Chapter (non-refereed)

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NITROGEN DEPOSITION - EFFECT ON NUTRIENT IMBALANCES AND WATER RELATIONS OF FOREST TREES

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Bulk deposition and throughfall measurements across Switzerland revealed that N deposition exceed critical load values of the UN-ECE (1992) guidelines for forests in most forest areas except in altitudes >1500 m asl. In permanent observation plots - 64 sites all over Switzerland - the nitrogen supply of beech and Norway spruce increased significantly in the past ten years whereas phosphorus (beech and spruce), potassium (spruce) and magnesium (beech) decreased. About all, the ratios of nutrients changed, hence increasing nutrient imbalances. Field data suggest as well that there is a correlation between nitrogen deposition and increased N/P ratio in leaves.

In an experimental study it could be shown that applications of 25-50 kg N ha^{-1} yr^{-1} decreased P, K and Mg supply and enhance N/P, N/K and N/Mg ratios significantly in potted beech and spruce after 2 and 5 years respectively. After 8 years, 100 kg N ha^{-1} yr^{-1} caused slight symptoms and 200-400 kg N ha^{-1} yr^{-1} acute damages due to nutrient disturbances about all in spruce. N-applications of ≥25 kg N ha^{-1} yr^{-1} increased the shoot:root ratio and leaf biomass significantly, leading to increased water stress susceptibility as it was observed in a drought experiment.

EFFECTS OF AMMONIA ON FOREST GROUND FLORA IN THE VICINITY OF A POULTRY FARM

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Atmospheric ammonia is recognised as an important atmospheric pollutant that may result in both acidification and eutrophication of ecosystems. Changes in species composition associated with increased N deposition, and particularly with NH_3 emissions from intensive agriculture, have occurred over much of Europe. Agricultural sources of NH_3 such as intensive animal units or farmyard manure stores are situated in the countryside frequently in close proximity to woodlands and heathlands. Some of these habitats will be of conservation interest and protected as Sites of Special Scientific Interest or even National Nature Reserves. A study has been made of the dispersion and effects of ammonia from a poultry farm in southern Scotland surrounded by fairly open fern-rich coniferous woodland. The farm contains 120,000 broilers and is situated in an area of low density mixed agricultural, with a background ammonia concentration of 1 ppb. Ammonia concentrations were large close to the poultry houses (long term mean of 13 ppb and 3-weekly ranges of up to 35 ppb at the down-wind site, 16 m north of the poultry unit wall, at the wood boundary) and declined exponentially, reaching half the wood edge value at 20 m into the forest and approaching background upwind values at 300 m in the forest.

Species composition of the forest ground flora was adversely affected within 50 m of the emission source with a 20% decline in species number and an increase in species such as *Chamaenerion angustifolium Deschampsia flexuosa* and *Holcus lanatus*. Nitrogen content in foliage of pleurocarpous moss species was very large (3%) close to the unit, declining to the upwind concentration at about 300 m from the poultry unit. Using the relationship previously described between bryophyte tissue and atmospheric nitrogen deposition (Pitcairn *et al.*, 1995), nitrogen deposition to the woodland surrounding the unit was estimated to be in the region of 100 kg N ha^{-1} yr^{-1}, not too disimilar from the value estimated from wet deposition of $NH_4^+ + NO_3^-$ and dry deposition of NH_3 and NO_2 of 78 kg N ha^{-1} yr^{-1} based on air concentration and deposition velocities. Nitrogen deposition at this site is very large and exceeds recommended critical loads for acidic coniferous forest i.e. 15-20 kg N ha^{-1} yr^{-1} to protect ground flora and is also in excess of that (11->50 kg N ha^{-1} yr^{-1}) proposed to protect tree health (Hornung *et al.*, 1995). Critical levels of ammonia proposed at Egham (11.6 ppb annual mean; Ashmore & Wilson, 1994) are also exceeded at the woodland edge and it is probable that the damage observed on spruce and pine (needle yellowing and needle loss) at the poultry farm may be due both to high concentrations of ammonia and N deposition. Although changes in species composition were confined largely to the immediate 50 m, foliar nitrogen content was affected for a distance of 300 m . Variations in soil type and light intensity may play a role in the changes observed. Experiments to further investigate these effects are in progress together with studies centred around other animal units.

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EFFECTS OF AMMONIUM SULPHATE DEPOSITION ON A LOWLAND DRY HEATH

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Critical loads of nitrogen are currently based on computer models which predict that long-term nitrogen deposition will lead to increased tissue nitrogen levels; these will be accompanied by increased sensitivity to secondary stresses which may in turn lead to canopy breakdown and replacement by acid grassland communities. However, there is a lack of empirical data from long-term experiments at deposition rates close to the proposed critical load of 15-22 kg N ha^{-1} yr^{-1} to validate model-based predictions.

Since 1989, the effects of adding 7.5 kg N ha^{-1} yr^{-1} or 15.4 kg ha^{-1} yr^{-1}, in the form of ammonium sulphate, to a lowland dry heath have been investigated to Thursley Common, a National Nature Reserve, located about 45km SW of London. The background deposition at this site is approximately 15 kg ha^{-1} yr^{-1}, close to the proposed critical load.

Over the past five years, there have been large and significant increases in shoot growth, flowering, canopy density and litter production of heather in response to the nitrogen additions. However, only small, non-significant increases in shoot nitrogen content have been observed, with no clear evidence of altered sensitivity to biotic or abiotic stresses. Nevertheless, some of the responses observed suggest the potential for increases in heather beetle attack, late spring frost damage, and possibly plant water stress. Thus the experimental results at this stage offer some empirical support for the proposed critical load value.