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

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Summer School, Peyresq, France, 7 Sept 2007

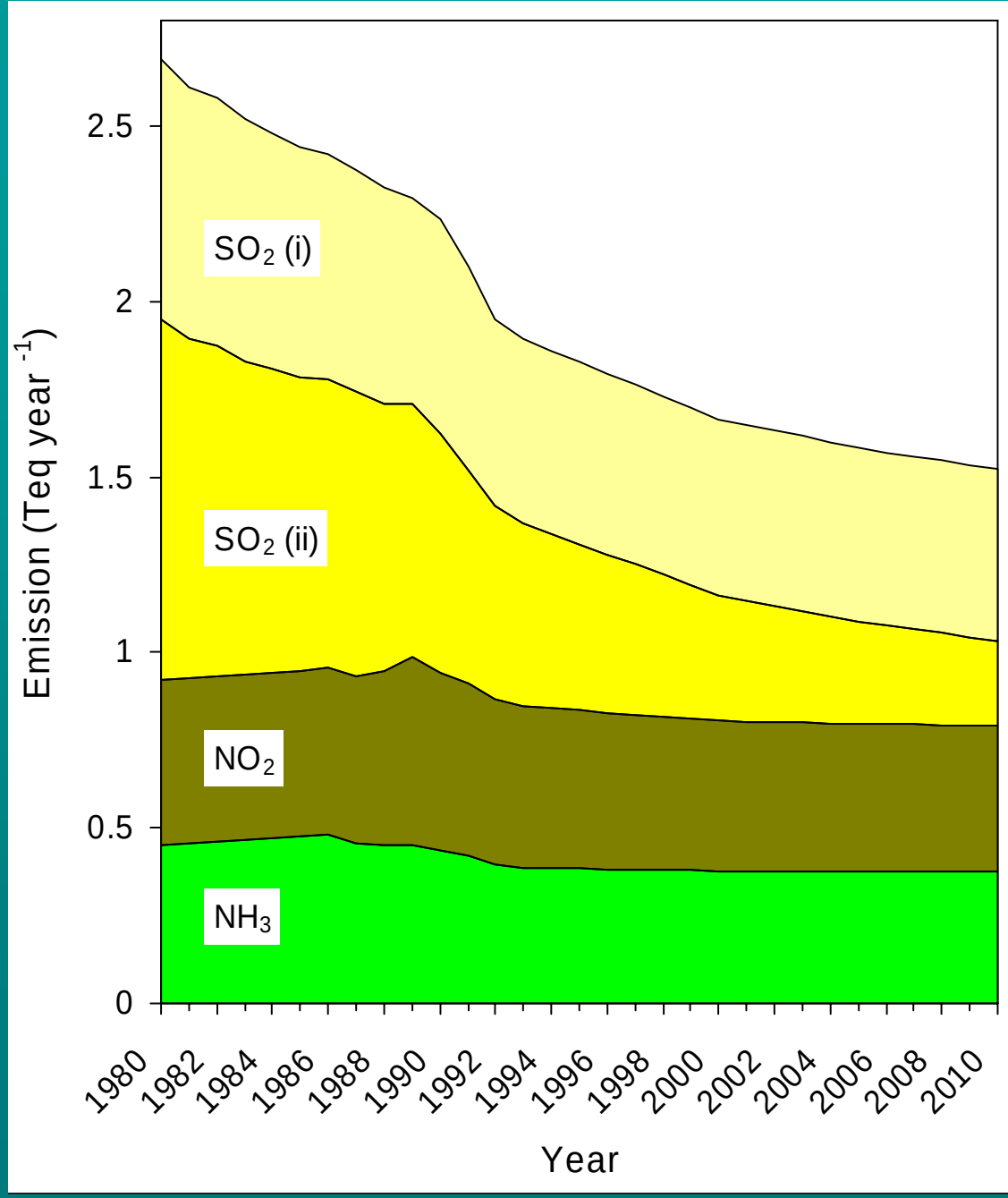
The problem

- 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!

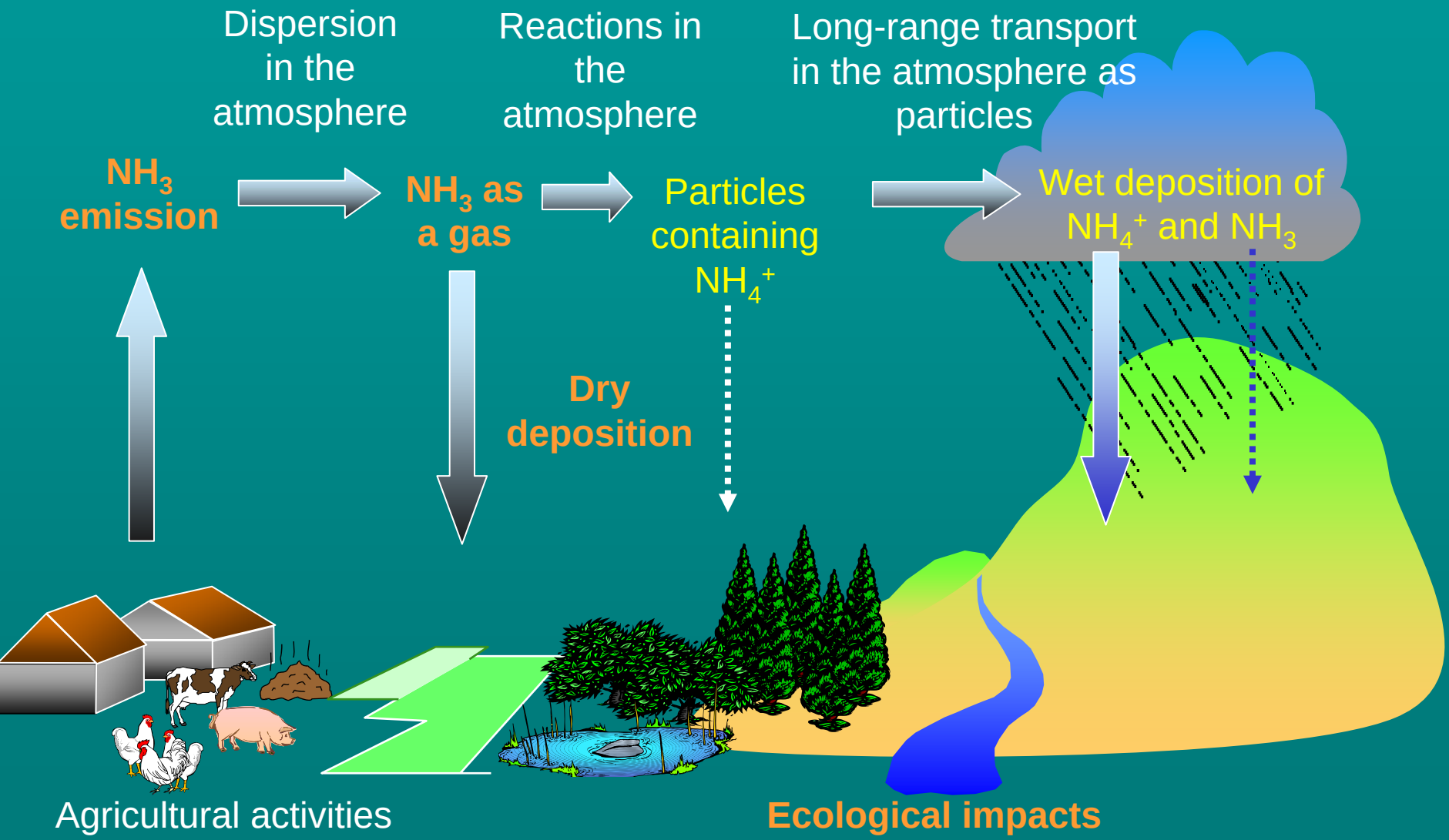
Erasmus Darwin (1731-1802)

On the benefits of ploughing in manure…

"Although **[the decomposition]** *is accomplished more slowly, yet it is attended with less loss of carbonic acid, of volatile alkali* **[ammonia]**, *of hydrogen, and of the fluid matter of heat;*

all of which are emitted in great quantity during the rapid fermentations of large heaps of manures, and are wasted in the atmosphere, or on unprolific grounds." [i.e., to semi-natural land]

Ammonia in the atmosphere



Effects of ammonia on the environment

Nitrogen reduces the abundance of woodland flowers

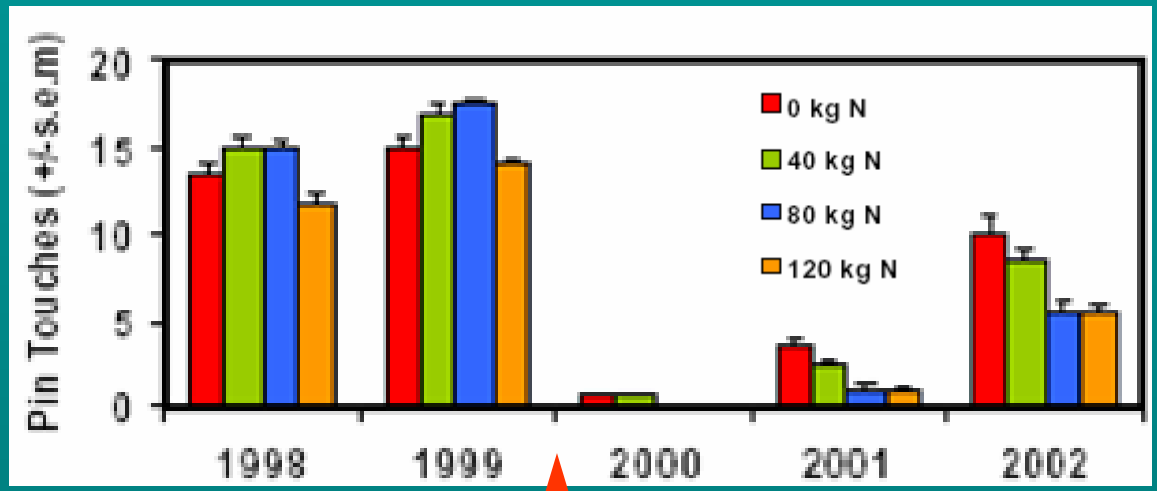
Wood sorrel (*Oxalis acetosella*)

Lost at the expense of:

Velvet grass (*Holcus lanatus*)

Interactive effect of N deposition and fire on *Calluna* cover in UK


Calluna (heather)

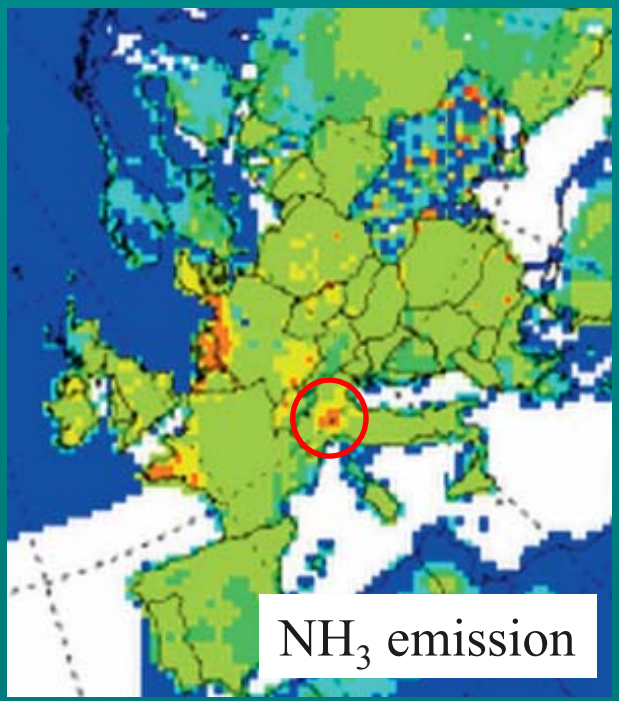


- Treatments started 1989, Ruabon, N. Wales
- Current work also considering recovery following reduced N inputs

Caporn et al., Manchester Metropolitan University

Ammonium nitrate contributes substantially to particulate matter (PM) concentrations

- Reduced visibility
- Human heath impacts



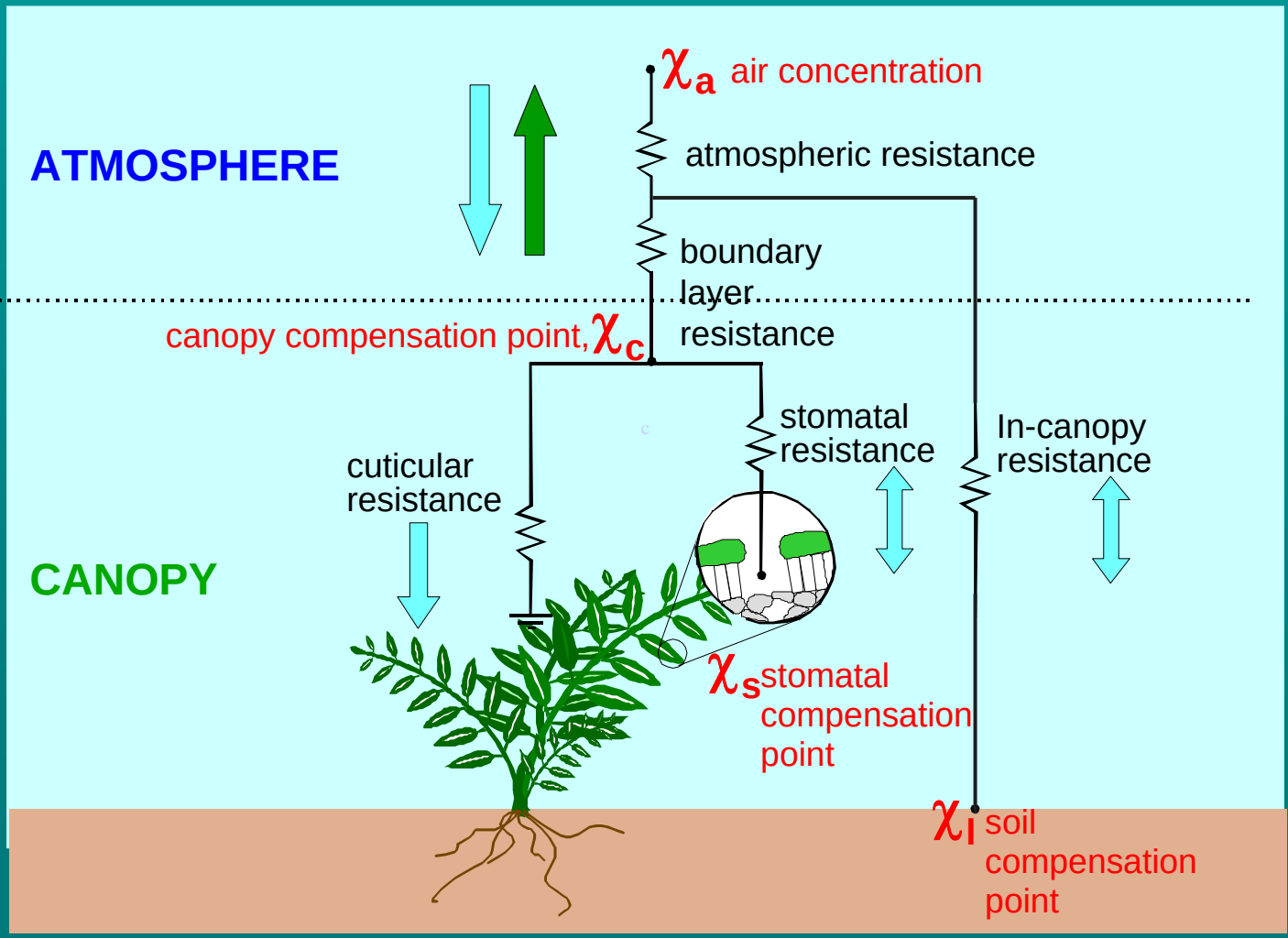
Parma, Emilia Romagna, Italy

Regional Up-Scaling up ammonia fluxes

Modelling ammonia fluxes

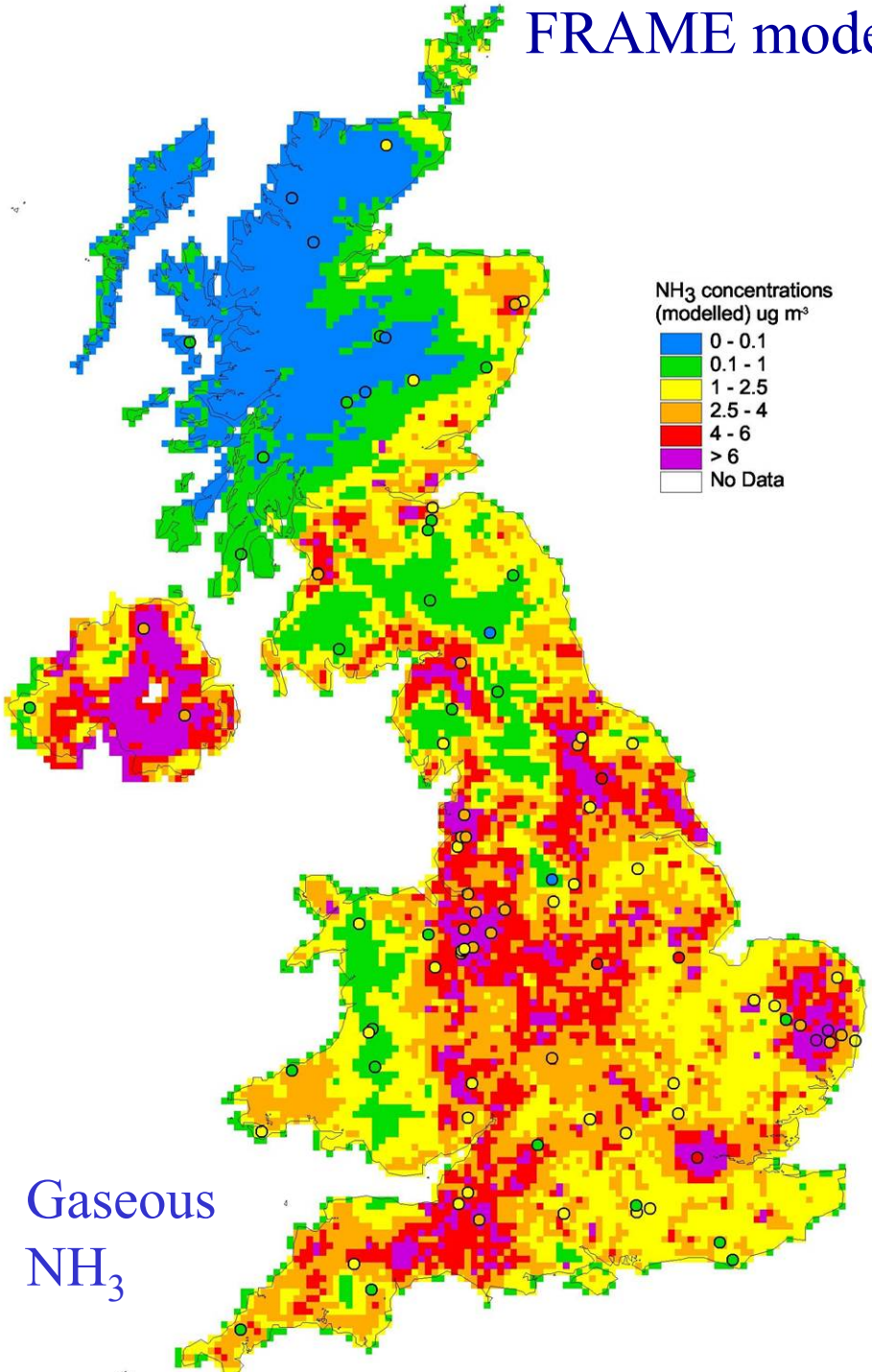
$\chi_s = f(T, \Gamma)$

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



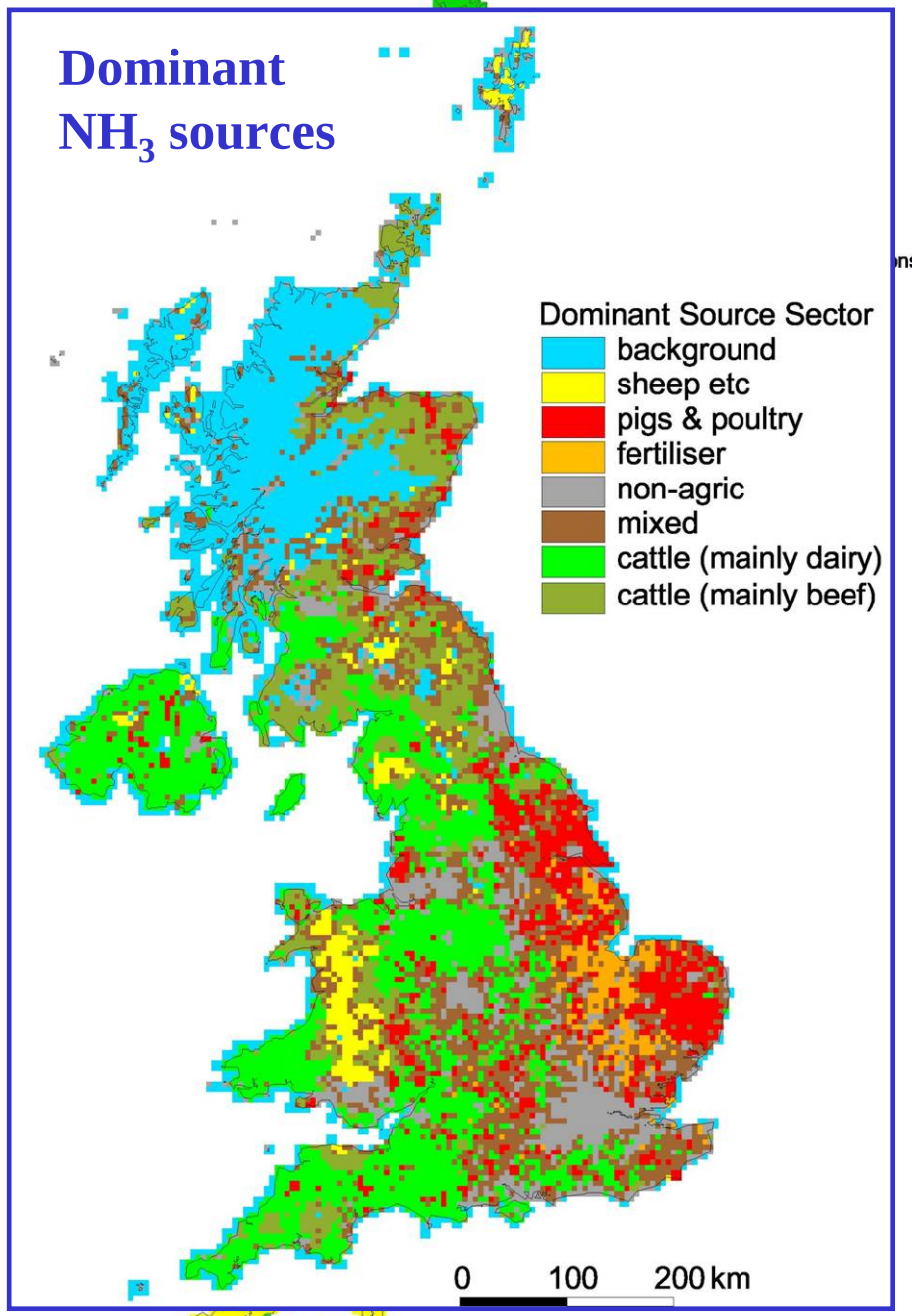
Nemitz, Milford & Sutton (2001) Quart.J. Royal. Meteor. Soc

FRAME model & UK Network

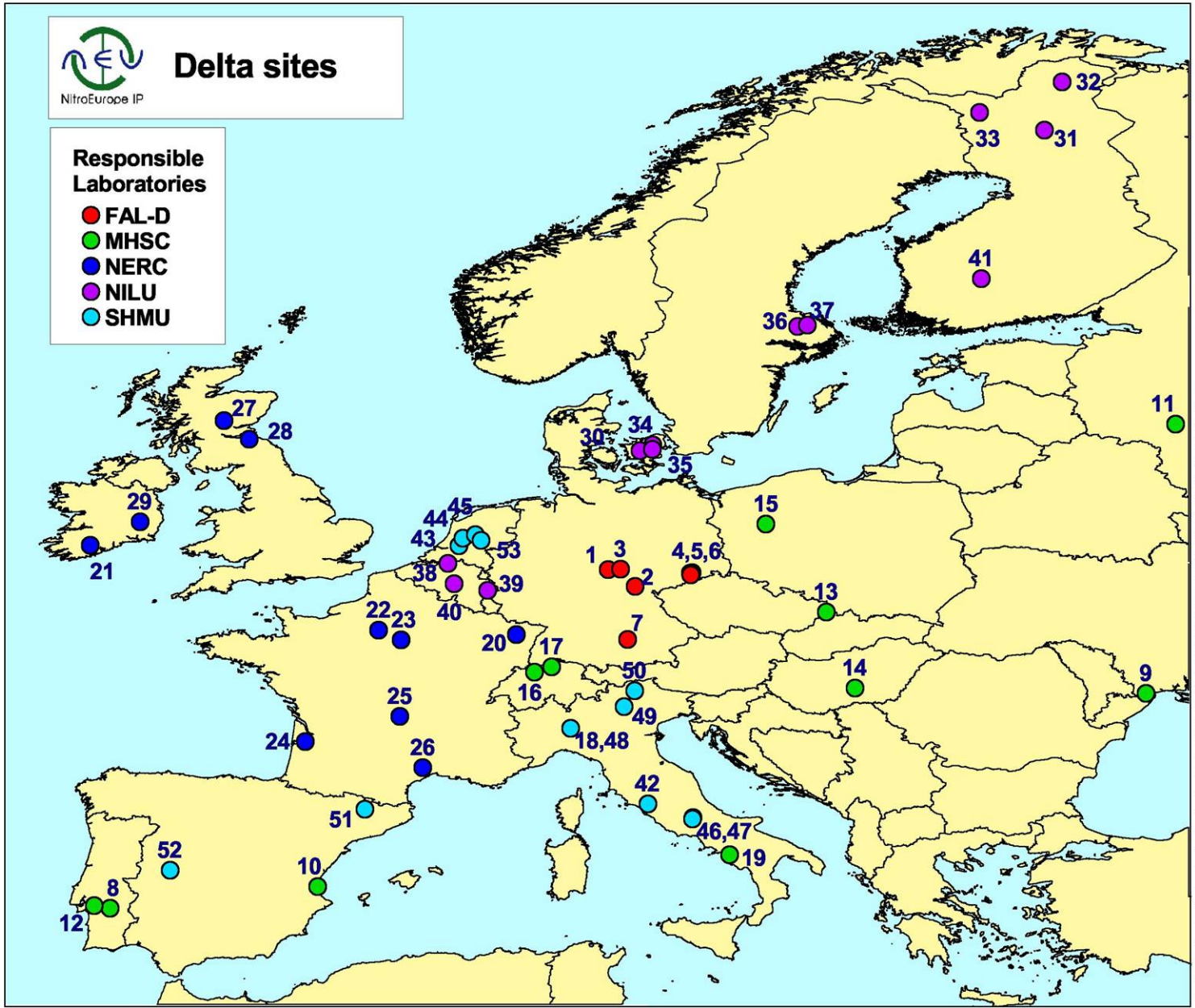


Gaseous
NH_3

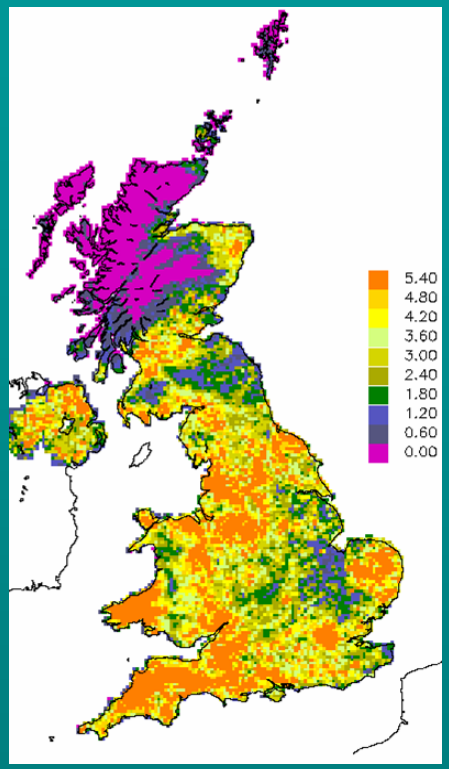
Dominant
NH_3 sources



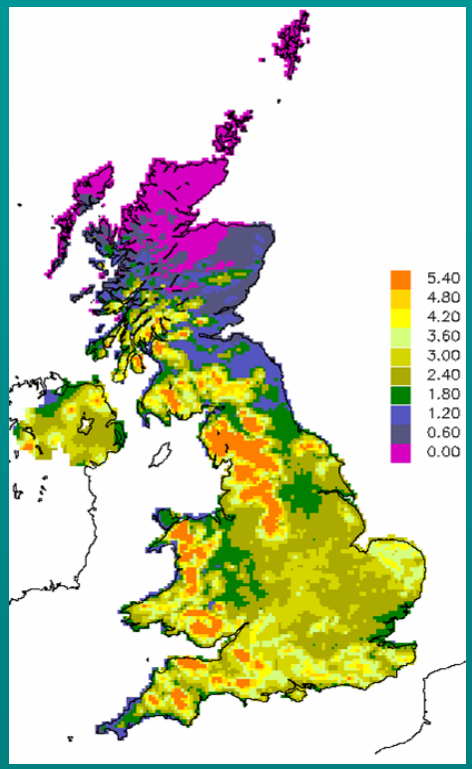
The NEU L1 DELTA Network



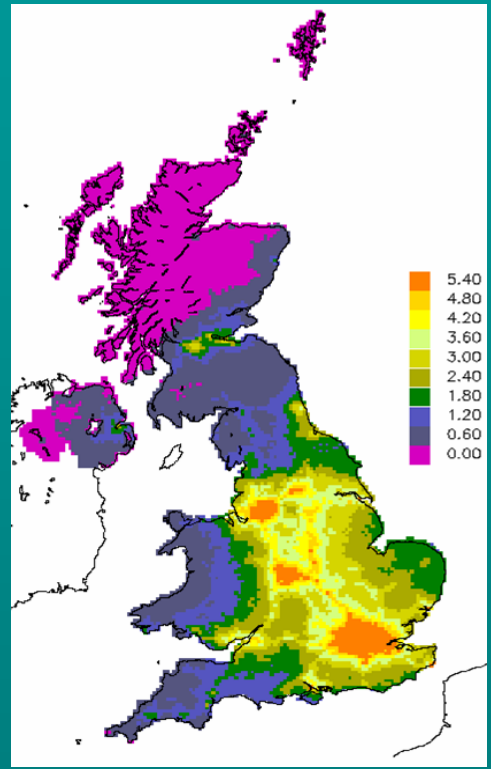
Nitrogen deposition in the UK



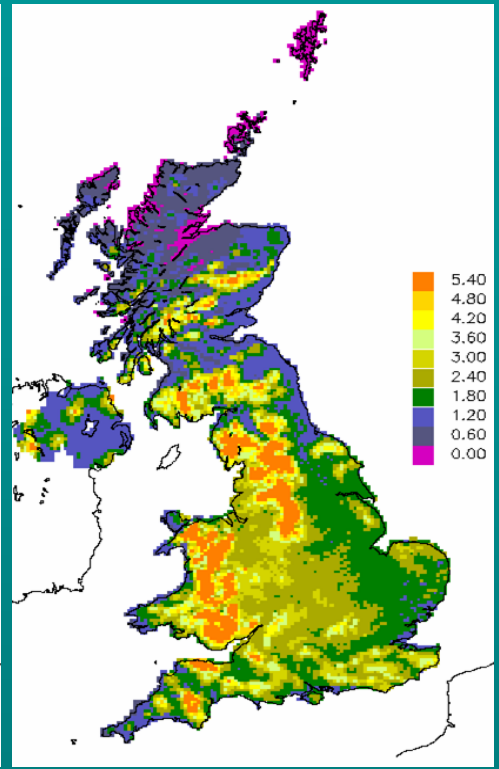
NH_3 dry deposition



NH_4 wet deposition



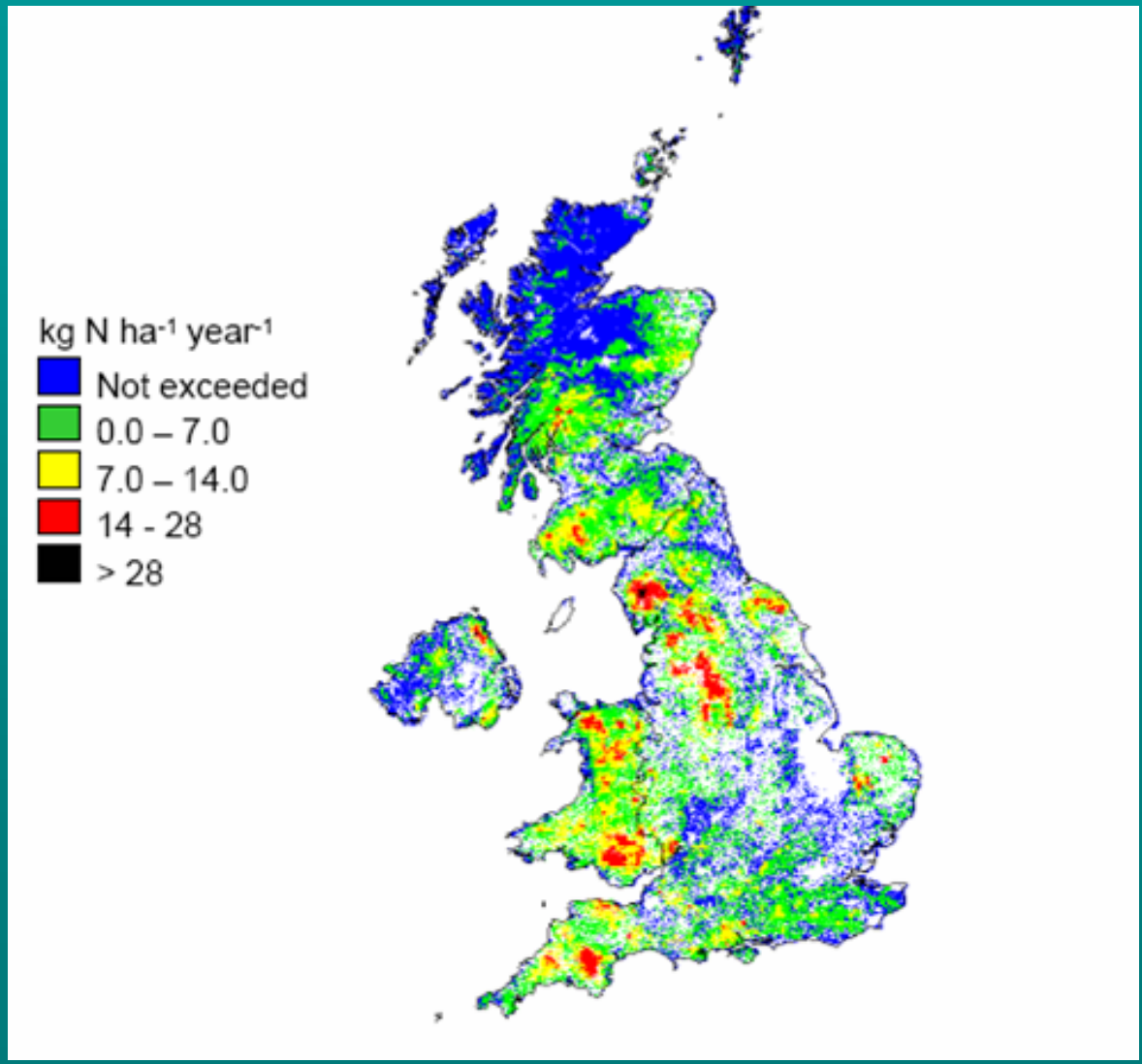
NO_y dry deposition



NO_3 wet deposition

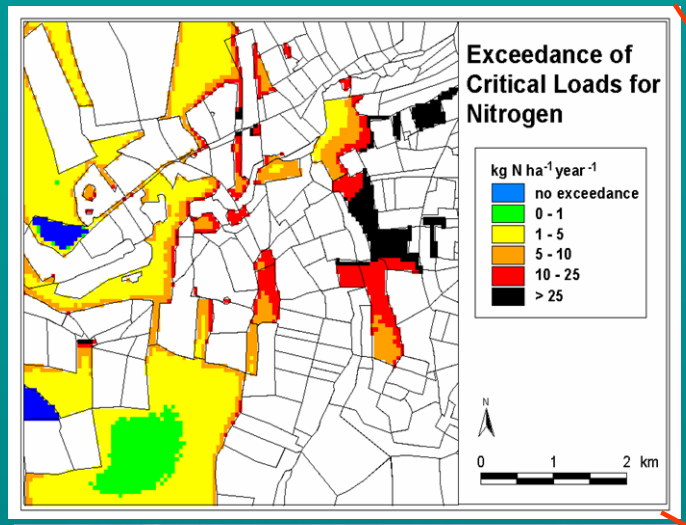
Outputs from the FRAME model. CEH Edinburgh and Univ. Edinburgh

Areas in the UK where nitrogen deposition exceeds environmental limits

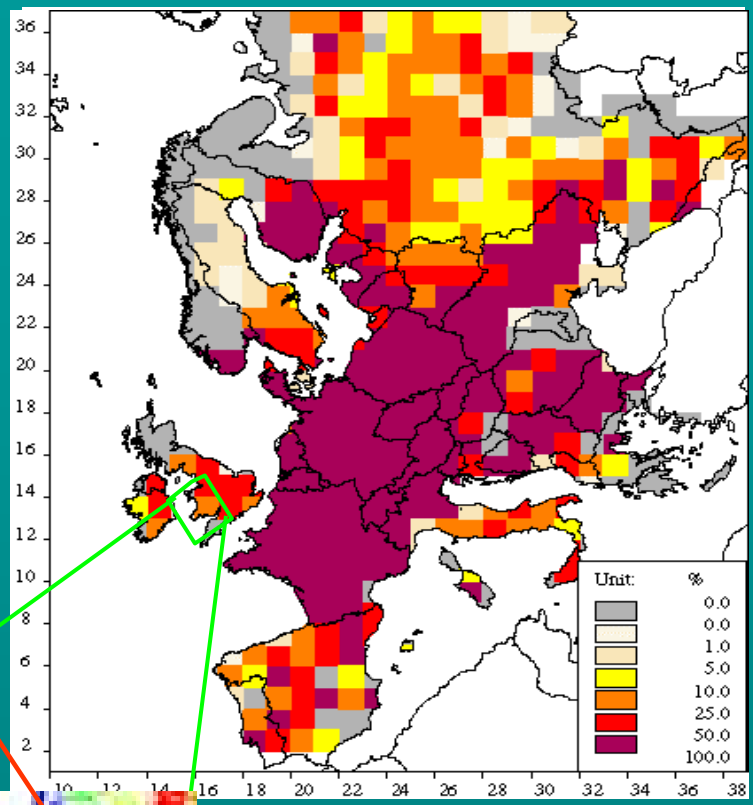


The problem with low resolution regional assessments

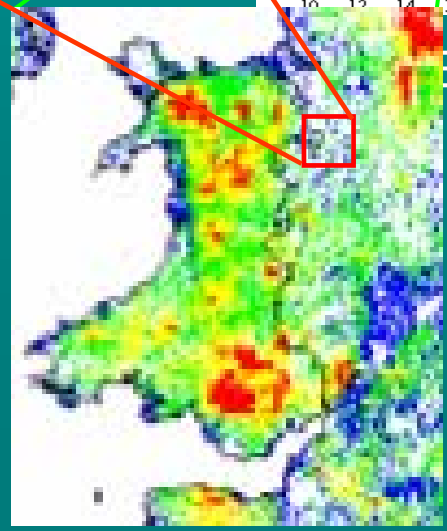
Dealing with spatial scale



Ecosystem protection



European exceedances of the critical load for nitrogen



National targets and policy

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.

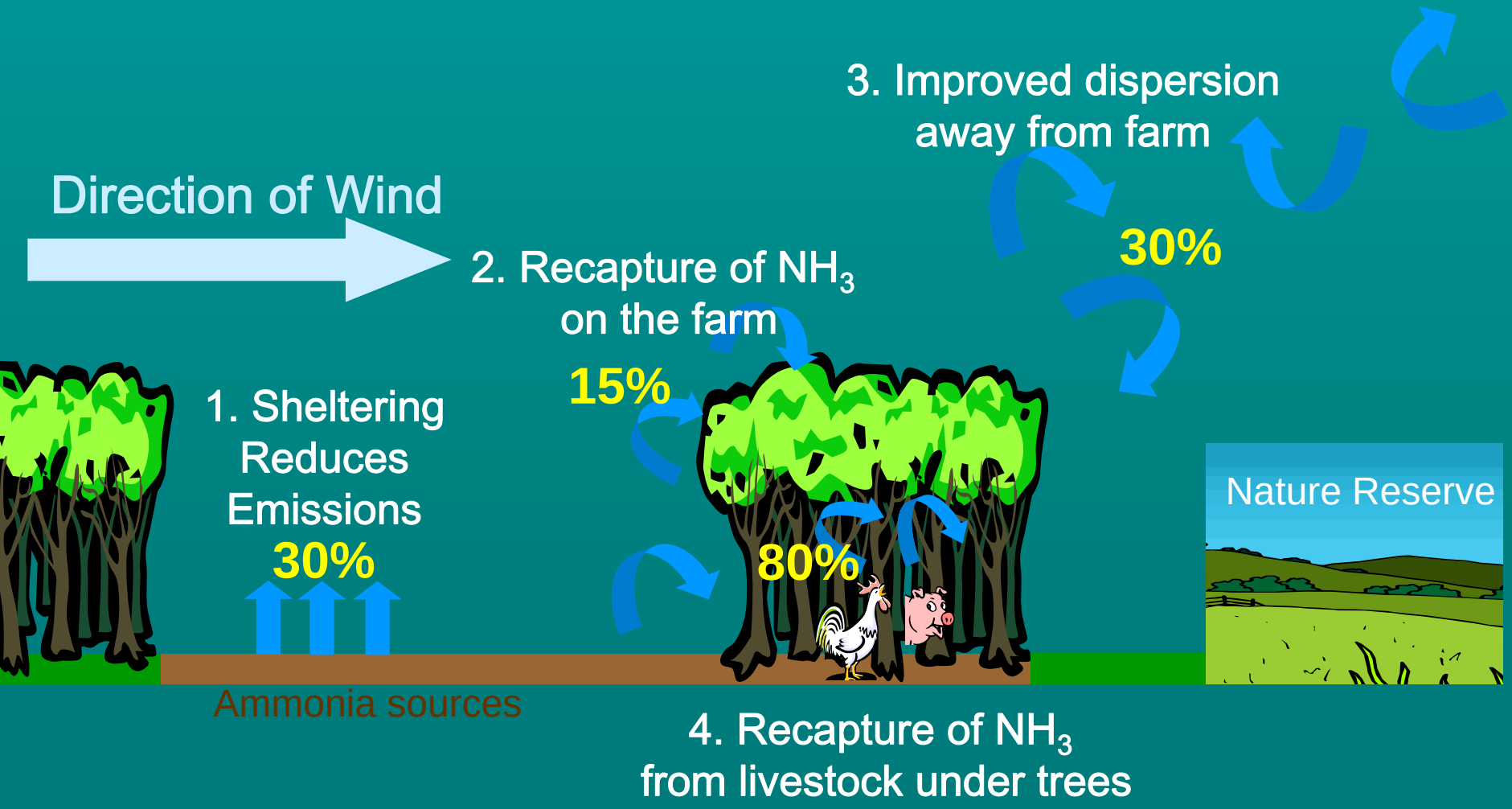
In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and,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

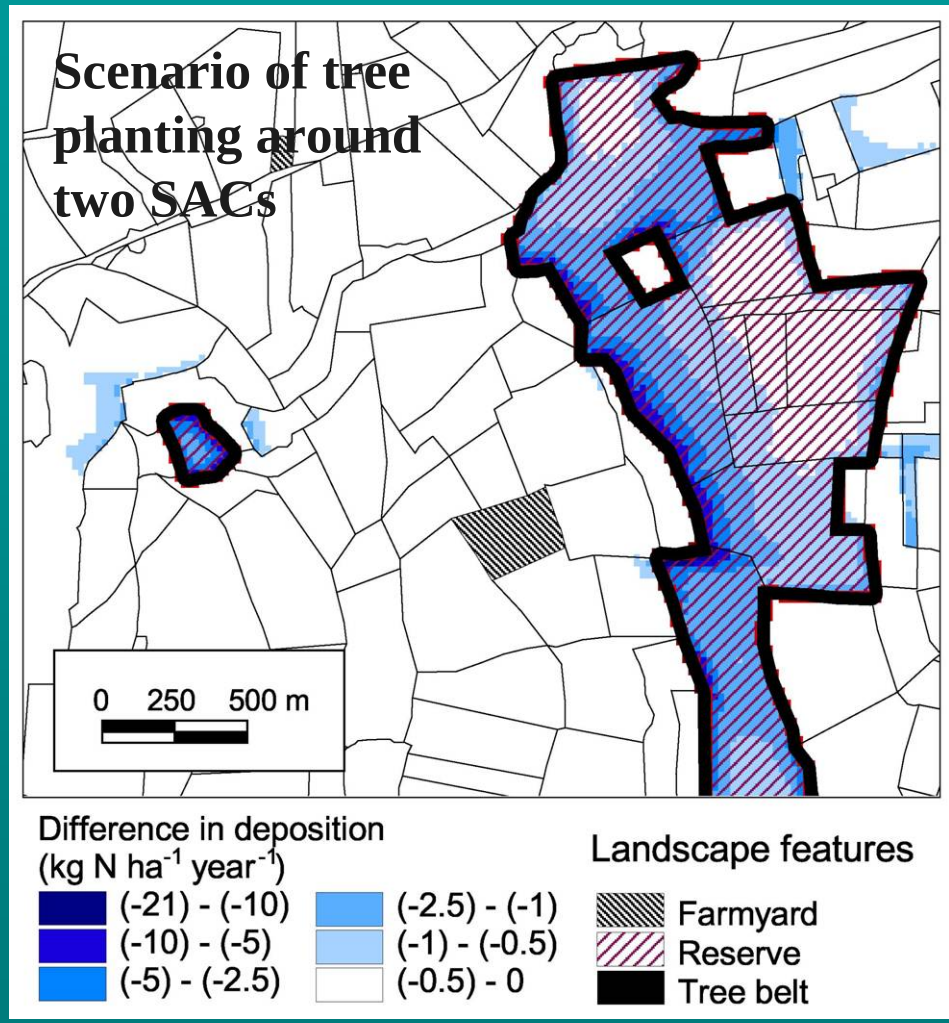
Landscape planning for ammonia & nitrogen mitigation

Four-way benefit of trees in spatial planning for ammonia



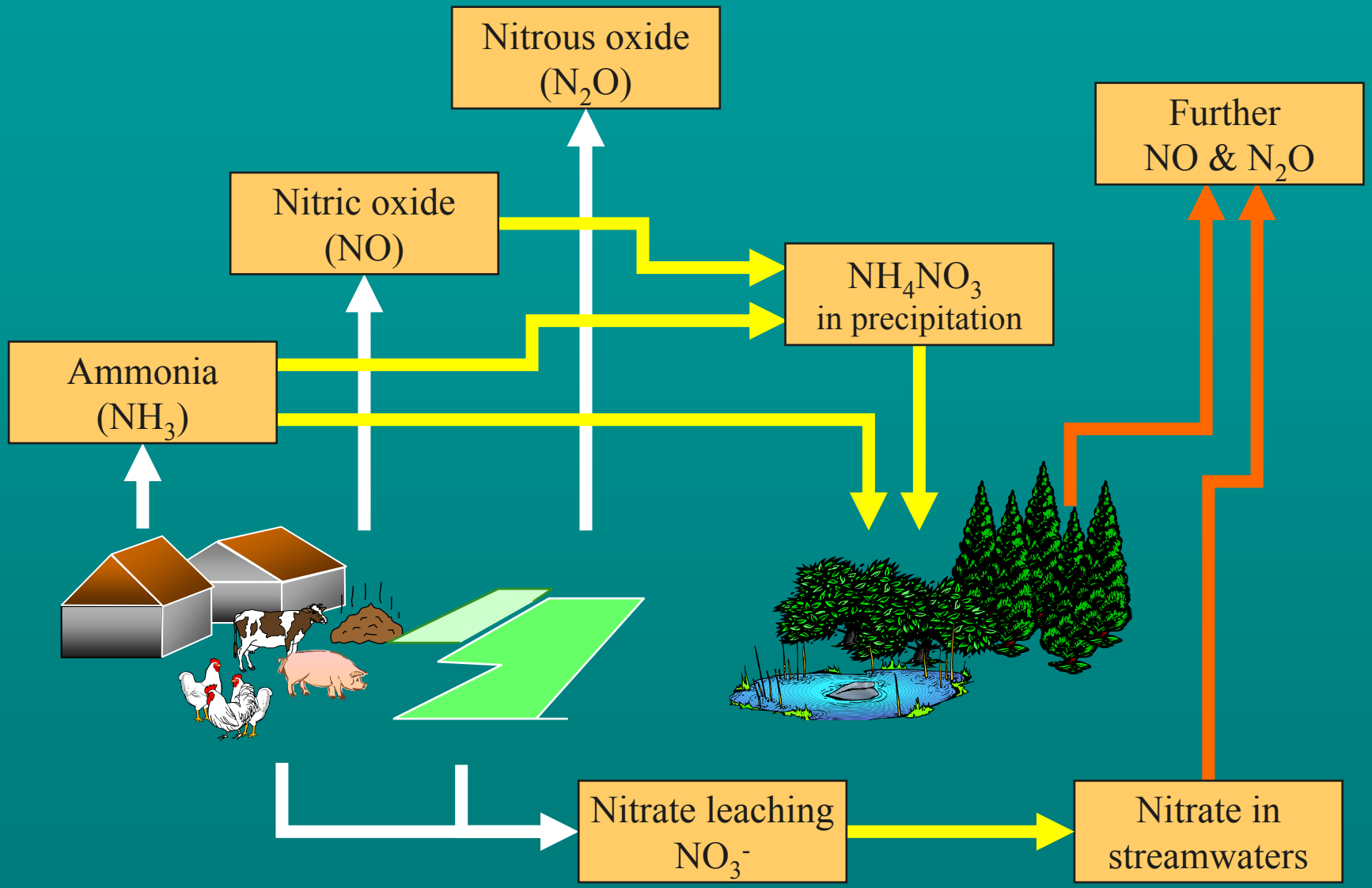
Designing woodland buffer zones

- 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



Dragosits et al. *Environ. Sci. & Policy* 2006 and EC Environment News Service

Multi-pollutant interactions for nitrogen



Abatement may swap one pollutant for another in the nitrogen cascade

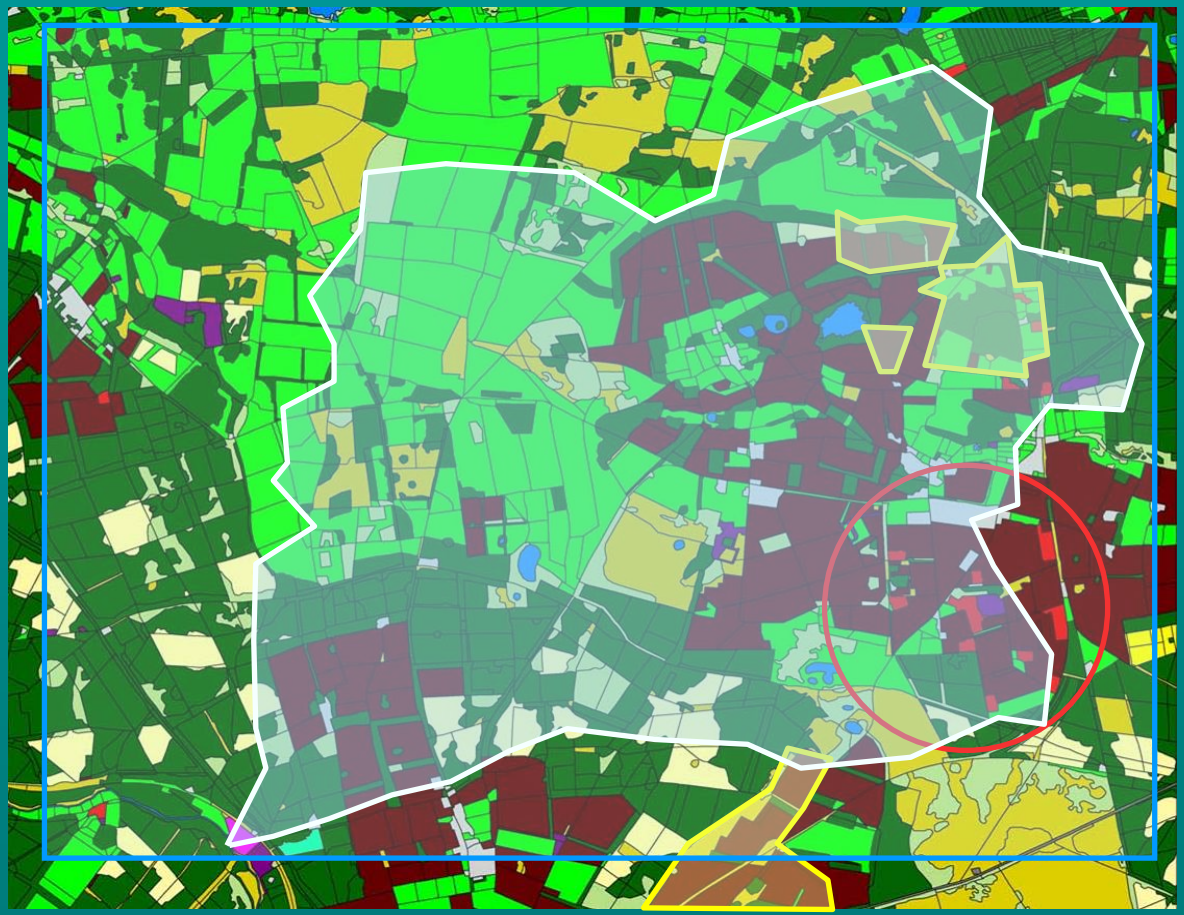
Landscapes integrate multiple spatial scales relevant for multi-pollutant assessment

Farmsteads

Farm units
(fields & buildings)

Water
dispersion

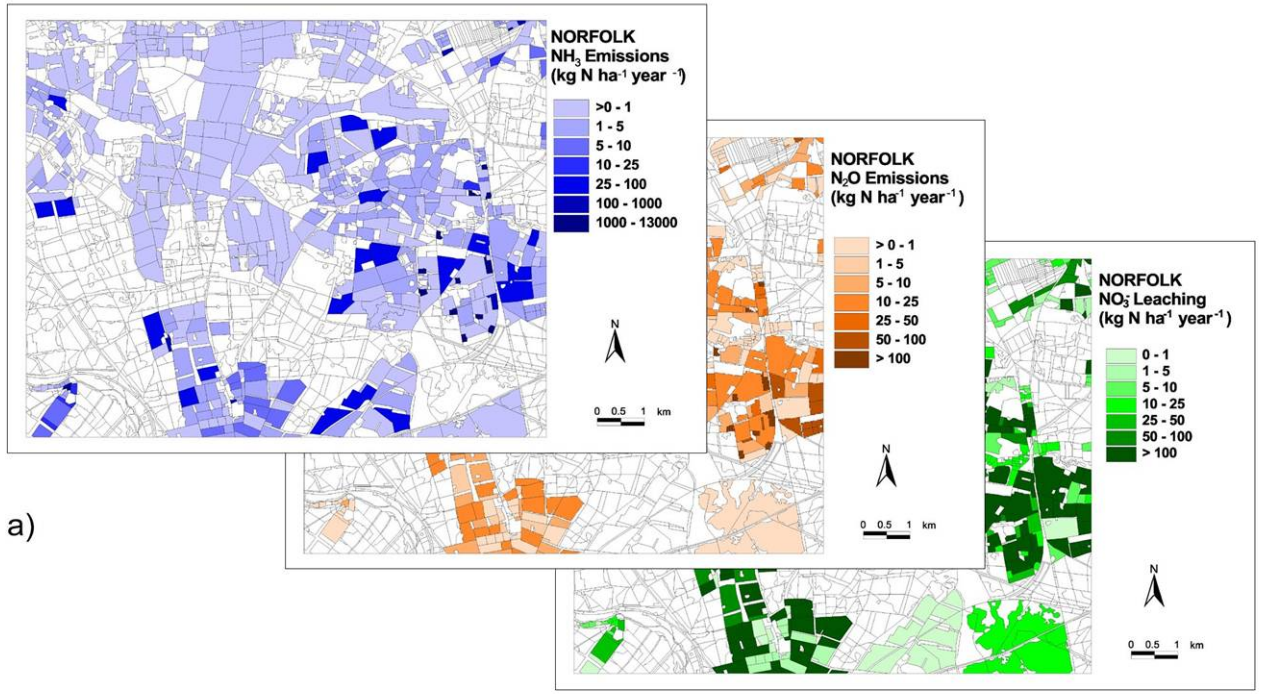
Atmospheric
dispersion



GaN2E

NitroEurope IP

Example outputs of the LANAS model



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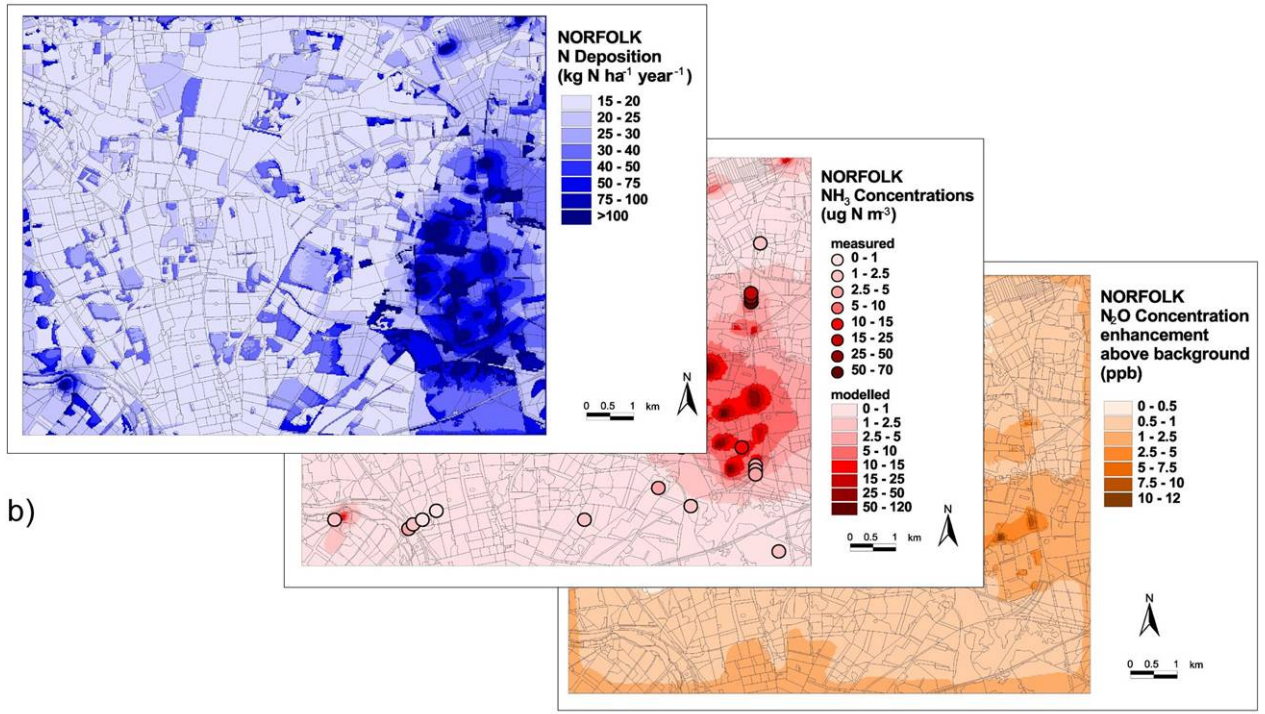


b)

NATURAL ENVIRONMENT RESEARCH COUNCIL

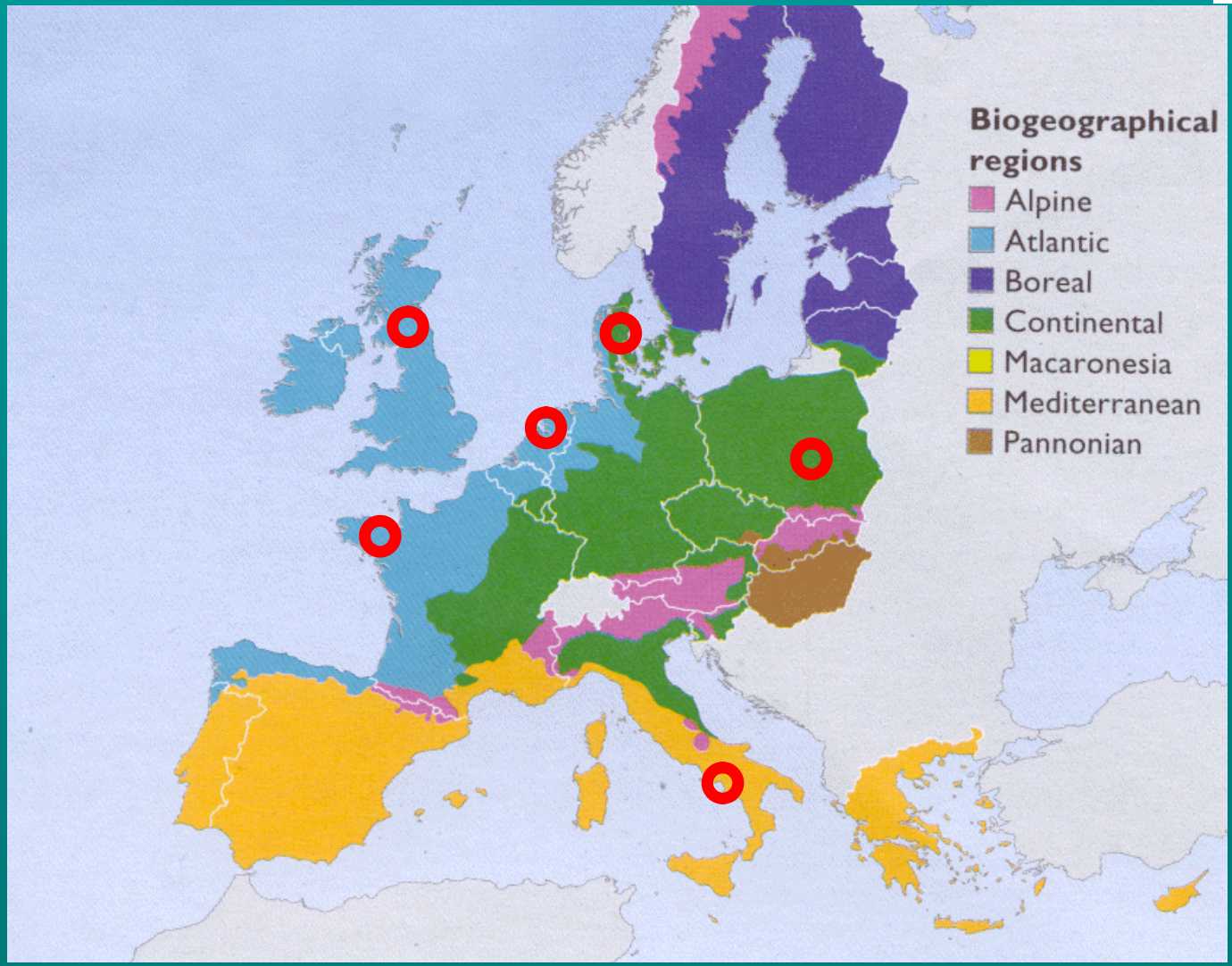
GaN2E

defra
Department for Environment Food and Rural Affairs

Theobald M.R et al. (2004) Water, Air & Soil Pollut.: Focus

NEU Landscape Network (C4)

NitroEurope IP



Ammonia Policy
Case Studies

Examples on the SMALL scale

Example 1: Public Planning Enquiry
"The Barn", Three Legged Cross

- 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 ☺

ENGLISH NATURE

Survey of lichens on birch trees adjacent to The Barn Application.rea

Holt and west Moors Heaths SSSI

Scale 1:5442 Map 1 of 1

English Nature
Dorset
Slepe Farm

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

- Your view?
- 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.

Example 2: Existing ammonia damage

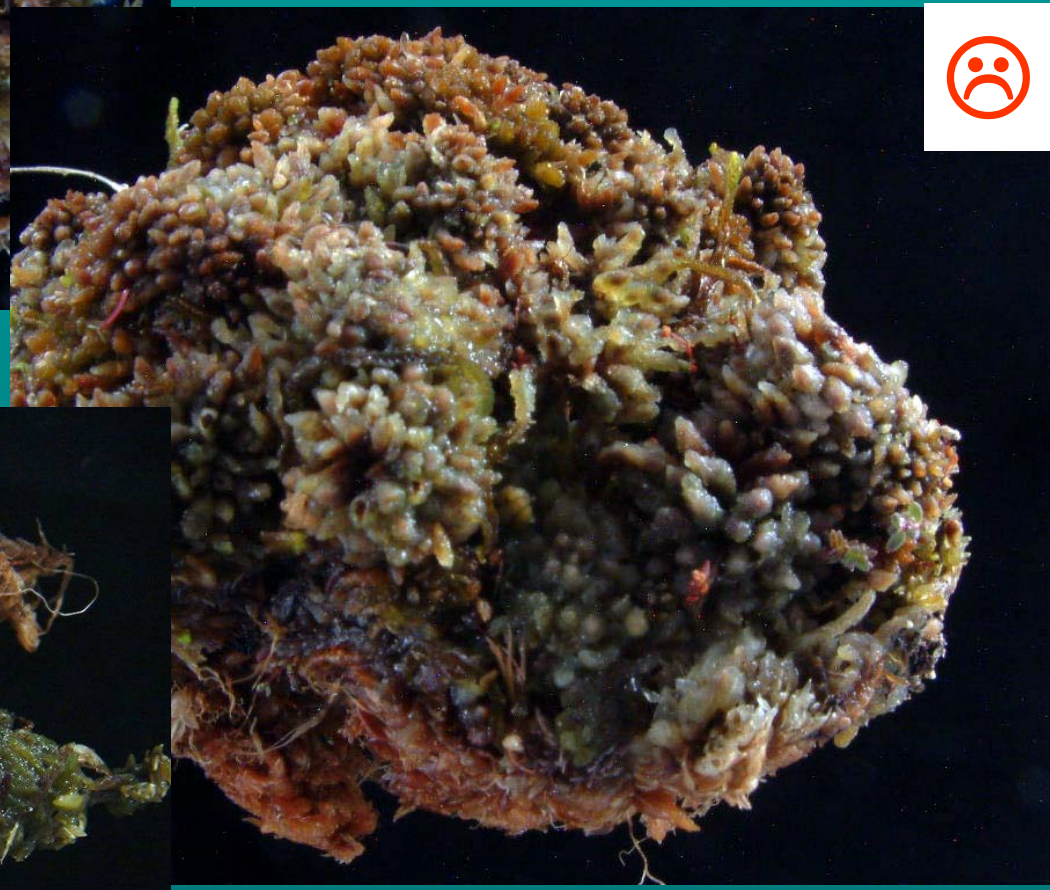
- SAC citation: "___ *Bog is one of the best remaining examples of an active raised bog within the drumlin landscape that occurs across the southern counties of Northern Ireland.*"

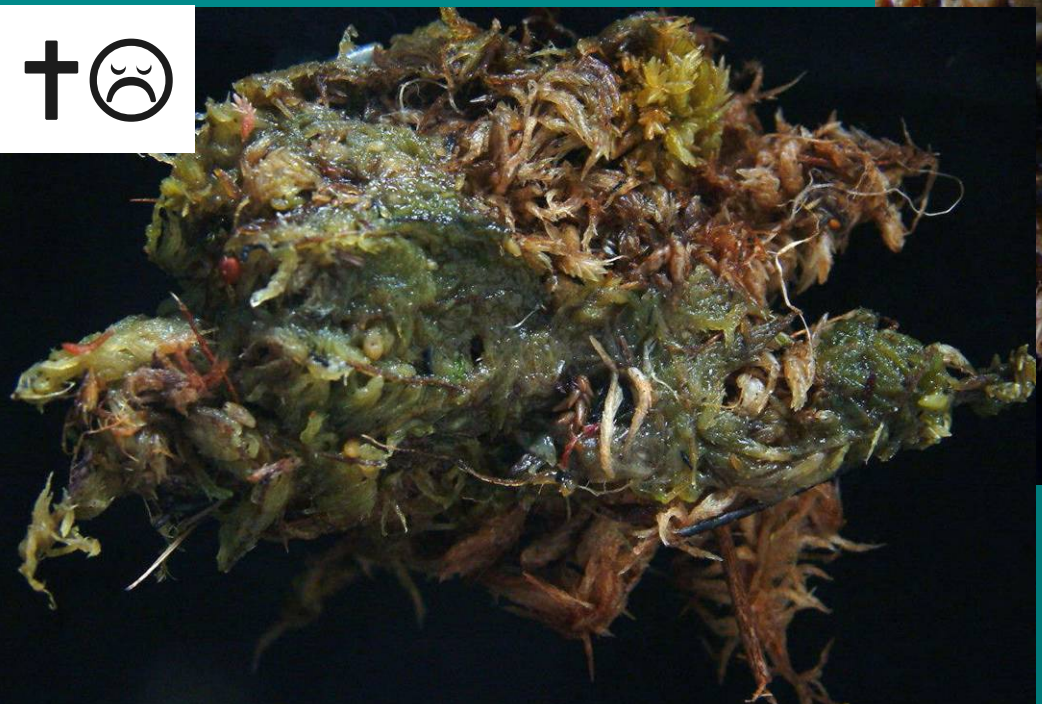
- Existing poultry farm adjacent to SAC:

Polytrichum moss

Lichen: Cladonia uncialis

Bog moss
Sphagnum imbricatum





Ammonia Policy

Development at the European scale

- Developments in the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP)

- Revision of the National Emissions Ceilings Directive
- Presentation to the European Parliament

New "Critical Levels" for NH_3

Expert Workshop on Ammonia under the UNECE "Convention on Long-Range Transboundary Air Pollution."

Old Critical Level	8 μg m^{-3} (annual mean)
New Critical Levels	
Lichens & bryophytes*	1 μg m^{-3}
Other vegetation	3 (2-4) μg m^{-3}

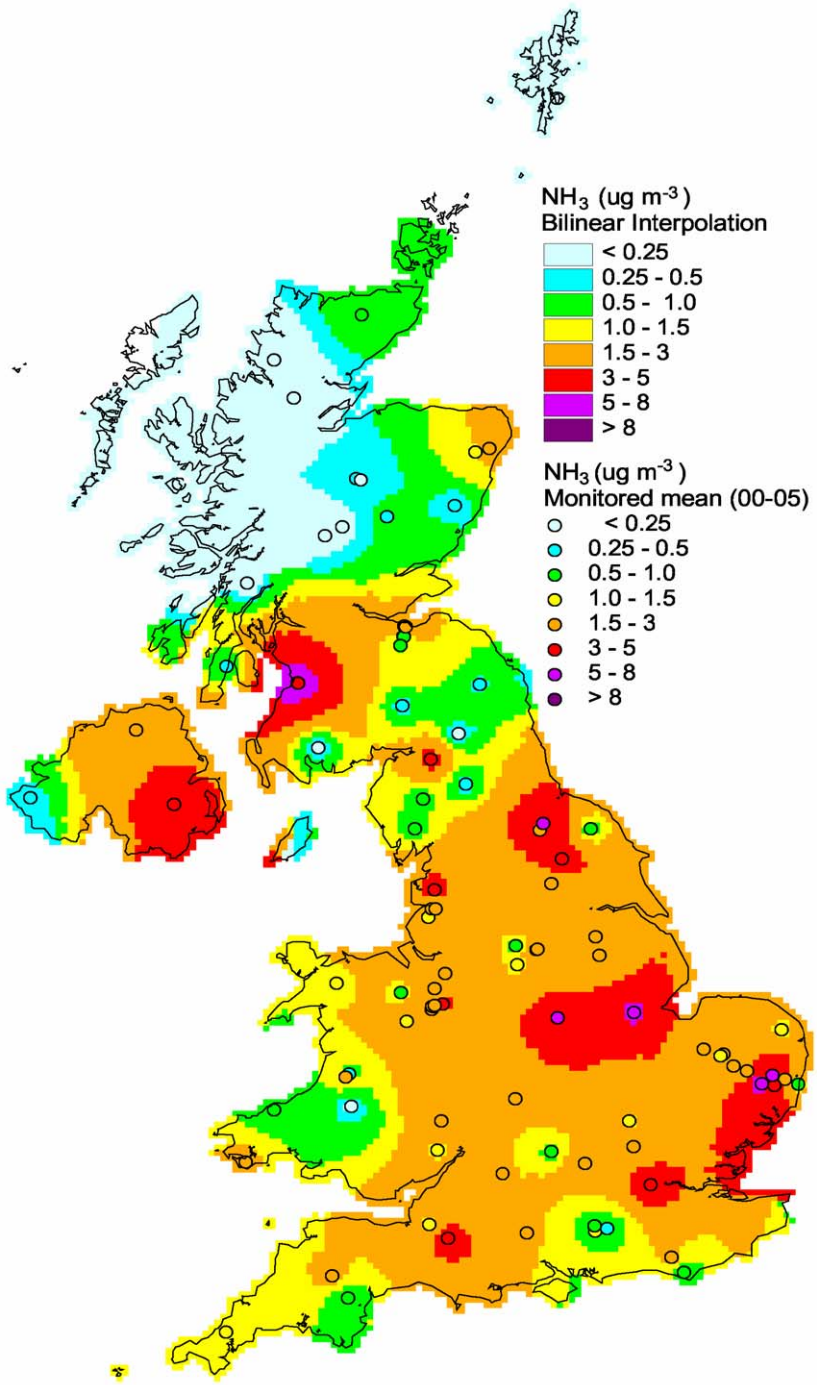
* including habitats where lower plants essential to ecosystem integrity

Implications of the new critical level

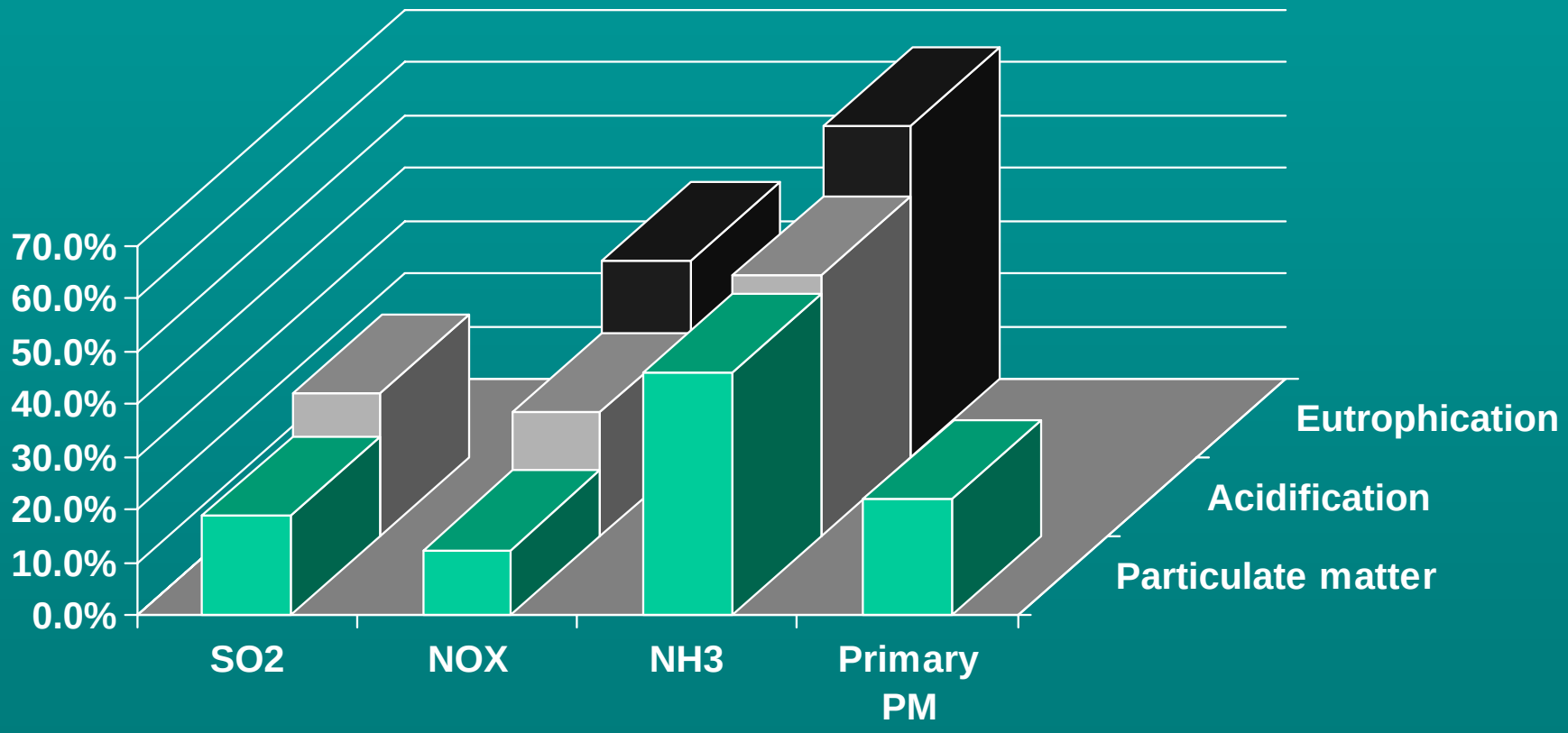
Threshold of 1 μg m^{-3} exceeded over
85% of England &
60% of UK

Sulphur dioxide largely gone.

Ammonia is now the major air pollution driver of lichen biodiversity.



Percentage contribution of primary pollutants to the effects in 2020



Spatial planning for ammonia and the Habitats Directive

- 6th Environmental Action Plan target – no significant effects. Not achievable for NH_3 by emission ceilings.

Recommendations

- Prioritize protection of SACs by setting an effect related objective:

  "Target to reduce the numbers of SACs where N critical loads are exceeded in each Member State by X%"
- Need to consider European livestock herd size.
- Regional and landscape spatial measures.
- Air quality target for NH_3 focused on SACs.

Conclusions: Ammonia problems

- In 2020 ammonia the largest contributor to acidification, eutrophication and particulate matter
- Current ammonia abatement is small compared with other sectors: more effort is required.
- Given costs and spatial variability, it is not feasible to protect all European ecosystems, while maintaining a viable livestock sector.

Conclusions: Ammonia and Strategies

- Special Areas of Conservation (SACs) are the logical priority for biodiversity protection
- Need an integrated view of the N cycle, linking agricultural NH_3, N_2O and NO_3^- losses (inc. acidification, eutrophication & PM).
- Better coordination of NECD, Kyoto, Nitrates Directive/WFD and CBD
- Now working to establish a new UNECE "Task Force on Integrated Nitrogen" to address these links.