Trends in nitrogen induced costs due to impacts on human health, climate and ecosystems in Europe between 1990 and 2015

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Abstract

This review paper illustrates the various impacts and interactions of inputs of reactive nitrogen on human health, climate and terrestrial and aquatic ecosystems in Europe, through impacts on air quality, greenhouse gases, soil quality and water quality. It focuses on a quantification of trends in threats, in terms of exceedances of critical thresholds, during the period 1990-2015. A cost-benefit analysis shows that environmental costs of reactive N release to the environment are substantial and tend to exceed the direct economic benefits for agriculture during this period. This provides a strong support for European N policies and stricter N emission targets.

Keywords: air pollution, aquatic ecosystems, biodiversity, forest vitality, human health, nitrogen, terrestrial ecosystems, soil quality, water quality

1. Quantifying trends in nitrogen use and nitrogen impacts

We made an overview of trends in nitrogen use and its potential impacts on human health, climate and ecosystems in Europe between 1990 and 2015 on the basis of inventory data, monitoring systems and model applications. We thus assessed changes in: (i) nitrogen (N) application by fertilizer and manure, (ii) emissions of nitrogen oxides (NO_x) and ammonia (NH_3), (iii) concentrations of NO_x, NH_3, ozone and particulate matter and their exceedances of limit/target levels in view of impacts on human health (iv) global warming

potential by the N induced emission of nitrous oxide and sequestration of CO_2, (v) deposition levels for N and acidity and their exceedances of critical levels in view of impacts on terrestrial ecosystems (vi) nitrate concentrations in ground water and N concentrations in surface water impacts and their exceedances of critical levels in view of impact on human health (ground water) and aquatic ecosystems (surface water) and on (vii) eutrophication ratio of various coastal waters.

2. Trends in external costs for N pollution

The economic value of N-damage was based on 'Willingness to Pay' of citizens to prevent premature death and loss of health, to prevent degradation of ecosystems or restore ecosystems, or to reduce greenhouse gas emissions after Van Grinsven et al. (2013). The estimated total damage costs of Nr decreased from €320 billion in 1990, to €265 billion in 2000, to €220 billion in 2010. The cost share of total impacts to human health is 46%, to ecosystems 56%, while the net impact on global warming is not significant (-2%); warming impacts of N2O are cancelled out by cooling impacts of N containing aerosols and N driven carbon sequestration (Figure 1).

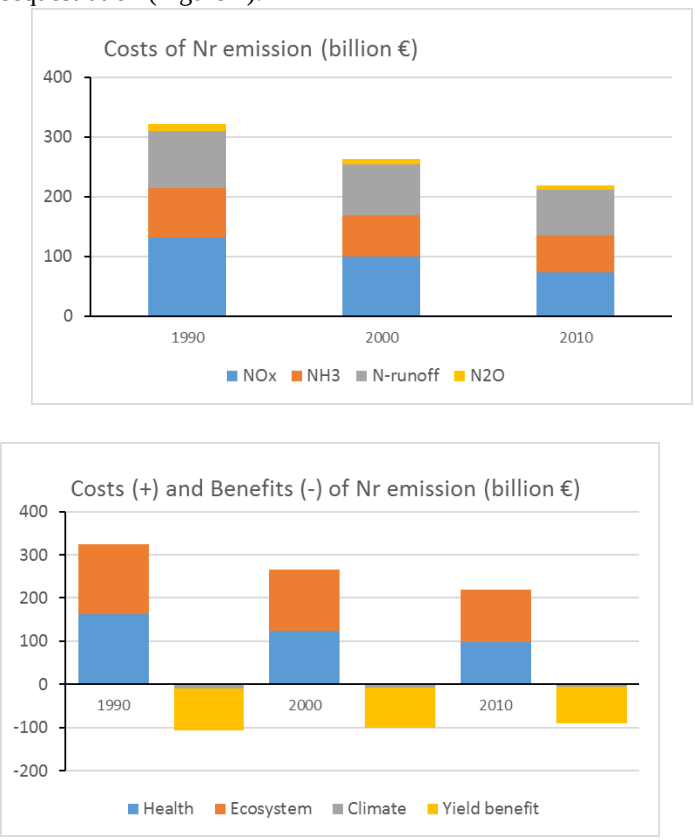

Figure 1 External cost of N pollution for various N components (top) and for various impacts and benefits for crop and wood production (bottom) for 1990, 2000 and 2010, using time-constant unit damage costs.

Net Nr benefits for crops and wood remained constant at €95 billion; the yield decrease by reduced N fertilization was compensated by the decrease of ozone damage These results provide a strong support for European N policies and stricter N emission targets, both for NOx and NH_3.

References

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