Assessing climate change risk to cultural assets by monitoring and quantifying the decay of heritage materials and its environmental constraints

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Abstract

The EU-funded project Hyperion aims at developing a “decision support system for improved resilience and sustainable reconstruction of historical areas” facing the impact of climate change and extreme weather events, with the aid of sensor-based and modeling tools. An essential part of the project involves the quantification of the current decay of cultural heritage, which may shed light on how heritage materials interact with the environment, react to microclimate stresses, and resist to future climate change in weathering models and simulations.

To that purpose, a novel experimental method based on the long-term monitoring of historical building materials, their deterioration, and the relevant environmental parameters in different geographic contexts, was designed. A selection of stone and wood materials historically used in different European countries are exposed outdoors to natural weathering, in the urban environment of Italy (Padova and Venice) and Norway (Tønsberg). In every location, the same set of samples are exposed at different orientations (North, South, and horizontal plane) and their surface microclimate parameters are being monitored with temperature and moisture sensors. The microclimate data series are compared with the climate data provided by both the complementary weather stations installed in each monitoring site and the stations of the official regional agencies of environmental monitoring. At the same time, the material decay is being measured by monitoring the changes in surface topography/recession, chemical composition, and color of each building material, that is, comparing the maps acquired before and during the exposure tests by 3D optical profilometry, micro X-ray fluorescence, and colorimetry. This investigation is expected to provide a solid base for developing models of future deterioration of cultural heritage and prediction of its endurance in a changing climate.