A NEW MACROSEISMIC CATALOGUE FOR CATALONIA

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Abstract

Since 1991, macroseismic data from the North East of Spain and the South of France have been compiled with the aim of producing an homogeneous seismic catalogue, useful for reliable seismic hazard studies. This compilation has been carried out firstly through a revision and critical comparison of existing catalogues, mainly those from the Instituto Geográfico Nacional (Spain) and BRGM-CEA-EDF (France); results from recent investigations on historical earthquakes have been incorporated to the catalogue; for the 20th century events, the original macroseismic questionnaires have been re-analysed. The publication of the catalogue corresponds to Volume 1 of the "Atlas Sísmic de Catalunya" which is composed of 918 individual records, one for each event, 58 of them corresponding to false or doubtful earthquakes. Moreover, the catalogue includes maps with the location of the epicentres and maps with the distribution of felt intensities for individual events.

1. Introduction

One of the problems associated to the assessment of seismic hazard in regions with moderate seismicity is the lack of data about earthquakes for long periods of time. The evaluation based on a few large events is a common feature for all these regions; this needs a search through historical documents. On the other hand, the careful analysis of the information contained in former compilations referring to the maximum possible number of earthquakes, is very important.

We present, in this study, a macroseismic catalogue for Catalonia and neighbouring regions which is the result of a long process: consideration of the existing compilations, representing the most significant information sources; incorporation of the results from the studies carried out in recent years referring to the historical earthquakes; re-assessment of the macroseismic questionnaires corresponding to the earthquakes during the present century and construction of a computerised data bank which has facilitated the critical comparison between the different sources. A homogeneous parametric catalogue has been obtained as a result of this process, which comprehensively represents all the available seismic information for the region under study.

T. Glade et al. (eds.), The Use of Historical Data in Natural Hazard Assessments, 71–79.

2. Methodology

The methodology used to prepare this seismic catalogue has basically been the critical comparison of the several catalogues containing macroseismic information on the region (Susagna et al., 1996).

The patterns followed are in agreement with the criteria established in the preparation of a European Catalogue within the BEECD Project: A Basic European Earthquake Catalogue and Database for the evaluation of long term seismicity and seismic hazard (Albini and Stucchi, 1997; http://emidius.itim.mi.cnr.it), which harmonises the information from different countries.

The catalogue comparison is of paramount interest for the region because the most important seismicity is at both sides of the border between France and Spain. This fact has led, in the past, to erroneous considerations about earthquakes: duplicities, different localizations for the same event, erroneous assessment of the intensity, etc.
Cases of this type are found, for instance, in high intensity earthquakes with epicentre in the French Pyrenees, felt in Catalonia and recorded in Spanish catalogues with the epicentre in Spain and a lower intensity. Recent studies, posterior to the publication of the mentioned compilations, have been considered in a second phase.

These are mainly historical seismicity studies, as the most important events happened during the Middle Ages (Olivera et al., 1994a, Olivera et al., 1994b, amongst others). Previous data bases, where all the information has been gathered, have been used to obtain a final parametric catalogue. Two separate data bases (before 1990 and after 1990) have been created, mainly due to the different origin of the information. Table 1 gives a list of the main parameters included in this data base for each earthquake.

TABLE 1. List of the parameters included in the seismic catalogue

Parameter	Content
Code	:Internal identification code
Date	:Date and time of the earthquake
Latitude	:Latitude of the epicentre
Longitude	:Longitude of the epicentre
Qe	:Epicentre quality index
Type of event	:Nature of the earthquake (fake, doubtful)
Relationship	:Aftershock or premonitory
N3	:Identifier of seismic series
Io	:Epicentral intensity
Ix	:Maximum intensity
Qi	:Intensity quality
Om	:Number of macroseismic observations
Region	:Name of the region of the epicentral area
Main Reference	:Information source selected

The information sources used as a starting point have been the following:

- The catalogue of the "Instituto Geográfico Nacional (IGN, 1991)", which includes a revised and completed version of the catalogue published by Mezcua and Martinez Solares (1983).

- The catalogue Suriñach and Roca (1982) (SURO), catalogue in parametric form which has been included in the data base.
- The comprehensive compilation of Fontserè and Iglésias (1971), (FONT) corresponding to the description of earthquake earlier than 1906. The information contained in this compilation has been converted to parametric form to allow the comparison with other catalogues.
- French data base SIRENE (BRGM-CEA-EDF, 1994), parametric catalogue of earthquakes with epicentre in the Pyrenees area.
- Macroseismic surveys from the "Observatorio Fabra", from which the originals were available, corresponding to seisms of the 20th Century (since 1914).
- Reports and publications related to research done on original historical documents, carried out at the "Servei Geològic de Catalunya (SGC)" in co-operation with historians of the Barcelona University.

For each earthquake, the number of records created has been the same as the number of information sources mentioning it, adding another record (SGC) where the parameters selected after the critical assessment have been included. The main source of information considered is also indicated. Table 2 presents an example for an earthquake with the major information available in the data base relative to the different agencies.

TABLE 2. Example of the five records in the work data base for the event of December 5, 1855.

Code of the event : 2810

Agency	*Date*	*Time*	*Lat. N*	*Long. E*	*Qe*	*Io*	*Qi*	*Region*	*Ref.*
IGN	1855 12 5	630	41 48	0 49		VI		Balaguer	
SIRENE	1855 12 5	1848	42 50	0 30	C	VII +	B	B.de Luchon	
SURO	1855 12 5	6	41 48	0 49		V		Balaguer	
FONT	1855 12 5	6				VI		Balaguer	
SGC	1855 12 5	1848	42 50	0 30	2	VII-VIII	2	B.de Luchon	SIRENE

3. Description of the Catalogue content

The publication presents, as a synthesis, several maps of epicentres. The first of them (figure 1) corresponds to the known earthquakes which have caused damage along history (intensity equal to or above VII MSK); the second indicates the earthquakes of intensity equal to or above V during the current century and a last one with the location of all events considered in the catalogue, including those with a doubtful location and those of unknown intensity, depending upon the quality of the location. The most important part of the publication is an individual information for each earthquake, showing the value of the parameters chosen from the aforementioned analysis. An individual map of the local intensities for specific earthquake has also been included, if enough information has been available on the perception of the earthquake in different locations. Finally, an epicentre list is shown, with the major parameters.

For the area studied, mainly corresponding to Catalonia, the epicentres between the co-ordinates of Longitude 0° 20'W to 3° 30'E and Latitude 40° N to 43°30'N have been considered. A total of 918 cards have been produced. Out of these, 306 correspond to events prior to 1900 and 612 after the year 1900. Of this total, 58 earthquakes

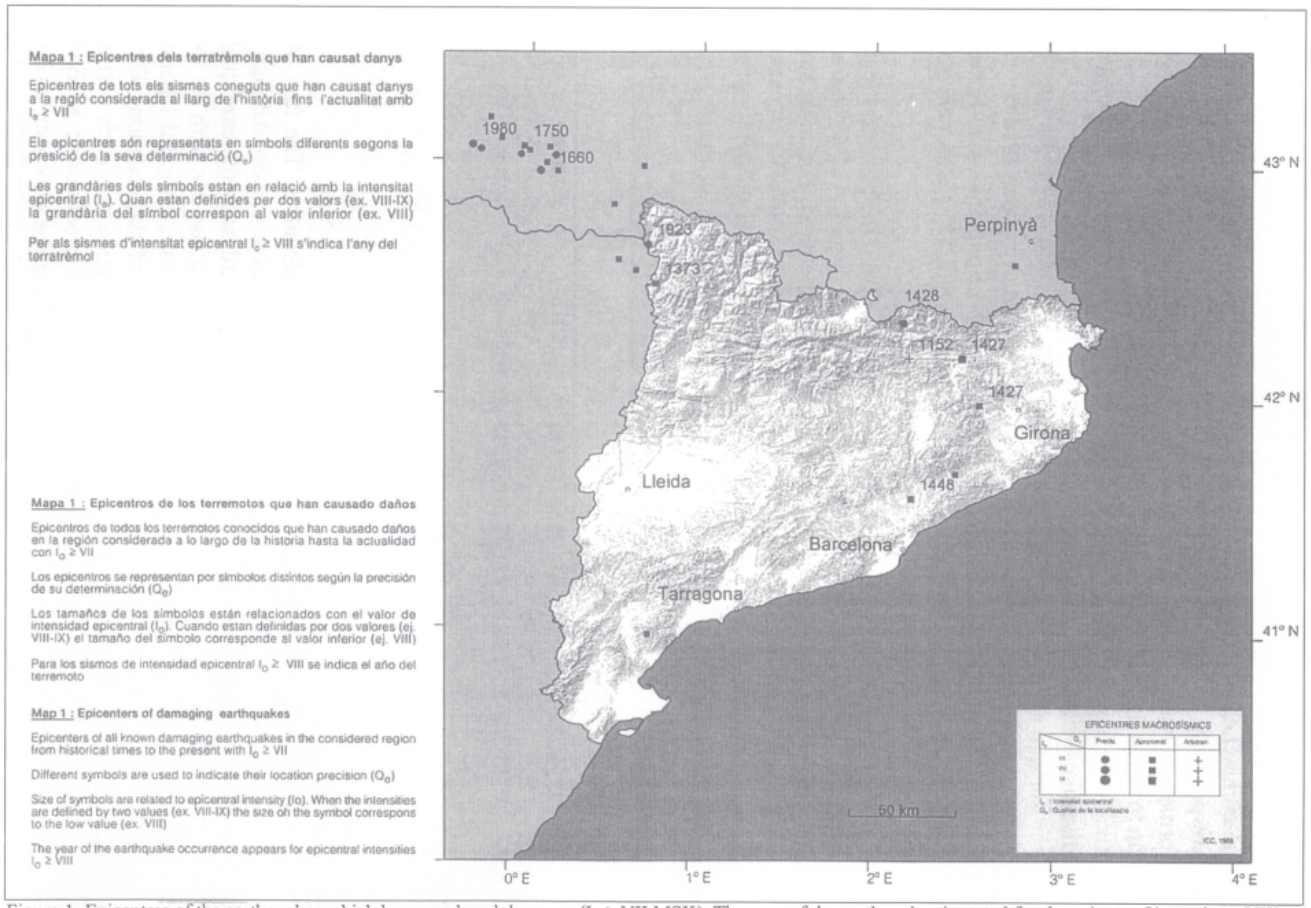

Figure 1. Epicentres of the earthquakes which have produced damages (Io ≥ VII MSK). The year of the earthquakes is stated for the seisms of intensity ≥ VIII

considered in former compilations as real, have been qualified as false or doubtful. Of the 860 earthquakes, 258 do not have an assigned intensity due to the lack of sufficient information. Map of the macroseismic observations is presented for a total of 109 earthquakes. An example of these maps is shown in figure 2.

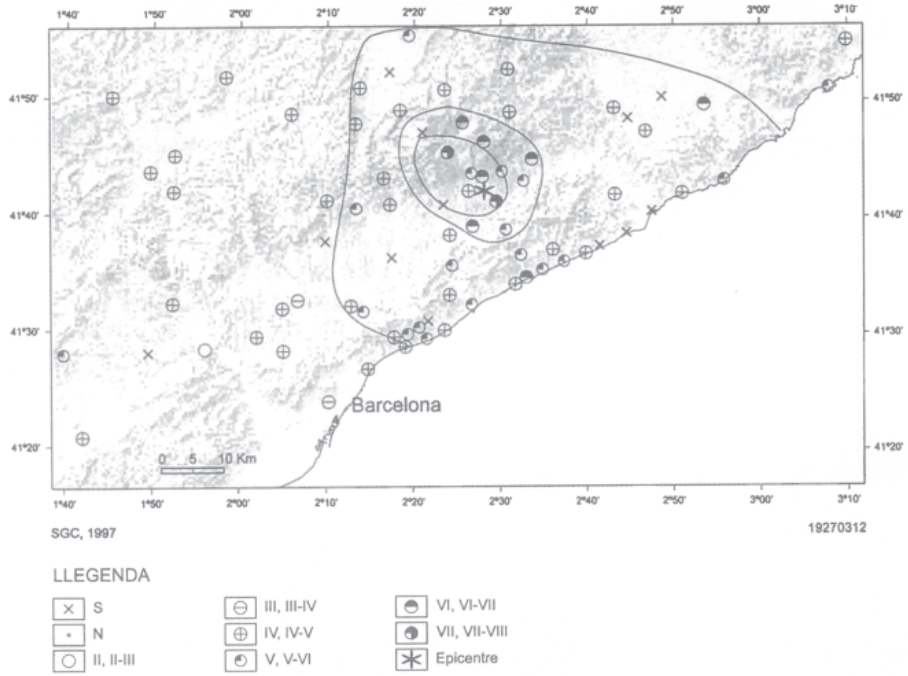

Figure 2. Distribution of the local intensities for the earthquake of intensity VII (MSK) on March 12, 1927 in Sant Celoni.

4. Preliminary analysis of the catalogue content

Considering the information source which has been maintained for each earthquake (and which appears as "reference" on the card), the information is split into the proportions shown in figure 3.

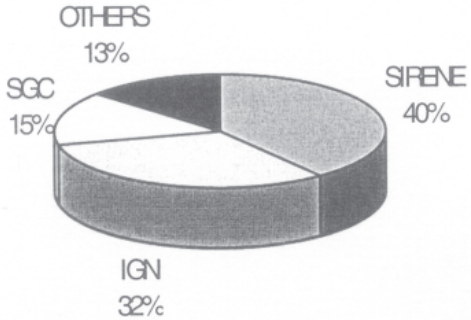

Figure 3. Distribution of the earthquakes in the catalogue classified according to the reference information.

As can be seen, more than one third of the information comes from the SIRENE data base, corresponding to the seismicity in the Pyrenees. Another third corresponds to the Spanish catalogue, published by the "Instituto Geográfico Nacional". The balance of the information comes from the new contributions (15% SGC) and 13% from Fontserè and Iglésies (1971), Suriñach and Roca (1982) and macroseismic surveys from the Fabra Observatory.

On the other hand, as has been seen in the maps (figure 1) the epicentres are represented with different symbols depending upon how accurate their localisation is. The quality of the epicentre can take values from 0 to 3, from higher to lower precision:

- Precise, 0, when the macroseismic information available is sufficient to accurately locate the epicentre (accuracy within a few kilometres) or has been instrumentally determined in recent earthquakes (with a symbol ● in the map).
- Approximate, 1 and 2, when the precision is estimated to be between 10 and 20 km (1) or a few dozen kilometres (2) (with a symbol ■ in the map).
- Arbitrary, 3, : when the information available comes from one place or region only. In these cases the epicentre is arbitrarily fixed in this location (with a symbol + in the map).

The false or doubtful ones have not been assigned.

The diagram in figure 4 shows how the catalogue content is split according to the quality of the epicentre. Nearly a third part of the epicenters correspond to a precision 3, i.e. epicenters fixed arbitrarily in the location where the earthquake is mentioned to be felt. A half part of the located earthquakes correspond to a precision 2, i.e. epicenters taken mainly from pre-existing catalogues, IGN and SIRENE, without any process of relocation. The 20% of the epicenters are well located with quality 0 or 1. A half part of these 20% of epicenters are taken from the SIRENE catalogue; for the other half part (less than 100 earthquakes) the epicenters were defined taking into account the complete distribution of felt intensities.

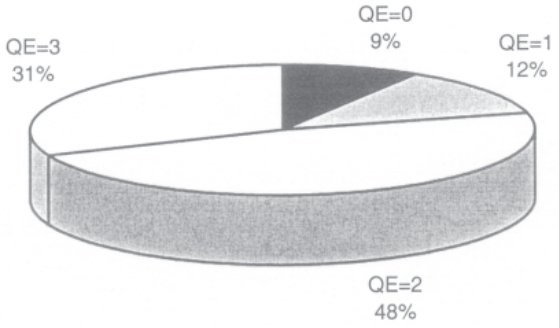

Figure 4. Distribution of the earthquakes in the catalogue classified according to the qualityof the epicentre (QE).

Finally, if the epicentral intensity is considered, the classification shown in the diagram of figure 5 is obtained (for intensities equal to or above V MSK). In this diagram, the distribution along the time for each category of intensity can be observed for periods of 10 years. The information corresponding to earthquakes with intensity equal to or under VII is very scarce before the 18th Century. However, the information seems complete for the higher intensities for the whole period considered. This consideration is important when estimating the frequency of occurrence for earthquakes of different intensity which represent the regional seismic activity.

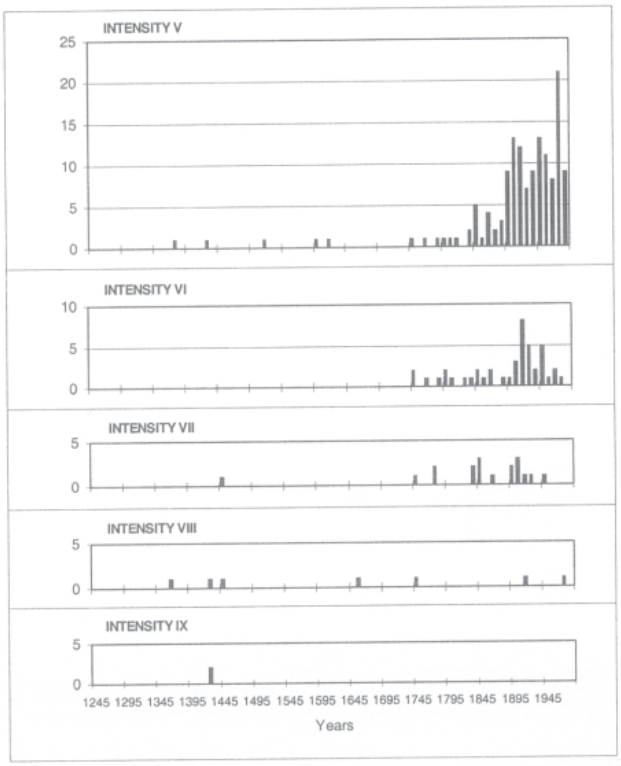

Figure 5. Distribution in time of earthquakes per intensity category for 10 year periods.

Figure 6 shows that only 26% of the seisms have an intensity equal to or above V (MSK). These have most of the incidence in the hazard analysis. The seisms without assigned intensity (30%) correspond mostly to events during the last 150 years and to another small group coincident with the seismic crisis in the Middle Ages.

The remaining seisms (44 %) have intensities under V (MSK) and are mainly from this century.

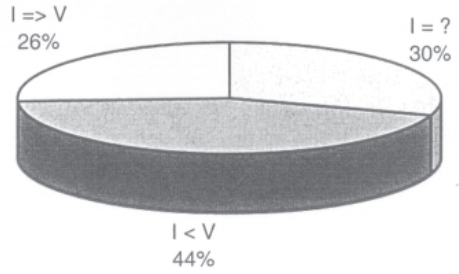

Figure 6. Distribution of the earthquakes in the catalogue, classified according to their intensity.

5. Conclusions

An updated data base of the seismicity of Catalonia and neighbouring regions has been obtained through the revision and update of the existing data. This data base is published as maps, individual record cards for each earthquake, and a parametric listing. The catalogue is published as Volume 1 of the "Seismic Atlas of Catalonia" (Susagna and Goula, 1999). Has been epicentral maps and the epicentral table can be found on: www.icc.es.

6. Acknowledgements

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