



NEtwork of Research Infrastructures for European Seismology

Deliverable D4
European macroseismic database (*demo version*)
1000-1600, $M > 5.0$
(October 2008)

Activity:	Distributed Archive of Historical Earthquake Data
Activity number:	NA4, Task 2, Task 3
Deliverable:	European macroseismic database (demo version) 1000-1600, $M > 5.0$
Deliverable number:	D4
Responsible activity leader:	M. Stucchi
Responsible participant:	INGV-MI
Author:	M. Stucchi, M. Locati with the collaboration of A. Cassera, A. Rovida, R. Musson, A. Roca, J. Batllo, C. Papaioannou, D. Faeh

Sixth Framework Programme
EC project number: 026130

Index

Summary

1. Introduction
2. State-of-the-art
 - 2.1. NA4 partners
 - 2.2. Non NA4 partners
3. The compilation of the NA4 macroseismic database: general aspects
4. The comprehensive European Macroseismic Database (EMD) 1000-1600, $M \geq 5$
5. Data management and dissemination

References

Appendices

- Appendix 1. Georeferencing
- The problem
 - Gazetteers and related issues
 - Misinterpretation
- Appendix 2. Macroseismic intensity assignment
- Macroseismic intensity scales
 - Unconventional (anomalous) intensity assignments
 - Locality special cases
 - Inappropriate macroseismic notations
 - The "conversion table"
 - Reliability
- Appendix 3. Format and content of the NA4 European Macroseismic Database
- Appendix 4. Studies/datasets contributing to EMD 1000-1600
- Appendix 5. Data dissemination: software, layout and related aspects
- Existing software implementations
 - Proposed solution:
 - Hardware and software requirements
 - Additional elements:
 - Intensity symbols
 - DEM
 - Administrative boundaries

Summary

The goal of this activity is to make macroseismic data (MDPs = macroseismic data points) homogeneous and available to public in digital form. Quoting the NERIES DoW 2005:

“Earthquake studies with MDP will be analysed, in order to: i) evaluate the reliability of the data, ii) assess a standard format for (re)compiling MDPs according to homogeneous criteria, in such a way that each entry will contain: a) time of earthquake occurrence; b) place-name, its identification and geographical coordinates as from the directory; c) assigned intensity value; d) a quality value representing the reliability of this datum for general use.

Common specifications and access procedures for existing European databases will be designed in such a way as to provide: (a) access by earthquake, to extract the intensity data points, and (b) access by locality, in order to provide seismic histories at the sites. The software to retrieve and visualise data will be structured in such a way as to be customisable and tailored to specific and different end-user requirements, and installed at the various databases. The layout of the web access will be designed in order to provide multiple views highlighting relationships between the data, for example providing, side by side, lists of data and their cartographic representations: MDP and maps, in the case of query by earthquake, or site intensities and graphical seismic history, in the case of query by locality. Data from large earthquakes will be progressively homogenized and made available to users, starting with the data from the datasets already structured”

The main steps of the work are described in the following; details and technical issues are dealt with in 5 Appendices. The core database contains data of earthquakes 1000-1600 with a wider magnitude range with respect to the initial forecast ($M \geq 5$ instead of $M \geq 5.5$). It must be recalled that the M-based selection is preliminary, as it was performed on the basis of the original M or I_0 values; as soon as M_w values will be re-determined from EMD, the selection will be updated accordingly.

Although the number of MDPs is not high (slightly more than 2000), the work performed in this time-window has encountered many problems related to the time-window peculiarities and, therefore, has served as a training for the whole database.

The document contains many methodological issues, agreed among NA4 partners through discussions and polls, on how to qualify the data and to compile the database. Such issues includes how to solve the problems of georeferencing the data and how to deal with alphanumeric or inappropriate macroseismic assignments. The results will make the work related to the other centuries easier and will establish a reference for future investigations.

D4 is actually composed by four main sub-deliverables:

- a) the implementation of the local databases (existing for Italy and Switzerland, in progress for the Iberian countries, Greece and UK), to comply with the scope of NA4 “A Distribute Archive of Historical Earthquake Data”;
- b) the compilation of the comprehensive, European Macroseismic Database for the most energetic events;
- c) the software for making EMD available through the Internet;
- d) the sub-version of item c) designed for assisting item a). This software will be made available inside and outside NA4 under an Open Source Licence.

1. Introduction

The goal of this activity is to make macroseismic data (MDPs = macroseismic data points) homogeneous and available to public in digital form.

If institutions and individual investigators who provide historical-macroscopic data would work according to well established and agreed procedures - as it happens for instrumental data - there would be no need for additional work; data will be compatible and the making of the European macroseismic database would require computer networking operations, only.

Unfortunately, this is not the case. The need for a European macroseismic database was clearly expressed in the 2005 NERIES DoW:

“Intensity data in Europe are still collected and archived in isolation by many of the seismological observatories, with varying criteria and degrees of commitment. Only few countries (Italy, France and Switzerland) have a consistent, available set of historical earthquake data, interpreted in terms of macroseismic data points (MDP). In other areas, scattered data are available on paper, though the coordinates of the data points are not easily obtainable and the place-names are missing in many cases. While a uniform intensity scale has recently been established for the Euro-Med region (EMS98) and is now widely used, existing databases for historical earthquakes have been compiled using a variety of intensity scales. Homogenisation and consistent documentation of many studies and data across Europe is missing. This is in stark contrast with the corresponding situation in the USA, where the centralised Earthquake Intensity Database provides more than 150,000 MDP data for over 23,000 damaging events after 1638, with the whole data set freely available on the Internet. Europe has a much longer history than the US, and needs to efficiently network historical data archives in order to be able to provide a pan-European, homogeneous macroseismic database to provide Euro-Med users with access to this kind of data, available at a variety of seismological infrastructures throughout Europe.

The current European situation is not different with respect to 2005. Three digital macroseismic databases are available through the internet; two of them are NA4 partners (Italy and Switzerland), the third one is from France. Other collections of MDPs are reported as available from varied countries and institutions.

Outside Europe, macroseismic databases are becoming increasingly available on internet, such as:

- USA: Intensity Database ranging from year 1638 to 1985 at the National Geophysical Data Center (NGDC; <http://www.ngdc.noaa.gov/hazard/intintro.shtml>);
- South America: Intensity Database ranging from year 1471 to 1985 at Centro Regional de Sismología para América del Sur (CERESIS; <http://www.ceresis.org/>);
- Venezuela: Sismología Histórica de Venezuela, at the Universidad de Los Andes which ranges from year 1530 to year 2001 (ULA; <http://sismicidad.ciens.ula.ve/>);
- Japan: database of historical earthquakes (Kobe University, Research Centre for Urban Safety; <http://historical.seismology.jp/erice/>).

Due to the fragmented situation described above, it is today impossible to get to the desired solution simply networking the existing databases. The strategy of NA4 is devoted to:

- a) encourage hidden data to emerge in a digital form and to develop local, coherent databases accessible through the web;
- b) build up a comprehensive, European macroseismic database, accessible through the web, with reference to the most energetic events, making use of public data only. National databases will not be challenged by this initiative. The European database will be updated according to a regular schedule and could be mirrored at varied institutions, for preservation and safety reasons [[http://en.wikipedia.org/wiki/Mirror_\(computing\)](http://en.wikipedia.org/wiki/Mirror_(computing))].

The goal of making macroseismic data homogeneous and available to the public in digital form is being achieved according to the following steps:

- i) establishing agreed, common format and rules of compilation;
- ii) compiling the data according to that format and making them available through the web at local level;
- iii) homogenising the data of the most energetic events with respect to: a) geographical and place-name reference; b) intensity coding, etc.;
- iv) making the data of the most energetic events available through a dedicated website and software.

2. State-of-the-art

2.1 NA4 partners

Italy. DBMI (DataBase Macrosismico Italiano) is available online in its 2004 version (Stucchi et al., 2007; <http://emidius.mi.ingv.it/DBMI04/>). It contains 58146 MDPs (MCS scale) related to 14161 localities (12943 in Italy) from 1041 events in the time-window from the Ancient Time to 2002. Place names and coordinates (given in decimal degrees) come from an ad hoc gazetteer. Data come from 68 studies. Most events have epicentral location in the Italian territory. DBMI makes the explicit choice not to incorporate data from foreign databases, in the view of a European database. The explanation is in Italian. The whole database can be downloaded. The data from DBMI04 have been used to compile the parametric catalogue CPTI04 (Gruppo di lavoro CPTI, 2004; <http://emidius.mi.ingv.it/CPTI/>), which also includes 1507 entries from other parametric catalogues and covers the same time-window of DBMI04.

An updated version of DBMI, DBMI08, is progressively released through the same URL. It will contain more than 84000 MDPs related to 15758 localities (14619 in Italy) from 1571 events supported by 95 studies. Data from DBMI04 and DBMI08 are free, with request of acknowledgement. They are accessible “by earthquake”, with a map provided, and “by locality”, with a standard graph.

Switzerland. The Earthquake Catalog of Switzerland (ECOS) (Faeh et al, 2003; <http://histserver.ethz.ch/>) covers the time frame 250 B.C. to 2008. ECOS can be screened with a query tool which allows selecting and downloading earthquake information as well as displaying it on maps. The historical macroseismic database (MECOS) is the basis of this web application. ECOS therefore provides macroseismic data (MDPs - all given in EMS 98) for most historical and a few recent events within the Swiss border, as well as the respective references.

Place names and coordinates (given in decimal degrees) come from an ad hoc gazetteer. Data for Switzerland are mainly produced by the Seismological Survey team of ETHZ, amended with data coming from DOM (Monachesi and Stucchi, 1997) and SISFRANCE for events in neighbouring regions. The studies of a few events have been published; for all the others references are provided online.

The whole database cannot be downloaded at once, whereas macroseismic information (MDPs) for each event can be downloaded. The total number of MDPs is not reported.

Greece. AUTH has unpublished MDPs (MM) from the work of Papazachos and Papazachou, 2003;

Catalunya. IGC has MDPs (MSK) from the work of Olivera et al., 2006 (without coordinates);

United Kingdom. BGS has unpublished MDPs (EMS98) from a work in progress by Musson, 2008.

2.2 Non NA4 partners

France. The French macroseismic database SISFRANCE (Scotti et al., 2004; <http://www.sisfrance.net/>) provides data, as of March 2008, “concerning about 6000 earthquakes felt in France, 1800 epicentres [lat., lon, lo but no M], 100.000 observations and about 10.000 references”. Macroscopic tables (MSK, EMS only for recent earthquakes) and maps, as well as the relevant bibliography, are provided for each event. Place names and coordinates (given in degrees and minutes) come from an ad hoc gazetteer. Data belong to the consortium of BRGM, IRSN and EDF; the terms of use are specified in the homepage. The whole database cannot be downloaded. References are provided for single events.

Spain. MDPs (EMS) are found in the catalogue by Martinez S. and Mezcua R., 2002, for many events, in form of tables without coordinates or maps.

Portugal. MDPs (EMS) are reported in the catalogue by Martinez S. and Mezcua R. for some events. In addition, unpublished material (MM) is available at some institutions. In a few cases MDPs are available from the literature (e.g. Justo and Salwa, 1998).

Belgium. ORB is currently developing a database with studies, bibliography and MDPs.

The Netherlands. No information available.

Germany. No information available; but some MDPs (MSK) are available from the literature

Austria. Some studies are published, although most of them do not carry MDPs. Some progress is expected in the frame of the contract between INGV and ZAMG (Wien).

Slovenia. MDPs (EMS) are reported by I. Cecic. Some progress is expected in the frame of the contract between INGV and Arso (Ljubljana).

Slovakia. MDPs (MSK) are reported by P. Labak. Some progress is expected in the frame of the contract between INGV and GPISAS (Bratislava).

Hungary. MDPs (MSK) are reported by T. Zsiros. Some progress is expected in the frame of the contract between INGV and GEORISK (Budapest).

Romania. The availability of data at Rumanian institutions is to be explored. MDPs (MSK) are reported by R. Tatevossian for the Vrancea Region; some progress is expected in the frame of the contract between INGV and IPE (Moskva).

Bulgaria. MDPs (MSK) are reported by R. Glavcheva. Some progress is expected in the frame of the contract between INGV and BAS (Sofia).

Greece. Further MDPs (MM) with respect to AUTH are reported by NKUA (K. Makropoulos and V. Kouskouna) for some events in Greece and today Turkey. Some progress is expected in the frame of the contract between INGV and NKUA (Athina).

MDPs are also available for some Mediterranean events (1000-1500) from individual papers (e.g. Guidoboni and Comastri, 1997). The situation in countries not mentioned above is under investigation. MDPs on paper are found in the Atlases of the Balkans (Shebalin, 1974) and Central and Eastern Europe (Prochazkova and Karnik, 1978).

3. The compilation of the NA4 macroseismic database: general aspects

Currently available MDPs are compiled according to varied format. The individual MDP can be considered as the elementary “macroscopic particle”; as such, it carries the three basic information: date, place and intensity value. Additional information on the event, source of the data, etc., are usually tabulated together with the MDP core, to allow queries and plots.

The compilation of the data according to a unique format requires to solve problems and adopt agreed standards, with special reference to the following aspects:

- a) *georeferencing*. MDPs must be referred to a coherent geographical reference system (gazetteer). National gazetteers are not coherent throughout Europe as regards the level of accuracy, the place names, and the coordinates format. Another problem concerns the identification of the localities mentioned by the historical sources, a task which sometimes is performed by other persons than the investigators of the historical sources ending out in some pitfalls;

- b) *macroseismic intensities*. Intensity values are given in varied scales (EMS, MSK, MCS, MM); the solution of this problem has been recently addressed by a paper (Musson et al., 2008, *submitted*). Further problems refer to how to deal with some “locality special cases”, such as intensity assignment related to single buildings, small settlements, large areas, etc. (see for instance Stucchi et al., 2000, Stucchi et al., 2007), and to “intensity special cases”, that are inappropriate intensity assignments in the current practice;
- c) *reliability*. The need of reliability estimates of MDPs is well established, although not common in the current practice. A solution proposed by Musson (1998) has not been widely adopted, so far. Only ECOS, SisFrance and the work by Olivera et al., 2006 adopt reliability codes with three or four levels. However, definitions are not homogeneous and they need to be investigated further.

The solutions of these problems are presented in App.1 and 2. They are currently dealt with by the local compilers.

The task of the NA4 central unit is to homogenise the data from the local datasets, bridging the gaps among the gazetteers, the solutions adopted for the special cases, etc.

The format according to which MDPs are to be compiled is presented in App.3: it comprises 4 sections:

- section 1 contains original MDPs, as they come from a study (paper) or dataset
- section 2 contains data recompiled according to the NA4 standards. Consolidated databases, such as ECOS, etc., fill up the second section only
- section 3 contains basic macroseismic earthquake parameters retrievable from the dataset and instrumental data (time-window 1900-on)
- section 4 will contain the final data checked and homogenised by the central NA4 unit

Obviously, the format will be upgraded according to the emerging needs.

4. The comprehensive European Macroseismic Database (EMD) 1000-1600, M ≥ 5.

The core database. It contains data of earthquakes with a wider magnitude range ($M \geq 5$ instead of $M \geq 5.5$) with respect to the initial forecast. It must be recalled that the M selection is preliminary as it was performed on the basis of the original M or I_0 values; as soon as M_w values will be re-determined from EMD, the selection will be updated accordingly.

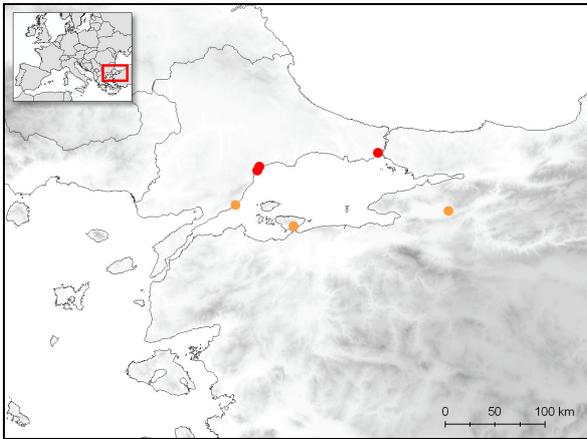
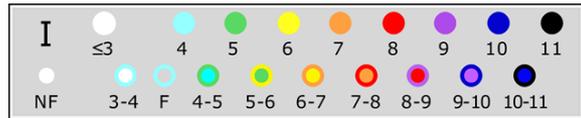
The original input datasets contain 2331 records of 297 events. As EMD is mainly “user-oriented”, 180 records have been classified as “side data”, as they do not supply macroseismically useful information. This is the case of all macroseismic assignments which cannot be related to any macroseismic scale, such as environmental effects; not classified information, etc. and all the assignments referred to large areas (such as Peloponissos, Piemont, Graubuenden, etc. (App.2). They will not be included in the core database and, therefore, in the following counting, although they will remain available. It may happen that for some events the original, maximum intensity or damage assignment is referred to a large area. Although this is a useful information, it is not suitable for application purposes.

The core database contains 2151 MDPs of 297 events. It is worth to note that, as from the NA4 Working File, the total number of events with $M \geq 5$ in the time-window 1000-1600 is 457. This means that about 1/3 of the events have no MDPs.

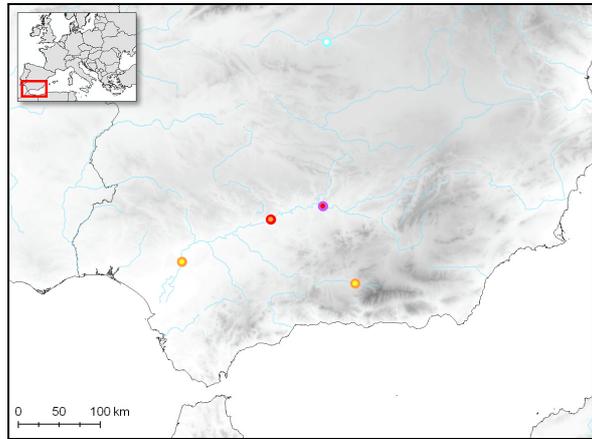
Some examples are plotted in Fig.1. The total MDPs are plotted in Fig.2 and the relevant preliminary epicentral locations in Fig.3. The number of MDPs per event (Fig.4) ranges from 1 to 133 (the Catalonia event of 1428, Olivera et al., 2006). The average MDP number is about 7, but only 50 events have more than 10 MDPs and only 20 have more than 20 MDPs.

The core database contains 1714 IDPs (datapoints with numerical intensity values, including the intermediate ones, such as 7-8, etc.) and 437 alphanumeric assignments (App.2).

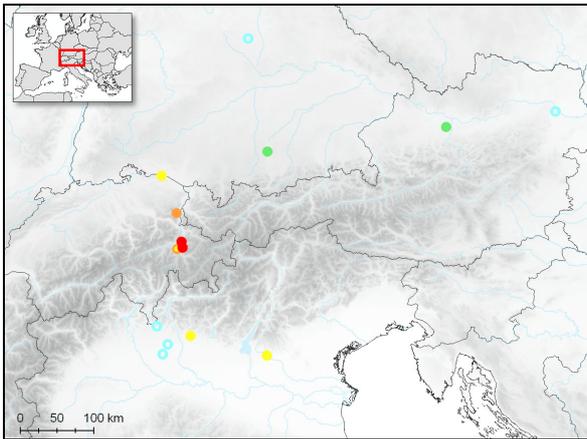
Intensity symbols



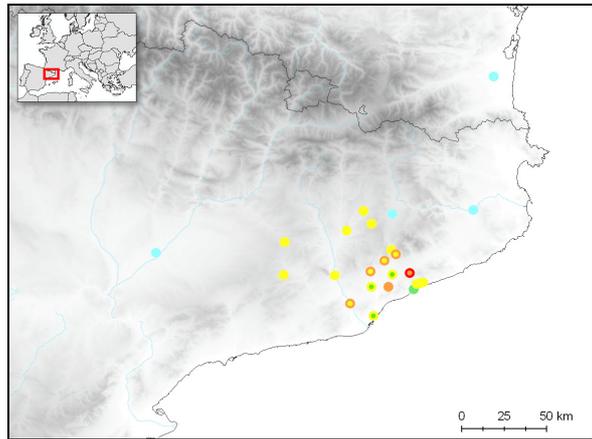
23.09.1063, Istanbul
from Papazachos & P., 2003



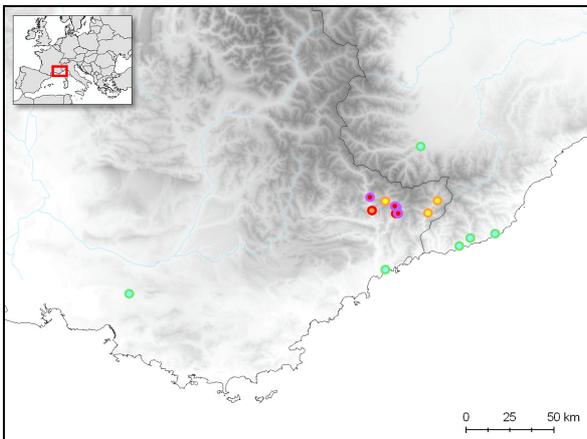
1169, Andújar
from Martinez S. & M., 2002



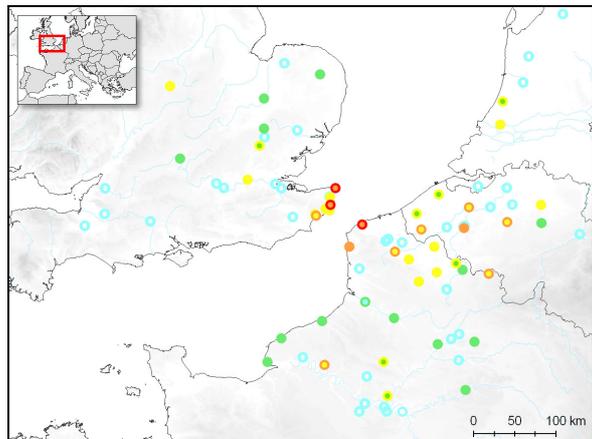
03.09.1295, Churwalden
from Schwarz-Z. et al., 2004



25.05.1448, Near Granollers
from Olivera et al., 2006



20.07.1564, Maritime Alps
Lambert et al., 1994



06.04.1580, Dover Straits
from Musson, 2008

Fig. 1 - Plot of the MDPs distribution of 6 selected events.

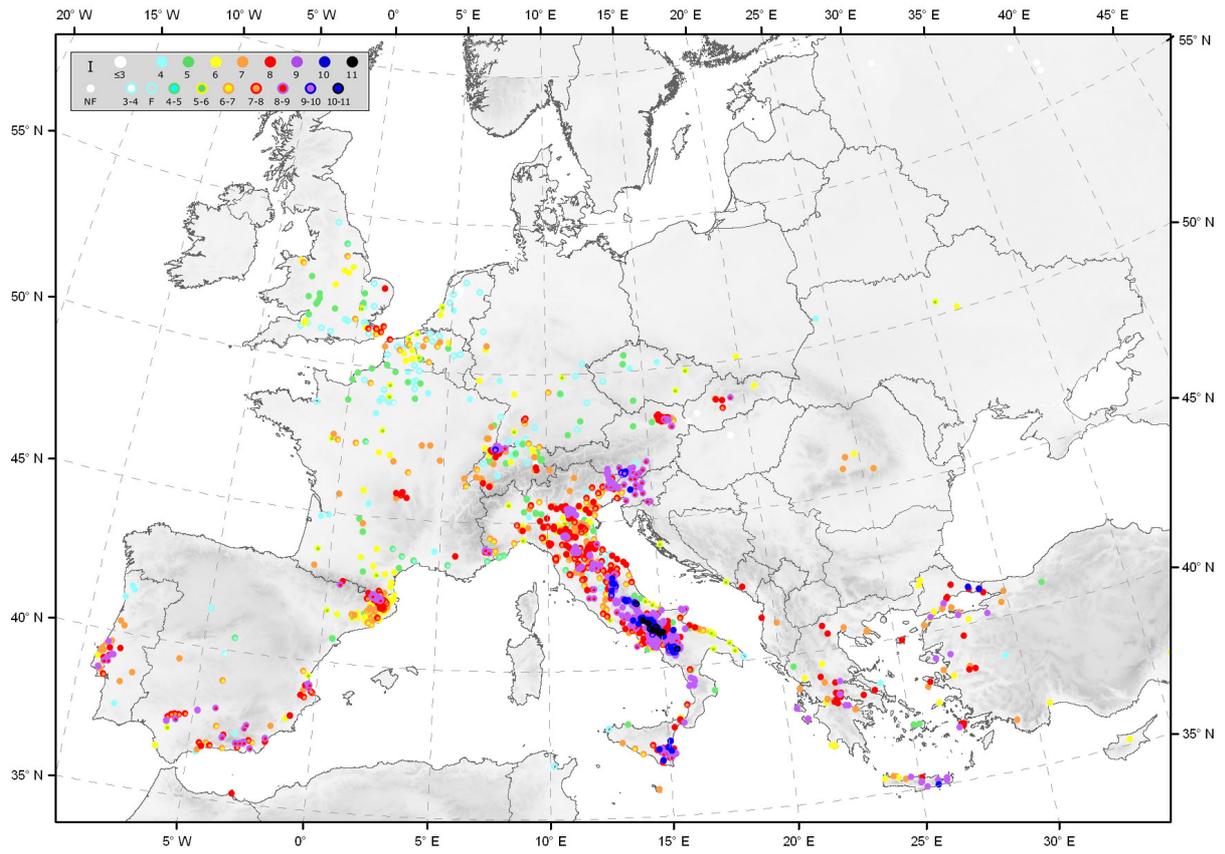


Fig. 2 - Plot of the 2167 MDPs of EMD 1000-1600.

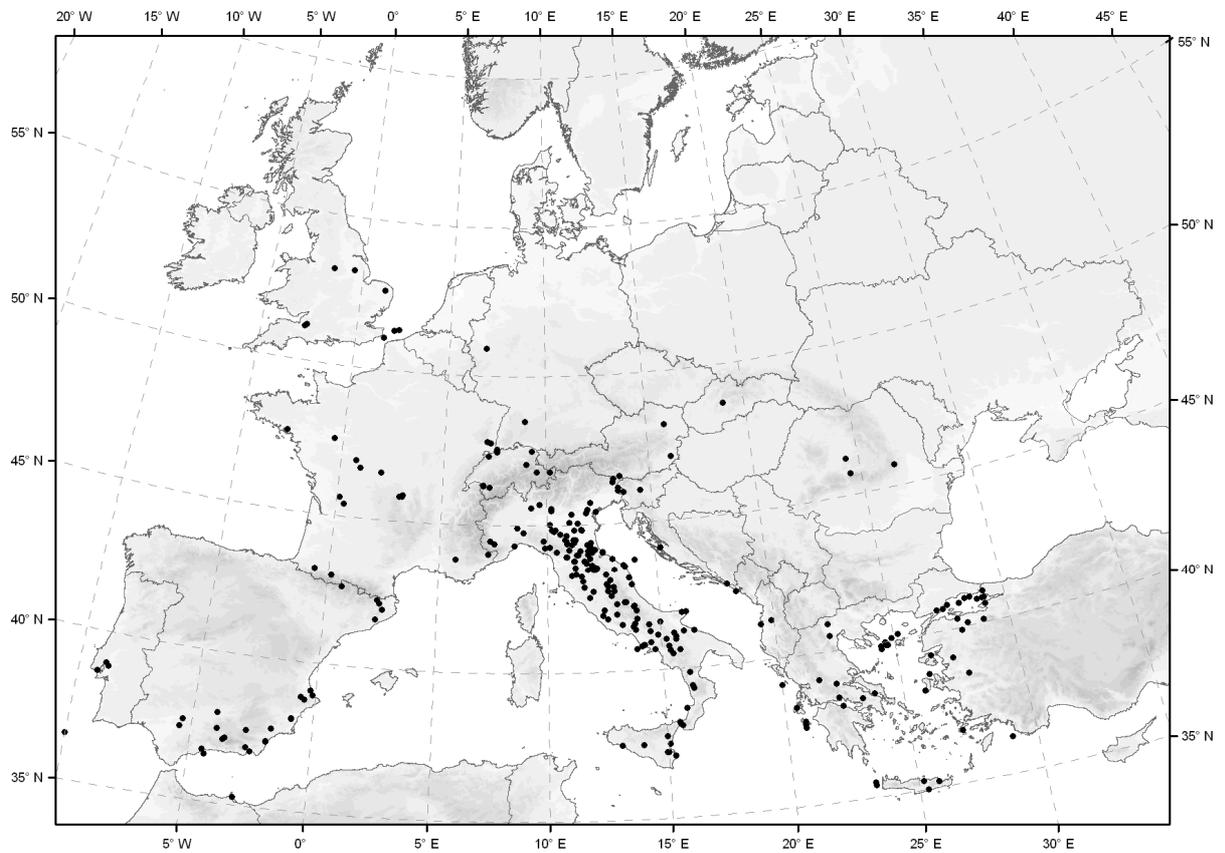


Fig. 3 - Preliminary epicentral location of the 296 events contributing to EMD 1000-1600.

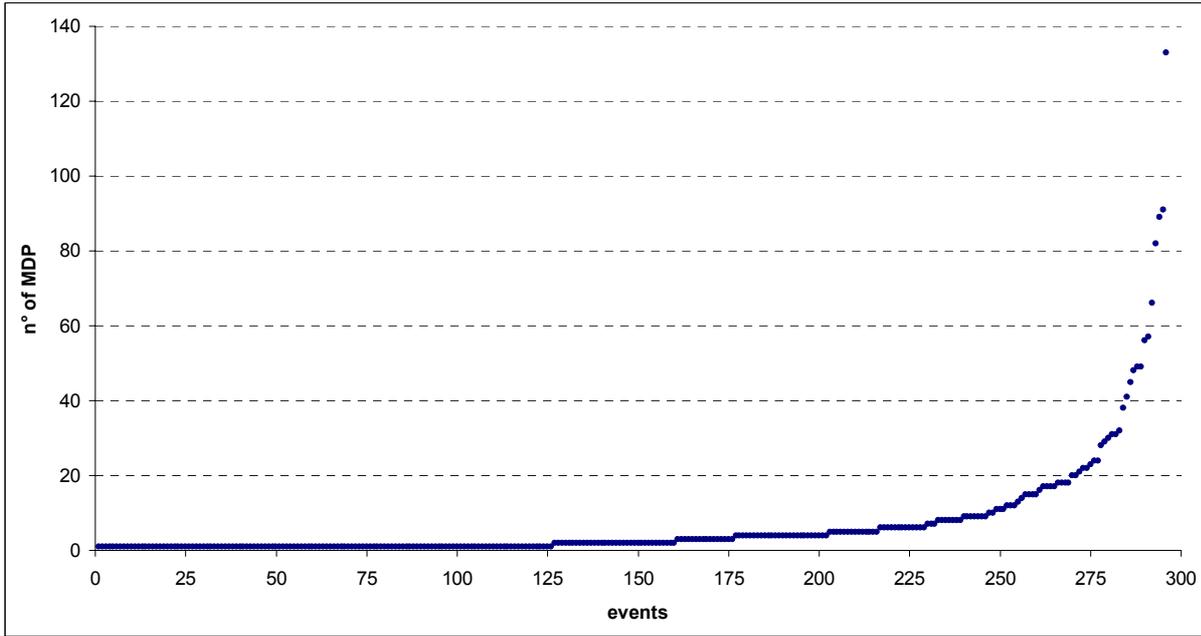


Fig. 4 - Number of MDPs per earthquake in EMD 1000-1600.

The 2151 MDPs come from 35 independent studies or datasets (Tab.1).

Tab. 1 - Studies/datasets and their contribution to EMD 1000-1600 (the extended version is in App.4).

study / dataset	Eqs	NMDP	N. of places
Albini et al., 2003	1	1	1
Arch.Mac.GDT CS, 1994	1	1	1
Arch.Mac.GDT MC, 1994	4	4	3
Arch.Mac.GDT SP, 1995	9	14	13
Barbano et al., 1996	4	5	4
Camassi et al., 2006	6	8	8
Camassi et al., 2007a	1	2	2
Castelli & Bern., 2006	2	6	6
Castelli et al., 1996	15	39	28
Castelli et al., 2007	3	59	44
Castelli, 2004a	1	19	19
Castelli, 2004b	2	2	2
ENEL, 1985	7	22	18
Figliuolo & Mar., 2002	2	2	2
Guidoboni & Com., 1997	1	32	32
Guidoboni et al., 2007	101	948	703
Margottini, 1984	1	1	1
Monachesi & Cas., 1992	1	2	2
Monachesi, 1987	3	33	29

study / dataset	Eqs	NMDP	N. of places
Postpischl, 1990	6	20	15
Stucchi, 1988	2	3	3
Italian studies	173	1223	941
Eisinger et al., 1992	2	29	28
Justo & Salwa, 1998	1	30	30
Labak, 1996	1	11	11
Lambert et al., 1994	1	15	15
Martinez S. & M., 2002	24	85	68
MECOS, 2002	12	108	86
Musson, 2008	7	128	117
Olivera et al., 2006	5	263	180
Papazachos & P., 1997 *	1	1	1
Papazachos & P., 2003 *	49	114	91
Radu & Toro, 1996	1	4	4
Schwarz-Z. et al., 2004	1	15	15
Shebalin (ed.), 1977	2	15	15
SisFrance **	17	110	99
total	296	2151	(1701)***

* datapoints by Papazachos & P., 1997 and 2003 are not shown in the volumes

** data under negotiation

*** 1530 places are mentioned in the core database: 171 are covered by more then one study.

The 2151 MDPs refer to 1530 places; for some of them the seismic history is rather consistent (Tab.2 and Fig.5).

Tab. 2 – Number of occurrences (1000-1600) in some European localities.

Place	occurrences	Place	occurrences
Bologna	20	Roma	10
Firenze	15	Lisboa	5
Istanbul	15	Granada	5
Venezia	12	Basel	8
Napoli	12	Barcelona	4

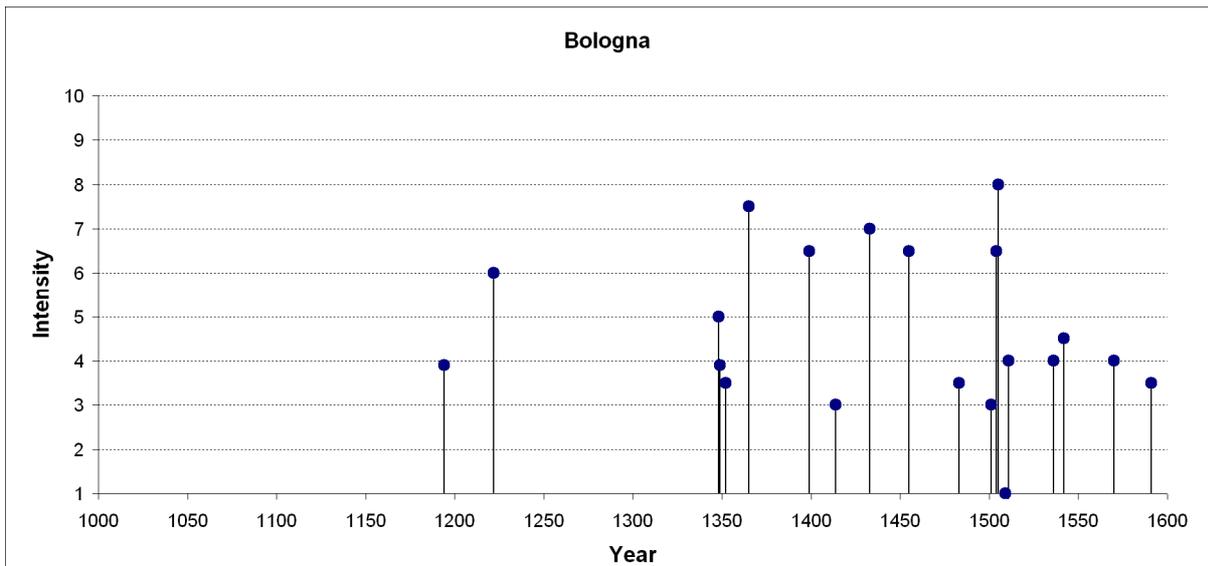
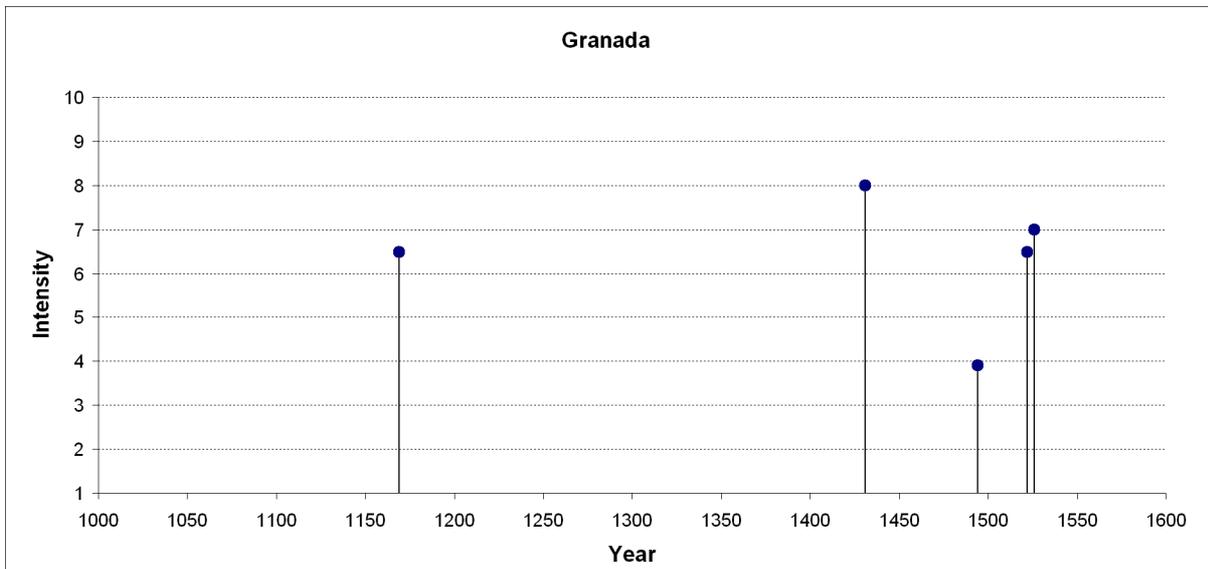


Fig. 5 – Seismic history (1000-1600) of Granada and Bologna.

Additional data. For some events, multiple studies from varied authors are available; in such cases the core database contains the data of the study which has been selected.

It has to be stressed that, on the one hand a study is a homogeneous dataset, compiled according to homogeneous criteria; on the other hand alternative studies, related to the same event, may be based upon conflicting interpretations. Each MDP belongs to its own study and cannot be considered as an independent observation to be merged with other MDPs, non homogeneous to it. To merge MDPs from a study with MDPs from other studies without consulting the background information would mix up investigation, sources and interpretation quality.

As a conclusion, merging MDPs is not recommendable and NA4 will not do it. It is recommended, instead, that in the future authors will agree to sit together and compile a comprehensive study.

For a few events an alternative study is also proposed as part of EMD 1000-1600, although not of the core: 1117 (Verona), 1356 (Basel), 1456 (Southern Italy), 1564 (Maritime Alps), 1580 (Dover Straits).

5. Data management and dissemination

The amount of data involved in the macroseismic database is of a limited quantity. A commonly available spreadsheet such as Microsoft Excel or other open source products like OpenOffice Calc provide satisfying solutions. Further development and detailed data analysis can be performed using a relational database management system such as Microsoft Access.

As for the dissemination via internet, the current solutions of DBMI, ECOS, SISFRANCE have been explored (see App.5). They show similarities and differences with respect to query by earthquake, query by place name, macroseismic tables, macroseismic maps, etc.

An updated version of the DBMI software solution (see App.5) has been designed for the EMD website (http://emidius.mi.ingv.it/neries_NA4/EMD) which makes the database of the most energetic events available through the web. (*to be implemented by November 15*).

A simplified version of the software, designed to allow easy publication on the internet of the regional macroseismic databases, will be freely available under an Open Source Licence.

References

- Bellettati D., Camassi R. and Molin D., 1993. Fake quakes in Italy through parametric catalogues and seismological compilations: case histories and typologies. *Terra Nova*, 5, 5, pp. 488-495.
- Faeh D., Giardini D., Bay F., Bernardi F., Braunmiller J., Deichmann N., Furrer M., Gantner L., Gisler M., Isenegger D., Jimenez M.J., Kaestli P., Koglin R., Masciardi V., Rutz M., Scheidegger C., Schibler R., Schorlemmer D., Schwarz-Zanetti G., Steimen S., Sellami S., Weimer S., Woessner J., 2003. Earthquake Catalogue Of Switzerland (ECOS) and the related macroseismic database. *Eclogae Geol. Helv.* 96, 219-236.
- Gruenthal G. (ed.), 1998. European Macroseismic Scale 1998 (EMS-98). *Cahiers du Centre Européen de Géodynamique et de Séismologie*, Luxembourg, vol. 15, 99 pp.
- Gruppo di Lavoro CPTI, 2004. *Catalogo Parametrico dei Terremoti Italiani, versione 2004 (CPTI04)*. INGV, Bologna. <http://emidius.mi.ingv.it/CPTI/>
- Guidoboni E. and Comastri A., 1997. The large earthquake of 8 August 1303 in Crete: seismic scenario and tsunami in the Mediterranean area. *Journal of Seismology*, 1, pp. 55-72.
- Hill L.L., 2006. *Georeferencing: the Geographic Associations of Information*. The MIT Press, Massachusetts Institute of Technology, pp. 288.
- Justo J.L. and Salwa C., 1998. The 1531 Lisbon Earthquake. *BSSA*, vol. 88, 2, pp. 319-328.
- Lambert J., Moroni A. and Stucchi M., 1994. An intensity distribution for the 1564, Maritime Alps earthquake. In: Albini P. e Moroni A. (eds.), *Materials of the CEC project "Review of Historical Seismicity in Europe"*, CNR, Milano, vol. 2, 143-152.
- Locati M. and Cassera A., 2008. Online tools facilities for historical earthquake data investigation. *Proceedings 6th International Conference on Scalable Vector Graphics*, 26-29 August 2008, Nuremberg, Germany, http://www.svgopen.org/2008/papers/49-Online_tools_facilities_for_historical_earthquake_data_investigation/
- Martinez Solares J.M. and Mezcua Rodriguez J. (eds), 2002. *Catalogo sismico de la Peninsula Iberica (880 a.C.-1990)*. IGN, Madrid, 254 pp.
- Monachesi, G. and Stucchi, M., 1997. DOM4.1, un database di osservazioni macrosismiche di terremoti di area italiana al di sopra della soglia del danno. GNDT, Internal report, Milano-Macerata. <http://emidius.mi.ingv.it/DOM/>
- Musson R., 1998. Intensity assignments from historical earthquake data: issues of certainty and quality. *Annali di Geofisica*, 41, 1, pp. 79-91.
- Musson R., Grünthal G. and Stucchi M., 2008. *The Comparison of Intensity Scales*, *submitted*.
- Musson R.M.W., 2008. *The seismicity of the British Isles to 1700*, BGS Technical Report OR/08/049.
- Olivera C., Redondo E., Lambert J., Riera Melis A. and Roca A., 2006. *Els terratrèmols dels segles XIV I XV a Catalunya*, Barcelona, Institut Cartogràfic de Catalunya, 407 pp.
- Papazachos B.C. and Papazachou C., 2003. *The earthquakes of Greece*. Ziti Publ. Co., Thessaloniki, Greece, 286 pp. (*in Greek*).
- Prochazkova D. and Karnik V. (eds.), 1978. *Atlas of Iseoseismal Maps. Central and Eastern Europe*. Geophysical Institute of the Czechoslovak Academy of Science, Prague.
- Schwarz-Zanetti G., Deichmann N., Fäh D., Masciadri V., Goll J., 2004. The earthquake in Chrurwalden (CH) of September 3, 1295. *Eclogae Geol. Helv.*, 97, 255-264.
- Scotti O., Baumont D., Quenet G., Levret A., 2004. The French macroseismic database SISFRANCE: objectives, results and perspectives. *Ann. Geophys.*, 47, 2-3, 571-581.
- Shebalin N. V. (ed.), 1974. *Atlas of isoseismal maps. UNDP-UNESCO Survey of the seismicity of the Balkan region, part III*, Skopje, 275 maps.
- SisFrance, 2002. *SisFrance: histoire et caractéristiques des sèismes ressentis en France mètropolitaine et sur ses abords*. <http://www.sisfrance.net/>
- Stucchi M., Camassi R., Rovida A., Locati M., Ercolani E., Meletti C., Migliavacca P., Bernardini F., Azzaro R. (eds.), 2007. *DBMI04, il database delle osservazioni macrosismiche dei terremoti italiani utilizzate per la compilazione del catalogo parametrico CPTI04*. *Quaderni di Geofisica*, 49, INGV, 38 pp. <http://emidius.mi.ingv.it/DBMI04/>.
- Stucchi M., P. Albini and G. Rubbia Rinaldi (2000). Historical earthquake data in Europe and the Euro-Mediterranean Intensity Database. *European-Mediterranean Seismological Centre Newsletter*, 16, pp. 5-7.

Appendices

App. 1 - Georeferencing

The problem. To be handled in local or global databases, MDPs must be referred to a coherent geographical reference system (gazetteer), in such a way that all data referring to the same locality are given the same geographical coordinates and place names.

Once agreed on this issue, two main questions are to be answered.

The first question is:

“who decides where e.g. Bruxelles/Brussel is located and how it is spelled?”

This is not a trivial question; it is taken from the summary page of the “EuroGeoNames” project, where the following statement can be found:

“The increasing use of public domain geographical information, especially geographical names data raises an interesting question given the pedigree of such data - who decides where (for the general population) European places are and how they are spelled?”

The second one, widely known to the historical seismological community, is the question

“is the historical earthquake record associated to the right locality?”

This question addresses the problems that arise from the identification of the localities mentioned by the historical sources.

Gazetteers and related issues

A European, reliable gazetteer does not exist. The summary page of the “EuroGeoNames” project reports:

“Considering the multilingualism and cultural richness in Europe, the people use different spellings and languages when talking about the same location and even within a country more than one spelling may be used. This is the European situation that should be considered as a prestige value and not as an obstacle! Thus, full richness, completeness and high quality of European data seem only to be guaranteed if the data providers are the European countries – creating and maintaining the source data – themselves.

According to existing popular web services using public domain data sources the answer would appear to be that by default and in lieu of an European alternative, it is not the respective National Mapping and Cadastral Agency (NMCA) – or another national institution – that decides where e.g. Bruxelles/Brussels is located and how it is spelled.

.....

The project EuroGeoNames (EGN) is creating a European geographical names data infrastructure and associated web services to help you to find the official spelling of a name, together with its spelling in other languages, its geographical location, its pronunciation, etc. And, as an additional major important “selling point”, the EGN project will set up a technical infrastructure based on Web Feature Services (WFS), which is not restricted to provide geographical names information only”.

Until such a tool is available, national gazetteers will be used.

The current situation at a national level, with reference to macroseismic data collection, is:

- Italy. DBMI uses an ad hoc gazetteer (DBMIdir), based on the critical collation of several sources of information such as the "ENEL-ISTAT" catalogue of Italian places (ENEL, 1978), "Istituto Geografico Militare" (IGM) 1:100.000 and 1:25000 maps, also available through the "Portale Cartografico Nazionale" (PCN). "Istituto Nazionale di Statistica" (ISTAT) (<http://www.istat.it/>) offers a gazetteer which has been found less reliable so far;
- Switzerland. ETHZ has an internal gazetteer; all ECOS MDPs are referenced using it;
- Spain. Iberian MDPs often do not come with geographical coordinates; the retrieved data are to be processed on the basis of IGN gazetteer (for internal use) or IGC (dedicated Gazetteer available at <http://www.icc.es/>);
- UK. UK MDPs are based on the public CIA world gazetteer, judged reliable for the area; the Ordnance Survey, the national mapping agency, offers a national gazetteer (<http://www.ordnancesurvey.co.uk/>);
- Greece. Greek MDPs are based on a gazetteer made by the Hellenic Military Geographical Service (HMGS) (<http://www.gys.gr/>);
- France. MDPs available from SisFrance are known to use an internal reference; the "Répertoire Géographique des Communes" (RGC) produced by the "Institut Géographique National" (<http://www.ign.fr/>) could be adopted in the future;

If a local official gazetteer is not available, "GEOnet Names Server" (GNS) (<http://earth-info.nga.mil/gns/html/>) can provide a sufficient alternative; its worldwide data (5.5 million places) is provided by the U.S. National Geospatial-Intelligence Agency's (NGA) and the U.S. Board on Geographic Names' (U.S. BGN). Such data are generally good for well known places, but the coordinates precision is scarce; the location is sometimes unreliable for small places and, therefore, a check is required. If GEOnet does not contain the searched place or if the location is considered unreliable after a check, other world wide gazetteers are available, such as the CIA World Gazetteer.

At the moment the data contained in EMD 1000-1600 are referred to 8 gazetteers:

- 6 local: DBMIdir for Italy, ECOS for Switzerland, SisFrance for France, IGN for Spain, IGC for the Catalunya and HMGS for Greece;
- 2 of a worldwide general purpose: GEOnet Names Server and CIA World Gazetteer.

The use of multiple gazetteers can introduce two types of problems:

- among gazetteers; localities near country borders may appear in two or more national gazetteers with different place names, coordinates and their precision. As a first choice, NA4 place names and coordinates are adopted from the gazetteer of the country to which the locality belongs today (Fig.6 and Fig.7). Further GIS checks are sometimes requested.
- within the same gazetteer. The very same place can be called in different ways and coordinates can be slightly different. It happens that gazetteers offer multiple entries for the same place, especially for cities; as a consequence, MDP compilers can produce ambiguous records, in the sense that a non unique identifier for the same place can be used. Another issue are coordinate errors: some places may be associated to coordinates that are clearly wrong (offshore, far away from the real centre, etc: see the two following examples from Italy, Fig.8 and Fig.9).

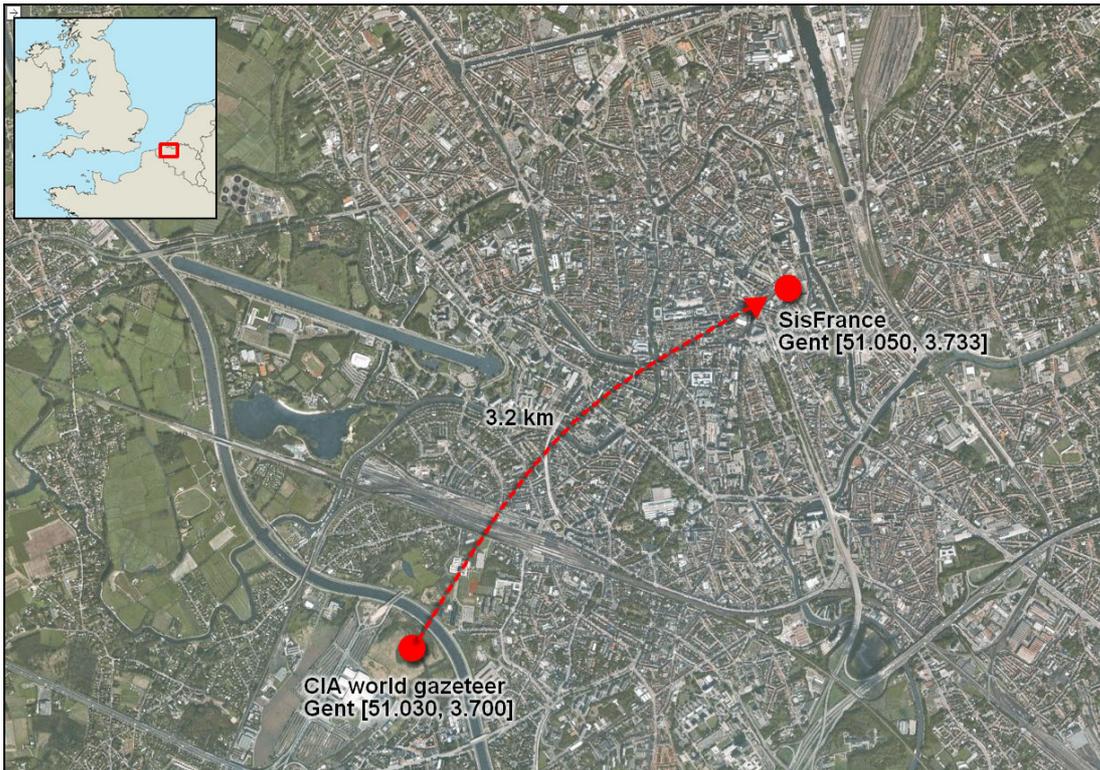


Fig. 6 - Differences between gazetteers: the coordinates of Gant (Belgium) differ between Sisfrance and the CIA world gazetteer by 3.2 km.



Fig. 7 - Differences between gazetteers: the coordinates of Bruxelles differ between Sisfrance and the CIA world gazetteer by 3.5 km.



Fig. 8 – Error in the Italian gazetteer: the coordinates of the city of Bari were (erroneously) pointing to a place far away from the city centre.



Fig. 9 – Error in the Italian gazetteer: the coordinates of the island of Ventotene fell offshore.

The distribution of MDPs with respect to the gazetteers is presented in Fig. 10 and Tab.6.

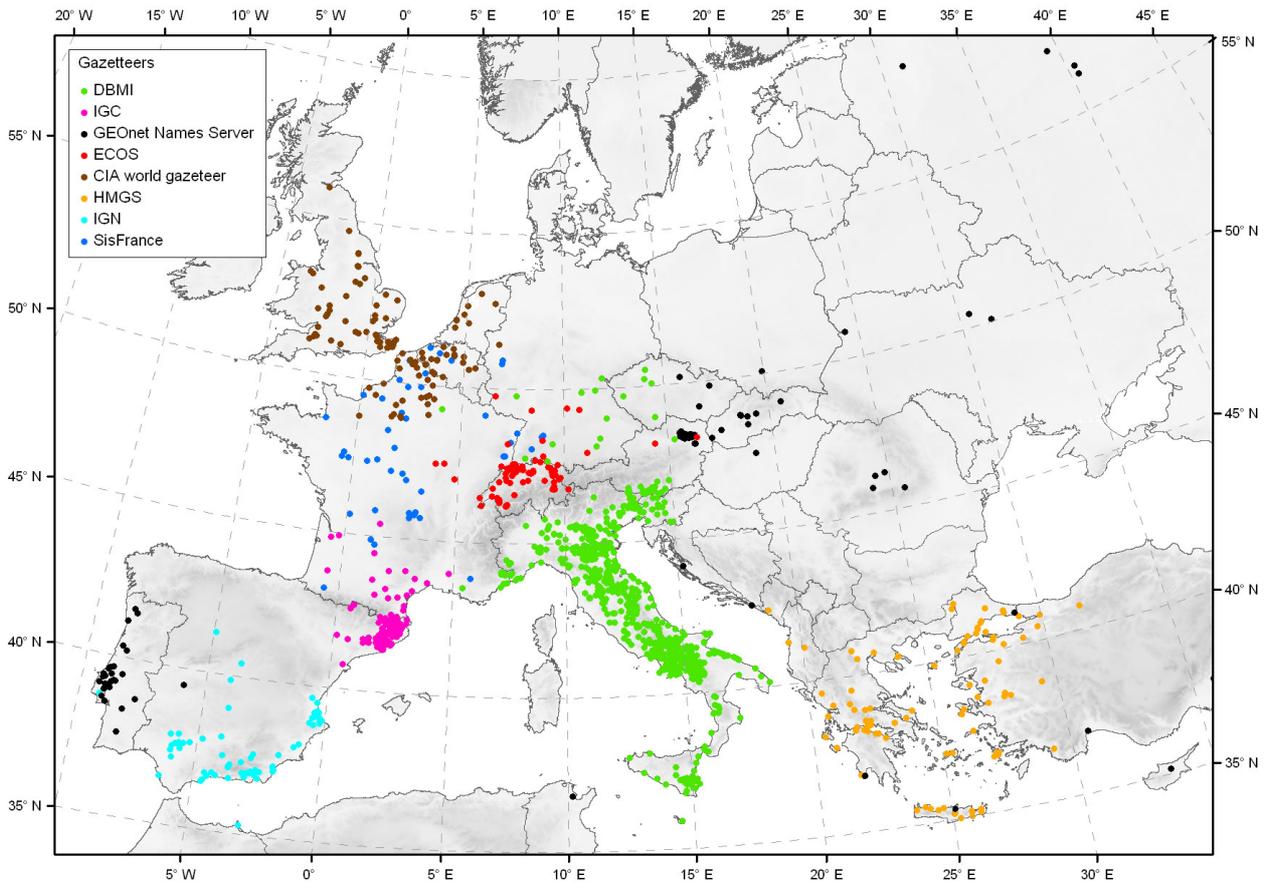


Fig. 10 - EMD 1000-1600: MDP distribution and adopted gazetteers.

Fig.10 shows that the statement of adopting – in principle – national gazetteers for the relevant localities is fulfilled for Switzerland and Italy, but not completely, yet, for France, Belgium, The Netherlands, Germany, etc., for which national gazetteers are not available as a whole. The work is in progress.

Tab. 6 – Adopted gazetteers and relevant data.

Gazetteer	N of MDP
CIA world gazetteer	117
DBMIdir	1216
ECOS	122
GEONet Names Server	123
HMGS	102
IGC	263
IGN	87
SISFRANCE	121
	2151

Misinterpretation

The process of recognizing places in a text and associating geospatial coordinates to them is called "geoparsing" (Hill, 2006).

Misinterpretation may occur as a result of association of the historical information to the wrong place. Actually, one of the most tricky issues while working with places is the name disambiguation process (Hill, 2006): many places have the same name or a similar one. When the place names refer to well know towns the problem can be easily solved; as regard to small villages, or worst, villages abandoned centuries ago, the disambiguation can be difficult. Places have changed names (sometimes also location), names have been corrupted, more than one locality with the same name exist in the area (Fig.11), etc.

The right place must be chosen in a way coherent with the information provided by the study; in other words, the investigator who release the study is the primary actor in the process. However, the database compiler can look for and correct inconsistencies; to that purpose, the compiler should preferably work with a well structured gazetteer implemented on a GIS, so that alternatives can be easily explored. A good geographical knowledge does help.

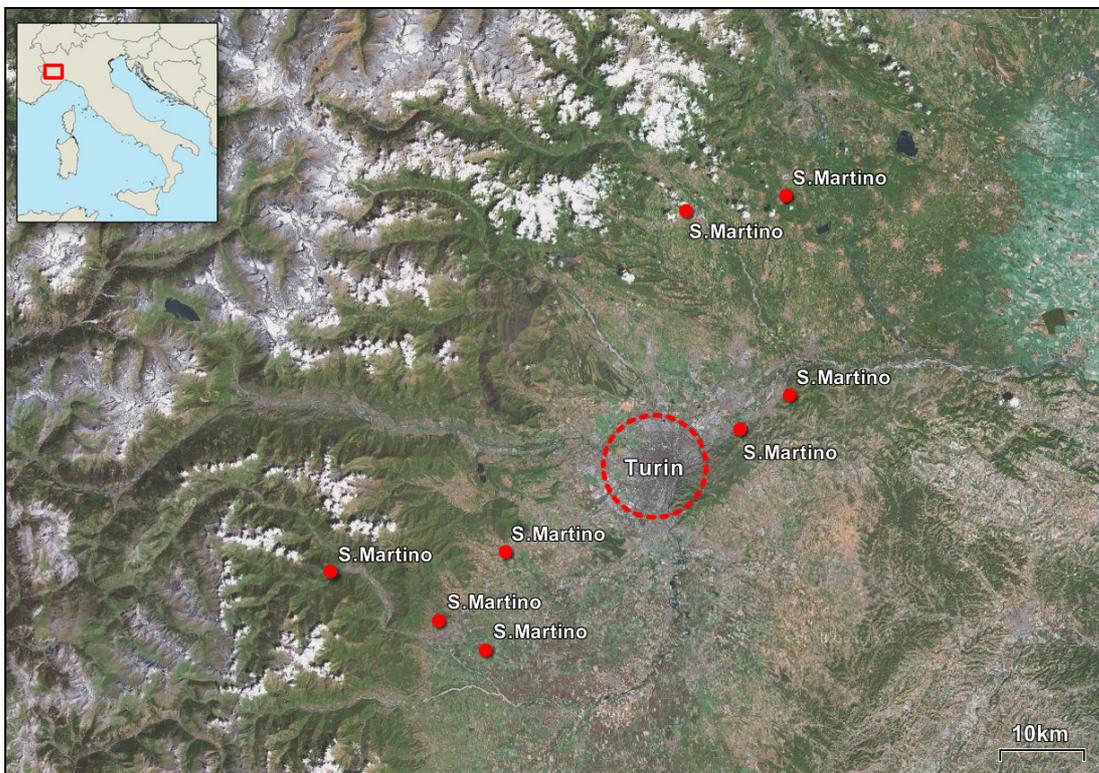


Fig. 11 – An example of problems in associating the historical information with a place: an earthquake study has a MDP in a place called "S.Martino" near Turin but it does not give coordinates. In this case the compiler must read carefully all the information mentioned in the study to identify the right "S.Martino".

Wrongly located MDPs are not easily detectable unless, for instance, the "wrong" MDPs are spotted on a map where the relevant intensity value is clearly misplaced with respect to the neighbouring values (Fig.12 and 13). The Italian macroseismic database DBMI04 can provide a number of examples that better help understanding the problem (Stucchi et al., 2007).

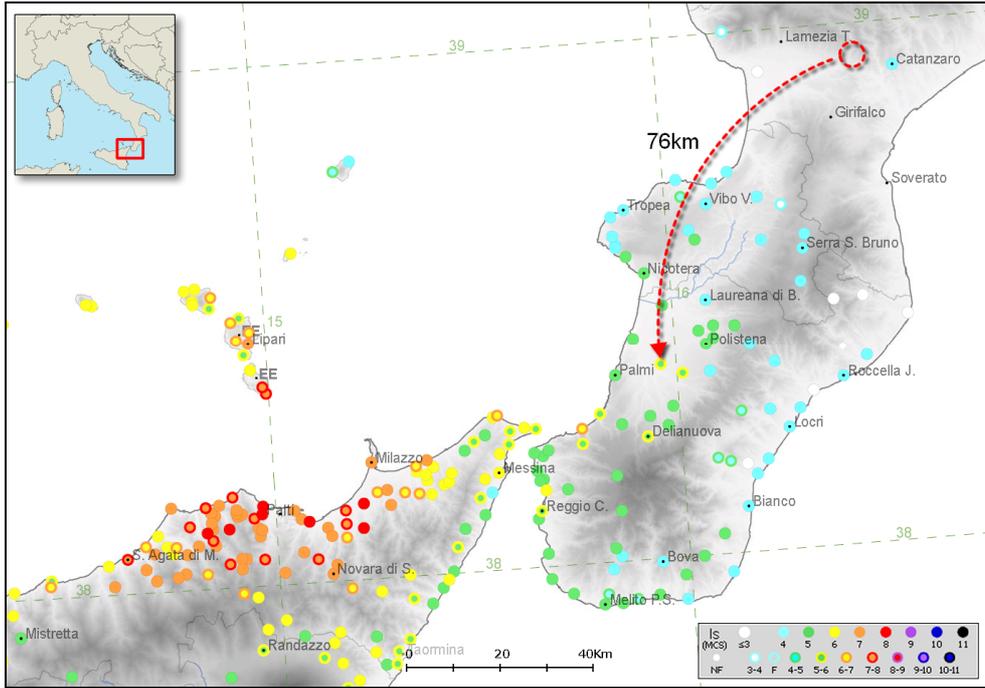


Fig. 12 – DBMI04: example of a MDP with $I_s = 5-6$ wrongly associated to a place called "Amato" in the case of the 15.04.1978 earthquake in southern Calabria. The study provided coordinates of "Amato" referring to the homonymous municipality; by studying the macroseismic distribution and reading the study, the MDP has been moved to another "Amato", suburb of the municipality of Taurianova.

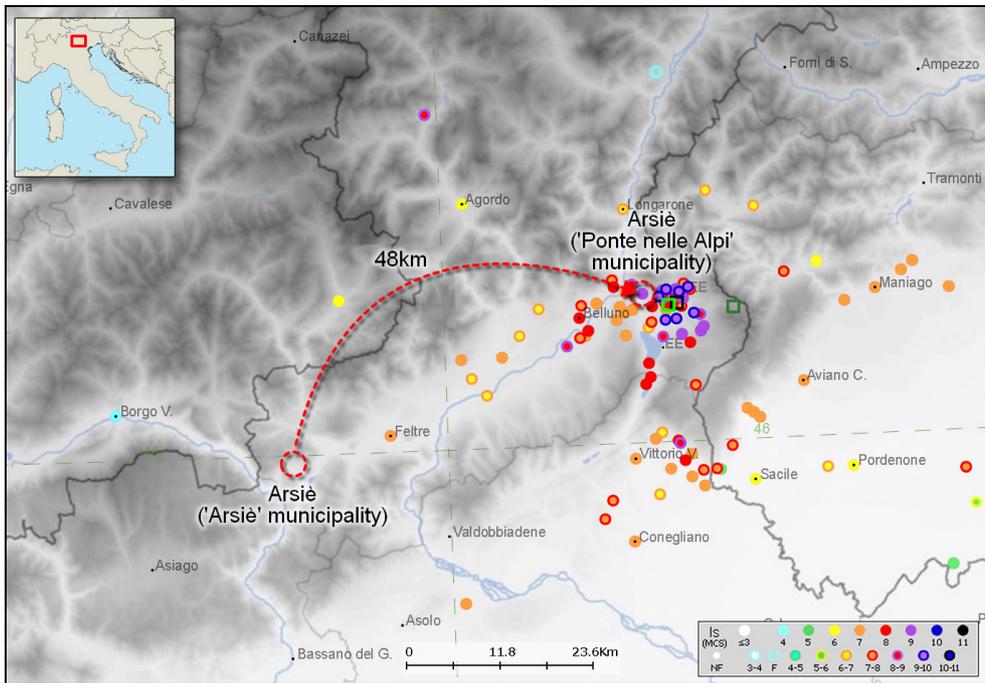


Fig. 13 – DBMI04: Example of a MDP with $I_s = 9$, wrongly associated to a place called "Arsiè" in the case of the 29.06.1873 earthquake in northern Italy. The study provides coordinates of the municipality "Arsiè", but $I_s = 9$ would be inconsistent with the intensity distribution. A check on the source allowed to discover that the record refers to a place close to Belluno. By checking the gazetteer, a place called "Arsiè" within the municipality of Ponte nelle Alpi near Belluno has been found; this location matches the historical record and the macroseismic distribution appears more reliable.

Of course, the consequences of such mistakes are proportional to the intensity and inversely proportional to the number of MDPs of the event. They can have dramatic consequences in the case of an event with one MDP only; a classical, extreme case is the event of 1353/54, early located in Italy because it was reported as felt in “Romagna”, while the source was to be read “Romania”, to be interpreted as the Byzantine Empire (Bellettati et al., 1993). On the other hand, it can be negligible in the case of an intensity 3 for an event with more than 100 MDPs. The solution of the problem may require to go back to the historical sources, and this is in most case out of the possibilities of NA4. However, in some cases a simple check of the gazetteer may offer the right solution.

Fig.14 gives an idea of the amount of misplacements found and corrected in the compilation of DBMI04. Lower distances are to be referred to gazetteer corrections, while higher ones to wrong locality identification and location.

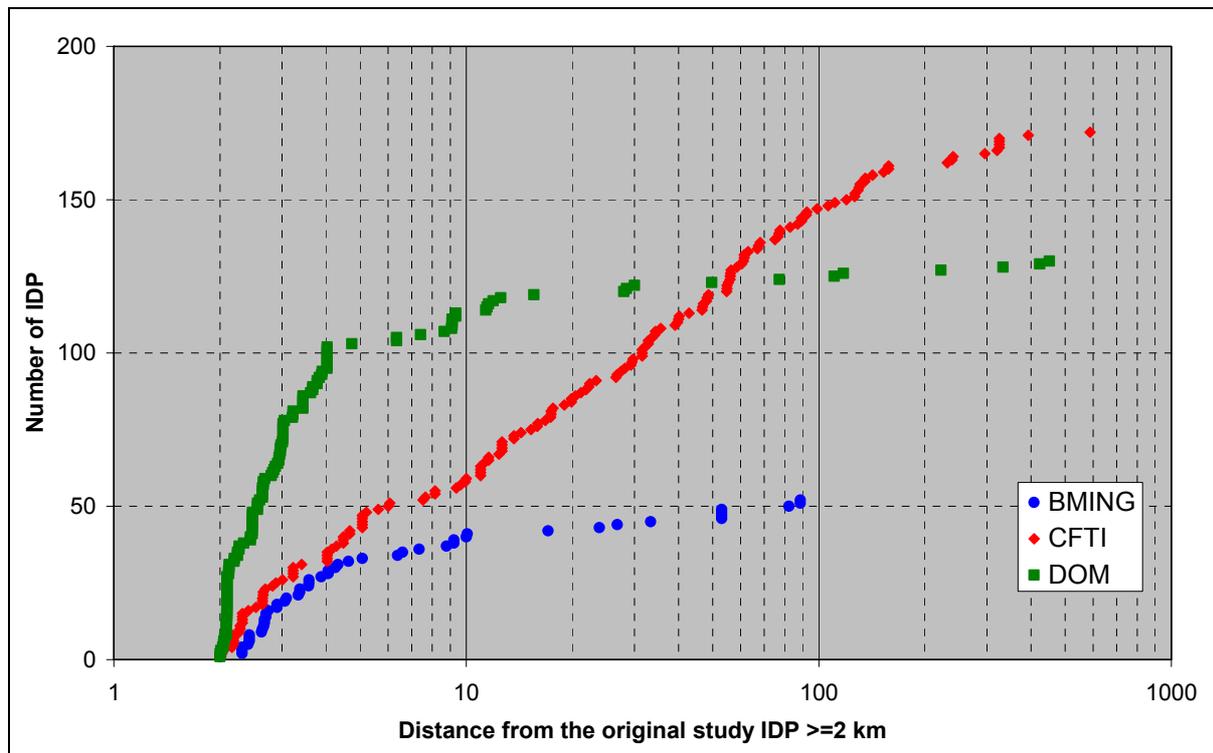


Fig. 14 - DBMI04. Misplacements to the original study coordinates (Stucchi et al., 2007).

The misplacements corrected in the compilation of EMD 1000-1600 are of minor size, so far (*in progress*).

App. 2 – Macro seismic intensity assignment

Macro seismic intensity scales. Intensity values are assessed in Europe according to varied macro seismic scales (EMS, MSK, MCS, MM); the question whether those values are comparable and, therefore, can be easily put together in the same column or not comes out for the compilation of any comprehensive macro seismic database.

While investigators have traditionally sought the possibility of theoretical conversions among the macro seismic intensity scales, with scarce success, this problem has been recently addressed by a paper (Musson et al., 2008, *submitted*). The conclusion is that the assignments performed with the macro seismic scales derived from the same “Mercalli” root (EMS, MSK, MCS, MM, that is, all the scales used in Europe) do not differ consistently (see Tab.7) and can be of the same size of the uncertainties related to the assignment procedure.

Under these circumstances, as a preliminary step the NA4 MDP database will put together MDPs from all European datasets, without further conversion.

Tab. 7 – Comparison among the “Mercalli family” intensity scales.
(from Musson et al., 2008, *submitted*).

MCS	EMS-98	MMI 56	EMS-98	MSK	EMS-98
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9
10	10	10	10	10	10
11	11	11	*	11	11
12	*	12	*	12	*

Unconventional (anomalous) intensity assignments. The assignment of a macro seismic intensity value is performed by comparing the effect description found in the source (historical, questionnaire, etc.) with a sequence of ideal word pictures. How this comparison is performed is part of the current practice; in most cases it appears like a sort of “black box”, the content of which is seldom available.

In some cases it happens that the investigator has some information which are not easily translatable in terms of intensity, for instance according to the EMS98 guideline (Gruenthal, 1998); however he wants to make this information usable in some way. Depending on the investigator own practice, it may happen that intensity is assigned: a) to places which are not suitable for proper intensity assignment, such as large areas, too small settlements, isolated buildings, etc. or; b) with inappropriate notations, such as F, HF, D, HD, other damage codes, ≥7, 7+, 7?, (7), etc.

Further subjectivity elements are then often introduced when such assignments are processed in the view of serving as input for computer codes addressing earthquake parameterisation or seismic hazard assessment. The number of such assignment can be negligible for recent events but it can be significative for medieval events; in such cases varied “translations” can lead to very different results.

It is therefore needed to reduce the anomalies, to homogenise such data, to keep record of any useful information and to use only the suitable data for each purpose. In the following the problems related to unsuitable places and inappropriate notations are discussed.

Locality special cases. It is mainly referred here to the case of large areas (TE), small settlements (SS), isolated buildings (IB), etc. where the current intensity assignments may conflict with the intensity definition and its statistical meaning, and to the case of unknown localities (UL). These problems have been addressed by Gruenthal et al., 1998; Stucchi et al., 2000; Stucchi et al. 2007, etc. After a poll among the NA4 partners, the solutions of Tab.8a have been adopted.

Tab. 8a – Problems assessment and solutions for macroseismic assignment to large areas, unknown localities, small settlements, isolated buildings.

locality special case	Lsc (code)	description	problem	solution
large area, territory	TE	area containing several localities; the size of the area exceeds the one suggested by the EMS98	intensity assignment is not compatible with the definition of intensity and any location would be arbitrary	coordinates and intensity are not assessed. F, D or HD and arbitrary coordinates, only for graphical representation, are assessed instead. These MDPs are not used for earthquake parameters determination
unknown (not located) locality	UL	a locality which both the author of the study and the MDP compiler is not able to locate today	coordinates cannot be assigned	these MDPs cannot be used for earthquake parameters determination

small settlement	SS	settlement the size of which is too small to supply a significant building sample for intensity assessment	intensity assignment is not compatible with the statistical meaning of intensity	coordinates are assessed; F, D or HD are assessed. As a first choice these MDPs should not be used for earthquake parameters determination.
isolated building	IB	single (isolated) building. A building standing alone, like a light tower, a country church etc.	intensity assignment is not compatible with the statistical meaning of intensity	coordinates are assessed; F, G3, G4 or G5 (grade damage of the EMS98) are assessed. These MDPs should not be used for earthquake parameters determination.

Intensity assignments related to places with codes TE, SS and IB have been modified accordingly. It must be stressed that while TE are easily detectable “*a posteriori*”, SS and IB localities are not; they should preferably be indicated by the authors of the studies. MDPs related to TE and UL places have been excluded from the user-oriented, core EMD database.

Another peculiar case is when intensity or damage is referred to “regular” places, but it is assigned on the basis of damage to single, monumental buildings only (MB). In other words, it is part of the current practice that an investigator assesses, say, $I_s = 8$ to a city on the basis of the fact that a church was heavily damaged. Actually, the investigator implicitly presumes that part of the ordinary buildings suffered similar damage level, and that this fact was not so important for being reported by the source.

But we also know cases for which only a monumental building was damaged, because of its particular vulnerability (this was the reason to exclude them from the use of the EMS98, by the

way). In those cases the intensity at that place was considerably lower than the level suggested by the damage to that building. Of course such cases are not easily detectable unless declared by the study itself or going back to the original records. Guidoboni et al., 2007, use the codes A, B, C, D, E: for such cases the relevant intensities have been corrected according to Tab 8b.

Tab. 8b – Problems assessment and solution for macroseismic assignment to monumental buildings located in a “regular” place.

locality special case	Lsc (code)	description	problem	solution
monumental building (located within a “regular” place)	[MB]	a single building, usually a monumental one, located within a “regular” place (es. a church in Verona), to which the only damage record for that locality is referred	intensity assignment is not compatible with the statistical meaning of intensity. No evidence for extending such information to other buildings	the coordinates of the place are assessed; F, G3, G4 or G5 (grade damage of the EMS98) is assessed. These MDPs should not be used for earthquake parameters determination.

So far the proposed solutions do not address the intensity assignment to very large cities (this problem seldom apply for the time window 1000-1600). However, in the practice the assignment is performed “by city quarters” in a few cases (see below).

Further special cases, like multiple settlements, deserted or absorbed localities, city quarters are being flagged (Tab. 8c). The relevant codes MS, DL, AL, CQ represent a warning, only.

Tab. 8c – Problems assessment and solutions for macroseismic assignment to multiple settlements, deserted localities, absorbed localities and city quarters.

locality special case	Lsc (code)	description	problem	solution
multiple settlement	MS	settlement whose traditional place name refers to a set of small settlements in a limited area, including small islands	the information may not strictly refer to the place name. However, no better interpretation can be provided	assess Is and coordinates. The code represents a warning for the user
deserted locality	DL	abandoned locality, eventually rebuilt elsewhere with the same or another name	the seismic history may show interruptions or non seismic gaps	assess Is and coordinates. The code is a warning for understanding the seismic history
absorbed locality	AL	a locality absorbed into a larger one	same as above	assess Is and coordinates. The code is a warning for understanding the seismic history
city quarter	CQ	information related to part of a city	the place name and the coordinates may be somewhat arbitrary	assess Is and coordinates. The code is a warning for understanding the seismic history

Inappropriate macroseismic notations. The current macroseismic practice, as inferred from the data gathered for compiling EMD 1000-1600, has shown that investigators make use of varied, inappropriate intensity notations, such as ≥ 7 , 7+, 7?, (7), HD (heavy damage), D (damage), F and similar (felt), HF (heavily felt), other damage notation, etc. (Tab.9a and Tab.9b).

In the time-window 1000-1600 such cases were 453 out of 2151, that is about 21%. Although such notations frequently represent the expression of true difficulties of the investigator in assign intensity from historical records, such data are of little help for the users, who generally apply ad hoc conversions for using them. It seems therefore more opportune to supply a standard, agreed conversion to be used for NA4.

A similar, though less problematic, issue is represented by the so called uncertain intensity values, such as 7-8, 7-9, etc. (Tab. 9c), which were 609 (about 30%). The most used solution to this problem is to assign 7.5 in the first case; actually, several studies/datasets provide similar, already compiled figures. Although this is not a straightforward solution, it can be acceptable.

Cases like 3-5 (two cases) or even 4-8 (one case) are more difficult, in the sense that they require a larger amount of personal interpretation. As a preliminary choice 3-5 can be translated into 4, and 4-8 into 6.

The “conversion table”. For the purpose of homogenising the data, allowing transparency and ensuring the repeatability of earthquake parameter determination it is necessary that all original data are translated according to agreed conventions; to address it case by case would require a huge amount of work and introduce further, hidden elements of subjectivity.

For this purpose, the “conversion table” (Tab.9a + Tab.9b + Tab.9c) has been agreed among NA4 partners, combining “*inappropriate intensity notations*” with “*locality special cases*”.

Four “translations” are proposed: all exclude the use of the data related to large areas (TE) which, together with other records, are supplied as “side data” (Tab.9d, 180 entries):

Is contains the figures which will appear in the EMD 1000-1600;
Ic1, Ic2, Ic3 represent three translations for the computer codes, in order of preference:

- Ic1, “rigid”: excludes the use of any value in the SS, IB, MB cases;
- Ic2, “flexible”: allows the use of ad hoc intensity values in the SS, IB, MB cases;
- Ic3, “range”: establishes a possible lower and upper bound to intensity values to allow sensitivity analysis (*the use of the data in this perspective is to be explored*).

To improve the quality of the dataset it is recommended that future datasets are compiled having this table in mind.

To improve transparency of the elaborations, it is recommended that future earthquake parameter determinations carry a code referring to the adopted translation.

The conversion table will be update according to the emerging needs.

Tab. 9a - Unconventional macroseismic assignments and their NA4 intensity translations.

orig.	found where	description	Lsc NA4	Is NA4	comment	N	Ic1 NA4	Ic2 NA4	Ic3 NA4
NF	varied	not felt		1		3	1.0	1.0	1.0
NF	varied	not felt	SS	1		0	-	1.0	1.0
NF	varied	not felt	IB	1		0	-	1.0	1.0
≥ 7 , >7, etc.	Schwarz Z. et al, 2004; Martinez S. and M.; 2002; Labak., 1996	greater than 7, etc.	any	7-8		8	7.5	7.5	7-8

7+ etc.	not found in this time-window	something plus 7, etc.	any	7-8		0	7.5	7.5	7-8
~7, etc.	Musson, 2008	around 7, etc.,		7		2	7.0	7.0	7.0
6?, 7? HD? L?, D? F?, etc.	Labak., 1996; Guidoboni and C., 1997; Musson, 2008; Castelli, 2004a	may be 7, etc.	any	7	put ? as reliability	13	7.0	7.0	7.0
(7) etc.	Eisinger et al., 1992	presumed uncertainty	any	7	reliability code?	6	7.0	7.0	7.0
		total				32			

Tab. 9b - Unconventional macroseismic assignments and their NA4 translations.

orig.	found where	description	Lsc NA4	Is NA4	comment	N	Ic1 NA4	Ic2 NA4	Ic3 NA4
HD DE H, E	varied; Guidoboni and C., 1997	heavy damage, destruction, extensive damage or total collapse		HD		12	8.5	8.5	-
HD, E 8-9 9	varied; Guidoboni and C., 1997	heavy damage, extensive damage or total collapse	SS	HD		8	-	8.5	-
A 8-9 HD	Guidoboni et al., 2007, varied	heavy damage to an isolated building	IB	G5	grade 5 of the EMS98	5	-	8.5	-
A	Guidoboni et al., 2007	heavy damage to a monumental building within a "true" locality	[MB]	G5	grade 5	10	-	8.5	-
B, C 7-8	Guidoboni et al., 2007	moderate damage to an isolated building	IB	G4	grade 4	2	-	7.5	-
B C	Guidoboni et al., 2007	moderate damage to a monumental building within a "true" locality	[MB]	G4	grade 4	18	-	7.5	-
D L	varied; Guidoboni and C., 1997	damage		D		55	6.5	6.5	-
D var. Is	varied; Guidoboni and C., 1997	damage	SS	D		9	-	6.5	-
D	varied	light damage to an isolated building	IB	G3	grade 3	0	-	6.5	-
E	Guidoboni et al., 2007	light damage to a monumental building within a "true" locality	[MB]	G3	grade 3	6	-	6.5	-
PD	Olivera et al., 2006	probable damage	any	D	put ? as reliability	56			
HF		heavily felt	any	F		0	3.9	3.9	-
F, S P, etc.	varied	felt, sentido, percepido		F		179	3.9	3.9	-
F, S P, etc.	varied	felt, sentido, percepido	SS IB	F		1	-	3.9	-
blank	Sisfrance	ressenti (if reliability is given)	any	F		60	3.9	3.9	
		total				421			

Tab. 9c - Uncertain macroseismic intensity assignments and their NA4 translations .

orig.	found where	description	Lsc NA4	Is NA4	comment	N	Ic1 NA4	Ic2 NA4	Ic3 NA4
6-7 etc.		uncertain value between 6 and 7, etc.	any	6-7	reliability code?	606	6.5	6.5	6-7
3-5 4-8 etc.	Labak, 1996; Justo and S.,	uncertain value between 3 and 5; 4 and 8, etc.	any	6-8	reliability code?	3	7.0	7.0	6-8
		total				609			

Tab. 9d – Side data (excluded from the core database): macroseismic intensity assignments to large areas, additional information and their NA4 handling.

orig.	where	description	Lsc NA4	Is NA4	comment	N	Ic1 NA4	Ic2 NA4	Ic3 NA4
8-9 9 9-10 HD, DE E	varied	heavy damage	TE	HD		11	-	-	-
6 7 7-8 8 D	varied	damage	TE	D		24	-	-	-
blank 3-4 F, S HF	Sisfrance, varied	heavily felt, felt	TE	F		17	-	-	-
NF	varied	not felt	TE	-		0	-	-	-
EE	Guidoboni et al., 2007	Environmental effects only (on land)	TE	E		4	-	-	-
		subtot. TE 56							
EE EF EN ET	Guidoboni et al., 2007; Olivera et al., 2006; Martinez S. and M., 2002	Environmental effects only (on land). Es.: landslide, liquefaction etc.	any	E		13	-	-	-
SW T	Lambert et al., 1994; Guidoboni and C., 1997	Environmental effects only (in the water). Es.: sea or lake waves	any	W		5	-	-	-
G NC ?	Guidoboni et al., 2007; Martinez S. and M., 2002; Olivera et al., 2006	Not classified effects	any	NC		32	-	-	-
N NR	Guidoboni et al., 2007; ENEL, 1985; Figliuolo and M., 2002	Not reported in the (coeval) sources	any	NR		70	-	-	-
7-8 H, L	varied	Unknown locality	UL	var.		4	-	-	-
		total				180			

Reliability. Some investigators assess the reliability of the intensity values using classes which are not coherent throughout Europe and not easily, or officially, translated for being used in the computer codes. The situation is summarised in Tab.10. This topic need to be investigated further.

Tab. 10 – List of reliability codes encountered in the compilation of EMD 1000-1600.

Source	Param.	Code	Description, original	Description, transl.	Note/explanation
SisFrance	Index	A	Intensité sûre	certain intensity	No further explanation in the website
		B	Intensité assez sûre	fairly certain intensity	
		C	Intensité incertaine	uncertain intensity	
Olivera et al., 2006	Qualitat	a	bona	good quality	Cada valor d'intensitat puntual vindrà acompanyat d'un paràmetre de qualitat representat per un indicador relatiu del seu grau de fiabilitat (a: bona, b: mitjana, o c: baixa), d'acord amb la tipologia de la font, el detall de les descripcions de danys i/o efectes dels terratrèmols, el nombre de descripcions coincidents o no, la disponibilitat d'informació anterior al terratrèmol que permeti avaluar la tipologia i estat dels edificis, etc. Quan una localitat té només informació d'1 edifici li assignarem qualitat c per tal de considerar les restriccions en l'ús de l'escala que estrictament s'hauria d'aplicar només quan es disposa d'un conjunt important de dades (sentit estadístic).
		b	mitjana	medium quality	
		c	baixa	poor quality	
ECOS	Site quality	good			No explanation in the website
		middle			
		poor			
		very poor			

The use of these data as an input for the automatic procedures of earthquake parameters determination is being investigated.

App. 3 – Format and content of the NA4 European Macroseismic Database 1000-1600

The format according to which MDPs are to be compiled is presented in Tab.11.

- Section 1 is for original MDPs, as they come from the relevant study or dataset;
 Section 2 is for the data recompiled according to the NA4 standards; consolidated databases, such as ECOS, etc., will fill up the second section only;
 Section 3 (not present in the format, yet) will contain the final data checked and homogenised by the the central NA4 unit;
 Section 4 contains basic macroseismic earthquake parameters retrievable from the relevant study or dataset (it does not contain earthquake parameters such as lat, lon, M as to derive them is NA4 task) and instrumental data, when available. Note: Although it is not strictly necessary to have earthquake parameters on the same line of the MDPs (they could be put on top of each earthquake dataset), to compile them in a unique dataset according to the proposed format allows to handle the data more easily with a relational database and/or a GIS.

The format will be upgraded according to the emerging needs.
 The content of EMD 1000-1600 is presented in the attached file.

Tab. 11 – EMD format (31.10.2008).

1. Original MDPs	MDP from the original study
1.1 Study (citation)	Short bibliographical citation
1.2 St	Status of the data (P = public; R = restricted)
1.3 Year	Time of the event (year)
1.4 Mo	Time of the event (month)
1.5 Da	Time of the event (day)
1.6 Ho	Time of the event (hour)
1.7 Mi	Time of the event (minute)
1.8 Se	Time of the event (second)
1.9 Ct	Any comment to problems or uncertainty in the time assessment
1.10 AxOr	Denomination of the area where the largest effects are located
1.11 LocOr	Place name
1.12 LatMDPOr	Place latitude
1.13 LonMDPOr	Place longitude
1.14 Loc info	Any information useful for identifying the locality
1.15 IOr	Intensity value
1.16 Additional notes	Any additional information or comment
2. Recompiled MDPs	MDP recompiled by partners according to the agreed rules
2.1 MDPid	Id of the MDP in the local database
2.2 Loc	Place name, from the regional gazetteer
2.3 Lsc	Locality special case
2.4 LatMDP	Place latitude, from the regional gazetteer (in geographic coordinate system, decimal degree)
2.5 LonMDP	Place longitude, from the regional gazetteer (in geographic coordinate system, decimal degree)
2.6 LatMDPg	Place latitude, for graphical use only (e.g.: large areas)
2.7 LonMDPg	Place longitude, for graphical use only (e.g.: large areas)

2.8	Gaz	Gazetteer (code)
2.9	Gazld	ID of the locality in the gazetteer
2.10	Datum	Datum used for the geodetic coordinates. The Datum is a set of parameters defining a coordinate system (see for instance http://en.wikipedia.org/wiki/Geodetic_system)
2.11	Cou	Present country code of the locality (codes as used on the Internet, see Tab.12)
2.12	Mis	Macroseismic intensity scale (e.g.: MM, MCS, MSK78, MSK81, EM92, EM98, etc.)
2.13	Is	Intensity or macroseismic value (as from Tab.9)
2.14	Rel	Reliability (as available from the convention in use locally)
2.15	Ic1	Intensity value to be used for computation (see agreed conversion, option 1)
2.16	Ic2	Intensity value to be used for computation (see agreed conversion, option 2)
2.17	Ic3	Intensity value to be used for computation (see agreed conversion, option 3)
2.18	Dis	Displacement (Distance between original and recompiled location)
2.19	Ren	Flag indicating that the place name has been modified with respect to the original
2.20	St2	Status of the data (P = public; R = restricted)
2.21	Rec_c	Record compiler (code)
2.22	Rec_d	Date (compact) of compilation of the record
2.23	Co_co	Compiler comment on any issue

3. Earthquake information *Parameters of the earthquake to which the above MSPs are referred (with the exclusion of *lat*, *lon*, *Mw*, to be determined from the above MDPs)*

3.1	EQid	Earthquake identifier
3.2	Ax	Recompiled denomination of the area where the largest effects are located
3.3	NMDP	Number of MDPs
3.4	Ixm	Maximum intensity value (among the MDPs)
3.5	NIDP	Number of MDPs
3.6	Ixi	Maximum intensity value (among the IDPs)
3.7	LatIns	Epicentral instrumental latitude
3.8	LonIns	Epicentral instrumental longitude
3.9	Epic. source	Source of the instrumental location
3.10	Depth	Instrumental depth
3.11	Depth source	Source of the instrumental depth
3.12	St3	Status of the data (P = public; R = restricted)
3.13	Mw	Moment magnitude
3.14	DMw	Uncertainty of the Mw estimate
3.15	TMw	Type of Mw estimate: O (native, determined from the moment tensor; CL, Cs, Cb when calculated from ML, Ms, mb, by means of regressions)
3.16	MwR	Regression used for obtaining Mw (citation or code)
3.17	Mw source	Source of the Mw
3.18	St4	Status of the data (P = public; R = restricted)

App. 4 - List of studies/datasets contributing to EMD 1000-1600
(extended version)

Full reference	Study/dataset	n° of EQ	N of MDPs	N of IDPs
Albini P., Migliavacca P. and Moroni A., 2003. Studio di alcuni terremoti di intensità epicentrale moderata in Italia settentrionale. Rapporto tecnico, INGV-MI, 58 pp. + appendices.	Albini et al., 2003	1	2	1
Archivio Macrosismico GNDT, 1994. Studi di terremoti attraverso i repertori sismologici e le loro fonti, UR Cosenza. Archivio macrosismico del GNDT, Milano.	Arch.Mac.GDT CS, 1994	1	1	1
Archivio Macrosismico GNDT, 1994. Studi di terremoti attraverso i repertori sismologici e le loro fonti, UR Macerata. Archivio macrosismico del GNDT, Milano.	Arch.Mac.GDT MC, 1994	4	4	4
Archivio Macrosismico GNDT, 1995. Studi preliminari di terremoti attraverso i repertori sismologici. Archivio macrosismico del GNDT, Milano.	Arch.Mac.GDT SP, 1995	9	14	14
Barbano F., Azzaro R., Birritta P., Castelli V., Lo Giudice E. and Moroni A., 1996. Stato delle conoscenze sui terremoti siciliani dall'anno 1000 al 1880: schede sintetiche. GNDT, Rapporto interno, Catania, 287 pp.	Barbano et al., 1996	4	5	5
Camassi R., Castelli V. and Postpischl L., 2006. "Here are lions": hunting for traces of unknown earthquakes around 15th-16th centuries AD. First European Conference on Earthquake Engineering and Seismology, Geneva, Switzerland, 3-8 September 2006, abstract ID 1967.	Camassi et al., 2006	6	8	8
Camassi R., Castelli V. and Molin D., 2007a. A reappraisal of the seismicity of the Pollino area. Internal Report INGV, Bologna.	Camassi et al., 2007a	1	2	2
Castelli V. and Bernardini F., 2006. Unearthing earthquakes in the Siense Crete: how we improved the seismic catalogue of a low seismicity area. Proc. First European Conference on Earthquake Engineering and Seismology, Geneva, Switzerland, 3-8 September 2006, Paper Number: 837.	Castelli & Bern., 2006	2	6	5
Castelli V., Monachesi G., Moroni A. and Stucchi M. (eds.), 1996. I terremoti toscani dall'anno 1000 al 1880: schede sintetiche. GNDT, Rapporto interno, Macerata-Milano, 314 pp.	Castelli et al., 1996	15	39	36
Castelli V., Galli P., Camassi R. and Caracciolo C.H., 2007. The 1561 earthquake(s) in Southern Italy: exploring possibilities. Journal of Earthquake Engineering (submitted).	Castelli et al., 2007	3	59	59
Castelli V., 2004a. Hidden behind the ranges: how the 13 April 1558 "Siense" earthquake was put in its place. Seismological Research Letters, 75, 3, 342-351.	Castelli, 2004a	1	19	18
Castelli V., 2004b. Between Tevere and Arno. A preliminary revision of seismicity in the Casentino-Sansepolcro (Tuscany, Italy), Boll. Geof. Teor. Appl., 45, 1-2, 25-49.	Castelli, 2004b	2	2	2
Eisinger U., Gutdeutsch R. and Hammerl C., 1992. Beiträge zur Erdbeben-geschichte von Niederösterreich. NÖ Schriften, 60, Wissenschaft, Wien, 154 pp.	Eisinger et al., 1992	2	29	29
ENEL, 1985. Studi e indagini per l'accertamento della idoneità tecnica delle aree suscettibili di insediamento di impianti nucleari per le Regioni Piemonte, Lombardia e Puglia: indagini di sismica storica. Rapporti tecnici predisposti da ISMES-SGA, Roma.	ENEL, 1985	7	22	20
Figliuolo B. and Marturano A., 2002. Terremoti in Italia Meridionale dal IX all'XI secolo. In: Marturano A. (ed.), Contributi per la storia dei terremoti nel bacino del Mediterraneo (secc. V-XVIII), Salerno, 33-67.	Figliuolo & Mar., 2002	2	2	2
Guidoboni E. and Comastri A., 1997. The large earthquake of 8 August 1303 in Crete: seismic scenario and tsunamis in the Mediterranean area. Journal of Seismology, 1, 55-72.	Guidoboni & Com., 1997	1	32	0

Guidoboni E., Ferrari G., Mariotti D., Comastri A., Tarabusi G. and Valensise G., 2007. Catalogo dei forti terremoti 461 a.C.-1997. http://storing.ingv.it/cfti4med/	Guidoboni et al., 2007	101	948	834
Justo J.L. and Salwa C., 1998. The 1531 Lisbon Earthquake. Bull. Seismol. Soc. Amer., 88, 2, 319-328.	Justo & Salwa, 1998	1	30	30
Labak P., 1996. Reinterpretacia Zemtrasenia 5.6.1443 na strednom Slovensku. Kalab Z. (ed.), Data Analysis in Seismology and Engineering Geophysics, Academy of Sciences of the Czech Republic, Institute of Geonics, Proceedings, vol. I, 83-93.	Labak, 1996	1	11	11
Lambert J., Moroni A. and Stucchi M., 1994. An intensity distribution for the 1564, Maritime Alps earthquake. In: Albini P. e Moroni A. (eds.), Materials of the CEC project "Review of Historical Seismicity in Europe", CNR, Milano, vol. 2, 143-152.	Lambert et al., 1994	1	15	15
Margottini C., 1984. Il terremoto del 1470 a Castel di Casio. CNEN, PAS-ISP-GEOL BR (84)1, 8 pp.	Margottini, 1984	1	1	1
Martinez Solares J.M. and J. Mezcua Rodriguez (eds), 2002. Catalogo sismico de la Peninsula Iberica (880 a.C.-1990). IGN, Madrid, 254 pp.	Martinez S. & M., 2002	24	85	71
Swiss Seimological Service, 2002. Macroseismic Earthquake Catalog of Switzerland. Zuerich. http://histserver.ethz.ch/	MECOS, 2002	12	108	94
Monachesi G. and Castelli V. (eds.), 1992. Sismicità dell'area aquilano-teramana dalla "analisi attraverso i cataloghi". Rapporto tecnico per la Regione Abruzzo, Osservatorio Geofisico Sperimentale, Macerata, 245 pp.	Monachesi & Cas., 1992	1	2	1
Monachesi G. (ed.), 1987. Revisione della sismicità di riferimento per i comuni di Cerreto d'Esi (AN), Esanatoglia (MC), Serra San Quirico (AN). Osservatorio Geofisico Sperimentale, Macerata, Internal report, 240 pp.	Monachesi, 1987	3	33	28
Musson R.M.W., 2008. The seismicity of the British Isles to 1700, BGS Technical Report OR/08/049.	Musson, 2008	7	128	63
Olivera C., Redondo E., Lambert J., Riera Melis A. and Roca A., 2006. Els terratrèmols dels segles XIV I XV a Catalunya, Barcelona, Institut Cartogràfic de Catalunya, 407 pp.	Olivera et al., 2006	5	263	146
Papazachos B. and Papazachou K., 1997. The Earthquakes of Greece. Thessaloniki, 304 pp.	Papazachos & P., 1997 *	1	1	1
Papazachos B.C. and Papazachou C., 2003. The earthquakes of Greece. Ziti Publ. Co., Thessaloniki, Greece, 286 pp. (in Greek).	Papazachos & P., 2003 *	49	114	114
Postpischl D. (ed.), 1990. Valutazione del rischio sismico per il territorio della Repubblica di San Marino. Istituto di Topografia, Geodesia e Geofisica Mineraria, Università di Bologna, RPT/TGGM/1/90, 826 pp.	Postpischl, 1990	6	20	20
Radu C. and Toro E., 1996. Two strong historical earthquakes in Transylvania (Romania): November 19, 1523 and October 3, 1880. Ann. Geofis., 39, 5, 1069-1078.	Radu & Toro, 1996	1	4	4
Schwarz-Zanetti G., Deichmann N., Fäh D., Masciadri V., Goll J., 2004 The earthquake in Churwalden (CH) of September 3, 1295. Eclogae geol. Helv., 97, 255-264.	Schwarz-Z. et al., 2004	1	15	9
Shebalin N.V. (ed.), 1977. Atlas of isoseismal maps for the "New Catalogue of Strong Earthquakes on the USSR territory from Ancient Times through 1975". Archive of the Institute of Physics of the Earth, Moscow (unpublished).	Shebalin (ed.), 1977	2	15	15
SisFrance. SisFrance: histoire et caractéristiques des séismes ressentis en France. http://www.sisfrance.net/	SisFrance	17	110	49
Stucchi M. (ed.), 1988. Revisione della sismicità storica dell'area anconetana. Rapporto tecnico per il Comune di Ancona, Milano, 138 pp.	Stucchi, 1988	2	3	2
	total	297	2151	1714

* datapoints by Papazachos & P., 1997 and 2003 are not shown in the volumes.

App. 5 - Data dissemination: software, layout and related aspects

Existing software implementations. Publishing a macroseismic database on the Internet requires three main components:

1. a DBMS (DataBase Management System);
2. a web mapping tool;
3. a web compliant interface to allow retrieving the data.

A tool that covers these three key points and that, at the same time, is “macroseismic” oriented doesn't exist, either in the software market nor in Open Source. As a consequence, the three existing online macroseismic databases, DBMI, SisFrance and ECOS, use customised software solutions:

- DBMI. Uses a self developed software (Stucchi et al., 2007; Locati and Cassera, 2008) for both managing the html web interface and creating interactive maps. The whole system is Open Source based as it uses PHP for server-side scripting, JavaScript for client-side interactivity and MySQL DBMS for storing and retrieving data;
- ECOS. Relies on a combination of internally developed and existing software: the web interface for retrieving html tabular data has been developed using server-side CGI (Common Gateway Interface) calls; macroseismic maps are generated using ESRI ArcIMS, a widely and general purpose proprietary mapping software which offers tools for interacting with the map: zoom, pan, print, features selection and a basic GIS query tool.
- SisFrance. Relies on a combination of self developed software and existing software. The html web interface uses ASP (Active Server Pages, a Microsoft proprietary server-side script engine) and the web-mapping is a customised version of MapServer, an Open Source software originally developed by the University of Minnesota.

While the DBMS does not represent a problem, the three solutions adopted for components 2) and 3) show advantages and disadvantages.

As for the web mapping tool, a complete Open Source solution would offer the best possibilities with respect to the key NERIES issues of customization and openness. Commercially available software, such as ESRI ArcIMS, could be a source of potential problems for the future. Otherwise Open Source projects, such as the MapServer package solution, are interesting but resulted poorly performing in our tests, as each request from the client is then processed by the server which sends back the result to the client.

The DBMI software was conceived for the same scope of NA4: all parts are customizable, it performs well on lightweight web-servers and offers good client level of interactivity.

As for the layout, the three databases have a different, self-developed, web interface. All of them offer a query by earthquake, although the way it is performed is different:

- DBMI. Shows the full earthquake list in a window; the list can be scrolled and sorted by date, epicentral area, total number of macroseismic datapoints, etc. The earthquake selection is performed by clicking on the relevant line. It is also possible to select clicking on the interactive map showing the epicentres. After selecting an event, the MDPs list are given on an interactive map and a downloadable table. All queries are performed within the same page (Fig.15). Offers also a query by place, to retrieve the relevant seismic history (Fig.16).
The entire database is downloadable in one go; a user registration is required.
- ECOS. Can query the database by date, time span, magnitude, epicentral area or a combination of them; the information is given in separate pages (Fig.17 and 18). Maps use

a series of thematic layers, such as three level of administrative boundaries and geological maps (Fig.19).

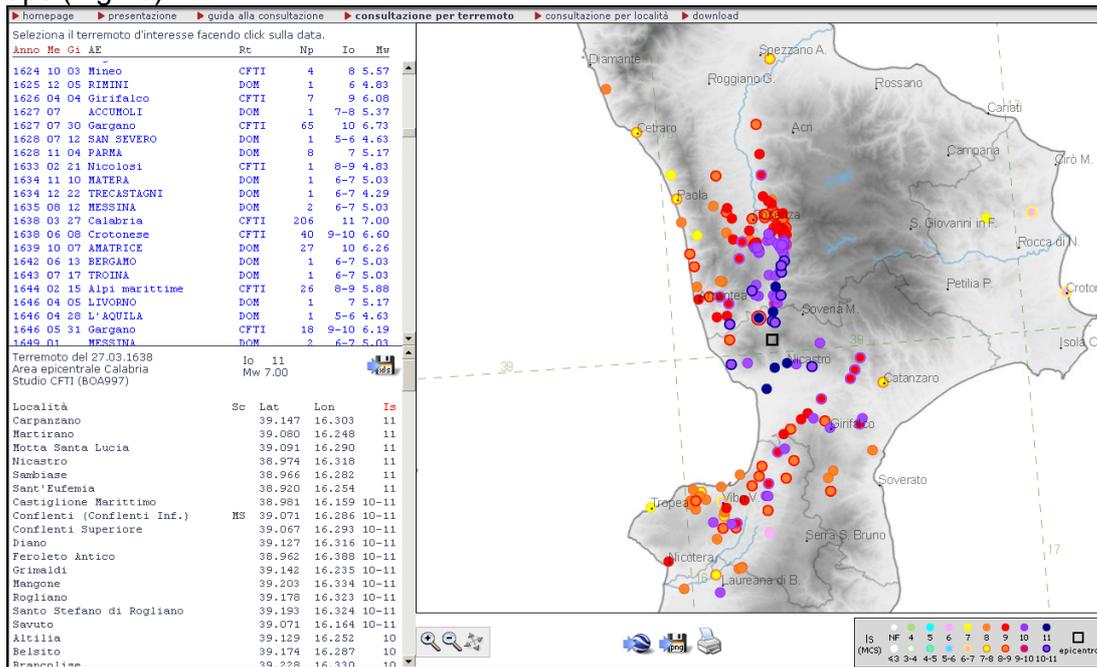


Fig.15 – DBMI04: the 1638 March 27 earthquake; all the information are presented within one browser page. The complete earthquake list on the upper left part; the selected event intensity map on the right and the corresponding list of MDPs in a table on the bottom left. To find a place in the map is possible by clicking on the place name in the table. Map interaction is possible in real-time: all the zooming and panning operation uses the computer client CPU; no data is transferred from the server once the map is rendered.

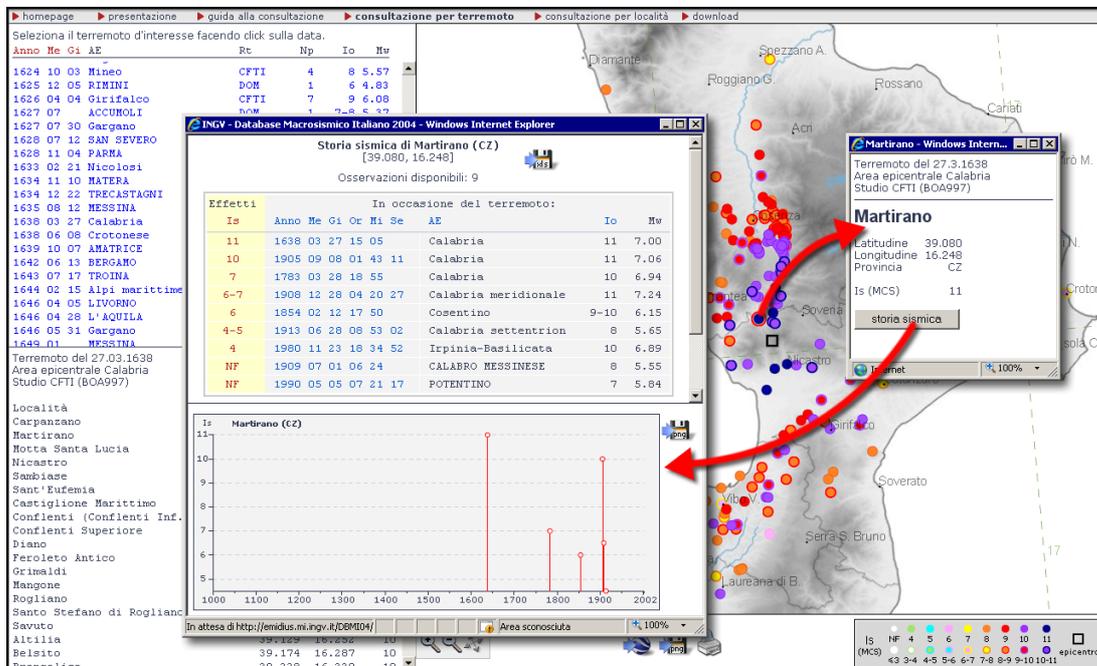


Fig.16 – DBMI04: MDPs represented on map are clickable; a popup appears and it is possible to obtain the seismic history of the place.

Earthquake Hazard and Risk

[e d f i](#)

[BACK](#) [NEW ECOS02 QUERY](#) [ECOS02 OVERVIEW](#) [SED HOME](#)

Earthquake No 30036 Ayent VS - January 25, 1946

[SHOW MACROSEISMIC TABLE](#) [SHOW MACROSEISMIC MAP](#)
[SHOW BIBLIOGRAPHY](#)

Main data source: [SED, MECOS02](#)
 Date: January 25, 1946 Time: 17 h 32'
 Earthquake type: main/single event Certainty code: certain

Epicenter: Ayent VS
 - Swiss coordinates: 597 km East 133 km North
 - Geographic coordinates: 7.4 ° East 46.35 ° North
 Location uncertainty: <= 20 km N-S <= 20 km W-E

Fig. 17 – ECOS: example of the summary page of the 1946 January 25 earthquake.

Swiss Seismological Service
Earthquake Hazard and Risk

[e d f i](#)

[BACK TO EARTHQUAKE LIST](#) [BACK TO DETAILS](#) [NEW ECOS02 QUERY](#) [ECOS02 OVERVIEW](#) [SED HOME](#)

Intensity site points for the earthquake of January 25 1946

with epicenter in Ayent VS

[SHOW BIBLIOGRAPHY](#) [SHOW MACROSEISMIC MAP](#) [DOWNLOAD TABLE](#)

town	country	ch_x	ch_y	lat	lon	Catalog id	Site quality	Intensity (EMS-98)
3960 SIERRE	CH	607.3	126.9	46.29	7.53	3	-	VIII
Pra Combère VS	CH	599.8	130.3	46.32	7.44	3	-	VIII
3965 CHIPPIIS	CH	607.9	125.3	46.28	7.54	3	-	VIII
1844 VILLENEUVE VD	CH	563.2	139	46.4	6.96	3	-	VII
1885 CHESIÈRES	CH	569.6	127.9	46.3	7.04	3	-	VII

Fig. 18 – ECOS: example of the MDPs table of the 1946 January 25 earthquake.

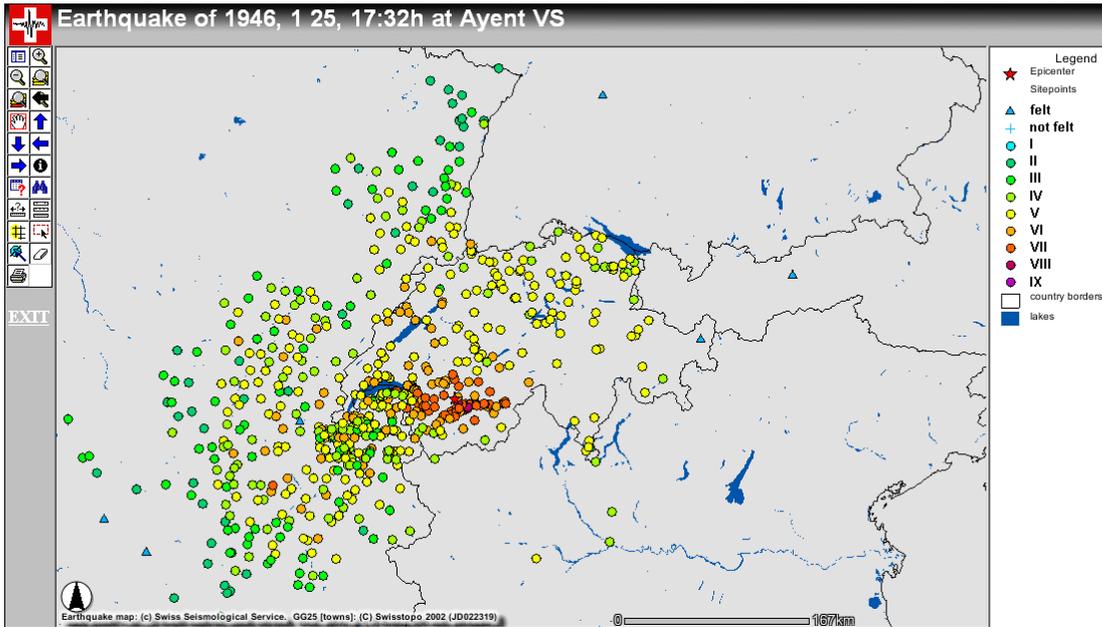


Fig. 19 – ECOS: map of the 1946 January 25 earthquake.

SisFrance. Can be consulted by chronological order, French Department, local district and epicentral intensity. The user can select an earthquake from a table (Fig.20) that can be filtered specifying a year. Once the earthquake has been selected, another page which summarises the earthquake characteristic is loaded; all further information, such as the list of intensities (Fig.21), the intensity distribution (Fig.22) and the bibliographical list are presented in separate pages;



Fig. 20 – SisFrance: list chronologically ordered earthquakes.

[Liste des observations](#)
[Caractéristiques du séisme](#)
[Carte macrosismique](#)
[Bibliographie](#)
[Carte d'isoséistes](#)
[Page d'accueil](#)

Identité : **380070**

Date du séisme : **25 Avril 1962**
 Heure du séisme : **4 h 44 min 48 sec**
 Région épicentrale : **VERCORS (CORRENCON-EN-VERCORS) – DAUPHINE**

1 2 3 4 5 6 ▶ ▶▶

Localité	Dept/Pays	Indice	Intensité	Effet	Longitude	Latitude
ABONDANCE	74	A	2,5		6° 43' E	46° 17' N
AIX-LES-BAINS	73	A			5° 55' E	46° 42' N
ALBENS	73	A	4,5		5° 57' E	46° 47' N
ALBERTVILLE	73	A	4,5		6° 23' E	46° 40' N
ALBY-SUR-CHERAN	74	B	3		6° 01' E	46° 49' N
ALIXAN	26	A	2,5		5° 02' E	44° 58' N
ALLEX	26	A	4		4° 55' E	44° 46' N
ANNEMASSE	74	A	3		6° 14' E	46° 12' N
ANNONAY	07	A	2,5		4° 40' E	46° 15' N
ANTHON	38	B	4		5° 10' E	46° 48' N
APPRIEU	38	A	4		5° 30' E	46° 24' N
ARANDON	38	A	3,5		5° 26' E	46° 43' N
ARTAS	38	A	3,5		5° 10' E	46° 32' N
AUBERIVES-SUR-VAREZE	38	A	4		4° 49' E	46° 25' N
AUTRANS	38	A	4,5		5° 33' E	46° 10' N
AVIERNOZ	74	A	3		6° 13' E	46° 59' N
AVIGNONNET	38	B	5		5° 41' E	44° 57' N
BALBINS	38	B	3		5° 14' E	46° 24' N
BARRAUX	38	B	4		5° 59' E	46° 26' N
BARSAC	26	A	3,5		5° 17' E	44° 44' N

Fig. 21 – SisFrance: MDPs table of the 1962 April 25 earthquake.

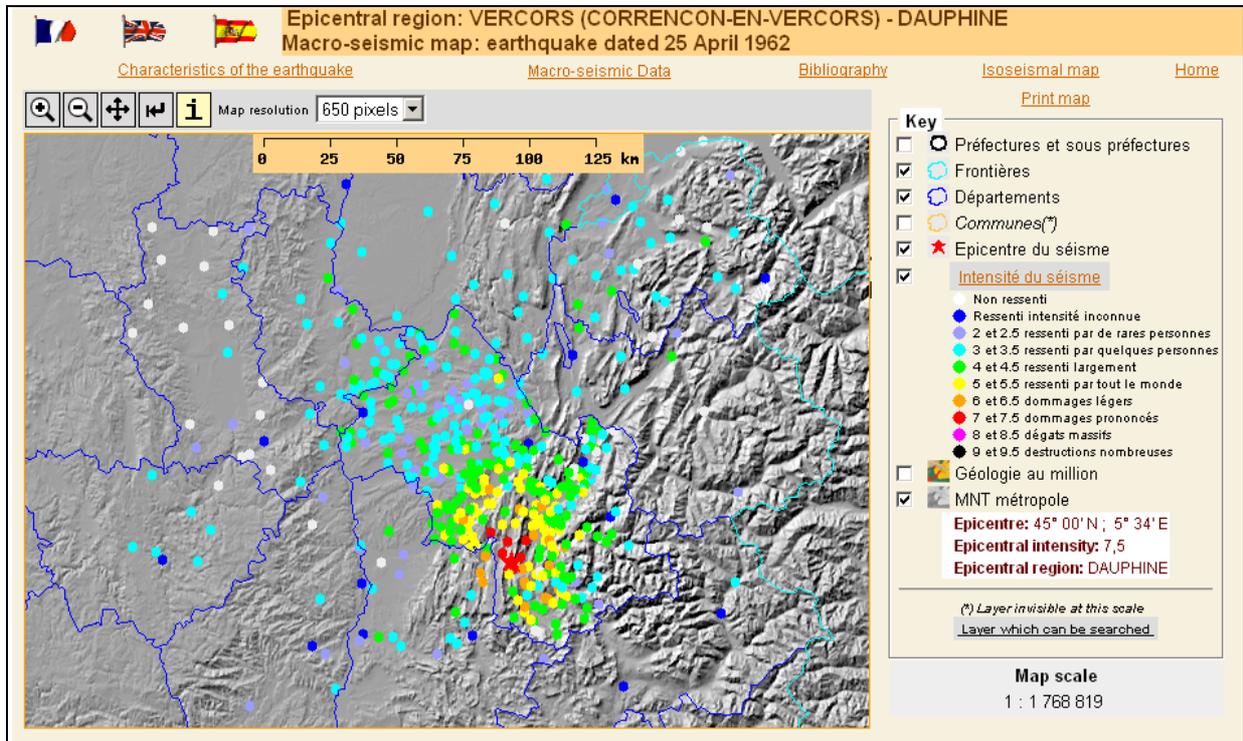


Fig. 22 – SisFrance: map of the 1962, April 25 earthquake.

A query by place name is only possible in DBMI (Fig.23); a seismic history is generated both in tabular form, with a list of occurred events, and using an interactive diagram (year vs intensity). Both the event table and the diagram are downloadable and by clicking on events the corresponding MDPs map is shown.

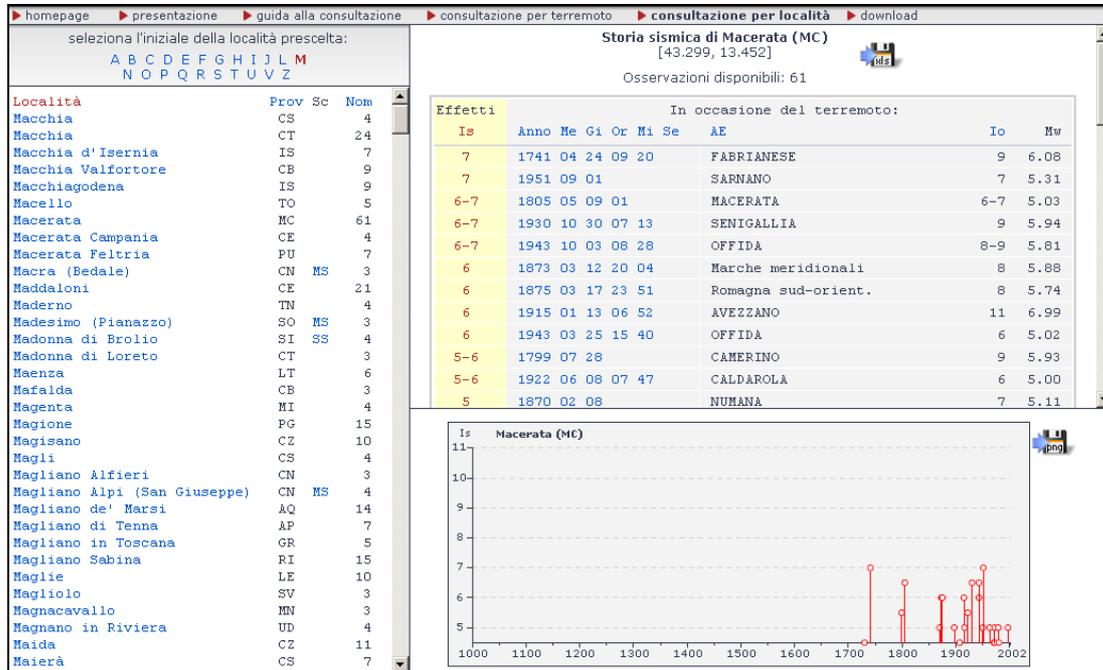


Fig. 23 – DBMI04: database access by place names.

Proposed solution. The proposed NA4 solution is an evolution of the DBMI software which, in its turn, can be considered a beta-status software - for INGV internal use only – of the NA4 version. The main feature which make it suitable for NA4 purposes are:

- does not need a powerful computer for serving pages to many clients at the same time;
- can work on generally available web server environments;
- cannot cause web security problems when installed, so it can be used also by institutions where local web policies are strict;
- an easy to use administration tool expressly designed for people working with historical earthquake data;
- it is completely open source based; it uses MySQL as the database management system, Scalable Vector Graphic (SVG) for both map representation and interactivity and two macro languages: PHP on the server side and JavaScript on the client side.

Many of the original DBMI aspects have been enhanced for NA4 purposes.

First of all a web administration interface has been completely re-designed: it now offers a friendly way of setting every aspect of the software without the need of touching the internal code. Administrators can set both web page layout details and how data tables are structured. Both the map layers content and how they will appear can be customised; zooming and panning tools are available; intensity data can be exported both in tabular format for common spreadsheets like MS Excel, and to GoogleEarth for a three dimensional exploration of the earthquake surroundings.

The software is based on interpreted macro languages (PHP and JavaScript), both easy to learn and editable at any time: no part of it is based on closed pre-generated obscure executables; all of these characteristics guarantee possible further development for everyone.

Hardware and software requirements. The proposed solution needs two computers: one to be used as a data management machine and another one as web server:

The data manager workstation is a normal PC preferably equipped with at least 2Gbyte of RAM and a 2Ghz processor. From the software point-of-view it must be configured with a "WAMP" environment (see <http://en.wikipedia.org/wiki/WAMP>), which is an acronym formed from the initials of the operating system (Windows) and the package's principal components: Apache (web server), MySQL (DBMS) and PHP (macro language). Other programs could be included, such as phpMyAdmin which provides an online interface for the MySQL database manager. The software can be used on Linux operating system using the corresponding environment "LAMP" (<http://en.wikipedia.org/wiki/LAMP>), however this solution is not tested.

A visual front-end for the DBMS is highly recommended; on Windows Microsoft Access can be used both for data analysis and for an easy data transfer into MySQL via the freely available ODBC (Open Database Connectivity) driver.

The NA4 software outputs a website with static pages, so no further calls to a DBMS or server-side scripts are performed. This solution has two major advantage:

- compatibility with any web server: no DBMS and server-side script engine are needed;
- basic hardware profile: a middle range computer can fulfil the task of serving complex maps to a huge number of visitors at the same time;
- high security: no attack to static pages is possible.

Additional elements. In order to publish macroseismic maps, additional elements such as intensity symbols, a DEM (Digital Elevation Model) and administrative boundaries are needed.

a) Intensity symbols. DBMI (1), ECOS (2) and SISFRANCE (3) macroseismic maps use different symbols for representing intensities. In Tab.13 a compromise solution is proposed.

Tab. 13 – Comparison of available symbols and compromise NA4 proposal.

Is value	DBMI04	ECOS	SISFRANCE	NA4
NF	○	+	○	
1		●		●
2	○	●	●	●
2-3	○		●	●
3	○	●	●	●
3-4	○		●	●
F	F	▲	●	○
4	●	●	●	●
4-5	●		●	●
5	●	●	●	●
5-6	●		●	●
6	●	●	●	●
6-7	●		●	●
7	●	●	●	●
7-8	●		●	●
8	●	●	●	●
8-9	●		●	●
9	●	●	●	●
9-10	●		●	●
10	●			●
10-11	●			●
11	●			●

b) DEM. The DEM on which intensities symbols will be plotted needs to be created in a GIS software. To date NA4 adopts the free NASA SRTM (Shuttle Radar Topography Mission) as a source dataset; the 90 meters resolution guarantees a good quality output. The resulting DEM is rendered using a flat shaded method (Fig.24) which, opposite to the shaded relief method (Fig.25), seems to supply a better background solution for representing intensity symbols.

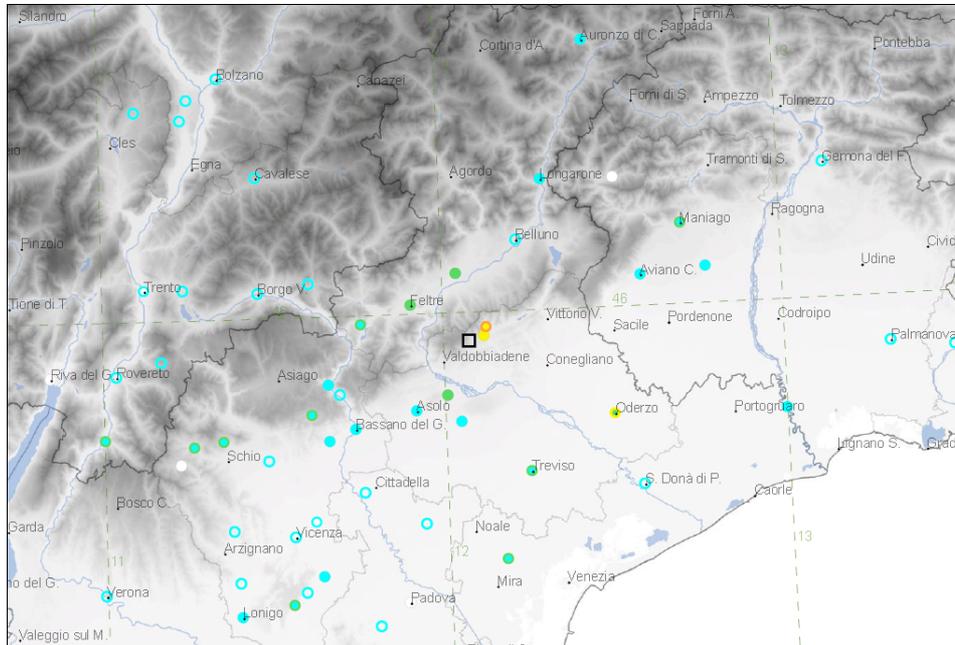


Fig. 24 – NA4 DEM: example of a flat shaded rendering method.

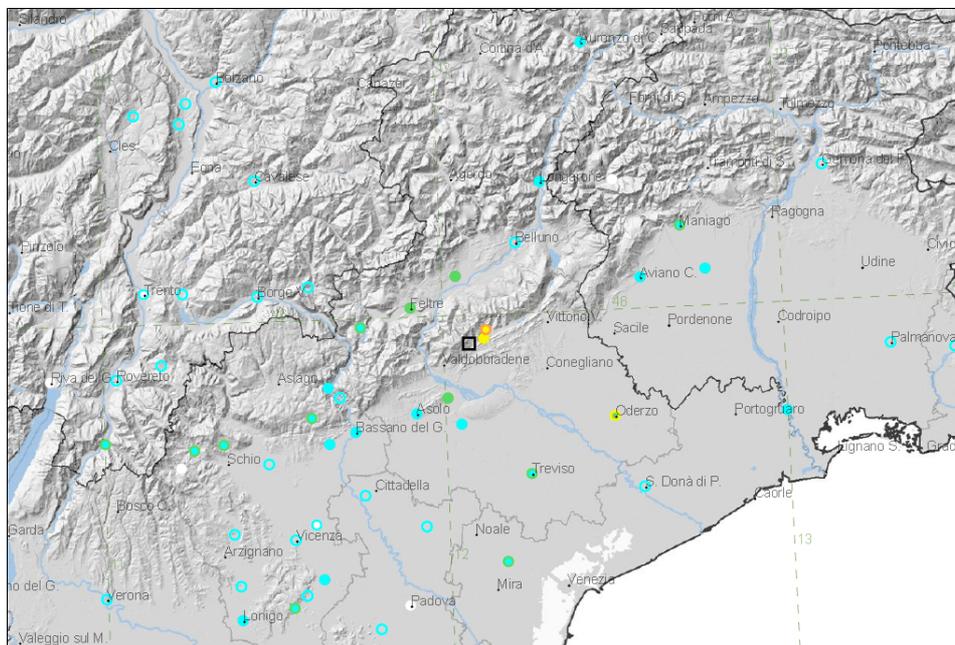


Fig. 25 – NA4 DEM: example of a shaded relief rendering method.

c) Administrative boundaries. For a better geographical understanding, maps usually presents today's administrative boundaries. NA4 uses the GADM (Global Administrative Areas) (<http://biogeو.berkeley.edu/gadm/>) published by the University of Berkeley under the Creative Commons Licence, which allow the free usage for non commercial products.

Paris, 30 January, 2008

Comments and review of "Report NA4 D4 European macroseismic database (*demo version*) 1000-1600, M > 5.0 », October, 2008

The goal of this activity is "to make macroseismic data (MDPs = macroseismic data points) homogeneous and available to public in digital form" at the European scale. This is of course a fundamental goal for future studies of seismic hazard in Europe. In the aim of reaching such a challenging goal, the NERIES project has already engaged an enormous effort, as testified by this deliverable, which will need to be pursued over a much longer timeframe than the duration of the NERIES project in order to be of use for the European community at large.

NERIES project NA4 D4 appears quite ambitious: in order for the database to be of use, an incredible effort would need to be financed in each country to support the interdisciplinary research necessary to fulfil the proposed goals. In this respect, NERIES leaders need to make a clearer statement as to which efforts are already engaged in the different European countries and how do they plan to co-ordinate them. Judging from this report and the state of the European macroseismic database available online to date, it appears that many countries either do not have data or are unwilling to provide it.

It seems primordial for the success and longevity of this project to have an engagement letter from each potential data provider (partner and non-partner alike) defining the extent of their engagements within this project in the short and the long term. For such a project to remain dynamic through time, contact persons should be formally identified in each country and should participate to the checking/refuting/discussion workshops throughout the homogenisation procedure process.

I am only one of the three representatives of the SISFRANCE database. I encourage the leaders of NERIES to submit an official European letter to the three SISFRANCE partners BRGM-EDF-IRSN specifying the nature of the NERIES request and of the long term objectives of the European Macroscopic database.

The SISFRANCE project has regular meetings where issues are discussed and settled upon as a group. The next meeting is scheduled for the 11th of March. I invite a NERIES representative to come and formulate such a request orally or to provide me with a clear and complete letter of request.

The following are questions/issues concerning the database (demo version available on the Neries NA4 site 30 January 2009).

The structure of the database resembles that of the DBMI04 database, which has a nice user-friendly interface. The European database contains today ~2000 MDPS, with 299 earthquakes of which 121 have 1 data point, 119 have 2-10, 27 have 11-20 and 23 have more than 20 MDP. Most of the MDP come from Italy (1223).

1. In the present structure of the database, the epicentral region of the earthquake is provided but the name of the country is missing.
2. When clicking on an event it would be nice to have the general view of the event (the first window should show all the data points available for that event - clicked on 1005)
3. Is there a plan to allow the user to consult directly the "studies" or is there a copyright problem?? It is difficult for the user to access a study such as "Papazachos B.C. and Papazachou C., 2003. The earthquakes of Greece. Ziti Publ. Co., Thessaloniki, Greece, 286 pp. (in Greek)." Or Postpischl D. (ed.), 1990. Valutazione del rischio sismico per il territorio della Repubblica di San Marino. Istituto di Topografia, Geodesia e Geofisica Mineraria, Università di Bologna, RPT/TGGM/1/90, 826 pp." Or "Castelli V., Monachesi G., Moroni A. and Stucchi M. (eds.), 1996. I terremoti toscani dall'anno 1000 al 1880: schede sintetiche. GNDT, Rapporto interno, Macerata-Milano, 314 pp. "
4. Codes such as NR, or MS, DL, G5 etc should be explained on the website.
5. So far the selection is only possible by earthquake; I presume the selection by locality is still planned?
6. What is done on the website when more than one study exists for a given event? (Dover 1580 for example).
7. The data is not downloadable today..
8. How much of the core file will be made available on the web? It is not clear whether the user will access "side data", "conversion tables" etc. for his/her own use.

The following are comments on the content of the report Appendices.

App1 Feedback issues: Does the project leader envisage a feedback to original data providers concerning the georeferencing mistakes identified in the course of the homogenization procedure?

App2. Conversion issues: Our experience in France (see Figure below) shows that a conversion between EMS and MCS is necessary, especially for intensities greater than VI-VII. This is maybe the trickiest part of the project that will have a major impact for the calibration exercise. Assuming that all intensity scales are the same, as suggested in this report, is certainly incorrect; at the same time introducing an ad hoc conversion scheme may also introduce systematic biases. I do not have a set solution to propose today: I do encourage the project leader, however to clearly identify the Intensity scale of origin.

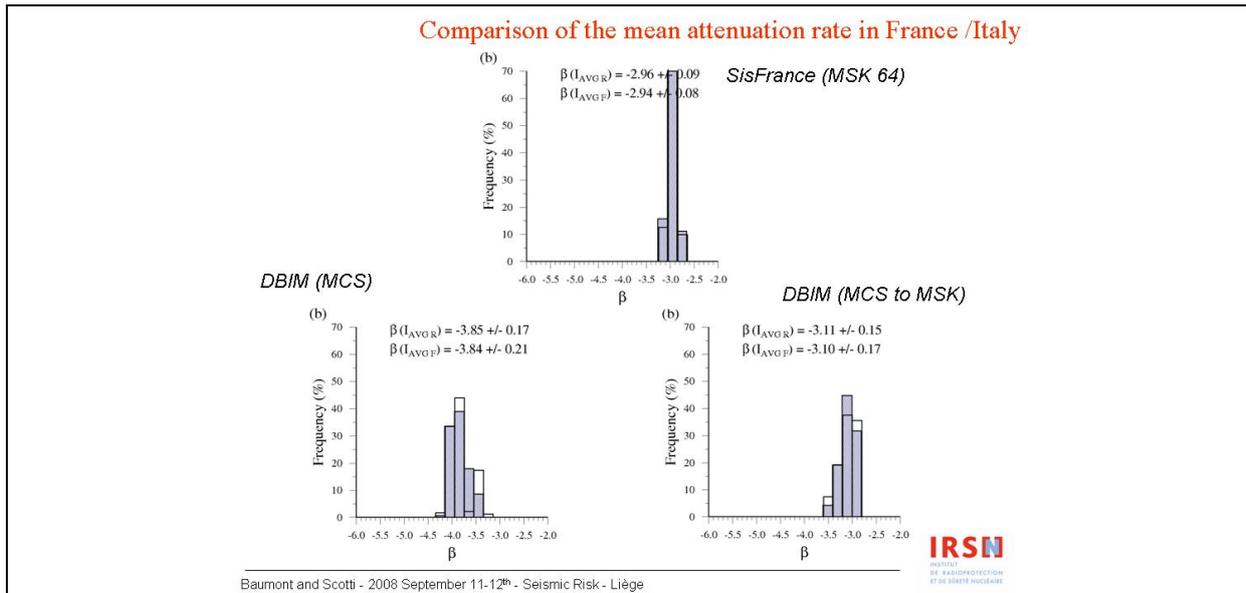


Table 2
Data Fitting and Goodness of Fit Parameters of Different Attenuation Parameters*

Model	α	β l/β	γ l/γ	R^2	s	F _{good} F _{best} F _(log)	n_u	n_d	ρ
I > VIII									
Bilinear	1.05 ± 0.12	0.047 ± 0.003	0.0203 ± 0.0006	0.99	0.13	2560.	1	31	1.00
		21.2 ± 1.4	49.2 ± 1.5			12.2	2	31	1.00
						14.0	1	31	1.00
CRAM	-1.40 ± 0.16	1.25 ± 0.04		0.97	0.20	1198.	1	33	1.00
SQ root	0.20 ± 0.10	0.416 ± 0.011		0.98	0.18	1510.	1	33	1.00
FT root	-3.00 ± 0.23	2.35 ± 0.07		0.97	0.22	996.	1	33	1.00
Log	-2.83 ± 0.31	3.67 ± 0.16		0.94	0.29	521.	1	33	1.00
Log + lin	-0.16 ± 0.35	1.52 ± 0.26	0.0144 ± 0.0016	0.98	0.16	1867.	1	32	1.00
I ≤ VIII									
Bilinear	0.37 ± 0.05	0.055 ± 0.002	0.0184 ± 0.0012	1.00	0.05	3470.	1	13	1.00
		18.2 ± 0.5	54.3 ± 3.5			11.1	2	13	1.00
						22.5	1	13	1.00
CRAM	-1.79 ± 0.13	1.24 ± 0.04		0.99	0.10	1180.	1	15	1.00
SQ root	-0.42 ± 0.12	0.45 ± 0.02		0.98	0.12	691.	1	15	1.00
FT root	-3.15 ± 0.15	2.24 ± 0.06		0.99	0.09	1466.	1	15	1.00
Log	-2.45 ± 0.14	3.13 ± 0.09		0.99	0.09	1299.	1	15	1.00
Log + lin	-2.06 ± 0.33	2.75 ± 0.30	0.004 ± 0.003	0.99	0.09	1457.	1	14	1.00

*As in Table 1, but with selection of the epicentral intensity

The top figure shows the probability density function of beta values obtained using a methodology developed at IRSN for a set of events in the MSK SISFRANCE database and a set of events in the DBIM04 MCS database (without and with a MCS to MSK conversion scheme). Without a conversion scheme for the Italian database we obtain a value of beta which is comparable to the one proposed by Gasperini 2001 when using a Log of distance-type law for I > VIII (his Table 2 is reported here). When applying a conversion scheme (suggested to us by Agnes Levret) we find a value of beta for the Italian dataset that is very similar to the

French one and very similar to the one proposed by Gasperini for $I \leq VIII$. SO we suspect that conversions between MCS and MSK are necessary before applying calibration schemes.

Remark: A macroseismic intensity assignment is the result of an historian/seismologist interpretation of written text. Will the end-user of the European Macroseismic Database be allowed to go back to the original sources used by the authors?

Felt MDPs should be tested for different values of intensities depending on the time period. Assuming Felt = 3-4 for all time periods may be incorrect.. I suggest you adjust this value as a function of the period.

If I understand Tab 9d correctly, there are 17 MDP in SISFRANCE which are assigned to a large area territory. Could you communicate such MDPS to me please? (An example of a useful feedback mechanism)

App. 3 No comments

App. 4 I made comments to the demo version in the text above.

I congratulate the Project leader and partners for the achievements made thus far and I wish them a lot of luck for a successful completion of this very important deliverable.

Yours sincerely,

Oona Scotti