



## **Advanced methods for the construction of seismic risk scenarios. Application to Barcelona city, Spain**

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In this work, a brief description of two models for assessing seismic damage scenarios in urban areas are presented, namely the vulnerability index method (VIM) and the capacity spectrum method (CEM). Both methods have been used to analyze the vulnerability and fragility of the dwelling buildings of Barcelona (Spain) and to develop earthquake scenarios for the city. The VIM characterizes the seismic action by means of EMS'98 macroseismic intensity and buildings by a vulnerability index, while the CEM defines the earthquake in terms of response or demand spectra and the building by means of capacity spectra. Damage probability matrices (DPM) for a given seismic scenario are obtained, in the VIM by assuming a binomial probability distribution and a simple function relating mean damage factor to intensity and vulnerability. In the CEM, DPM are obtained by using the spectral displacement of the performance point and specific fragility curves. Barcelona is a densely populated city with districts with more than 45000 inhabitants per squared kilometre. It is located on the Northeast part of the Iberian Peninsula, in a low to moderate seismic hazard region. A deterministic (historical event) and a probabilistic (10% occurrence probability in 50 years) earthquake are used to assess expected damage by using both methods. We have developed a GIS tool allowing storing, managing, analyzing, and displaying the large amount of spatial and tabular data involved in this kind of studies. A highly complete and reliable database has been arranged and used to obtain very detailed vulnerability maps and damage scenarios for the city at different levels: buildings, census tracks, neighbourhoods and districts. The obtained results are highly consistent with the historical and modern evolution of the populated area and they show how, in spite of the low to moderate seismic hazard, the expected seismic risk in Barcelona is significant because of the high vulnerability of their buildings. The detailed damage probability maps at

different scales have been of inestimable help for prevention, preparedness and civil protection strategies and for emergency planning in the city.