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Traffic-related immissions and their impact on historic buildings and monuments

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Air quality in Germany has improved essentially over the last decades. Because the concentrations of sulfur dioxide were reduced by more than 90% between 1990 and 2007 acid rain no longer seems to play a relevant role in the weathering of natural stone facades of historic buildings. But in the surroundings of urban traffic hot spots high emissions of nitrogen oxides and fine particulate matter (PM10) are observed. Therefore the question arises whether these airborne pollutants bear a potential for future damage of natural stone and other construction materials. In an interdisciplinary research program different approaches were pursued to evaluate the damage potential of today's traffic-induced immissions by exemplarily investigating two German cities, Mainz and Munich.

First calculations of average weathering rates for the stones concerned were made using the dose-response functions of the MULTI ASSESS program and the immission data from survey stations at traffic hot spots and at housing areas. Than the distribution of traffic-induced immissions (NO_2 and PM10) in the surrounding areas of major traffic pathways was calculated for both cities with the simulation program WINkfz. The resulting maps of mean pollutant concentrations were superimposed to inventory maps of historical monuments to allow the identification of monuments with high pollution loads. Additionally different classes of natural stones were distinguished regarding their chemical reactivity.

Two prominent monuments with high traffic-induced pollution loads were selected for small scale simulations of pollutant immissions with the simulation program MISKAM. The dispersion of pollutants to different directions and building heights were calculated and the influence of broadleaf trees in the surrounding of the buildings was evaluated (summer versus winter situation). PM10 measurements were carried out at different building heights of the two buildings. Collection of PM10 dust and single-particle analyses by ESEM permits the classification of PM10 particles and the identification and quantification of the traffic-induced part of total PM10.