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Economic Commission for Europe

Executive Body for the Convention on Long-range
Transboundary Air Pollution

**Steering Body to the Cooperative Programme for
Monitoring and Evaluation of the Long-range
Transmission of Air Pollutants in Europe**

Working Group on Effects

First joint session*

Geneva, 14–18 September 2015

Items 14 and 15 of the provisional agenda

Proposed call for data

**Progress in activities in 2015 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 (ICP Materials) 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

* The Executive Body to the Convention agreed that, as of 2015, the Working Group on Effects and the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe should meet jointly, to achieve enhanced integration and cooperation between the Convention's two scientific subsidiary bodies (ECE/EB.AIR/122, para. 47 (b)).

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implementation of the Convention (ECE/EB.AIR/122/Add.2, items 1.1.10 and 1.1.14).

The report of the ICP Materials presents the results of its thirty-first Task Force meeting (Kjeller, Norway, 22–24 April 2015). In particular, the report describes exposures for trend analysis of corrosion of carbon steel, weathering steel, zinc, copper, aluminium, limestone and soiling of modern glass (2011–2015) and summarizes the current status of the pilot study and pre-announcement of a call for data on inventory and condition of stock of materials at risk at the United Nations Educational, Scientific and Cultural Organization (UNESCO) cultural heritage sites.

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-third session (Geneva, 17–19 September 2014). 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).

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, Slovakia, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland and the United States of America (17 countries and approximately 30 experts) participate in the work of ICP Materials.

3. The thirty-first meeting of the ICP Materials Task Force was held in Kjeller, Norway from 22 to 24 April 2015 with 19 (two by remote access) participants from 14 countries and representatives of the Convention Secretariat and the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters).

4. During 2014 the following reports were delivered: Report No. 75, Environmental data report. October 2011 to December 2012 and Report No 76, Trends in pollution corrosion and soiling 1987–2012. The reports are available on the ICP Materials home page.¹

5. In 2015, the following ICP Materials reports are expected: Report No 77 Pilot study on inventory and condition of stock of materials at risk at UNESCO cultural heritage sites. Part IV: The relationship between the environment and the artefact; and Report No 78 Technical Manual for the trend exposure programme 2014–2015.

6. In addition, a proposed call for data on inventory and condition of stock materials at UNESCO cultural heritage sites will be presented and discussed (agenda item 14, ECE/EB.AIR/GE.1/2015/1-ECE/EB.AIR/WG.1/2015/1).

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)² specify that for effects of particulate matter on materials the 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

¹ www.corr-institute.se/icp-materials/web/page.aspx?sid=3293.

² Adopted by the Executive Body for the Convention by its decision 2008/1 (see ECE/EB.AIR/96/Add.1).

part of the ongoing activities of ICP Materials (for exposure of materials for trend analysis, see below). In addition, ICP Materials has contributed to the WGE report “trends in ecosystem and health responses to long-range transported atmospheric pollutants” (agenda item 7, ECE/EB.AIR/GE.1/2015/1-ECE/EB.AIR/WG.1/2015/1).

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. The thirty-second meeting of the ICP Materials Task Force will be held in St Petersburg, 11–13 May 2016 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. ICP Waters participated in the thirty-first meeting of the ICP Materials Task Force held in Kjeller, Norway from 22 to 24 April 2015, and gave an overview of the activities of ICP Waters.

10. ICP Materials has participated in the common work to produce the WGE report “trends in ecosystem and health responses to long-range transported atmospheric pollutants”, co-ordinated by ICP Waters.

11. For the work of the WGE report on trends and the 2014 report on trends in corrosion and soiling 1987–2012, ICP Materials has successfully used data from EMEP, in particular measurement data (Chemical Coordinating Centre) and model results (Meteorological Synthesizing Centre-West).

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 1987–2012 were reported above. The on-going exposure (2014–2015) includes samples of carbon steel, zinc, copper, limestone and soiling of modern glass. In addition, samples exposed for four years (2011–2015) of carbon steel, weathering steel, zinc, aluminium and limestone will be evaluated and reported in 2016.

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

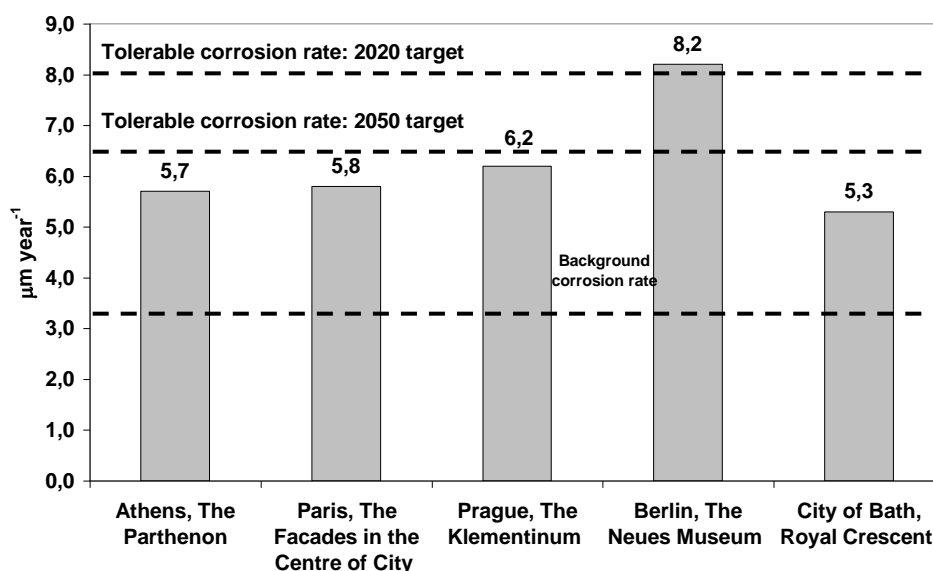
13. ICP Materials is continuing a pilot study on inventory and conditions of stock of materials at risk at five UNESCO cultural heritage sites: Paris, France (banks of the Seine); Prague, Czech Republic (National Library); Berlin, Germany (Neues Museum); Bath, United Kingdom (Royal Crescent); and Greece, Athens (the Parthenon).

14. The UNESCO study is presented in four separate reports: I Methodology (Report 68); II Determination of stock of materials at risk for individual monuments (Report 70); III Economic evaluation (Report 73) and; IV The relationship between the environment and the artefact (Report 77). The last concluding part IV will be finalised in 2015. The main conclusions from the study are reported below.

15. *What is the current situation of the predicted corrosion due to air pollution of the limestone material at the studied cultural monuments?* Calculated recession rates after one year of exposure, based on dose-response functions of the limestone material at the studied UNESCO sites, are well above the background corrosion rate ($3.2 \mu\text{m year}^{-1}$) and generally close to the target for the year 2050 ($6.4 \mu\text{m year}^{-1}$) or even at one case close to the target for 2020 ($8.0 \mu\text{m year}^{-1}$). This is illustrated in figure 1, which shows the estimated recession rate for limestone, first year exposure, at the five studied cultural monuments.

Figure

Estimated recession rate for limestone, first year exposure, at the five studied cultural monuments



16. *What is the cost of damage to materials due to air pollution of these works of art and historic buildings?* 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 ($\text{m}^{-2} \text{year}^{-1}$) to €43.8 $\text{m}^{-2} \text{year}^{-1}$, depending 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 $\text{m}^{-2} \text{year}^{-1}$ to €28 $\text{m}^{-2} \text{year}^{-1}$. Cost estimates are, however, subject to uncertainty due to the assumption in estimating lifetimes of materials and the cost of the interventions.

17. *What are the main pollutants responsible for the predicted corrosion of limestone material of the studied cultural monuments?* At current low concentrations, sulphur dioxide (SO_2) is still an important deteriorating agent for limestone but not more the dominant factor. In a multi-pollutant scenario, nitric acid (HNO_3 , produced from atmospheric nitric oxides) and particulate matter seem to play a prominent role in determining damage of limestone. Nitric acid and particulate matter concentrations are higher in cities, where most of our cultural heritage is situated. The acidity of precipitation, expressed by the pH value, seems to have a little impact on corrosion in the current situation.

18. *What improvements in the predicted corrosion of limestone materials of the studied cultural monuments can be estimated in recent years?* The improvement of air quality between 2000 and 2010 in the cities that host the studied UNESCO sites has produced a small but quantifiable decrease in the recession rate for limestone, first year exposure, which extends practically to most of the metropolitan areas. The decrease in correspondence of the studied UNESCO sites is about 5-8 per cent. The estimated decrease in the recession rate for limestone is mainly attributable to a significant reduction of air concentration of SO₂, which has nearly halved in the time period investigated. By contrast, air concentrations of nitrogen dioxide (NO₂), HNO₃, ozone (O₃) and particulate matter (PM₁₀) were basically stagnant, with small increases or decreases depending on the particular site, and therefore with limited effects on the overall recession rate.

19. *What is the role of the anthropogenic activities in cities in determining the levels of pollutants affecting the studied UNESCO sites and thus the damage of the materials these objects are built with?* The studied UNESCO sites are located in the heart of European capitals. In these urban areas, several air quality problems are present, mainly related to NO₂ and particulate matter, two pollutants that currently seem to play a prominent role in determining damage of limestone. Road traffic is an important source for both pollutants in these metropolitan areas. Additional sources are energy production and distribution, incomplete biomass combustion for heat production, e.g. in domestic boilers, wood stoves and fireplaces, and in some case, industry production and harbour activities. Regional background and long-range transport significantly contribute to pollutant levels.

20. In April 2015, the Task Force of ICP Materials at its 31st meeting in Kjeller, Norway (22–24 April 2015) agreed to launch a Call for Data on “Inventory and condition of stock of materials at UNESCO cultural heritage sites”. As the issuance of the official Call for Data will depend on adoption by the First Joint Session of the Steering Body to the EMEP and the Working Group on Effects (Geneva, 14–18 September 2015), a preannouncement letter was sent to Heads of Delegations to the WGE on 18 June 2015 for early information purposes only. In case of a WGE adoption, the Call for Data is planned to be launched in late 2015, with an anticipated deadline for data submission on mid-March 2016.

21. The main objective of this Call for Data is to collect available and relevant information/data to be used for the identification of UNESCO cultural heritage sites that are at a potential risk of corrosion or soiling in order to provide relevant data on the adverse effects of air pollutant concentrations on materials. Thus, this ICP Materials Call for Data is in line with the requirements of the Convention’s Long-Term Strategy, and with the workplan for 2014–2015.

22. Details of the motivation for this call and the organization of the activities were provided in the preannouncement letter mentioned above and will also be presented in connection with agenda item 14 (ECE/EB.AIR/GE.1/2015/1-ECE/EB.AIR/WG.1/2015/1). The template and instructions for submission will be published in the Call Announcement together with the Call documents.

IV. Messages for the attention of other bodies

23. Detailed analysis of trend results for the period 1987–2012 are provided in report 76, which is available for download from the ICP Materials home page. This is the main background document for the ICP Materials contribution to the WGE report on trends and, later on to the 2016 assessment report.

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. ICP Materials is in the process of preparing a call for data on inventory and condition of stock materials at UNESCO cultural heritage sites and a pre-announcement was sent to Heads of Delegations to the WGE on 18 June 2015 (see paras. 20-22). This is a continuation of the pilot study on inventory and conditions of stock of materials at risk at five UNESCO cultural heritage sites, which will be concluded this year and is summarised above based on results from four individual reports during the period 2011–2015 (see paras. 13-19).
