

### 1.2.3 NA4 : Distributed archive of historical earthquake data

<b>Participant number</b>	11	14	20	3	16		
<b>Participant short name</b>	INGV	BGS	IGC	ETHZ	ITSAK		<b>Total</b>
<b>Person-months</b>	42 (24)	4	4.5	3 (1)	2		<b>55.5 (25)</b>

#### Summary

After the discussion in the occasion of the Second Annual Meeting and the comments from the management, the work plan of NA4 was revised in order to match the request of a consistent initiative for calibrating the tools for determining the parameters of the historical earthquakes. This activity absorbed most of the manpower allotted for NA4; the rest was dedicated to continue the implementation of the Distributed Archive of Historical Earthquake Data.

#### Calibrating earthquake parameters

The aim of the “calibration initiative” was to calibrate, in a homogeneous way, three methods for determining earthquake parameters from macroseismic data: Boxer, Meep, Bakun & Wentworth, with special reference to five areas: Aegean, Iberian, Italian, Great Britain and Switzerland.

For each area a dataset of about fifteen earthquakes of the 20th century, selected to cover the largest magnitude range, was compiled according to homogeneous procedures. The Boxer and Meep methods are accompanied by codes which provide calibrated coefficients from the input dataset. The Bakun & Wentworth method requires an intensity attenuation relation as function of the moment magnitude and hypocentral distance. Such relations were obtained for each area calibrating the coefficients of a log-linear function with regression procedures from the same dataset used for calibrating the other methods. As the Bakun & Wentworth method accepts any attenuation relation, other recently published relations were also considered.

The procedures were discussed in a meeting held in Milan (December 4-5, 2008), which was attended by all the partners, the NERIES coordinator and leading scientists in this topic, including W. Bakun, P. Gasperini and O. Scotti. After the workshop several improvements were performed, on the methodological side and on the regional application, by means of e-mail exchanges and small, local meetings. Input data and results were put together by INGV-MI; progress was shared with the partners practically in real time by means of a dedicated, restricted website.

The calibrated coefficients were then validated determining the parameters of another ten events. For Boxer and Meep one set of coefficients only was available for each area; therefore, the validation exercise was devoted to survey whether the use of such coefficients would lead to realistic results. For the Bakun & Wentworth at least two alternatives were available in all areas; the scope was, therefore, to select the “best performing” one.

At the end of this phase, a set of coefficients for each region was released for the three mentioned methods. Such coefficients show ups and downs; as a general issue, 15 events may not be sufficient for supplying reliable results (adopting another 15 events would lead to different results). On the other hand, some regions could not even provide 15 events covering medium to large magnitudes; in the case of Boxer, for instance, this makes impossible to provide the coefficients for high intensities and, therefore, the method will fail when processing large historical data. This phase also demonstrated that, with the exception of few regions, to seek for European sub-regional calibration is out of reach, due to the lack of sufficient sets of calibrating events. The results, which represent an additional deliverable, have been labelled as D5, part 1.

#### Implementing the Distributed archive of historical data

The implementation of the Distributed Archive of Historical Earthquake Data, which remains the main goal of NA4, continued. It was re-agreed that NA4 archive consists of local, possibly coherent, public units and a central core (earthquake studies inventory and IDPs database for large events, at least), to be constantly updated. It was also agreed that the NA4 inventory and archive will consider “available”

material only. "Available" means material which is published or in some stable and public form, for instance on the web. NA4 partners are responsible for developing their public archive (earthquake studies and digital IDPs). In particular, Italy and Switzerland developed the official DBMI and ECOS databases and websites; Catalunya made pdf material available on the web and encouraged the publication of the material of Spain; BGS and ITSAK are on the way of publishing pdf material and MDP's. In addition, INGV-MI put together additional material related to the Mediterranean and the Balkans, and linked data from Sisfrance. INGV-MI also promoted and funded historical investigation in the Balkans.

The inventory of the available basic material was completed up to 1750 (D6). Events were divided into (rough) energy classes: very large, large, medium, small, very small, fake and probably fake. The electronic archive of earthquake studies, demo version (D2), was implemented and completed for the time window 1000-1600, with reference to the events from very large to medium, including some small, too. The content and the software was presented in a meeting of the GEM project and appreciated by the participants. The European Macroseismic Database (EMD) (D7) was implemented – building on D4 – with the data of the time-window 1601-1700 (partly) and the XXth century events used for the calibration initiative. The EMD online mapping software is undergone a substantial code revision and it is currently under beta testing by the NA4 partners. By using a friendly user interface it is possible to create a whole website with tables and interactive maps starting from an earthquake list and the corresponding intensity data. The website can be published straight away; it doesn't require any web security measure nor a powerful web server.

### **Compiling the European earthquake catalogue**

The European earthquake catalogue, demo version, 1000-1600 (D5) has been compiled according to the following steps. For each event included in the inventory (D1), the preferred dataset was selected. Then: i) if the dataset consists of Macroseismic Data Points (MDP) (64%), the parameters were derived with the three methods described above and the three solutions made available; ii) if the dataset consists of a report (21%), as a preliminary step the reliability of the current parameters was checked against the content of the report; iii) if no dataset is available (15%), no other solution was provided, yet. In many cases a comment was added for making the understanding easier. The historical research allowed an assessment that about 30 events are to be considered fake or very doubtful. The demo version, portion North of 45°, was compared with the recently published CENEC catalogue by Gruenthal et al., 2009; the differences were evidenced and explained.

As for the events with MDPs, the parameters were determined making use of the results of the calibration initiative described above, applying them to the historical data (1000-1600) put together within D4. To insure data and processing to be homogeneous, input data were homogenised by INGV-MI according to the standards agreed within D4. The first run of the codes was then also performed by INGV-MI and the results discussed with the relevant partner. As the application of the methods is not straightforward, in many cases more iterations were needed. The results were made available, once again, through a dedicated, restricted website, commented and compared with the so called "current, available parameters", that are, the corresponding parameters as available from the current national catalogues. In short, the results show ups and downs and need further negotiation. One of the main problem is that in this time-window only few MDPs are available per earthquake; another problem comes from the presumed, offshore events, which are badly constrained by few MDPs.

### **Deviations from the work plan**

The work required after the revision of the Workplan, and performed thereafter accordingly, was huge. Part of it exceeded the allotted manpower. As the manpower left after the two first years was limited, it required additional manpower from INGV-MI. The earthquake in Central Italy (April, 2009) also required manpower in a phase where NA4 results were being put together. The only deviation is that D6 covers the time window 1601-1750 instead of 1800; on the other hand, D5 part 1 represent an additional deliverable. In a similar way, D7 contains much more data (1601-1750,  $M \geq 5$ ) with respect to the forecast; on the other hand, it contains the 1901-on data used for the calibration initiative, which is slightly different – although in addition - with respect to the forecast. It also contains an advanced version of the intensity web mapping tool software.

**Milestones and Deliverables**

No	Deliverable/Milestone Name	WP /Task No	Lead Contractor(s)	Planned (in months)	Achieved (in months)	Nature
M2	Electronic archive of earthquake studies, demo version. Modification planned, see NA4-D2.	4	INGV/BGS	36	36	Report D2
M5	European intensity database, demo version, 1000 to 1600 M>5.5	1	INGV	-	36	Report D4
M6	European earthquake catalogue, demo version, 1000 to 1600	4	INGV	-	36	Report D5
M7	Inventory of the available basic material, 1601 to 1800	1	INGV	30	36	Report D6 <sup>1)</sup>
D2	Electronic archive of earthquake studies, demo version	1	INGV	36	36	database
<a href="http://emidius.mi.ingv.it/neries_NA4/">http://emidius.mi.ingv.it/neries_NA4/</a>						
D5	Part 1. The NA4 calibration initiative results Part. 2 European Earthquake catalogue, demo version, 1000-1600	4	INGV-BGS	30	36	report/ database
D6	Inventory of the available basic material, 1601-1750 <sup>1)</sup>	1	INGV	30	36	Database, report
D7	Part 1. European intensity database, 1601-1750, and 1901 to 1963, M>5.8 (part, see remarks in text) Part 2. Improved intensity web mapping tool	2-3	INGV	36	36	database/ software, report

<sup>1)</sup> Note deviation in working plan for D6

**Workshops and Meetings**

Date	Title/subject of meeting /workshop	Location	Number of attendees	Comments
08.09.06	NA4 business meeting	Crete	6	
08.11.05	BGS-INGV	Edinburgh	2	
08.11.12	ITSAK-INGV	Thessaloniki	3	
08.11.05-08	IGC-INGV	Barcelona	4	
08.12.03-04	NA4 workshop on earthquake parameters determination from macroseismic datapoints	Milan	20	
09.01.19-20	ETHZ-INGV	Zürich	3	
09.01.27-30	ARSO-INGV	Ljubljana	2	
09.03.11	SISFRANCE-INGV	Paris	10	
09.05.19-20	ITSAK-INGV	Thessaloniki	2	
09.05.27-28	Univ.Lisbon-INGV	Lisbon	2	