First ALTERNET Summer School in Peyresq 27 August – 8 September 2006

Talk given by Mark Sutton, Saturday 2 September

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

Summary

Farming yields very important ecosystem services for humans, e.g. food as the most important service and habitats for many organisms in farmed cultural landscapes. But farming leads also to pollution even when following the "good practices" of farming. In general, emissions have been a problem since the 19th century with the start of urbanisation and industrialisation. Ammonia emission from agriculture is a new problem. At the end of the 20th century important progress has been achieved in reducing European acidifying emissions, especially sulphur dioxide (SO_2) emissions dropped massively. But levels in nitrous oxide (NO_x) and ammonia (NH_3) stayed high. Ammonia is mainly emitted by livestock – cute little cows, chicken and sheep. This is known since the early 19th century – quote by Arthur Young (1807) – and the work on fertilisers done by Justus von Liebig. Known effects of increased NH_3 on biological systems span from reduction of wood flower abundance in expense of widespread grasses to interactions of soil nitrogen content with the main disturbance regime, e.g. heath and fire regime.

Lack of data on NH_3-emissions is a serious problem. Lichen were used as bio-indicators for SO_2-emissions, but the problem of lichen extinction and SO_2-emissions is history because of the reductions achieved. But NH_3 is a new stressor and lichen show high sensitivity to emissions, too. Some acidophytes, like e.g. Troll's Beard which also grows in the forests around Peyresq, hate NH_3 because it acts as base in chemical reactions. Nitrophytes, e.g. *Xanthoria*, on the other hand thrive under high NH_3-concentrations. In an extensive study it was estimated that 78 % of lichen communities in England and 54 % of lichen communities in the UK are affected by ammonia.

Ammonia converts easily into ammonium (NH_4^+) which contributes substantially to particulate matter (PM) concentrations. Mark showed a picture of the city of Parma in Italy where PM decreases visibility similar to misty weather. Parma is close to agricultural production facilities. To identify the main emitters of NH_3 and the most heavily polluted regions in the UK they modelled NH_3-fluxes on the country-scale. Regional up-scaling of ammonia fluxes is a main research topic. Mark showed maps of concentrations of gaseous

NH_3, where quite local hotspots could be identified, and of aerosol NH_4^+ (coupled with dispersion models), where large regions in middle and south-eastern England receive high loads of ammonium. Through comparison of maps with agricultural production the emitters can be identified. These are especially large poultry and pig farms and dairy farms. Interestingly, ammonia concentrations drop immediately to background levels on the sea due to absorption and decreased surface ruggedness.

To extend these results to the continental scale of Europe a new network of measurement sites was developed (DELTA-Project). Monitoring ammonia concentrations has a high priority across Europe, because emissions show pronounced fluctuations in space and time. New measurement techniques are applied which allow standardisation and less work-intensive data-collection on the European scale.

But long-term impacts on ecosystems can only be understood through knowledge of total loads of nitrogen deposited. Maps of critical loads and nitrogen exceedance limits try to give answers. But how can we deal with the problem of scale? How can we protect the ecosystem or habitat on the local scale when dealing with emissions on the continental scale? When focussing down from the continental to the regional or local scale more and more structures in the NH_3-deposition appear. Locally very high deposition exceedance and areas of low depositions were found next to each other. Implications from landscape level variability are that nature reserves near farms are at risk and that edges of forests receive high loads of ammonia. In order to reduce impact of NH_3-depositions on the surroundings of a farm sheltering of animals and trees on the farm-site can be used to mitigate ammonia depositions. But understanding of multi-pollutant interactions for nitrogen, e.g. ammonia emissions, nitrate leaching or nitric oxide emissions, is still at an early stage and abatement of one may swap one pollutant for another in the nitrogen cascade. The same holds true for a landscape scale approach towards N-emission reduction where multi-pollutant interactions integrate with multiple spatial scales since different pollutants disperse and concentrate on different scales.

Given explicit spatial GIS data derived from emission-dispersion models with high spatial resolution it is realistically impossible to protect all ecosystems across Europe while maintaining livestock agriculture in its present form. Therefore, society needs to define priorities for protection from atmospheric ammonia depositions. Here the Habitats Directive, which designates a EU-wide network of protected areas for conservation of habitats and species (so-called NATURA 2000), needs to be considered. The Habitats Directive envisages a high level of protection and – most important – it applies the precautionary principle. The results achieved up to now can therefore be used in local landscape planning to mitigate

ammonia and nitrogen depositions on valuable ecosystems or habitats. Mark reported an example of SW-England where the issue of ammonia effects on a Special Area of Conservation (SAC) under the Habitats Directive was “tested” the first time under a public inquiry in the UK. He was part of the inquiry as scientific advisor. The decision was that the farm close to the SAC could not be developed because of probable and possible impacts of ammonia emissions. This case has wider implications. Further the ammonia problem becomes of higher policy relevance under the European Commissions proposal for a Thematic Strategy for Air Pollution with targets for 2020, because NH_3 will be the major contributor to eutrophication, acidification and particulate matter (PM) in 2020. Integrated pollution measurements need strict EU-wide policies for agreement on European livestock numbers, spatial planning for ammonia and the Habitats Directive, reduction of national NH_3-ceilings, setting an air quality objective for annual mean NH_3 and incorporate costs of mitigation measurements into agri-environmental schemes.

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