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RECENT RESULTS AND UPDATING OF SCIENTIFIC AND TECHNICAL KNOWLEDGE

EFFECTS-BASED INDICATORS FOR USE IN INTEGRATED ASSESSMENT

Report by the Coordination Centre for Effects and the Task Force of the International Cooperative Programme on the Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends

I. INTRODUCTION

1. The International Cooperative Programme (ICP) on the Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping) and its Coordination Centre for Effects (CCE) have developed options for target-setting for 2020 and 2050, their use in integrated assessment modelling, and effects indicators. The results are presented here in accordance with item 3.7 of the 2009 workplan for the implementation of the Convention (ECE/EB.AIR/96/Add.2) adopted by the Executive Body at its twenty-sixth session in December 2008.

2. At its twenty-sixth session in December 2008, the Executive Body invited the Task Force on Integrated Assessment Modelling, in cooperation with the Working Group on Effects, to discuss and present the merits of the different options for target-setting for 2020 and the aspirational non-binding targets for 2050 for Parties within the geographic scope of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) They should use the most recent critical loads and levels data and bear in mind that the ambition level for the revision of the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) should be defined according to the objective set out in article 2 of the Protocol.

3. CCE provided input to the Workshop on non-binding aspirational targets for air pollution for the year 2050 (5–6 March 2009 in Utrecht, the Netherlands). CCE recommended choosing aspirational targets to derive required reductions of exposure and deposition as well as related emissions and abatement measures.

4. Effects targets should protect biodiversity and ecosystem services for human well-being. Targets could be based on critical loads or on target loads, the latter aiming at recovery of ecosystems in a target year and calculated with dynamic models. Full recovery in 2050 would require more emission reductions than attaining critical loads in 2050.

5. At its forty-forth session in April 2009 the Working Group on Strategies and Review encouraged the development and use of effects-based indicators. These would be linked to integrated assessment modelling and be based on the aspirational aim for 2050 of no further threats to human health and the environment from the atmosphere.

6. This report summarizes: (a) the indicators available from ICP Modelling and Mapping to support the revision of the Gothenburg Protocol; (b) a mechanism for using these indicators on a broad European scale in a scenario-specific context, in collaboration with the Centre for Integrated Assessment Modelling (CIAM) and the Meteorological Synthesizing Centre-West (MSC-W) of EMEP; and (c) further development of indicators and modelling of biodiversity effects, as decided at the nineteenth CCE workshop and the twenty-fifth meeting of the Programme Task Force of ICP Modelling and Mapping, both held in May 2009.

II. AVAILABLE EFFECTS-BASED INDICATORS

7. This section describes indicators based on classes of the European Nature Information System (EUNIS) and habitats in the Natura 2000 areas of the European Union (EU) located within EMEP modelling domain (see CCE 2008). The word “scenario” denotes a projection of air pollutant concentrations and depositions using a specific baseline for emissions.

8. Indicators type A. These scenario-independent indicators aim to assess the highest atmospheric wet and dry deposition that would not adversely affect ecosystem structure or function (unit: eq ha^{-1} a^{-1}):

(a) Critical loads for acidification, which are also available for selected Canadian ecosystems);

(b) Critical loads for eutrophication due to excess N deposition;

(c) Empirical critical loads of nutrient N.

9. Indicators type B. These are scenario-independent indicators for which critical biological or geochemical limits have been established to sustain the health of natural systems:

(a) Critical indicators to compute critical loads for acidification (e.g. base cation to aluminium ratio (Bc/Al), pH, base saturation);

(b) Critical indicators to compute critical loads for eutrophication (e.g. N concentration, carbon-to-nitrogen ratio).

10. Indicators type C. The following scenario-specific indicators can be used to assess the amount of deposition exceeding critical loads, or area exceeded. They are also part of the core set indicators of the European Environmental Agency (EEA) and the EU project, "Streamlining European 2010 biodiversity indicators" (SEBI2010). They are computed for different spatial scales (unit: eq ha^{-1} a^{-1}):

(a) Average accumulated exceedance (AAE) of acidic deposition exceeding critical loads for acidification;

(b) AAE of N deposition exceeding critical loads for eutrophication;

(c) Ecosystem area exceeded (percentage or km^2).

11. Indicators type D. These scenario-independent indicators can be used to assess the deposition required in an implementation year (e.g. 2020) to obtain the recovery of a critical indicator to its critical limit value by a target year (e.g. 2050):

(a) Target loads for acidification;

(b) Target loads for eutrophication.

12. Indicators type E. The following scenario-specific indicators assess the amount by which critical indicator values violate critical limits, or related time or area. The violation of a critical

indicator and AAE can be combined to policy-relevant assessments, which evaluate the feasibility of the ecosystem health to recover and required time:

(a) Non-achievement of target loads for acidification;

(b) Non-achievement of target loads for eutrophication;

(c) Area where critical limits are violated;

(d) Damage delay time and recovery delay time.

13. Indicators type F. The following scenario-specific indicators can be used to tentatively assess biodiversity indicators such as vegetation species richness and similarity:

(a) AAE of N deposition exceeding empirical critical loads;

(b) Change of biodiversity (species richness).

14. Indicators type G. The scenario-specific indicator for the robustness of exceedance of nutrient N deposition exceeding critical loads, based on an ensemble assessment of impacts (CCE 2007), is the likelihood of exceedance.

III. USING EFFECTS-BASED INDICATORS IN INTEGRATED ASSESSMENT

15. Integrated assessment of scenario alternatives is generally carried out by CIAM and the Task Force on Integrated Assessment Modelling, mainly using the GAINS (Greenhouse Gas and Air Pollution Interactions and Synergies) model. The general objective of assessments is the minimization of overall abatement costs to achieve an agreed reduction target, which is based on a set of environmental and human health indicators. Ecosystem-specific exceedance is computed from country emissions, using CCE methods and linear source-receptor relationships based the atmospheric chemistry and transport model of EMEP.

16. The effects-based assessment was earlier limited to the computation and reporting of exceedance by CIAM. To support the revision of the Gothenburg Protocol, the thirty-fifth meeting of the Task Force on Integrated Assessment Modelling in June 2009 recommended ex-post analyses and reporting.

17. These ex-post analyses would be based on scenarios on emissions, concentrations and depositions from CIAM. The analyses would be carried out by effects-oriented programmes and their centres, as their methods and knowledge were not implemented in the GAINS model.

18. The ex-post analyses by ICPs would include both quantitative and qualitative information. Quantitative information could include scenario-specific time delays of recovery

and damage, relative exceedance of ozone levels (e.g. based on concentrations or fluxes), and the health risks of particulate matter. Qualitative information could include expert opinions on the effects of scenarios.

19. The Bureau of the Working Group on Effects requested CCE to assist the ICPs in using the scenario data from CIAM. CCE adapted files for concentrations and depositions of 2005 and provided assistance to ICPs in exploring their use for site-specific assessment. The aim was to prepare to analyse effects of an agreed baseline scenario in autumn 2009 and other scenarios in 2010.

20. The annex of this report describes the assessment capabilities of CCE, in collaboration with the national focal centres (NFCs) of ICP Modelling and Mapping. It illustrates the use of effects-based indicators, which CCE uses to support of the (ex-post) analyses of policy scenarios to be explored by the Task Force on Integrated Assessment Modelling and the Working Group on Strategies and Review. An effects-based analysis starts with an emission scenario of the GAINS model of CIAM. Two pathways can be taken, both starting with the exceedance of critical loads.

21. The first pathway (upper one in the annex) reflects the use of computed critical loads (indicators type A) to analyse the location and magnitude of excessive acidification or eutrophication (indicators type C). Then dynamic modelling can be applied to assess the future state of acidification and eutrophication (indicators type B) and to generate the indicators type D and E.

22. The second pathway (lower one in the annex) addresses the use of empirical critical loads (indicators type A) to analyse the exceedance and effects on biodiversity (indicators type F), including ecosystem functions (see appendix C in CCE 2008).

23. The ensemble assessment of impacts (CCE 2007) is finally used to assess the robustness between scenarios, different effects-based assessments and conclusions by CCE.

IV. FURTHER DEVELOPMENT OF EFFECTS-BASED INDICATORS

24. The objectives of the twenty-fifth meeting of the Programme Task Force of ICP Modelling and Mapping included improvement of the knowledge of biological endpoints of biodiversity through progress in the dynamic modelling of vegetation changes and in the development of empirical critical loads. A session of the nineteenth CCE workshop addressed current state of empirical critical loads and provided insights into new knowledge in different geographical areas of European vegetation.

25. The CCE workshop concluded that a method for site-specific scenario analysis of the change of ground vegetation under climate change was now available (Alterra/CCE 2007). It also concluded that critical loads for eutrophication could be derived based on biodiversity.

26. A European application of dynamic models of vegetation change would require a vision on: (a) a reference for the species population in a reference time period; (b) a target segment, i.e. a well-defined part of the ecosystem or species population to be protected; and (c) an acceptable limit for an endpoint, indicated by, inter alia, ecosystem functions, genetic pools or protection of rare species.

27. The very simple dynamic model (VSD) currently includes carbon and N dynamics, denoted as VSD+. It was successfully calibrated for sites in three countries (Bonten et al. 2009). VSD was successfully implemented by many NFCs. VSD+ would require, as minimum, three new input parameters: (a) daily or weekly temperature; (b) daily or weekly soil moisture; and (c) vegetation age. Default values can be used for the other new input parameters. Future work includes testing to European sites, application to regions in Europe, linkage to biodiversity models (including those used by some NFCs) and developing a steady-state version for critical loads calculations.

28. CCE workshop also considered further development of indicators for use in integrated assessment. It concluded that ICP Modelling and Mapping should explore the applicability of indicators for damage to biodiversity at European scale. The work would consider red list criteria (Van Dobben 2009), thresholds for habitat suitability (Rowe 2009), or deviation from a reference state (Jensen 2009).

29. The Task Force decided to propose to the Working Group on Effects to consider a call for input data from NFCs of ICP Modelling and Mapping. NFCs would include data used in currently best available dynamic vegetation models. The call is planned for autumn 2009.

30. The Task Force also decided to revise empirical critical loads of N. This would be done in a research project, to be initiated in 2009. The decision was based on current knowledge of this topic (Bobbink 2009, Braun 2009, Nordin 2009, Gimeno 2009). The project will be co-funded by CCE, Switzerland and Germany. An expert workshop will be organized, tentatively for spring 2010 in the Netherlands. The work will update the information by Achermann and Bobbink (2003), and revise the *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends* in 2011.

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[1] The references have been reproduced as received by the secretariat.
[2] Most of the above references are available at: www.pbl.nl/cce.

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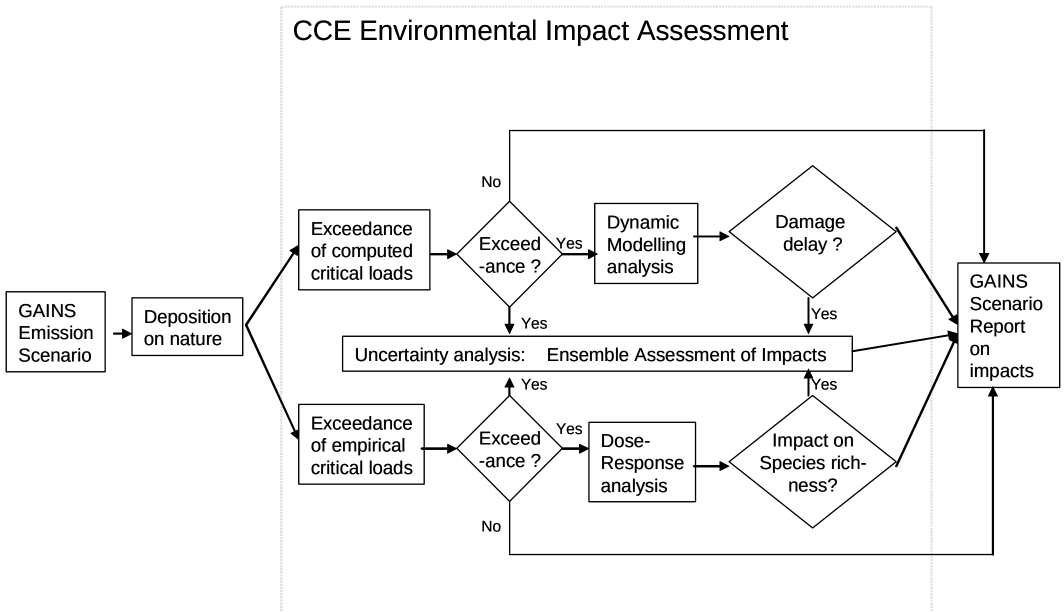
Annex

Simplified framework to assess effects of acidification and eutrophication within integrated assessment modelling, such as the GAINS model



Source: CCE 2008.
