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Air pollution from agriculture: The role of ammonia

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Atmospheric ammonia (NH_3) is a key European air pollutant with effects on both the environment and human health. While much progress has been made in reducing SO_2 and NO_x emissions, there have been few measures for ammonia abatement and much more effort is required if significant effects of air pollution on human health and the environment should be avoided (target of the EU 6th EAP).

The main source of ammonia emissions is volatilization from livestock wastes (~74%), especially cattle, poultry, pigs with smaller emissions from sheep. Other sources are the application of N fertilizers to land (~9%) and a wide range of non-agricultural sources (contributing ~17%). The ammonia problem is due to increases in livestock numbers and intensification of N input, especially since the 1950s.

Emitted ammonia reacts with sulphur and oxidized nitrogen in the atmosphere to form ammonium particles, which contribute significantly to overall PM concentrations in Europe. Typically ammonium provides 20-35% of the inorganic fraction of PM1.0 and PM2.5, with significant impacts on human health and atmospheric visitility. In the worse affected parts of Europe, identified anthropogenic PM2.5 is estimated to lead to a loss in life expectancy of 9-36 months.

Ammonia gas and ammonium particles undergo long-range atmospheric transport and are deposited to ecosystems as dry deposition (direct absorption) and wet deposition (in precipitation). Ammonia gas is the main problem in source regions, with wet deposition the main problem in remote areas. As agricultural land is mainly a source of ammonia, most ammonia is absorbed by semi-natural ecosystems and forests, thereby concentrating the inputs into the most sensitive areas. Oxidation of ammonia in soils leads to soil acidification, while the extra nitrogen (N) has a eutrophicating effect changing plant species composition. Key issues are the loss of heathland species and certain woodland flowers and their replacement by N loving grasses, while lichens are also extremely sensitive to low levels of gaseous ammonia. Current levels of ammonia are estimated to be causing major biodiversity impacts on sites designated under the Habitats Directive.

Existing spatial modelling and integrated assessment provide a good picture of the levels of ammonia, ammonium PM and their contribution to environment and human health effects. As SO_2 and NO_x emissions have been reduced, ammonia has already become the largest single contributor to acidification and eutrophication and by 2020 will be the largest inorganic contributor to PM concentrations. This shows that concerted efforts are now needed to achieve significant reductions in European ammonia emissions. At present, abatement efforts have been very patchy across Europe: a small number of countries have implemented programs to reduce emissions. Others have relied on reductions in animal numbers (due to other causes), and in some cases animal numbers (and emissions) have been increasing.

Adoption of an ambitious EU scenario for emissions abatement including reductions in ammonia will have a major effect in reducing the exceedance of critical loads for nitrogen effects on ecosystems and on the human health effects of PM. The feasible technical reductions in ammonia are however smaller than for SO_2 and NO_x. For this reason, future strategies need to be based firstly on agreement of national ambitions for the sizes of their livestock heards. Secondly, technical emission reduction measures for ammonia need to be applied with a broader committment across Europe if major achievements are to be made.

Two key points need to be recognized in seeking strategies to ammonia emission control: a) the need for an integrated approach to manage agricultural nitrogen in relation to multi-pollutant effects, and b) the need for spatial strategies to maximize the environmental benefits per unit ammonia emission reduction.

Agricultural nitrogen has several polluting effects, including greehouse gas emissions (especially N_2O), particulate matter from ammonium, biodiversity effects of ammonia and effects of nitrate leaching on water quality. Nitrogen cascades through the environment, so measures to reduce one form of nitrogen pollution may increase emissions of other forms. Priority should therefore be given to measures that lead to synergistic benefits (e.g. reduced N inputs, more effective N usage). Some measures involving trade-offs will remain essential, and in these cases pollutant priorities need to be agreed according to local environmental sensitivities. For example, ammonia may be agreed to be a priority pollutant adjacent to Natura 2000 sites (under the Habitats Directive), while nitrate might be the priority in a sensitive catchment.

The need for spatial strategies is highlighted by the difference between feasible ammonia emission reductions and the ambition to avoid all significant adverse effects (6th EAP). Fundamentally, it is not possible to avoid significant critical loads exceedance for nitrogen while maintaining a viable livestock sector in Europe. This is particularly because of the problem of spatial scale: as maps are made at fine scales they show large spatial variability, with extremely high exceedance near farms, and forest edges. If it is accepted that not everthing can be protected, then there is a strong case identifying the priorities for ecosystem protection. The high degree of protection afforded to the Natura 2000 sites (inc. Special Areas of Conservation, SACs), already places these as legal priority. Spatial strategies should therefore be developed that focus not just on reducing emissions, but on maximizing the protection of these sites. In this case spatial planning measures (including landscape level measures such as buffer zones) provide additional tools to maximise benefits for a given ammonia emission reduction.

The following proposals are made here:

- Support further reductions in national emissions ceilings (scenario A+ is suitably ambitious)
- Set an effects based objective "to reduce the numbers of SACs where N critical loads are exceeded in each member state by X%"
- Set an air quality objective for annual mean ammonia concentations (in relation to critical levels) applicable for SACs.
- Use national and landscape spatial planning to help meet objectives
- Extend IPPC Directive to include cattle (with a realistic farm size limit, e.g. >200 dairy cows, and excluding small cattle farms from the directive)
- Incorporate eligible costs of ammonia mitigation measures and spatial strategies into agri-environment financing mechanisms.
- The long term development should be to encourage the underpinning research needed to take a fully integrated nitrogen approach to agricultural air pollution abatement.