United Nations ECE/EB.AIR/WG.1/2013/7

Economic and Social Council

Distr.: General
6 September 2013

English only

Economic Commission for Europe

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

Working Group on Effects

Thirty-second session
Geneva, 12 and 13 September 2013
Item 4 of the provisional agenda
Recent results and updating of scientific and technical knowledge

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 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 2012–2013 workplan for the implementation of the Convention (ECE/EB.AIR/109/Add.2, items 3.1 (d) and 3.2)). The report details, in particular, the withdrawal of specimens from the 2011–2012 trend exposure for corrosion and soiling, continuation 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, and a report on exposure of modern glass 2008–2012 and soiling dose-response functions.

I. Introduction

1. The work of the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials) in 2013 and since its last report include withdrawal of specimens from the 2011–2012 trend exposure for corrosion and soiling, continuation 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 and a report on exposure of modern glass 2008–2012 and soiling dose-response functions. The results are presented here in accordance with item 3.1 (d) (activities common to all ICPs) and item 3.2 (ICP Materials) of the 2012–2013 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/109/Add.2).

II. Workplan items common to all International Cooperative 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/2008/11)[1] 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 part of the ongoing activities of ICP Materials (for exposure of materials for trend analysis, see below).

B. Ex post assessment

3. ICP Materials contributed to the Working Group on Effects 2012 impact assessment report: effects indicators as tools to evaluate air pollution abatement policies (ECE/EB.AIR/WG.1/2012/13) — an informative illustration from the Working Group on Effects analysis of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) scenarios. ICP Materials is prepared to make additional updates based on the revised emission scenarios as requested when data are available.

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

4. The Russian Federation is a recent active member of the ICP Materials task force and contributes with an exposure site in the ongoing exposure for trend analysis (see below). Prioritized countries in Eastern Europe, the Caucasus and Central Asia for involvement in the 2014 exposure for trend analysis are: Belarus, Kazakhstan, Republic of Moldova and Ukraine.

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

III. Ongoing activities

A. Trends in pollution, corrosion and soiling

5. Exposures for trend analysis are performed each third year in the network of ICP Materials test sites. Results from the 2008–2009 exposure for trend analysis and trends for the period 1987–2009 were reported in 2011. The ongoing exposure for trend analysis started in the fall of 2011 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. An updated report for 2013 will include corrosion and soiling data in the network of test sites for the 2011–2012 exposure for trend analysis.

6. The environmental characterization is also extended with a one-year campaign by including measurements of formic and acetic acid, which are possible new important confounding factors, in addition to the normal characterization of the gaseous pollutants sulphur dioxide, nitrogen oxides, ozone and nitric acid. Preliminary results, however, indicate that the concentrations of formic and acetic acid are very low outdoors and do not significantly contribute to corrosion.

B. Pilot study on inventory and condition of stock of materials at risk at UNESCO cultural heritage sites

7. ICP Materials is conducting 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: Paris, France (banks of the Seine); Prague, Czech Republic (National Library); Berlin, Germany (Neues Museum); Bath, United Kingdom of Great Britain and Northern Ireland (old part of town); Greece, Athens (Acropolis).

8. This year the pilot study focus is on estimation of corrosion costs at the selected sites. The cost calculations were based on a replacement/maintenance value for limestone/ marble of 440 € m^{-2} and a tolerable total corrosion attack before action of 50 µm, corresponding to sensitive ornaments already corroded to a certain extent, or 100 µm, corresponding to ornaments weathered to a normal extent. Based on these values taking 50 µm as an example, the cost in background areas is 28 € m^{-2} $year^{-1}$, in areas with the 2050 target 56 € m^{-2} $year^{-1}$ and in areas with the 2020 target 70 € m^{-2} $year^{-1}$. For an object situated in an area with actual corrosion rates corresponding to the 2050 target this would result in a corrosion cost for replacement/maintenance due to air pollution of 56 – 28 = 28 € m^{-2} $year^{-1}$ or 50 per cent of the total costs.

IV. Exposure of modern glass 2008–2012 and soiling dose-response functions

9. According to the decision adopted by the Executive Body at its twenty-eighth session (ECE.EB.AIR/106/Add.1, decision 2010/2), the International Cooperative Programmes under the Working Group on Effects were requested to look at the adverse effects of black carbon, and ICP Materials has identified soiling of materials as the most

important effect. ICP Materials performed exposures of modern glass 2008–2012, including development of dose-response functions to be reported in 2013.

10. The quantification of soiling is different for transparent (glass) and non-transparent materials as transparent materials are quantified by changes in haze (ratio of direct and diffuse transmittance transmittance expressed in per cent) and non-transparent materials by changes in reflectance compared with unsoiled surfaces. The four-year exposure of modern glass shows that the threshold of 1 per cent of haze (corresponding to visual nuisance felt by human eyes) is exceeded after one year for all the sites and can reach up to 5 per cent after four years (even 8–10 per cent in two specific sites). However, haze tends to rapidly saturate around values less than 2 per cent for rural sites, whereas the evolution is still linearly increasing for urban and industrial sites after four years.

11. The previous developed dose-response functions for transparent materials was based on an S-shaped curve (Hill's function) whose amplitude is controlled by environmental parameters (sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and coarse particulate matter PM_{10}),[2,3] while dose-response functions for non-transparent materials are described by exponential or square root models. The Hill's equation used for the temporal evolution foresees a saturation of the haze. However, this trend was deduced from one or two years' exposure data and only from one set of long-term data (Paris). This new long-term exposure (2008–2012) in 11 sites shows that this stagnation is not observed everywhere. Therefore, a new temporal trend of the haze could be established, based on a power law function ($H=a \bullet t^b$) whose b parameter is site dependent (rural vs. urban and industrial).

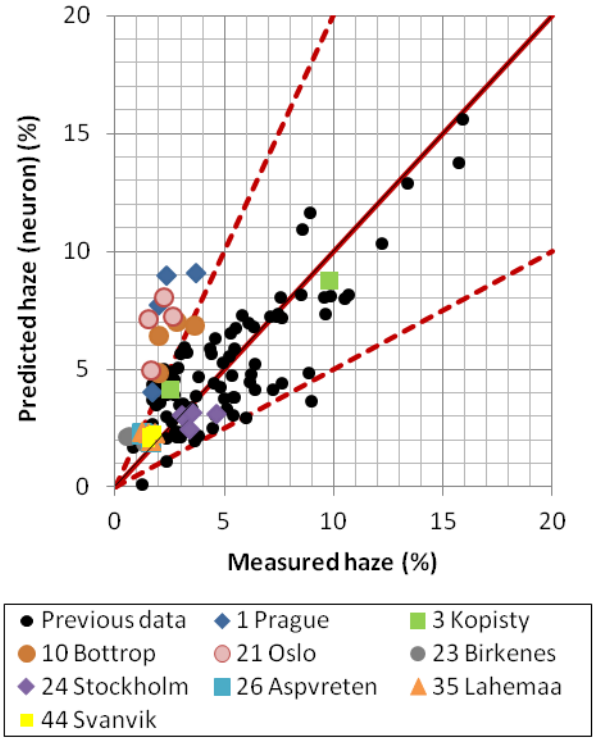
12. The two kinds of dose-response functions for haze of modern glass that have been developed including SO_2, NO_2 and PM_{10} as pollution parameters (multilinear regression and neural network) are both validated with the new data set (four years' exposure 2008–2012). Preliminary results demonstrate that the predicted haze can be predicted to within about a factor of 2, except for three sites, where the haze is overestimated (figure 1).

[2] Particles with a diameter of 10 micrometres or less.

[3] Soiling of exposed materials and dose-response functions for modern glass. See ICP Materials report on soiling of exposed materials (report 59), available from http://www.corr-institute.se/ICP-Materials/web/page.aspx?refid=18

Figure 1

Test of the neural network dose-response function with the new data set from the 2008–2012 exposure campaign



Note: Red line indicates that predicted haze is equal to the measured haze (dash lines within a factor of 2).