The building up process of a macroseismic intensity database

M. Locati and D. Viganò
INGV Milano
When an earthquake occurs we usually see the map of epicentres
How do we assess the macroseismic intensity?

A field survey is required in order to evaluate the effects on buildings.
Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many well built ordinary buildings suffer moderate damage: small cracks in walls, fall of plaster, parts of chimneys fall down; older buildings may show large cracks in walls and failure of fill-in walls.

VI Slightly damaging
Many people are frightened and run outdoors. Some objects fall. Many houses suffer slight non-structural damage like hair-line cracks and fall of small pieces of plaster.
Macroseismic Data Point (MDP) map of the 15th October 1996

<table>
<thead>
<tr>
<th>Data</th>
<th>Ax</th>
<th>Np</th>
<th>Io</th>
<th>Mw</th>
</tr>
</thead>
<tbody>
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<td>1995</td>
<td>11</td>
<td>21</td>
<td>04:04</td>
<td>Torinese</td>
</tr>
<tr>
<td>1996</td>
<td>02</td>
<td>27</td>
<td>12:13</td>
<td>Barcis</td>
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<td>13:04</td>
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<td>04</td>
<td>13:00</td>
<td>CLAUT-BARCIS</td>
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<tr>
<td>1996</td>
<td>04</td>
<td>27</td>
<td>00:33</td>
<td>Cosentino</td>
</tr>
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<td>1996</td>
<td>10</td>
<td>15</td>
<td>09:55</td>
<td>Correggio</td>
</tr>
<tr>
<td>1996</td>
<td>12</td>
<td>02</td>
<td>13:01</td>
<td>C.DA LUMINARIA</td>
</tr>
<tr>
<td>1997</td>
<td>03</td>
<td>19</td>
<td>23:10</td>
<td>Matese</td>
</tr>
<tr>
<td>1997</td>
<td>05</td>
<td>12</td>
<td>13:50</td>
<td>MASSA MARTANA</td>
</tr>
<tr>
<td>1997</td>
<td>05</td>
<td>12</td>
<td>22:13</td>
<td>Reggiano</td>
</tr>
<tr>
<td>1997</td>
<td>06</td>
<td>09</td>
<td>14:10</td>
<td>Vibonese</td>
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<tr>
<td>1997</td>
<td>07</td>
<td>08</td>
<td>08:13</td>
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</tr>
<tr>
<td>1997</td>
<td>07</td>
<td>15</td>
<td>08:51</td>
<td>Appennino umbro-marchigiano</td>
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</table>

Terremoto 1996 10 15 09:56:02 Correggio
Studio macros. Camassi et al., 1996 [Np 135, Imax 7]

Epicentro

<table>
<thead>
<tr>
<th>Località</th>
<th>Sc</th>
<th>Lat</th>
<th>Lon</th>
<th>I [MCS]</th>
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<td>Bagnolo in Piano</td>
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<tr>
<td>Correggio</td>
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<td>Argine</td>
<td>44.782</td>
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<td>Forlì-Cesena</td>
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<td>10.759</td>
<td>6</td>
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<tr>
<td>Quattro Castella</td>
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<td>6</td>
<td></td>
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<td>Rio Saliceto</td>
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<td>Castelnuovo di Sotto</td>
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<td>Gualtieri</td>
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</table>
Macroseismic Data Point (MDP) map of the 12th February 1806

Select the event by clicking on the data.

<table>
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<tr>
<th>Data</th>
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<th>Np</th>
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<th>Mw</th>
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<td>Slovenia</td>
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<td>5.64 ±0.22</td>
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<td>1802 05 12 09:00</td>
<td>VALLE DELL'OGLIO</td>
<td>85 8</td>
<td>6-7</td>
<td>4.99 ±0.53</td>
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<tr>
<td>1802 10 31</td>
<td>Val d'Orcia</td>
<td>11 7</td>
<td>6-7</td>
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<tr>
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<tr>
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<tr>
<td>1805 05 09 01:00</td>
<td>MACERATA</td>
<td>3 5-6</td>
<td>6.62 ±0.11</td>
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<tr>
<td>1805 07 26 21:00</td>
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<td>223 10</td>
<td>6-7</td>
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<tr>
<td>1806 02 12</td>
<td>NOVELLARA</td>
<td>28 7</td>
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<tr>
<td>1806 07 21 09:00</td>
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<tr>
<td>1806 08 26 07:35</td>
<td>Colli Albani</td>
<td>35 8</td>
<td>6-7</td>
<td>5.54 ±0.38</td>
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<tr>
<td>1807 01 28 17:00</td>
<td>ISENIA</td>
<td>1 5-6</td>
<td>6-7</td>
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<tr>
<td>1807 11 11</td>
<td>TRAMUTOLA</td>
<td>6 6-7</td>
<td>6-7</td>
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<tr>
<td>1808 04 02 16:43</td>
<td>Valle del Pellice</td>
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<td>6-7</td>
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Terremoto 1806 02 12 NOVELLARA
Studio macros. ENEL, 1985 [Np 28, Imax 7]

Epicentro CPTI11 □ Mw 5.19
macrosismico □ Mw 5.19

Località Sc Lat Lon I [MCS]
Brescia 44.900 10.515 7
Campagnola Emilia 44.841 10.759 7
Correggio 44.771 10.779 7
Novellara 44.845 10.731 7
Viadana 44.929 10.522 7
Gualtieri 44.903 10.631 6-7
Reggio nell'Emilia 44.697 10.631 6-7
Guastalla 44.921 10.654 6-7
Reggio 44.919 10.804 6-7
Sabbioneta 44.999 10.489 6-7
San Tommaso 44.739 10.731 6-7
Boretto 44.907 10.553 6-7
Carpì 44.784 10.885 6-7
Fabbrico 44.872 10.809 6-7
Milano 45.464 9.190 5-6
Parma 44.801 10.329 5
Padova 45.407 11.876 4-5
Bologna 44.498 11.340 4-5
Casalmaggiore 44.988 10.421 4-5
Modena 44.647 10.925 4-5
Ostiglia 45.066 11.137 4-5
Macroseismic Data Point (MDP) map of the 19th March 1624

Seeziona il terremoto facendo click sulla data.

<table>
<thead>
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<th>Data</th>
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<th>Mw</th>
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<tr>
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<tr>
<td>1614 08</td>
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<td></td>
<td>6-7</td>
<td>4.93 ± 0.34</td>
</tr>
<tr>
<td>1621 08 09</td>
<td></td>
<td></td>
<td></td>
<td>CALABRIA</td>
</tr>
<tr>
<td>1622 05 05</td>
<td>11:00</td>
<td>Slovenia</td>
<td>3</td>
<td>5.35 ± 0.34</td>
</tr>
<tr>
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<td>19:45</td>
<td>Argenta</td>
<td>18</td>
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<tr>
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<td>Mineo</td>
<td>4</td>
<td>5.57 ± 0.34</td>
</tr>
<tr>
<td>1625 09</td>
<td></td>
<td></td>
<td>1-9</td>
<td>5.78 ± 0.34</td>
</tr>
<tr>
<td>1625 12 05</td>
<td></td>
<td></td>
<td></td>
<td>RIMINI</td>
</tr>
<tr>
<td>1626 04 04</td>
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<td>Girifulco</td>
<td>7</td>
<td>6.03 ± 0.82</td>
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<tr>
<td>1627 07</td>
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<td></td>
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<td>ACCUMOLI</td>
</tr>
<tr>
<td>1627 07 30</td>
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<td>Gargano</td>
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<tr>
<td>1627 08 07</td>
<td>16:40</td>
<td>Gargano</td>
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Terremoto 1624 03 19 19:45 Argenta
Studio macro. Guidoboni et al., 2007 [Np 18, Imax 8-9]

Epicentro CPTI11 Mw 5.47
Macrosismo Mw 5.47

Località Sc Lat Lon I [MCS]
Argenta 44.615 11.837 8-9
Portomaggiore 44.698 11.805 7-8
Bando 44.644 11.885 7
Belriguardo 44.753 11.756 7
Boccalone 44.640 11.801 7
Filo 44.588 11.930 7
San Biagio 44.587 11.866 7
Trava 44.670 11.892 7
Copp ano 44.894 11.830 6
Ferrara 44.836 11.618 6
Carp i 44.784 10.885 5
Ravenna 44.417 12.198 5
Venezia 45.438 12.335 5
Bologna 44.498 11.340 4
Modena 44.647 10.925 4
Padova 45.407 11.876 F
Reggio nell'Emilia 44.697 10.631 F
Cento 44.727 11.289 NC
Macroseismic Data Point (MDP) map of the 17th November 1570

http://emidius.mi.ingv.it/DBMI11
Historical earthquake studies: obtaining MDPs from the past

Macroseismic intensity

Stucchi & Albini, 1992

Macroseismic intensity

Historical records

http://storing.ingv.it/cfti4med/

Historical earthquake study “Guidoboni et al., 2007”

http://storing.ingv.it/cfti4med/

Stucchi & Albini, 1992
Historical earthquake studies: obtaining MDPs from the past

Stucchi & Albini, 1992
Already georeferenced places must be checked

Galli et al., 2002
1930 07 23 Irpinia
I'max 10

Cervinara, Is 7-8
[41.789, 13.025]

158km

Cervinara, Is 7-8
[41.021, 14.617]
Summary

Data entry
- From analog table: 1) scan, 2) OCR, 3) check
- From digital table: 2) data re-formatting, 2) data transfer to database
- From a map: 1) georef. map, 2) places georeference

Geographical checks
- Place name: 1) source name, 2) corresponding modern name
- Georeferencing: 1) plot, 2) coordinate check, 3) unique place identifier
  e.g.: a single building or settlement, island, territory
- Special place type: e.g.: too small place (e.g.: castle, lighthouse) or too big areas (e.g.: Anatolia, Sicily)

Intensity checks
- Macroseismic scales: EMS, MM, MCS, MSK, JMA, CIS
  e.g.: 6-8, 7?, >7, F, D, HD, DE
- "Unconventionals": too small place (e.g.: castle, lighthouse) or too big areas (e.g.: Anatolia, Sicily)
How to publish MDP datasets on the Web

Macroseismic Intensity Data Online Publisher

A tool created and developed by INGV since 2006 for easily publish MDP data on the Internet.

It generates a website with:
• epicentres overview map
• single earthquake MDP map
• seismic histories
• maximum intensity map
• references information
• downloadable tables
• export to Google Earth & QuakeML

Advantages:
• safe from web attacks (only html with JavaScript pages)
• standard web server (no database server required)
• internal geographical maps (no need of external web resources)
• websites can be browsed offline

http://www.emidius.eu/MIDOP/
Publishing MDP data on the Web: the MIDOP tool

1. List of earthquakes
2. List of MDPs

http://www.emidius.eu/MIDOP/
Output example: place seismic histories
Example of use: earthquakes parameters assessment

- epicentre & magnitude + uncertainties
- epicentre & magnitude + uncertainties
- epicentre & magnitude + uncertainties

historical MDP dataset

- Bakun & W., 1997
- Boxer, 1999
- MEEP, 2008

earthquakes calibration dataset with good MDPs coverage and reliable instrumental parameters
DBMI11, the 2011 release of the Italian Macroseismic Database

From year 1000 to year 2006
86071 MDPs
1683 earthquakes (Mag>=4.5)

http://emidius.mi.ingv.it/DBMI11
DBMI11, the 2011 release of the Italian Macroseismic Database

From year 1000 to year 2006
86071 MDPs
1683 earthquakes (Mag>=4.5)

http://emidius.mi.ingv.it/DBMI11
AHEAD: macroseismic database
From year 1000 to year 1899
42358  MDPs
2410  earthquakes (Mag>=4.5)

AHEAD, the European Archive of Historical Earthquake Data
http://www.emidius.eu/AHEAD
AHEAD, the European Archive of Historical Earthquake Data

From year 1000 to year 1899
42358 MDPs
2410 earthquakes (Mag>=4.5)

Intensity data supporting the parameters of SHEEC
SHARE European Earthquake Catalogue

http://www.emidius.eu/AHEAD
AHEAD, the European Archive of Historical Earthquake Data

EC Projects NERIES (2006-2010) and SHARE (2009-2012)

NERIES Module NA4, "Distributed Archive of Historical Earthquake Data"
SHARE WP3, Task 3.1, "European earthquake database"

AHEAD European Archive of Historical Earthquake Data

Fake Earthquakes

Collaborative Inventory

Earthquakes Digital Library

Earthquake Background Datasets

EQs w MDPs

Macroseismic Database (homogenized MDPs)

Intensity Web Mapping Tool

Historical Sources

UK Historical Earthquake Database (BGS)
SISFRANCE (BRGM, IRSN, EDF)
ECOS (ETHZ)
DBMI (INGV)
Bases de datos de intensidad macrosísmica (IGN)
Base de Dades Macrosísmica (IGC)
Macroseismic Data of the University of Athens
Macroseismic Data of the University of Thessaloniki
others…
AHEAD, the European Archive of Historical Earthquake Data

Online databases before 2006

- Sisfrance
- ECOS
- DBMI
AHEAD, the European Archive of Historical Earthquake Data

Online databases now, 2012

- Partner
- INGV contractor
- Collaborator

France
Italy
Switzerland
Catalunya
Spain
UK
Greece
- Athens
- Thessaloniki
Portugal

AHEAD, the European Archive of Historical Earthquake Data
AHEAD, the European Archive of Historical Earthquake Data

3 January 1117, 15:15

Veronese

Catalogues   Studies  Seismicity  Add a comment

Guidoboni et al., 2007
Reported date: 3 January 1117, 15:15
- full reference
- 55 MDPs  Imax 9

Guidoboni et al., 2005
Reported date: 3 January 1117, 15h
- full reference
- 55 MDPs  Imax 9

Galli, 2005
Reported date: 3 January 1117
- full reference

Camassi & Stu., 1997
Reported date: 3 January 1117, 13h
- full reference

Boschi et al., 1997
Reported date: 3 January 1117, 13h
- full reference
- 85 MDPs  Imax 9

Alexandre, 1990
Reported date: 3 January 1117
- full reference

http://www.emidius.eu/AHEAD  internal beta version
AHEAD, the European Archive of Historical Earthquake Data

3 January 1117, 16:15

Veronese

Create a seismicity buffer
- by radius (km, max 500) 100
- by drawing a polygon

Mw (SHEEC, 2011)

Year

1000-1300 1751-1830
1301-1500 1831-1875
1501-1600 1876-1899
1601-1750

extra large Mw >= 7.00
large 5.80 <= Mw < 7.00
medium 5.00 <= Mw < 5.80
small Mw < 5.00
not determined

http://www.emidius.eu/AHEAD
Global Earthquake Model (GEM), Tools for compiling the Global Earthquake History

**Global Component project** that will produce a common set of definitions, strategies, standards, quality criteria and formats

INGV & BGS coordination
Activity: 2010 - ongoing
Time-window: 1000-1903
Magnitude: >=7
a Global Component project that will produce a common set of definitions, strategies, standards, quality criteria and formats

Global Earthquake Model (GEM), Tools for compiling the Global Earthquake History

INGV & BGS coordination
Activity: 2010 - ongoing
Time-window: 1000-1903
Magnitude: >=7

Thank you!
mario.locati@mi.ingv.it