

Quantitative impact of the recent abatement of air pollution on the weathering of stone and glass of the UNESCO List in Paris

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At the beginning of the 21st century air pollution in Paris continued to considerably decrease. An evident visual consequence was the replacement of thick gypseous black crusts by thin grey coverings on the façades.

A quantitative approach of this phenomenon was taken by measurement in the field, followed by calculation using Dose-Response Functions (DRF) and mapping the geographic distribution on a grid of 100m x100m of: 1) The total surface of façades of buildings and monuments in the part of Paris inscribed on the UNESCO List between the Ile Saint-Louis and the Concorde Square; 2) The surface of limestone and window glass present on each façade; 3) The distribution of SO₂, NO₂ and PM10 concentration every year from 1997 to 2014; 4) The response of materials to climatic and pollution doses; 5) The effective damage to limestone and window glass.

Results of measurements in the field: 1) The 772 buildings and monuments inventoried have 20 674 m in length and 414 811 m² in façade surface: they are representative of the centre of Paris; 2) Limestone occupies 348 268 m² and window glass 207 394 m²; 3) The mean annual concentration in SO₂ dropped from 20 to less than 3 µg m⁻³; NO₂ from 60 to 40 µg m⁻³ and PM10 from 30 to 20 µg m⁻³.

Results by application of DRF: 4) Limestone recession was divided by 5 in 18 years, from 10 to 2 µm y⁻¹, but with only a spatial variation of 2%; 5) Limestone reflectance increased from 70.5 to 72.5 %; 6) The annual mass of deposited and neo-formed particles on window glass decreased from 100 to 20 µg cm⁻²; 7) The annual haze of window glass decreased from 8 to 3.5%.

Effective damage to stone and glass: 8) The mean annual mass of limestone eroded on the façades decreased according to time but with an irregular geographic distribution from 348 to 22 kg by cell of the map; 9) The mean annual mass of particles deposited or neo-formed on window glass decreased according to time but with an irregular geographic distribution from 4.7 to 0.1 kg by cell of the map.

Conclusion. The abatement of air pollution observed in Paris at the beginning of the 21st century had a direct consequence on the weathering of stone and glass. It is quantitatively highlighted in this study.