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PRELIMINARY MODELLING AND MAPPING OF CRITICAL LOADS OF CADMIUM AND LEAD IN EUROPE: RESULTS OF A CALL FOR VOLUNTARY NATIONAL DATA CONTRIBUTIONS

Note prepared by the Coordination Center for Effects (CCE) of the
International Cooperative Programme on Modelling and Mapping of
Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP M&M),
with the assistance of the secretariat

I. INTRODUCTION

1. At its twentieth session, the Working Group on Effects "noted the need to further develop and test the methodology for mapping critical loads for heavy metals (Pb, Cd) and, to this end, invited ICP Mapping and CCE to issue, by the end of 2001, a call for relevant data to be provided by the National Focal Centres (NFCs) on a voluntary basis" (EB.AIR/WG.1/2001/2, para. 37 (f)).

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2. In response to this invitation, CCE issued such a call for data on 18 December 2001 requesting its 24 NFCs to respond not later than 11 March 2002. In support of this call NFCs were provided with a guidance document entitled "Guidance for the Calculation of Critical Loads for Cadmium and Lead in Terrestrial and Aquatic Ecosystems" (De Vries *et al.*, 2001).

3. The guidance document was produced on the initiative of CCE in collaboration with members of an expert group on critical limits and an expert group on transfer functions (results reported in De Vries *et al.*, 2002) which had been set up at the seventeenth meeting of the Task Force on ICP Modelling and Mapping in Bratislava in 2001.

4. The aim of the document was to provide up-to-date guidance to derive critical loads of heavy metals for both terrestrial and aquatic ecosystems, harmonizing knowledge from:

(a) Two manuals presenting guidelines for calculation methods, critical limits and input data for the calculation of critical loads of heavy metals for terrestrial ecosystems (De Vries and Bakker, 1998) and aquatic ecosystems (De Vries *et al.*, 1998);

(b) The results of a workshop on effects-based approaches for heavy metals held in Schwerin, Germany, 12 – 15 October 1999, focusing on both the use of methods and transfer functions and on critical limits to calculate critical loads (Gregor *et al*., 1999);

(c) The results of a Ad hoc international expert group meeting on effect-based critical limits for heavy metals held on 11 –13 October 2000 in Bratislava (Curlik *et al*., 2000);

(d) The recommendations of 1995-2001 CCE workshop sessions addressing heavy metals.

5. NFCs were requested to provide <u>effect-based critical loads</u> and <u>stand-still loads</u> using the 50 km x 50 km EMEP grid system.

6. <u>Effect-based critical loads</u> in the context of the Convention equal the atmospheric deposition that will not lead to concentrations of heavy metals above critical limits in defined compartments in a steady-state situation. In fact, critical loads should also include inputs other than those from the atmosphere. These critical loads can be derived using (i) critical limits of heavy metal concentrations in the soil solution which will not harm microbiota and plants and/or (ii) critical limits of (reactive) soil metal concentrations which will not lead to adverse impacts on soil functioning, such as soil invertebrates that ingest soil.

7. <u>Stand-still loads</u> in the context of the Convention equal the atmospheric deposition that will not lead to any further accumulation of heavy metals in the soil. In fact, stand-still loads should also include inputs other than those from the atmosphere.

8. Finally, NFCs were encouraged to provide ecosystem information using the European Nature Information System (EUNIS) to enhance cross-border comparison of sensitive ecosystems (see also Hall, 2001).

9. Following recommendations from the bureaux of the EMEP Steering Body and the Working Group on Effects at their joint meeting in February 2002, collaboration has started between the EMEP Meteorological Synthesizing Centre-East (MSC-E) and CCE. The aim is to

use MSC-E results of modelled deposition of cadmium and lead (deposition fields in 1990, 2000 and 2010) for the computation of preliminary exceedance maps. MSC-E and CCE also agreed to attempt to assess ecosystem-dependent exceedances using the CCE land cover map (de Smet and Hettelingh, 2001).

II. RESPONSE BY THE NATIONAL FOCAL CENTRES OF ICP M&M

10. Preliminary results of the call for data were presented and discussed at the twelfth CCE workshop and the eighteenth meeting of the Task Force on ICP M&M, which were held back-to-back in Sorrento (Italy), on 15-19 April 2002.

11. Eleven Parties (Belarus, Bulgaria, Czech Republic, Germany, Italy, Netherlands, Russian Federation, Slovakia, Switzerland, Ukraine and United Kingdom) provided critical loads data. Six Parties (Austria, Belgium, Finland, France, Norway and Sweden) informed CCE that they were not able to respond to the call for data at this time.

12. Effects-based critical loads (protecting microbiota and plants) were submitted by ten Parties. Germany also submitted critical loads that protect soil organisms (e.g. invertebrates). Seven Parties (Bulgaria, Czech Republic, Germany, Italy, Netherlands, Slovakia, and United Kingdom) submitted stand-still loads. Italy provided loads based on semi-dynamic calculations which are shown on European maps of stand-still loads.

13. All Parties provided critical loads for forest ecosystems, three Parties also included natural vegetation. Three Parties also provided critical loads for arable land implying that atmospheric deposition is a major contributor to heavy metals input to these soils.

14. A detailed description of the response by the National Focal Centres, preliminary European maps of critical loads of cadmium and lead, and preliminary exceedance maps can be found in a collaborative CCE – MSC-E report (Hettelingh *et al.*, 2002).

III. PRELIMINARY MAPS OF CRITICAL LOADS OF CADMIUM AND LEAD

15. European critical loads/stand-still loads maps of cadmium and lead have been produced using data provided by participating countries. Due to the preliminary and exploratory nature of the modelling and mapping exercise, no European databases have been used by CCE to fill regional gaps of critical loads.

16. Critical loads/stand-still loads maps of cadmium and lead are shown in figures I and II, respectively. The maps show 5th percentile critical loads in each 50 km x 50 km EMEP grid cell. A 5th percentile critical load implies that 95% of the mapped ecosystems will be protected from adverse effects if the atmospheric deposition of cadmium in that grid cell is equal to this critical load value. Similarly, the 5th percentile stand-still load refers to protection against accumulation.

17. Figure I shows the maps of the 5th percentile of effects-based critical loads (top) and stand-still loads (bottom) of cadmium. Comparison of the two maps shows that the

stand-still approach may lead to lower values for cadmium in the Czech Republic, Germany, the Netherlands and the United Kingdom and higher values in Bulgaria and Slovakia.

18. Figure II shows the maps of the 5th percentile of effects-based critical loads (top) and stand-still loads (bottom) of lead. Comparison of the two maps shows that the stand-still approach may lead to lower values for lead in the Czech Republic, Germany, the Netherlands and the United Kingdom and to higher values in Bulgaria and Slovakia.

IV. CONCLUSIONS AND RECOMMENDATIONS

19. An extensive review of the conclusions and recommendations concerning future actions on modelling and mapping of critical loads of heavy metals can be found in the reports of the twelfth CCE workshop (see www.rivm.nl/cce) and the eighteenth meeting of the Task Force on ICP M&M (see www.icpmapping.org), and in the collaborative CCE – MSC-E report (Hettelingh *et al.*, 2002).

20. The following are recommended:

(a) A review of total heavy metal inputs (i.e. atmospheric deposition and other sources, taking present concentrations in soil/soil solution into account);
(b) A review of methods to identify regions where the application of the stand-still approach might be more appropriate than an effects-based approach;
(c) A review of cross-border variability of the heavy metal content in soils and the exploration of methods to establish natural and anthropogenic shares of heavy metals in present soil content data;
(d) The exploration of whether atmospheric deposition of heavy metals significantly influences the metal content in agricultural soils;
(e) The further analysis of possible inconsistencies of critical load parameter values across borders;
(f) The further review of critical limits and transfer functions;
(g) The exploration of critical limits which can be related to human health;
(h) The exploration of effects-based approaches for mercury.

21. At its eighteenth meeting, the Task Force on ICP M&M recommended to the Working Group on Effects that the work of the expert group on critical limits and the expert group on transfer functions should continue in 2003, making full use of the preliminary results of modelling and mapping of critical loads of cadmium and lead based on voluntary national data contributions.

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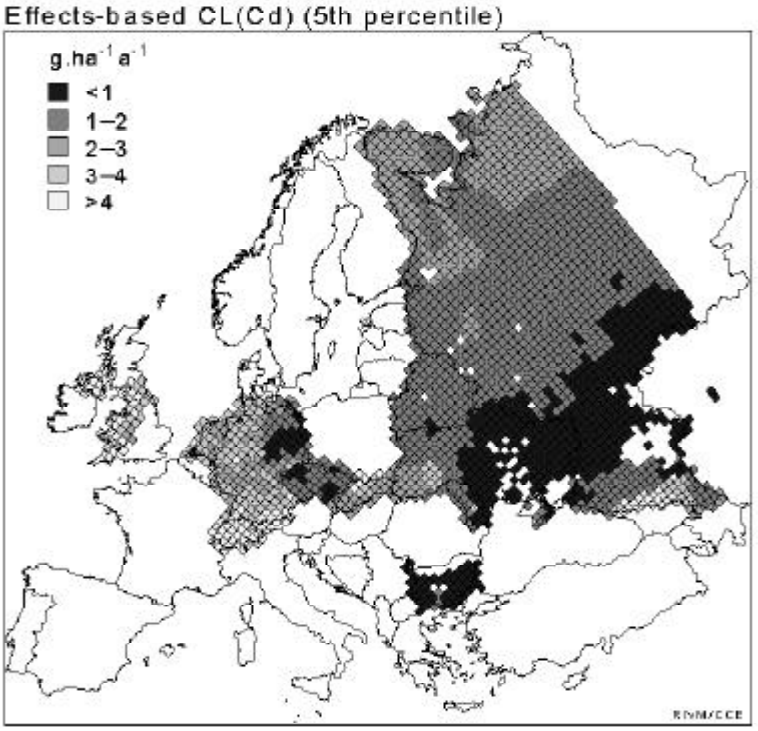
Note: These references are reproduced in the form in which they were received by the secretariat.

The boundaries shown on maps presented in figures I and II do not imply official endorsement or acceptance by the United Nations.



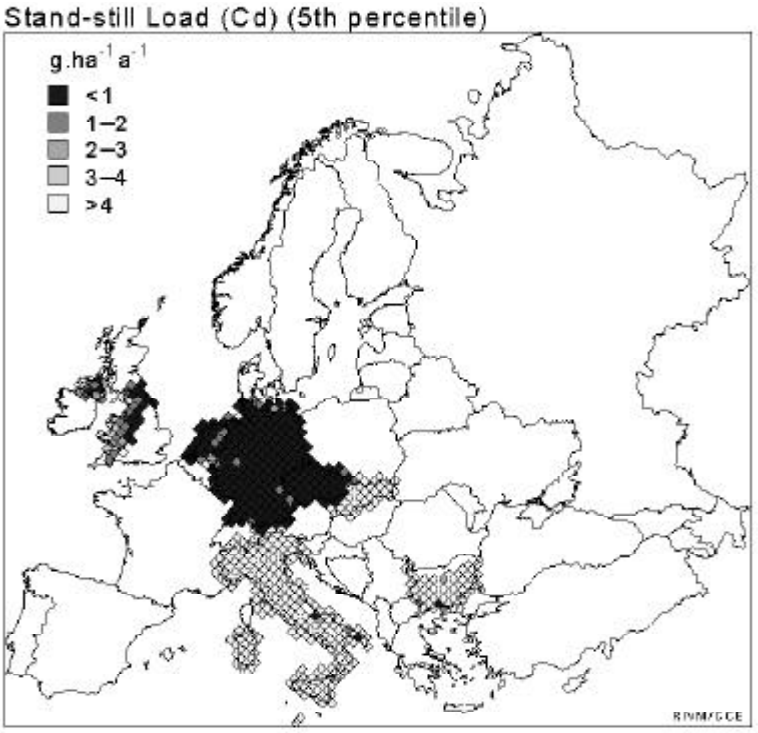


Figure I: Preliminary maps of the 5th percentile critical loads of effects-based critical loads (top) and stand-still loads (bottom) of cadmium. Comparison of the two preliminary maps shows that the stand-still approach generally leads to lower values for cadmium in the Czech Republic, Germany, the Netherlands and the United Kingdom and higher values in Bulgaria and Slovakia.

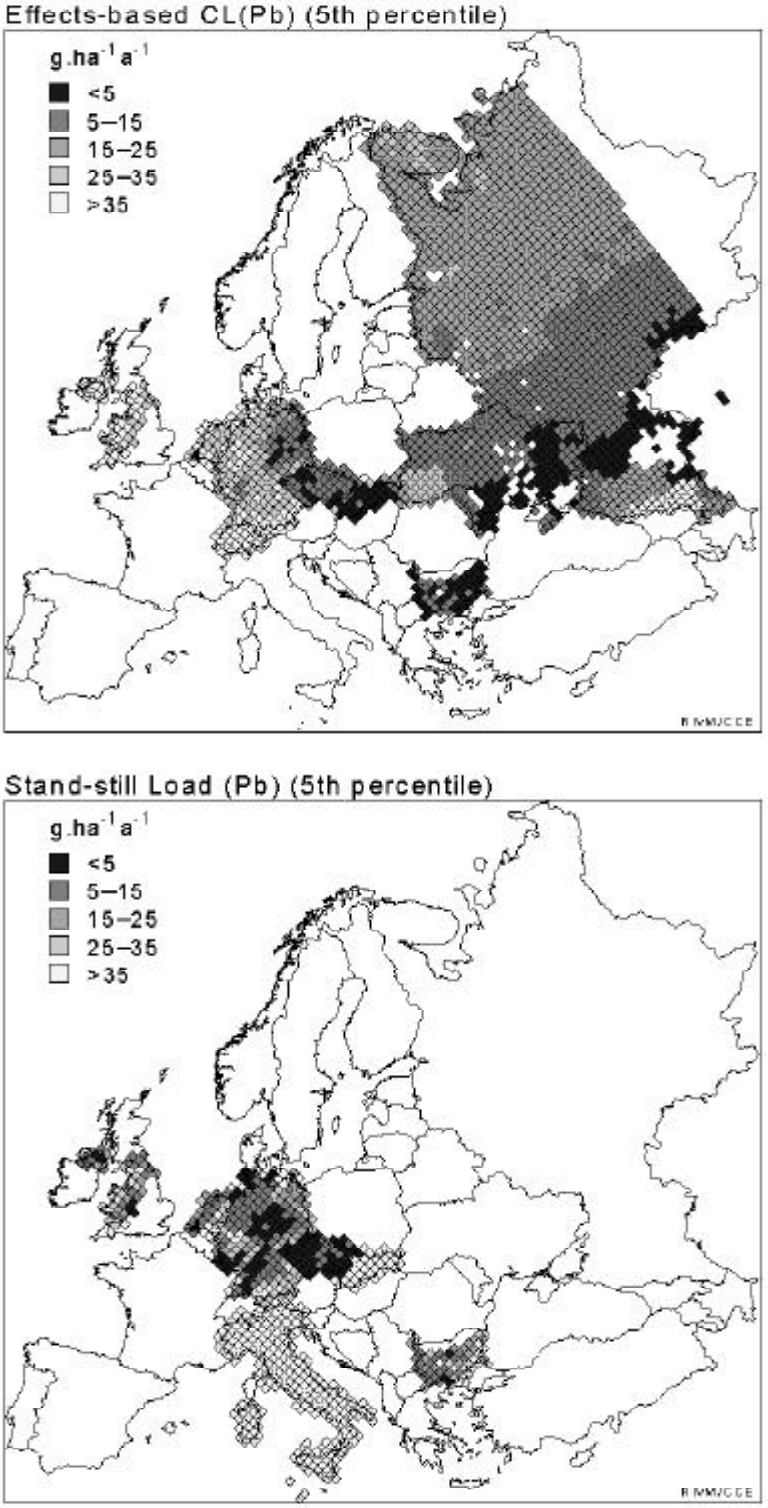


Figure II: Preliminary maps of the 5th percentile critical loads of effects-based critical loads (top) and stand-still loads (bottom) of lead. Comparison of the two preliminary maps shows that the stand-still approach generally leads to lower values for lead in the Czech Republic, Germany, the Netherlands and the United Kingdom and to higher values in Bulgaria and Slovakia.