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WORKSHOP ON MAPPING AIR POLLUTION EFFECTS ON MATERIALS, INCLUDING STOCK AT RISK

Summary report prepared by the workshop's Co-Chairmen

I. INTRODUCTION

1. The workshop on mapping air pollution effects on materials, including stock at risk, took place in Stockholm, Sweden, from 14 to 16 June 2000. The workshop was organized by the Swedish Corrosion Institute, Stockholm, and the German Federal Environmental Agency (UBA), with support from the Swedish Environmental Protection Agency, the Nordic Council of Ministers, and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

2. The workshop was attended by 33 experts from 17 countries (Belarus, Belgium, Bulgaria, Czech Republic, Estonia, France, Germany, Italy, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Russian Federation, Sweden, Switzerland and United Kingdom). The workshop was co-chaired by Mr. H. Gregor (Germany), Chairman of the International Cooperative Programme (ICP) on Modelling and Mapping, and Mr. V. Kucera (Sweden), Chairman of ICP

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Materials. It was also attended by several other members of the Task Forces on ICP Modelling and Mapping and ICP Materials, as well as by representatives of the Coordination Center for Effects (CCE) and the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

3. The major objectives of the workshop were to:

(a) Review the present state of knowledge regarding mapping areas of increased risk of corrosion and regarding inventories of stock of materials at risk, for the purpose of estimating economic damage due to corrosion;
(b) Provide the basis for recommendations of common mapping procedures and for methodologies on the assessment of stock at risk, thereby facilitating reliable comparisons between Parties to the Convention;
(c) Propose revisions of the Mapping Manual based on the conclusions from the workshop.

4. The workshop addressed the following issues:

(a) Applicability of available dose-response functions for mapping procedures;
(b) Differences and similarities of mapping procedures for ecosystems and materials;
(c) Requirements and availability of pollution and meteorological parameters for mapping at European, national and urban scales;
(d) Applicability of methods for assessing the stock of materials at risk on different objects including cultural heritage;
(e) Applicability of methods for assessing the stock of materials at risk on different geographical scales, including the use of satellite data and census data for mapping;
(f) Possibilities for transferring stock-at-risk data between cities; and
(g) Updating the Mapping Manual (especially its chapter 4).

II. WORKSHOP DISCUSSIONS

5. The workshop was opened by Mr. L. Lindau (Sweden), who welcomed the participants on behalf of the host country and the host authorities/organizers.

6. Mr. H. Gregor and Mr. V. Kucera reviewed the background of the workshop, described its aims and introduced its programme.

7. The workshop was organized in a series of plenary sessions, during which 15 papers were presented. Detailed discussions were carried out in two parallel discussion groups. The outcome of these discussions was then considered and summed up during the final plenary session.

8. The background papers, which provided the basis for the discussions, focused on:

(a) Trends in corrosion due to acidifying air pollutants;

(b) Mapping of areas with increased risk of corrosion in Bulgaria, China, Germany, Norway and Switzerland;

(c) Assessment of stock of materials, including cultural heritage, at risk at different scales (world, regional, national and city/district);

(d) Calculation of costs caused by environmental impact;

(e) Heavy metals release by corrosion of structural materials; and

(f) Mapping Manual: its purpose, present state, needs for updating.

III. SPECIFIC CONCLUSIONS AND RECOMMENDATIONS

A. Applicability of available dose-response functions for mapping procedures

9. The unified ICP Materials 8-year dose response functions are at present the best available functions to apply for mapping procedures on both national and European scales. They are based on a combination of experimental data and the results of its statistical analysis taking into account the current state of knowledge relating to the deterioration of materials.

10. All countries are encouraged to attempt to produce maps of the effect of pollution on buildings and building materials using the ICP Materials damage functions. This work will need to be coordinated and additional funding at national or international level may be required and should be addressed.

B. Differences and similarities of mapping procedures for ecosystems and materials

11. In principle no difference exists between mapping procedures of ecosystem receptors and material receptors. As mapping procedures are similar, the approach of “acceptable” corrosion rates and pollution levels can be applied in a similar way as the concepts of critical levels/loads.

12. However, a major difference between the mapping procedures of ecosystem receptors and material receptors is the geographical distribution of the stock at risk and its concentration in specific and defined locations, non-urban areas for ecosystems and urban areas for materials. This leads to difficulties using identical environmental data sets.

13. In the future, effort needs to be concentrated on the collection of data on the geographical distribution and quantity (stock) of the materials at risk. In some countries this may require work nationwide, but in others it is likely that it will require work to be concentrated on urban areas.

14. Differences and similarities of mapping procedures for cultural heritage and other materials also need to be taken into account.

C. Requirements and availability of pollution and meteorological parameters for mapping on European, national and urban scales

15. As a first step, mapping on a 50 km x 50 km grid is possible at the European scale, but for future refinements a smaller grid resolution is preferred.

16. Mapping at a national scale is possible and this has already been carried out at scales varying between 50 km and 1 km squares. ICP Modelling and Mapping should provide a document investigating the effect of mapping at different scales, from 50 km x 50 km to 1 km x 1 km.

17. Many of the required environmental and pollutant data are in principle available on the regional scale, for example from EMEP. In the case of EU countries much of this is required to fulfil various EU directives. However, every country will need to identify its own data sets.

18. There is a need, however, to characterize pollution and meteorological parameters of urban areas due to the high concentration of materials at these locations. In the mapping of urban areas it will also be important to consider the high temperatures found in larger cities ('heat island effects') and reduced relative humidities. It will also be important to consider the correlation between concentrations of NO_2 and O_3, otherwise the mapping of O_3 in urban areas may be difficult. In the future it will probably also be necessary to obtain data on particulates and HNO_3.

19. It is likely that benefits will arise from a cooperation between the World Health Organization (WHO) and UN/ECE. From an integrated assessment point of view, there is a link between the conditions that lead to corrosion and those that affect human health, for example high concentrations of particulates. Also, both stock of materials at risk and people at risk are concentrated in urban areas.

D. Applicability of methods for assessing the stock of materials at risk on different objects, including cultural heritage

20. It should be noted that the terms "building stock" and "stock at risk" are taken to include also technological infrastructure (for example, electrical transmission towers, railway bridges, fuel storage tanks, etc.). The available assessment methods are applicable to most of the building stock, the main exceptions are individual and unique buildings. The methods all use a generalization based on limited samples of buildings.

21. Cultural heritage should be treated as a special case in stock-at-risk assessment – some objects can be generalized but some require individual attention (for example Notre Dame, Paris, or S. Marco Square, Venice). This should help to ensure that this important part of stock is not overlooked in international policy negotiations.

22. Some attempts have been made to use production figures and import statistics but the considerable uncertainty in the end-use makes the application of this method very difficult.

23. In working out the responses to pollution, the application of more resistant materials should also be taken into account (in these cases the surfaces are usually not maintained or replaced earlier in polluted atmospheres).

E. Applicability of methods for assessing the stock of materials at risk on different geographical scales, including use of satellite data and census data for mapping

24. A range of methods can be applied to estimate the stock of buildings; the method chosen will depend on the scale at which mapping is to be undertaken. Scales to be considered include regional (European), national, district/city, and individual buildings.

25. At the regional scale, the assessment can be based on census data (population, floor space per person), and a generalized set of data of materials per square metre of floor space.

26. At the national scale, assessment can be based on census data, identikits, land coverage, satellite images or other land-use data.

27. Identikits are defined as the classification of the building stock into different building types and the quantification of the materials for each building element in each building type. Identikits are good for generalizations but not for specific buildings.

28. At the district/city scale, assessment can be based on identikits, building registers, inspections, street maps and aerial photos. This approach can also be applied to ‘quarters’ within cities if there are areas with discrete characteristics.

29. Individual buildings are best assessed by surveys, inspections and photographs.

F. Possibilities for transferring stock-at-risk data between cities

30. Data for stock at risk can be transferred from one geographical area to another where no data exist. However, it should be noted that this may involve large uncertainties since some parts of the information might not be transferable. However, it should be considered a temporary measure until local data become available.

31. If no data exist for a particular location then a set of default values should be used. These should be based on the data available for other cities or countries – for example data are available for Stockholm, Oslo, Prague, Birmingham, Lincoln, Ostrava, and data for galvanized steel constructions for Germany.

G. Updating the Mapping Manual (Chapter 4)

32. The participants of the workshop agreed that the current chapter 4 in the Mapping Manual required some revision. The workshop recommends the following changes:

(a) The existing dose-response functions should be changed to the ICP Materials dose-response functions based on the 8-year exposure period. At present there are dose-response functions available for weathering steel, zinc (galvanized steel), aluminium, copper, bronze, limestone, dolomitic sandstone, glass representative of medieval stained-glass windows, painted wood and painted steel. The dose-response functions for these materials are based on measurement

of SO_2, temperature, relative humidity, O_3, amount of precipitation and acidity and chloride concentration of precipitation;

(b) The Mapping Manual should continue to include provision for the use of alternative dose-response functions if these are more appropriate to particular circumstances. However, whenever possible the functions listed in the Manual should be used;

(c) The Manual should state that mapping the potential corrosion or deterioration of materials should be carried out using the EMEP 50 km x 50 km grid and that data on the required pollutant and meteorological parameters are available on this scale from EMEP. However, for mapping the deterioration of materials the uncertainties over the use of these data for urban areas means that data specific to those urban areas on a finer scale should be sought whenever possible;

(d) The method for estimating O_3 from NO_2 concentrations should continue to be included in the Manual;

(e) Consideration should be given to revising the method for assessing background levels. This could involve the replacement of the '10-percentile' with a background based on natural pollutants. The revision should include a procedure for the assessment. However, the Manual could also include default values for background levels for national or international scale mapping;

(f) The Manual should continue to include the concept of 'acceptable levels' but the title of the chapter should be changed to remove direct reference to the concept. This concept is still seen as an important tool for producing outputs from any mapping exercise as it provides policy makers with methods to study the benefits of pollution abatement policy. The exact choice of acceptable level and 'n' value may depend on national policy;

(g) Methods for determining the building stock and its spatial distribution, and details of default values based on existing studies should be included in the stock-at-risk section. Details of references for previous studies should also be included;

(h) The calculation of costs resulting from corrosion is very important and so the current section 4.2.4 should be extended to include some references to previous work on the calculation of costs.

33. There are other groups of materials that are important but not currently included in the Manual. These groups include those where dose-response functions are available but only from limited studies (for example polymers) and those where dose-response functions are not available.

34 ICP Materials will be responsible for the revision of chapter 4 of the Mapping Manual with the support of ICP Modelling and Mapping. The revised chapter will be presented to both Task Forces at their respective meetings in 2001.

IV. OVERALL CONCLUSIONS AND RECOMMENDATIONS OF THE WORKSHOP

35. The available dose-response functions have proved to be useful for mapping; this has been demonstrated by the results of mapping exercises in a number of countries. Even so, there is a need to verify the mapping exercises by additional exposure of materials in individual countries.

36. Stock-at-risk data are an essential part of any estimate of the extent of damage to materials and the associated costs, and the potential benefits of pollution abatement. However, at present

only a limited number of assessment studies of stock of materials at risk is available within the UN/ECE region.

37. The workshop acknowledged that, despite the substantial progress made during the past years, there were still important gaps of knowledge:

(a) More research is needed to improve dose-response functions in general but especially to cope with changes over time in environmental conditions, in particular the reductions in SO_2 and the relative, or absolute, increase in the effect of suspended particulates and HNO_3. Particulates are seen as an important area since their removal from building materials by cleaning can have a very significant economic cost. In the case of particulates, it is likely that both materials directly affected by acidic gases and others that are usually considered inert will need to be investigated. In addition, the functions should be applicable to long time periods and so they need to take into account 'steady state' corrosion;

(b) In the future, effort needs to be concentrated on the collection of data on the geographical distribution and quantity (stock) of the materials at risk. In some countries this may require work nationwide, but in others it is likely that it will require work to be concentrated on urban areas. Each study reported will strengthen the database for estimates of the extent of damage to materials and the associated costs, and the potential benefits of pollution abatement;

(c) The ecological risks of the release of heavy metals from structural materials to soils, surface waters and groundwaters should be investigated. As a first step, dose-response functions for calculating the run-off of metals from materials exposed in the atmosphere are required.

38. A common methodology for the assessment of stock of materials at risk should be worked out in order to facilitate comparisons. It may be necessary to adjust the building type sub-divisions (for example the limits for different time periods) to take account of local conditions and the format of national census data. The methodology should be made available to all countries and mapping at an international level should be encouraged.