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Costs and benefits of nitrogen in the European environment

Note from the Co-chairs of the Task Force on Reactive Nitrogen

Key points

1. As part of the work of the Task Force on Reactive Nitrogen, substantial progress has been made in linking different reactive nitrogen (N_r) threats under the European Nitrogen Assessment (ENA), which is due to be published in 2011.
2. The ENA chapter on costs and benefits of has highlighted how the damage costs of N_r are substantially in excess of typical mitigation costs, providing important support for the policies in further control of N_r pollutants. In particular, the largest estimated damage costs are associated with NO_x and NH_3 emissions, with rather smaller damage costs associated with nitrate leaching and N_2O emissions. These findings identify the need to give further attention to reducing NO_x and NH_3 emissions.
3. Although the costings are focused on the EU-27, the principles can be expected to apply widely across the UNECE region.
4. This note shows:
    a. The Executive Summary of the ENA chapter on Costs and Benefits.
    b. A key table on the estimated damage costs, expressed as euro per kg Nr from the ENA chapter
    c. A graph of the overall damage costs of Nr in the EU-27, from the ENA chapter, including low and high estimates based on estimated uncertainties.

Executive Summary of ENA Chapter on Costs and benefits of Reactive Nitrogen

5. The executive summary is taken from the ENA chapter 22, Brink et al. (2011),

Nature of the Problem

a. Single issue policies have been an effective means of reducing reactive nitrogen (N_r) emissions in the EU, but to make further reductions more integrated approaches are required.

Approaches

b. This chapter shows how Cost-Benefit Analysis (CBA) can provide guidance for the setting of new policy priorities for the abatement of the European N_r emissions from an integrated perspective.
c. Data on costs and benefits of N_r-abatement, including four national and regional case studies, are reviewed and made comparable by expression in euro per kg of added N_r (agriculture) or kg of reduced N_r emission (unit cost approach).

d. Social cost estimates are based on Willingness to Pay (WTP) for human life or health, for ecosystem services and greenhouse gas (GHG) emission reduction.

Key findings

e. The total annual N_r-related damage in EU27 ranges between 70 and 320 billion Euro, equivalent to 150-750 euro/capita, of which about 75% is related to health damage and air pollution. This damage cost constitutes 1-4% of the average European income.
f. Inferred social costs of health impacts from NO_x are highest (10-30 euro per kg of pollutant-N_r emission). Health costs from secondary ammonium particles (2-20 euro/kg N), from GHG balance effects of N_2O (5-15 euro/kg N), from ecosystem impacts via N-runoff (5-20 euro/kg N) and by N-deposition (2-10 euro/kg N) are intermediate. Costs of health impacts from NO_3 in drinking water (0-4 euro/kg N) and by N_2O via stratospheric ozone depletion (1-3 euro/kg N) are estimated to be low.
g. The social benefit of N_r for the farmer ranges between 1 and 3 euro per kg added N-fertilizer equivalent. Internalizing the environmental costs of N-fertilization would lower the optimal N-rate for arable production in North-West Europe by about 50 kg/ha.

Uncertainties

h. Major uncertainties in our approach are dose-response relationships and poor comparability of WTP studies. Also it is often not simple to identify the N_r-share in adverse impacts and in abatement measures.

Recommendations

i. The CBA results presented provide support for the present focus of EU and UNECE N-policies on air pollution and human health, and on reducing ammonia emissions from agriculture; the social benefits of abatement tend to exceed the additional costs.
j. Although options are attractive that offer simultaneous reductions of all N pollutants, the CBA points to the need to prioritize NO_x and NH_3 abatement over the abatement of N_2O emissions. Social cost of potential increases in emissions of N_2O and nitrate, when enforcing low ammonia emission techniques, are overwhelmed by the social benefits of decreased NH_3-emission.

Tabular and Graphical Summary of Results

6. The following Table summarizes the social damage costs as Euro per kg N_r. Note that as the total amounts of the different N_r forms are very different (i.e. much smaller for N_2O, see the Table), the total damage costs are much smaller for N_2O than the other N_r pollutants.
7. Accounting for the impacts of the emissions in 2000 of N_2O, NO_x, NH_3 to air and N to water, the total annual N-damage in the EU27 ranges between 70 and 320 billion Euro. This corresponds to a welfare loss of 150-750 euro per capita, which is in turn equivalent to 0.8 to 3.9% of the average disposable per capita income in the EU27 in 2000 (www.epp.eurostat.ec.europa.eu). About 60% of these damage costs are related to human health, 35% to ecosystem health and 5% to the effects on the greenhouse gas balance.

Ongoing work

8. There remain significant uncertainties in the current estimates of costs of ammonia mitigation as included in the GAINS model. The view of some experts in the Task Force on Reactive Nitrogen is that the actual costs may in many cases be smaller than currently estimated. To review these issues, the Task Force is holding an Expert Workshop and

additional Task Force meeting (TFRN-6) on the "Costs of Ammonia Mitigation and the Climate Co-benefits" (25-27 October 2010, Paris) (http://www.clrtap-tfrn.org/node/94) the results of which will be reported to WGSR-48.

Table 1 Emissions of N_r in EU27 and estimated ranges of unit damage costs for the major N_r pollutants and, between brackets, single values inferred from studies used in this assessment.

	Emission-EU27[a]		Health	Ecosystem	Climate	Total
	Tg N_r	% agric	euro/kg N_r	euro/kg N_r	euro/kg Nr	euro/kg N_r
N_r to water	4.9	60	0-4 (1[b])	5-20 (12[d])		5-24 (13)
NH_3-N to air	3.5	80	2-20 (12[c])	2-10 (2[e])		4-30 (14)
NO_x -N to air	3.4	10	10-30 (18[c])	2-10 (2[e])		12-40 (20)
N_2O-N to air	0.8	40	1-3 (2[f])		5-15 (9[g])	6-18 (11)

a) EU27 Emissions for year 2000 based on various sources (a.o. EMEP, MITERRA)

b) Health damage from nitrate in groundwater based drinking water based on Grinsven *et al.* (2010). Lower limit for unit damage costs for health impacts of NO_3 (colon cancer)

c) Based on unit damage costs damage for airborne NO_x (20 euro/ kg N_r) and NH_3 (12 euro/kg N_r) from ExternE (2005) after conversion of results per mass of pollutant to mass of N_r in pollutant. Range arbitrarily set at ± 10 euro/ kg N_r for both NO_x and NH_3. With respect to NH_3 the lower bound reflects the present debate over the importance of health impacts from ammonium in airborne particlulate matter.

d) Upper bound based on WTP for a 'healthy Baltic' from study of Söderqvist and Hasselström (2008) and assumption in Gren *et al*. (2008) that damage can be repaired by 50% reduction of N-load to Baltic Sea. Lower bound arbitrarily set at 25% of upper bound.

e) Ecosystem damage by deposition of NH_3 and NO_x on terrestrial ecosystem. Lower bound based on the EU NEEDS project (Ott, 2006) representing the cost for restoring biodiversity loss due to N_r. Upper bound arbitrarily set at 5 times lower bound as a possible value when using an ecosystem service approach (uncertain share of N_r).

f) Increased incidence of skin cancers and cataracts from depletion of stratospheric ozone. Unit damage cost is inferred from a global LCA study by Struijs *et al.* (2010).

g) Climate damage based on contribution of N_2O-N to greenhouse gas balance and CO_2-price. Uncertainty range based on variation of CO_2-price since 2005 between 10 and 30 euro/t.

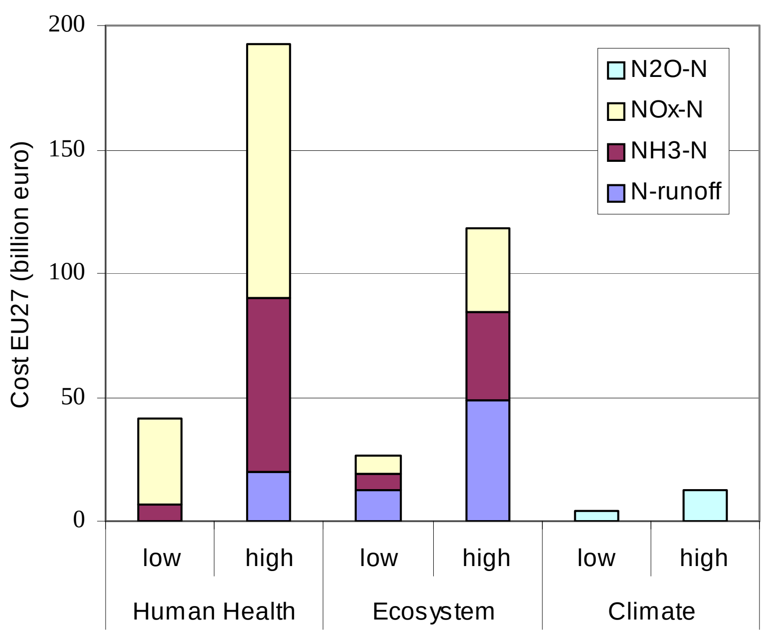

Fig. 1 Low and high estimates of total social damage in EU27 as a result of environmental N-emissions in 2000.

References

Brink, Corjan, Hans van Grinsven, Brian H. Jacobsen, Ari Rabl, Ing-Marie Gren, Mike Holland, Zbigniew Klimont, Kevin Hicks, Roy Brouwer, Roald Dickens, Jaap Willems, Mette Termansen, Gerard Velthof, Rob Alkemade, Mark van Oorschot and J Webb (2011) Costs and benefits of nitrogen in the environment. In: *The European Nitrogen Assessment.* (ed. M.A. Sutton, C.M. Howard, J.W. Erisman, G. Billen, A. Bleeker, P. Grennfelt, H. van Grinsven and B. Grizzetti), Cambridge University Press (in press)

Grinsven H.J.M. van, Rabl A., de Kok T.M., Grizzetti B. (2010). Estimation of incidence and social cost of colon cancer due to nitrate in drinking water in the EU: a tentative cost-benefit assessment. *Environmental Health* (in press).

Gren, I.-M., Jonzon, Y., Lindqvist, M,. (2008). Costs of nutrient reductions to the Baltic Sea – Technical report. Working paper 2008:1. Department of Economics, SLU, Uppsala.

Ott, W., Baur M., Kaufmann Y., Frishknecht R., Steiner R., (2006). Assessment of biodiversity losses. Deliverable D4.2.-RS 1b/WP4 – July 06. NEEDS (New Energy Externalities Developments and Sustainability). Project nr. 502678. Switzerland.

Struijs, J., Van Dijk, A., Slaper, H., Van Wijnen, H.J., Velders, G.J.M., Chaplin, G., Huijbregts, M.A.J., (2010). Spatial- and time-explicit human damage modeling of ozone depleting substances in life cycle impact assessment *Environmental Science and Technology*, 44, 204-209.