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Item 6 (b) of the provisional agenda
Progress in activities in 2014 and future work: integrated assessment modelling

Integrated assessment modelling

Report by the co-Chairs of the Task Force on Integrated Assessment Modelling

Summary

The present report describes the results of the forty-third session of Task Force on Integrated Assessment Modelling under the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (Helsinki, 6–7 May 2014). The report provides an overview of recent changes in the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model and results of scenario analyses, as well as the exchange of national and international experiences with integrated assessment modelling, in accordance with the Task Force mandate set out in the 2014–2015 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR.122/Add.2, items 1.5.1, 1.5.2, 1.5.4, 1.5.6–1.5.8) and the Long-term Strategy for the Convention (ECE/EB.AIR/106/Add.1).

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I. Introduction

1. The present report describes the results of the forty-third session of Task Force on Integrated Assessment Modelling under the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), held in Helsinki on 6 and 7 May 2014.[1]

A. Attendance

2. Thirty-six experts from the following Parties to the Convention on Long-range Transboundary Air Pollution attended the meeting: Belarus, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Norway, Portugal, Sweden, Switzerland and United Kingdom of Great Britain and Northern Ireland. Experts from Croatia and Spain participated via web conferencing. In addition, the EMEP Centre for Integrated Assessment Modelling (CIAM), the Expert Group on Techno-Economic Issues (EGTEI), the European Environment Bureau (EEB), the oil companies' European association for environment, health and safety in refining and distribution (CONCAWE) and the European Commission (EC) were represented.

B. Organization of work and objectives of the meeting

3. Mr. R. Maas (Netherlands) and Mr. S. Åström (Sweden) chaired the Task Force meeting. Ms. L. Kauppi, Director General of the Finish Environmental Institute (SYKE), welcomed the Task Force to Helsinki.

4. The Task Force Chair opened the meeting and presented the latest developments under the Convention, and defined the objectives of the forty-third Task Force meeting, which were to review recent changes in the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model[2] and results of scenario analyses, as well as the exchange of national and international experiences with integrated assessment modelling.

II. Recent policy developments

5. A representative from the EC presented the latest information on its proposed new Clean Air Policy Package.[3] The Package included a proposal for a revised National Emission Ceilings (NEC) Directive,[4] a proposal for a directive on controlling emissions from medium-sized combustion plants and a proposal for ratifying the revised Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol). The main policy objective of the Package was to reduce by half the health impacts of air pollution by 2030. The analysis showed that in 2030 there would be substantial co-benefits between climate and air pollution policies. A reduction of European Union (EU)

[1] Presentations made during the meeting and the reports presented are available from http://www.iiasa.ac.at/web/home/research/researchPrograms/MitigationofAirPollutionandGreenhousegases/Integrated-Assessment.en.html.

[2] See http://gains.iiasa.ac.at/models/.

[3] See http://ec.europa.eu/environment/air/clean_air_policy.htm.

[4] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants

greenhouse gas emissions by 40 per cent would reduce air pollution control costs from €3.3 billion to €2.5 billion annually.

6. After adoption of the Package by the EC, the European Council was now analysing it. Bilateral meetings with experts from EU member States on input data to the GAINS model were ongoing and clarifications on specific topics (e.g., marine offsets) were being produced. In June 2014, the European Council was to have an orientation debate on the revised NEC Directive. The parliamentary work would start after the new European Parliament was in office. A rapporteur had already been nominated. Supplementary analysis might be needed via the Parliamentary Ex-ante Impact Assessment Committee.

7. In parallel, other policy initiatives were being pursued: the new Ecodesign Directive[5] implementing acts; the revision of the Non-road Mobile Machinery Directive[6] (including inland shipping); and the implementation of the Euro 6 emission standard.[7] For the new 2030 policy framework for climate and energy, the European Council had issued its conclusion of 20/21 March 2014.[8] Currently, the implications for EU member States were being analysed, and a final decision on the new framework was expected by October 2014.

III. Recent developments of the Greenhouse Gas and Air Pollution Interactions and Synergies model

8. A representative of CIAM presented an overview of the GAINS scenarios produced for the EC. The target of the scenarios was to reduce the health effects of air pollution, based on a comprehensive source allocation of population exposure to fine particulate matter ($PM_{2.5}$).

9. For the European air quality database (AirBase)[9] monitoring stations, the GAINS model enabled apportionment of observed $PM_{2.5}$ concentrations to natural sources, transboundary contributions, sources within the same city and from within the street canyon. In addition, the various economic sectors that contributed to those categories could be quantified.

10. That allocation, which provided the basis for the subsequent cost-effectiveness analysis, differed greatly over Europe, depending on emissions in neighbouring countries and topographic conditions.

11. The ambition level of the original proposal by EC had been based on the equilibrium between marginal costs and monetized marginal health benefits of emission abatement. The final EC proposal deviated from that theoretically optimum point in order to consider additional aspects.

12. At the EU level, a number of key measures in the following areas would achieve a large part of the proposed reduction (on top of baseline):

(a) *Industry and heating plants*:

(i) The proposed new medium-sized combustion plants directive;

[5] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.

[6] Directive 97/68/EC of the European Parliament and of the Council of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery, as amended.

[7] See http://ec.europa.eu/enterprise/sectors/automotive/environment/euro5/index_en.htm.

[8] Available from http://ec.europa.eu/clima/policies/2030/documentation_en.htm.

[9] See http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8.

(ii) Reducing emissions from some industrial sources to the lower range provided in the Best Available Techniques Reference Documents (BREFs);

(iii) Anaerobic digestion of industrial food waste (methane);

(b) *Households*: the new Ecodesign Directive (pellets for new boilers in single family houses);

(c) *Non-road mobile machinery*: Stage V for inland waterways (Selective Catalytic Reactor/Reaction (SCR)) and construction machinery;

(d) *Agriculture* (measures mainly affecting large farms (>300 animals)):

(i) Improved storage of manure, plus anaerobic digestion at large farms;

(ii) Improved application of manure on soil on large farms (ammonia);

(iii) Improved application of urea fertilizer or substitution by ammonium nitrate;

13. In regard to the last item, it was noted that a new report on agricultural measures would soon be delivered by CIAM.

14. The total cost of the suggested air pollution controls ranged between €2.5 and €3.3 billion per year, depending on the future climate policy. Cost savings from the proposed methane measures would balance part of those costs, so that net costs ranged between €0.9 and €1.5 billion per year.

15. The analysis clearly demonstrated that effective solutions to the particulate matter problem in Europe required international cooperation, due to the strong transboundary transport of particulate matter and its precursor emissions.

IV. Other work related to the Greenhouse Gas and Air Pollution Interactions and Synergies model

16. The Task Force noted with interest the CONCAWE efforts to develop the Strategic Model for Assessing Reduction Targets in the European Region (SMARTER) assessment tool.[10] SMARTER used the GAINS model cost curves and economic values on environmental and health impacts and enabled a fast sensitivity analysis, e.g., for different ambition levels, the inclusion of climate impacts in the optimization, or different weights for the toxicity of components of particulate matter.

17. The Task Force also noted the tool developed by EGTEI to quantify the implications of emission limit values specified in national legislation on total national emissions and to import them into the GAINS database, especially for countries in Eastern Europe, the Caucasus and Central Asia. Use of the tool had demonstrated that implementing the technical annexes of the revised Gothenburg Protocol would significantly reduce emissions in countries of Eastern Europe, the Caucasus and Central Asia.

18. The Task Force further noted the developments of the Forum for air quality modelling in Europe (FAIRMODE)[11] project, which aimed at harmonizing and promoting the use of models in support of national air pollution policy development. One of the project's striking findings was that currently air quality models used for national policy support were often not validated against measurements.

[10] See http://aeriseurope.com/software_smarter.html.

[11] See http://fairmode.jrc.ec.europa.eu/.

19. A representative of the EC Joint Research Centre presented recent developments of the "Integrated assessment for regional and local air quality policies" (APPRAISAL)[12] project, which had, among other things, identified that analysis of source appointment of emissions was important for local air quality management. Also, in local policymaking, it was found that the air quality models used were often poorly validated against measurements.

20. One of the final conclusions from another EU initiative, the recently finalized Linking Impact Assessment Instruments to Sustainability Expertise (LIAISE)[13] project, was that knowledge for policy support was often under-utilized. That was partly due to a lack of understanding among experts of the needs of policymakers and insufficient involvement of experts in the final stages of policymaking. The Convention was seen as a positive example in that regard, as trust building between scientists and policymakers was characteristic of the work undertaken within its framework.

21. The Task Force took note of the work in the "Socio Economic Implications for Individual Responses to Air Pollution policies in EU +27" (SEFIRA) project,[14] which aimed at integrating social sciences in integrated assessment of air quality policy. In SEFIRA, discrete choice experiments were used to identify key aspects determining the policy acceptability and probability for behavioural change, highlighting also the relevance of socioeconomic differences. The challenge addressed by the project was to use the policy acceptability weights in the GAINS optimization process in order to rank air quality measures on the basis of acceptability criteria.

22. The EMEP Meteorological Synthesizing Centre-West estimated the potential for further reductions of ambient $PM_{2.5}$ concentrations through further reduction of ammonia emissions. It had been found that additional efforts on ammonia beyond the Gothenburg Protocol reduction obligations would lead to significant further reductions of PM concentrations, and subsequently to positive health impacts, although the impacts would vary over Europe. The cost-effectiveness of ammonia emission reductions for reducing PM exposure would, however, also differ between regions.

23. The Task Force Chair presented the current developments within the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation). The Task Force requested ICP Vegetation to further assess the response of ozone fluxes towards further emission reductions in Europe and to compare them with declines in hemispheric background ozone.

24. The latest updates on the health benefits of reduced emission levels had been minor in terms of the impact on the cost-benefit analysis performed for EU air pollution policy. Additions suggested in the study on the World Health Organization's "Health risks of air pollution in Europe" (HRAPIE)[15] project included impacts on bronchitis in children. The most significant outcome of HRAPIE was the effect on mortality and morbidity from exposure to nitrogen dioxide concentrations, which was not included in the current update of health impact calculations performed for the EC, inter alia, because of the risk of double counting with the impacts of PM.

25. The Task Force noted the CIAM analysis on sustainable long-term levels of emissions. CIAM had explored the lowest level of emissions that could result from the maximum control efforts of measures that were currently considered in GAINS, including a stringent greenhouse gas emission reduction, healthy diets, ongoing concentration processes

[12] See http://www.appraisal-fp7.eu/site/index.php

[13] See http://www.peer.eu/projects/peer-flagship-projects/liaise/.

[14] See http://www.sefira-project.eu/ad/pagina-di-esempio/.

[15] See http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/health-risks-of-air-pollution-in-europe-hrapie-project.-new-emerging-risks-to-health-from-air-pollution-results-from-the-survey-of-experts.

in the agricultural sector and full application of all currently available emission control techniques. It had been found that, in general, residual health and ecosystems impacts of those emission levels, computed with the current GAINS parameterization, were below the confidence range of current impact assessment methodologies, especially when limitations from current model resolution were considered. Neither current policy trends, nor the emission levels of the revised Gothenburg Protocol, would be sufficient to meet those emission levels.

V. Benefits to biodiversity and ecosystem services

26. The Task Force took note of the results of the workshop on the valuation of air pollution damage to biodiversity and ecosystems (see annex) and noted recent developments within the "Effects of climate change on air pollution impacts and responses strategies for European ecosystems" (ECLAIRE) project.[16] Preliminary results for the EU as a whole suggested that monetized ozone impacts on ecosystem services could be substantial compared with monetized ozone impacts on health, crops and materials. For nitrogen, the ecosystem services approach, by focusing on the positive (short-term) impacts on forest growth and carbon sequestration, would capture negative impacts of excess nitrogen (e.g., on biodiversity) only to a limited extent. Different options had been explored to quantify the (stated or revealed) willingness to pay for biodiversity protection. Preliminary outcomes showed a substantial lower willingness to pay for nature than for health protection.

27. A representative of the United Kingdom presented the country-specific results of ECLAIRE work. Ozone had led to high damage to forest growth in Central Europe and even in Scandinavia. In order to extrapolate the findings from a United Kingdom study on the willingness to pay for biodiversity improvement to the European scale, additional assumptions had to be made on the income dependency of the values and the impact of the relative abundance of the available nature in a given country. The sensitivity for alternative assumptions also had to be assessed.

VI. National modelling experiences

28. The Task Force took note of the work on integrated assessment modelling in Belarus, and the current focus on supporting modelling with emission trend analysis. National data were now available for an update of CIAM estimates on the use of emission control in the transport sector of Belarus. The share of vehicles with recent Euro standards would be higher than currently assumed in GAINS. Cost-effective measures had been identified that would enable Belarus to achieve its ambition level in the revised Gothenburg Protocol.

29. Spain has recently developed the Atmospheric Evaluation and Research Integrated system for Spain (AERIS)[17] Iberian integrated assessment model. The Spanish expert presented the features of the model and cross model comparisons of environmental and health impacts calculated. One feature of the model was that it included ecosystem damages for five types of forests and nine different crops.

30. In Finland, much of the current work on integrated assessment modelling was focused on black carbon. That had resulted in a voluntary submission of a black carbon emission inventory to CEIP in February 2014. It was expected that the Arctic Council

[16] See http://www.eclaire-fp7.eu/.

[17] See Michel Vedrenne and others, "Advancements in the design and validation of an air pollution integrated assessment model for Spain", *Environmental Modelling and Software*, vol. 57 (July 2014), pp. 177–191. Available from http://www.sciencedirect.com/science/article/pii/S1364815214000802.

would recommend to start reporting emissions of black carbon and to define relevant actions. A number of important reference reports had been produced for different international bodies clarifying the current state of knowledge.

31. The Norwegian Environment Agency had proposed an action plan for Norwegian emissions of short-lived climate forcers.[18]

32. The expert from Portugal presented the method used in Portugal for developing the latest air pollution emission projections. The baseline showed higher volatile organic compounds (VOCs) and $PM_{2.5}$ emissions than in the GAINS baseline. Differences were mainly caused by differences in the vehicle fleet composition in the base year, the application of nitrogen fertilizer, domestic biomass burning and the inclusion of the Azores and Madeira in the GAINS data.

33. The Swedish expert gave an overview of the current integrated assessment modelling activities in Sweden, which were currently focused on policy support and research on synergies and conflicts between air pollution and climate change. Experiences from the bilateral consultation with CIAM showed that the main discrepancies found were the VOCs and nitrogen oxides emissions in 2005 from the transport sector.

34. In the Netherlands, the new NEC Directive proposal was being reviewed in a process to inform the parliament. The major differences between the Dutch assessment and the new proposal were in road transport (more diesel vehicles in GAINS, more kilometres driven with old cars in 2005) and inland shipping (increased energy intensity not taken into account). According to the Dutch assessment, nitrogen oxides abatement would be much more costly and the VOC emission reduction target was technically infeasible.

35. Integrated assessment modelling in the United Kingdom was being expanded to cover ozone and black carbon, and to encompass cost-benefit analysis. Developments included improvement of urban modelling to reflect traffic characteristics in relation to limit values, and more detailed work on $PM_{2.5}$ source apportionment, including new estimates of secondary organic aerosol. Particular attention was being paid to uncertainties and robustness for policy application. Comparison of national assessments with EC-proposed scenarios modelled by GAINS raised issues regarding the achievement of emission standards for Euro 6 and beyond, and demonstrated the advantages of more detailed national analysis of ecosystem protection in indicating benefits for designated sites. Investigation of the revised health benefits from HRAPIE also needed to be followed up, including the direct effects of nitrogen dioxide.

36. The French expert presented approaches to scenario development with GAINS-France and ongoing analyses for the revision of the NEC Directive, as well as examples of results. Analyses involved comparison of GAINS-EU scenarios with national projections and with GAINS-France scenarios. As first results, they showed that in the NEC scenarios for France (Baseline and EC Proposal) certain activities were missing, and that historic emission levels for several pollutants, as well as nitrogen oxides transport emissions for the whole period (2005–2030), were below those of the national projections. Also, the cost-effectiveness of GAINS mitigation measures for fertilizers needed verification. A health impact assessment for France confirmed benefits from international cooperation in air pollution policymaking.

37. A representative of CIAM observed that one of the major challenges in aligning data in GAINS with national emission inventories for 2005 was that the national submissions tended to change significantly over time. The current bilateral consultation would be

[18] See Norwegian Environment Agency, *Summary of of proposed action plan for Norwegian emissions of shortlived climate forcers*, report M135/2014, available from http://www.miljodirektoratet.no/no/Publikasjoner/2014/Mars-20141/Summary-of-proposed-action-plan-for-Norwegian-emissions-of-shortlived-climate-forcers/.

finalized by the end of May 2014. The findings from those consultations would be reported to the EC in June 2014. If the EC found it important, further sensitivity analysis might follow.

VII. Implementation of the 2014–2015 workplan for the implementation of the Convention

38. The Task Force co-Chairs presented the following information on the implementation of the respective items of the 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR.122/Add.2):

(a) Item 1.5.1:

(i) Updates of the GAINS model were ongoing, with new information on emissions, emerging technologies, health and ecosystem impacts, and on ozone fluxes;

(ii) With regard to downscaling ammonia deposition to protected areas, GAINS deposition scenarios were now available for Natura 2000[19] areas. With the help of the Coordination Centre for Effects (CCE) those results could be presented as exceedances of critical loads for nitrogen. CCE had developed a methodology to assess the loss of biodiversity. A call for data had been sent out to Parties. Within the ECLAIRE project, the impacts of nitrogen deposition on ecosystem services were being further assessed. The Task Force had participated in a workshop organized by the Department for Environment Food and Rural Affairs of the United Kingdom, on 4 and 5 December 2013, on the role of nitrogen reduction for nature management;[20]

(iii) Concerning interaction with Parties (meetings, consultations, workshops) on input data to GAINS, GAINS scenarios had been compared with national data and perspectives on future developments. The challenge was to harmonize GAINS with inconsistent and frequently changing emission data for 2005 reported by the Parties. A few errors had been found for some countries in the sulphur content of fuels, VOC emission factors from mopeds and PM emission factors from road abrasion. Several Parties used different assumptions than GAINS on traffic projections (e.g., the share of diesel and petrol cars and the future share of old cars), which would lead to different projections for nitrogen oxides and VOCs. There appeared to be inconsistencies in reported national PM emissions from domestic biomass burning and agricultural waste burning. Some countries had a different perspective than GAINS with regard to future agricultural production and fertilizer use;

(b) Item 1.5.2: Analysis of the implications of EU policy proposals on air quality in the ECE region was ongoing;

(c) Item 1.5.3, Analysis of the effectiveness of hemispheric control strategies, and Item 1.5.8, Joint workshop on linking geographical scales: The joint Task Force/Task Force on Hemispheric Transport of Air Pollution workshop was scheduled for 14 and 15 October 2014 at the International Institute for Applied Systems Analysis. CIAM had developed global-scale scenarios that could be used for assessing clean air, climate and nitrogen policies. Also, emission scenarios for mercury had been developed;

[19] See http://ec.europa.eu/environment/nature/natura2000/.

[20] See http://jncc.defra.gov.uk/page-5954.

(d) Item 1.5.4: Increasing linkages with local-scale air pollution and cost-effective local measures, including co-benefits (congestion, healthy lifestyles and reduced heat stress) was scheduled for 2015;

(e) Item 1.5.5, Providing support to Parties to the Convention, in particular countries in Eastern Europe, the Caucasus and Central Asia: A Russian GAINS model had been completed in December 2013. The model disaggregated the European part of the Russian Federation into six regions. Cooperation with the Institute for Nature Management in Minsk had boosted integrated assessment capabilities in Belarus. An Excel tool especially for countries in Eastern Europe, the Caucasus and Central Asia had been developed in cooperation with EGTEI to quantify the implications of including emission limit values in national legislation on the total national emissions and to import them into the GAINS database. Use of the tool indicated that implementing the technical annexes of the revised Gothenburg Protocol would significantly reduce national emissions in countries of Eastern Europe, the Caucasus and Central Asia;

(f) Item 1.5.6, Communicating and disseminating scientific developments, model and methodology improvements, data and products through the Task Force website: Relevant reports and presentations were available via the Task Force website;[21]

(g) Item 1.5.7, Exchanging information on national and international integrated assessment activities at annual Task Force meetings: The forty-forth meeting was scheduled to be held in Edinburgh, United Kingdom, in May 2015.

39. While awaiting formal decisions on the funding of the Assessment Report, the co-Chairs of the Task Force had volunteered to assist the Chair of the Working Group on Effects in drafting an outline for the Assessment Report scheduled for 2016. The Task Force discussed the format and issues to be covered in the Assessment Report. Several experts stressed that the target group should be beyond the Executive Body and that more emphasis should be on remaining challenges. The co-Chairs invited the Task Force experts to contribute to the report.

VIII. Other business

40. The Task Force identified the following issues for the attention of other groups and task forces:

(a) The Task Force had requested the Task Force on Measurements and Modelling and the Task Force on Emission Inventories and Projections to harmonize the treatment of “condensables”. Those were particulates from (domestic) burning processes that were formed outside of chimneys. Most countries did not report those condensables in their emission inventories, nor were they included in atmospheric transport models, although their contribution to PM concentrations could be substantial;

(b) The Network of Experts on Benefits and Economic Instruments had been dismantled. The Task Force was prepared to take over the tasks of the Network provided funding was available to perform cost-benefit analyses and assess the effectiveness of economic instruments.

41. It was noted that the lack of funding to reimburse travel costs to representatives from countries of Eastern Europe, the Caucasus and Central Asia significantly reduced participation of experts from those countries. The Convention secretariat advised the Task

[21] See http://www.iiasa.ac.at/web/home/research/researchPrograms/MitigationofAirPollutionandGreenhousegases/Integrated-Assessment.en.html.

Force to include a special section in the agenda of a future Task Force meeting devoted to capacity-building, in order to be eligible for funds available within the secretariat for such activities.

Annex

Summary report of the workshop on the valuation of damage to ecosystem services due to air pollution (Zagreb, 24–25 October 2013)

1. Forty-four experts from the following Parties to the Convention attended a workshop on the valuation of damage to ecosystem services due to air pollution, held in Zagreb on 24 and 25 October 2013: Austria, Croatia, Denmark, Germany, Finland, France, Netherlands, Norway, Spain, Sweden, Switzerland and United Kingdom. In addition, representatives from the following bodies and associations attended the meeting: CIAM; CONCAWE; EEB; EMEP; ICP Vegetation; the International Cooperative Programme on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends; the Network of Experts on Benefits and Economic Instruments; and the Working Group on Effects. The main themes and concerns addressed at the workshop, and its conclusions, are summarized below. The full report is available online.[22]

2. Currently, monetary valuation can only be applied in a meaningful way to a small part of all relevant ecosystem services. Only for the provision of food, wood, carbon storage and clean water can a market price be derived easily and with wide applicability. The value of supporting services that are crucial for long-term sustainability (photosynthesis, soil formation, nutrient cycling) is difficult to monetize. Monetary values for biodiversity based on willingness-to-pay surveys show large variations and inconsistencies. While the ecosystem service approach is useful in bringing economists and natural scientists together to increase understanding, it should not eliminate the use of physical endpoint indicators in decision-making.

3. Monetized estimates suggest that ecological benefits of air pollution reduction would be small relative to health impacts. However, it must be recognized that the research is at an early stage and is far from complete. The limitations of the damage function, ecosystem service assessment and valuation approaches, particularly in relation to long-term sustainability and interaction between stressors, need further consideration before robust conclusions on the relative importance of health and ecological impacts can be drawn.

4. The ecosystem services approach is not a replacement for approaches aimed at long-term sustainability. It is important to continue long-term systems analysis to support goal-oriented policy development. There was sincere doubt whether economic values derived from marketable services or from individual willingness to pay surveys should play a leading role in policy decisions related to such a complex issue as biodiversity protection. As biodiversity is a public good that cannot be replaced, values for nature areas that were implicitly revealed in historical political choices (such as the designation of Natura 2000 areas) were according to several participants more appropriate than the stated preferences by (less informed) individuals.

5. However, there is a benefit in further exploring, mapping and quantifying the damage to ecosystem services, as it could contribute to the mutual learning and understanding of policymakers, stakeholders, economists and other scientists involved.

[22] See http://www.iiasa.ac.at/web/home/research/researchPrograms/MitigationofAirPollutionandGreenhousegases/Report_TFIAM-NEBEI-ECLAIRE_workshop.pdf.

6. The valuation of biodiversity is still in its infant stages. Current economic valuation techniques used in the United Kingdom might prove useful if they can be linked to effect indicators used at the European level. Additional action is needed to explore the usefulness of such valuation and the extension towards other endpoints, such as the protection of endangered species and charismatic species, the reduction of dominant non-desirable species (e.g., replacement of heathland plants by grasses) and the resilience of habitat types (including typical species).

7. As an alternative, the shadow price approach (restoration costs, mitigation costs needed for a favourable conservation status of Natura 2000 areas) should also be further explored in estimating the potential benefits of air pollution policy.

8. Given the current state of knowledge, bold assumptions need to be made when estimating the economic damage to ecosystem services. Explicit analysis of the sensitivity for the assumptions made will be important.