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LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Working Group on Effects
(Seventeenth session, 26-28 August 1998)
Items 5 and 6 of the provisional agenda

1998 JOINT REPORT OF THE INTERNATIONAL COOPERATIVE PROGRAMMES AND THE MAPPING PROGRAMME

Report compiled by the secretariat in collaboration with the Extended Bureau of the Working Group on Effects

I. INTRODUCTION

1. At the fifteenth session of the Executive Body, it was agreed that the secretariat would prepare a draft annual summary report based on information provided by the lead countries and programme centres for consideration by the Working Group on Effects. In addition, the Bureau and International Cooperative Programmes and the Mapping Programme were charged with submitting a draft substantive report on trends, reviewing the trends in the atmospheric transport and effects of sulphur, nitrogen and ozone (ECE/EB.AIR/53, annex V, sections 3.1.1 and 3.1.2). Discussions by the Working Group on Effects at its sixteenth session resulted in a request to the Extended Bureau to consider

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changes to the Joint Report to reflect the most important activities (EB.AIR/WG.1/1997/2, para. 45 (e)). As a result, the Extended Bureau agreed at its meeting in February 1998 to collate an executive summary of the Substantive Report on Trends as the major part of the programmes' joint Report.

2. This report presents the executive summary of the trends report and, in the annexes, a summary of the achievements of the individual programmes since the sixteenth session of the Working Group on Effects. It also presents the lists of activities/tasks to be addressed in the coming year, as proposed by the programmes in response to the priority needs of the Executive Body.

II. THE SUBSTANTIVE REPORT ON TRENDS

3. Most of the international programmes operating under the Working Group on Effects have been in existence for 10 years or more. Data have been collected throughout this time and some programmes have access to additional data sets going back further in time. Some programmes have already analysed their data and have reported interesting results. In the ECE region there have also been significant changes in the emissions of atmospheric pollutants over the last decade. The fall in sulphur emissions, for example, is in line with the national obligations under Protocols to the Convention. It was considered timely to bring together the effects data available from the work under the Convention to identify significant trends, especially improvements, which might be associated with decreased emission levels. The report considers both empirical trends estimates based on measurements and future trends estimates based on models. In this way it examines both recent changes and predicts those which may be expected in the future as other protocols come into force.

III. PAST AND FUTURE TRENDS IN POLLUTANT EMISSIONS, CONCENTRATIONS AND DEPOSITIONS AND EXCEEDANCES OF CRITICAL LOADS AND LEVELS

4. Data from EMEP show that European emissions of sulphur (S) had by 1995 declined by about 55% from their peak in 1975. The implementation of the 1994 Oslo Protocol and other already agreed policy measures will result in further decreases. In contrast, European emissions of total (oxidized + reduced) nitrogen (N) have not declined substantially from their peak in the early eighties. Current reduction plans suggest continued emissions at about this level. Trends in the emissions of sulphur and nitrogen in North America are similar.

5. Trends in the deposition of acidifying pollutants (S and N) modelled by EMEP/MSC-W reflect the changes in the emissions reported. While the highest deposition values of sulphur have been in central Europe throughout the last decades, the extent of the high deposition areas has shrunk considerably over the past twenty years and the maximum value has halved from about 10 $gS/m^2/yr$ in 1975 to about 5 $gS/m^2/yr$ in 1995. From EMEP/CCC monitoring results it seems that base cation deposition, which neutralizes deposited acidity, is constant or declining throughout Europe. This may offset some of the benefits of S and N emission reductions. Concentrations of ozone modelled by EMEP/MSC-W vary considerably from year to year and from country to country across Europe, but there are no apparent trends over time.

6. Deposition monitoring at sites of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP IM)

mainly provides data for site-specific effects assessment and modelling work. Decreasing trends in non-marine sulphate deposition and rainwater acidity were observed between 1988 and 1995 at many ICP IM sites in the Nordic countries, as well as at sites in Belarus, the Russias Federation and in the Netherlands (sulphate). Decreasing NO_3^-/NH_4^+ deposition was apparent at some IM sites in the Nordic countries in the 1990s.

7. Ozone concentration trends have been investigated by the International Cooperative Programme on Effects of Air Pollution and Other Stresses on Crops and Non-wood Plants (ICP Crops) using data collected from the 1989 - 1997 experimental seasons. However, no clear trends in ozone dose accumulated over a threshold of 40 ppb during daylight hours (AOT40) can be identified, largely due to the inter-annual variability of ozone concentrations. Geographic differences can be identified within the data, with the central and southern sites showing higher concentrations and doses, and thus greater exceedance of the long-term critical level. Variations in the ozone concentration profile are also detectable between sites and years. Some sites exhibit higher concentrations for shorter periods, while others show lower concentrations for longer periods. The short-term critical level has a level II factor, vapour pressure deficit (VPD), in its definition. This influences the extent of exceedance, since some sites with low ozone concentrations show greater exceedance due to low VPDs.

8. Of the environmental parameters measured in the network of urban and rural sites of the International Cooperative Programme on Effects of Air Pollution on Materials, Including Historic and Cultural Monuments (ICP Materials), only SO_2, NO_2 and H^+ exhibit trends. All of these are decreasing, with SO_2 having the strongest trend and NO_2 the weakest. For O_3 no specific trends were observed.

9. Comparing the European critical loads map with deposition maps shows the location and amount of exceedance of the 5-th percentile critical load of acidity (which protects 95% of the ecosystem area in a grid cell) for the past, the present and the future. Current reduction plans for emissions in 2010 would result in significant improvements from maximum levels around 1975. For sulphur and nitrogen acidity, this is mirrored by a greater than four-fold reduction in the ecosystem area exceeded. For nutrient nitrogen critical loads, the improvements are small. As a result, the overall level of exceedance, for acidity and nutrient nitrogen, is reduced by only 40% of ecosystem areas from the 2.5 million km^2 in 1980 to about 1.5 million km^2 in 2010.

10. Estimates of air concentrations of SO_2 at Level I sites of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) indicate that, for the most important tree species, the critical level of 20 $g.m^{-3}$ SO_2 was exceeded on about 25% of the plots in 1986 and on about 10% of the plots in 1995. The decrease follows the large-scale sulphur emission reductions achieved after 1986.

IV. EMPIRICAL TRENDS IN EFFECTS

11. Regional trend analyses of surface water chemistry sites of the International Cooperative Programme on Assessment and Monitoring of Acidification Rivers and Lakes (ICP Waters) show that sulphate concentrations

are decreasing at almost all sites, and in almost all cases the decreases in the 1990s are larger than those the of the 1980s. In the Nordic countries (Finland, Sweden, Norway) alkalinity decreased in the 1980s (acidification), but increases in the 1990s (recovery). At many European sites (Italy, Germany, Netherlands, Denmark) alkalinity also increased in the 1980s, but the rate accelerates in the 1990s. The remaining regions (Adirondacks and Quebec, midwestern North America, United Kingdom) show either no recovery or further acidification. Regions with declining sulphate that fail to show recovery in alkalinity in the 1990s are characterized by strongly declining base cation concentrations. All of the hydrogen ion (H^+) trends detectable at a regional level are consistent with the alkalinity trends observed within each region. The 1980s were characterized by increases in nitrate in almost all regions. These increases have levelled out in the 1990s. Compared with sulphur, nitrogen is much more involved in biological processes within ecosystems. Hence, changes in N deposition may not always directly correlate with changes in inorganic N leaching in runoff.

12. The ICP IM results on surface water chemistry are largely consistent with the ICP Waters data. As a consequence of reduced sulphur deposition, the non-marine sulphate and hydrogen ion (H^+) concentrations in runoff water declined at most ICP IM sites in Nordic countries in 1988-1995. Decreasing nitrate concentrations are also commonly observed. For sites in other regions the nitrogen results are more difficult to interpret. Increasing nitrate concentrations are detected for certain catchments in Sweden, indicating possible signs of developing nitrogen saturation. These results suggest that nitrogen needs special attention in any further work.

13. ICP Waters reports important findings on trends in aquatic fauna. By comparing invertebrate samples taken before and after 1990, improvements can be observed at many Norwegian and German sites. This is confirmed by correlation analyses between time and the acidification index applied to Norwegian long-term data series (periods chosen: 1981 - 1988 and 1989 - 1994). Statistical analysis (Norwegian data sets) shows a high correlation of invertebrate assemblages with pH and total aluminium (Al), and also a significant correlation with calcium. Trend analyses indicate considerable improvements from 1991 to 1995 (increase in pH, decrease in total Al).

14. ICP Forests has observed the forests of Europe, where tree crown condition has been deteriorating on a large scale over several years. Distinct clusters of plots with heavily damaged trees exist in various parts of Europe. Though tree defoliation is largely influenced by natural site characteristics, the deterioration is most severe in those regions of central Europe where sulphur and nitrogen deposition are the highest. In some of these regions, Scots pine recovered after a decrease in air pollution and improved weather conditions. Trends in crown condition of the most common species are related to soil and humus types. Crown condition is affected by many stress factors. However, the large-scale deterioration over more than a decade is not readily explainable by natural stressors alone. It is possible to identify spatial correlations between heavily damaged forest areas with regional differences in air quality, certain soil parameters and the nutritional status of trees in central Europe. On a large scale, air pollution is considered as a predisposing or triggering factor.

15. Analysis of biomonitoring data from ICP Crops sites between 1989 and 1997 indicates that visible ozone injury occurred in at least one year at every

site, and in every year at some sites, for example, those in central and southern Europe. In recent years (1994-1997), a more detailed survey of the timing of visible injury on Trifolium repens (white clover) indicates that injury occurs during each of the four to five 28-day sampling periods of each season at one third of the ICP Crops sites.

16. Observations by ICP Materials show that the decreasing trend in the concentration of acidifying air pollutants has resulted in bringing down the corrosion rate of the exposed materials. Both carbon steel and zinc show a decrease in corrosion in unsheltered as well as in sheltered positions. The decrease in corrosivity occurred first in Scandinavia and later in western and central Europe.

17. SO_2 is the largest single contributing factor to the decreasing corrosion trends. Decreasing H^+ in precipitation is also a contributing factor; its effect is, however, much smaller than that of dry deposition. The decrease in corrosivity is generally larger than expected from the drop in SO_2 and H^+ concentrations. This cannot be directly related to a specific pollutant and reflects the multi-pollutant character of the process of material degradation. This is also a motivation for future investigations of trends within the ICP Materials which will include synergistic effects of SO_2 and NO_2 and/or O_3 and effects of particulates, which have not been measured so far.

V. FUTURE TRENDS IN SOILS AND WATER CHEMISTRY

18. Dynamic modelling has been a key activity of ICP IM during recent years. A linked model has been developed, allowing emission/deposition scenario assessment at selected ICP IM sites. These models are flexible and can be adjusted for the assessment of alternative scenarios of policy importance. According to the models, the timing of emission reductions determines the rate of recovery over a shorter time scale (up to 30 years). The quicker the target level of reductions is achieved, the more rapid the surface water and soil status recover. For the long-term response (> 30 years), the magnitude of emission reduction is more important than the timing of the reduction. The model simulations also indicate that N emission controls are extremely important to bring about the maximum recovery in response to S emission reductions. Nitrogen breakthrough has the potential to not only offset the recovery predicted in response to S emission reductions but further to promote substantial deterioration in the pH status of fresh waters and other N pollution problems in some areas of Europe.

VI. CONCLUSIONS

19. Reductions in emissions of sulphur have resulted in a decrease in deposited acidity throughout Europe and North America. Pollutant monitoring carried out by ICPs reflects the general trends reported by EMEP. The decreases are linked to the observed recovery of the chemistry and biology in fresh waters (ICP Waters and IM) and the rate of corrosion of materials (ICP Materials) in many parts of the ECE region. Critical loads exceedances are falling and are predicted to fall further in the future. However, despite these changes and estimated decreases in critical level exceedances for SO_2 concentrations at ICP Forests Level I sites, forest condition shows continued signs of deterioration in some parts of Europe, but these results may be due to the many other stress factors which exist in addition to air pollution.

20. Dynamic modelling studies (ICP IM) show that recovery from acidification will be slow in many cases, with long-term recovery influenced more by the reduction in deposition than its timing.

21. Measurements of ozone concentrations in the monitoring programmes reflect the marked yearly variation and geographical differences reported by EMEP. Effects of ozone on crops (ICP Crops) and materials (ICP Materials) are widespread and the trends follow the yearly changes in pollutant concentrations.

Note: The references in the annexes below have been reproduced in the form in which they were received by the secretariat.

Annex I

REVIEW OF THE ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATIVE PROGRAMME ON ASSESSMENT AND MONITORING OF AIR POLLUTION EFFECTS ON FORESTS

I. ACTIVITIES SINCE THE SIXTEENTH SESSION OF THE WORKING GROUP ON EFFECTS

1. The fourteenth meeting of the Task Force on ICP Forests was held from 23 to 27 May 1998 in Segovia (Spain) and was attended by 65 experts representing 32 Parties to the Convention.

2. At its fourteenth meeting, the Task Force of ICP Forests adopted a strategy for the further development of the programme until the year 2001. In a status and strategy paper drafted by the lead country, the Programme Coordinating Centre (PCC) and the Programme Coordinating Group (PCG), the priorities for the programme's further implementation were laid down, taking into account the priorities defined by the Executive Body. The strategy refers to monitoring activities, data management and evaluation, the reporting system and administrative tools.

3. In programme activities, the emphasis was on the evaluation of intensive monitoring data (level II). Key parameters and several relationships between them were identified. As for the large-scale monitoring (level I), the expanded data sets on soil and foliage were studied from new perspectives, and the crown condition surveys were continued and evaluated, paying special attention to trends.

4. Based on the decisions taken at the fifteenth session of the Executive Body, a literature study on cause-effect relationships will be presented at the seventeenth session of the Working Group on Effects. The study, prepared by PCC, several authors and an editorial board, highlights the latest results of forest damage research, with special attention to the effects of air pollution.

5. In the planned Temperal and Boreal Forest Resources Assessment (TBFRA 2000), UN/ECE and the Food and Agriculture Organization of the United Nations (FAO) aim to supplement the usual quantitative information with qualitative information. PCC provided country-specific information on the development of defoliation over time in broadleaves, conifers and the total of all species. This information was based on data received from 35 European countries over up to 11 survey years.

6. Based on the decisions taken at the thirteenth meeting of the Task Force on ICP Forests, PCC collected editorial comments on the revised version of the programme manual from the National Focal Centres (NFCs), the Expert Panels and

the ad hoc working groups. Based on these comments, PCC prepared the fourth edition of the manual. The final version has a modular design, consisting of detachable submanuals on crown condition assessments, soil analyses, foliage analyses, increment studies, deposition measurements, vegetation assessments and meteorological observations. In cooperation with ICP on Integrated Monitoring, a comparison of the manuals of both programmes was initiated. The results of the comparison, presented to the Working Group on Effects, may serve as a basis for further methodological harmonizations between the two programmes.

7. PCC and the Forest Soil Coordinating Centre (FSCC) in Ghent, Belgium, agreed on a common two-year project featuring integrated evaluations of the level I data on crown condition, soil condition and the nutritional status of forest trees. The project will be co-financed by the European Commission (DG VI) and will start in September 1998. Further in-depth studies, including level I and possibly level II data, will be performed until 1999 within the framework of the further elaboration of the substantive report on trends in the effects of air pollution.

8. Following its obligations as the main data centre of ICP Forests, PCC installed a data bank system and established a data bank for level I data on crown condition, soil and foliage. Level II data are planned to be added in July 1998. The complete data bank will be linked with the geographical information system and suitable statistical applications software.

9. The following reports were prepared for and presented at the fourteenth Task Force meeting:

(a) Forest Condition in Europe (Executive report 1998);
(b) Forest Condition in Europe (Technical report 1998);
(c) Intensive Monitoring of Forest Condition in Europe (Technical report 1998);
(d) Latest State of Forest Damage Research (Literature study 1998).

10. Three international intercalibration courses on crown condition assessment were organized in cooperation with the European Commission (EC):

(a) Tenth Intercalibration Course on Crown Condition Assessment for Mediterranean countries held in Montpellier (France) in June 1997;
(b) Third Intercalibration Course on Crown Condition Assessment for Northern Europe held in Hole (Norway) in June 1997;
(c) Twelfth Intercalibration Course on Crown Condition Assessment for Central and Eastern Europe held in Bozi Dar (Czech Republic) in June 1997.

II. ACTIVITIES AND TASKS PLANNED FOR 1998/1999

A. Activities/tasks related to the present objectives of the programme

(a) Thirteenth Central and Eastern European Intercalibration Course (Slovenia) on crown condition;
(b) Fourth Northern European Intercalibration Course (Denmark) on crown condition;
(c) Eleventh Mediterranean Intercalibration Course (Spain) on crown condition;
(d) First Meeting of the Expert Panel on Crown Condition (Germany);
(e) Eighth Meeting of the Expert Panel on Soil (Belgium);
(f) Fifth Meeting of the Expert Panel on Foliage (Austria);
(g) Fourth Meeting of the Expert Panel on Deposition (Sweden);
(h) Publication of the 1998 Forest Condition Report (Technical Report);
(i) Publication of the 1998 Forest Condition Report (Executive Report);
(j) Publication of the 1998 Level II Report (Technical Report);
(k) Publication of the proceedings of the monitoring workshop in Belarus;
(l) Critical review of the soil survey, decision upon the repetition of the soil survey (level I);
(m) Critical review of the foliar survey, decision upon the repetition of the foliar survey (level I);
(n) Drafting of the 1999 Forest Condition Report (Technical Report);
(o) Drafting of the 1999 Forest Condition Report (Executive Report);
(p) Submission of level II data to the Forest Intensive Monitoring Coordinating Institute (FIMCI) by NFCs;
(q) Submission of level I crown condition data to PCC;
(r) Further development of methods for phenological assessments on level II;
(s) Further development of the evaluation strategy for level II by the EU and its consultant FIMCI in collaboration with the Scientific Advisory Group and NFCs.

B. Activities/task aimed at further developing of the programme

(a) Publication of the literature study on the latest state of forest damage research;
(b) Contribution to the substantive reports on trends in air pollution effects;
(c) Integrated evaluation of soil, foliar and crown condition data level I;
(d) Progress report on level III;
(e) Calculation of critical levels/loads and their exceedances on level I and II;
(f) Development of a link between levels I and II ;
(g) Establishment of a data bank system at PCC for the complete level I and II database.

C. Activities/tasks to be carried out in close cooperation with other ICPs

(a) Harmonization of methods with the ICP on Integrated Monitoring as part of the preparation for common activities on level III.

Annex II

REVIEW OF THE ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATIVE PROGRAMME ON ASSESSMENT AND MONITORING OF ACIDIFICATION OF RIVERS AND LAKES

I. ACTIVITIES SINCE THE SIXTEENTH SESSION OF THE WORKING GROUP ON EFFECTS

1. The thirteenth meeting of the Programme Task Force was held from 23 to 25 October 1997 in Pitlochry (United Kingdom) and was attended by 35 experts from 15 countries. At present 26 countries participate in the ICP Waters activities. Since last year Croatia and Estonia have joined the programme.

2. The Task Force considered two reports: (i) the draft report on critical loads and critical load exceedances for ICP Waters sites; and (ii) the report on chemical intercalibration 1997. The Task Force also reviewed the present status in data submissions and organization of the programme database.

3. The Task Force was also presented with new data on trends in surface water chemistry. Results from more than 40 ICP Waters sites had shown that curvilinear trends were common, the year 1990 could be seen as the inflection point. Sulphate was decreasing at almost all sites; the decrease was bigger in the 90s than in the 80s. Also, positive changes in alkalinity observed at European sites had confirmed the conclusions of the Nine-year report.

4. As the Nine-year report had not shown any conclusive results for assessed ICP Waters sites in the United Kingdom, a more detailed meta-analysis of trends in acidification of the United Kingdom's surface waters was undertaken. This analysis, which also included some additional sites, confirmed in principle the general trends observed in Europe.

5. The Task Force aproved the conclusions and recommendations of the draft report with preliminary results of the assessment of critical loads for ICP Waters sites. A summary of the report will be presented at the seventeenth session of the Working Group on Effects in August 1998 as document EB.AIR/WG.1/1998/8.

6. Fourty-seven laboratories in 22 countries participated (some for the first time) in the 1997 intercalibration of chemical components, covering major ions, organic matter and aluminium fractions. More than 78 per cent of the results were acceptable and in general more than 80 per cent were acceptable for most ions. For pH only 43 per cent were acceptable, stirring and/or non-stirring seems to be an important factor for determining pH. The Task Force agreed that the 1998 intercalibration exercise should focus on the same parameters as in 1997. The Task Force reiterated its offer to include in this exercise laboratories participating in activities of other ICPs.

7. Five laboratories participated in the 1997 intercalibration of biological material. As three of them were not in a position to present results, the evaluating report could not be submitted to the Task Force.

8. The programme centre in close cooperation with ICP IM is preparing the joint workshop on assessment and monitoring of aquatic biology, to be held back to back with the fourteenth meeting of the Task Force on ICP Waters in October 1998 in Zakopane, Poland.

II. ACTIVITIES AND TASKS PLANNED FOR 1998/1999

A. Activities/tasks related to the present objectives of the programme

(a) Drafting the outline for the 12-year report;
(b) Drafting the 1997 technical report on representativeness of ICP Waters sites;
(c) Drafting a report on heavy metals in the ICP Waters database;
(d) Intercalibration of biota 1998;
(e) Intercalibration of chemistry 1998;
(f) Summary of critical assessment of trends in intercalibration results.

B. Activities/tasks aimed at further developing the programme

(a) Further consideration of problems related to regional lake and river database, e.g. develop an international network to secure the necessary cover of relevant areas;
(b) Evaluate contributions to revue the sulphur protocol;
(c) Preparation for the presentation of ICP Waters on the Internet.

C. Activities/tasks to be carried out in close cooperation with other ICPs

(a) Participation in the substantive report on trends requested by the Working Group on Effects;
(b) Prepare a workshop on biological assessment and monitoring (including its financing) in cooperation with ICP Integrated Monitoring (main topic of the workshop will be the assessment of various techniques for evaluating aquatic biota).

III. LIST OF PUBLISHED DOCUMENTS AND REPORTS

Hovind, H. 1997. Intercomparison 9711. pH, K_{25}, HCO_3, NO_3 + NO_2, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC and COD-Mn. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3716-97. ISBN 82-577-3284-2. ICP-Waters-report 42/1997.

Johannessen, M. and Skjelkvåle, B.L. 1997. International Cooperative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes - ICP-Waters; Programme objectives, organisation and main results. In: Proceedings to "International Conference on management of Transboundary Waters in Europe" 22-25 September 1997 in Poland. Programme Centre, NIVA, Oslo. ICP-Waters Report 43/1997.

Henriksen, A. and Posch, M. 1998. Critical load and their exceedances for ICP-Waters sites. Programme Centre, NIVA, Oslo. NIVA-Report SNO 3821-98, ICP-Waters Report 44/1998.

Stoddard, J.L. Traaen, T.S. Skjelkvåle B.L., and Johannessen M. 1998. Assessment of Nitrogen Leaching at UN/ECE ICP-Waters sites. In press Environmental Pollution.

ICP-Waters 1998. Summary of the 9-year report. NIVA-Report SNO 3879-98. ICP-Waters report 46/1998.

Annex III

REVIEW OF THE ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATIVE PROGRAMME ON EFFECTS OF AIR POLLUTION ON MATERIALS, INCLUDING HISTORIC AND CULTURAL MONUMENTS

I. ACTIVITIES SINCE THE SIXTEENTH SESSION OF THE WORKING GROUP ON EFFECTS

1. At the thirteenth meeting of the Programme Task Force held in Rome, Italy, in May 1997, draft ICP Materials Reports No. 22-30 were presented. These include the final evaluation of 8-year exposures for individual materials and were subject to further development and analysis. The Results of environmental data from the 8-year exposure period were available in their final form (Report No. 21: Final environmental data report September 87 to August 95). This report was presented at the sixteenth session of the Working Group on Effects in 1997.

2. Further statistical analysis of trends in corrosion and environmental data was performed and resulted in the ICP Materials contribution to the substantive report "Air Pollution: past and future trends".

3. The Workshop on the Effects of Air Pollutants on Materials was held from 25 to 27 May 1998 in Berlin (Germany) to present and critically review the final evaluation of the 8-year exposure results and develop final dose-response relations. The Workshop was attended by 45 experts from 19 countries (Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Israel, Italy, Norway, Portugal, Russian Federation, Spain, Sweden, Switzerland, United Kingdom and the United States of America).

4. At the Workshop participants also reported ongoing activities related to, and results achieved by the use of dose-response functions, derived by ICP Materials, for mapping areas with a high risk of deterioration of materials and for calculating corrosion costs.

5. The fourteenth meeting of the Programme Task Force was held from 27 to 29 May 1998 in Berlin, and was attended by participants from 15 countries (Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Israel, Norway, Portugal, Russian Federation, Spain, Sweden, Switzerland and the United Kingdom). The meeting addressed in particular the following issues:

(a) Presentation and adoption of final technical reports No. 22-30 (see publication list);
(b) Planning of the multi-pollutant programme, including withdrawal of specimens, description of new test sites, exposure of additional materials and reporting of environmental data including additional measurements.

6. The new exposure programme to assess multi-pollutant effects on materials, including cultural heritage, was started in the autumn of 1997 and involves 30 test sites and 19 countries (Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Greece, Israel, Italy, Norway, Portugal, Russian Federation, Spain, Sweden, Switzerland, United Kingdom and the United States of America).

7. The withdrawal of materials after 1-year's exposure in the revised trend analysis programme was performed in autumn 1997.

II. ACTIVITIES AND TASKS PLANNED FOR 1998/99

A. Activities/tasks related to the present objectives of the programme

(a) Final report on the first phase of the programme to the Working Group on Effects at its seventeenth session in August 1998: Analysis of data after 8 years of exposure. Dose-response functions and corrosion trends (see doc. EB.AIR/WG.1/1998/9);

(b) Submission of final technical reports on analysis of 8-year environmental data and corrosion data for individaual materials group, and of the report on commun statistical analysis, including final dose-response relations. ICP Materials Reports 22-30 (see publication list);

(c) Preparation and publication of proceedings of the Workshop on the Effects of Air Pollutants on Materials (Berlin, May 1998);

(d) Preparation of a revised version of the materials chapter in the UN/ECE Mapping Manual, taking into account the dose-response functions based on the 8-year exposure;

(e) Planning of the fifteenth meeting of the Programme Task Force to be held from 9 to 11 June 1999 in Toronto, Canada;

(f) Further implementation and development of activities related to the use of dose-response functions obtained by the ICP Materials for mapping areas with a high risk of deterioration of materials and calculating corrosion costs.

B. Activities/tasks aimed at futher developing the programme

(a) Withdrawal of materials and evaluation of their 1-year exposure in the new exposure programme to assess multi-pollutant effects on materials, including cultural heritage (autumn 1998);

(b) Evaluation of the results of 1-year exposure of materials (autumn 1996-1997) in the revised trend analysis programme including zinc and steel specimens;

(c) Creation of a database of environmental data for the first year of exposure in the new network of test sites by the environmental sub-centre (Norwegian Institute for Air Research).

III. LIST OF PUBLISHED DOCUMENTS AND REPORTS

"UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 21: Final environmental data report September 87 to August 95." Norwegian Institute for Air Research (NILU), Lilleström, Norway, 1997.

"UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 22: Corrosion attack on weathering steel, zinc and aluminium. Evaluation after 8 years of exposure." SVÚOM Praha a. s. (former National Research Institute for Protection of Materials), Prague, Czech Republic, 1998.

"UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 23: Corrosion attack on copper and cast bronze. Evaluation after 8 years of exposure." Bavarian State Conservation Office, Munich, Germany, 1998.

"UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 24: Evaluation of decay to stone tablets: Part 3. After exposure for 8 years" Building Research Establishment (BRE), Garston, Watford, United Kingdom, 1998.

UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 25: Evaluation of decay to paint systems for wood, steel and galvanized steel after 8 years of exposure." Norwegian Institute for Air Research (NILU), Lilleström, Norway, 1998.

UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 26: Corrosion attack on electric contact materials. Evaluation after 8 years of exposure." Swedish Corrosion Institute, Stockholm, Sweden, 1998.

UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 27: Evaluation of decay to glass samples after 1 and 2 years of exposure." Institute of chemistry, Academy of Fine Arts, Vienna, Austria, 1998.

UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 28: Evaluation of decay to polymer samples after 4 years of exposure." Swedish Corrosion Institute, Stockholm, Sweden, Draft.

"UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 29: Trends of corrosivity based on corrosion rates. Part 2." SVÚOM Praha a. s. (former National Research Institute for Protection of Materials), Prague, Czech Republic, 1998.

UN/ECE International co-operative programme on effects on materials, including historic and cultural monuments. Report No. 30: Statistical analysis of 8 year materials exposure and acceptable deterioration and pollution levels" Swedish Corrosion Institute, Stockholm, Sweden, 1998.

Annex IV

REVIEW OF THE ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATIVE PROGRAMME ON EFFECTS OF AIR POLLUTION AND OTHER STRESSES ON CROPS AND NON-WOOD PLANTS

I. ACTIVITIES SINCE THE SIXTEENTH SESSION OF THE WORKING GROUP ON EFFECTS

1. The eleventh meeting of the programme Task Force was held at Wageningen (Netherlands) from 14 to 16 January 1998 and was attended by 42 participants from 13 countries. The Chairman of the Working Group on Effects and representatives of the Coordination Center for Effects (CCE), the Task Force on Mapping and ICP Forests were also present. New short-term objectives were set for the ICP Crops reflecting the increased participation from the mapping community; the need for further information on the responses of semi-natural vegetation to ozone; and the requirement to monitor heavy metal deposition to crops. Participants presented results and discussion papers on the physiological effects of ozone on crops and natural vegetation, and on the methods for modelling and mapping critical level exceedance and ozone fluxes to vegetation. A workshop on the use of artificial neural networks to analyse environmental data was held on the day before the Task Force meeting, and was attended by 18 participants from ICP Crops, ICP Forests and CCE.

2. Data from the 1997 experimental season of ICP Crops were collected from participants and analysed at the Programme Coordination Centre. Statistical and artificial neural network methods were used to identify the key influencing factors on the ozone dose-response relationship for clover biomass, and to validate the short-term critical level.

3. The ICP Crops Coordination Centre hosted a meeting of all groups concerned with mapping ozone effects on vegetation in December 1997. Participants from Imperial College (London, United Kingdom), Stockholm Environment Institute (York, United Kingdom), CCE, EMEP, and ICP Crops attended the meeting and agreed to share the of work for level II mapping.

4. ICP Crops data from 1989 - 1997 have been processed and described in preparation of their inclusion in the UN/ECE subtantive report on trends in the impacts of long-range transboundary air pollution.

5. Two papers describing recent ICP Crops results have been submitted to Environmental Pollution, and a further paper has been published in Transactions on Neural Networks. Three other papers have been published in Conference Proceedings, including a paper on biomonitoring of heavy metals, submitted to the UN/ECE Bad Harzburg workshop on heavy metals and POPs.

6. The 1998 experimental season of ICP Crops has been organized by the

Coordination Centre. An experimental protocol, sensitive and resistant clover clone seedlings, and wick material have been distributed to each participant. The revised experimental programme includes the clover clone experiment, monitoring of the phenology of wheat and potato, surveys of visible injury, and analysis of leaf material for heavy metal content.

7. Ms. G. Mills, Chairperson of ICP Crops, has recently moved to the Institute of Terrestrial Ecology, Bangor, United Kingdom. The Coordination Centre for ICP Crops has been transferred to the Institute of Terrestrial Ecology, Bangor Research Unit, University of Wales, Deiniol Road, Bangor, Gwynedd, United Kingdom, LL57 2UP (Telephone: +44-1248-370045, Fax: +44-1248-355365, e-mail: g.mills@ite.ac.uk). Data processing and modelling will be conducted by Mr. G. Ball, Department of Computing, Nottingham Trent University, Burton Street, Nottingham, United Kingdom, NG1 4BU (Telephone: +44-115-9418418 ex. 2218, Fax: +44-115-9486518, e-mail: graham.balls@ntu.ac.uk).

II. ACTIVITIES AND TASKS PLANNED FOR 1998/1999

A. Activities/tasks related to the present objectives of the programme

(a) Continuation of clover clone experiment to monitor the effects of exceedance of the long-term critical level for ozone on biomass;
(b) Continue to monitor the phenology of wheat and, for the first time in 1998, potato, in commercial fields to provide growth stage information for level II modelling and mapping procedures;
(c) Monitor the timing of occurrence of visible injury on clover at the experimental sites, and on commercial crops in nearby fields;
(d) Conduct the first experiments to determine the extent of heavy metal deposition on vegetation by sampling clover clone foliage for lead and cadmium content;
(e) Analyse clover clone data to determine the relative importance of level II factors, and to incorporate their influence into the dose-response function for ozone;
(f) Incorporate ozone flux estimates into the dose-response function with the aim of suggesting a critical flux of ozone for clover;
(g) Revise the short-term critical level for ozone by incorporating level II factors.

B. Activities/tasks aimed at further developing the programme

(a) Continue to review and process data to identify plants or communities of natural vegetation which are sensitive to ozone;
(b) Revise methodology for monitoring heavy metal deposition following the pilot study to be conducted during 1998;

(c) Develop methods for modelling ozone flux to vegetation.

C. Activities/tasks to be carried out in close collaboration with other ICPs

(a) Continue to coordinate level II work on critical levels for ozone, by collaborating with CCE, TF Mapping, and EMEP;
(b) Provide CCE with modified dose-response function(s) which incorporate level II factors;
(c) Provide CCE with information on sites where yield reduction and/or visible injury occurs when the critical levels for ozone are exceeded;
(d) Continue collaboration with the Task Force on Economic Assessment of Abatement Strategies by providing information necessary for the economic assessment of crop losses.

III. LIST OF PUBLISHED DOCUMENTS AND REPORTS

UN/ECE Documents:

Annual Progress Report for the ICP Crops (1997/8). To be presented at the seventeenth session of the Working Group on Effects.

Progress report on incorporating level II factors into the critical levels for ozone, and the development of maps. Technical Report to be presented at the seventeenth session of the Working Group on Effects.

UN/ECE (1998). The ICP Crops Experimental Protocol. The ICP Crops Coordination Centre, Institute of Terrestrial Ecology, Bangor, United Kingdom.

A contribution has been prepared for inclusion in the first draft of the UN/ECE Subtantive Report on Trends in the Impacts of Long-range Transboundary Air Pollution.

An ICP Crops contribution to the 1998 Joint Report of the International Cooperative Programmes and Mapping Programme was provided to the UN/ECE secretariat.

De Temmerman, L., Mills, G., Tonneijck, A. and Vandermeiren, K. Biomonitoring long-range transport of heavy metals with plant cultures. Proceedings of the UN/ECE Workshop on Heavy Metals and POPs, Bad Harzburg, November 1997.

Papers submitted for publication:

Benton, J., Fuhrer, J., Gimeno, B.S., Skärby, L., Palmer-Brown, D., Ball, G., Roadknight, C. and Mills, G. UN/ECE ICP Crops experiments into the effects of ambient ozone on crops in Europe: I - Revision of the short-term critical level for injury development. Submitted to Environmental Pollution.

Ball, G., Benton, J., Fuhrer J., Gimeno, B.S., Skärby, L., Palmer-Brown, D., Roadknight, C. and Mills, G. UN/ECE ICP Crops experiments into the effects of ambient ozone on crops in Europe: II - Factors which modify the biomass dose response relationship for white clover (Trifolium repens). Submitted to Environmental Pollution.

Benton, J. (1998). Ozone Pollution and Crop Production. The Agronomist.1/98 p. 7-10.

Roadknight, C. M., Ball, G. R., Mills, G. E., and Palmer-Brown, D. (1997). Modelling complex environmental data. Transactions on Neural Networks, 8, 856 - 862.

Roadknight, C. M., Palmer-Brown, D. and Mills, G.E. (in press). The analysis of artificial neural network data models. Accepted by the International Symposium on Intelligent Data Analysis, Birkbeck College, August 1997.

Roadknight, C. M., Palmer-Brown, D. and Mills, G. E. (in press). Correlated Activated Pruning (CAPing). Lecture notes in Computer Science. Springer-Verlag.

The following paper was published using some information and data supplied by ICP Crops participants:

Lyons, T.M., Barnes, J.D. and Davison, A.D. (1997). Relationships between ozone resistance and climate in European populations of Plantago major. New Phytologist. 136, 503-510.

Annex V

REVIEW OF THE ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATIVE PROGRAMME ON INTEGRATED MONITORING OF AIR POLLUTION EFFECTS ON ECOSYSTEMS

I. ACTIVITIES SINCE THE SIXTEENTH SESSION OF THE WORKING GROUP ON EFFECTS

1. The sixth meeting of the Programme Task Force on ICP Integrated Monitoring was held in Tallinn, Estonia, from 20 to 22 April 1998. The meeting was attended by 39 experts from 16 countries.

2. The revision of the ICP IM manual was a priority in the 1997/1998 programme. Following the in-depth discussion of the first draft of the revised ICP IM manual at the fifth Task Force meeting in Dwingeloo, Netherlands, in 1997, the Programme Centre, assisted by an editorial group, produced a second draft. This 2.0 draft was sent out to National Focal Points and other ICPs for comments in September 1997. The received comments were incorporated into the third draft of the manual, distributed in February 1998. The third draft was approved with some amendments at the sixth Task Force meeting. The final version of the revised ICP IM manual will be presented at the seventeenth session of the Working Group on Effects in August 1998.

3. In October 1997 the National Focal Points (NFPs) reported their 1996 results to the IM Programme Centre. The Programme Centre carried out, to a certain degree, a quality control of the results and incorporated them into the ICP IM database.

4. Institutes participating in ICP IM activities in Denmark, Finland, Spain, Sweden and the United Kingdom continued to receive funding from the LIFE Financial Instrument of the European Union for the ongoing project on the development of assessment and monitoring techniques at integrated monitoring sites in Europe. The final report from this project will be available in June 1998.

5. A workshop on field methods, as part of the EU/LIFE project, was held in Asa, Sweden, from 15 to 17 September 1997.

6. A workshop on advanced data analysis for modelling and assessment of biogeochemical effects of air pollution in temperate ecosystems was held in Madrid, Spain, from 8 to 11 October 1997, as part of the EU/LIFE project.

7. The programme centres of ICP IM and ICP Forests have continued their cooperation aiming, in particular, to harmonize manuals and identify possible common monitoring sites. The progress report on this activity will be presented to the Working Group on Effects in August 1998.

8. The joint report on temporal trends 'Air Pollution: Past and Future Trends' is being prepared by all ICPs and the Mapping Programme. ICP IM contributes to the UN/ECE substantive report on temporal trends in the impacts of air pollution with data on measured trends in bulk deposition, throughfall and water chemistry as well as modelled trends in soil and water acidification. The ICP IM contribution is based on results presented in the Sixth Annual Report and results from the EU/LIFE project.

II. ACTIVITIES AND TASKS PLANNED FOR 1998/1999

A. Activities/tasks related to the present objectives of the programme

(a) Inclusion of quality controlled national data for 1997 in the IM database (October 1998);
(b) Processing of additional information (background info/site descriptions) at the Programme Centre and inclusion in GIS database (1998/1999);
(c) Finalization of the IM Manual and presentation to the Working Group on Effects (August 1998);
(d) Continued trend analysis and further elaboration of ICP IM parts of the joint report: 'Air Pollution: Past and Future Trends' (1998/1999).

B. Activities/tasks aimed at further developing the programme

(a) Assessment of heavy metal pools and fluxes at ICP IM sites (starting 1998 under the leadership of Sweden);
(b) Continued efforts to enhance studies on bio-indication;
(c) Cooperation with other organizations and research projects outside the Convention, e.g. EU/NoLIMITS and IFEF projects and GTOS (1998/1999).

C. Activities/tasks to be carried out in close cooperation with other ICPs

(a) Preparations for the joint ICP Waters and ICP IM workshop on assessment and monitoring of aquatic biology (Zakopane, Poland, October 1998);
(b) Comparison of sites, exchange of information and data with other ICPs, to optimize the network of monitoring sites (1998/1999);
(c) Participation in inter-laboratory comparisons organized by other ICPs (1998/1999).

III. LIST OF PUBLISHED DOCUMENTS AND REPORTS

Forsius, M., Alveteg, M., Bak, J., Guardans, R., Holmberg, M., Jenkins, A., Johansson, M., Kleemola, S., Rankinen, K., Renshaw, M., Sverdrup, H. and Syri, S. 1997. Assessment of the Effects of the EU Acidification Strategy: Dynamic modelling on Integrated Monitoring sites. Finnish Environment Institute, Helsinki. ISBN 952-11-0979-3. 40 p.

Forsius, M., Alveteg, M., Jenkins, A., Johansson, M., Kleemola, S., Lükewille, A., Posch, M., Sverdrup, H. and Walse, C. 1998. MAGIC, SAFE and SMART model applications at Integrated Monitoring Sites: Effects of emission reduction scenarios. Water, Air and Soil Pollution (in press).

Forsius, M., Guardans, R., Jenkins, A., Lundin, L. and Nielsen, K.E. (eds.) 1998. Integrated Monitoring: Environmental assessment through model and empirical analysis - Final results from an EU/LIFE-project. The Finnish Environment 218 (in press). Finnish Environment Institute, Helsinki. ISBN 952-11-0302-7. 172 p.

Kleemola, S. and Forsius, M. (eds.) 1998. ICP Integrated Monitoring, 7th Annual Report. The Finnish Environment (in press). Finnish Environment Institute, Helsinki.

Annex VI

REVIEW OF THE ACTIVITIES AND ACCOMPLISHMENTS OF THE MAPPING PROGRAMME CARRIED OUT BY THE TASK FORCE ON MAPPING AND THE COORDINATION CENTER FOR EFFECTS

I. ACTIVITIES SINCE THE SIXTEENTH SESSION OF THE WORKING GROUP ON EFFECTS

A. Introduction

1. The Task Force on Mapping at its fourteenth meeting, held back to back with the ninth CCE Workshop, reviewed the present state of relevant technical knowledge and availability of data, taking into account the results of recent workshops.

2. In the programme activities special attention was given to the refinement of critical load maps by applying and further developing the methods laid down in the Mapping Manual, with the aim of supplying a firm and harmonized basis for negotiations of a new multi-pollutant multi-effect protocol on nitrogen oxides and related substances.

B. Recent workshops on critical levels and loads

3. The ninth CCE Workshop on mapping critical loads and levels, held in Kristiansand, Norway, in May 1998, reviewed and discussed recent results on mapping critical loads and levels on national and European levels and methodologies to be used in future mapping activities. The main results and conclusions of the workshop are:

(a) There has been continuing improvement in the European critical loads database with respect to geographical coverage, methodology and quality of results. The transparency of the database has also increased. Still, some problems remain with respect to data resolution, density and coverage;
(b) It was recommended that European critical load exceedence maps should present results of ecosystem protection precentages. The use of average accumulated exceedences and numbers derived from them should be limited to defining targets in integrated assessment model optimization;
(c) It was strongly recommended that when using critical loads data within the European Union Strategy to combat acidification, integrated assessments should take into account all ecosystem processes regarding nitrogen (i.e. eutrophication in addition to acidification).

4. The Workshop on critical limits and effect-based approaches for heavy metals and persistent organic pollutants was held in November 1997 in Bad Harzburg, Germany. The Workshop adopted a number of conclusions and recommendations and stressed that:

(a) Critical loads could and should be determined and mapped for a number of heavy metals; risk assessment methods for POPs should be further developed on a voluntary basis; and critical limits for heavy metals and POPs should be further developed in close cooperation with other international organizations;
(b) Further work is necessary before effect-based approaches can be fully implemented for heavy metals and POPs. However, within a reasonable time-frame, e.g. 5 years, these approaches might be applied in such a way that the results could form a basis for policy decisions.

C. Review of activities within the mapping programme

5. Revised maps of critical loads for nitrogen and sulphur ($CL_{max}(S)$, $CL_{min/max}(N)$ and $CL_{nut}(N)$ based on national data from 24 countries (including for the first time data from Bulgaria, Belarus, Republic of Moldova and Slovakia) were presented at the fourteenth meeting of the Task Force on Mapping. The variation of critical load input variables between countries due to methodological/conceptual differences has decreased due to a more widespread application of Mapping Manual methods. The Task Force adopted these maps for submission to the Working Group on Effects (see document EB.AIR/WG.1/1998/5) on the understanding that comments from some National Focal Centres (Austria, Germany, Ireland, Sweden and United Kingdom), discussed at the Task Force meeting, would be incorporated.

6. Isolines of ecosystem protection and accumulated exceedances have been computed for each EMEP grid cell and provided to the modelling groups under the Task Force on Integrated Assessment Modelling for use in integrated assessment. These data have also been used in other work such as the EU Acidification Strategy. The definition of accumulated exceedances has partly solved the problem of having to decide between ecosystem gap closure (reducing the unprotected ecosystem area by a certain percentage) and exceedance gap closure (reducing the exceedance of the fifth-percentile critical loads by a certain percentage).

7. The investigation into uncertainties in critical load calculations was further intensified by National Focal Centres and by CCE. A progress report on this investigation will be presented at the eighteenth session of the Working Group on Effects in 1999.

8. As part of the work to prepare maps of critical levels of ozone and their exceedances, preliminary assessments of critical levels for ozone using a level II approach (including modifying factors) have been carried out in cooperation with ICP Crops and EMEP/MSC-W.

9. In collaboration with CCE, ICP Waters computed critical loads and their exceedances for 92 watersheds in Europe and North America. In 1990, critical loads for acidity were exceeded at 51 of the 72 European sites. At 32 they

will still be exceeded in 2010 under current emission reduction plans. This shows that there is a strong need to further decrease emissions.

10. The results of the workshop on critical limits and effects-based approaches for heavy metals and persistent organic pollutants were presented to the Executive Body at its fifteenth session and the workshop report (document EB.AIR/WG.1/1998/13) will be considered by the Working Group on Effects at its seventeenth session. The Task Force on Mapping expects the Working Group on Effects to discuss and decide on proposed activities concerning heavy metals and POPs within the Mapping Programme and the other ICPs.

II. ACTIVITIES AND TASKS PLANNED FOR 1998/1999

A. Activities/tasks (incl. preparation of reports and documents) related to the present objectives of the programme

(a) Continue to update databases of critical loads of sulphur and nitrogen, based on the EMEP 50 x 50 km² grid;
(b) Further develop European stock-at-risk maps, based on European land-use maps;
(c) Develop critical limits for heavy metals and persistent organic pollutants (POPs) and critical loads for heavy metals, in accordance with the conclusions and recommendations of the 1997 Bad Harzburg Workshop;
(d) Organize subregional workshops to facilitate the comparison of mapping values in border areas as well as to further increase participation of Mediterranean and east European countries;
(e) Continue to analyse exceedance calculations using the critical load functions in a multi-pollutant, multi-effect approach, especially considering accumulated exceedances;
(f) Investigate uncertainties in critical load and critical load exceedance calculations and, if appropriate, agree on a revision of methods laid down in the Mapping Manual.

B. Activities/tasks aimed at further developing of the programme

(a) Propose updated objectives and, if appropriate, amend scope and objectives of the Mapping Programme, considering priorities of the Executive Body and the Working Group on Effects, as well as those of individual countries and other international organizations such as the European Commission.

C. Activities/tasks to be carried out in close cooperation or jointly with other programmes

(a) Assist the Task Force on Integrated Assessment Modelling in performing

integrated assessment for the negotiations of a new nitrogen protocol;

(b) Identify trends and effects associated with the implementation of the Protocol on Further Reduction of Sulphur Emissions;

(c) Develop methods to scale critical level (e.g. ozone AOT40) exceedances and critical load exceedances between EMEP grid and small-scale values up or down.

(d) Map critical levels, giving priority to critical levels of ozone for crops and their exceedances including modifying factors (Level II);

(e) Further develop dynamic modelling procedures in cooperation with ICPs and NFCs.

III. LIST OF PUBLISHED DOCUMENTS AND REPORTS

Hettelingh, J.-P., M. Posch and P.A.M. de Smet, 1997. The use of critical thresholds to assess natural stock at risk. Environmental Research Forum Vols.7-8, pp. 536-544.

Posch, M., 1998. Averaging and other simplifications in dynamic soil models. In: DIAE/CIEMAT (ed.): Data Analysis for Modelling and Assessment of Biogeochemical Effects of Air Pollution in Temperate Ecosystems. Workshop Report, CIEMAT, Madrid, Spain, pp.61-67.

Henriksen A. and M. Posch, 1998. Critical loads and their exceedances for ICP-Waters sites. ICP-Waters Report 45/1998. Norwegian Institute for Water Research, Oslo, Norway, 35 pp.

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