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Working Group on Effects
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Item 6 (a) of the provisional agenda

WORKSHOP ON EFFECT-BASED APPROACHES FOR HEAVY METALS

Summary report prepared by the organizing committee
with the assistance of the secretariat

I. INTRODUCTION

1. The workshop on effects-based approaches for heavy metals was organized by the German Federal Environmental Agency (UBA) in Schwerin, Germany, from 12 to 15 October 1999.

2. The workshop was attended by 65 participants from 20 countries (Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, Germany, Netherlands, Norway, Poland, Republic of Moldova, Russian Federation, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom, Ukraine and United States of America). The Chairman of the Working Group on Effects, as well as representatives of the EMEP Meteorological Synthesizing Centre-East

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(MSC-E), the International Cooperative Programmes (ICPs) on Forests, Integrated Monitoring, Vegetation and Waters, the Task Force on Mapping and several of its national focal centres were also present. The UN/ECE secretariat was also represented. Mr. H.-D. Gregor (Germany) chaired the workshop.

3. The Aarhus Protocol on Heavy Metals (in its article 6) encouraged Parties to address in their research, development and monitoring activities (primarily focusing on Pb, Cd, Hg), inter alia, emissions, long-range transport and deposition levels and their modelling, existing levels in the biotic and abiotic environment; pollutant pathways and inventories in representative ecosystems; effects on human health and the environment; and the further development of an effects-based approach which would integrate new information (for the purpose of formulating future optimized control strategies which also take into account economic and technological factors).

4. The first workshop on critical limits and effects-based approaches for heavy metals and persistent organic pollutants, under the auspices of the Convention, was held in November 1997 in Bad Harzburg, Germany. Two years later the follow-up workshop reviewed the results of the efforts to further develop methods for effects-based approaches, as requested in the Aarhus Protocol on Heavy Metals.

5. The workshop=s objectives were to:

(a) Present and exchange information on, and the evaluation of, new methodologies and databases on sources, pathways and key processes of heavy metals in soils and surface waters and model analyses;
(b) Discuss the updated versions of the manuals for calculating critical loads of heavy metals for soils and surface waters;
(c) Review national activities in applying effects-based approaches for heavy metals following the Bad Harzburg workshop, and present experience in deriving critical limits and critical loads (including their mapping) from studies on a national scale;
(d) Build consensus on critical limits and methods for their derivation;
(e) Consider the reliability of critical loads in view of critical limits, modelling knowledge and data uncertainty;
(f) Identify gaps in the scientific knowledge and in related modelling approaches, as well as data needs and available data sets; and
(g) Draw up recommendations for national and international research programmes.

60 The workshop was organized in a series of plenary and parallel individual expert sessions (working groups). Prior to the workshop its scientific preparatory committee had drawn up a set of specific questions to be addressed by the working groups in their discussions. Also circulated before the workshop as background documents were two manuals prepared by experts from the Netherlands:

(a) Manual for Calculating Critical Loads of Heavy Metals for Terrestrial Ecosystems (DeVries and Bakker, 1998); and

(b) Manual for Calculating Critical Loads of Heavy Metals for Aquatic Ecosystems (DeVries, Bakker and Sverdrup, 1998).

The International Cooperative Programmes and EMEP MSC-E, as well as other international bodies and organizations, were also invited to present available information and data relevant to the workshop=s objectives.

70 In the plenary sessions, key presentations reviewing existing knowledge and available data were complemented by short communications and posters. Problems related to critical limits and pathways, and the calculation methods for aquatic and terrestrial systems, were discussed in three parallel working groups, which reported their results to the plenary sessions:

(a) Working group on critical limits;
(b) Working group on key processes and models in terrestrial systems; and
(c) Working group on key processes and models in freshwater systems.

II. CONCLUSIONS AND RECOMMENDATIONS

80 Conclusions and recommendations drawn up by the individual working groups were discussed and approved by the plenary session. The participants also agreed on a number of overall conclusions and recommendations.

A. Working group on critical limits

1. Conclusions

90 All countries represented at the workshop had experienced heavy metal problems, but they varied in type and risk.

100 Available critical limits varied widely among countries. Most of them were not effect-based but expressed as total concentrations. Therefore, currently existing critical limits were found not to be adequate for critical load calculations (especially for soils).

110 In general, the current understanding of the problem and the available data were considered sufficient to calculate critical limits of heavy metals. However, soil data might not yet be expressed in the most desirable form of soluble fractions.

2. Recommendations

120 Draw up various policy options and compare their consequences, to supply policy makers with relevant scientific information for decision-making (with respect to both the critical load approach, and the nature and level of protection in the critical limit assessment).

130 Most essentially, re-evaluate the available toxicity data for soils using transformation functions for those data sets that have both data on the ANo Observed Effect Concentration@

(NOEC) and also on soil properties influencing the bioavailability. Furthermore, available food quality criteria should be related to soil solution criteria by re-evaluating available databases on metals in crops and soil, and the soil properties influencing metal bioavailability.

B. Working group on key processes and models in terrestrial systems

1. Conclusions

140 Effect-based approaches should be used for the derivation of critical loads. Areas currently above critical limits should be clearly identified when applying these methods. Critical loads could also be calculated based on the criterion of preventing further accumulation in soils if this is an agreed policy objective.

150 Critical loads are derived for a steady-state perspective. However, insight into the dynamics, and the time, to reach a critical content in the soil, or other compartments, is also needed.

160 At present the uncertainty in modelling complexation is so large that, for calculations on a regional or European scale, it is not recommendable to express critical limits as free ion activities.

170 Mass balance models should be based on the reactive (total potential available) pool of metals in the soil. Deposition should be added to this pool, except for any fraction which can be identified as non-reactive. For regional applications there needs to be a standardized operational definition of this pool.

180 Transfer functions should be developed between reactive metal content and total soil solution concentration, based on clay content, organic matter content and pH, which can be applied across Europe.

190 The models developed have to be validated on existing data sets across Europe using dynamic versions of the models.

2. Recommendations

200 Develop relationships between different extraction methods used to quantify the reactive (total potentially available) metal content in soils and a standardized, operationally defined, extraction method.

210 Develop transfer functions to relate the reactive pool of metals to the total pool (e.g. aqua regia) based on soil properties.

220 Derive transfer functions between the reactive metal content in soil and the soil solution concentration based on pH, organic matter content and clay content.

230 Evaluate the applicability of transfer functions for the whole of Europe. If needed, different transfer functions for different climatic regions and groups of soil types have to be derived.

240 Derive transfer function for the organic horizon in forest soils, in addition to transfer functions for mineral soils.

250 Identify appropriate data sets for the validation of dynamic models.

260 Compare heavy metal deposition calculated by EMEP with local deposition measurements.

C. Working group on key processes and models in freshwater systems

1. Conclusions

270 There is a need to map critical loads for waters, given the evidence from ICP Waters and the Nordic lake survey that lakes in Scandinavia exceed critical levels of Cd (10%) and Pb (1%). Furthermore, 50% of Swedish lakes contain fish that exceed Hg health limits.

280 Potentially feasible approaches to modelling Hg critical loads are now available, as they were previously for Cd and Pb.

290 Candidate models for Pb, Cd and Hg (steady-state and dynamic, empirical and process-oriented) are ready for testing.

2. Recommendations

300 Test different candidate models, in particular dynamic versions based on either concentration transfer or mass balance, and involve the scientific community in evaluating the validity of these models. Countries that experience heavy metal problems should take the lead in providing resources for the testing of heavy metal critical load models.

310 Improve knowledge of Hg deposition (speciation, reactivity, litterfall).

320 Continue model development to provide users with a Amenu@ of models.

D. Overall conclusions of the workshop

330 All countries represented at the workshop had experienced heavy metal problems. However, these varied in type. Different environmental compartments have different deposition rates, species at risk and severity of impacts.

340 A critical load should be based on an effect-based critical limit. In addition, a "critical" load may be calculated using the Astand still@ principle. The lower of the two may be used to define the critical load for the system.

350 The methodology to derive critical loads for heavy metals should be consistent with the methodology applied for acidifying substances.

360 Soil will become the most important compartment in the future, therefore soil solution parameters are especially needed.

370 Terrestrial transfer functions have to be developed to transform total heavy metal concentrations in soils into concentrations of the soil solution.

380 It is considered most essential to re-evaluate available soil data using transformation functions for those data sets that have data both on NOEC and on soil properties influencing the bio-availability. Available food quality criteria should be related to soil solution criteria by re-evaluating databases on metals in crops and soils, and the soil properties influencing metal bio-availability. The influence of soil properties (pH, clay content, organic carbon) on ecotoxicological effects should be included in experiments to develop the required information for critical limits in the future.

390 Aquatic models are ready to run and should be tested now to validate the parameters used.

400 The validation of dynamic models should be initiated.

E. Future activities

410 The participants were invited to help to close the gaps identified in present knowledge by initiating/developing relevant activities and striving for adequate funding in their countries. They were also encouraged to apply, test and validate the models that were presented and discussed.

420 ICPs should provide any available data/information needed for further work.

430 The workshop recommended establishing an ad hoc expert group on effect-based critical limits to provide a forum for the assessment of critical limits related to soil concentrations. It should take into account soil properties identified as influencing the bio-availability of heavy metals. While Germany offered to coordinate these activities, countries were invited to participate (as a contribution in kind).

440 Based on draft proposals prepared by the Task Force on Mapping, the Working Group on Effects was requested to consider its plans for future heavy-metals-related activities.