Centre Sismologique Euro-Méditerranéen
European-Mediterranean Seismological Centre

Newsletter

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EDITORIAL

The EMSC/ORFEUS joint co-ordinating committee met in Thessalonki in March, with the main item on the agenda to explore how our members, under the auspices of the ESC, could collaborate with the Europrobe deep seismic sounding community and Eurogeosurveys. The driver is the destruction caused by the Turkey and Greece earthquakes of last summer which highlighted the need for increased efforts across the spectrum of geoscientists, engineers, civil authorities and planners to combat the increasing number of natural disasters which we face. There is some analytical evidence that the Izmit earthquake was so unusual that the devastation cannot be entirely the result of poor construction. The outcome of our interactions in Thessaloniki is a plan to hold a broadly-based workshop on 3 - 4 November 2000 in Assisi to advance our thinking on the way forward and to engage the EU in facilitating relevant research towards practical advances and the mitigation of earthquake disasters in the wider European-Mediterranean region.

I anticipate that, in advance of that workshop, we will be able to review the position and pursue parallel initiatives during the ESC conference in Lisbon, 11 - 15 September. The planning of this meeting of our parent body is well advanced and I urge members to support the event to the full and to join us at our General Assembly which will take place during the meeting. Your support, your votes, your criticisms and visions for the future of EMSC are always welcome.

Chris Browitt
President

Seismic Stations in CIS Countries (SSCC): Internet Accessible Database

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The SSCC data base is a new telematics product that represents on Internet the seismological stations of the United System of Seismic Observations on the CIS territory. The data base describes locations and technical specifications of instruments.
This product serves as an example of modern Internet techniques for handling seismological databases application. Similar techniques can be used in development of data base in different kinds of environmental activities.
SSCC is the joint project of the European-Mediterranean Seismological Centre (EMSC) and the Centre of Geophysical Data Studies and Telematics Applications in Moscow which is a key-nodal member of EMSC.

International Background

Approximately 100 years ago the first seismological observatories began making timed recordings of ground motions. Since that time the number of stations has increased dramatically into the thousands, leading to the necessity to systematize them as well as to unify their observations.

In 1908 the international seismological centers started the publication of the stations lists. The catalogue of the Bureau Central de l'Association de Seismologie (BCIS),which included around 200 stations, was the first. Indeed, due to the increasing number of seismological stations such lists had to be often reviewed. The staff of the International Seismological Summary at Kew (ISS) under the International Association of Seismology published on a regular basis the updated lists of stations, operating around the world and transmitting the data to ISS. The stations are arranged by name in alphabetic order and their description contains the country of their location and their geographical coordinates (latitude, longitude, elevation). For example, the list ISS /1/, published in

1961, contained the description of 755 stations. Such data are extremely important for finding the parameters of the earthquake's epicenter and are used for different kinds of seismological research.

The beginning of the 60s marked dramatic changes in seismology: the analysis of seismological data, as well as the registration of seismological events, started to be based on computers methods. At the same time the Worldwide Standard Seismograph Network (WWSSN) was set - 120 stations with standard technical facilities were launched in 60 countries across the world. Both Canadian Network and the Unified System of Seismic Observations (USSO) of the USSR joined the WWSSN some time later. It allowed to expand the number of observations and raised considerably the accuracy of the epicenter coordinate determinations.

Simultaneously to the creation of WWSSN the three-letter codes for names of the seismological stations were introduced by the U.S. Coast and Geodetic Survey with the aim to simplify the treatment of seismological observations by computer programs. These codes were then used in the Preliminary Determination of Epicenters and the Earthquake Data Reports, published by the National Earthquake Information Center (NEIC) of the U.S. Geological Survey and in Seismological Bulletin of the International

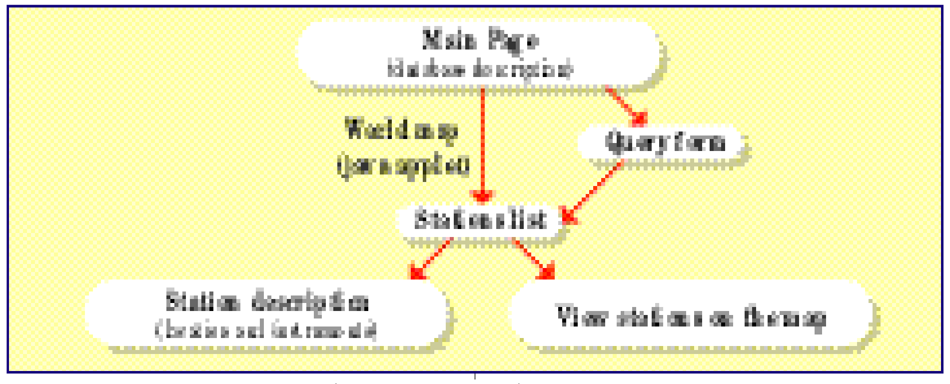


Figure 1: User operation structure

Seismological Centre (ISC) in the United Kingdom. Very soon the three-letter codes became used world-wide.

The list of all world seismological stations for which NEIC has assigned an international code, in cooperation with ISC are published on a regular basis by the NEIC, as well as by the ISC /2,3/.Such lists are permanently expanded with information about the new stations and are regularly corrected by introduction of more precise coordinates of stations, their network maintenance etc. Numerous stations are already closed, however the information about them is necessary for different seismological researches. The increasing number of stations actually led to the introduction of the four-symbol codes. Actually, the information about seismological stations is available on Internet /4/.

Up to 90s the territory of the Former Soviet Union was a "white spot" in this system as far as real locations and descriptions of seismic stations are concerned. The Internet accessible on-line data base presented in this paper is the first attempt to close this gap.

Initial Information

The Unified System of Seismic Observations (USSO) of the USSR was set up by the USSR Academy of Sciences in 1965. It included:

- the base stations with medium- and short-period instruments. The functions of the base stations were to record earthquakes having surface-wave magnitudes of $M \geq 4.0$ and to acquire data on world seismicity.
- the regional stations with short-period instruments and responsible for recording weak local and near earthquakes not recorded by base stations.

Since the creation of the USSO of the USSR and until the USSR's collapse the development of the Network had been based on construction of new stations, mostly the regional ones, in the zones of considerable seismic activity. While in 1965 the USSO included 71 stations, by 1990 their numbers grew up to 468 with 123 base stations and 345 regional ones.

The list of base stations Network of the USSO is updated on an annual basis and is published by the Geophysical Survey, Russian Academy of Science (RAS) in Obninsk.The list includes the names, codes, the stations coordinates, the list of equipment with their parameters and instrument amplitude and phase characteristics /5/.

The lists of the regional stations were published in the seismological bulletins, issued by different research centers in the USSR, responsible for such regional base stations /6,7/.

The single catalogue of all USSR seismic stations with their coordinates and detailed equipment description did not exist for numerous reasons. Only in 1963-1964 the department of the Seismic Service of the Institute of Physics of the Earth issued two

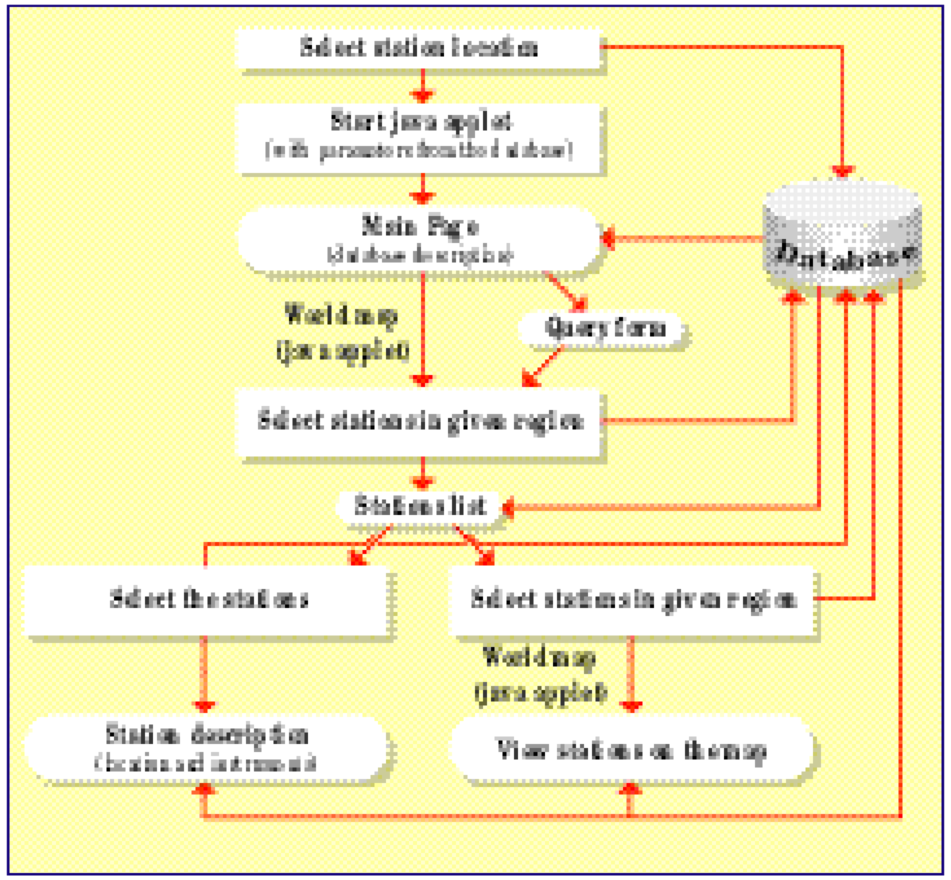


Figure 2 : Database access structure

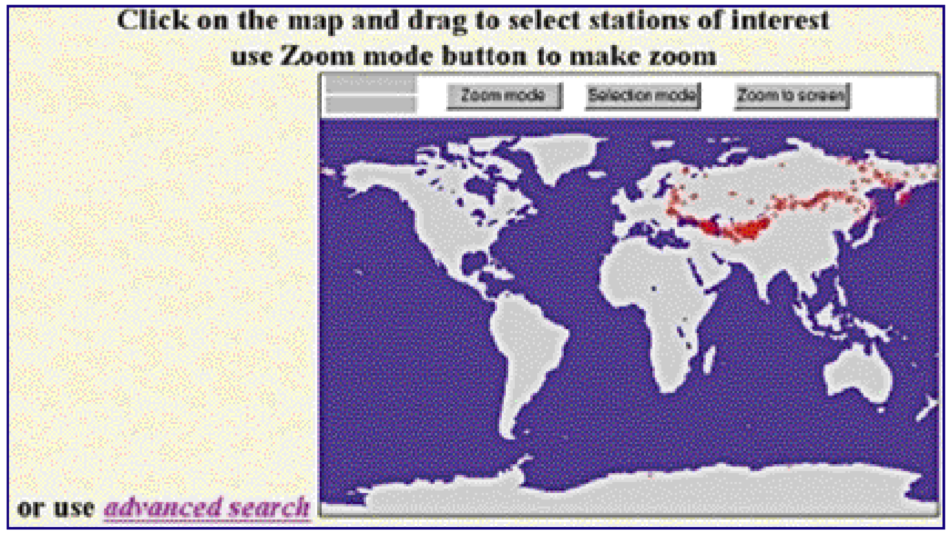


Figure 3: Dynamic map with all seismological stations of the Unified System of Seismic Observations.

books "The parameters and the frequency characteristics of USSR seismological stations' equipment". However, these publications were never updated or repeated.

The first significant publication - N.V.Kondorskaya, I.V.Fedorova " Seismic Stations of the Unified System of Seismic Observations in the USSR as of 01.01.1990" /8/ - appeared after the USSR's collapse. It contains descriptions of the seismological stations of the USSO in the former USSR as of January 1, 1990. The considerable advantage of this publication is that for a number of stations the accuracy of coordinates to 0.001 degree and their elevations above the sea level with the accuracy of 1 meter are published for the first time.

The seismological stations in the catalogue are grouped in the following regions: the Carpathians, Crimea, Caucasus, Kopetdag, Central Asia and Kazakhstan, Altai and Sayan, Baylkal, Amur, Sakhalin, Kuril-Okhotsk, Kamchatka and Komandorsky Islands, North-East, Yakutia, Arctic and Antarktic, Baltic Shield , European part of the USSR, Ural. The stations are arranged in alphabetic order for each of these regions. The information about each station contains the station name, the USSR code (if such exists), the station type (base or regional), the year of launching, the coordinates - latitude, longitude, elevation, the details about the equipment such as its type, recorded components, maximum magnification, maximum period and the information about the institutional affiliation of the station.

SSCC on-line Data base

In 1998 the Centre of Geophysical Data Studies and Telematics Applications RAS and World Data Center B for Solid Earth Physics, Geophysical Center RAS took an initiative to approach EMSC with the project proposal to launch the data base on Seismic Stations in CIS Countries (SSCC) accessible on Internet. Having received positive evaluation the project has been funded by EMSC. In the end of 1998 the project was completed.

As the first step the data from the publication /8/ were transformed into computer form. Then these computer data were verified and expanded by introducing the international codes of the stations (if available). The codes of the stations were put in correspondence to the list of the International Seismological Centre /3/.

The elaboration of the SSCC on-line data base, using the verified and collected stations information, came as an extension of the already existed Strong Motion Data Base (SMDB) /9, 10/. SMDB is one of the major elements of EMSC activities and CGDS in Moscow is responsible for SMDB maintenance and development, as EMSC key-nodal member.

The SSCC data base was made accessible on Internet using Java technology at the address:
http://socrates.wdcb.rssi.ru/SSCC/

The data base is located on Windows NT platform under standard NT web server (Internet Information Server). Microsoft jet is used as Data base Management System (DBMS). Data base is maintained using MSAccess 95/97 from local host.

The structure of the WWW interface for this data base is represented on two diagrams. The first diagram is a simple WWW interface description from user point of view (Figure 1). On the second one you can see the interrelation of the data base operations and the user WWW interface (Figure 2).

The created module includes the dynamic map (Figure 3), which shows the location of all seismological stations of the USSO. Selecting the part of the map by zoom window, the user finds the enlarged picture of the selected territory with its stations, enumerated in the table, which also contains all details about the station location (Figure 4) and the next table for each station with equipment and timing of its activity (Figure 5)

The Internet users could also find the needed information about the stations, filling out the query form (Figure 6) and defining the criteria for the search: the name of the station, the region and the country of location, the coordinates, the type of instruments, the time of the station creation etc. To check the English spelling of the station's, region's or country's name the user could address the table of correspondences. Both query form and Java scripts pass the user query to a server script, which makes a request to the database and creates HTML page to be sent to client browser. So a user can receive station list (Figure 4). The stations can be seen on the map. One station can be selected to get its detailed description and instruments (Figure 5).

Initially based on the publication /8/, the data base was considerably enlarged by the information about actually closed seismological stations and updated by

[Main page] [Query form]

View map

Station name	Region	Country	Start date	Latitude	Longitude	Elevation
Brest	Baltic Shield, West Russia, Ural	Belarus	1989001	52.533	23.733	0.17
Gomel	Baltic Shield, West Russia, Ural	Belarus	1989001	52.6	31.08	0.132
Minsk	Baltic Shield, West Russia, Ural	Belarus	1965001	54.5	27.833	0.198
Moskow	Baltic Shield, West Russia, Ural	Russia	1936001	55.738	37.625	0.124
Naroch	Baltic Shield, West Russia, Ural	Belarus	1972001	54.9	26.7	0.189
Obninsk	Baltic Shield, West Russia, Ural	Russia	1967001	55.115	36.568	0.13
Pulkovo	Baltic Shield, West Russia, Ural	Russia	1906001	59.773	30.324	0.065
Riga	Baltic Shield, West Russia, Ural	Latvia	1973001	56.783	24.45	
Soligorsk	Baltic Shield, West Russia, Ural	Russia	1980001	52.85	27.466	-0.443
Suginchay	Baltic Shield, West Russia, Ural	Lithuania	1988001	54.3	25.586	
Tallinn	Baltic Shield, West Russia, Ural	Estonia	1989001	59.416	24.75	
Tartu	Baltic Shield, West Russia, Ural	Estonia	1987001	58.383	26.716	

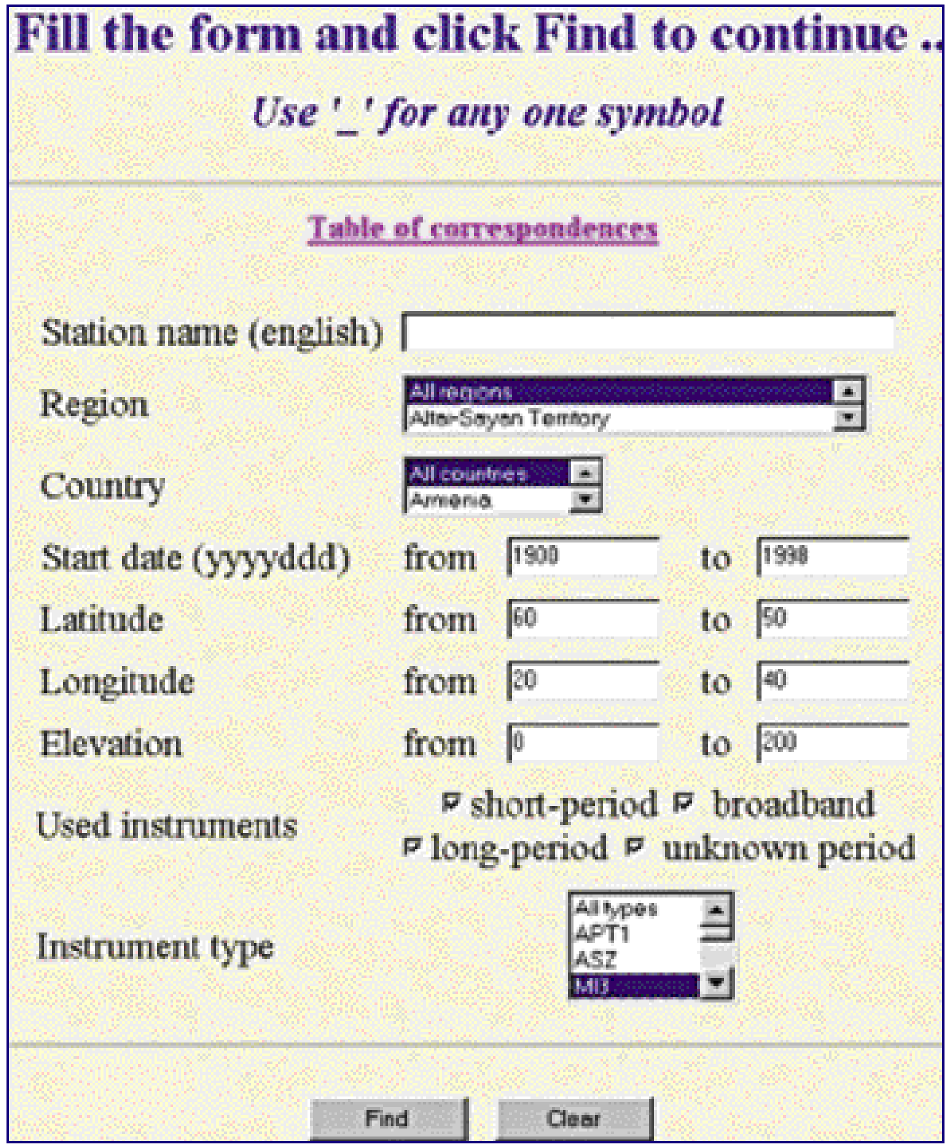
Figure 4: Table of the station locations

introducing the additional stations outside the USSO network. These additional stations allow to obtain seismic data on the investigation of regional seismicity in areas where there are few or no seismological stations, on the investigations of seismicity in and near cities where strong or destructive earthquakes have occurred. Since these stations were incorporated into the data base, the total number of stations has increased from 465 to 531. The parameters for these additional stations were collected from different sources and were put in correspondence with the list of the International Seismological Center /3/. However, the details about their equipment are still unavailable.

Acknowledgements

The authors have an honour and pleasure to acknowledge an important contribution the EMSC, that provided funding for the SSCC data base and EMSC Secretary General Dr. Florence Riviere that did a number of important comments at the time of the project development.

The authors also greatly appreciated the contribution of Prof. Nadezhda Kondorskaya, former head of the USSO in the USSR.



Fill the form and click Find to continue ..

Use '_' for any one symbol

Table of correspondences

Station name (english)				
Region	All regions / Altai-Sayan Territory			
Country	All countries / Armenia			
Start date (yyyyddd)	from	1900	to	1998
Latitude	from	60	to	50
Longitude	from	20	to	40
Elevation	from	0	to	200
Used instruments	short-period, broadband, long-period, unknown period			
Instrument type	All types / APT1 / ASZ / MB			

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Figure 6: Query form

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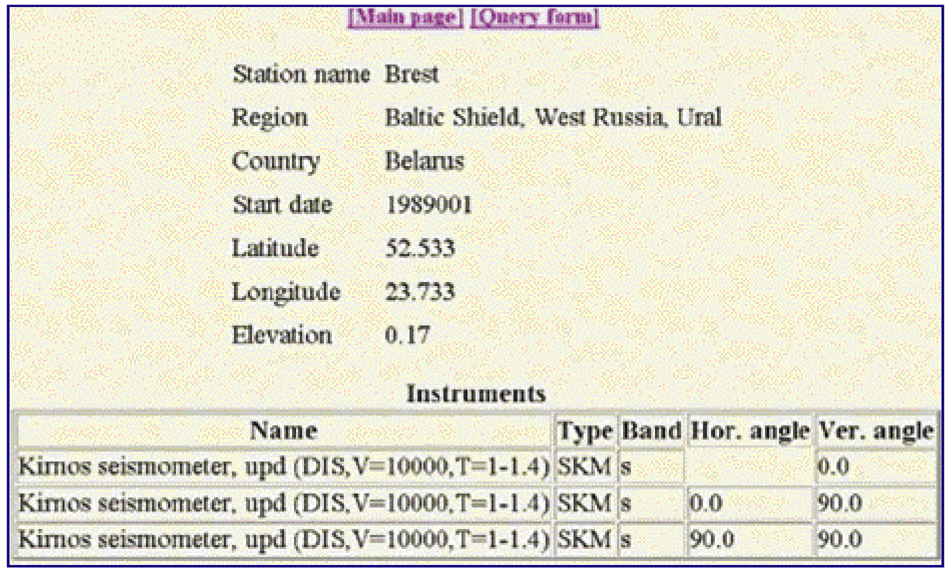

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Station name	Brest
Region	Baltic Shield, West Russia, Ural
Country	Belarus
Start date	1989001
Latitude	52.533
Longitude	23.733
Elevation	0.17

Instruments

Name	Type	Band	Hor. angle	Ver. angle
Kirnos seismometer, upd (DIS,V=10000,T=1-1.4)	SKM	s		0.0
Kirnos seismometer, upd (DIS,V=10000,T=1-1.4)	SKM	s	0.0	90.0
Kirnos seismometer, upd (DIS,V=10000,T=1-1.4)	SKM	s	90.0	90.0

Figure 5: Station with the instruments and timing of its activity

Historical earthquake data in Europe and the Euro-Mediterranean Intensity Database

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Introduction

Historical earthquake data represent a wealth of potential information on long-term seismicity which, in its turn, contributes to understand tectonics and to assess seismic hazard.

In the last two decades, the retrieval and interpretation of historical data became a systematic activity in many countries of the world. This investigation, previously performed mostly by individuals - some of them using just amateurish approach - acquired self-consistent, rigorous rules from the merge of scientific and historical expertise.

Historical data contributed to update parametric earthquake catalogues, eliminating fake events or duplications, making earthquake sizes and locations more realistic, etc. Of course, the quality of their historical background is rather assorted. According to the survey performed in the frame of the former EC project BEECD "A Basic European Earthquake Catalogue and a Database for the evaluation of long-term seismicity and seismic hazard" 1995-1998 (Stucchi et al., 2000; see also http://emidius.irrs.mi.cnr.it/BEECD/home.html), the datasets (roots) from which the earthquake parameters of the current parametric catalogues are determined range from:

- no information at all (type 5)
- a set of parameters taken from another parameter catalogue (type 4)
- a few lines, compiled for summarising the earthquake knowledge (type 3)
- papers or monographs reporting comprehensive investigation (type 2)
- papers or monographs reporting comprehensive investigation, with macroseismic intensities assessed for each reported locality (type 1).

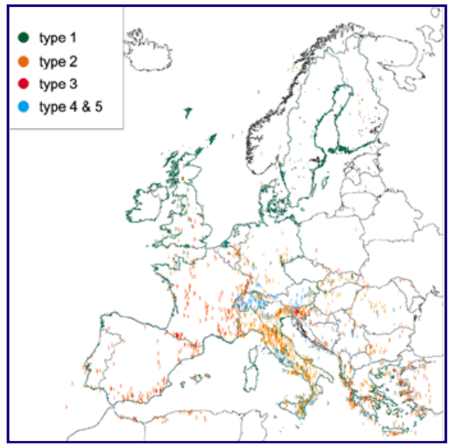


Figure 1 - Distribution of the root type in the damaging European earthquakes.

With respect to damaging earthquakes (Ix/Io ≥ 5/6 or M ≥ 4.0) in the time-window 1400-1899 (4083 earthquakes), the share of the root type is the following (Fig. 1):

type 1:	***19%***
type 2 & 3:	***59%***
type 4 & 5:	***22%***

To provide reliable earthquake parameters, this wealth of information needs to be processed according to scientific, non subjective, formalised, possibly uniform procedures. This can be done starting from datasets of type 1 only, that is, from intensity data points (IDP).

Today, type 1 roots represent a minority in Europe. To improve roots of type 2 to 4 so that they become roots of type 1 is a major task. While in a few cases roots of type 2 need only intensity assessment to be upgraded, roots of type 3 need more work in most cases. Roots of type 4 and 5 require to start the investigation more or less from scratch.

However, this task is indispensable to fully exploit the available data and to bring them to a level comparable with the instrumental ones. Beside many national efforts and some international projects, EMSC/CSEM has recognised the importance of this task by establishing the Istituto di Ricerca sul Rischio Sismico, CNR, Milano, as key-nodal member for the dissemination of historical earthquake data and catalogues (http://emidius.irrs.mi.cnr.it/EMSC-KNM-HEDC).

Intensity data points

Intensity data points (IDP) represent the formalisation of the historical records, through which they become macroseismic data. They represent the elementary cells of the macroseismic archive and must carry at least the following information: time, location (place-name and co-ordinates), intensity. These parameters are to be assessed homogeneously for all IDP to be put together.

Time is leading parameter: that is, IDP carrying the same time "make" the earthquake. Time is usually given according to varied time systems. To convert time to UTM solves some problems, though the time given by the historical sources can be of some help, as well.

DL	***deserted locality.*** Locality no longer inhabited, which can be now a "ruin" or just a toponyim. In some cases it can have been rebuilt in another place with the same name or a different one.
AL	***absorbed locality.*** Locality once independent which was absorbed by a contiguous one.
MS	***multiple settlement.*** In some cases the information associated to the given name corresponds to a set small localities (e.g. a small administrative unit, a small island, etc.) and cannot be referred to one of them.
NL	***not located.*** Locality the location of which was impossible so far.
TE	***territory.*** The information refers to an area (e.g. Lombardia, Provence, Peloponnesus). In such cases it is suggested not to assess intensity but to give a code for classifying the effects (e.g.: DE = destruction; D = damage; F = felt; NF = not felt) and to supply no co-ordinates.
SS	***small settlement.*** These are the cases of a country church surrounded by a few buildings, a large farmhouse, a castle, etc. and of all the situations where the size of the settlement is below the threshold suggested by Grünthal (1998). It is suggested not to assess intensity but to give a code for classifying the effects (e.g.: DE = destruction; D = damage; F = felt; NF = not felt).
SB	***solitary building.*** Church, tower, lighthouse, etc. Case similar to the previous one: to be dealt with in the same way.

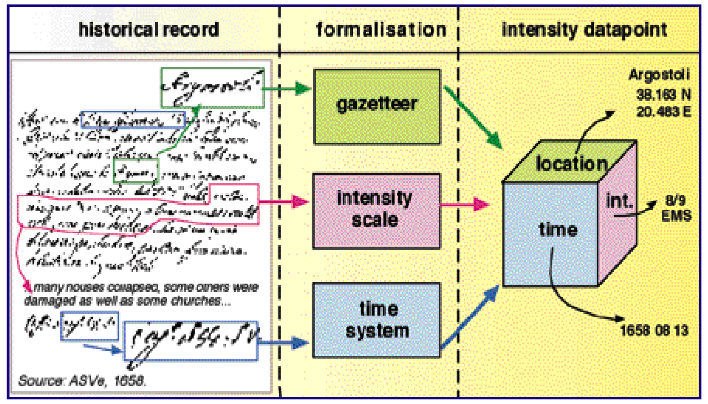
Tab.1 - Special locality cases (SL).

Places should be always called with the same place-name and given the same co-ordinates, referred to the same co-ordinate system.Therefore, it is necessary to adopt a common geographical authority (gazetteer) to which data points are to be referred. Europe has no unified, available gazetteer so far; rather, each country, or at least most of them, have one, or even more than one; in some cases such authority/ies needs ad-hoc implementation.
Ad-hoc solutions for dealing with special cases, such as change of place-name with time, reconstruction of localities with the same name in other places, incorporation of a locality into another one, etc. can be dealt with by means of a dedicated parameter SL (see Tab.1).

Intensities come in terms of many intensity scales (MCS, varied MSK, modified MM, EMS92 and EMS98 among the most common ones). Empirical correlations between intensity scales are not recommended to make intensities homogeneous; however, on the other hand, differences among intensity assessments performed by use of different European scales are less or equal to differences among intensity assessment performed by varied investigators using the same records and the same intensity scale. Major problems can be met only with intensities assessed in terms of older scales (such as De Rossi-Forel) or MCS scale (an Italian anomaly). Much larger problems concerns intensities assessed from records referring to single buildings or large areas (see Tab.1). In both cases the fulfilment connected with the statistical nature of intensity are not met;therefore, attempts to assess intensity may give biased results and should be avoided (Grünthal, 1998).

Finally, it might be useful that IDP carry some additional information, such as: root to which they belong; code(s) of the gazetteer according to which today place-names and co-ordinates are given; country of the locality;quality code (see for instance the coding system proposed by Musson, 1998); source of the historical record; time and locality place-name as quoted by the historical source; some parameters of the earthquake to which they belong.

How a historical record is processed to become an intensity data point: the case of Argostoli (earthquake of 13 August 1658.)



The figure above shows an example of how a historical record is processed to become an intensity data point.The hand-written text comes from a documentary source (ASVe, 1658), a letter written to the Senate of Venice by the then Venetian Governor of Kefallinia (also Cefalonia, abbreviated in "Ceffa" in the text), in the Ionian Islands.

Time. The date of the letter (bottom, blue), is "5 August 1658 S.V.", which means expressed according to the Old Style calendar. The same applies for the date of the earthquake (top, blue) is given as "li tre del corrente S.V." (on the 3rd of the same month, O.S.). The translation into New Style, corresponding to Gregorian calendar, is obtained by adding 10 days in this case. The earthquake then occurred on 13 August 1658.

Location. Argostoli was a small village on the seaside at the time of the earthquake (it developed as a town starting from 1757, when it became the capital of the island). Its location did not change through the centuries; today its name can be found written both as Argostoli and Argostolion.

Intensity. The governor describes damage suffered by the village in these terms "many houses collapsed, some others were damaged as well as some churches".According to the EM-98 intensity scale, all buildings have been assigned vulnerability class A and the description has been interpreted as reporting an intermediate situation between degrees 8 and 9.

Macroseismic data in Europe

Only a few country (Italy, France) have a consistent, accessible set of intensity data points (IDP) as yet, offered on CD (Boschi et al., 1997), web sites (Monachesi and Stucchi, 1997, Boschi et al., 1997) or paper (Levret et al., 1996). In other areas, some data are presented in terms of isoseismal maps, either without IDP (es.: Mezcua, 1982, etc.) or with IDP (es.: Shebalin, 1964; Papazachos et al., 1997,etc.), though the co-ordinates of the data points are not easily obtainable and the place-names are missing. Further, scattered intensity data exist; some are public, some not. The ESC WG "Macroseismology" in 1996 and the BEECD project later performed a preliminary inventory of the existing intensity data and the format in which they come.

According to the results of this inventory, in the time-window 1400-1899 and with respect to damaging earthquakes, IDP exist - in principle - for about 800 earthquakes (19%). However, data of 677 earthquakes out of 800 are available on magnetic support; of 26 on paper only; of 101 are just reported as existing. In all, a number of about 30.000 IDP is reported as existing in this time-window; however, the distribution of these figures is not homogeneous throughout Europe, as it reflects efforts of varied purpose and size.
A limited number of earthquakes with IDP is also found in the time-window 1000-1399. On the other hand, according to the results of a preliminary survey performed in the frame of the ESC WG "Macroseismology" (1996) the situation improves in the XX century, when macroseismic surveys, performed by means of questionnaires, were organised in many countries, although with no constant effort throughout the whole Europe and the whole century.

EMID, the Euro-Mediterranean Intensity Database

The need for a Euro-Mediterranean Intensity Database available to the users is widely recognised and it has been recommended also by the European Seismological Commission. In the United States of America the "Earthquake Intensity Database 1683-1985" is already available on-line (http://www.ngdc.noaa.gov/seg/hazard/eqint.html)

The main requirement to build up such a database is that data are homogeneous and compiled according to the same format. If these requirements are fulfilled,data do not need to be resident on the same server;they can stay on the owner server or, better, on both.

How to make them homogeneous was discussed above; it will require some decisions (time-system, intensity scale, gazetteer, etc.) and some work. The format proposed for the Euro-Mediterranean Intensity Database is given in Tab.2.

Here follows a simplified example of how the entries of the database look like (some parameters are not determined, yet):

Ye	Mo	Da	Ho	Mi	Ct	Rt	Idloc	Sl	Latdp	Londp	Cn	Gaz	Nloc	Is	Sc	Q	Idpen
1638	08	13	--	--	--	ALB97	ARGOSTOLI	--	38.163	20.483	GR	--	--	8/9	EM	--	1237
1751	07	27	03	--	--	MON87	CASE SANTA CROCE	SS	43.225	12.721	IT	EN81+	48960	D	MC	--	7529
1829	03	21	--	--	--	DLT84	XIXONA	--	38.540	- 0.506	ES	--	--	5/6	MM	--	10027
1863	10	06	02	22	--	MUA98	HEREFORD	--	52.050	- 2.710	UK	--	--	6	EM	--	16373

Tab.2 - Format of the Euro-Mediterranean Intensity Database.

n	code	parameters	size
		parameters of the intensity data point	
1	Ye	year	5
2	Mo	month	2
3	Da	day	2
4	Ho	hour	2
5	Mi	minute	2
6	Ct	comment to time	2
7	Rt	root (study)	7
8	Idloc	locality place-name (in the gazetteer)	25
9	SL	locality special case	2
10	Latdp	latitude	6
11	Londp	longitude	7
12	Cn	country (today)	2
13	Gaz	gazetteer	7
14	Nloc	locality number (in the gazetteer)	6
15	Is	intensity (at the site)	5
16	Sc	intensity scale	2
17	Q	quality	3
18	Idpen	IDP entry number	6
		tot.	88

n	code	parameters	size
		parameters of the historical record	
21	Hiso	source of the hist. record	7
22	Yes	year (in the source)	5
23	Mos	month (in the source)	2
24	Das	day (in the source)	2
25	Hos	hour (in the source)	2
26	Mis	minute (in the source)	2
27	Cts	comment to time	2
28	Ts	time-system (in the source)	1
29	Quloc	locality place-name (in the source)	25
30			
31			
		parameters of the earthquake	
32	Ax	area of largest effects	20
33	Io	epicentral intensity	5
34	M	magnitude	3
35	Een	earthquake entry number	6
		tot.	82

Of course, data must be public, which is not a common issue. This problem can be solved only recognising that putting data together will be a benefit for everybody. For this purpose, EMSC/CSEM organises - through the web site http://emidius.irrs.mi.cnr.it/EMID - an inventory of the data existing and asks agencies and individuals for collaboration.

EMID on the web

Some of the existing IDP (1400-1899) - at least the public ones - are on the way of being made available, with the authors agreement, on the EMID web site http://emidius.irrs.mi.cnr.it/EMID. It hosts today 20 earthquakes, which serve as a starting point for implementation.
The scheme is the same of the web site which makes the Italian "DOM" macroseismic database (Monachesi & Stucchi, 1997) available to public (http://emidius.itim.mi.cnr.it/DOM/home.html). Users can make queries "by earthquake" and "by locality".

The basic idea of the control panel corresponding to the query "by earthquake" is that the user might be willing to browse contemporaneously data at varied level of synthesis: a) earthquake parameters, intensity data points as b) table and c) map (Rubbia R. et al., 1998). Scrolling the parametric catalogue, users locate the record corresponding to the selected earthquake; "clicking" on it; table and map appears in the lower part of the frame (Padula and Rubbia R., 1999).
The query "by locality" requires that place-names are homogeneously assessed. As this is not the case for EMID, this query is non active, yet; however, it can be seen how it works on "DOM". Comments and suggestions are obviously welcome.

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Database Schema ISC1.0

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Background

Like many seismological data centres, the International Seismological Centre (ISC) is making fundamental changes in the way that it manages data. These changes are occurring, in part, because they can now be done with confidence. More than a few years ago, it may have appeared risky to try out seemingly experimental new systems. But there are still costs involved, and it is fair to ask what purposes are served by re-organisation of the data.

At the ISC, as at many operational centres, data have been held in a variety of structures that were originally designed to accommodate the limitations of computing hardware 10 to 30 years ago. The requirements for collecting, automatically processing, manually analysing, and publishing data differ from each other. It is unsurprising that different compromises turned out to best serve ISC objectives for each of these tasks when computing capabilities were stretched to their limits.

The volume of data relevant to seismic monitoring at any scale is growing quickly. Even the volume of parametric data – measurements summarising the content of waveforms most salient for particular purposes – grows with both the installation of new stations and new analysis techniques that require an increasing number of measurements from each waveform. But computing capabilities continue growing even more quickly, so it would seem that there ought not be any particularly difficult problems, at least with managing parametric data.

New Requirements

As a result of the growth in data volumes and computing capabilities, however, seismological data centres now need to undertake previously daunting tasks. Capabilities that are now urgently required include:

- Preserve and take advantage of more collected information that are now neglected, including preliminary associations.
- Provide a consistent interface to users to select from recently collected data awaiting analysis and analyzed data already published in the Bulletin.
- Respond to data requests quickly enough to serve interactive interfaces such as the ISC's web site.
- Use an interactive editing system in which several ISC seismologists simultaneously test hypotheses and update hypocentral parameters.

Preserving all of the data ought to be straightforward since large disks are affordable. Difficulties in changing current practice arise from intermixing of data management and data processing in older programs. As a result, adding new attributes to the collected data requires modification even of programs that continue using only existing attributes. Providing a consistent interface to users is also straightforward in principal; one might simply define a new data format with all of the attributes in any of the several existing formats. The challenge again, is that so many existing programs must be modified.

The index structures and algorithms needed to search data quickly are now well known, although the effort to implement them might stretch the resources of many seismological data centres, including the ISC. More fundamentally, a sophisticated approach to development is required to preserve flexibility, so that indexes can be re-configured easily when usage patterns change or new attributes are added.

The special aspect of interactive editing is that more than one user or process may be updating the data simultaneously and there must be some mechanism to maintain the integrity of the data while this occurs. The most commonly used solution is to create a single process for managing the data, and a protocol that each editor process uses to communicate with the data manager. Writing software including robust inter-process communication would indeed be a formidable challenge for a small organisation such as the ISC.

Nature of Relational Databases

Fortunately, commercial data management systems satisfying these requirements are now available at low cost. Of the alternative organisational models, management systems for relational databases are the most widely available. It is true that some ways of viewing seismological data conform to hierarchical or object-oriented data models. But the fit of seismic bulletin data to the relational model is reasonable enough, and it is unsurprising that the relational model is the one most often used at seismological data centres.

A glance at a seismic bulletin shows that seismologists have been organising their data into tables with many similarities to the relational model for decades. In detail, however, a relation in a database differs from a table in a seismic bulletin in two important ways:

- There is no intrinsic ordering of rows in a relation.
- All of the rows of a relation share the same format.

The implication of these properties of relations is that the association of a particular seismic reading with a particular earthquake cannot be indicated implicitly by its physical location in a data file. To begin with, the data manager does not allow other processes to specify the physical location of a row, and ignores the physical location of rows in responding to queries. What's more, hypocenters and phases readings are normally stored in separate relations, each with only the attributes required to describe either a hypocenter or a reading.

PHASE				HYPOCENTER				
STA	TIME	PHASE	HYPID	HYPID	TIME	LAT	LON	AUTH
CEY	00:07:20.8	Pg	3	2	00:07:14.7	45.760	14.900	LJU
VVI	00:07:47.0	PN	3	3	00:07:14.3	45.761	14.887	ISC
JTN	00:40:57.8	Pg		5	00:40:54.8	30.510	130.930	JMA
JKC	00:41:07.4	Pg	6	6	00:40:55.0	30.545	130.899	ISC

Figure 1a. Association using one external key. Hypocenter ID is the primary key in the HYPOCENTER relation. The CEY and VVI phases are associated with the ISC hypocenter at 07:14.3, the JTN phase is not associated with any hypocenter, and the JKC phase is associated with the ISC hypocenter at 40:55.0. A hypocenter can have any number of associated arrivals, but an arrival can be associated with no more than one hypocenter.

PHASE				ASSOCIATION		HYPOCENTER				
STA	TIME	PHASE	PHID	PHID	HYPID	HYPID	TIME	LAT	LON	AUTH
CEY	00:07:20.8	Pg	1	1	2	2	00:07:14.7	45.76	14.90	LJU
VVI	00:07:47.0	PN	22	1	3	3	00:07:14.3	45.76	14.89	ISC
JTN	00:40:57.8	Pg	31	22	3	5	00:40:54.8	30.51	130.93	JMA
JKC	00:41:07.4	Pg	33	31	5	6	00:40:55.0	30.55	130.90	ISC
				33	5					
				33	6					

Figure 1b. Association using two external keys. Hypocenter ID is the primary key in the HYPOCENTER relation and Phase ID is the primary key in the PHASE relation. The CEY and VVI phases are associated with the ISC hypocenter at 07:14.7, but the CEY phase is also associated with the LJU hypocenter. The JKT phase is associated with both the ISC hypocenter at 40:55.0 and the JMA hypocenter, while the JTN phase is associated only with the JMA hypocenter.

But representing association by physical ordering was a compromise that we now wish to dispense with, anyway. The ISC wants to represent association of a reading with several different hypocenters, including reported associations from other agencies as well as its own association hypotheses. Of course, there are also multiple readings associated with each hypocenter, so the relationship between hypocenters and readings is "many-to-many" rather than "one-to-one" or "one-to-many". Physical ordering is unsuited to representing "many-to-many" relationships.

Linking Relations with External Keys

The most widely-used mechanism for representing links between rows in different relations is "external keys": a unique index for each row in a relation, a primary key, and possibly multiple links to a row that relation by using the key externally, i.e., the same key values in other relations.

We could represent association by creating a primary key in a relation of hypocenters, and using that key externally in a relation of readings (Figure 1a). This mechanism has actually been used in the ISC's "working tape format" for many years. It has the advantage over physical ordering of supporting re-association of a reading with a different event while minimising re-arrangement of the data. This was an essential feature when "working tape format" files were manipulated on tapes rather than disks. For our more comprehensive goals, however, this mechanism is insufficient because of the same fundamental limitation as physical ordering: it allows a reading to be associated with only one hypocenter.

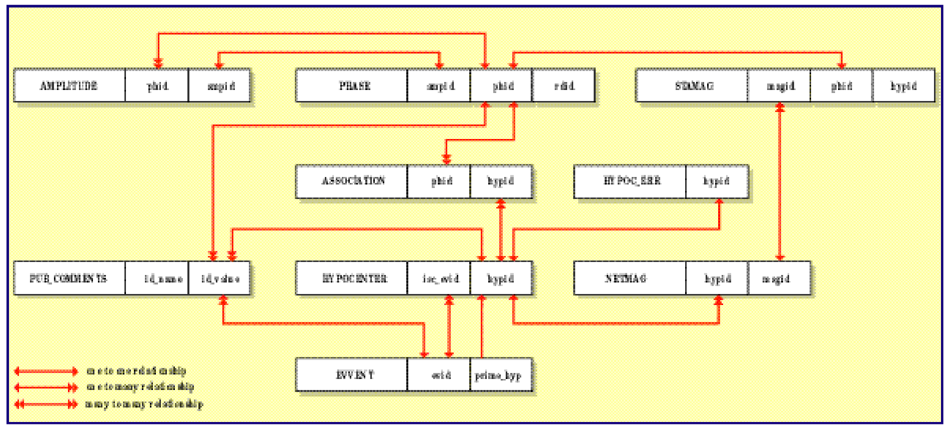

Figure 2. External keys joining principal relations of the ISC database schema.

Alternatively, we could create primary keys in both the hypocenter and reading relations, and associate the two by using both keys externally in a third relation (Figure 1b). The mechanism is conceptually more complex and requires more resources, i.e., more disk space for the extra relation and more processing to select all of the data about readings associated with a hypocenter. The benefit from paying these costs is that we can now associate a reading with, say, an ISC-computed hypocenter by inserting a new row in the association relation without deleting the association of the reading with a reported hypocenter.

Relation Formats

The example of alternative ways to use external keys demonstrates that important decisions must be made in deciding the format of the relations or, in the jargon of relational databases, designing the schema. In designing the ISC's schema, we have been guided by

othe CSS3.0 schema used by the GSETT-3 IDC, and modifications of it by other agencies

- the ISC's existing operational requirements and the data structures used to meet them in the ISC's existing data file formats
- envisaged new requirements, including use of reported associations and distribution of data before analysis

The most important changes to CSS3.0 are based on the ISC's requirements to

- treat sets of phases at one station from one event as a unit, a "reading" in our terminology, that may be associated, disassociated, re-associated or deleted as a group.
- treat some readings as duplicates of others, either read independently or reported to the ISC by different routes from the same source.
- have ways of marking several different types of data as not suitable for use or re-publication, without actually deleting the data.

The design process was iterative, and involved making at least preliminary outlines of further requirements, such as details of operations required for support of on-line editing. Since those were preliminary, stored procedures, integrity constraints, and certain details about indexes are still being developed.

We have, however, made descriptions of 14 principal relations (Table 1) and the external keys that are used for joins between them (Figure 2) available from our web site, at http://www.isc.ac.uk/Documents/Schema. The descriptions include a list of attributes for each relation, and more comprehensive information in a list of all of the attributes occurring in any relation. We have avoided using names of some CSS3.0 relations, so that if required we could create CSS3.0 relations as views on our base tables.

Most users of ISC data will not need to concern themselves with the ISC's schema, since we are developing programs to insert data from existing data exchange formats to our database, and other programs to select from the database and write files in the existing exchange formats. Nevertheless, we welcome comments and suggestions on our schema and encourage other data centres to contact us if they are planning a relational database and would like to discuss

Relation	Each row contains ...	attributes	rows
EVENT	summary about an earthquake, explosion or rockburst	9	940,000
HYPOCENTER	an estimate of the time and location of a seismic event	31	2,000,000
HYPOC_ERR	a description of the uncertainty of a hypocentral location	23	1,500,000
NETMAG	magnitude for an event, averaged over a network	11	1,100,000
PHASE	description of an individual phase arrival	26	29,500,000
AMPLITUDE	one measured amplitude and period for a phase	10	4,500,000
ASSOCIATION	information relating one phase to one seismic event	21	29,500,000
STAMAG	magnitude estimate for a hypocenter from one amplitude	12	4,400,000
PUB_COMMENTS	text intended for publication in the Bulletin	10	1,400,000
REMARK	a note used for internal purposes	7	2300
SITE	summary information about a station	17	8200
SITE_INFO	one additional datum about a station in the site table	4	3900
AFFILIATION	name of a network to which a station belongs	9	120
SITE_OUTAGE	times between which a station was not operating	9	120

Table 1. Summary of principal relations of the ISC database schema.

MFS_Strong Motion Databank and Database (Universidad Politécnica de Madrid)

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INTRODUCTION

The Iberian Peninsula is a region of moderate seismicity, where most of the accelerograms recorded until now correspond to earthquakes of low magnitude. These records are not enough to assess seismic hazard directly according to the instrumental parameters or to estimate especific response spectra for sites in the area. The possibility of access to strong ground motion recorded in other zones is specially interesting and provides a way out to this problem.
Extrapolation of the knowledge (source effects, attenuations, and local amplifications) obtained from accelerograms recorded in regions of similar characteristics to the region studied, could be carried out, whithin the adequate margins of uncertainty.
For these reasons a research project has been developed, the DAÑOS project, financed by the Spanish Nuclear Safety Council and the National Enterprise for Radioactive Waste Disposal. The project is aimed at the characterization of ground motions in the Iberian Peninsula's sites and one of the main activities has been the design of a strong motion databank, called MFS, by compiling and classifying accelerograms and spectra from all over the world. (Benito et al., 1998; Cabañas et al., 1999)

DATA BANK STRUCTURE

A schematic representation of the data bank design is shown in figure 1. The adopted design makes it easier both the selection of the records and the parameters for their analysis and treatment, and subsequent applications in the Earthquake Engineering field.

The design model adopted by the storing and proccesing of data include three different parts:

- The so-called Data Bank, composed by an extensive collection of accelerograms and spectra from all over the world.
- The associated Data Base, including seismological characteristics of data.
- The Informatic Utilities, with the software for the explotation and proccesing of data.

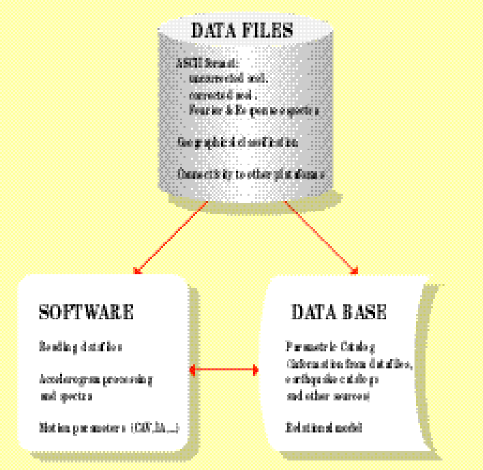

Figure 1.Structure of MFS Data Bank.

Data Bank

It is composed by the data files with time-history accelerations, Fourier spectra and response spectra, corresponding to the strong motion records. The files (ASCII) are stored in a Work Station, under UNIX (Solaris).
The classification of files is based on the geographical location of data, with a first level of clustering by extensive regions, a second level by countries and a third level by type of record (accelerogram corrected and non corrected, Fourier spectrum, response spectrum). The name of the file provides an identification of the record kind.

Data Base

It is the catalogation system of the strong motion records and contains the seismological characteristics of these, related to the earthquake, record station and instrumentation. It is an esential tool for the easy use of the data bank information. The schedule followed is a relational model composed by five tables: Earthquake, Station, Components, Non corrected and Corrected. The explotation of all the information is carried out through the MFSDaños program,designed for this aim.

Informatic Utilities

Different programs and macros (SAC-LLNL) have been developed for the analysis of data and their treatment, and two main programs have been designed for the selection and data proccesing: MFS Daños and ITA Daños.

MFS Daños. It is an interface program of MFS Data Base, aimed at facilitating queries and handling of these data to any user. The program allows to make general queries, involving all the tables and data, or other more specific questions by the selection of different parameters or interval values through the logic combination desired. One of its outputs is shown in figure 2.

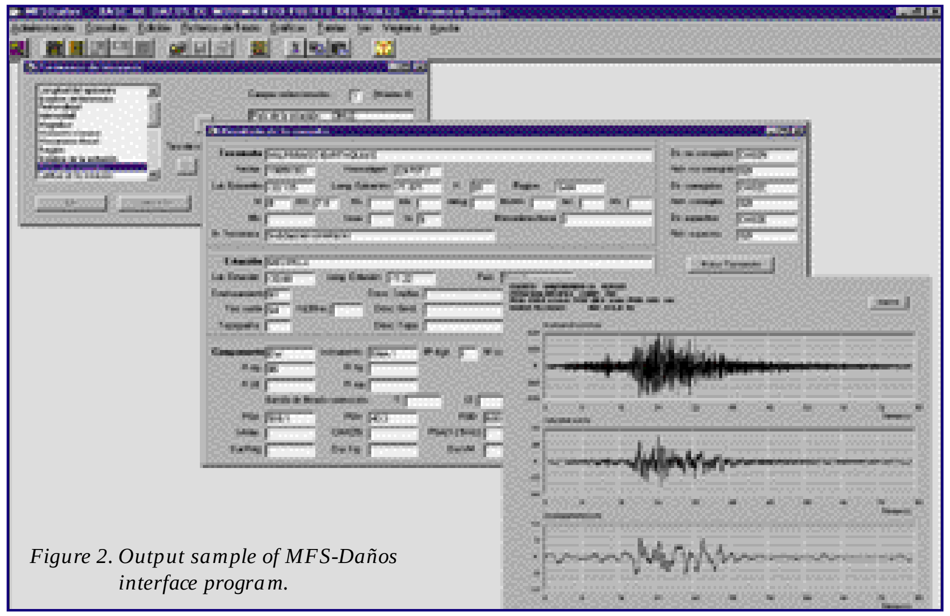

Figure 2. Output sample of MFS-Daños interface program.

ITADaños. It is an interface for proccessing strong motion records which allows reading and conversion between different formats, accelerograms correction, spectra estimation and representation of different graphics output, with the possibility of conecting to other programs (for instance Excel-Microsoft). This interface links to BAP software (Basic Accelerogram Procesing) developed at USGS (converse 1995) for proccessing records. The main menu of the program is shown in figure 3.

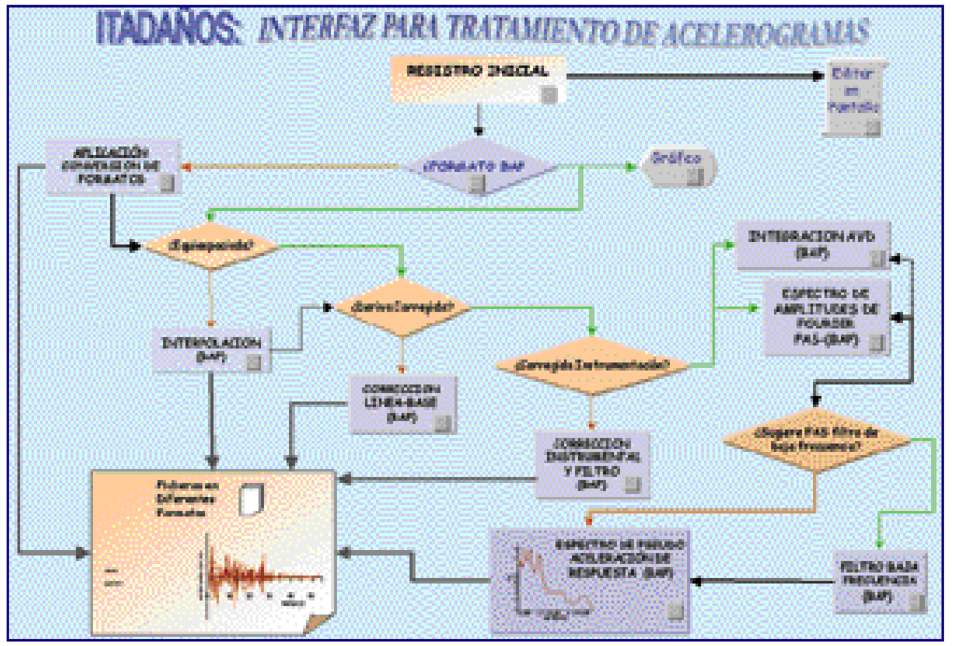

Figure 3. Main menu of the ITA-Daños program.

COMPOSITION OF DATA BANK

To date, the MFS Databank has stored more than 15,000 strong ground motion recorded components, corresponding to 1,400 events. Related information to these records is still being updated in the associated Database. A quick look at the stored data and their geographical distribution can be seen in figure 4, where earthquakes and records percentages of each region are shown.

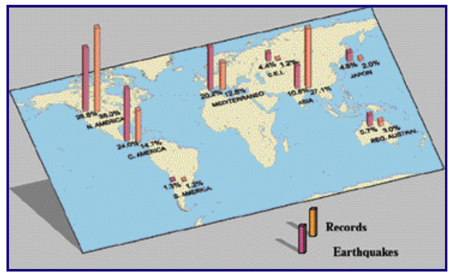

Figure 4.- Geographical distribution of data contained in the MFS-Databank.

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L. Cabañas, B. Benito, C. Cabañas, M.E. Jiménez, P. Gómez, M. López, S. Álvarez, M.S. Ramírez and R.Nuche, (1999). "Banco de Datos de Movimiento Fuerte del Suelo Desarrollado en el Proyecto Daños"1er Congreso Nacional de Ingeniería Sísmica,Murcia, 1999.

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The ORFEUS page

NEW EC-PROJECT: MEREDIAN

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MEREDIAN, an acronym for Mediterranean-European Rapid Earthquake Data Information and Archiving Network,is a 3-year European project co-ordinated within ORFEUS and sponsored by the EC. This project aims at upgrading the ORFEUS related earthquake waveform data infrastructure in Europe and its immediate surroundings. Our goal is to provide open,rapid and easy access to a large volume of high-quality earthquake waveform data for research and rapid earthquake analysis.

Key elements are:

- Securing access to real-time data (minutes-hours delay) and a large volume of quality controlled archived data (maximum delay of one year).
- Implementing (automated) data exchange mechanisms(AutoDRM,satellite communication)
- Developing a distributed European seismological archive (using the NetDC protocol)
- Co-ordinating software development and securing seismological software through the "open source concept"with a special focus on Java.

Project highlights

A large effort within the project lies on the consortium members, i.e. major national observatories and ORFEUS, to ensure that data is properly archives and, most important, easy and rapidly accessible to other observatories across the borders and to the research community. Further, many elements within the project can directly benefit others and be exploited by them. Some of these are summarised below:

Pilot project VSAT. An experiment to retrieve waveform data by listening in to existing satellite network data transmissions.

AutoDRM. Active installation of AutoDRM software at seismological observatories throughout the European-Mediterranean area.

EuroSpyder. Expanding waveform data retrieval and archiving for M ≥ 5.0 earthquakes within the European-Mediterranean area.

Format conversion. Offering more assistance and facilities for conversion to the standard SEED format for archiving (a.o. further developing SeedStuff).

Near Real Time (NRT) data exchange. Developing and installing (semi) automatic data exchange procedures for archiving with a minimum of delay (weeks, months).

SeisComp. Further development of data acquisition, processing and communications software packages for Linux.

Seismogram Viewer. Further development of data viewing and basic analysis tools in Java enabling data import from both local source and the Internet.

How can I benefit?

The MEREDIAN project is a so-called "Support for Research Infrastructure" project and intended to benefit both the user of earthquake waveform data and the seismological observatories throughout Europe and its surroundings. Therefore its progress and development will be monitored within ORFEUS. Consequently, you are invited to participate within the different ORFEUS meetings, working group's etc. Also, if you find any interest in the aspects summarised above you are welcome to contact ORFEUS (http://orfeus.knmi.nl). As soon as the project has officially started a specific MEREDIAN web site will be created at ORFEUS an overview over the different activities.

Project specifics

- EC-PROPOSAL:EVR1-1999-00006
- CONTRACT: Finalising negotiation phase
- PROJECT CO-ORDINATOR:Royal Netherlands Meteorological Institute / Seismological Division: Torild van Eck
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- National Observatory of Athens, Institute of Geodynamic, Athens, Greece.
- GeoForschungsZentrum, Potsdam,Germany.
- Centre National de la Recherche Scientifique, Délégation de la Côtes d'Azur, Nice, France.
- Zentralanstalt für Meteorologie und Geodynamic, Vienna, Austria.
- Swiss Federal Institute of Technology, Zürich,Switzerland.
- Norwegian Seismic Array, Kjeller, Norway.
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PROJECT START: Summer 2000
PROJECT DURATION:3 years

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Next EMSC Assembly General

The next assembly will take place on September 13, 2000, during the ESC meeting in Lisbon, Portugal.

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