WORKSHOP ON INTEGRATED MODELLING OF NITROGEN

Report by the Chair of the Task Force on Integrated Assessment Modelling in co-operation with the organizers of the workshop

1. The workshop on the integrated modelling of nitrogen took place from 28 to 30 November 2007 in Laxenburg, Austria, in accordance with the Executive Body's 2007 work plan. It was organized by the Task Force on Integrated Assessment Modelling, the COST Action

729 and the “Research network programme Nitrogen in Europe” (NinE) of the European Science Foundation. The International Institute for Applied Systems Analysis (IIASA) hosted the meeting.

2. Eighty-two experts attended the workshop. The following Parties to the Convention were represented: Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Serbia, Slovak Republic, Spain, Sweden, and the United Kingdom of Great Britain and Northern Ireland; and the European community (EC). Also present were representatives of the International Cooperative Programmes (ICP) of the Working Group on Effects on Waters, on Integrated Monitoring, and on Modelling and Mapping, the Coordination Centre for Effects (CCE), the Centre for Integrated Assessment Modelling (CIAM) and the Meteorological Synthesizing Centre-West (MSC-W) of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), the Expert Group on Techno-economic Issues, the European Environment Agency (EEA), the European Commission and its Joint Research Centre (JRC), the European Environmental Bureau (EEB), the European Fertilizer Manufacturers Association (EFMA) and the Oil Companies’ European Organization for Environment, Health and Safety in Refining and Distribution (CONCAWE). A member of the secretariat also attended.

3. Mr. R. Maas (Netherlands), Mr. M. Amann (Austria), Mr. J. W. Erisman (Netherlands), Mr. M. Sutton (United Kingdom) and Mr. J. Sliggers (Netherlands) chaired the meeting.

I. AIMS OF THE WORKSHOP

4. The objectives of the workshop were to:

(a) explore the possibilities for a holistic approach of nitrogen;
(b) design the framework that was needed for such an approach;
(c) review the integrated assessment modelling approaches that were available to include nitrogen;
(d) define necessary future developments;
(e) prepare a proposal for a possible integrated nitrogen approach within the review and possible revision of the 1999 Gothenburg Protocol.

5. Mr. L. Hordijk welcomed the participants on behalf of IIASA. During the workshop several models were presented, that covered the European, the national or the regional scale[1].

[1] Presentations can be found on www.iiasa.ac.at/rains/meetings/IAM_Nitrogen/IAM_Nitrogen.html

II. CONCLUSIONS

A. Nitrogen related policies

6. In several policy areas nitrogen plays an important role. Especially in biodiversity policy, climate change policy, air pollution policy, surface water and groundwater policy and marine policy the losses of nitrogen to the environment in its different forms are getting attention. In agricultural policy the availability of nitrogen is important to produce food or biomass. The coherence and consistency of the policy actions involved are points of concern as the awareness of the nitrogen flow across the societal and natural system seems often insufficient. Policy decisions at all levels for different forms of reactive nitrogen (ammonia, nitrogen oxides, nitrous oxide and nitrates) are quite often stand alone decisions. This causes the risk of swapping nitrogen in potentially more harmful directions. The workshop noted the need for an integrated approach to manage reactive nitrogen and make full use of existing tools.

7. Nitrogen is linked with several environmental problems. Nitrate is a threat for drinking water and could lead to algae bloom and ‘dead zones’ in coastal seas. Nitrous oxide contributes to global warming. Nitrogen oxides in air causes ozone formation and together with ammonia is contributes to exposure of the population to fine particles and the exceedance of critical loads for ecosystems. The latter will eventually lead to a loss of biodiversity: e.g. blueberries, heather and rare forest flowers being replaced by grasses and nettle, which could also reduce the diversity of butterflies, birds and mammals in nature areas, as well as the stability and economic value of ecosystems functions.

8. The workshop took note of nitrogen related work under the Working Group on Effects of the Convention as well as the upcoming European Nitrogen Assessment (ENA) and many international activities related to nitrogen such as the Nitro Europe Integrated Project under the sixth framework programme, Cost Action 729, the European Science Foundation’s (ESF) Nitrogen in Europe Programme (NinE) and the global Integrated Nitrogen Initiative (INI). It was noted that effect based policies for air, water and climate could benefit from an integrated approach. Such an approach could improve the consistency and cost-effectiveness for the different policies. There appear to be several possibilities for synergy, but also trade offs, e.g between policies aimed at nitrates (in groundwater and seas), ammonia and nitrous oxides.

9. The workshop was informed that the Thematic Strategy on Air Pollution, launched by the European Commission in September 2005, also addresses the need for a coherent and integrated approach to nitrogen management. The revision of the National Emission Ceilings Directive (NECD) will respect this need and furthermore, priority will be attached to measures and policies to reduce “excessive” nitrogen use in agriculture and which simultaneously address nitrates in

water, and ammonia and nitrous oxide emissions to air[2].

B. Availability of data

10. Science can improve the linkages between policy areas by providing consistent data. The consistency in nitrogen data can be improved via nitrogen budget calculations at different scales. Such budget (or balance) calculations can show how the input of nitrogen in the economy is transformed into reactive forms of nitrogen, what sectors contribute to the nitrogen losses to the environment and how certain policy measures will influence the flow of nitrogen. The workshop noted that budget calculations can also prove to be a powerful communication tool for decision takers both at (inter)national level and regional level. Even at farm level it could contribute to the awareness of farmers of the losses of nitrogen and promote a more efficient use of nitrogen by getting the right amount of ammonia at the right place at the right time.

11. For several countries or regions nitrogen budget calculations have been made. There is however a need for harmonizing the methodology.

12. Nitrogen budget calculations can be a good method to detect weaknesses in activity data and in nitrogen emission estimates. Preliminary results indicate that especially the nitrous oxide emissions data (from soils, wetlands and aquatic systems) show gaps. Nitrogen budget calculations for Germany show that reactive nitrogen losses consist of roughly 40% of nitrate emissions to water and of 30% of ammonia emissions, 25% of nitrogen oxides emissions and 5% of nitrous oxide emissions to air. Agriculture contributes almost 60% to the total reactive nitrogen losses. Industry, energy production, transport (including ships) and waste treatment are also significant. Almost 10% of the total nitrogen balance could not be accounted for.

C. Integrated nitrogen modelling

13. Current assessment models usually address only single effects of nitrogen and don't take always into account costs. Assessment models need to be broadened to address the multiple effects of nitrogen simultaneously and to deliver fully cost-effective policy advice while decreasing the risk of pollutant swapping. Assessments with agricultural models show that structural changes in human diets, livestock numbers, animal feed and mineral use can reduce all types of nitrogen loss at the same time.

14. Different forms of reactive nitrogen lead to different environmental impacts at different timescales and at different geographical scales. An effect based approach including dynamic modelling is required to consider the cascading effects of nitrogen in an appropriate way. In

[2] http://ec.europa.eu/environment/air/cafe/activities/ammonia_en.htm

addition substantial work is needed to better quantify the environmental damage of different forms of nitrogen and to determine which policy measures should have priority.

15. The workshop noted that it is doubtful whether a single comprehensive optimization model is useful, feasible or explainable. It seemed more useful to be able to clarify the trade offs and potential synergies between policy choices. This would not require a new comprehensive optimization model, but could be done by linking existing models. The workshop noted that there was a need to make environmental constraints for different timescales and geographical scales comparable. E.g. national targets for the emissions of nitrous oxide and ammonia could be translated into regional targets in order to improve its coherence with regional constraints for nitrates in groundwater and regional targets for biodiversity.

16. The nitrogen cycle is interconnected with other biogeochemical cycles such as the carbon, the phosphorus, the sulphur and the water cycle. Changes in other cycles will affect the nitrogen cycle. All cycles will influence biodiversity.

17. At the European level existing models for the projection of agricultural production, future land use,, air pollution, water pollution and biodiversity impacts can be linked. This could enable the analysis of the consequences of European strategies such as the reform of the Common Agricultural Policy and the production of biofuels for the losses of nitrogen and its impacts on biodiversity, climate change and health. The first steps in linking models have been made, e.g. via the EC4MACS framework, the CAPRI-DNDC framework, the FATE modelling framework and the Eururalis framework (acronyms to be spelled out..). Further improvements still have to be made in order to guarantee consistency. The workshop noted results of such linked models indicating that the use of rapeseed as a biofuel would increase emissions of nitrous oxide and lead to a net increase in greenhouse gas emissions. Biomass production will require additional inputs of nitrogen and this could lead to a loss of biodiversity. Linkages with the Global Trade Analysis Project model (GTAP) indicate that increased demand of biofuels in Europe would increase deforestation and biodiversity loss in especially Brazil. Also the influence on food prices is a reason for concern.

18. It is currently possible to add restrictions for nitrous oxide emissions and nitrate leaching to the GAINS model in order to optimize national emission ceilings for ammonia and nitrogen oxides without violating decisions taken in the framework of climate policy and water policy.

19. It would be possible to use air quality policy scenarios for nitrogen deposition and nitrate leaching from nature areas in water quality models for river catchments areas and coastal waters.

20. Biogeochemical models, such as those developed in Sweden, Netherlands and Germany, are capable to simulate regional nitrogen turnover. Linked with biodiversity models it appears possible to assess long-term impacts of nitrogen in forest ecosystems, as well as the effects of

whole tree harvesting which is becoming a current practice in order to increase the use of biomass in power generation. Monitoring is needed to complete the knowledge on the nitrogen balance in order to further improve these assessments.

21. The workshop acknowledged the need for regional and landscape scale assessments of the various nitrogen impacts. Such models could take into account the sensitivity of Natura 2000 areas, the protection of vulnerable groundwater layers and the contribution to the water quality of river basins and coastal zones. Regional assessments could show the trade offs between these impact indicators and the economic indicators such as soil productivity, food production costs and agricultural employment. Though it was deemed sensible to keep the use of these more detailed regional models for national purposes, the European scale work could benefit from the findings of such assessments.

22. It is possible to optimize nitrogen use at the farm or regional and landscape level, once constraints for the various types of nitrogen losses are translated to these levels. Further analysis is required to show whether a regional cap on the total loss of nitrogen could be used instead of specific caps for ammonia or nitrate losses, without unacceptable effects for health, biodiversity or climate. Such a total cap might improve the cost-effectiveness of environmental policy. The workshop noted that the different types of reactive nitrogen are not completely interchangeable, that aquifers and river basins not always necessarily match with regions and that for an optimal result each cap should have an ‘owner’ which could be difficult to achieve at a regional level..

23. In order to find the right answer to certain policy questions complex models could be needed. The challenge is to simplify as much as possible the relationship between inputs and outputs of models and to use these simplified presentation for policy analyses while maintaining complex approaches for scientific review. The Nitrogen Visualisation Tool can be seen as a good practice for communicating complex modelling systems in a comprehensible way to policy makers[3].

24. The critical load concept, which was instrumental for the effect based approach under the Convention, needs to address specific policy relevant nitrogen effects to biodiversity. The importance of knowledge of nitrogen effects to biodiversity is acknowledged in the work plan of the Working Group on Effects.

[3] www.initrogen.org/visualization

III. RECOMMENDATIONS FOR FUTURE WORK

25. The workshop recommends the proposed task force on Reactive Nitrogen to identify the timing and information requirements of the various policy processes; to raise awareness of the linkages between them and to give practical advice on how the policy consistency can be improved. Integrated nitrogen modelling should not be seen as the prime goal, but as a means to solve policy problems in a more cost-effective way. A firm link with environmental policy problems as well as economic concerns (better regulation, use of economic instruments) should remain the focus of attention.

26. Modellers should carry on developing modelling tools for an integrated approach at various spatial and temporal scales, with a stronger incorporation of costs, validate them and proactively communicate their usefulness to policymakers.

27. Better data are required to improve the quality of models. Nitrogen budget calculations can prove to be an important means to better underpin the reliability and consistency of emission data. The proposed task force on reactive nitrogen is therefore recommended to develop a common methodology for nitrogen budget calculations. Findings that er relevant for the quality of emission estimates could be reflected in the work on emission inventories under the Convention. The proposed task force could be requested to list the pros and cons of integrating nitrogen budget calculations in the reporting requirements of the Convention.

28. Integrated assessment modellers of the Convention are recommended to review the feasibility and usefulness of linking models as to incorporate policy decisions for water pollution, greenhouse gas reduction, biomass production and revision of the European agricultural policy in its analyses. An operational combination of existing models may be more efficient than the development of new comprehensive models.

29. European biodiversity indicators used in the SEBI2010 programme include indicators developed under the Working Group of Effects. Effects modellers of the Convention are recommended to continue the collaboration with SEBI 2010 in developing persuasive nitrogen relevant impact indicators for natural and, to the extend possible, non-natural areas, as appropriate, under the work plan of the Working Group.

30. The proposed task force on reactive nitrogen is recommended to evaluate measures and instruments and recommend how different nitrogen related environmental targets can be efficiently met in an integrated way. It is recommended that the task force adopts an effect based approach to identify synergies and antagonisms between policy measures and related environmental targets. It is also recommended - in co-operation with agricultural economists - to

identify the trade offs between environmental targets and economic goals such as agricultural production costs.

31. The proposed task force should make use of existing work by the Working Group on Effects and the EMEP Steering Body.

32. Further study could be done by policy analysts to determine the effects of various sequences in policy decisions on the overall cost-effectiveness of nitrogen related policies. Currently it is not clear whether and when global constraints for nitrous oxides should be determined first, or regional constraints for nitrates leaching or ammonia emissions should be considered as mitigation priorities.
