# Earthquake risk assessment and damage scenarios mapping: application to Catalonia.

A. Roca [1], X. Goula [1], T. Susagna [1, 2], M. González [2], J. Chávez [1]

[1] Institut Cartogràfic de Catalunya, Parc de Montjuïc, 08038 Barcelona, roca@icc.es
[2] Observatori Fabra, Rambla dels Estudis, 115, 08002 Barcelona.

In order to estimate potencial earthquake damage and risk it is necessary to assess the seismic hazard and to evaluate vulnerability.

This communication presents a methodology for the evaluation of earthquake vulnerability and risk of dwelling buildings at a regional scale. This methodology allows a preliminary evaluation of the seismic risk to be taken for the purpose of prevention of disasters in regions of low-to-moderate seismicity, as it is the case of Catalonia, where detailed information of damages for past earthquakes is not available.

The general characteristics of the developed methodology are the following:

I) It is a statistical method that can be used with few data on buildings characteristics that are generally available without needing field surveys.

II) It is based on the definition of macroseismic intensity; this variable, in spite of being a measure of the effects of the earthquakes that may involve a certain degree of subjectivity, has the advantage that can be used in the complete analysis of the seismic risk.

III) The building structural typology has been expressed according to the typologies defined in the intensity scales, and the damages expected for each intensity has been deduced using damage probability matrices.

With this approach damage scenarios for Catalonia (NE Spain) including estimation of human casualties and economic losses have been generated.

## Methodology steps

The methodology developed can be summarized in five steps:

1) Proposition of the seismic zones map (it combines the main characteristics of a probabilistic method and a deterministic method) for a return period of 500 years in terms of intensity [1]. The local effects are incorporated from the geotechnical characterization of the urban nucleus of Catalonia (900 aprox.), classifying them in four groups (R, A, B and C, corresponding to: hard rock, very cohesive materials, semi-compact materials and not cohesive material and soft sands respectively) [2]. This classification of soils leads to increasing half degree of intensity in the seismic zones map for urban nucleus with B and C soils.

2) Classification of the dwelling existing buildings in vulnerability classes according to the European Macroseismic Scale (EMS-92) [3] using simple statistical data from the building census [4].

3) Assessment of possible damages in buildings due to the action of the earthquake considered in each case. For this, it was needed to obtain damage probability matrices for the EMS-92 scale using damage data from the Irpinia, Italy, 1980 earthquake [4]

4) Estimation of human casualties using two different methodologies: Coburn et al. [5] and Applied Technology Council [6].

5) Evaluation of the direct economic losses generated for the physical damage in dwelling buildings [4].

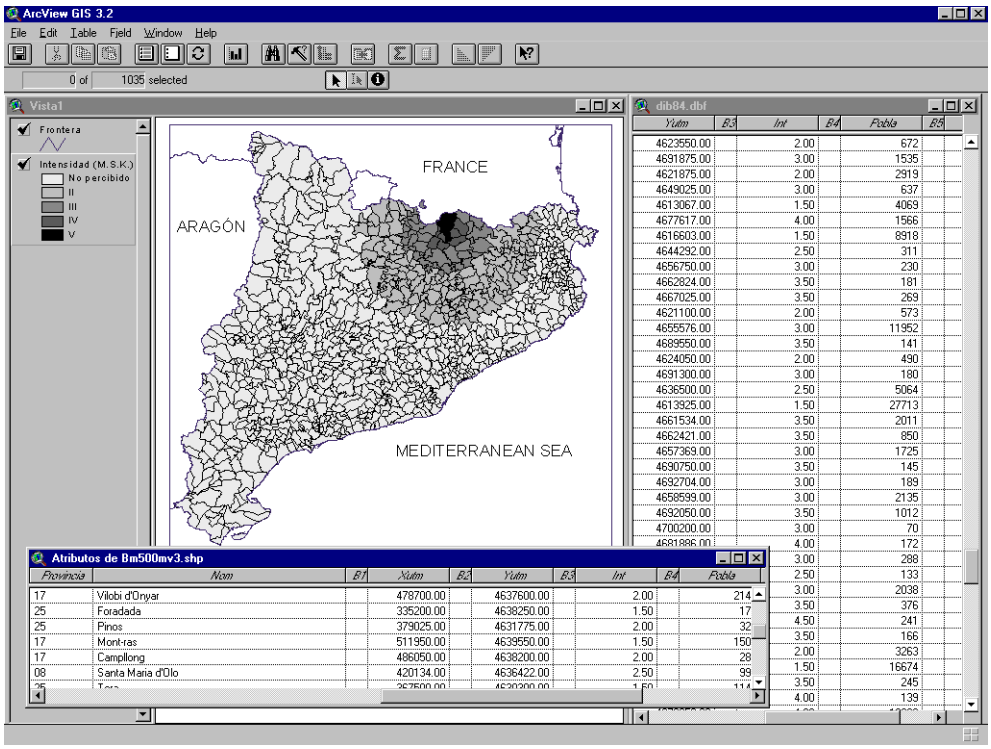
A tool for emergency preparedness

This methodology has been integrated to an automatic calculation process to generate damage scenarios for an estimation of the possible effects for the preparation of the emergencies and also to give a first forecast, in conjunction with a new VSAT based real time seismological network [7], immediately after occurring an earthquake.

The main objective of the simulation of damage scenarios is to carry out, in case of earthquake, a quick evaluation of the possible intensities that one could have felt in each municipality of the region, the possible number of people that could have felt the earthquake with several intensities and the affected area for each intensity. If the earthquake has an intensity high enough to produce damages, the method gives an estimation of damages to buildings, human casualties and economic losses [8].

This damage scenarios simulation becomes a useful, simple and quick tool for civil protection for the preparation and activation of the emergency plans.

A Geographical Information System (GIS) is used to visualize the results together with different information layers.



References:
[1] Secanell R., Goula X., Susagna T., Fleta J., Roca A. (1999). " Mapa de zonas sísmicas de Catalunya". 1er Congreso Nacional de Ingeniería Sísmica. Murcia. p.p. 251-259

[2] Fleta J., Estruch I., Goula X. (1998). " Geotechnical characterization for the regional assessment of seismic risc in Catalonia. Proc. Of the IV Meeting of Environmental and Engineering Geophysical Society (European Section). Barcelona p.p. 669- 702.

[3] Grünthal G. (1993). European Macroseismic Scale 1992 (up-dated MSK-scale). Conseil de l'Europe. Chaiers du Centre Européen de Geódynamique et de Séismologie. Vol 7. Luxembourg.

[4] Chávez J., Goula X., Roca A., Presmanes J., López- Arroyo A.(1998)." Preliminary seismic risk assessment for Catalonia (Spain)". 11Th European Conference on Earthquake Engineering. CD-ROM. Balkema. Rotterdan.

[5] Coburn, A.W., Spence, R.J.S. y Pomonis, A.(1992). Factors determining human casualty levels in earthquakes: Mortality prediction in building collapse. Proceedings of the 10th World Conference on Earthquake Engineering. Madrid.p.p. 5989-5994.

[6] Applied Technology Council. (1985). Earthquake damage evaluation data for California, (ATC-13) Redwood City California.

[7] Roca A, Goula X. , Olmedillas J.C., Olivera C., Susagna T., Figueras S. and Fleta J. (2000) " A new broadband seismic network with real time satellite transmisión in Catalonia (Spain)". 2ª Asamblea Hispano-Portuguesa de Geodesia y Geofísica. Lagos (Algarve- Portugal). p.p. 209-210

[8] González M., Chávez J., Susagna T., Goula X., Roca A.(2000) " Simulación de escenarios de daños: Aplicación al terremoto del Ripollés (Girona) de 1428". 2ª Asamblea Hispano-Portuguesa de Geodesia y Geofísica. Lagos (Algarve- Portugal). p.p. 203-204