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# Ecosystem-scale trade-offs between impacts of ozone and reactive nitrogen

Ed Rowe (1), Felicity Hayes (1), Kasia Sawicka (1), Gina Mills (1), Laurence Jones (1), Filip Moldan (2), Bassin Sereina (3), Netty van Dijk (4), and Chris Evans (1)

(1) Centre for Ecology and Hydrology, Bangor, UK (ecro@ceh.ac.uk), (2) IVL Swedish Environmental Research Institute, Gothenburg, Sweden (Filip.Moldan@ivl.se), (3) Agroscope, Cadenazzo, Switzerland (seraina.bassin@agroscope.admin.ch), (4) Centre for Ecology and Hydrology, Edinburgh, UK (nvd@ceh.ac.uk)

Nitrogen (N) deposition stimulates plant productivity in many terrestrial ecosystems. This is clearly beneficial for production agriculture and forestry, but increased litterfall and decreased ground-level light availability reduce the suitability of habitats for many biota (Jones et al., 2014). This mechanism (Hautier et al., 2009), together with the acidifying effects of N (Stevens et al., 2010), has caused considerable biodiversity loss at global scale. Ozone, by contrast, has the effect of reducing plant production, and a simple assessment would suggest that this might mitigate the effects of N pollution. We explored the interactions between ozone and nitrogen at mechanistic level using a version of the MADOC model (Rowe et al., 2014) modified to include effects of ozone. The model was tested against data from long-term monitoring and experimental sites with a focus on nitrogen and/or ozone effects. Effects on biodiversity were assessed by coupling the MADOC model to the MultiMOVE plant species model. We used this model-chain to explore trade-offs and synergies between the impacts of nitrogen and ozone on biodiversity and ecosystem biogeochemistry.

In a review of the effects of ozone on ecosystem processes, two consistent effects were found: decreased net primary production due to damage to photosynthetic mechanisms; and an increase in litter nitrogen apparently caused by interference of ozone with the retranslocation process (Mills, in prep.). Insufficient evidence was found to justify inclusion of posited interactive mechanisms such as increased ozone susceptibility with greater nitrogen supply. However, the MADOC model illustrated emergent ozone-nitrogen interactions at ecosystem scale, for example an increase in N leaching due to decreased plant demand and greater litter N content. Empirical evidence for interactive effects of nitrogen and ozone at ecosystem scale is severely lacking, but simulated results were consistent with soil and soil solution observations from long-term experiments with N addition (bog at Whim Moss and coniferous forest at Gårdsjön) and ozone treatments (alpine grassland at Alp Flix).

Effects of N pollution on biodiversity were well illustrated by the model chain. Acidification and eutrophication both tended to have negative effects on “positive indicator” species i.e. those that are distinctive for particular habitats, and neutral or positive effects on more ubiquitous species. Simulations suggested that ozone is likely to have beneficial effects on these distinctive species, principally because of decreased productivity. However, this may not occur in reality since responses of individual species to ozone vary considerably, and are not currently included in the model chain. We identify knowledge gaps which would be a useful focus for future experimental studies and surveys. Using relatively simple models of ecosystem biogeochemistry and species responses, together with an awareness of where simplifications might lead to unreliable conclusions, can help clarify research questions to be addressed in experimental studies.

Hautier, Y. et al. 2009. Science 324, 636-638.
Jones, L. et al. 2014. Ecosystem Services 7, 76–88.
Mills, G. et al. in prep. Environmental Pollution.
Rowe, E.C. et al. 2014. Environmental Pollution 184, 271-282.
Stevens, C.J. et al. 2010. Functional Ecology 24, 478-484.