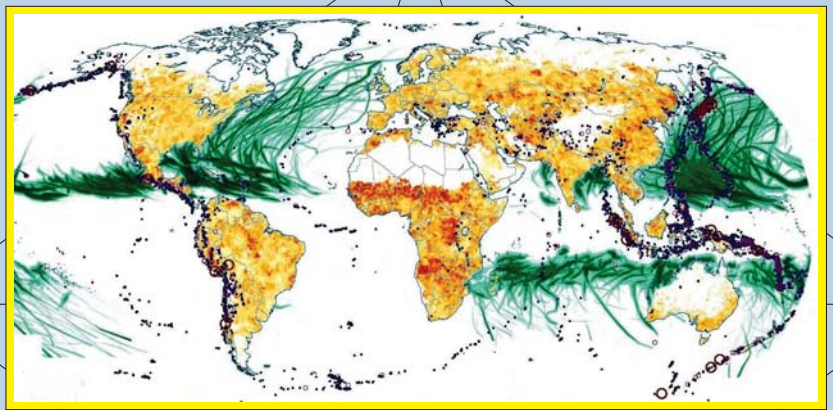
RESILIENCE AND SUSTAINABILITY OF

CITIES

IN HAZARDOUS ENVIRONMENTS

Flavio Dobran



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Editor

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CITTÀ

IN AMBIENTI PERICOLOSI

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Preventive Conservation of Monuments Based on DELPHI Method and Fuzzy Logic

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Abstract. Preventive conservation requires identification, evaluation, and prioritization of the maintenance and restoration of cultural heritage under different hazards. The degradation of monuments is due to the effects caused by different agents (earthquakes, floods, weathering, pollution agents, anthropogenic factors) that produce total or partial losses of architectonic elements or their alterations. The conservation degree of each monument depends on the vulnerability, and its index is an indirect function of the level of deterioration, whereas the hazards depend on the localization and its environment conditions, social development and anthropogenic agents. RIVUPH and Art-Risk are Spanish projects based on the analysis of environmental risk in historical cities and models to assess vulnerability and lives of buildings in order to improve the preventive

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conservation of monuments with similar characteristics. For this purpose, two different approaches have been evaluated: DELPHI method and Fuzzy Logic, where both tools are based on the opinion of experts in the field. The vulnerability analysis of three churches of Seville (Spain) have been studied to assess the monuments' conservation degree. Both models (DELPHI and Fuzzy Logic) are able to forecast the necessities of restoration overlapping different scenarios.

Keywords: Hazard, vulnerability, preventive conservation, artificial intelligence, GIS, heritage building.

1. Introduction

European Council established the recommendations on architectural heritage protection against natural disasters such as earthquakes, floods, fires, etc. [1]. Since 1993 the concepts have evolved, including preventive conservation, emergency managements, and resilience. Preventive conservation reduces high cost of cultural heritage interventions and allows to preserve buildings and to increase the resilience of monuments in historical cities.

An optimal maintenance or preventive conservation strategy acts both against disasters and against damages caused by the passage of time, and for this purpose new methodologies based on multi-scenario risks as a combination of hazards and vulnerabilities have been developed [2].

2. Methodology

The conservation degree of each monument defines its vulnerability, response to emergency situations, and preparedness for resilience, whereas the hazards depend on their design, location and its environment conditions, social development, and anthropogenic agents. RIVUPH and Art-Risk are Spanish projects based on the analysis of environmental risk in historical cities and models to assess vulnerability and lives of buildings in order to improve the preventive conservation of monuments with similar characteristics.

In this paper, two different approaches based on DELPHI method [3] and Fuzzy Logic [4] have been applied to three monuments (Santa Marina, Omnium Sanctorum, and San Marcos) by 10 experts as a blind interlaboratory experiment.

3. Results

Santa Marina, Omnium Sanctorum, and San Marcos are Gothic-Mudejar churches dating from the thirteenth and fourteenth centuries and are located in the historical city of Seville (Spain), established as parish churches after their recapture in 1248. Table 1 shows the expanded vulnerability index (Vie%) and fuzzy buildings service life (FBSL) of the three buildings studied by the 10 experts.

Table 1. Expanded vulnerability index (Vie%) and fuzzy buildings service life (FBSL) of Santa Marina, Omnium Sanctorum, and San Marcos churches in Seville.

Churches	Vie(%)	FBSL (years)
Santa Marina	30±9	21±8
Omnium Sanctorum	42±18	27±6
San Marcos	23±5	27±11

Expanded vulnerability index (Vie%) suggests that the Omnium Sanctorum building needs an intervention before the church Santa Marina, whereas the fuzzy building life FBSL index suggests that Santa Marina is the monument that needs first intervention. The deviations vary between 5-18 years and depend on the experts' opinions about the degree of conservation. This implies that further studies and a second round analysis on expert decisions are necessary to categorize the damage.

4. Conclusions

Both DELPHI method and Fuzzy Logic procedures provide protocols to develop policies for making decisions about which monuments should be preserved on a list of monuments. These methodologies allow comparisons of risks of buildings of similar characteristics to analyse~~s~~ strategies for cultural heritage preservation, though they are limited in accuracy. This enables Public Administration to make decisions for preventive conservation, resilient policies, and prioritize the restoration resources of a city or even a region. Further studies should focus on the uncertainty associated in the analysis.

5. Acknowledgments

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