



Multi-criteria analysis for the detection of the most critical European UNESCO Heritage sites

Andrea Valagussa (1), Paolo Frattini (1), Nadia Berta (1), Daniele Spizzichino (2), Gabriele Leoni (2), Claudio Margottini (2), and Giovanni Battista Crosta (1)

(1) Università degli Studi di Milano - Bicocca, Earth and Environmental Sciences, Milano, Italy (paolo.frattini@unimib.it),
(2) ISPRA, Institute for Environmental Protection and Research, Geological Survey of Italy, Rome, Italy

A GIS-based multi-criteria analysis has been implemented to identify and to rank the most critical UNESCO Heritage sites at the European scale in the context of PROTHEGO JPI-Project. Two multi-criteria methods have been tested and applied to more than 300 European UNESCO Sites. First, the Analytic Hierarchy Procedure (AHP) was applied to the data of the UNESCO Periodic Report, in relation to 13 natural hazards that have affected or can potentially affect the Heritage sites. According to these reports, 22% of sites are without any documented hazard and 70% of the sites have at least one hazard affecting the site. The most important hazards on the European country are: fire (wildfire), storm, flooding, earthquake and erosion. For each UNESCO site, the potential risk was calculated as a weighed sum of the hazards that affect the site. The weights of the 13 hazards were obtained by AHP procedure, which is a technique for multi-attribute decision making that enables the decomposition of a problem into hierarchy, based on the opinion of different experts about the dominance of risks. The weights are obtained by rescaling between 0 and 1 the eigenvectors relative to the maximum eigenvalue for the matrix of the coefficients. The internal coherence of the expert's attributions is defined through the calculation of the consistency ratio (Saaty, 1990). The result of the AHP method consists in a map of the UNESCO sites ranked according to the potential risk, where the site most at risk results to be the Geirangerfjord and Nærøyfjord in Norway. However, the quality of these results lies in the reliability of the Period Reports, which are produced by different experts with unknown level of scientific background.

To test the reliability of these results, a comparison of the information of the periodic reports with available high-quality datasets (earthquake, volcano and landslide) at the Italian scale has been performed. Sites properly classified by the Period Reports range from 65% (earthquake hazard) to 98% (volcano hazard), with a high underestimation of landslide hazard.

Due to this high value of uncertainty, we developed a new methodology to identify and to rank the most critical UNESCO Heritage sites on the basis of three natural hazards (landslide, earthquake, and volcano) for which reliable European-scale hazard maps are available. For each UNESCO site, a potential risk was calculated as the product of hazard (from the available maps) and potential vulnerability. The latter is obtained considering the typology of site (e.g. monument, cultural landscape, and cultural road), the presence or absence of resident and/or tourist, the position of the site (underground/over-ground). Through this methodology, a new ranking of the European UNESCO Sites has been obtained. In this ranking, the historic center of Naples results to be the most-at-danger site of the European continent.