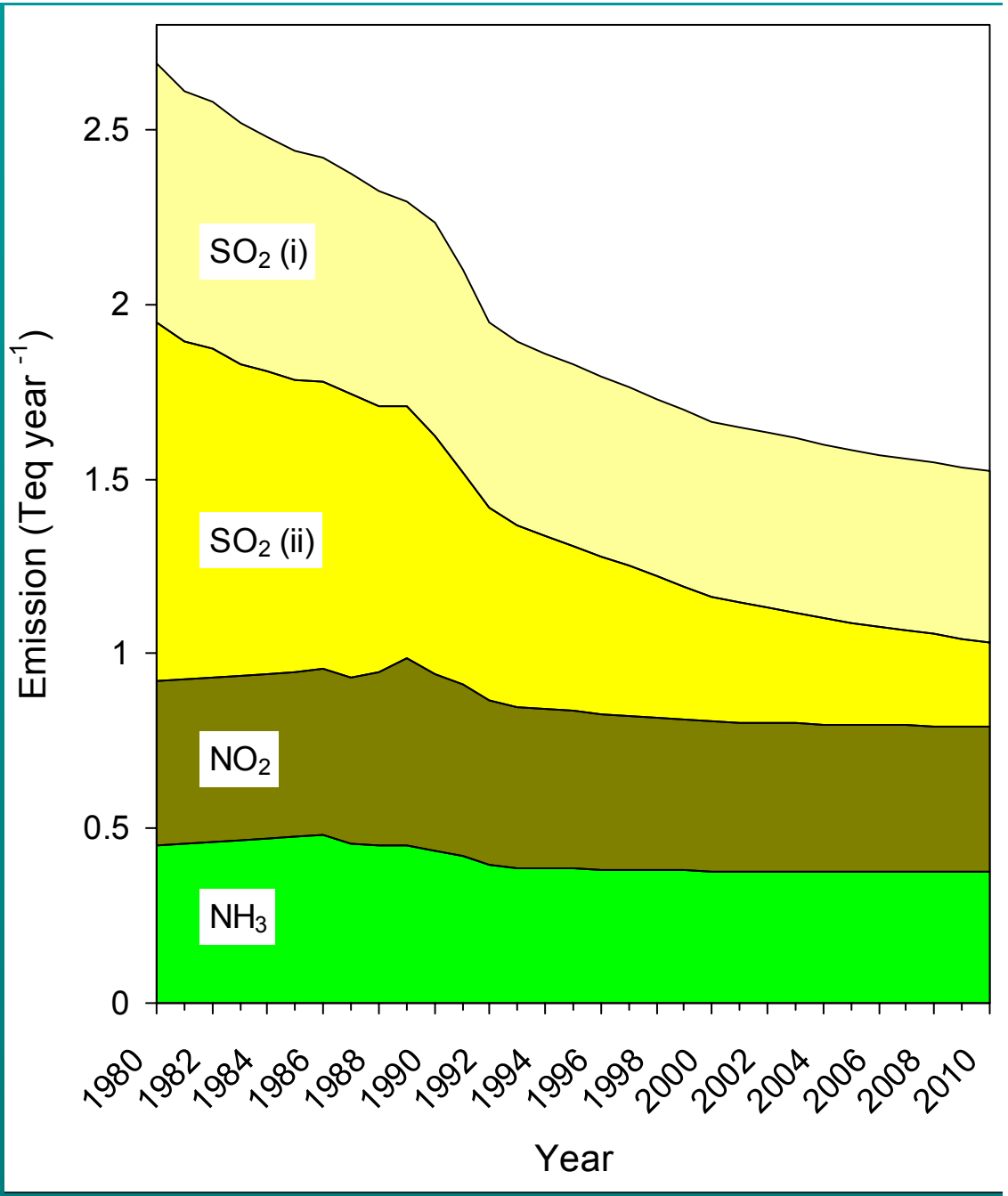
The problem

- Farming is not just a force for environmental protection
- Some aspects of farming lead to environmental pollution (even when following “good practice”)

Examples:

- Leaching of nitrates to soils and water courses
- Emissions of ammonia to the atmosphere

Progress in reducing European acidifying emissions



The new polluters!

Arthur Young:
cited in Pott's Agricultural Cylopedia 1807

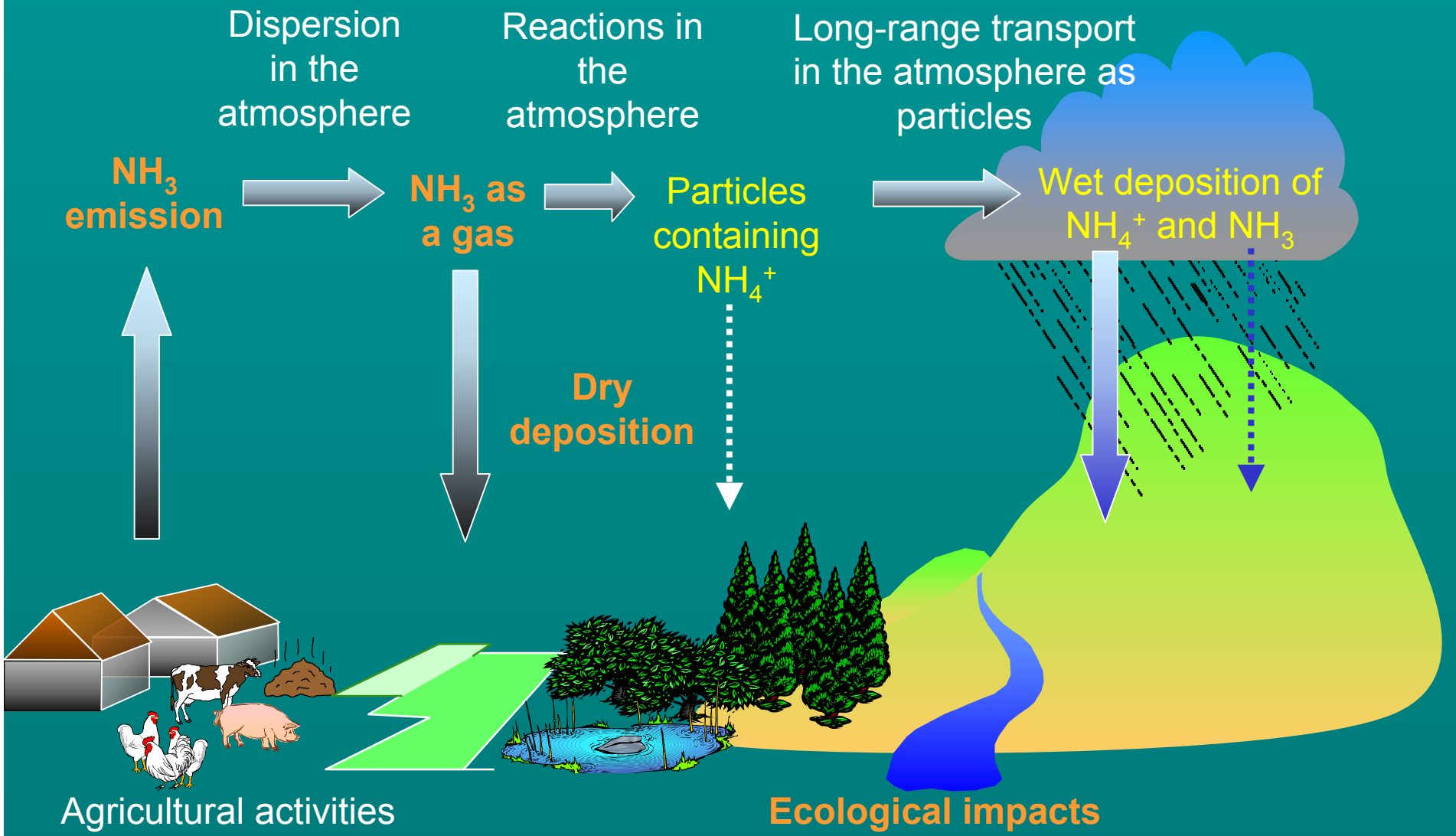
"He who is within the sphere of the scent of a dunghill, smells that which his crop would have eaten, if he had permitted it.

Instead of manuring his land, he manures the atmosphere; and before his dunghill has finished turning, he has manured another parish, perhaps another county."

Agriculture and Environment

- Farmers as custodians of the environment
- Agricultural production and European subsidies for food production
- Reform of Common Agricultural Policy: subsidies increasingly decoupled from production; new subsidies for wildlife management, farm woodlands etc.
- Possible results:
  - less intensive, more environmentally friendly agriculture
  - Polarisation: productive areas intensify; marginal areas extensify

Ammonia in the atmosphere



Effects of ammonia on the environment

Nitrogen reduces the abundance of woodland flowers

Wood sorrel (*Oxalis acetosella*)

Lost at the expense of:

Velvet grass (*Holcus lanatus*)

Effect of gaseous NH_3 on flowering of Cotton grass (*Eriorphorum vaginatum*)

Ambient NH_3

100 ug m^{-3} NH_3

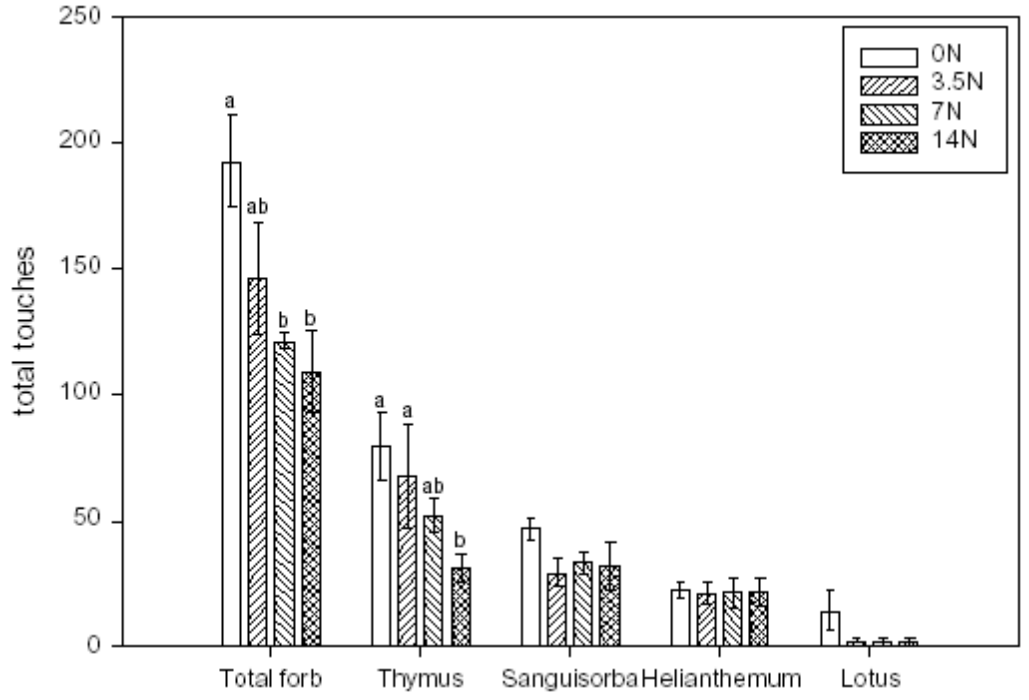
- Work also characterizing the relative effects of wet vs dry N deposition

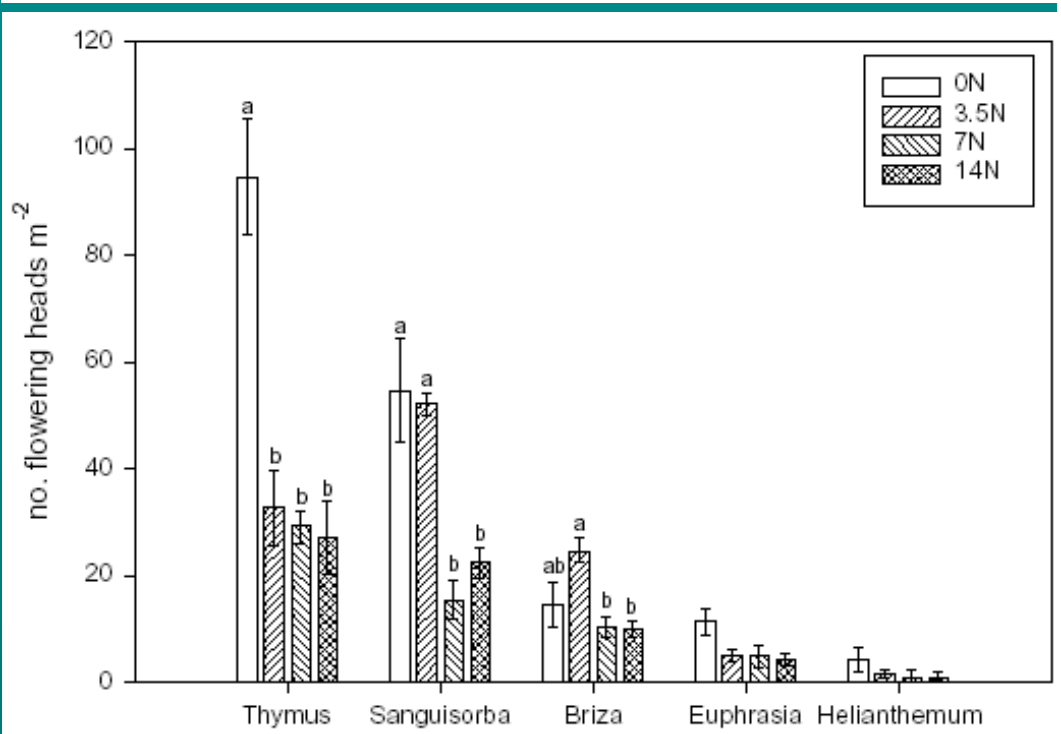
Leith et al. CEH Edinburgh

Effect of N deposition on forbs in calcareous grassland – Wardlaw Hay Cop

12 years of treatments –
large effects but no extinctions

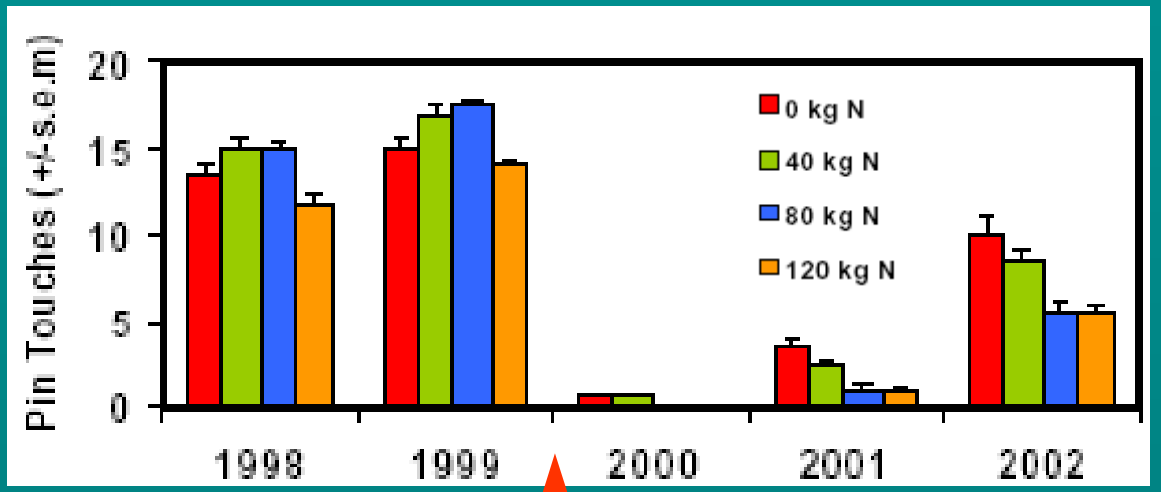
Lee et al., University of Sheffield





Interactive effect of N deposition and fire on *Calluna* cover at Ruabon


Calluna (heather)

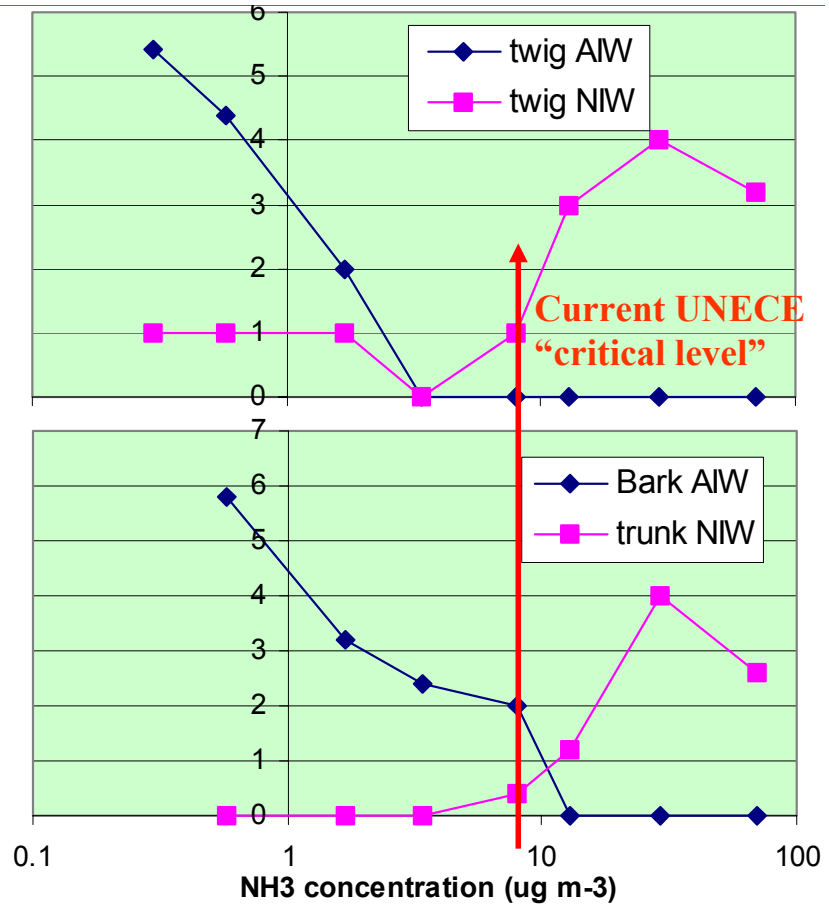


- Treatments started 1989, Ruabon, N. Wales
- Current work also considering recovery following reduced N inputs

Caporn et al., Manchester Metropolitan University

Sensitivity of lichens to NH_3

Acidophytes (AIW) hate NH_3



"**Troll's Beard**" (*Bryoria*):
disappearing from many sites

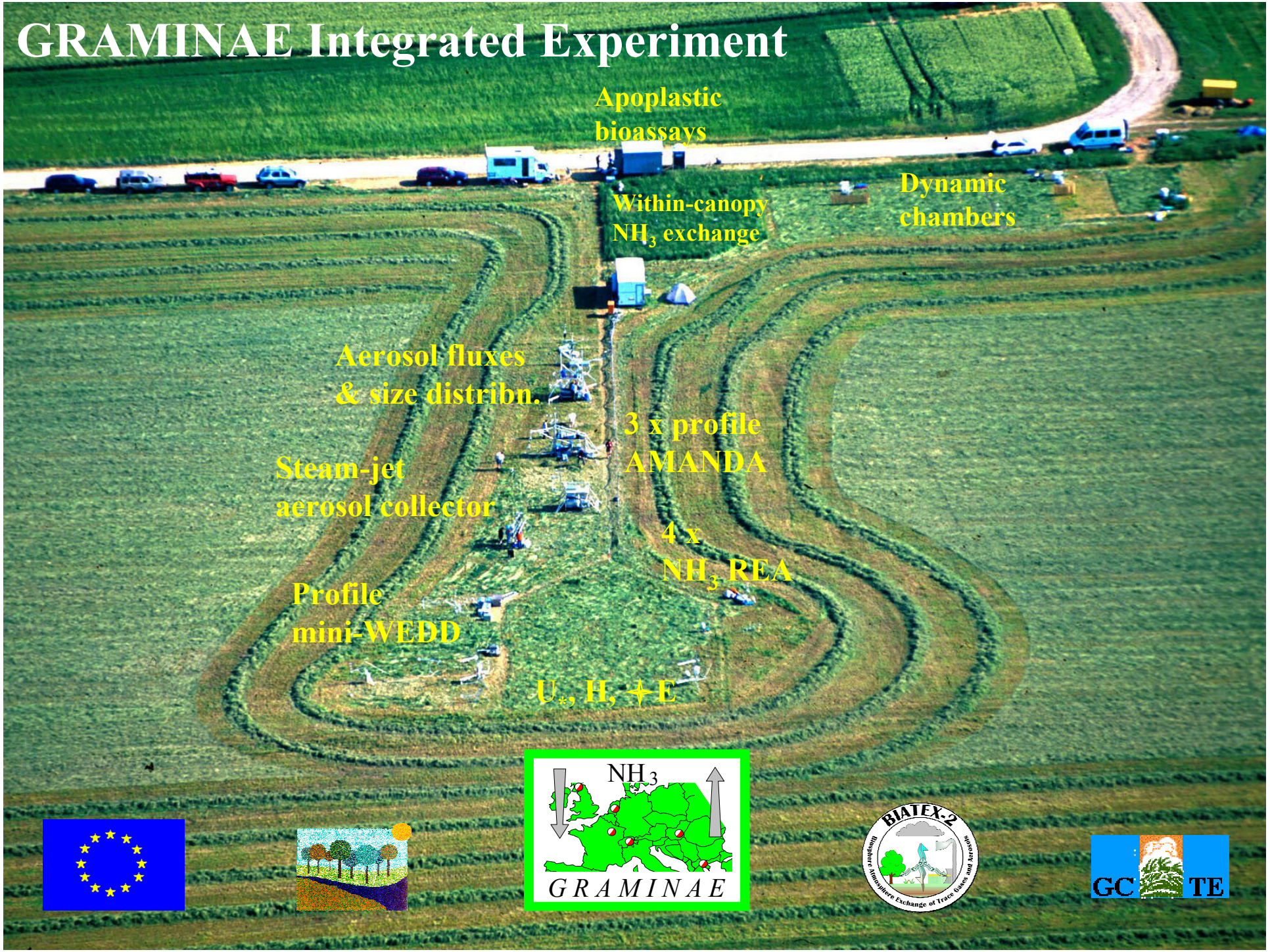
Cladonia

Nitrophytes (NIW) love NH_3

Xanthoria
thrives by farms

Process measurements and modelling of ammonia fluxes

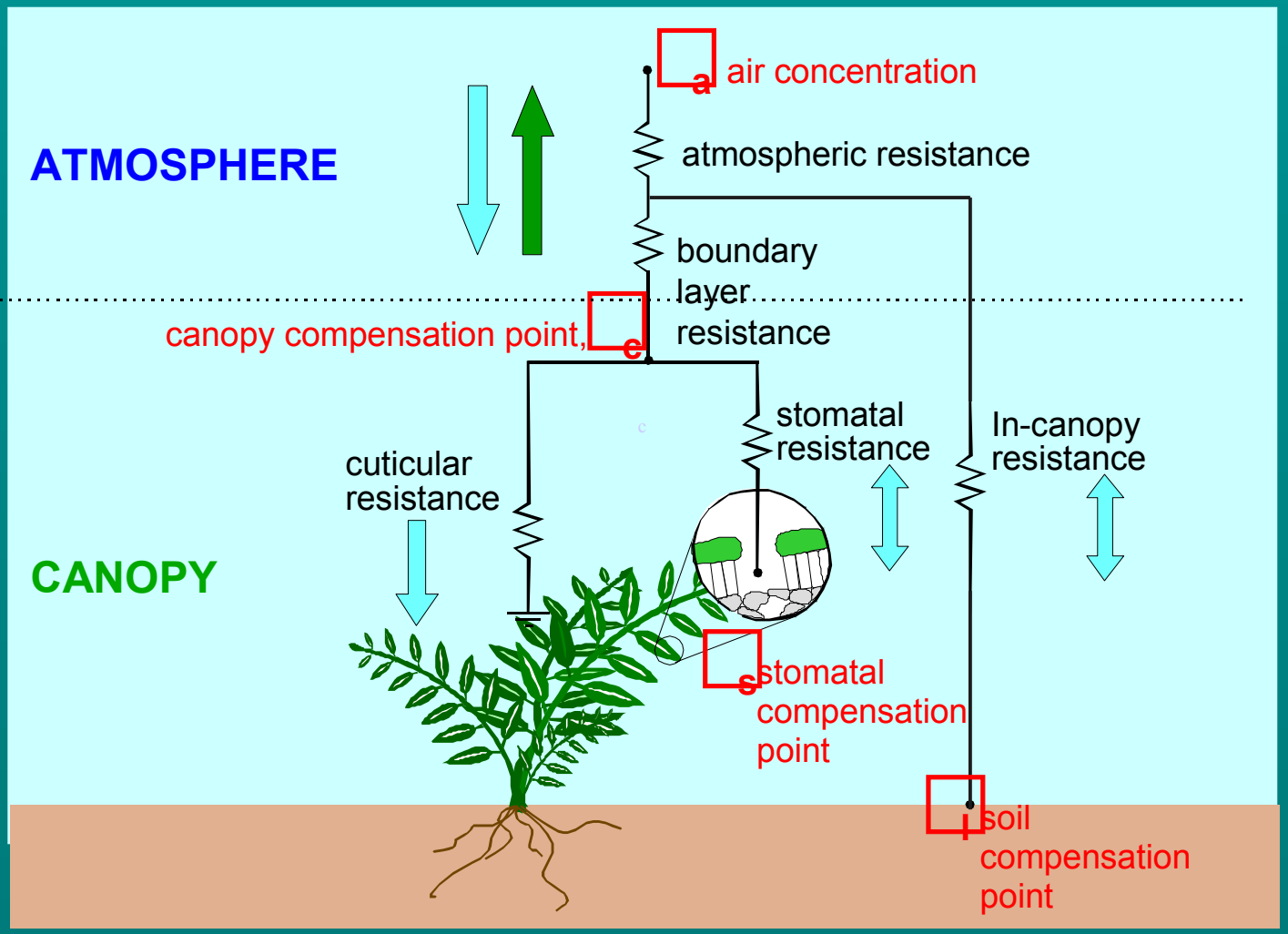
GRAMINAE Integrated Experiment



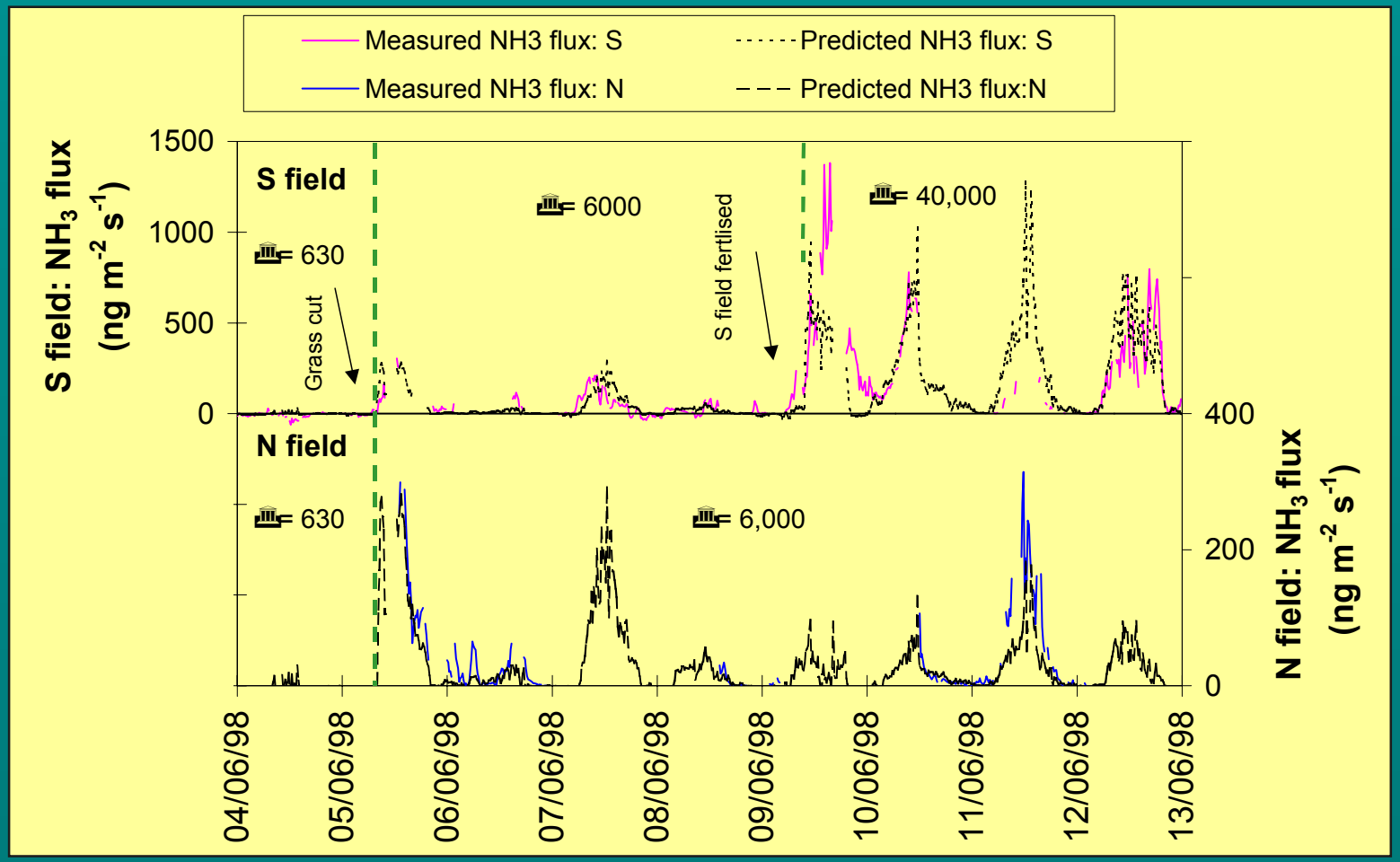
Modelling ammonia fluxes

$\square_s = f(T, \square)$

$\square = \frac{[NH_4^+]_{apo}}{[H^+]_{apo}}$

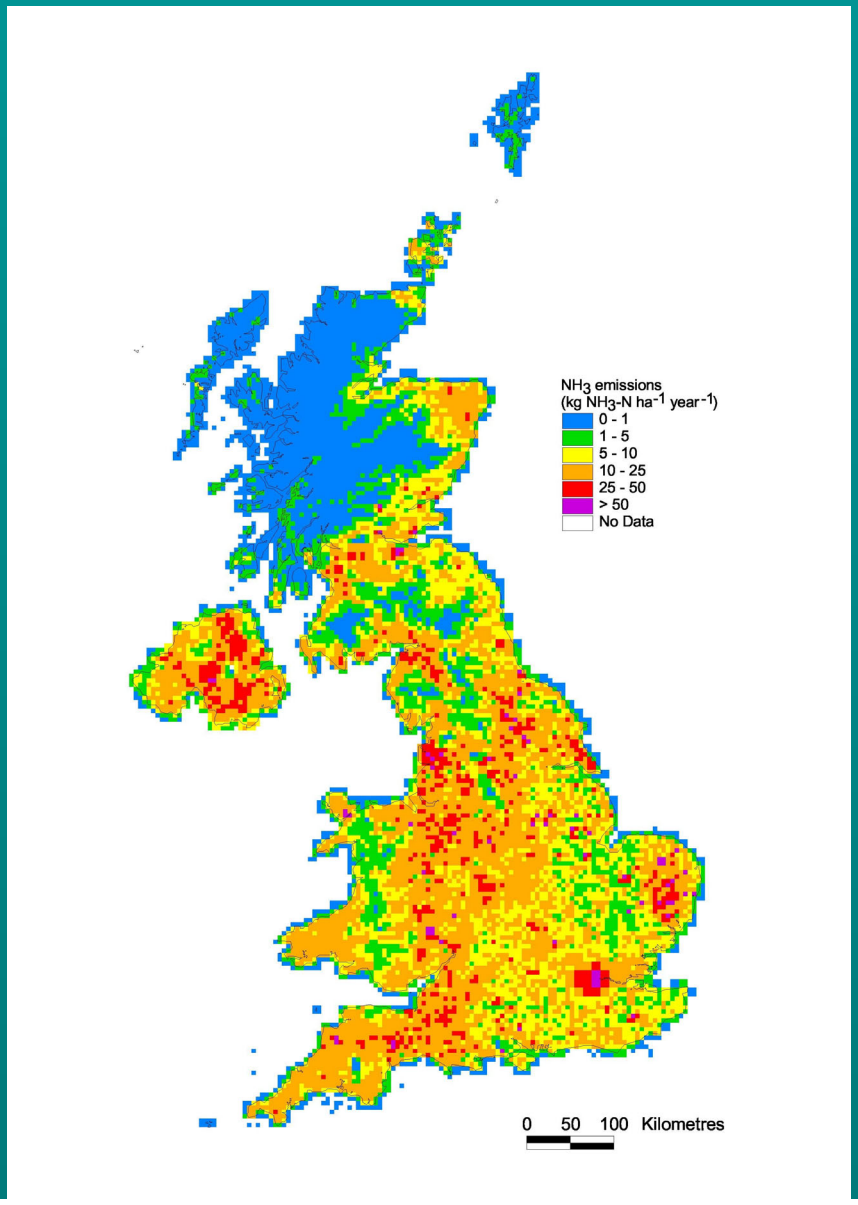


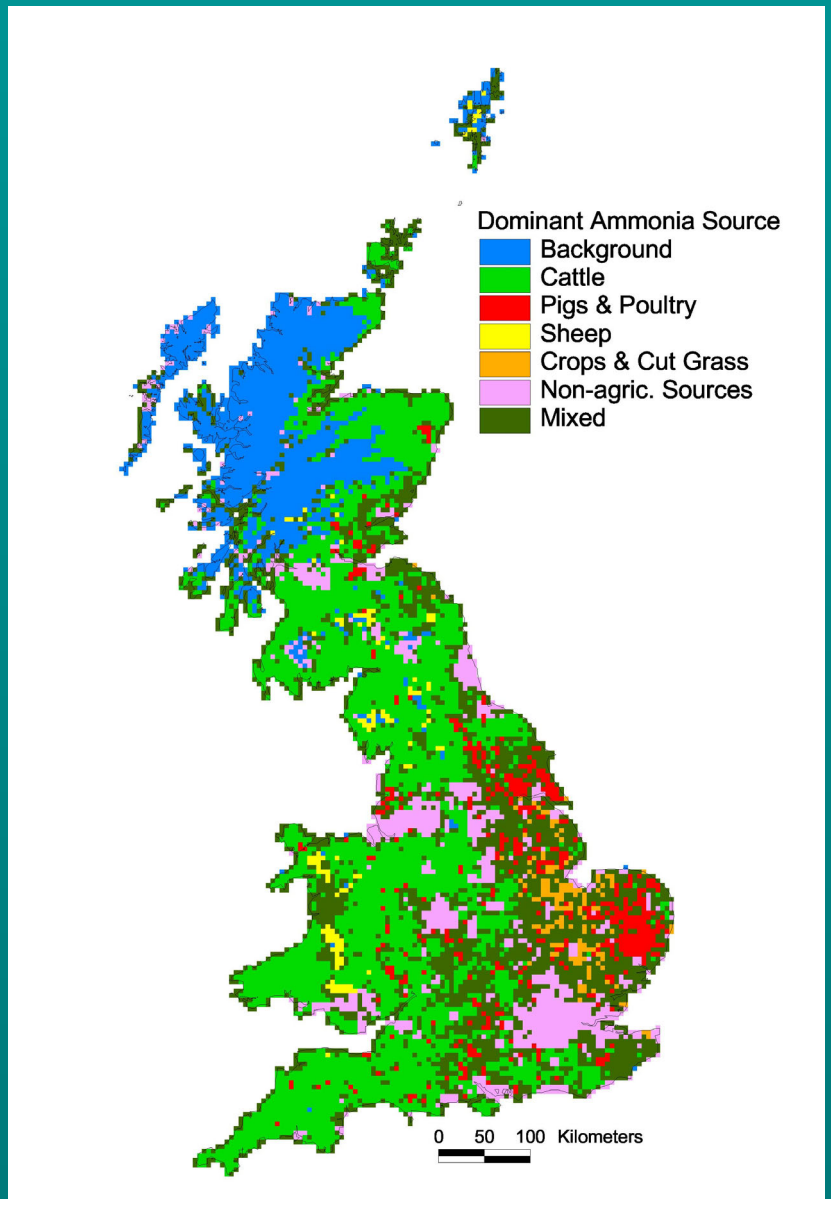
Measured and modelled ammonia flux over grassland



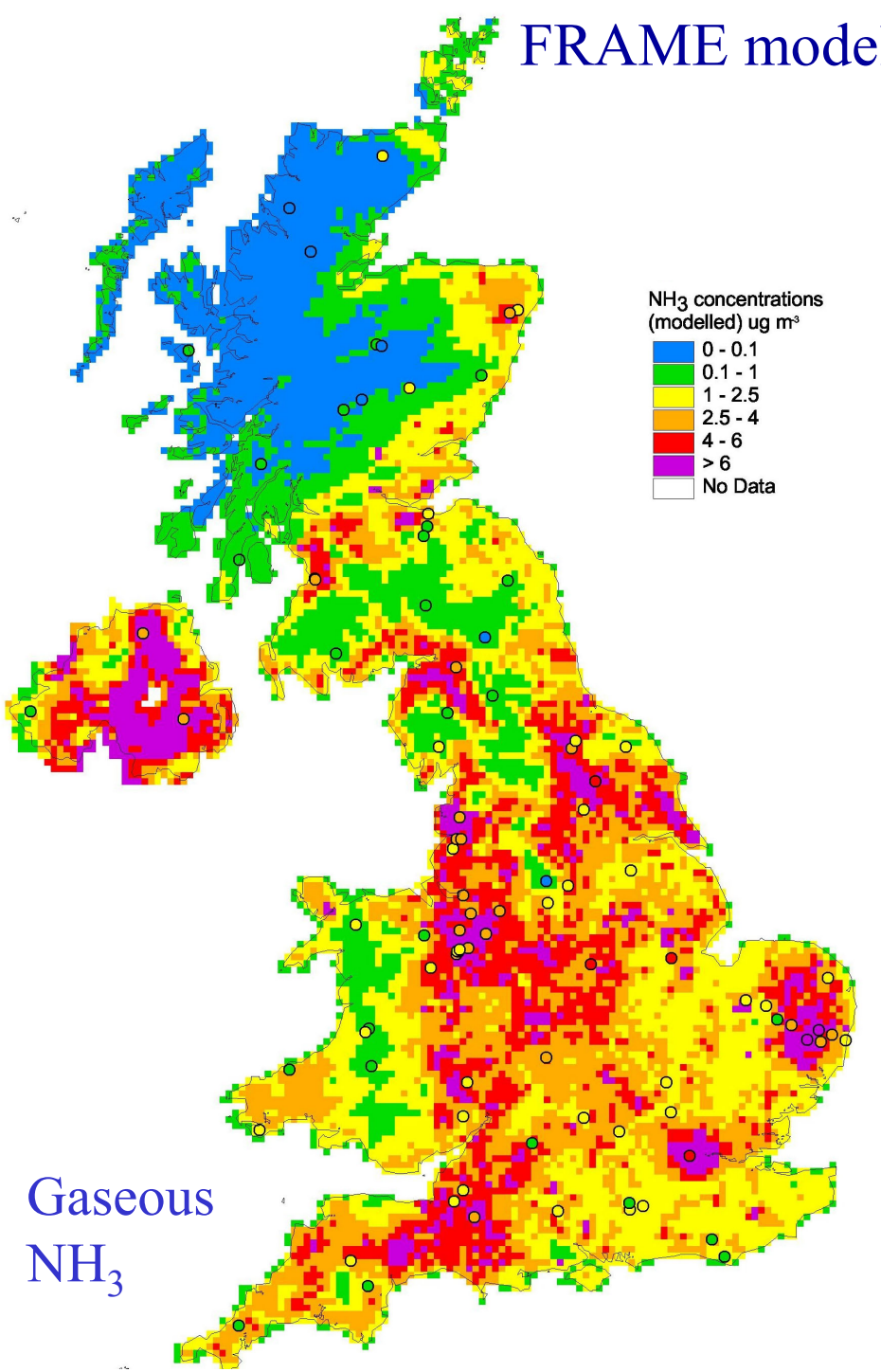
Regional Up-Scaling up ammonia fluxes

Ammonia emissions over the UK

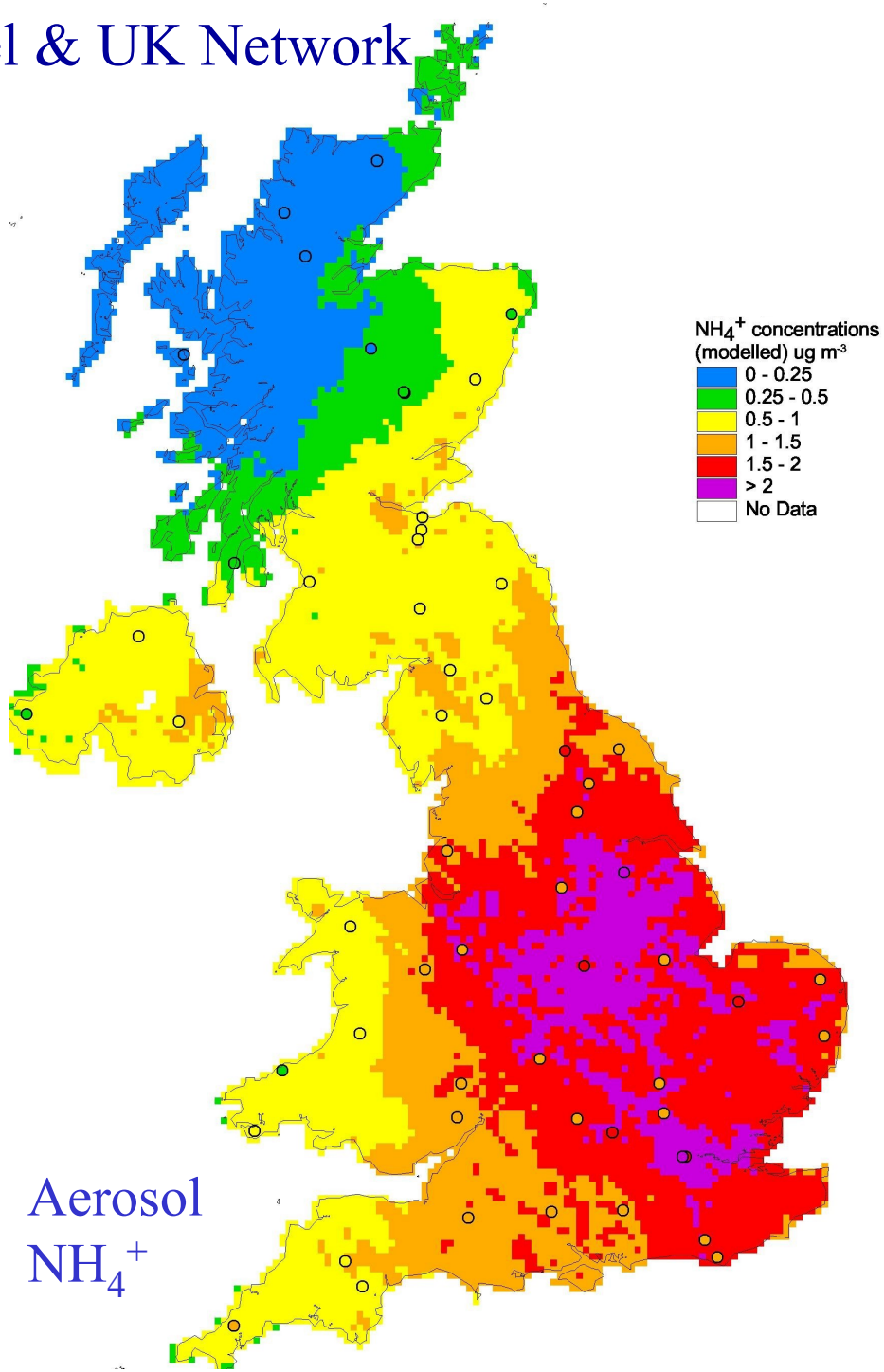




FRAME model & UK Network

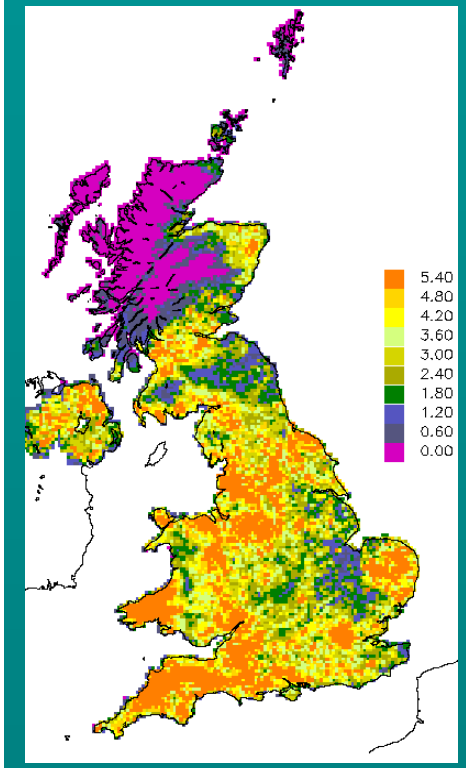


Gaseous
NH_3

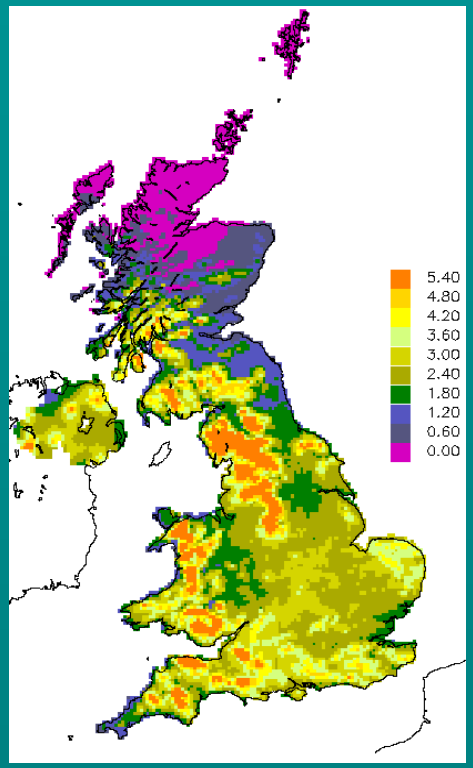


Aerosol
NH_4^+

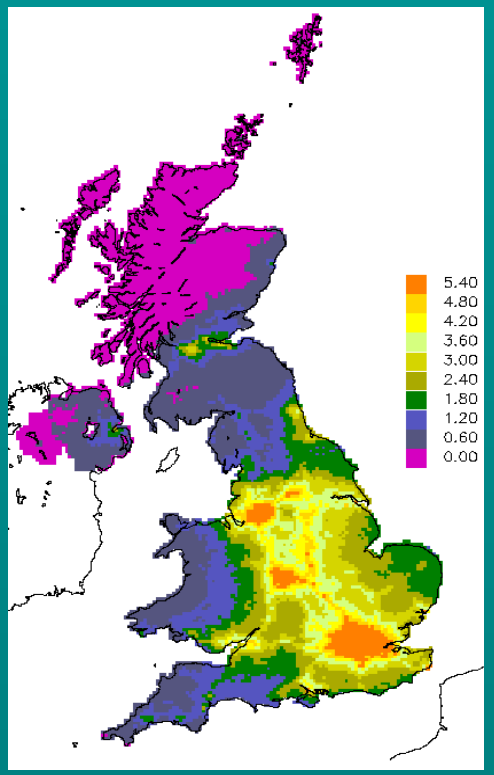
Nitrogen deposition in the UK



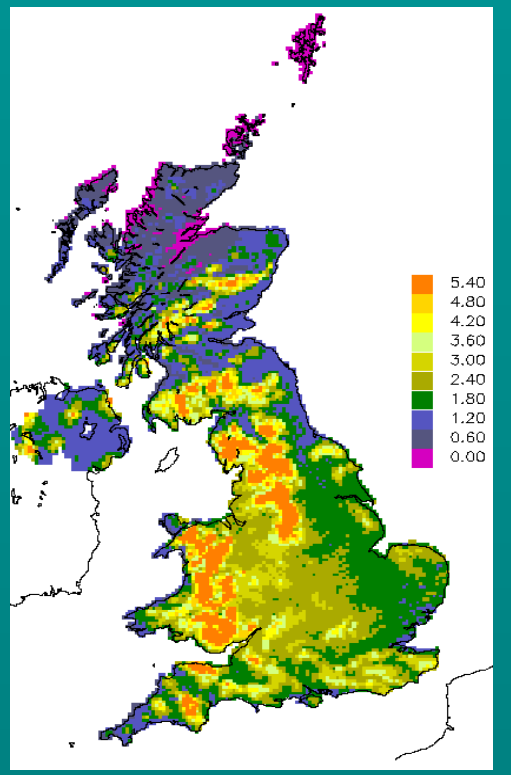
NH_3 dry deposition



NH_4 wet deposition



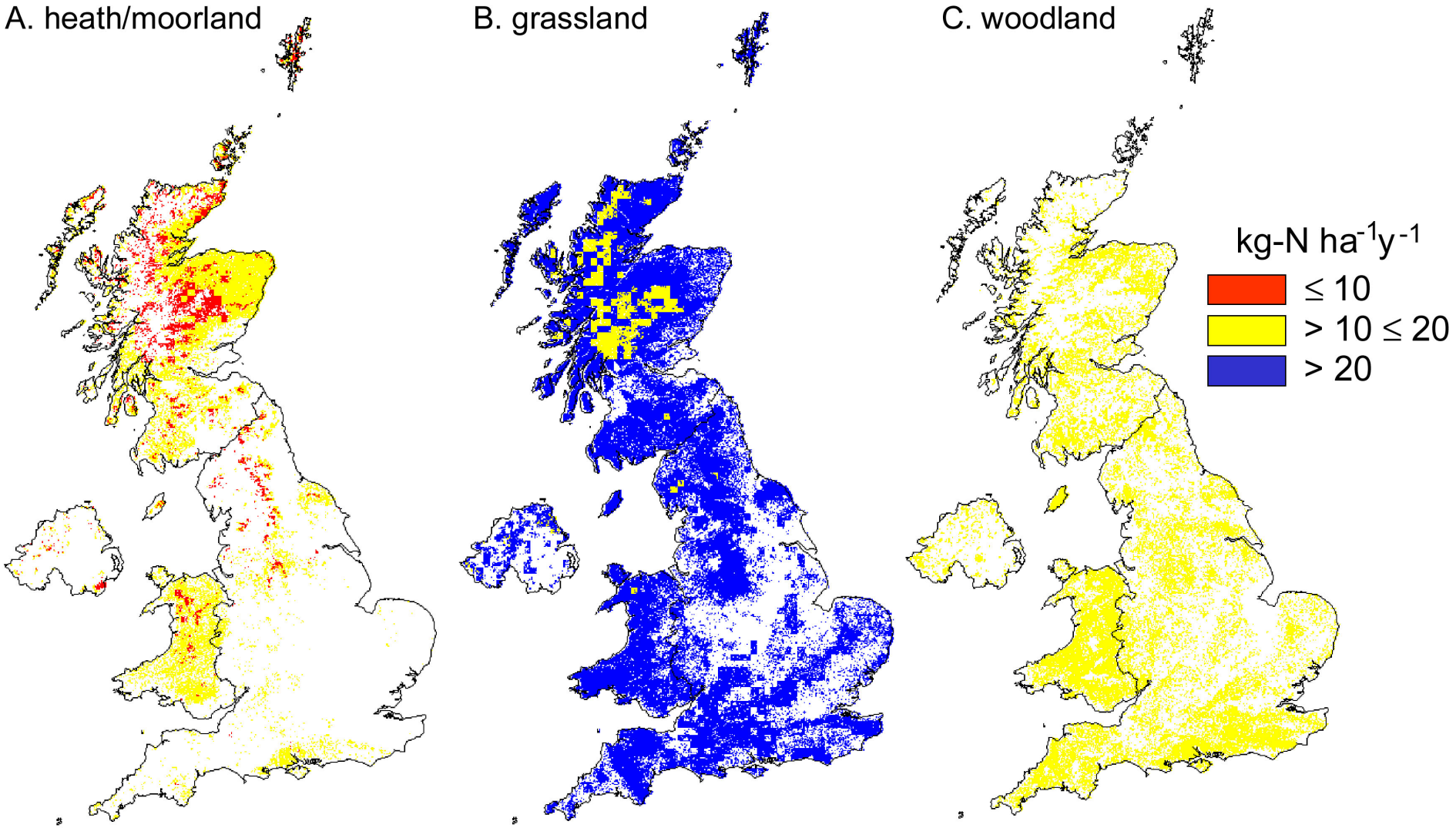
NO_y dry deposition



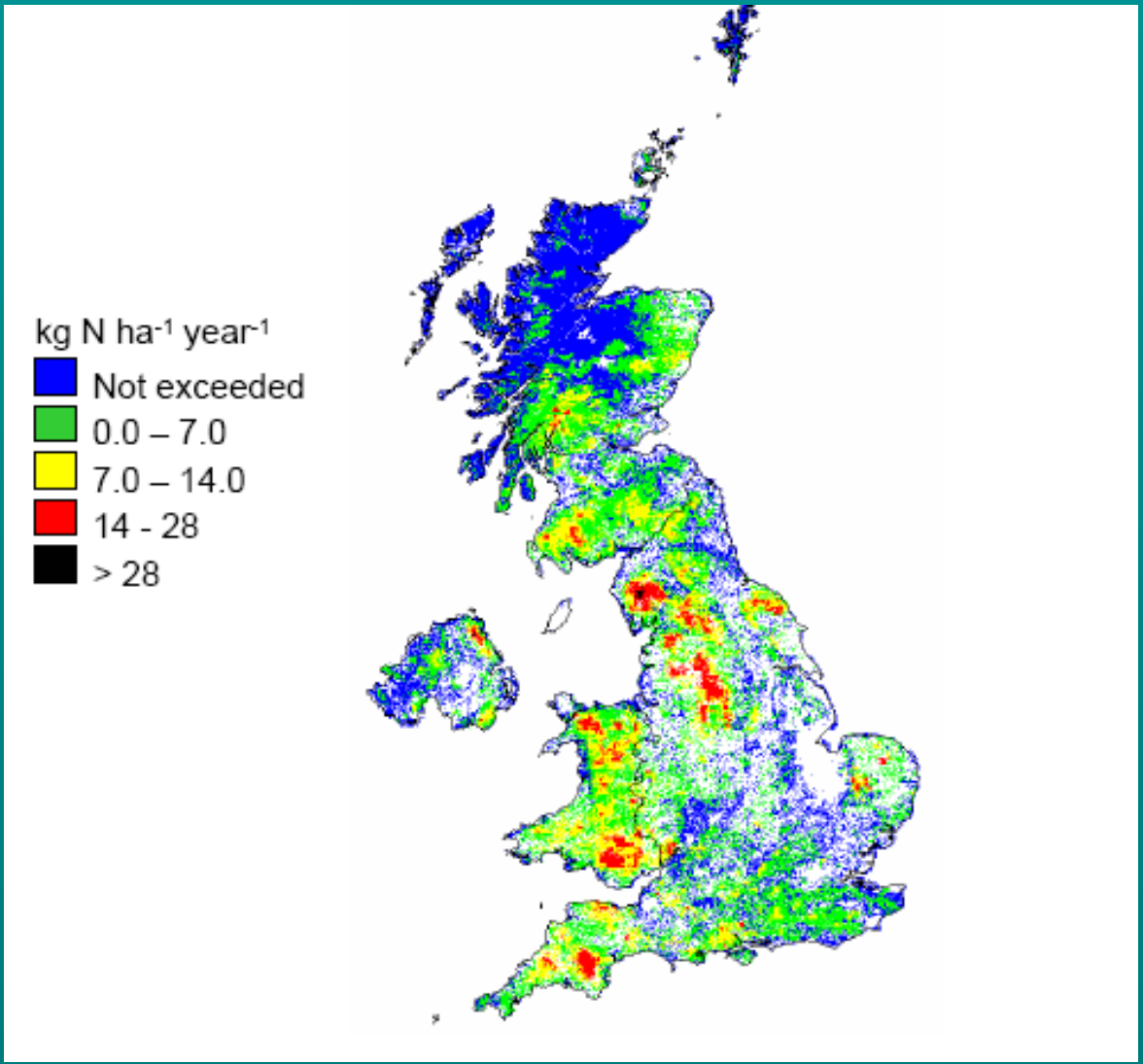
NO_3 wet deposition

Outputs from the FRAME model. CEH Edinburgh and Univ. Edinburgh

Critical loads for nitrogen



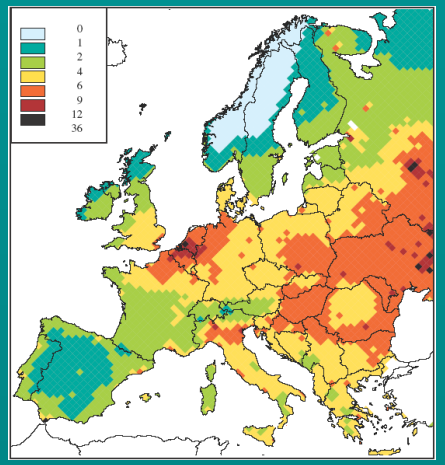
Areas in the UK where nitrogen deposition exceeds environmental limits



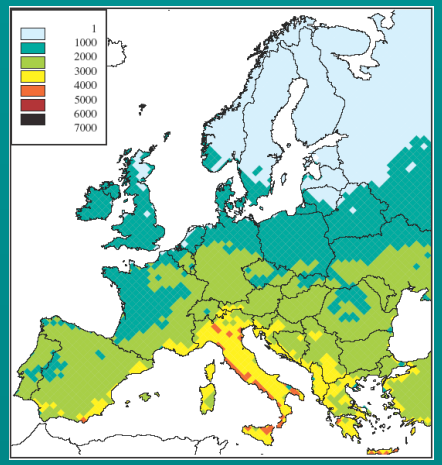
The problem with low resolution regional assessments

Remaining problem areas in 2020

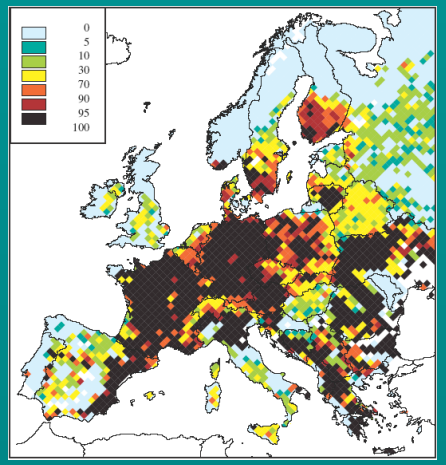
Light blue = no risk



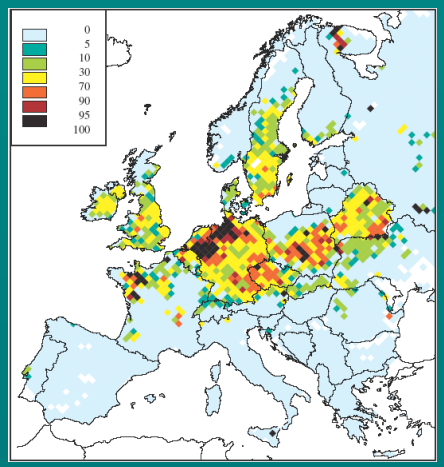
Health - PM



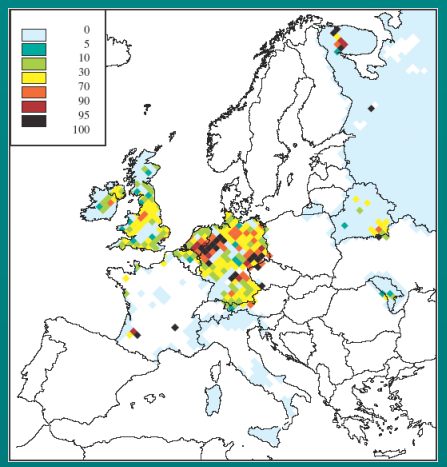
Health+vegetation - ozone



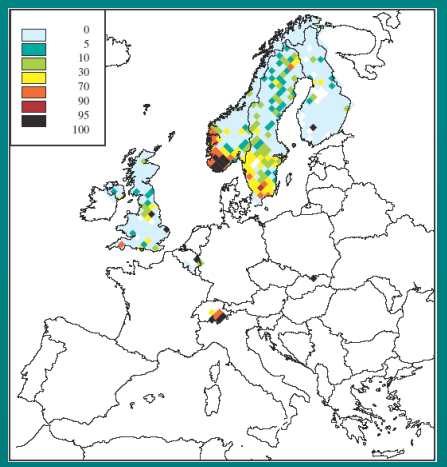
Vegetation – N dep.



Forests – acid dep.



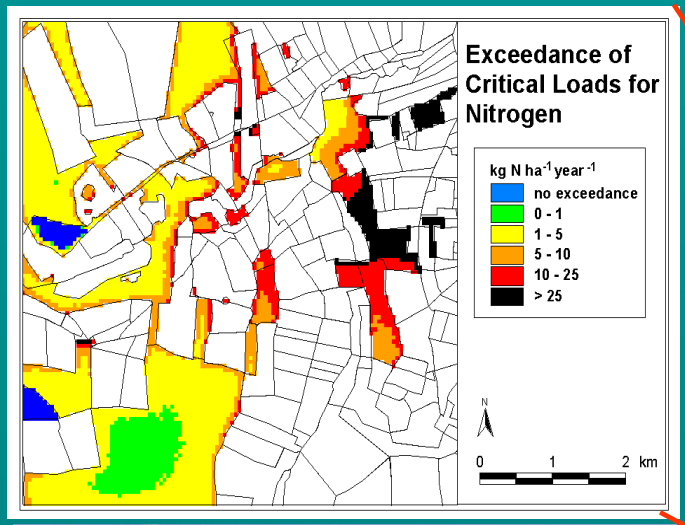
Semi-natural – acid dep.



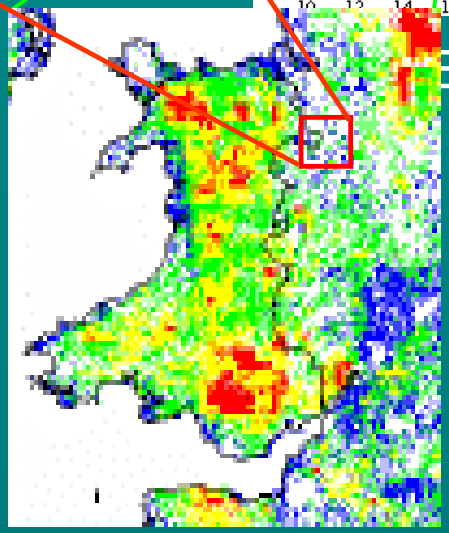
Freshwater – acid dep.

IIASA, Amann

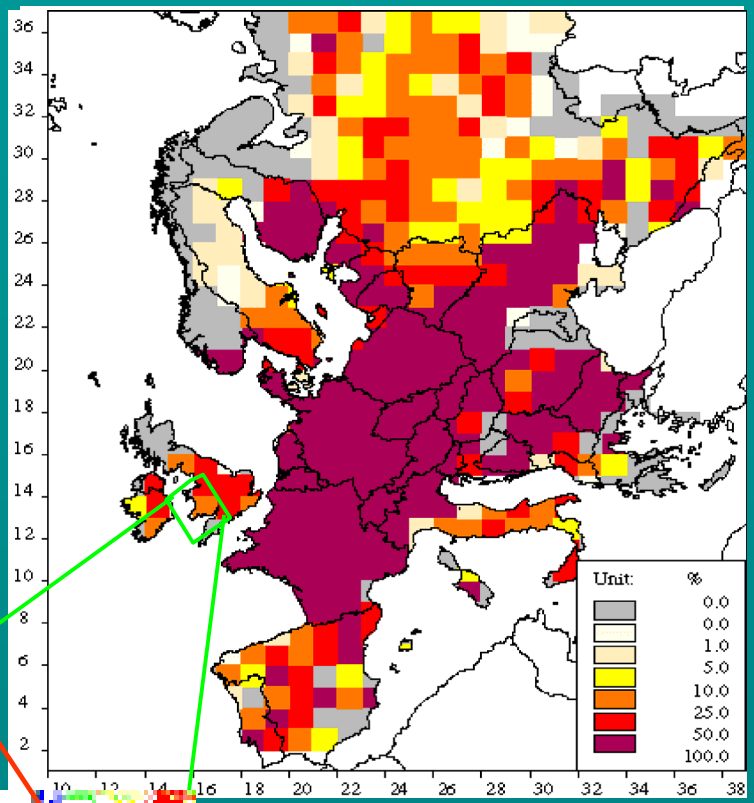
Dealing with spatial scale



Ecosystem protection

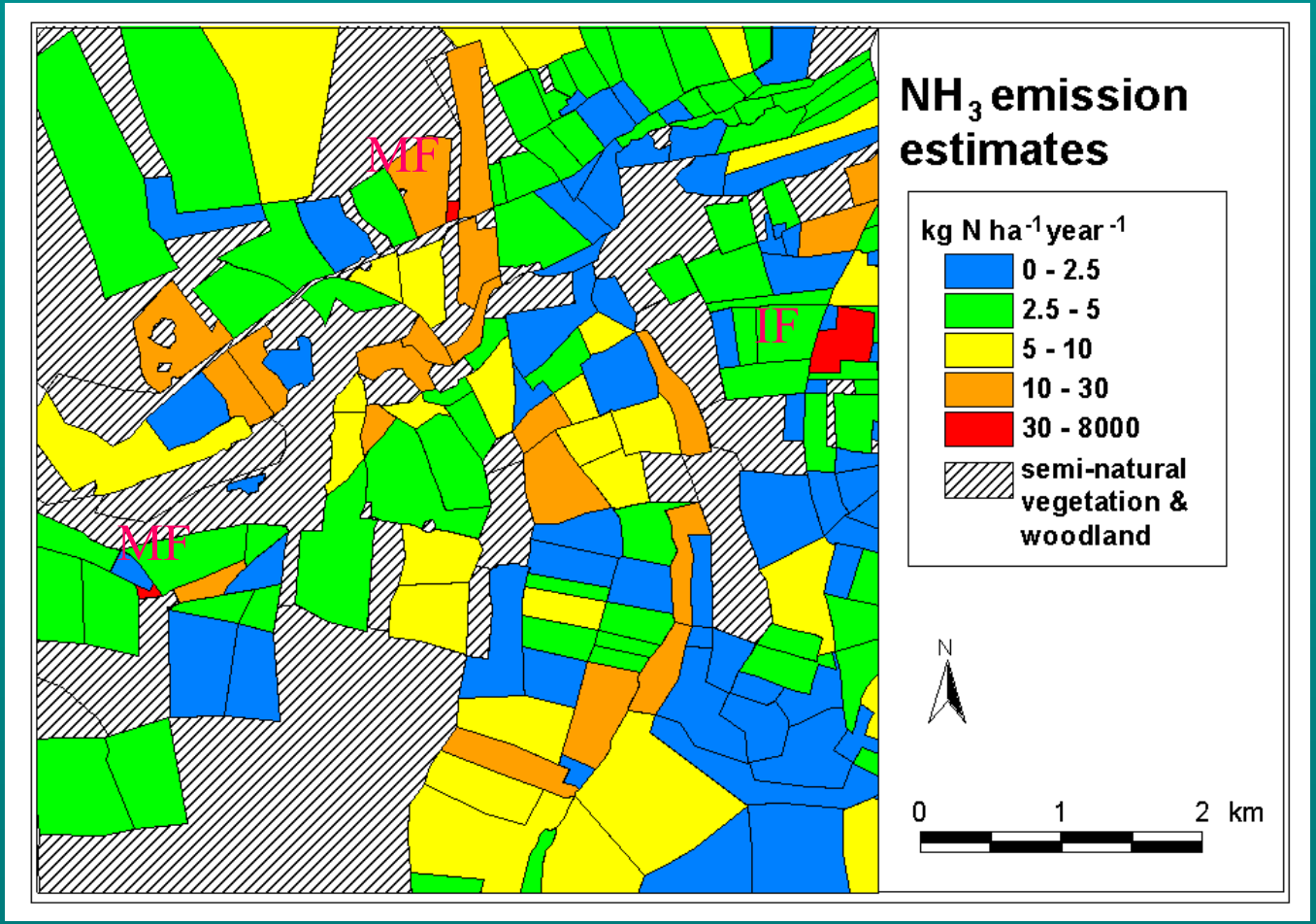


National targets and policy



European exceedances of the critical load for nitrogen

Case Study: Ammonia emissions

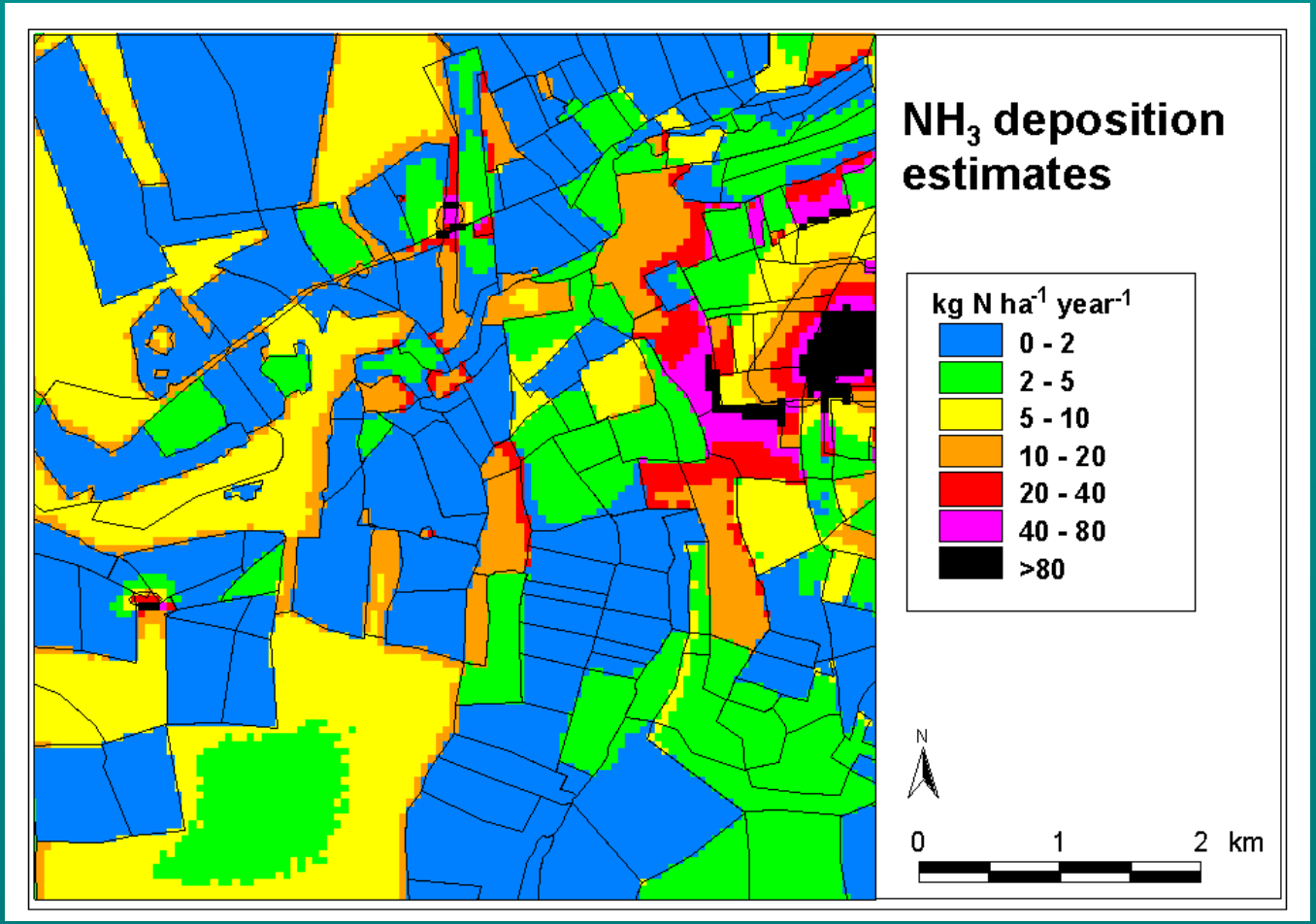


IF: Intensive Farm
MF: Mixed Farm

Dragosits et al. (Environ. Pollution 2002)

CEH

Modelled ammonia dry deposition

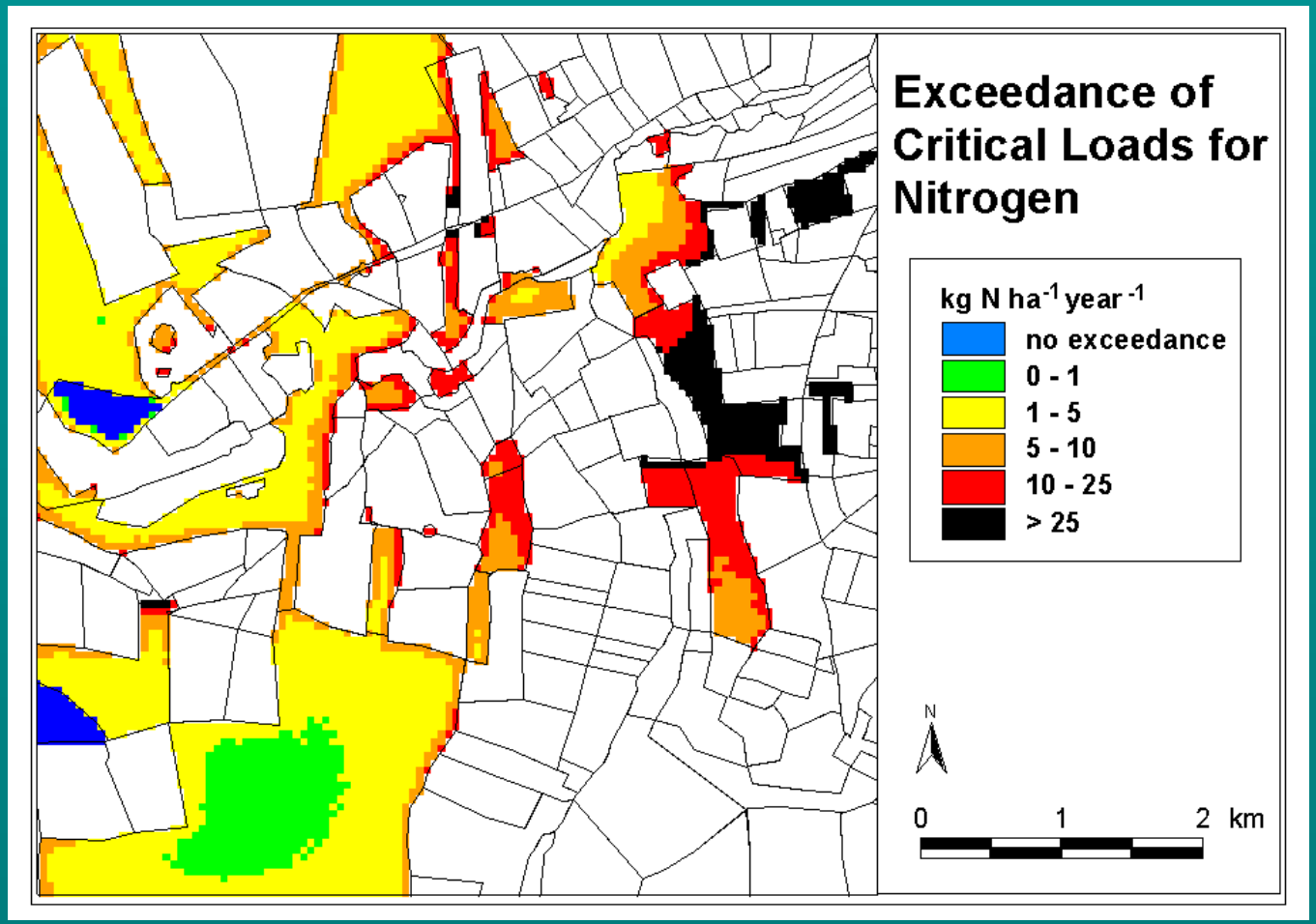


The largest NH_3 Deposition occurs Near the intensive Farm and at the edges Of woodland and Semi-natural land.

Deposition is less In the centre of large Semi-natural areas.

CEH

Exceedance of critical loads for nitrogen at a field scale



Implications of landscape level variability

- Nature areas near farms are more at risk
- Edges of woodland areas at high risk (the bits that are seen)
- The exeedance is so massive that there is **no way that realistic national emission strategies will avoid impacts of ammonia**

What should get the priority?

- We need food – so surely we can't close down all the farms?
- Do we demand a pristine environment everywhere or are some losses acceptable?
- Should we move from blanket "common misery" abatement to spatially targetted approaches? (→winners & losers)
- If we cannot protect everywhere, how do we prioritize what should be protected?

Importance of the Habitats Directive

- A series of designated sites across Europe (Natura 2000):
  - Special Areas of Conservation (SACs) (Ecosystems)
  - Special Protection Areas (SPAs) (Birds)
- EU envisage a high level of protection.
- Precautionary principle applied

Article 6 (3)

Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives.

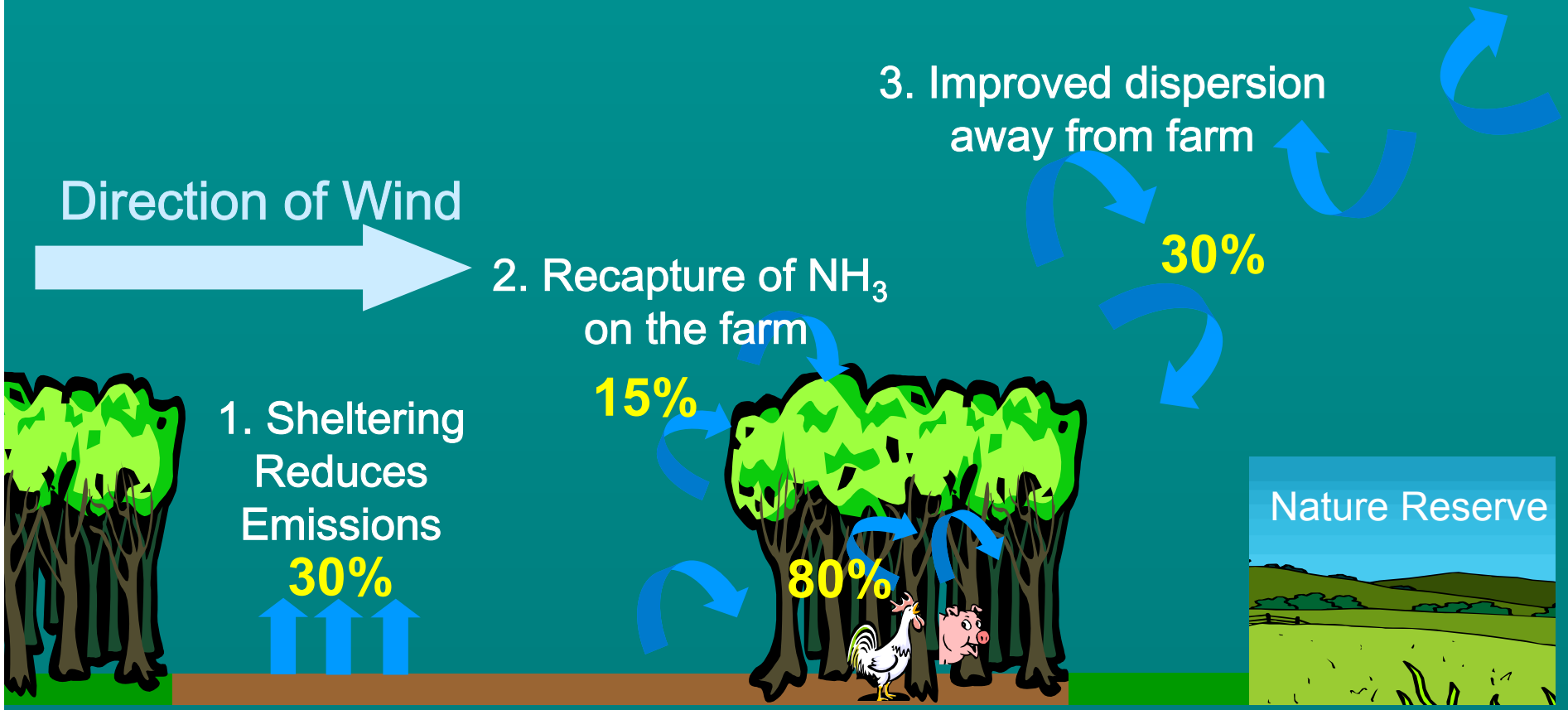
In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

Application to air pollution and ammonia

- Air pollution disperses: so has implications for remote developments
- High degree of uncertainty with air pollution impacts.
- Where doubt – then a plan should be refused (unless "overriding public interest")
- E.g. if critical loads already exceeded (~15 kg N ha^{-1} $year^{-1}$), what is a significant amount of extra N deposition? 0, 1, 10 kg?

Landscape planning for ammonia & nitrogen mitigation

Four-way benefit of trees in spatial planning for ammonia

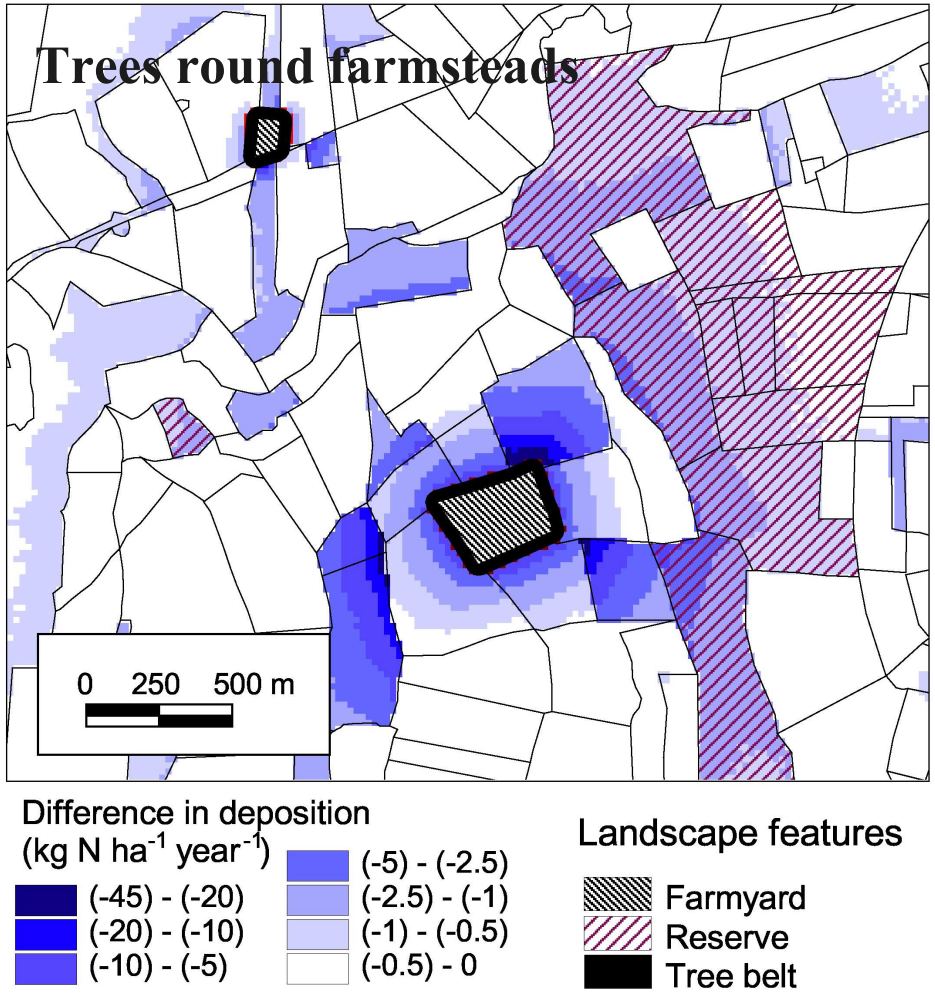


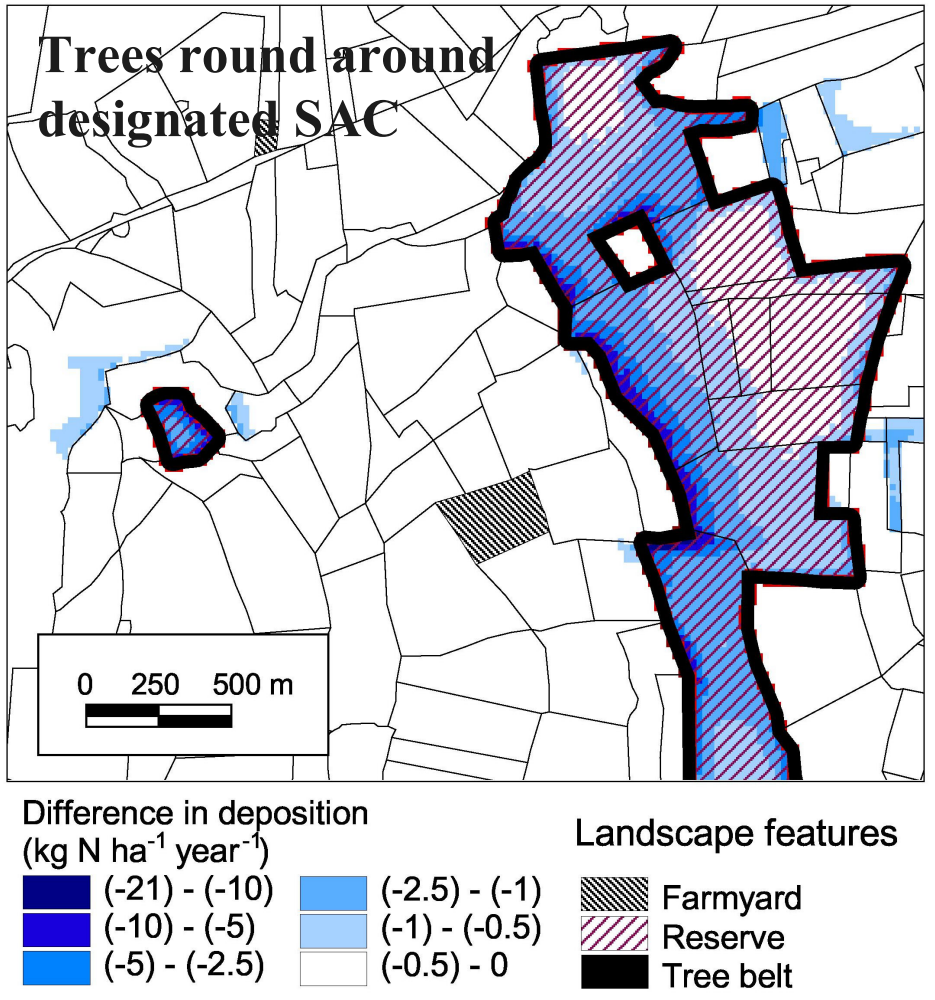
Designing woodland buffer zones

- Choice of trees, canopy structure and planting area to maximize direct benefits
- Consideration of other benefits
  - Screening effect round farms
  - Biodiversity in farm woodlands
  - Increase in “core area” of existing reserves
  - Buffering for aquatic pollutants

Scenarios of tree belts on N deposition at Ambridge

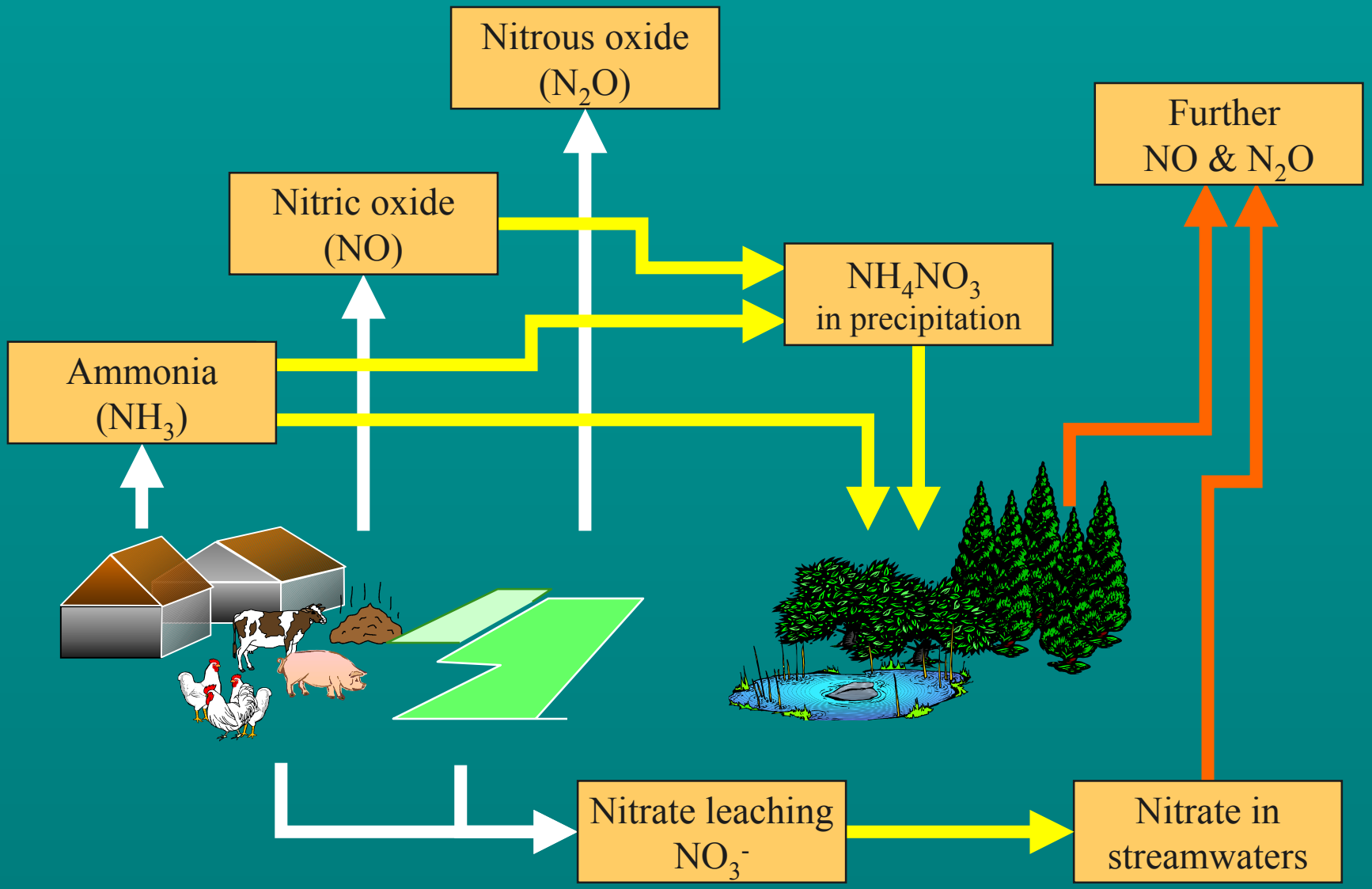
Two farms, two hypothetical SACs; 50 m belts of trees





Defra: AMBER project

Multi-pollutant interactions for nitrogen



Abatement may swap one pollutant for another in the nitrogen cascade

Landscapes integrate multiple spatial scales relevant for multi-pollutant assessment

Farmsteads

Farm units
(fields & buildings)

Water
dispersion

Atmospheric
dispersion

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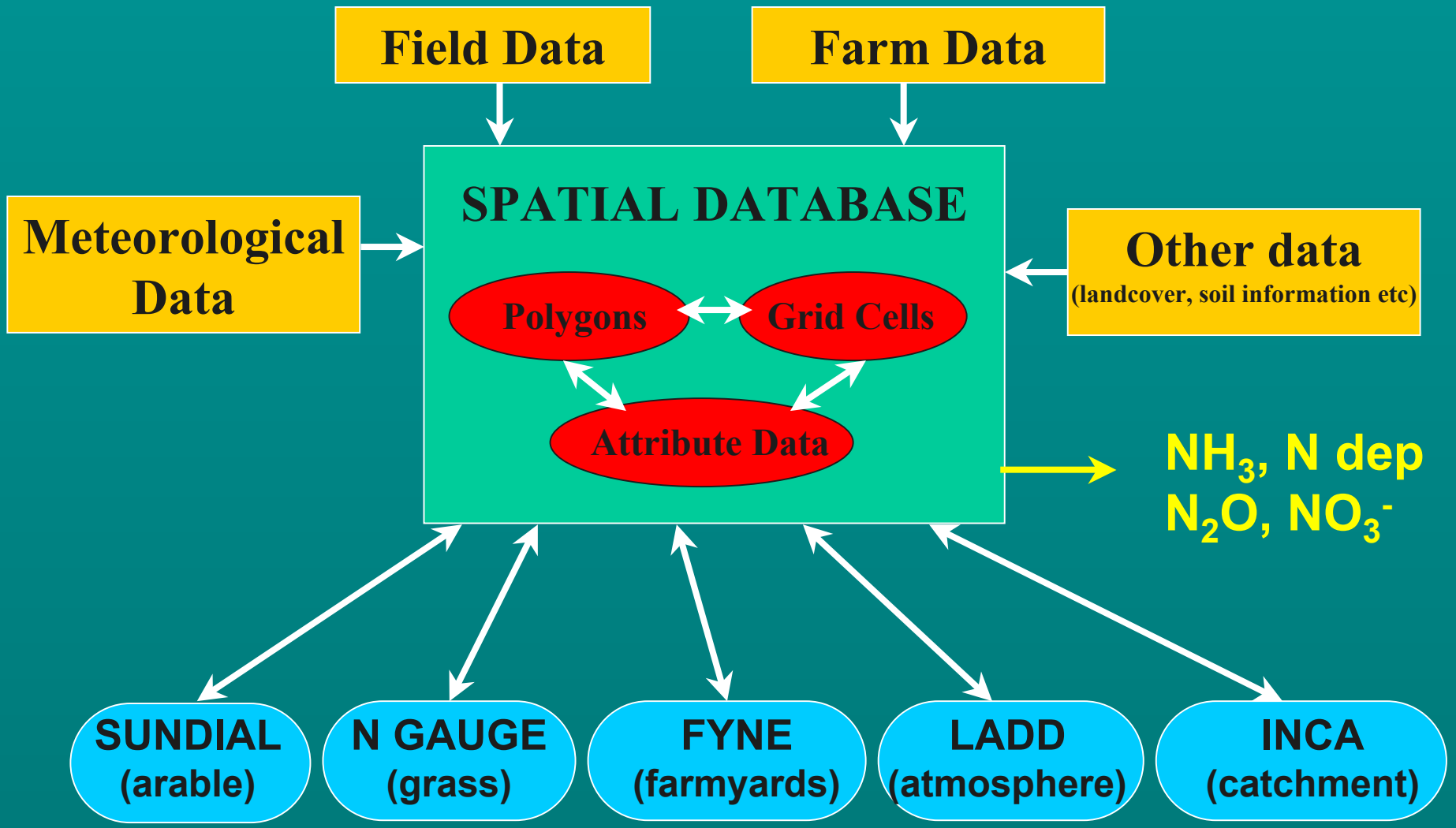
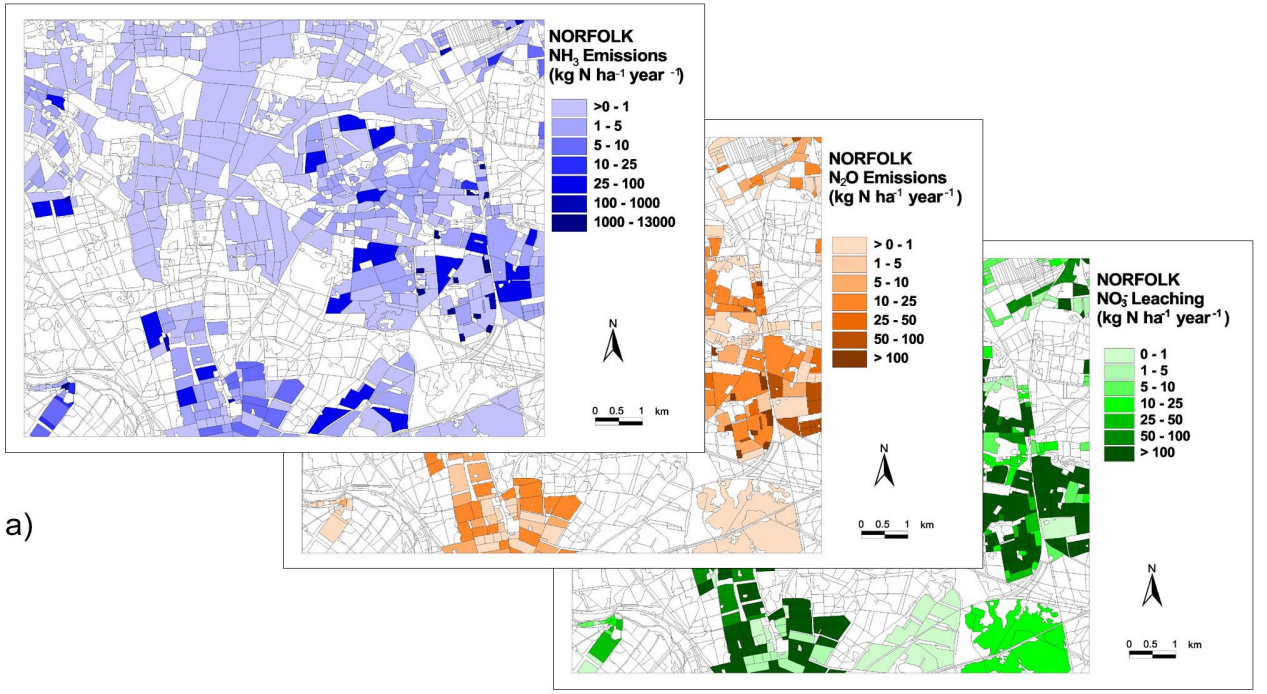
An integrated model framework: LANAS

Landscape Analysis of Nitrogen & Abatement Strategies



Example outputs of the LANAS model



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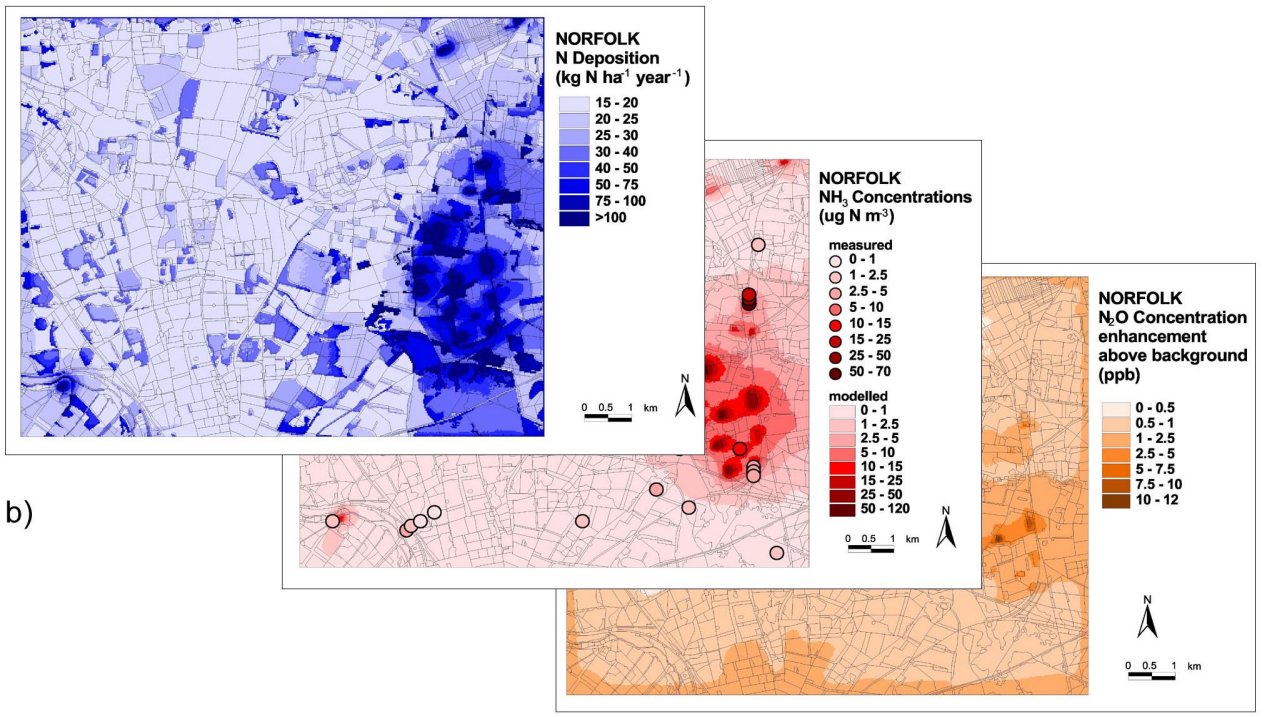

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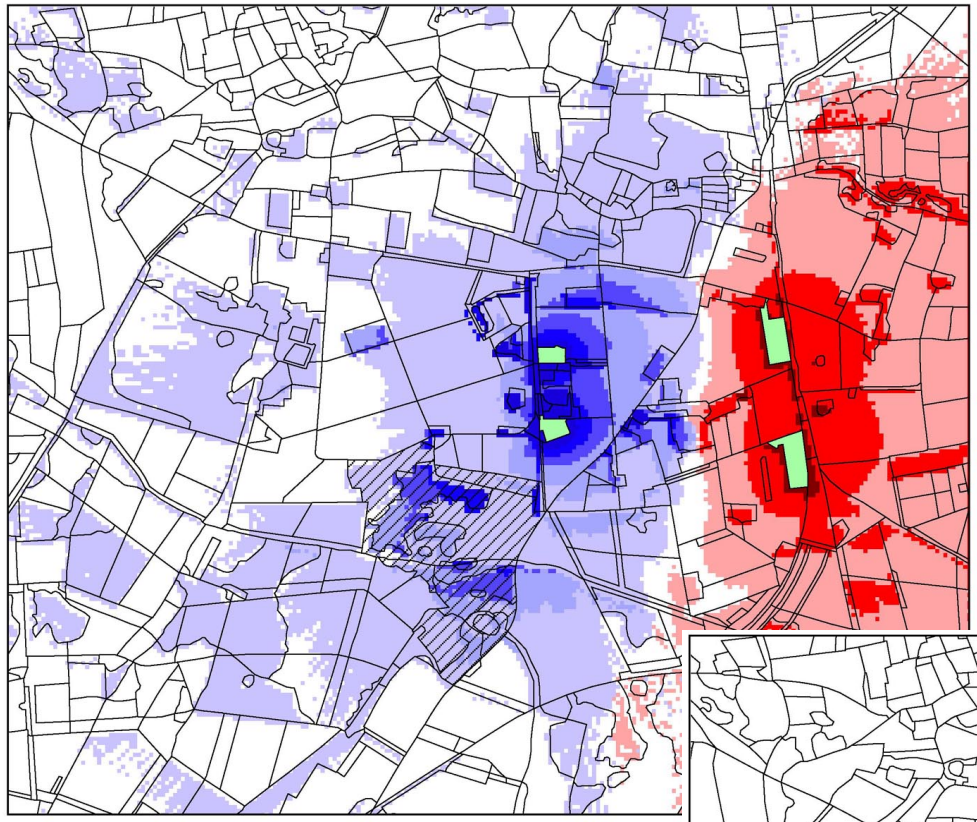
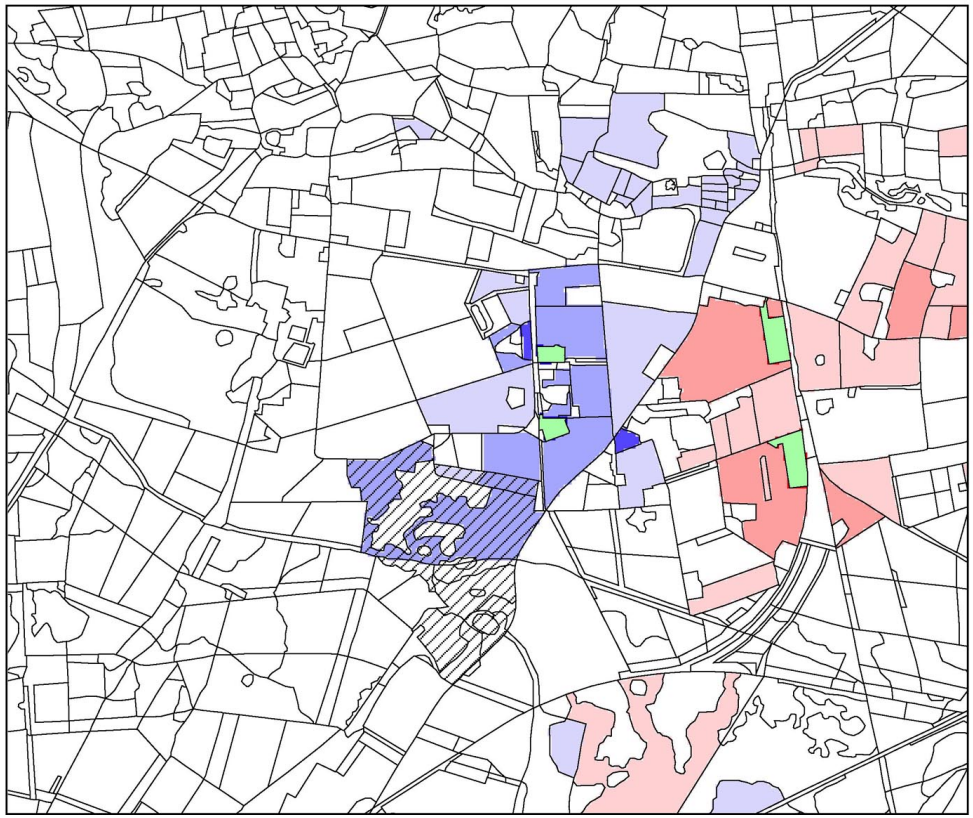


NORFOLK
Sc3 - Sc1
Difference in
N Deposition
(kg N ha^{-1} $year^{-1}$)

- < (-100)
- (-100) - (-50)
- (-50) - (-25)
- (-25) - (-10)
- (-10) - (-1)
- (-1) - 1
- 1-10
- 10-100
- > 100
- Farms
- Nature reserve

Two poultry farms ‘moved’ 1.5 km east of Special Area of Conservation (SAC)

Landscape planning scenario



NORFOLK
Sc3-Sc1
Difference in
NO_3^- leaching
(kg N ha^{-1} $year^{-1}$)

- (-50) - (-25)
- (-25) - (-10)
- (-10) - (-1)
- (-1) - (-0.1)
- (-0.1) - 0.1
- 0.1 - 1
- 1 - 10
- 10 - 25
- 25 - 50
- Farms
- Nature reserve

N

0 0.5 1 km

Research Challenges

- Improve performance and integration of landscape models
- Develop scientific basis to improve design of agro-forestry systems for nutrient pollution abatement
- Quantify economic benefits and social acceptability – consider how to integrate into agri-environment financing mechanisms
- Treating interactions with other pollutants: carbon, greenhouse gases, phosphorus….

To finish….

Case Study:
Public Planning Enquiry

“The Barn”,
Three Legged Cross, March 2004

- Farmer wanted to start a free range chicken farm in Dorset
- Tiny “environmentallly friendly” farm (only 2500 chickens)
- But: farm right next to a Special Area of Conservation (SAC) heathland designated under the Habitats Directive.
- Farming is not considered “development”, but he needed planning permission for a house to live there.
- Small example, but this is the first time in the UK that the issue of ammonia effects has been “tested” in a public inquiry. Therefore wider implications.

The Stakeholders

In favour

- Farmer
- Farmer's agents
- Farmers lawyer

Against

- East Dorset District Council: Planning Authority
- English Nature (national body responsible for Natura2000)
- Lawyer of Council and English Nature
- Neighbours
- Former Girlfriend…

Other personal positions

- Joint Nature Conservation Committee (UK body)
- Scientific expert ☺

Holt & West Moors SSSI, Three-Legged Cross Public Planning Enquiry (2004)

At issue: The Farmer's view

- Wants a house and a business
- Argues that any ammonia issue is a red herring, as permission only needed for the building not the chickens
- Even if ammonia is relevant, argues that the farm is too small to have an effect with only 2500 chicken (some farms have >500,000 birds)
- Argues that, with good practice, emissions are negligible anyway.

At issue: English Nature's view

- The building and farm activity have to be considered as a whole, as he would only get permission in this area as "accommodation for an agricultural worker"
- The heathland is designated as a Special Area of Conservation (SAC) – the EU Habitats Directive affords this the highest level of protection.
- Before permission can be granted under the Habitat Regulations: *it must be demonstrated that there would be no adverse effect* (onus of proof on the farmer)
- The scientific evidence suggests that there would be negative effects of ammonia emissions on the heathland.

My evidence

- Expert witness for English Nature and the local council – The job is to report scientific understanding rather than to campaign for either agriculture or environment.
- I described the emission, dispersion and deposition process to the English Nature barrister and was then cross-examined.
- I gave expert judgement of “possible” effects 300 m into the SAC, and “probable” effects 50 m into the SAC.
- I applied a screening model (SCAIL), which suggested an extra 15 kg N deposition /hectare/year from the farm .
- My expectation was that lichens and other healthand plants would be lost, which are “designated features” of the SAC.

Decision on the Public Inquiry

- The Inspector upheld English Nature and the Council's views completely:
  - Link between house and the farm
  - Effects of ammonia are real
  - Regulation 6 (3) of the Directive: he had to refuse it.
- Plus
  - negative effects of urbanization
  - He also dismissed a claim by the farmer under the international convention on Human Rights

What do we learn for the future…

- European policy to reduce ammonia emissions based mainly on technical measures on farms and total emission ceilings (e.g. UK: 297 ktonne/year by 2010).
- This will NOT be sufficient to protect large areas of the Europe.

• Society needs to prioritize what it wants to protect (e.g. SACs, Nature Reserves).

•Based on the prioritization, we need to investigate the wider use of spatial planning to put high emission farms in the right places.

•The Habitat Directive applies, but there is a “loop-hole”: Farming is not normally considered as ‘development’ for planning purposes. Perhaps it should be.