HISTORICAL CLIMATE DATA FOR CULTURAL HERITAGE CONSERVATION

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Historical climate (up to millennium-long timescales) affects the decay and conservation of stone historical buildings in Europe. During their history, monuments are degraded by climate and pollution. The long term damage to the built environment has been previously reviewed by Brimblecombe and Camuffo (2002). Using their approach as a base for our study, we stress the concept of Heritage Climatology (Brimblecombe, 2009), which can be seen as the study of climate parameters that affect monuments, materials and sites. These parameters differ from those typical in meteorology, such as temperature or relative humidity, and concentrate on aspects and combinations related to material damage. We select London, central England and some other points in Europe to present examples of some well-known decay mechanisms for stone, such as dissolution as an effect of rainfall and SO_2, blackening as a result of soot deposition, frost shattering, degradation by soluble salts and colonisation by organisms. Meteorological and pollution input is available for only a relatively short part of the millennium-long span of the study, so we have utilised non-instrumental weather records and single-box models of air pollution. Damage functions from a range of sources are used to estimate deterioration of carbonate stone and blackening of stone surfaces in London, which showed changes in damage rates with time (Brimblecombe and Grossi, 2008 and 2009). Deterioration is especially intense from the 1700s. Soiling was particularly rapid in the late 19th century. The increase and subsequent decrease in damage may be interpreted in terms of a Kuznets curve (Brimblecombe and Grossi, 2009). The centuries where pollution controlled damage to durable building material seem to be over. Climate is a factor of increasing importance in the deterioration of monuments. The Köppen-Geiger climate classification is a good approximation for some heritage risks (Brimblecombe, 2009: Grossi et al, *submitted*), but it does not treat wind, sea-salt deposition and even relative humidity. Frost and salt damage can be assessed by estimating the frequency of phase transitions. Historical instrumental records suggest changes in the frequency of freeze-thaw cycles (Brimblecombe and Camuffo, 2002). Studies on climatology of salt damage suggest that the frequency of salts transitions strongly depends to the monthly relative humidity and temperature. The number of transitions shows distinct seasonality which can be related to Köppen-Geiger climate types. A similar approach is used to proxy biological colonisation and or dissolution by the karst effect. Moreover, indoor damage rates could be derived after predicting pollution and climate within interior building by linking outdoor reanalysed climate data, pollution projections and climate models with functions that allow outdoor conditions to be propagated indoors.

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