Ammonia emissions, impacts & solutions.

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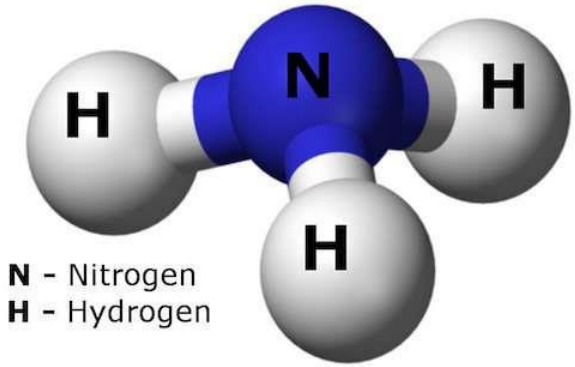
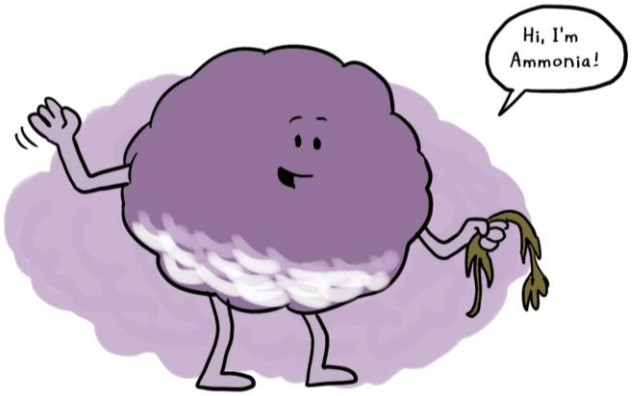
What is ammonia

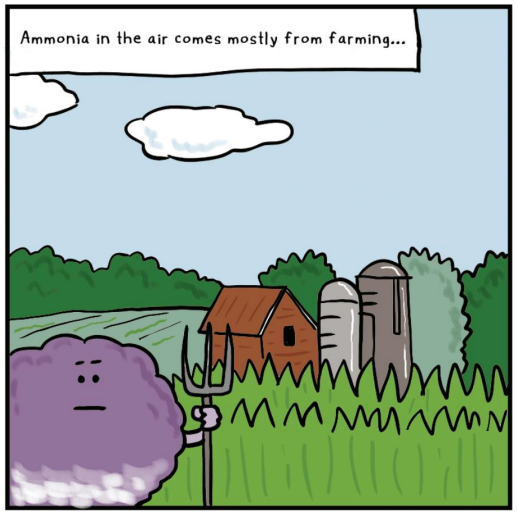
- Compound of nitrogen and hydrogen with the formula NH_3
  - Colourless gas
  - Characteristic pungent smell
- Short residency time in the atmosphere
  - Readily reacts with other chemicals to form particulate matter
    - NH_3 problematic locally
    - Particulate matter transported long distances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



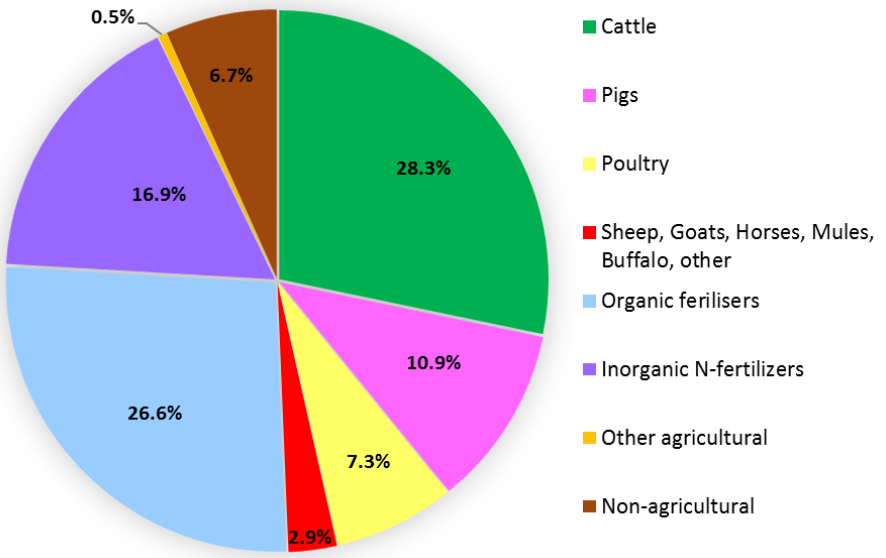


Sources of NH3

- 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

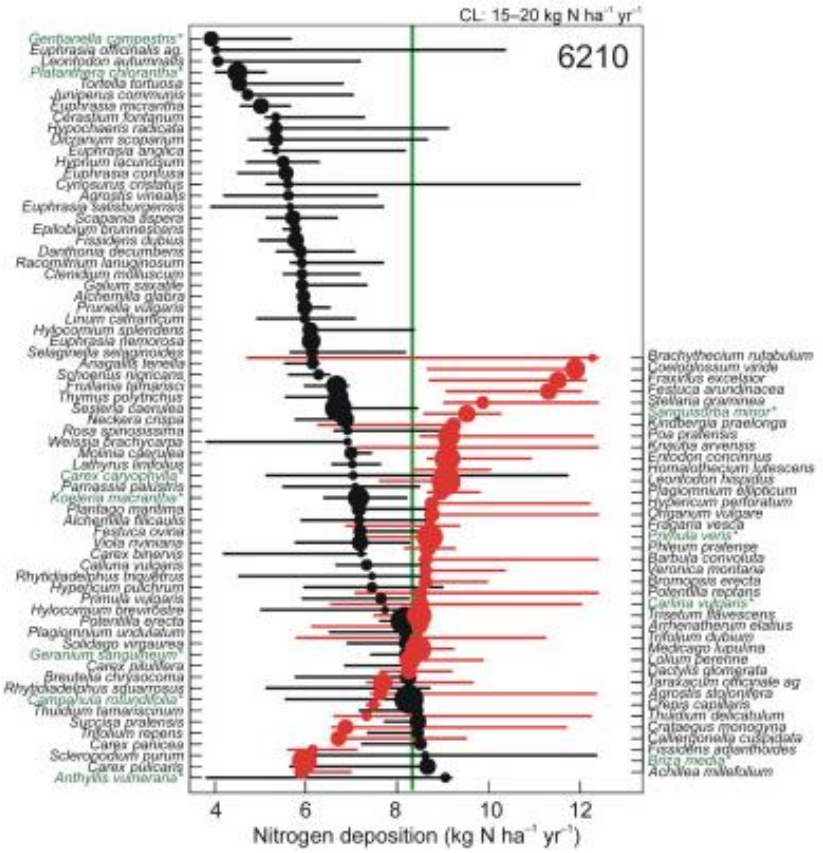


Where Impacts Occur

- 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 NH_3

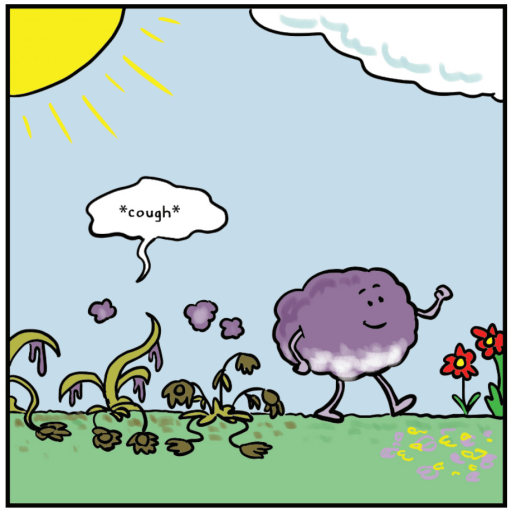
- Contribution of pollutant above which negative consequences are expected
- **Critical levels**
  - Atmospheric concentrations of NH_3
  - Annual average
  - UNECE critical levels of;
    - 1 µg NH_3 m^{-3} for lichens & bryophytes
    - 3 µg NH_3 m^{-3} for higher plants
- **Critical loads**
  - Total nitrogen deposited (including NH_3)
    - 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 Erica tetralix	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



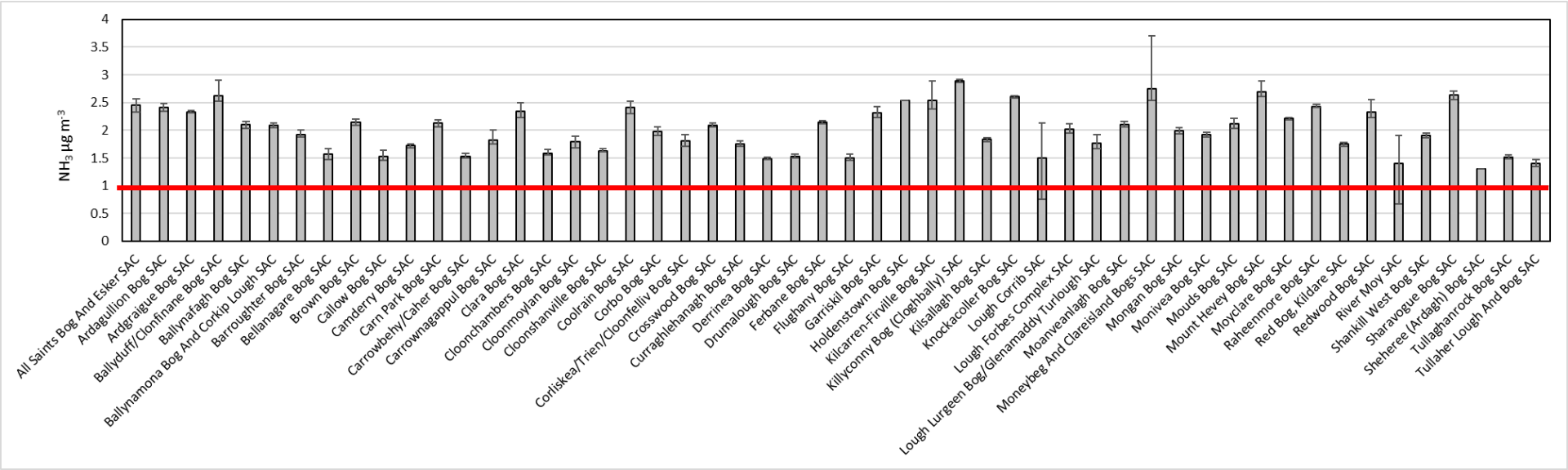
- Ecology is impacted through
  - **Direct toxicity** of ammonia itself
  - **Eutrophication** as deposited reactive nitrogen
  - **Acidification** as deposited nitrogen

- 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

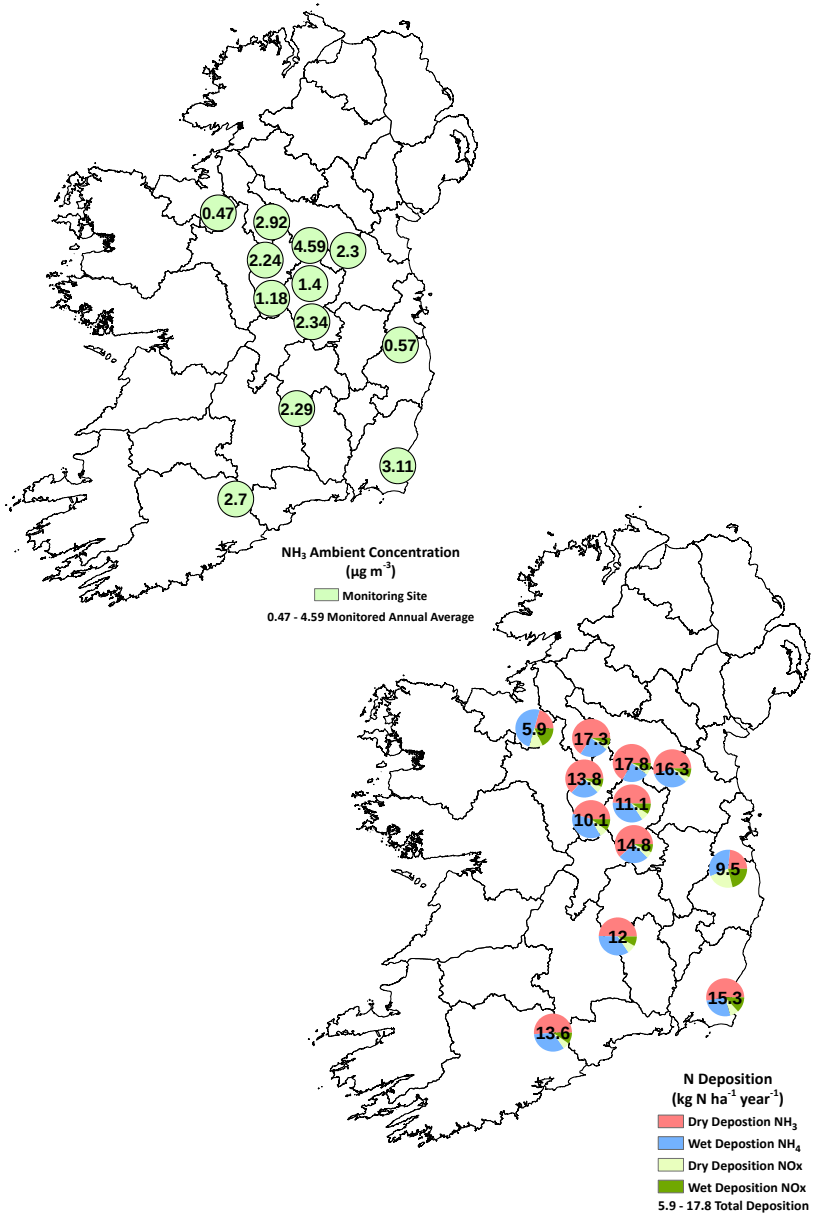
Impacts on Natura 2000

- 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

- NH_3 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



National Parks & Wildlife Service

Ammonia N2K

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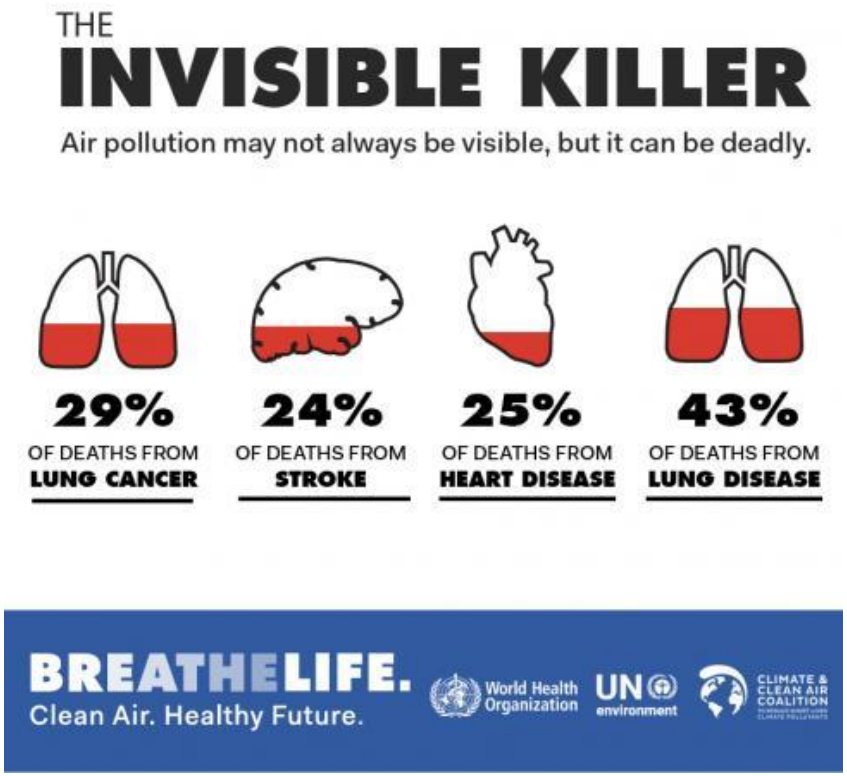
UWE BRISTOL

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 µg NH_3 m^{-3}
  - Above the critical level of 1 µg NH_3 m^{-3}
  - No intensive hotspot sources of ammonia nearby
  - Closest is > 3 km downwind
  - Only local sources of ammonia
    - Adjacent dairy farming
    - Slurry spreading

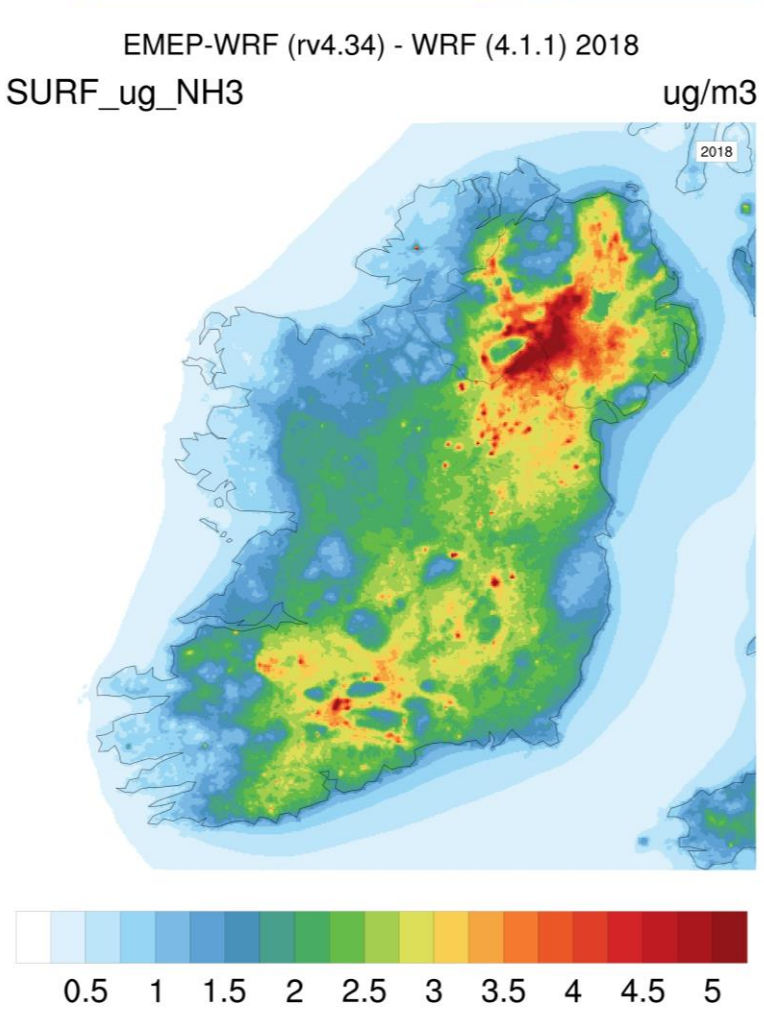
Human Health

- Particulate matter (PM2.5) formed from ammonia
  - From reactions with other atmospheric pollutants
    - Primarily NOx and SOx
  - PM 2.5 passes through lungs into bloodstream
  - An increase cardiovascular hospital admissions by 1% for every additional 10 µg/m^3 in the air
- Managing NH_3 emissions
  - Best route to reduce urban PM2.5
- In Europe 50% of urban PM2.5
  - Formed from agricultural NH_3



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



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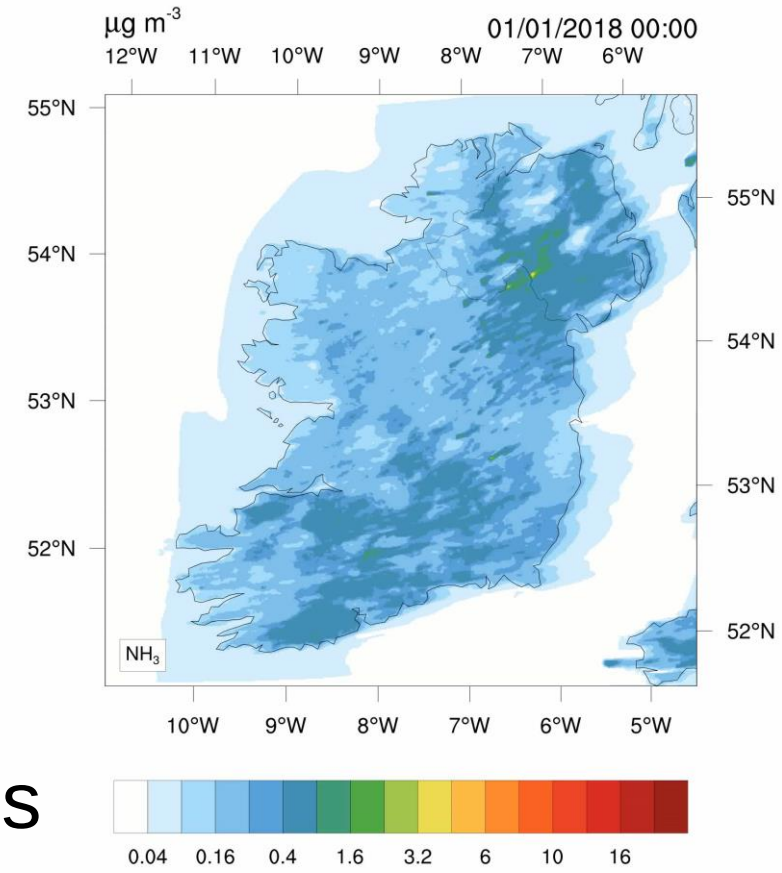
Seasonal & Spatial Variation

- 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



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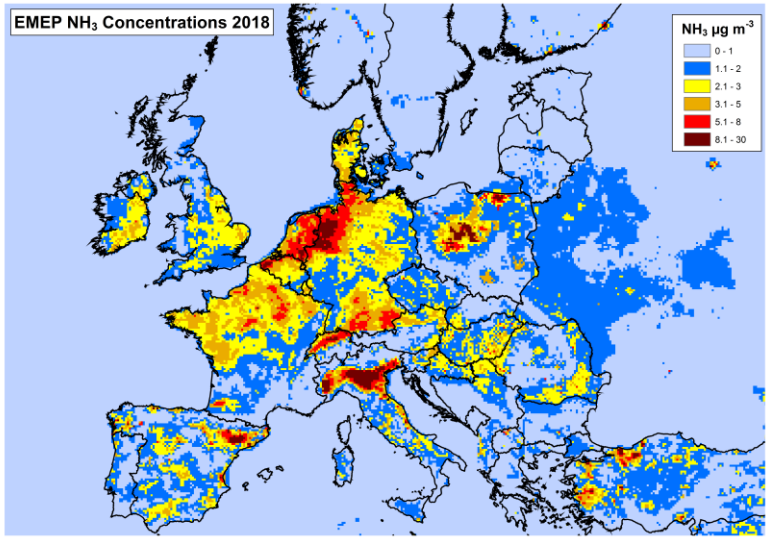
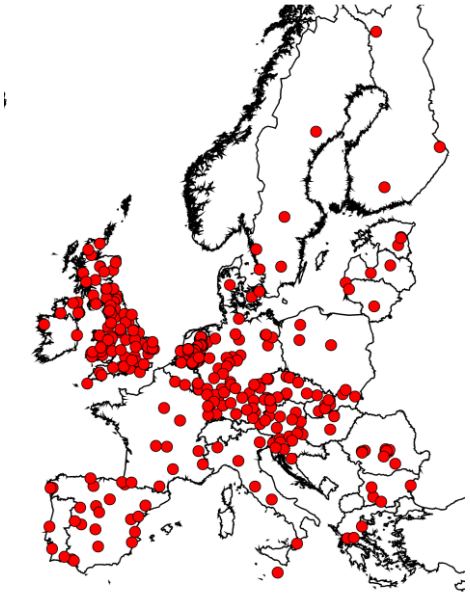
NEC Directive Monitoring



- **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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