



MIDOP: Macroseismic Intensity Data Online Publisher

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Abstract

Within the Networking Activity 4 (NA4) "Distributed Archive of Historical Earthquake Data" of the EU NERIES project, a massive quantity of macroseismic data related to earthquakes of the past centuries is being published online. The NA4 working team is composed of many researchers coming from five European National Institutions. The retrieved data range from year 1000 to year 1900 and cover all of Europe. The presented tool "MIDOP" is being specifically developed for intuitive online publication of macroseismic maps of historical earthquakes.

Introduction

The main goal of the NA4 module "Distributed Archive or Historical Earthquake Data" of the EU NERIES project is to establish and implement an Archive of Historical Earthquake Data (AHEAD), with special reference to the supporting data, to be used to compile a homogeneous European Parametric Earthquake Catalogue. This task is being accomplished by searching, retrieving, evaluating and making available the macroseismic datasets on European and Mediterranean earthquakes occurred in the time-span 1000-1900.

The most important supporting material is the "historical earthquake study", used by researchers to publish a comprehensive reports with all the information regarding a specific earthquake. Among the retrieved information, a study presents the "macroseismic intensity data" which describe the level of damage expressed using a Macroscopic Scale (e.g. the EMS98 [Grünthal et al., 1998]) caused by an earthquake in a set of places. Usually these data come in form of tables or as maps printed on paper; only rarely data are available in digital form.

Among other tasks, the NA4 working team is dedicated to make available online these intensity data by publishing interactive maps.

Until now no dedicated software for online map publishing existed and general purpose solutions had been adopted. However a macroseismic map requires a series of additional information such as explanation on the sources used, detailed places information and representation of the level of damage using special symbols. These requirements are of difficult implementation using out-of-the-box tools, because they result in extremely time-consuming and hard to do customization, as well as manual operations. These are tasks that NA4 working team could not afford.

Previous experience in historical macroseismic maps publishing systems available in Europe have been considered: the Italian DBMI04 [Stucchi et al., 2007], the Swiss ECOS [ECOS, 2002] and the French SisFrance [Sisfrance, 2009] databases.

In the end, the best fitting solution to NA4 scopes was identified as the mapping solution adopted by DBMI04 (Fig.1), internally developed at INGV in Milano [Locati and Cassera, 2008]. But a straightforward adoption of the DBMI04 solution was not possible because of the complete lack of a friendly GUI and the tightly Italian-oriented code.

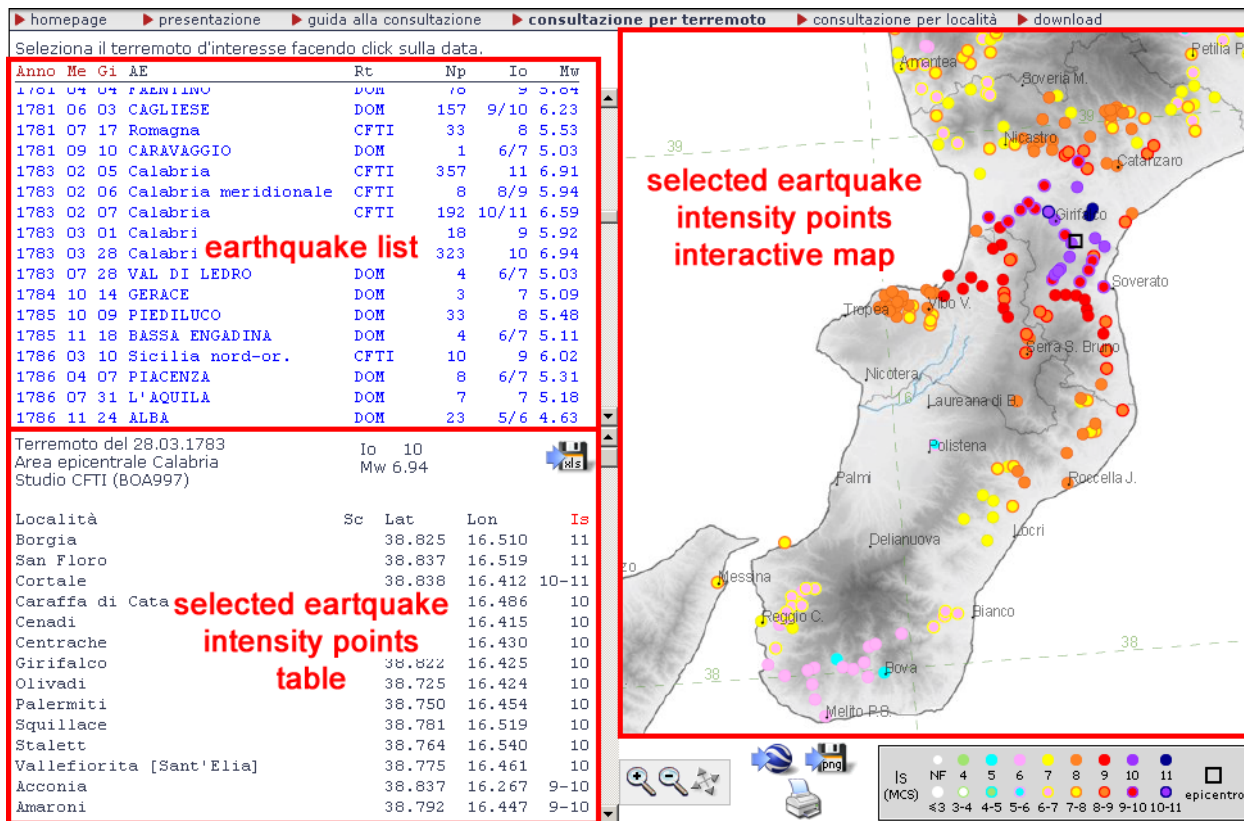


Figure 1. DBMI04 website structure: query by earthquake.

An improvement was required, and the working team decided to create MIDOP, a specific tool strongly inspired by the DBMI software, but allowing web-inexperienced researchers to easily transform unappealing tables into deeply customized interactive maps. SVG is being chosen as a method of serving maps as it natively offers a DOM (Document Object Model) coherent way of manipulating represented elements, resulting in an easy-to-implement development process.

Profile of a typical user

Profiling the final user [Hung et al., 2003] is of fundamental importance in order to better optimize the developing workflow and helps avoiding last minute core changes.

The typical user of MIDOP is historical seismologist. As it generally happens within the scientific community, the seismologist feels comfortable while using online resources through web browsers, resulting in confidence while doing web searches, consulting archives and compiling forms. Seismologists are completely unaware of the technical issues involved in online publication. They usually have no experience and only few exceptions know the first principles of HTML or others macro-languages, nearly none of them have experience in online security issues. Seismologists are confident with word processors, spreadsheets and the use of GIS softwares in order to create maps; some have knowledge of programming language, commonly FORTRAN.

Historical seismologist experts are a small niche in the seismological community. Generally, modern seismology uses data coming from instrumental recording, which born digital. Historical seismology is focused on written evidence and human observations of the earthquake phenomenon in the past centuries.

IT people should be aware that the different origin of the data makes a substantial difference to the data approach adopted by researchers, a difference that must be taken into account while designing a technological product.

Required functionalities

Before implementing the tool, a series of requirements have been filed by listening first to involved researchers and then to the IT people of the different research Institutions.

The tool addresses a series of tasks:

- it manages a parametric catalogue of earthquakes;
- for each earthquake it creates:
 - a table listing the affected places and their macroseismic intensity;
 - o an interactive map of the macroseismic intensity points;
- for every place mentioned it creates:
 - the list of earthquakes and the relative level of damage experienced;
 - a diagram representing the level of damage experienced at the place for each earthquake.

The features most requested by seismologists are:

- use of already existing standards in terms of input data table formats and content;
- effortless online publication of the material, reducing as much as possible the problems while transferring material to IT staff;
- interactive maps, featuring zoom, pan and search trough the represented places;
- use of a long standing and open technology, avoiding possible technology bottleneck or solutions that might disappear in the years to come;
- possibility to interactively add points on already published maps;
- export of the published material both to printer and to downloadable files such as XLS (Microsoft Excel spreadsheet files);
- easy-to-understand graphical user interface, using as much as possible seismological terms;
- complete coding-free approach;
- graphical customization, both of the geographical features and symbols used.

Features requested by the IT people are:

- safety measures against probable online attacks;
- lightweight, a solution that can be implemented in a small footprint server;
- comfortable way of transferring the produced material from the researchers to the final web server.

Adopted solution

A completely coding-free approach has been adopted.

By using a comprehensive control panel based on a user friendly web interface, researchers will be able to create on their development workstation a website from scratch. Once the website has been created, its publication on the web is as easy as dragging a folder to the final web server.

Everything is realized using open source solutions:

- PHP scripting language and MySQL as a Database Management System for the server side;
- HTML, SVG and JavaScript for the client side part.

As input data, MIDOP requires two tables:

- the earthquake list, with origin time, epicentral area, historical study references and epicenters (if available);
- the macroseismic intensity distribution for each earthquake, with georeferenced places [Hill, 2006] and the level of damage;

The MIDOP itself is subdivided in four main parts:

1. the websites manager;
2. the selected website settings control panel;
3. the publication tool;
4. the real-time website preview.

MIDOP can manage multiple websites (Fig.2), each with its customized settings. The switch between websites is done easily via a dedicated control panel.

► site vars settings

selected	title	directory name	description	date	remove
<input type="radio"/>	default	vars_default	built-in default website	last modified August 24 2009 06:45 created April 3 2009 12:52	<input type="button" value="remove"/>
<input type="radio"/>	NA4 validation	vars_na4_validation	website dedicated to the NA4 validation process of the calibration initiative	last modified August 24 2009 06:45 created April 5 2009 20:54	<input type="button" value="remove"/>
<input type="radio"/>	NA4 calibration	vars_na4_calibrator	website dedicated to the NA4 calibration initiative	last modified August 24 2009 06:45 created May 5 2009 10:53	<input type="button" value="remove"/>
<input checked="" type="radio"/>	NA4 EMD	vars_na4_emd	European Macroseismic Database website - Preliminary	last modified August 24 2009 06:45 created May 14 2009 17:43	<input type="button" value="remove"/>

Figure 2. MIDOP: websites manager.

The following aspect can be customized for every website:

- the MySQL server (Fig.3), specifying where MIDOP will take data from. It is possible to use a remote MySQL server, if permitted by the server policy. This solution will let the working group better calibrate the workflow;

DB access | Structure | EQ list | EQ map | MDP map | EQ info | MDP list | Query by place | Publish!

FLUSH CACHED FILES | SAVE SETTINGS

MySql access parameters

host name*	localhost
user name*	root
password*	
database*	neries

MySql selected database tables

earthquake list (catalog)*	emd_eq_catalogue
Macroseismic Data Points (MDP) table*	emd_mdp_database
earthquake studies table	na4_references
reference places on map	ref_places

Edit source code

this page vars

* required field

Figure 3. MIDOP control panel: MySQL parameters.

- the frameset structure (Fig.4);
- the language (Fig.4), at the moment only English, Italian and Spanish are built-in; unsupported languages might be supported by adding a translated text file;

Website structure

absolute site url	http://emidius.mi.ingv.it/neries_NA4/EMD
navigation bar	<input checked="" type="checkbox"/>
query by earthquake	<input checked="" type="checkbox"/>
query by place	<input checked="" type="checkbox"/>

HTML frame structure

left frame width*	495	px
upper left frame height*	35	%
middle left frame height*	150	px
lower left frame height*	35	%

Site language

default language	english
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Figure 4. MIDOP control panel: frames and language settings.

- every parameter used from input tables might have a custom field name: MIDOP will "abstract" its content by using internal field variable names (e.g. the MIDOP concept of "epicentral area" might be attached to any field name, Fig.5);

Earthquake parameters

<i>i</i> EQ unique identifier*	EQid_archive	▼
year	web_Year	▼
month	web_Mo	▼
<i>i</i> date*	day	web_Da
	hour	web_Ho
	minutes	web_Mi
	seconds	web_Se
<i>i</i> epicentral area	web_Ax	▼
<i>i</i> epicentral area shortened	web_Ax	▼
<i>i</i> study unique identifier*	Rcode	▼
<i>i</i> study short citation	Study	▼

Figure 5. MIDOP control panel: earthquake settings.

- the bibliographical information (Fig.6) describing used historical earthquake studies;

Earthquake studies

i show in popup

<i>i</i> study unique identifier*	code	▼	<input checked="" type="radio"/> yes	<input type="radio"/> no
<i>i</i> short citation	short	▼	<input checked="" type="radio"/> yes	<input type="radio"/> no
<i>i</i> complete citation	citation_english	▼	<input checked="" type="radio"/> yes	<input type="radio"/> no
<i>i</i> external link	link	▼	<input checked="" type="radio"/> yes	<input type="radio"/> no
<i>i</i> image link		▼	<input type="radio"/> yes	<input checked="" type="radio"/> no
<i>i</i> whole root pdf link		▼	<input type="radio"/> yes	<input checked="" type="radio"/> no
<i>i</i> year of publication		▼	<input type="radio"/> yes	<input checked="" type="radio"/> no
<i>i</i> authors		▼	<input type="radio"/> yes	<input checked="" type="radio"/> no

Figure 6. MIDOP control panel: bibliographical settings.

- the plotted epicenter (Fig.7) might be selected from a set of predefined symbols; new symbols can be created simply customizing a text file containing basic SVG objects. Multiple epicenters can be created;

► Earthquake epicentres

Epicentre 1

label	Instr.
source	Inst_Source
method	
latitude	Inst_lat
longitude	Inst_lon
intensity	
intensity (numerical value)	
magnitude	Inst_M
magnitude (numerical value)	Inst_M
magnitude error	Inst_DM
type of magnitude	
magnitude source	
symbols	★ StarBlack <input type="button" value="edit"/>
box	
box colour	#FFFFFF <input type="button" value="edit"/>
preferred epicenter source	

Figure 7. MIDOP control panel: epicenters settings.

- table columns content and headers labels (Fig.8);

► Earthquake list table columns definition

	columns title	columns content	chars	align	link	sort	sorting rules
1st	Year Mo Da Ho Mi Se	date	20	L	<input checked="" type="radio"/>	<input checked="" type="radio"/>	earthquake list (catalog): web_Date A->Z <input type="button" value="add a sort rule"/>
2nd	Epicentral area	epicentral area	24	L	<input type="radio"/>	<input type="radio"/>	earthquake list (catalog): web_Ax A->Z <input type="button" value="add a sort rule"/> earthquake list (catalog): web_Date A->Z <input type="button" value="remove"/>
3rd	MDPs	numbers of point	5	R	<input type="radio"/>	<input type="radio"/>	POINT: numbers of point Z->A <input type="button" value="add a sort rule"/> earthquake list (catalog): web_Date A->Z <input type="button" value="remove"/>
4th	lx	max intensity	5	L	<input type="radio"/>	<input type="radio"/>	POINT: max intensity Z->A <input type="button" value="add a sort rule"/> earthquake list (catalog): web_Date A->Z <input type="button" value="remove"/>
5th				L	<input type="radio"/>	<input type="radio"/>	
6th				L	<input type="radio"/>	<input type="radio"/>	
7th				L	<input type="radio"/>	<input type="radio"/>	
8th				L	<input type="radio"/>	<input type="radio"/>	
9th				L	<input type="radio"/>	<input type="radio"/>	
10th				L	<input type="radio"/>	<input type="radio"/>	

Figure 8. MIDOP control panel: earthquake list table settings.

- single or multiple groups of earthquakes (Fig.9) can be created automatically by specifying different time-spans;

Figure 9. MIDOP control panel: group of earthquake lists settings.

- the default zoom and framing (Fig.10), that can be fixed or automatically adapted to every earthquake damage area;

Figure 10. MIDOP control panel: view and framing settings.

- toggles for switching on or off (Fig.11):
 - the geographical grid;
 - the zoom and pan tool;
 - the graphical scale bar;
 - the printing tool;
 - the add custom markers tools for end users (markers are added via ECMA scripts on the client browser);
 - the export of html tables as spreadsheet files (e.g. MS Excel);
 - the export to Google Earths KML based files;

- the inclusion of a pre-generated flatshaded or hillshaded DEM (Digital Elevation Model);
- the automatic generation of place seismic histories, where the list of earthquakes occurred in a place is presented both as a table and as an interactive diagram.

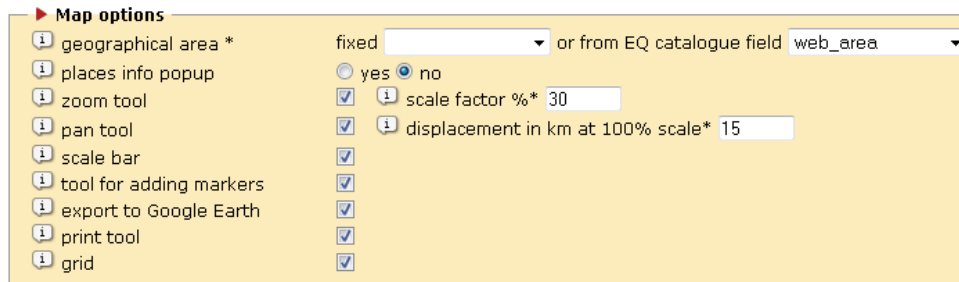


Figure 11. MIDOP control panel: available map tools.

- the list of showed geographical layers (Fig.12);

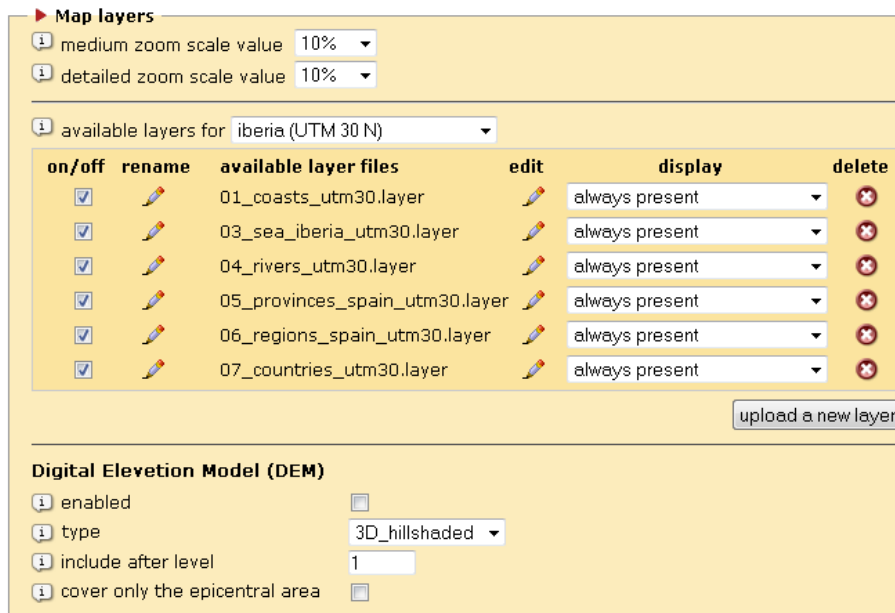


Figure 12. MIDOP control panel: geographical layers settings.

- the countries to be considered for the "query by place" functionality (Fig.13).

query by place settings

countries to be considered

<input checked="" type="checkbox"/>	AD (Andorra)	<input checked="" type="checkbox"/>	LU (Luxembourg)
<input checked="" type="checkbox"/>	AL (Albania)	<input type="checkbox"/>	MA (Morocco)
<input checked="" type="checkbox"/>	AT (Austria)	<input checked="" type="checkbox"/>	MC (Monaco)
<input checked="" type="checkbox"/>	BE (Belgium)	<input checked="" type="checkbox"/>	ME (Montenegro)
<input checked="" type="checkbox"/>	BG (Bulgaria)	<input checked="" type="checkbox"/>	MK (Macedonia)
<input checked="" type="checkbox"/>	CH (Switzerland)	<input checked="" type="checkbox"/>	MT (Malta)
<input type="checkbox"/>	CY (Cyprus)	<input checked="" type="checkbox"/>	NL (Netherlands)
<input checked="" type="checkbox"/>	CZ (Czech Republic)	<input checked="" type="checkbox"/>	PL (Poland)
<input checked="" type="checkbox"/>	DE (Germany)	<input checked="" type="checkbox"/>	PT (Portugal)
<input type="checkbox"/>	EG (Egypt)	<input checked="" type="checkbox"/>	RO (Romania)
<input checked="" type="checkbox"/>	ES (Spain)	<input checked="" type="checkbox"/>	RS (Serbia)
<input checked="" type="checkbox"/>	FR (France)	<input type="checkbox"/>	RU (Russian Federation)
<input type="checkbox"/>	GG (Guernsey)	<input checked="" type="checkbox"/>	SI (Slovenia)
<input checked="" type="checkbox"/>	GR (Greece)	<input checked="" type="checkbox"/>	SK (Slovakia)
<input checked="" type="checkbox"/>	HR (Croatia)	<input checked="" type="checkbox"/>	SM (San Marino)
<input checked="" type="checkbox"/>	HU (Hungary)	<input type="checkbox"/>	SY (Syrian Arab Republic)
<input type="checkbox"/>	IL (Israel)	<input type="checkbox"/>	TN (Tunisia)
<input checked="" type="checkbox"/>	IT (Italy)	<input type="checkbox"/>	TR (Turkey)
<input checked="" type="checkbox"/>	JE (Jersey)	<input type="checkbox"/>	UA (Ukraine)
<input type="checkbox"/>	JO (Jordan)	<input checked="" type="checkbox"/>	UK (United Kingdom)
<input checked="" type="checkbox"/>	LI (Liechtenstein)		

number of earthquake for seismic history creation*

enable the seismic history table download

seismic history diagram

minimum intensity value represented in the seismic history diagram *

seismic history diagram X axis years steps *

place position map

fixed distance of view extension

show a map with the place position

symbol radius


symbol color 

Figure 13. MIDOP control panel: geographical layers settings.

Technically the MIDOP mapping system is logically quite simple and the workflow is as following:

- the user select an earthquake from the catalogue;
- the corresponding list of macroseismic intensity points are queried from the specified MySQL server;
- based on the control panel settings, the system decides the geographical area to be covered (by using a fixed or a dynamic method);
- loads the selected geographical pre-generated SVG layers, with administrative boundaries, rivers and lakes;
- if requested, includes within the SVG the raster DEM layer using a base64 method;
- creates a GZIP compressed text file layering the selected earthquake geographical parts.

At the end of the process MIDOP generates a SVG map file (Fig.14) for every earthquake, and wrap everything up, using a series of highly customized HTML pages that can interact with the SVG DOM structure using JavaScript. Generated maps can be exported to Google Earth by generating KML files (Fig.15).

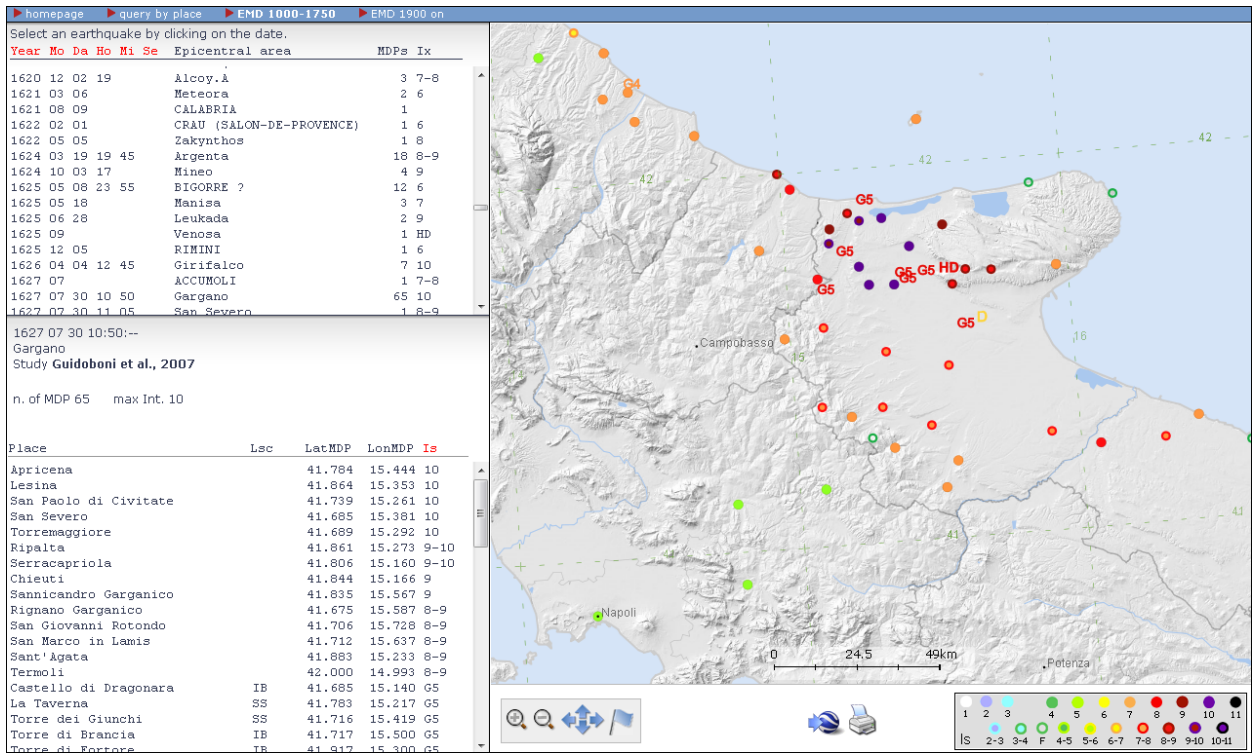


Figure 14. MIDOP output example: query by earthquake.

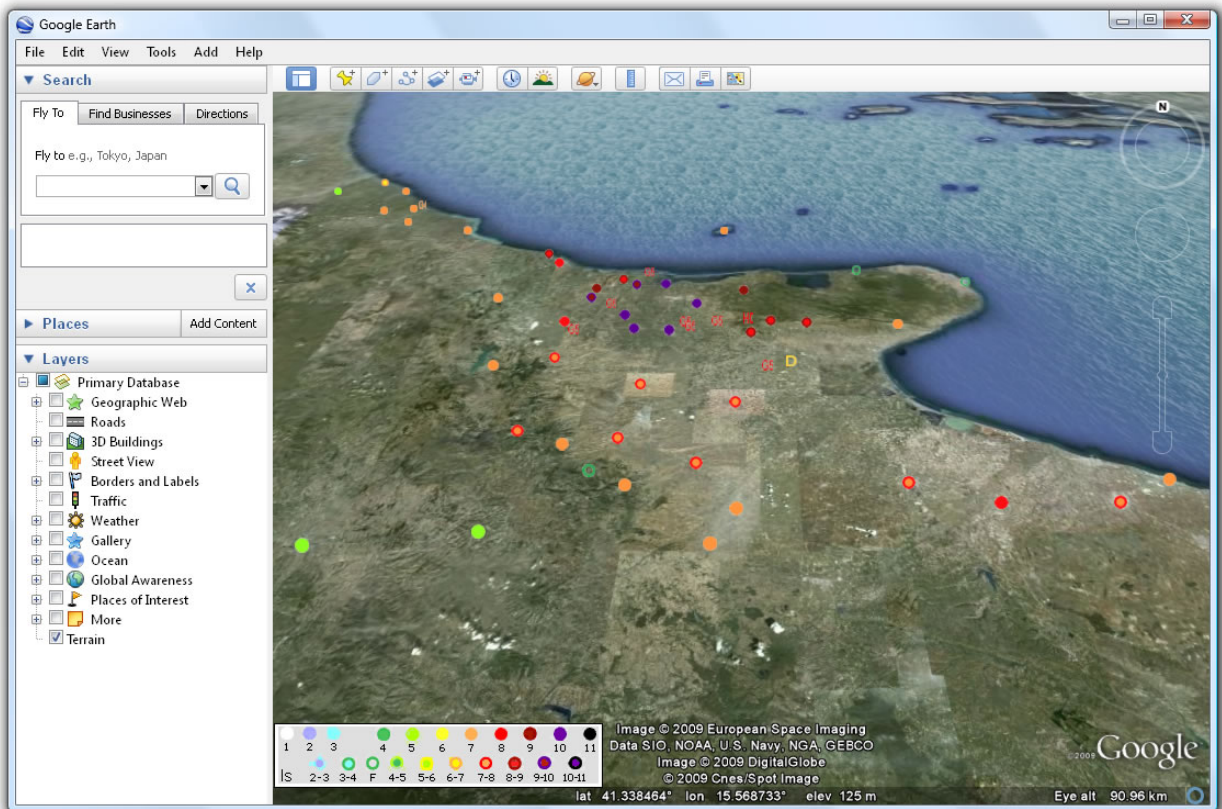


Figure 15. MIDOP output example: earthquake export to Google Earth.

If enabled in the control panel, MIDOP also generates a series of HTML and SVG files for the "query by place" functionality (Fig.16), where is showed the list of felt earthquakes in the selected place.

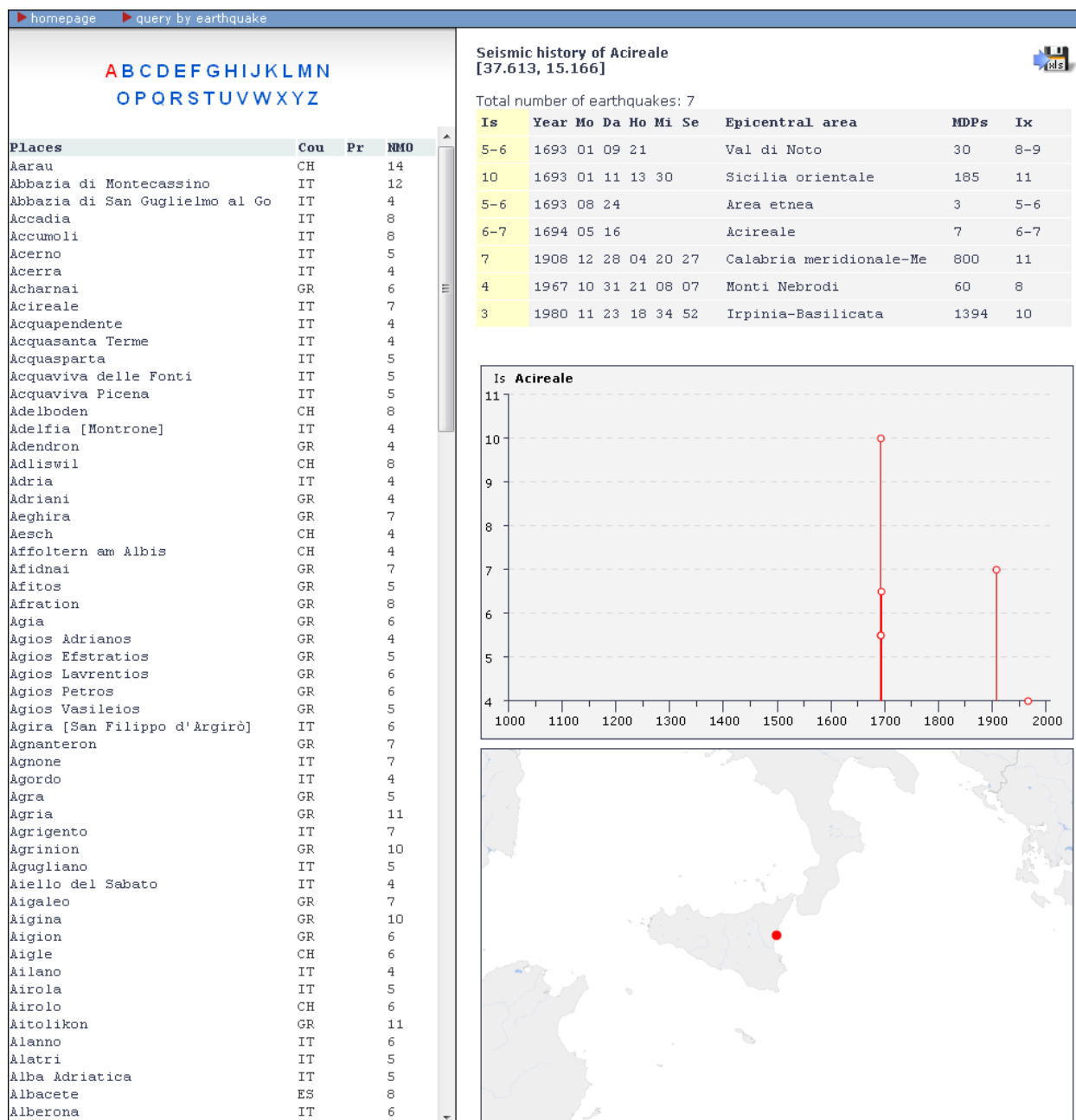


Figure 16. MIDOP output example: query by place.

Once the user is satisfied by what MIDOP is showing in the preview mode, the entire website can be created using a dedicated control panel (Fig.17). The generated website will be a self-contained folder with everything is needed in order to publish it on the Internet.

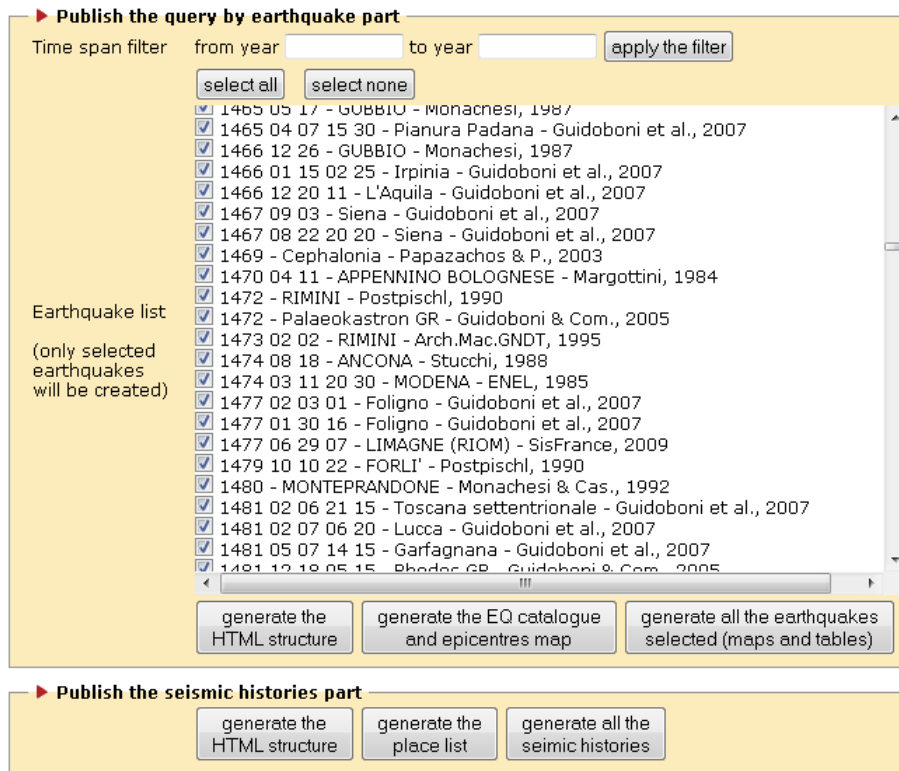


Figure 17. MIDOP control panel: final website publication.

Published website will contain also two XML files, not directly used by the system itself:

- an XML file containing the entire catalogue of earthquake published;
- an XML file with all the macroseismic intensity observations for every earthquake.

These files might be useful for a series of activities, from simple machine readable backup, to remote querying future systems.

The drawback of such an approach is that users are allowed to generate maps only for areas covered by MIDOP. To overcome this issue, the system is designed with customization in mind and users will be able to add new layers uploading their own layers.

The concept of "layer" in MIDOP indicates plain text files containing SVG groups ("g" elements). This virtually puts no limitation to what MIDOP can represent.

SVG geographical layers are at the moment coming from simply offline conversion of ESRI shapefiles (.shp) using the freely available "shp2svg" utility [Neumann, 2007].

It is currently under finalization a tool for direct upload and conversion of shapefiles, making the publishing workflow much easier.

So far the only real geographical limitation in MIDOP is that it is only able to produce data using UTM zones.

Built-in geographical layers cover at the moment the whole Europe.

The choice of the final creation of a "passive" website folder that does not require any interaction with a database backend or complex server side interaction, was made for satisfying the following requirement:

- simplicity when transferring material to IT people who are practically taking care of the web server part;
- IT request for a secure product;
- use of a long lasting solution, which will be able in years to come.

Each of the above mentioned requests, brought us a completely self-sustained solution. More than others, the last one forced us to avoid the adoption of external resources such as Google Maps: who knows what it will happen to it in fifteen years from now?

Man power resources dedicated to historical seismology will not guarantee a constant update of already published material, which might result in possibly unreadable content in the future.

Another advantage of this solution is the extremely low web server requirement in terms of hardware, software and bandwidth, enlarging enormously the potential user base.

User's feedback

A period of beta testing is currently underway in order to fix major bugs and obtain direct feedback from potential users.

Three institutions have been involved until now: the INGV in Milan, where the NA4 module is coordinated, the Institut Geologic de Catalunya (IGC) in Barcelona and the Faculty of Science of the University of Lisbon (FCUL).

All tests have been done using historical data (prior to 1900) in order to both debug the application and publish online some earthquake studies previously available on paper only.

So far the beta testing period has been quite fruitful: various bugs have been discovered and solved, some GUI part is being made clearer and some functionality added.

The most important change adopted is the possibility of specifying at which zoom each level layers must be shown or hidden. For example it is now possible to have a complete view of an entire country with only the first level of administrative boundaries, hiding the second and third, resulting in a much clearer and effective map visualization.

Conclusions and future development

The scope of the NERIES NA4 module is to create a distributed Archive of Historical Earthquake Data.

Such a networking activity will require a networking capability extension to what MIDOP is able to do at the moment.

This will be reached by an extensive use of the "hidden" XML file produced while publishing the website. These files might be used by a yet to be designed solution that will let the different MIDOP website already published to communicate among each other, and above all, will let the central unit to coordinate the regional data centers.

From the client user point-of-view, more tools can be created for real-time manipulation of the consulted map. Among others, a sort of geographical layer upload system is under evaluation. This solution will make life easier for users while studying already published earthquakes, since it will not be any more necessary to download intensity points and use unfriendly offline GIS "heavy monsters".

Another possible extension to MIDOP is to better exploit the superior graphical quality of SVG maps produced, possibly leading to a direct use of these maps in scientific documentation.

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