Effects of airborne particulate matter on building surfaces

Fact Sheet

Project information

<table>
<thead>
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<th>Start date</th>
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<th>Coordinated by:</th>
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<td>United Kingdom</td>
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Objective

The objective is to quantify the deposition rates of important pollutants, including particulate elemental carbon, selected ions and trace metals, their accumulation rates on building surfaces and their resulting effects.

A study has been set up to quantify the deposition rates of important pollutants, including particulate elemental carbon, selected ions and trace metals, their accumulation rates on surfaces and their resulting effects, including soiling and decay. Monitoring sites were situated at cathedrals in London, Coimbra, Oporto and Vienna. These sites were chosen on the basis of existing air pollution data for each city and the importance of each cathedral in terms of Europe’s cultural heritage. The concentrations of nitrogen dioxide were determined using passive diffusion tubes. The amount of atmospheric particulate matter at each sampling site was estimated daily as dark smoke, measured using a reflectometer. Soiling of building materials was measured using the change in reflectance and scanning electron microscopy (SEM) was used to identify particles collected at each of the monitoring sites.

Procedures for modelling the soiling process have been developed assuming that soiling is due to deposition of particulate matter from the atmosphere. Physical and empirical damage functions have been formulated to quantify effects of air pollutants on the deterioration of building materials. The theoretical models will be developed and tested against the results of the monitoring programme. This will result in a detailed quantification of the role of particulate matter in the soiling and decay of selected surfaces of historic monuments.

Although soiling and decay may appear to involve very different processes, there is some evidence that they are linked. Elemental carbon, present in airborne particulate matter, is probably a major contributor to soiling and also may act as a catalyst in stone damage mechanisms. In addition, particulate deposition provides an input of acidic species.
The main areas to be addressed are: the sources of depositing particulate matter; the soiling of building surfaces; and the contribution of particulate matter to acid deposition. Monitoring sites are situated at cathedrals in London, Coimbra, Oporto and Vienna. These sites have been chosen on the basis of existing air pollution data for each city and the importance of each cathedral in terms of Europe's cultural heritage. They are considered necessary to achieve an adequate database taking account of the range of contributing pollutant source and meteorology in Europe. At each step, the following will be measured:

- levels of total suspended particulates, dark smoke, sulphur dioxide, nitrogen oxides and particulate elemental carbon in the atmosphere;
- size distribution of airborne particulate matter;
- levels of trace elements (lead, chromium, manganese, nickel, vanadium, selenium, arsenic, aluminium, iron, copper, zinc, beryllium, and molybdenum) and ions (sulphate, nitrate, chloride, ammonium, potassium(1+), sodium(1+), calcium(2+), and magnesium(2+)) in airborne and deposited matter;
- and rates of soiling of building surfaces.

The results of this programme will lead to the following:

- application of emission inventory modelling procedures to describe pollutant emissions to the atmosphere;
- use of statistical dispersion modelling techniques to relate emission rates to levels in the atmosphere and in deposition;
- use of receptor modelling techniques as a complementary approach to identify the sources of pollutants in deposited matter;
- modelling of the rates of soiling and identification of its sources;
- and quantification of the rate of deposition of acidic particulate species and their contribution to overall acid deposition.

A major contribution of this research is that, in addition to describing and explaining the effects of airborne particulate matter depositing on the surfaces of historic monuments, source identification will allow for the introduction of appropriate control procedures. For example, if the project quantifies the contribution of particulate elemental carbon to soiling and decay and identifies diesels as the main source of this pollutant, this could be taken into account when establishing future emission standards for diesel vehicles.

**Programme(s)**

**FP2-STEP** - Two specific research and technological development programmes (EEC) in the field of the environment, STEP/EPOCH - STEP -, 1989-1992

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