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Working Group on Effects

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Progress in activities in 2014 and further development of effects-oriented activities

Effects of air pollution on materials

Progress report by the Programme Coordinating Centre of the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments

Summary

The present report presents the results of the activities undertaken over the past year since the previous report by the Programme Coordinating Centre for the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments to the Working Group on Effects. The activities and the report on them are in accordance with the request of the Executive Body to the Convention on Long-range Transboundary Air Pollution in its 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2, items 1.1.10 and 1.1.14). The report details, in particular, trends in corrosion of carbon steel, zinc, copper and limestone (1987–2012) and soiling of modern glass (2005–2012) and summarizes the current status of the pilot study on inventory and condition of stock of materials at risk at the United Nations Educational, Scientific and Cultural Organization (UNESCO) cultural heritage sites.

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I. Introduction and overview of deliverables

1. The present report by the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials) describes results and activities carried out by that programme since its last report to the Working Group on Effects, submitted to the Working Group's thirty-second session (Geneva, 12–13 September 2013). The results are presented here in accordance with items 1.1.10 (a)–(c) and 1.1.14 of the 2014–2015 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/122/Add.2). Workplan item 1.1.14 (b) (United Nations Educational, Scientific and Cultural Organization (UNESCO) sites) will be reported on by ICP Materials in its next annual report to the Working Group.

2. ICP Materials is co-chaired by Mr. Johan Tidblad (Sweden) and Mr. Pasquale Spezzano (Italy) with Johan Tidblad acting also as head of the ICP Materials Programme Centre. Austria, the Czech Republic, Estonia, Finland, France, Germany, Greece, Italy, Norway, Poland, the Russian Federation, Spain, Sweden, Switzerland and the United Kingdom of Great Britain and Northern Ireland (15 countries and approximately 30 experts) participate in the work of ICP Materials. There are also currently discussions under way with Slovakia and the United States of America about the possibility of their joining the programme by providing a test site.

3. The thirtieth meeting of the ICP Materials Task Force was held in Stockholm from 23 to 25 April 2014 with 18 participants from 10 countries.

4. During 2013 the following reports were delivered: Report No. 72, Results of corrosion and soiling from the 2011–2012 exposure programme for trend analysis; Report No 73, Pilot study on inventory and condition of stock of materials at risk at UNESCO cultural heritage sites, Part III economic evaluation; and Report No 74, Results of the exposure on modern glass 2008–2012 and soiling dose-response functions.

5. In 2014, the following reports are expected: Report No 75, Environmental data report, October 2011 to November 2012; and Report No 76, Trends in pollution, corrosion and soiling 1987–2012.

6. In addition, a call for data on inventory and condition of stock materials at UNESCO cultural heritage sites is expected to be pre-announced at the Working Group's thirty-third session, then finalized and submitted to the Working Group in 2015 for its consideration and adoption. The call is expected to be launched in early 2016.

II. Workplan items common to all International Cooperative Programmes

A. Guidelines on reporting of monitoring and modelling of air pollution effects

7. The guidelines for reporting on the monitoring and modelling of air pollution effects (ECE/EB.AIR/2008/11)[1] specify that for effects of particulate matter on materials the

[1] Adopted by the Executive Body for the Convention by its decision 2008/1 (see ECE/EB.AIR/96/Add.1).

degree of soiling should be reported, and for multiple pollutant effects on materials the corrosion of indicator materials carbon steel, zinc and limestone should be reported. This is part of the ongoing activities of ICP Materials (for exposure of materials for trend analysis, see below).

B. Efforts to enhance the involvement of countries in Eastern Europe, the Caucasus and Central Asia

8. The Russian Federation is an active member of the ICP Materials Task Force and contributes with an exposure site in the ongoing exposure for trend analysis. Discussions are also ongoing to increase its involvement by providing an additional test site in Moscow and organizing a Task Force meeting in the Russian Federation with an increased number of invitations for participants from countries in Eastern Europe, the Caucasus and Central Asia.

C. Cooperation with programmes and activities outside the region

9. Even though the technical procedures specific for ICP Materials are given in its technical manuals,[2] ICP Materials prefers to use International Organization for Standardization (ISO) standards to describe general methodologies for managing test sites and exposing samples on test sites. The advantage is that ISO methodology is used not just in the United Nations Economic Commission for Europe (ECE) region but worldwide.

10. In this context, participants from two important groups were invited to give presentations at the Task Force's thirtieth meeting: Working Group 4 (WG 4) on atmospheric corrosion testing and classification of ISO Technical Committee (TC) 156 on corrosion of metals and alloys (ISO/TC 156/WG4);[3] and European Committee for Standardization (CEN) TC 346 on conservation of cultural property.[4]

11. A representative of ISO/TC 156/WG4 informed the Task Force about a proposal for a new work item on the production of a technical specification of mapping procedures for metallic materials. It is especially important that ICP Materials is represented in this work and communicates with the International Cooperative Programme on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping) to ensure that contents of this specification are in agreement with the *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*[5] (Modelling and Mapping Manual).

[2] See http://www.corr-institute.se/ICP-Materials/web/page.aspx?refid=16.

[3] See http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=53264.

[4] See http://ge-iic.com/ojs/index.php/revista/article/view/194.

[5] Germany, Federal Environmental Agency (Berlin: December 2004). Available from http://www.icpmapping.org/Mapping_Manual.

III. Workplan items specific to the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments

A. Corrosion and soiling of selected materials under different environmental conditions

12. Exposures for trend analysis are performed each third year in the network of ICP Materials test sites. Results from the 2011–2012 exposure for trend analysis were reported in 2013 and included 23 test sites in Austria, Bulgaria, the Czech Republic, France, Germany, Greece, Italy, Latvia, Norway, Poland, the Russian Federation, Spain, Sweden and Switzerland. The exposure was extended with additional materials and exposure duration and included the traditional corrosion trend materials, carbon steel, zinc and limestone (one and four years), and in addition weathering steel (one, two and seven years), copper (one year) and aluminium (two years). Soiling was performed — as usual — with exposure of modern glass for one year since an extended exposure is ongoing with final four-year withdrawal in 2012 and reporting in 2013.

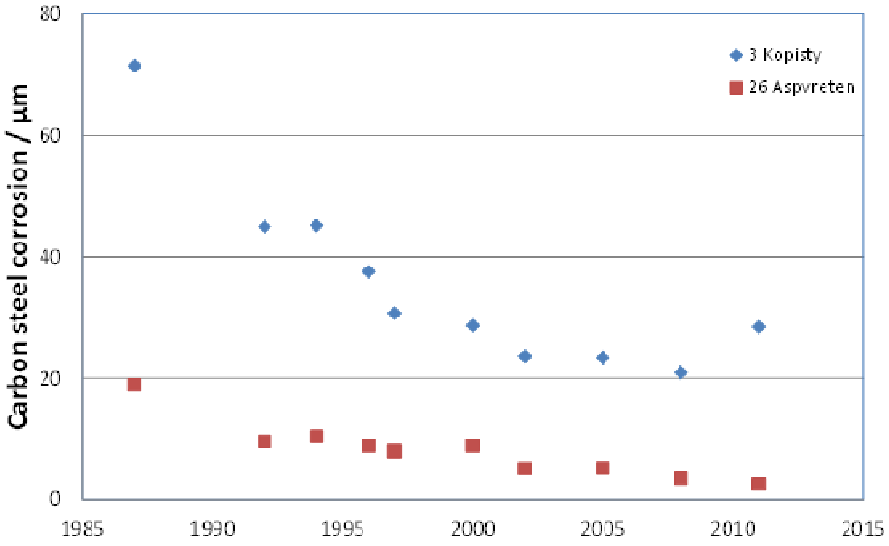
13. The environmental characterization was also extended with a one-year campaign by including measurements of formic and acetic acid, which were possible new important confounding factors, in addition to the normal characterization of the gaseous pollutants sulphur dioxide, nitrogen oxides, ozone and nitric acid. However, the concentrations of formic and acetic acid are very low outdoors and do not significantly contribute to corrosion. Therefore, they will not be included as recommended measured parameters for ICP Materials.

14. The 2014 report (report No. 76 mentioned above) on trends in pollution, corrosion and soiling 1987–2012 focuses on the policy-relevant questions with answers based on corrosion of carbon steel, zinc, copper and limestone (1987–2012) and soiling of modern glass (2005–2012). The policy-relevant questions are discussed below.

15. *What improvements in corrosion and soiling of materials and cultural heritage can be observed?* Since 1987 corrosion of all materials has decreased substantially. The magnitude of the decrease varies from site to site and depending on material, but is typically 50 per cent. Some improvements can be observed since the year 2000, for example, for carbon steel, but these improvements are minor. This is illustrated in figure 1, which shows corrosion of carbon steel exposed at two selected test sites. Worth noting is that even for the originally “clean” site (Aspvreten), there has been substantial improvement in corrosion and air quality during this period.

Figure 1

Carbon steel corrosion (in micrometres (µm)) after one year of exposure at two selected sites in the ICP Materials network: Kopisty, Czech Republic, and Aspvreten, Sweden



16. *What are the main pollutants responsible for corrosion and soiling of materials and cultural heritage, and can the most recent dose-response functions predict corrosion and soiling in the current multi-pollutant situation?* The importance of sulphur dioxide for corrosion has decreased substantially over the period studied, but it still plays some role. Nitric acid and particulate matter (including black carbon) are still of great importance for corrosion and soiling of materials and cultural heritage. Wet acid deposition is of less importance, but is still significant for corrosion of some materials and in some locations. Functions developed for the multi-pollutant situation can predict corrosion only to some degree and it is suggested that they can be improved taking into account data that has been gathered since their development.

17. *Considering the improvements, are there still differences in corrosion and soiling between polluted and non-polluted areas?* Corrosion and soiling is still above the 2020 target for a few sites and above the 2050 target for even more sites, with the exceedances occurring at the most polluted sites.

18. *Will climate change decrease or increase the risk of corrosion and soiling due to pollution?* For polluted areas, with no significant influence of chloride deposition, climate change will result in increased corrosion in the north and decreased corrosion in the south, and if pollution is constant. This will require stronger demands on air quality standards for Northern Europe related to corrosion. The magnitude of the effect is very uncertain, and present estimates are dependent on the scenario used for climate change. Climate change will not affect the risk for soiling, but one of the main important parameters, black carbon, is also a short-lived climate forcer.

B. United Nations Educational, Scientific and Cultural Organization cultural heritage sites

19. ICP Materials is continuing a pilot study on inventory and conditions of stock of materials at risk at five UNESCO cultural heritage sites: Paris, France (banks of the Seine);

Prague, Czech Republic (National Library); Berlin, Germany (Neues Museum); Bath, United Kingdom (Royal Crescent); and Greece, Athens (the Parthenon).

20. Estimation of corrosion costs at the five selected sites shows that actual corrosion due to air pollution would result in material deterioration costs ranging from €9.2 per square metre per year (m^{-2} $year^{-1}$) to €43.8 m^{-2} $year^{-1}$, dep ending on the status of the material, the pollution level and the climatic conditions. These costs add to the cost in background areas, estimated from €14 m^{-2} $year^{-1}$ to €28 m^{-2} $year^{-1}$. Cost estimates are, however, subject to uncertainty due to the assumption in estimating lifetimes of materials and the cost of the interventions.

21. At current air concentrations, sulphur dioxide is no longer the dominant factor for the degradation of these selected monuments. Nitric acid and particulate matter seem to play a prominent role in determining corrosion damage of limestone. In developing future actions for protecting historical and cultural monuments like the UNESCO cultural heritage sites, it would be important to consider the reduction of atmospheric nitric acid and particulate matter with a size less than or equal to 10 microns in diameter concentrations.

IV. Messages for the attention of other bodies

22. The four policy questions related to trends in corrosion and soiling (see paras. 15–18) are policy-relevant issues for the attention of the Executive Body to the Convention and its relevant subsidiary bodies, and for the general public.

23. The information on a proposal for a new work item on the production of a technical specification of mapping procedures (see para. 11) is for the attention of ICP Modelling and Mapping, and the information on formic and acetic acid (para. 13) and the occurrence of independent measurements of these parameters is for the attention of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

24. The information regarding the involvement of the Russian Federation (see para. 8) is relevant for the further involvement of countries in Eastern Europe, the Caucasus and Central Asia.

25. Technical cooperation with ISO bodies is described in paragraph 11.

26. ICP Materials is in the process of preparing a call for data on inventory and condition of stock materials at UNESCO cultural heritage sites. A pre-announcement is planned at the thirty-third session of Working Group on Effects in 2014, with an expected review and adoption by the Working Group in 2015 and a launch in early 2016.