Economic Commission for Europe

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

Working Group on Effects

Thirtieth session
Geneva, 27–29 September 2011
Item 4 of the provisional agenda

Recent results and updating of scientific and technical knowledge

Effects of Air Pollution on Materials

Report by the Programme Coordinating Centre of the International Cooperative Programme on Materials, including Historic and Cultural Monuments

I. Introduction

1. The work of International Cooperative Programme on Materials, including Historic and Cultural Monuments (ICP Materials) in 2011 covered trends in corrosion and soiling for the period 1987-2009 and the first part of a pilot study on inventory and condition of stock of materials at risk at UNESCO cultural heritage sites. The results are presented here in accordance with item 3.1d (activities common to all ICPs) and item 3.2 (ICP Materials) of the 2011 work plan for the implementation of the Long-range Transboundary Air Pollution Convention (ECE/EB.AIR/106/Add.2), adopted by the Executive Body at its twenty-eighth session in December 2010.

II. Workplan items common to all programmes

A. Guidelines on Reporting of Monitoring and Modelling of Air Pollution Effects

2. The guidelines for reporting on the monitoring and modelling of air pollution effects ECE/EB.AIR/WG.1/2008/16/Rev.1 (ECE/EB.AIR/2008/11) specifies that for effects of particulate matter on materials the degree of soiling (Annex II, Table 4) should be reported, and for multiple pollutant effects on materials the corrosion of indicator materials (carbon...
steel, zinc, limestone (Annex II, Table 5) should be reported. This is done under item II.D, III and IV.A below.

B. Heavy metals baseline assessment

3. ICP Materials has not conducted any work on the heavy metals baseline assessment during 2011.

C. Comparison of activities across continents and regions (outreach)

4. The Russian Federation is now an active member of the ICP Materials Task Force and will contribute with an exposure site in the upcoming exposure for trend analysis 2011-2012. Regarding the possible involvement of other countries from Eastern Europe, the Caucasus and Central Asia, the latest ICP Materials Task Force meeting in Prague 2011 decided to first contact the following countries: Belarus, Ukraine, Kazakhstan and Moldova. The medium-term aim is that one or more of these countries should contribute with an exposure site in the next exposure for trend analysis in 2014-15.

D. Ex post assessment

5. ICP Materials has contributed to the Working Group on Effects analysis of the achievements, potential benefits and damages on health, materials and the environment of Gothenburg Protocol\(^1\) scenarios. Targets for protecting materials have been established (Table 1). EMEP\(^2\) grids with calculated corrosion and soiling levels exceeding those targets are shown in Figure 1 for the Nat 2000, Nat 2020 and MFR 2020 scenarios. The effects on materials will decrease, but not disappear by 2020; large areas are still impacted, mainly in central Europe.

Table 1.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>2020</th>
<th>2050</th>
</tr>
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<tbody>
<tr>
<td>Carbon steel corrosion</td>
<td>&lt; 20 µm year(^{-1})</td>
<td>&lt; 16 µm year(^{-1})</td>
</tr>
<tr>
<td>Zinc corrosion</td>
<td>&lt; 1,1 µm year(^{-1})</td>
<td>&lt; 0,9 µm year(^{-1})</td>
</tr>
<tr>
<td>Limestone corrosion</td>
<td>&lt; 8,0 µm year(^{-1})</td>
<td>&lt; 6,5 µm year(^{-1})</td>
</tr>
<tr>
<td>Soiling measured as loss in reflectance compared to an unsoiled surface</td>
<td>&lt; 35% after 10 years</td>
<td>&lt; 35% after 20 years</td>
</tr>
</tbody>
</table>

\(^1\) 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone

\(^2\) Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
6. When comparing the calculated limestone corrosion values used as a basis for the Nat 2000 scenario map in Figure 1 to measured limestone corrosion values (2000-2001) at ICP Materials test sites the ratio was about 0.85 for sites with medium corrosion, 0.8 for sites with high corrosion and 0.6 for sites with very high corrosion. Values for zinc and carbon steel were similar. These discrepancies are not due to systematic errors in the dose-response functions but instead due to more aggressive conditions in urban areas, where materials and cultural heritage are located, compared to the large areas covered by the EMEP grids, especially for sites with high corrosion. More intense effects are thus expected in urban areas than shown on the maps and a better evaluation of urban pollution is needed to calculate impacts on materials.
III. Effect of black carbon (BC) on materials

7. According to the decision adopted at the twenty-eight session of the executive body of the LRTAP Convention (ECE.EB.AIR/106/Add.1, Decision 2010/2) the ICPs were requested to look at adverse effects of black carbon (BC). ICP Materials has identified soiling of materials as the most important effect. Several parameters have been used in the quantification of soiling including dark smoke (DS), total suspended particulate (TSP), particulate elemental carbon (PEC) also known as BC and PM10. For PM10, ICP Materials has previously calculated 20 µg m\(^{-3}\) for 2020 and 10 µg m\(^{-3}\) for 2050 as preliminary targets based on the criteria given in table 1. ICP Materials will perform a critical review of dose-response functions related to BC including aesthetic thresholds with preliminary conclusions to the 30th session of the Working Group on Effects (2011) and with a report on the effect of the effects of BC on the soiling of materials (2012 work plan).

IV. Cross-Cutting issues

A. Trends in pollution, corrosion and soiling 1987–2009

8. Observed corrosion values at ICP Materials test sites have been compared to targets for protecting materials of infrastructure and cultural heritage for 2020 (given in table 1). In 1987, 85% to 90% of the sites, depending on material, had corrosion values above the 2020 target. During the period 1987 to 2000 the number of sites exceeding the 2020 target decreased substantially but since the year 2000 no obvious decrease has been observed. For the 2008-2009 exposure 12% of the sites for carbon steel, 21% for zinc and 48% for limestone showed corrosion values above the 2020 target.

9. For soiling, only two exposures have been performed 2005-2006 and 2008-2009. No average increase or decrease was observed for haze, which is the appropriate soiling parameter for modern glass.

B. Environmental data from the 2008–2009 exposure programme for trend analysis

10. The average absolute pollutant levels have changed during the period 1987-2009 not only because of changing pollutant concentrations, but also because of ICP Materials test site selection. Figure 2 shows average relative SO\(_2\), NO\(_2\) and O\(_3\) concentrations at ICP Materials, corrected for site selection. The average trends are quite different for the gases. O\(_3\) increased during the 1990’s, but has been relatively constant after this period. NO\(_2\) has decreased and continues to decrease over the entire period while the decrease in SO\(_2\) ceased during 2000 to 2006 with a slight decrease in the most recent exposure in 2008-2009.
C. Pilot study on inventory and condition of stock of materials at risk at UNESCO cultural heritage sites;

11. ICP Materials will conduct a pilot study on inventory and conditions of stock of materials at risk at some UNESCO cultural heritage sites. The sites are situated in different parts of Europe and for all of them the environmental data are available. The sites are: France, Paris – the banks of Seine; Czech Republic, Prague – National Library; Germany, Berlin- Neues Museum; UK, city of Bath, old part; Greece, Athens-Acropolis.

12. The first part of the study, to be completed in 2011, will include inventory of materials of the selected cultural monuments. The application of DRF for individual materials will be used to assess the risk of corrosion and soiling to individual monuments.