A New Online Intensity Data Point Database for Portugal

J. Batlló
Instituto D. Luiz, IDL-UL, Lisboa, Portugal

F. Carrilho, P. Alves & J. Cruz
Instituto de Meteorologia, I. P., Lisboa, Portugal

M. Locati
Istituto Nazionale di Geofisica e Vulcanologia, Milano, Italy

SUMMARY:
Online macroseismic intensity databases are becoming common tools in the framework activities related to seismic hazard assessment as they can offer a consistent information background. In Europe, institutions such as INGV (IT), ETH (CH) and Sisfrance (FR) have well-established Macroseismic Intensity Databases. In the framework of the EC projects NERIES (2006-2010) and SHARE (2009-2012), the European "Archive of Historical EArthquake Data" AHEAD was established. Other European institutions are now in the process of creating their own intensity databases following a common standard proposed by AHEAD.
Portugal is among those countries working on a macroseismic intensity database, as at present an updated general compilation of the mainland Portugal macroseismicity is still unavailable. The IM, has among its short term objectives to compile a macroseismic database and to give free access to it on the web. To manage it, the MIDOP software, created and developed by the Italian INGV has been selected. It allows easy access to earthquake listing and visualization of geographical distribution of intensity data points through a web page without the need of installing a complex infrastructure. MIDOP underlying structure strictly follows the standard proposed by AHEAD and by its adoption the collected data will be compatible with other national databases. The status of the project is here presented.

Keywords: Macroseismology, Portugal, Online catalogue.

1. INTRODUCTION

Macroseismic intensity data, often referred as MDPs (Macroseismic Data Points), are commonly used as a background resource of information for seismic hazard assessment. Well organized databases allow optimizing the use of such kind of data. At a European level, research institutions such as INGV (IT), ETH (CH) and Sisfrance (FR) have well-established Macroseismic Intensity Databases openly available on the web. In the last few years, in the framework of the activities of the EC Projects “Network of Research Infrastructures for European Seismology” NERIES (2006-2010) and “Project Seismic Hazard Harmonization in Europe” SHARE (2009-2012), a new pan-European database called the “Archive of Historical EArthquake Data” AHEAD was established. The initiative has two main scopes: i) establishing a cooperative effort for archiving historical European earthquakes and II) trying to standardise the approach on retrieving, storing, analysing and presenting historical macroseismic information. On the wave of such projects, other institutions such as BGS (UK), ITSAK (GR), IGN (ES) and NOA (GR) started organizing their own macroseismic intensity databases.

Portugal is still missing such a resource of well-organized and easy-accessible information. But, to improve this situation, the Instituto de Meteorologia, I. P. (IM), in charge of surveying Portugal seismicity, has among its short term objectives to compile a first version of the database and to give free access to it on the web. This new macroseismic catalogue and database for Portugal mainland will be built by assembling the available material and organising it in a comprehensive database. This database will serve as a base for further revisions and specific studies.

European-wise, existing macroseismic databases at INGV, ETH and Sisfrance adopts different technical solutions, both for organising and for presenting their own data. As on developing AHEAD, our effort was starting from scratch (studies and data sources are collected and reviewed before introducing them on the archive), much attention was paid to lay a solid basis upon which building up the database. The standard proposed by AHEAD can guarantee a long-term sustainability as it was created trying to homogenise all the past European efforts. In order to support the growth of local intensity databases, AHEAD created a convenient tool called MIDOP (Macroseismic Intensity Data Online Publisher) to organise and publish intensity data on the Internet using a user friendly interface. This flexible software is designed and developed by the Istituto Nazionale di Geofisica e Vulcanologia (INGV) and allows easy access to earthquakes listing and visualization of geographical distribution of intensity data points through an intuitive point-and-click web page.

For these reasons, MIDOP has been selected to organize the new Portuguese macroseismic database to be implemented by the IM, with the collaboration of other groups involved in studying Portuguese macroseismicity (IDL, LNEC. IST). Nevertheless, as the same software has been adopted or is under implementation in other European seismic institutions, such a solution will greatly help the collaboration with other institutions in this topic.

2. MACROSEISMIC DATA IN PORTUGAL

Macroseismic studies have been a topic of permanent interest in the Iberian Peninsula. Roca *et al*. (2004) summarized the state of the art ten years ago. Focusing on Portugal, the 1980'ies saw large efforts to revise the Portuguese seismic catalogue and its associated macroseismic effects on behalf of the initiatives taken by the *Gabinete de Protecção e Segurança Nuclear.* After this lively period, only few studies on specific topics or earthquakes have been undertaken (e. g., Justo and Salwa, 1998; Teves-Costa and Batlló, 2011). As a result, an updated general compilation of the mainland Portugal macroseismicity is still unavailable.

Since its creation in 1947, the IM has been compiling and evaluating macroseismic information about the earthquakes felt in the whole country and publishing intensity data points as printed volumes I and II of "Anuário Sismológico de Portugal" covering, respectively, from 1947 until 1973 and from 1974 to 2000. The Volume III, covering from 2001 onwards, changed its name to "Anuário Macrossismológico de Portugal". Figure 1 shows the front cover of the last published issue.

All the IM macroseismic intensity data published since 1947 are stored in an internal application called MACROSS, which was developed for exchanging data with other tools operating at IM such as Seisan. Seisan is a seismic analysis system for analyzing earthquakes from analog and digital data (Ottemöller *et al*., 2012). Like any other Seisan data, macroseismic data are stored in a database like structure using the file system, where there is one well-formatted ASCII file per event. Each file contains the original time of the event, the place information (name, latitude and longitude) and the corresponding macroseismic intensity.

3. TECHNICAL IMPLEMENTATION

Within the European project NERIES, the NA4 module "Distributed Archive of Historical Earthquake Data" (http://emidius.mi.ingv.it/neries_NA4) developed an open source software called MIDOP ("Macroseismic Intensity Data Online Publisher" http://emidius.eu/MIDOP), which allows publishing macroseismic data on the Internet (Locati and Cassera, 2010). The tool is developed by INGV, and it is being maintained and used in the activity framework of AHEAD ("European Archive of Historical Earthquake Data", http://emidius.eu/AHEAD). MIDOP can convert unappealing data tables into interactive and easily personalised maps ready to be put on the Internet. The generated content is safe against hacker attacks, it does not require a powerful web server or a complex installation and has no

maintenance issues. These four key features simplify enormously the adoption of MIDOP in a seismic institution which has usually limited resources, especially for managing macroseismic data.

Figure 1. Cover of one of the last published issues of the "Anuário Macrossísmológico de Portugal".

Publishing data on the Internet is a common task in seismology, a task which however is usually carried out by third party subjects with a different knowledge than those seismologists who did actually created such data. This situation causes a back and forth process of information between the data producer (the seismologist) and the web content developer due to a lack of common knowledge between the two parties. The process can easily end up with errors or misleading presentation information in the published material. By design, MIDOP tries to fill the gap between data production and publications, allowing seismologists to directly tweak most aspects of the final layout of the web content by using an intuitive point-and-click control panel.

The starting point consists on the building up of two data tables: a) the list of earthquakes and b) the observed macroseismic intensity data related to each of the mentioned earthquakes (details on these tables are described in the next sections).

An additional and optional table with the bibliographical references of the information displayed can be added.

MIDOP already contains a set of geographic data (at least the first and second level of administrative subdivisions, important cities and the topographic DEM) covering the whole Europe and generates maps using the most appropriate UTM zone for the displayed data. The geographic layers can be

enabled or disabled and can be styled according to a specific requirement (Fig. 2). Additional custom geographic layers can be created easily by converting ESRI-shapefiles into SVG files (Scalable Vector Graphics), the W3C standard used in MIDOP for representing maps.

In order to use MIDOP, a development machine is required and a web server (Apache), a macro language (PHP) and a DBMS (MySQL) should be installed. The generated output website is composed of simple HTML files with JavaScript and interactive maps are standard W3C SVG (Scalable Vector Format) files. As MIDOP will be used directly by the seismologist who directly manages the macroseismic data, the development computer is commonly the PC of the seismologist itself. If otherwise the tool is going to be used in a team environment, it can be also installed on an intranet server using a remote connection to the MySQL server.

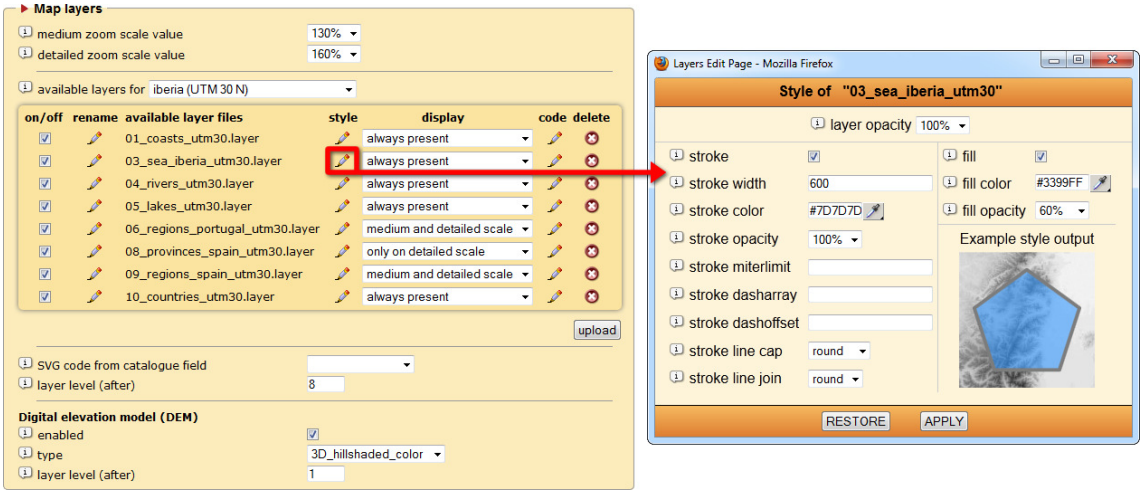

Figure 2. Available settings for geographic layers customisation.

Publishing a website is divided into a three stages process: 1) loading the list of earthquakes and intensity data tables into MySQL; 2) customizing the content and the final visual layout (source fields to be used, intensity symbols, style the selected geographical layers and the default zoom level); 3) generating the output folder with the self-sustained website (HTML and image files) which is ready to be transferred to the web server of the institution. Multiple websites can be managed with a single MIDOP installation, each with its own settings.

Users can view published material by selecting earthquakes from a map or from a table, and for each earthquake it is possible to map and zoom the map in real time. Such interaction with the content does not require any further request to the webserver as any operation is performed directly by the client browser. If needed, intensity data can be downloaded as a Microsoft Excel file or viewed into Google Earth.

3.1. Earthquake list input

The minimum set of information required in this table is the origin-time and the unique code identifier of the earthquake. This identifier must be a number or an alphanumeric code, and it should be different from the origin-time as it can cause problems when working with historical earthquakes (large uncertainties of time, sometimes even days or months) or when a wide area is covered.

If available, a set of additional information can be used (Figure 3). In the case of IM, available data for the period 1947 to present consist in the epicentral coordinates, most of them calculated from instrumental data (even there is still some earthquake not detected by seismograph and known only by its macroseismic effects), the epicentral intensity and, for some events, magnitude (mainly from the seventies onwards and calculated with a local formula).

3.2. Macroseismic intensity data input

The minimum set of information for this table is the reference identification code of the earthquake (the same used in the earthquake list table), the observed macroseismic intensity value and the location coordinates to which the intensity is referred to.

Other additional information can also be included in the table, namely:

- the macroseismic scale used for expressing the intensity (MSK, MCS, EMS, MM);
- the name of the place, both as it was in the historical time of the earthquake and the modern one;
- special place/site cases, if any (e.g., a presently inhabited or deserted place, a suburb of a city, an isolated buildings, a large territory, etc.);
- an alphanumeric code expressing the quality of the intensity value;
- the country to which the place belongs and three more levels of administrative subdivision (e.g., region, province and municipality);
- The Gazetteer adopted to associate the uniqueness of the coordinates identifying the location.

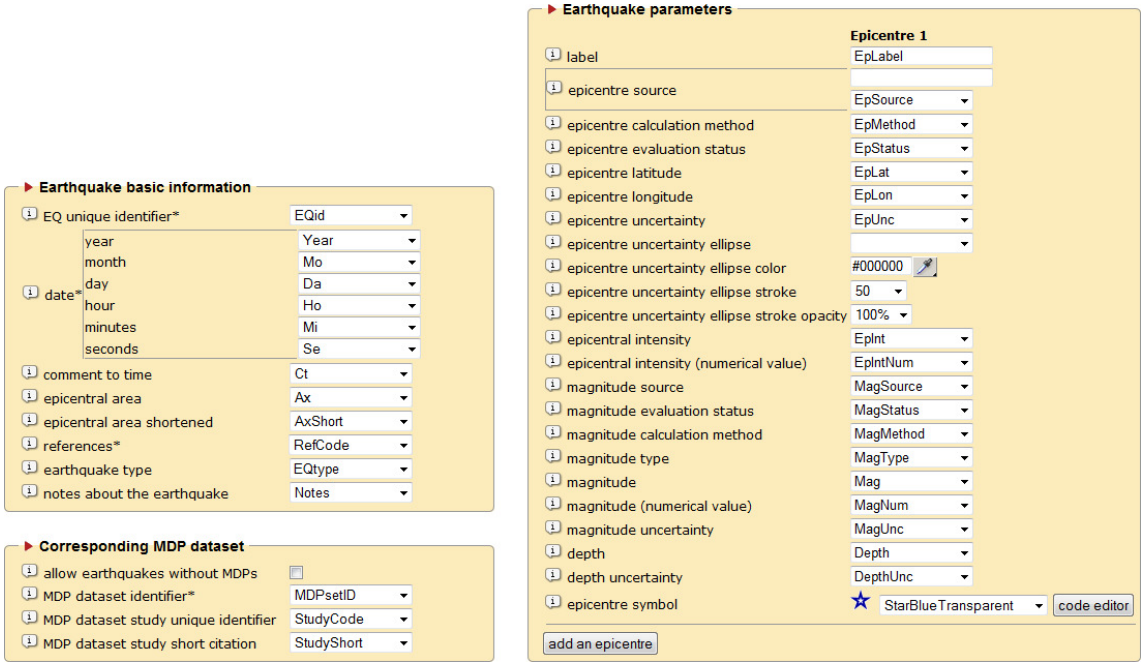

Figure 3. MIDOP Control Panel, setting the list of available earthquakes and their available parameters.

If mentioned places are identified by a unique code among all earthquakes, MIDOP can generate a seismic history for each place (the list of all earthquakes occurred there) in tabular form and in an interactive diagram.

The original ASCII macroseismic intensity files used at IM contained only the intensity values, the place names and their coordinates. In order generate place seismic histories, IM revised all the original files in order to assign a unique identifier to each place. For this reason, a throughout effort to review the coordinates of all the municipal units (in Portugal they are called “freguesias”) has been made greatly improving the location of many of them (Portuguese territory is organized in three levels, the basic municipal unit is the “freguesia” –parish/municipality-, several “freguesias” form a “concelho” –county-, and several “concelhos” form a distrito –department or province). In the old databases,

location of “freguesias” was taken in the geographical centre of its territory, resulting in some points being placed in forest, lakes, etc. Now these coordinates are all placed in the approximated centre of the populated area, to which the assigned macroseismic intensity is referring to.

4. PRESENT STATUS OF THE INTENSITY DATABASE AT IM

This project started in the framework activities of the NA4 module of the EC project NERIES, which was focused on the historical time-window from year 1000 to 1899 and partially (only for big events) from 1900 to 1963. For such period the most important events were retrieved and formatted. During the year 2010 the first attempt using MIDOP at the Institute of Meteorology, IP (IM) began. The work consisted of the installation and configuration of the software on one server and the upload of the macroseismic data available. The tool is now up and running and it is used internally to keep data organised and accessible for analysis. A preliminary database for the XX Century Portugal mainland has been assembled on the basis of information contained in the database of macroseismic information from 1947 to the present. MACROSS has been used to generate tables that formed the basis for the implementation of MIDOP. The available ASCII files for each event have been automatically converted to a unique EXCEL file. This new file has been completely revised and extended with years with additional information such as the place identifier and used as input for MIDOP. For the previous years (1900-1947) the data points contained in Choffat (1904), Choffat and Bensaude (1912), Pereira de Sousa (1914, 1917, 1922), Miranda (1930), Sousa Moreira (1991) and other manuscript documentation and internal reports preserved at the archive of the IM and mainly recompiled by the former prof. Sousa Moreira have been used to compile a new file for that period. Also some recent reviews have been included (ex. Teves-Costa and Batlló, 2011).

So far a problem of the elaborated database is the lack of homogeneity of the input data. At least six different scales are used: Rossi-Forel, Mercalli (twelve degrees), MCS17, MM31, MM56 and EMS98. Data sources for earthquakes in the period 1900-1947 are really unequal. For some earthquakes we keep in our records throughout complete damage descriptions allowing a later review of the intensity degree assignation. Instead for some others (maybe 25% of the events) just a list of the assigned intensity degrees is available. It is currently under evaluation the possibility to adopt an a-priori equivalency between macroseismic scales, as proposed by Musson et al. (2010) or some other procedure for homogenising the input data. If this is the case, it is clear that original data should be kept (something as a “backup column”, of easy implementation in the database) for the future so it will be ever known this procedure was applied and, if needed, it can be removed or changed. We are also evaluating the possibility to assign a quality level to each MDP based on the available damage descriptions.

While processing data we found problems in the origin-time of some event, causing duplication of events. The reason of such error was a misleading use of local versus UTC times (UTC was not adopted in Portugal until 1913).

5. FUTURE DEVELOPMENTS

Future developments include the increase of MDPs by extending the coverage in space and time, both backwards and forwards. For events occurred prior to the XX Century, the revision and updating performed under NERIES and SHARE projects was extremely helpful. As already pointed out, a careful revision and homogenization of the XX century data is still required, with special attention to the time window 1900-1947.

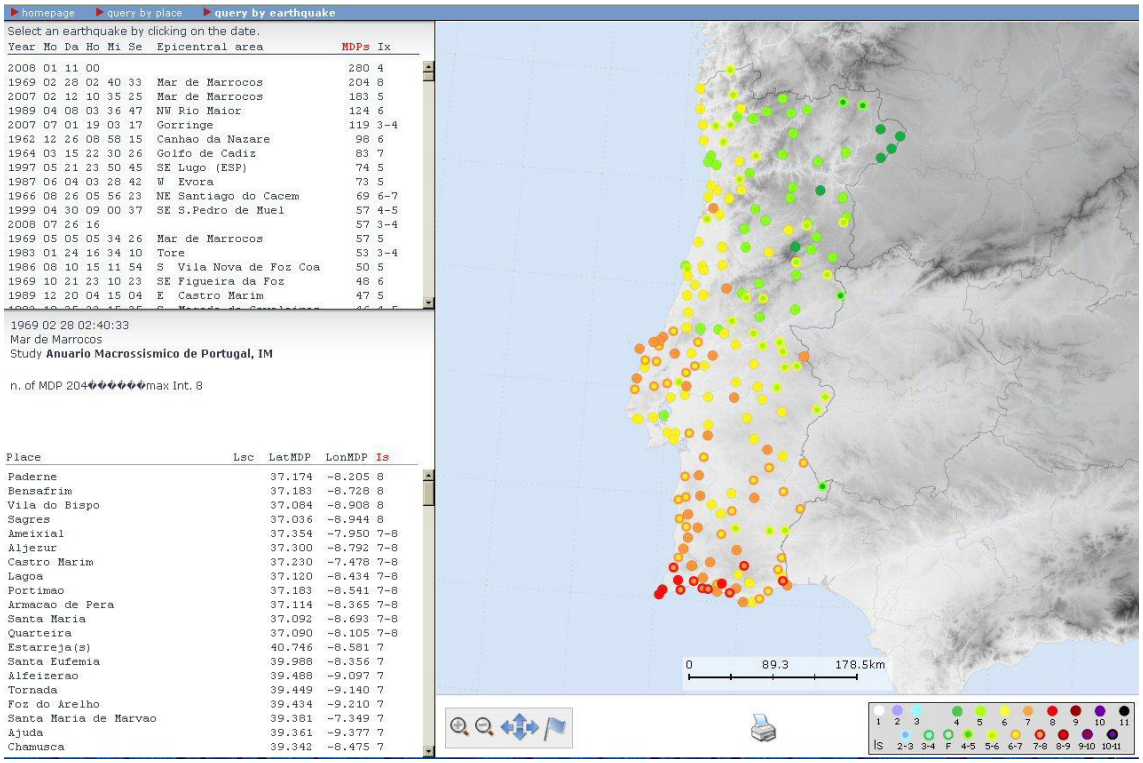

Figure 4. Example of the MIDOP output for the great earthquake of 28 February Atlantic de1969 using IM data.

Magnitudes, epicentral intensities and the reference studies for all events will most probably be included whenever available. Magnitude uncertainties will be also included, but they are available only for those events with an instrumental location. Moreover, as epicentral locations have been calculated with different methods (instrumental locations, automatic procedures with MDP, even expert criteria for some old offshore Atlantic events), it is necessary to keep track of all these information for future users.

A further step is to include the intensity data available for the Azores and Madeira islands, resulting in a more complete coverage of the entire Portugal, both the mainland and the islands. It is expected that during the year 2012 the database, or at least part of it, will be made publicly available through the IM webportal. Figure 4 shows an output example of data already available, in this case the MDPs corresponding to the great Atlantic event occurred on the 28th of February 1969. Figure 5 shows the seismic history example of Lisbon.

It must be made clear that the undertaken activity of building up a comprehensive macroseismic intensity database for the whole Portugal is a huge task which has just started. By adopting the standards proposed by AHEAD and its related tool MIDOP we were able to well organise and manage our greatly underestimated data resources. Moreover by adopting such standard we are confident of being able to better collaborate with other institutions, especially those in the rest of the Iberian Peninsula.

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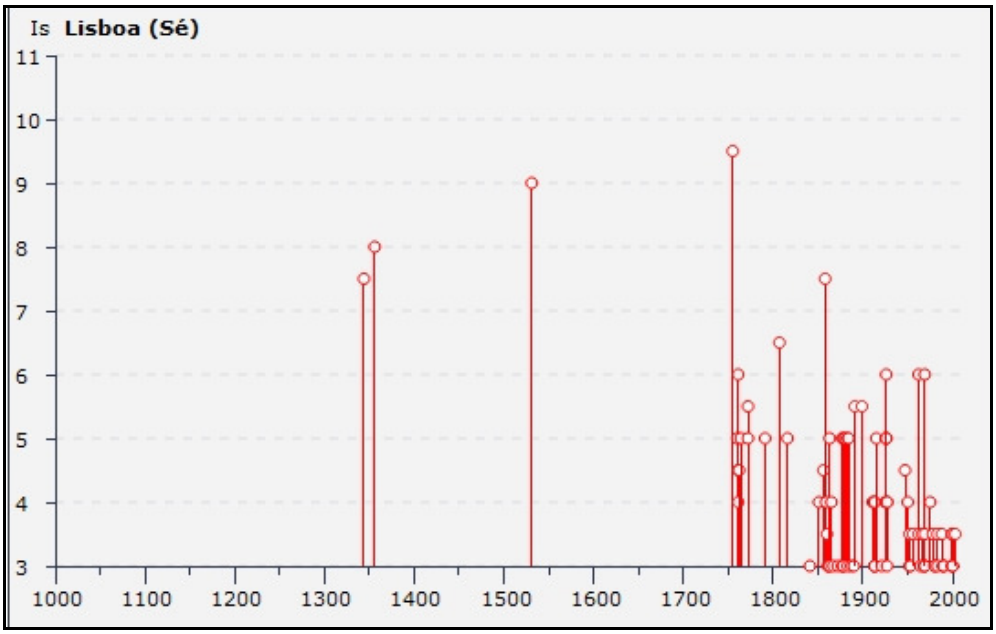

Figure 5. Example of the seismic history output for the "freguesia" of "Lisboa – Sé" (Lisbon – Catedral). This is only a preliminary output as the catalogue is not yet fully introduced in the database.

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