

Nitrogen shares in global environmental impacts and crop production

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Abstract

The increased use of nitrogen (N) fertilizer and emissions of reactive N compounds (Nr) from agriculture, food consumption and combustion of fossil fuels, constitute one of the largest global environmental problems. The N-shares in world regions for impacts of ambient air pollution and human health range between 5 and 60%, for impacts on terrestrial biodiversity between 1 and 17% and on global warming around 2-3%. However, Nr use in fertilizer is also a major factor for increased crop productivity, with N-shares ranging between 10 and 55% for major food crops in world regions.

Keywords: fertilizer, air pollution, biodiversity

Disclaimer: Some results are preliminary

1. Introduction

Nr impacts human wellbeing and ecosystems in many ways. The contribution of the Nr load to impacts - the N-share - is a useful metric to communicate the relevance of N pollution and mitigation (Erisman et al., 2013).

2. N shares per end point

2.1 Human health

N-shares in mortality due to particulate matter (PM) and surface ozone were quantified by model perturbation on GeoChem TM5-FASST. The global N-share in premature deaths by AAP in 2015 was 20%. The global N-share in

mortality by PM_{2.5} in 2013 was 46%, ranging from 8% in Africa to 54% in the European Union; the global N-share by surface ozone was 39%, ranging between 18 % in Africa and 45% in Asia.

2.2 Natural ecosystems

The N-share for the global loss of terrestrial biodiversity in 2015 was determined by the GLOBIO model at 7%, ranging from 1% in central Asia, to 17% in Central Africa. The N impacts on coastal and marine ecosystem services were determined from aquatic meta-analysis studies.

2.3 Crop production

Long-term response of crop yield to synthetic N fertilizers, when soil N is in near steady with N input, is different from when derived from annual field trials. Long-term N-shares for synthetic N fertilizers in global maize, wheat and rice were estimated with the NBCalCer model. The weighted mean was 47%, ranging from 23% in Africa to 63% in Eastern Europe.

2.4 Global warming

The N₂O-share in the global warming potential is around 6%. In addition there is CO₂ release due to NO_x induced O₃ exposure, reducing net primary production (NPP) while inversely there is CO₂ uptake due to increased NPP in response to N deposition from NO_x and NH₃ emissions. The share of N-deposition in global carbon sequestration in forest in 10-20%. Net cooling effects compensate the warming effect of N₂O by 60%, implying an N share of 2-3% only.

3. Conclusion

N-shares confirm that Nr is a major global pollutant. Combining N-shares with analysis of exceedance of N impact thresholds and with cost-benefit analysis is useful to set priorities in environmental policy and to design integrated N policies (Fig.1).

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References

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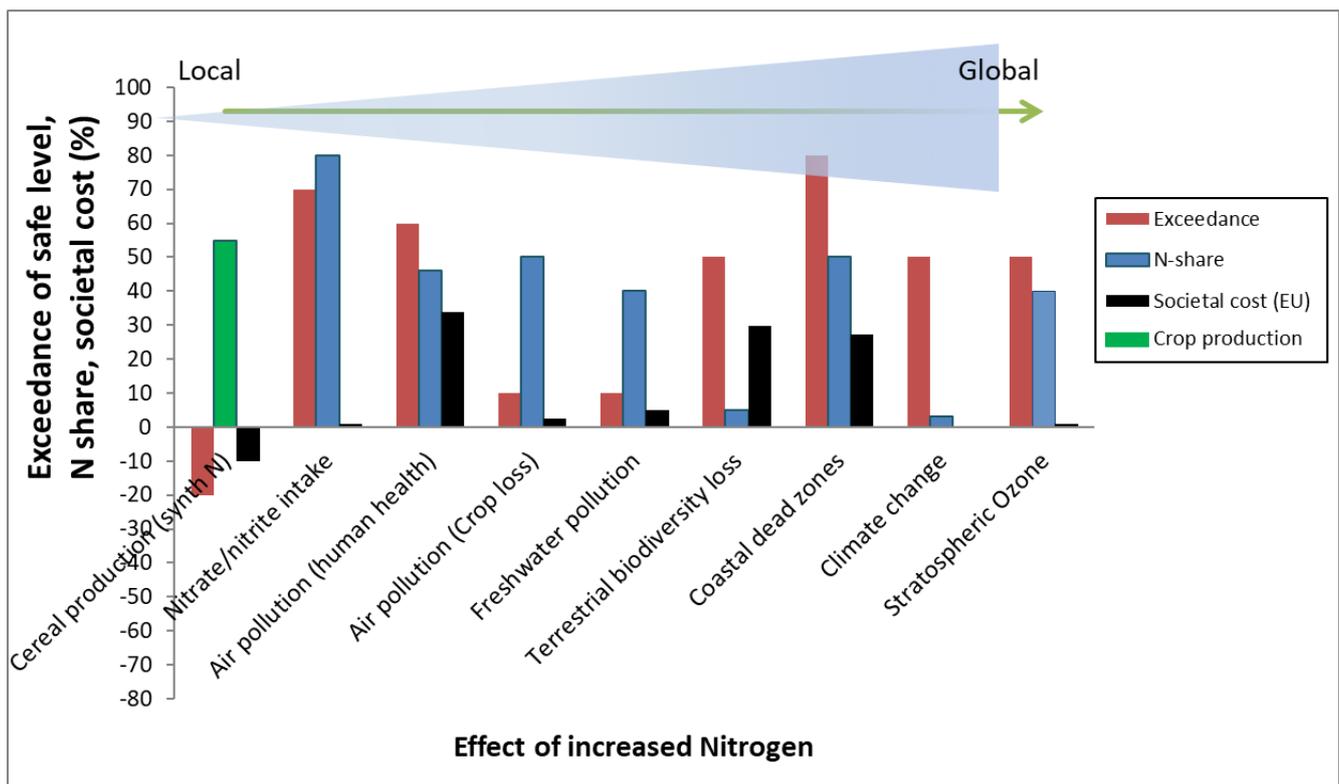


Fig. 1: Overview of the state of impacts of Nr from local to global scale. Exceedance of thresholds (red bars), N-shares of impacts (blue bars) and cereal production (green bar; and EU data). Negative exceedance for cereals is undershoot of farm Economic Optimum N fertilizer rate (here for wheat). Complemented with share of N impact in total societal cost of N pollution (black bars); using EU cost data (total cost about € 300 billion/yr). For crops negative cost is farm gate value of cereal production.