



Ammonia emissions, impacts & solutions.

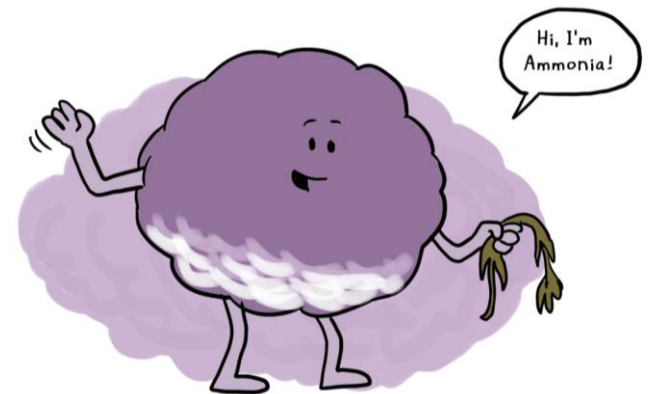
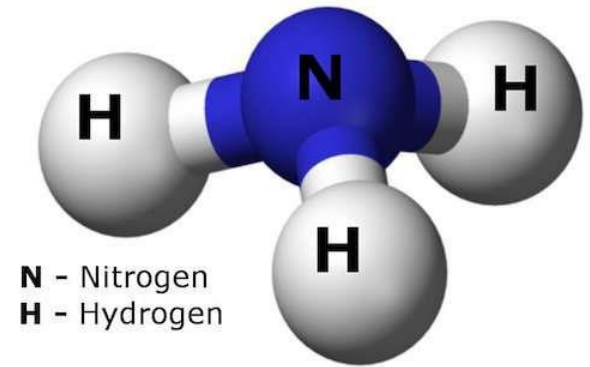
Prof. Dominika Krol – Teagasc

Dr. David “Dáithí” Kelleghan MCIEEM – University College Dublin



What is ammonia

- Compound of nitrogen and hydrogen with the formula NH_3
 - Colourless gas
 - Characteristic pungent smell
- Short residency time in the atmosphere
 - Readily reacts with other chemicals to form particulate matter
 - NH_3 problematic locally
 - Particulate matter transported long distances – problem far away
- Impacts on;
 - Environment
 - Human health

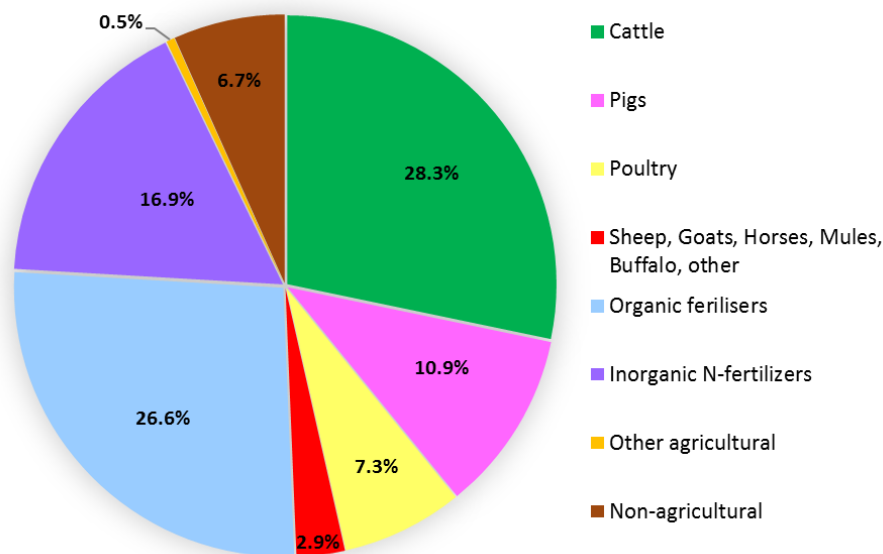


Sources of NH₃

- In Ireland
 - 99% of emissions from agriculture
- Across 28 EU Member States
 - 93.4 % of emissions
- Fertilisers
 - Inorganic/synthetic
 - Organic/animal slurry or manure
 - Account for 43.5% of EU emissions
- Cattle
 - Dairy and beef
 - Account for 28.3%
- Pigs & Poultry
 - Account for 18.2%

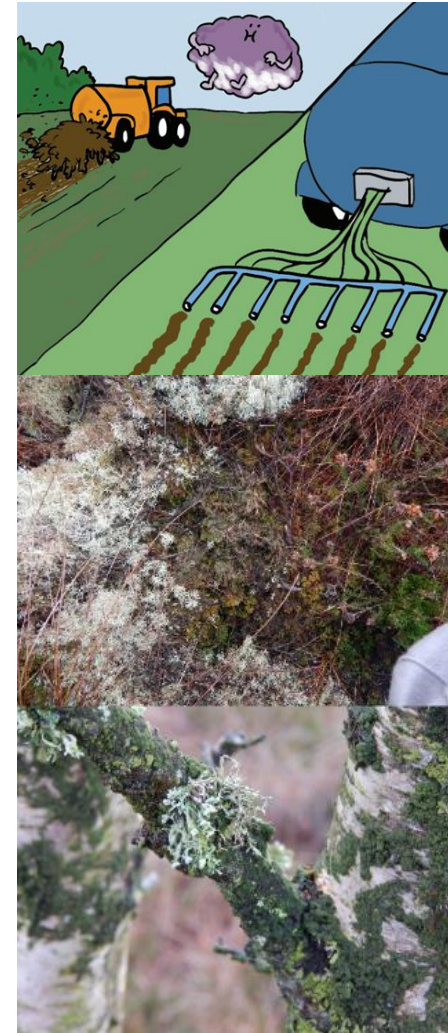


Emission Breakdown from 28 EU MS



Where Impacts Occur

- Unlike Greenhouse Gas emissions
 - National ceilings limit the contribution to an international problem
- Ammonia impacts and effects are primarily local problems
 - High emissions effect the neighbouring environment directly
- Carbon trading is not possible,
 - Source is proximal the impacted area
- Following chemical transformation in the atmosphere
 - Can disperse several km contributing to
 - Wet deposition – total nitrogen deposition
 - Human health impacts



Impacts of NH₃

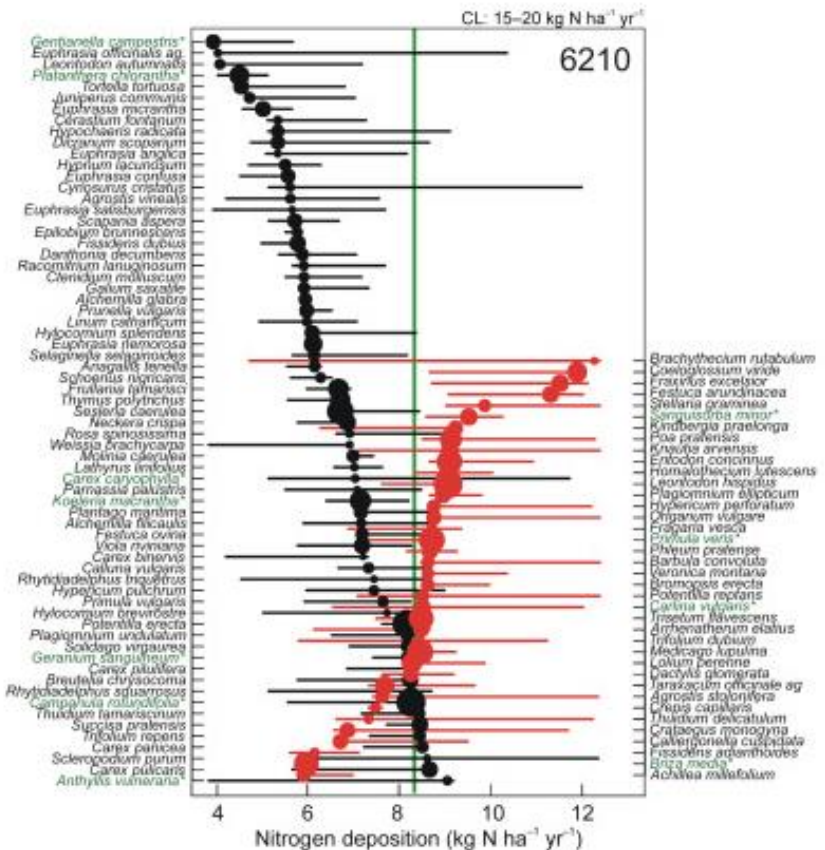
- Contribution of pollutant above which negative consequences are expected

■ Critical levels

- Atmospheric concentrations of NH₃
- Annual average
- UNECE critical levels of;
 - 1 µg NH₃ m⁻³ for lichens & bryophytes
 - 3 µg NH₃ m⁻³ for higher plants

■ Critical loads

- Total nitrogen deposited (including NH₃)
 - Includes wet and dry deposition
- 30 year average
- Habitat specific
- These may be too high to protect ecology

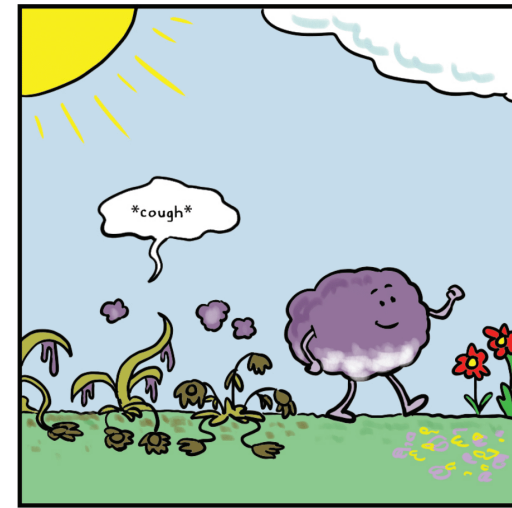


Annex 1 Code	Annex 1 Habitat	Critical Load kg N ha ⁻¹ y ⁻¹	Species Change Point kg N ha ⁻¹ y ⁻¹
4010	Northern Atlantic wet heaths with <i>Erica tetralix</i>	10 - 15	4.9
4030	European dry heaths	10 - 20	4.1
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)	15 - 25	8.3
7130	Active blanket bogs	5 - 10	4.9

Kayla Wilkins, Julian Aherne, Andy Bleasdale. Vegetation community change points suggest that critical loads of nutrient nitrogen may be too high, *Atmospheric Environment*, Volume 146, 2016, Pages 324-331, ISSN 1352-2310
<https://doi.org/10.1016/j.atmosenv.2016.07.016>.

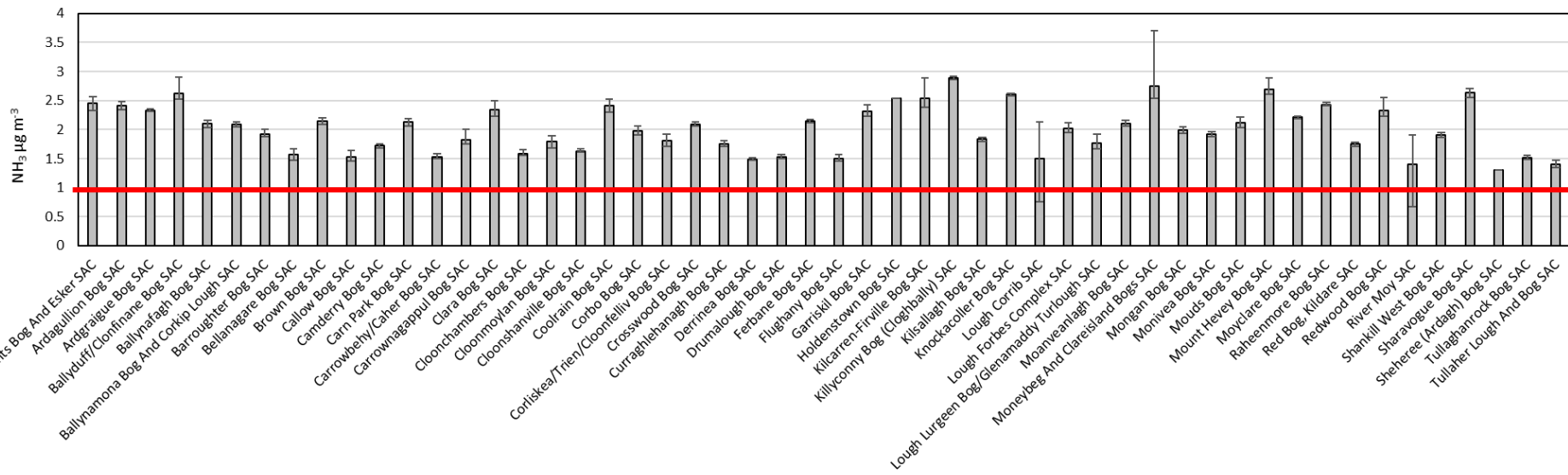
Ecological Effects of NH_3

- Ecology is impacted through
 - **Direct toxicity** of ammonia itself
 - **Eutrophication** as deposited reactive nitrogen
 - **Acidification** as deposited nitrogen
- Diverse range of impacts;
 - Loss or damage to nitrophobic species e.g. *Sphagnum* sp.
 - Encouraging nitrophytic species e.g. algal slimes
 - Exacerbating impacts from drought, frost, pathogens, etc
- Poses significant threat to conservation of Irish habitats



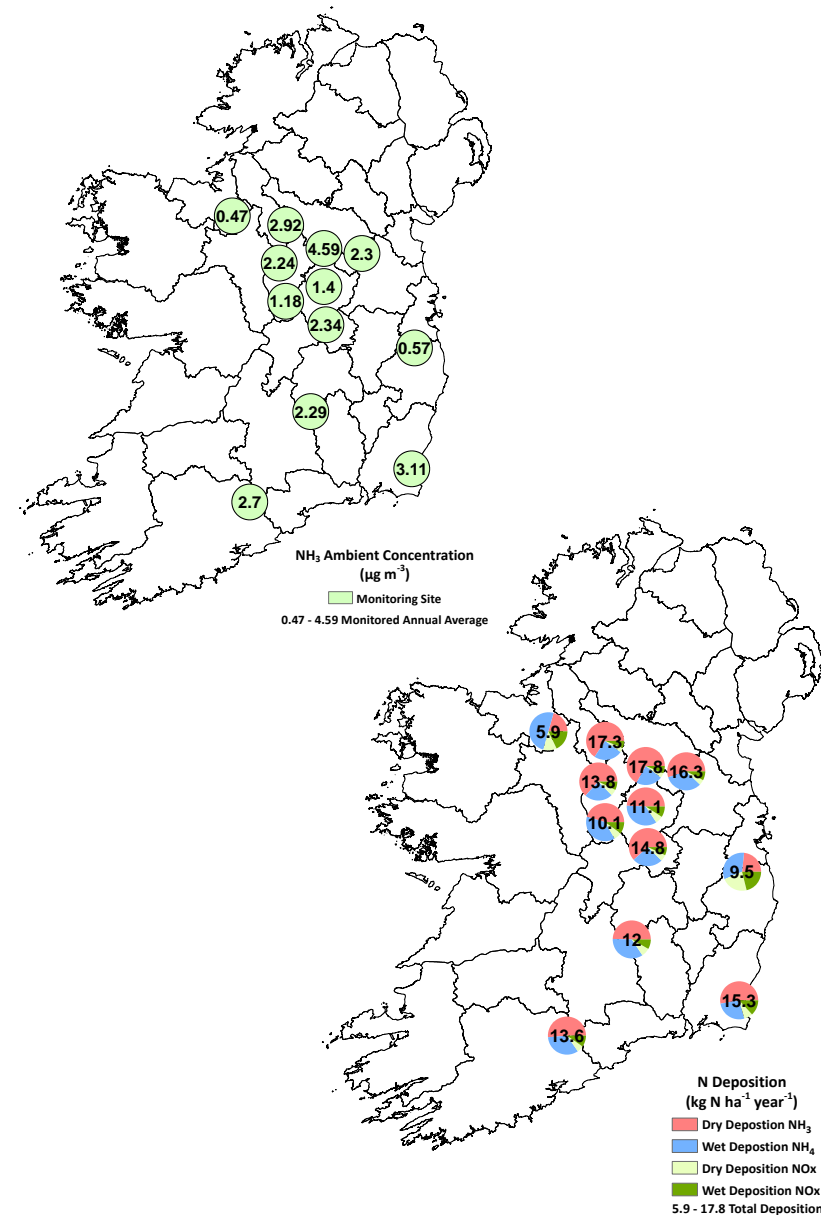
Impacts on Natura 2000

- Natura 2000 legally protected under the Habitats Directive
- No plan or project which allows impacts on such sites is permitted
- Currently all “Active raised bog” Natura 2000 sites exceed concentrations that would cause an impact
 - Based on most recently available concentration model



Monitored Impacts

- NH₃ concentration monitoring on;
 - 12 Natura 2000 sites in Ireland
 - 12 months
- All raised bogs monitored exceeded critical levels and loads for impacts
- Only 2 sites fell below lower critical level for lichens and moss
 - Both upland sites
 - Second site (Wicklow Mountains) exceeded critical loads
 - Due to wet deposition of nitrogen from upwind agriculture



Raheenmore Bog

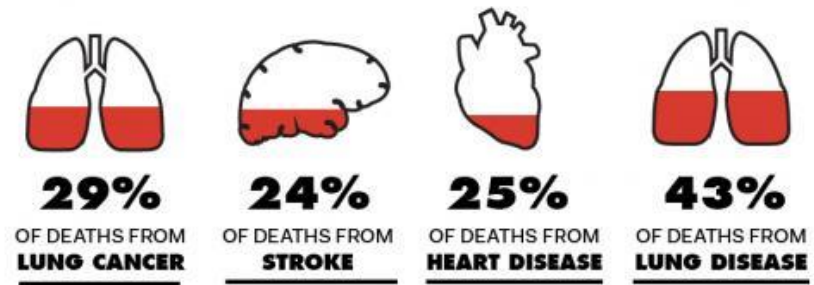
- Not just from intensive hotspot sources
 - e.g. housed pig and poultry
- Impacts from passive sources
- On Raheenmore Bog SAC in Co. Offaly
 - Monitored concentration of $2.3 \mu\text{g NH}_3 \text{ m}^{-3}$
 - Above the critical level of $1 \mu\text{g NH}_3 \text{ m}^{-3}$
 - No intensive hotspot sources of ammonia nearby
 - Closest is > 3 km downwind
 - Only local sources of ammonia
 - Adjacent dairy farming
 - Slurry spreading



Human Health

- Particulate matter (PM_{2.5}) formed from ammonia
 - From reactions with other atmospheric pollutants
 - Primarily NO_x and SO_x
 - PM 2.5 passes through lungs into bloodstream
 - An increase cardiovascular hospital admissions by 1% for every additional 10 µg/m³ in the air
- Managing NH₃ emissions
 - Best route to reduce urban PM_{2.5}
- In Europe 50% of urban PM_{2.5}
 - Formed from agricultural NH₃

THE
INVISIBLE KILLER
Air pollution may not always be visible, but it can be deadly.



BREATHE LIFE.
Clean Air. Healthy Future.



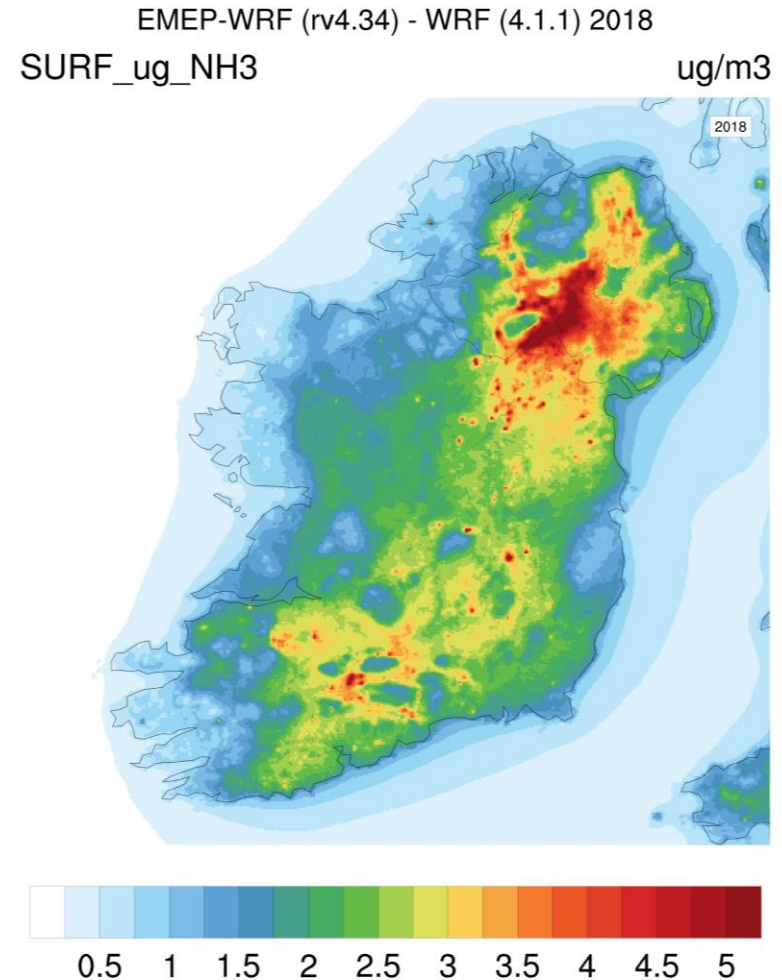
World Health
Organization



CLIMATE &
CLEAN AIR
COALITION

National Modelling

- National emission models compiled by the University of Aarhus (MapEire)
 - How much NH_3 emitted per km^2
- Concentration model developed by UKCEH / UCD project
- Uses meteorological data to
 - Model how NH_3 disperses in atmosphere
 - Resulting local concentrations
 - Calculate critical level exceedances

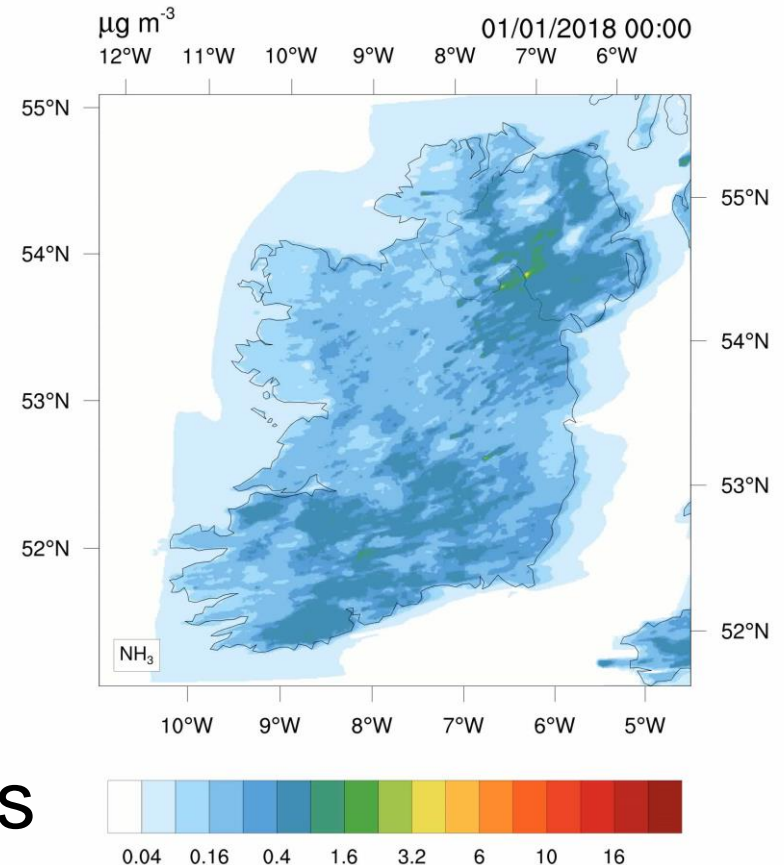


UK Centre for
Ecology & Hydrology



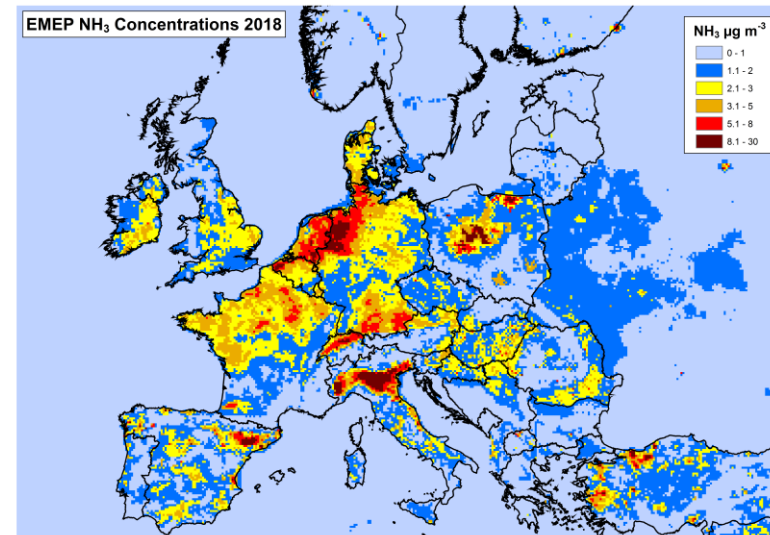
Seasonal & Spatial Variation

- Concentrations highly dependant on local emissions
- Highly spatially variable
- Where you have high agricultural activity
 - High concentrations
- Emissions & concentrations
 - Highest when warm
 - Lowest when cold



NEC Directive Monitoring

- **National Emissions Ceilings Directive 2016/2284/EU**
 - Originally intended to limit emissions
- Recent updates now requires member states to;
 - set up national monitoring network on sensitive sites
 - to monitor long term impacts and effects of air pollution
- Monitor for example;
 - NH_3 concentrations
 - Nitrogen deposition
 - Vegetative community responses
 - % tissue nitrogen in mosses
 - Nitrogen content in soils
 - etc.



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