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Centre Sismologique Euro-Méditerranéen
European-Mediterranean Seismological Centre

Newsletter

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EDITORIAL

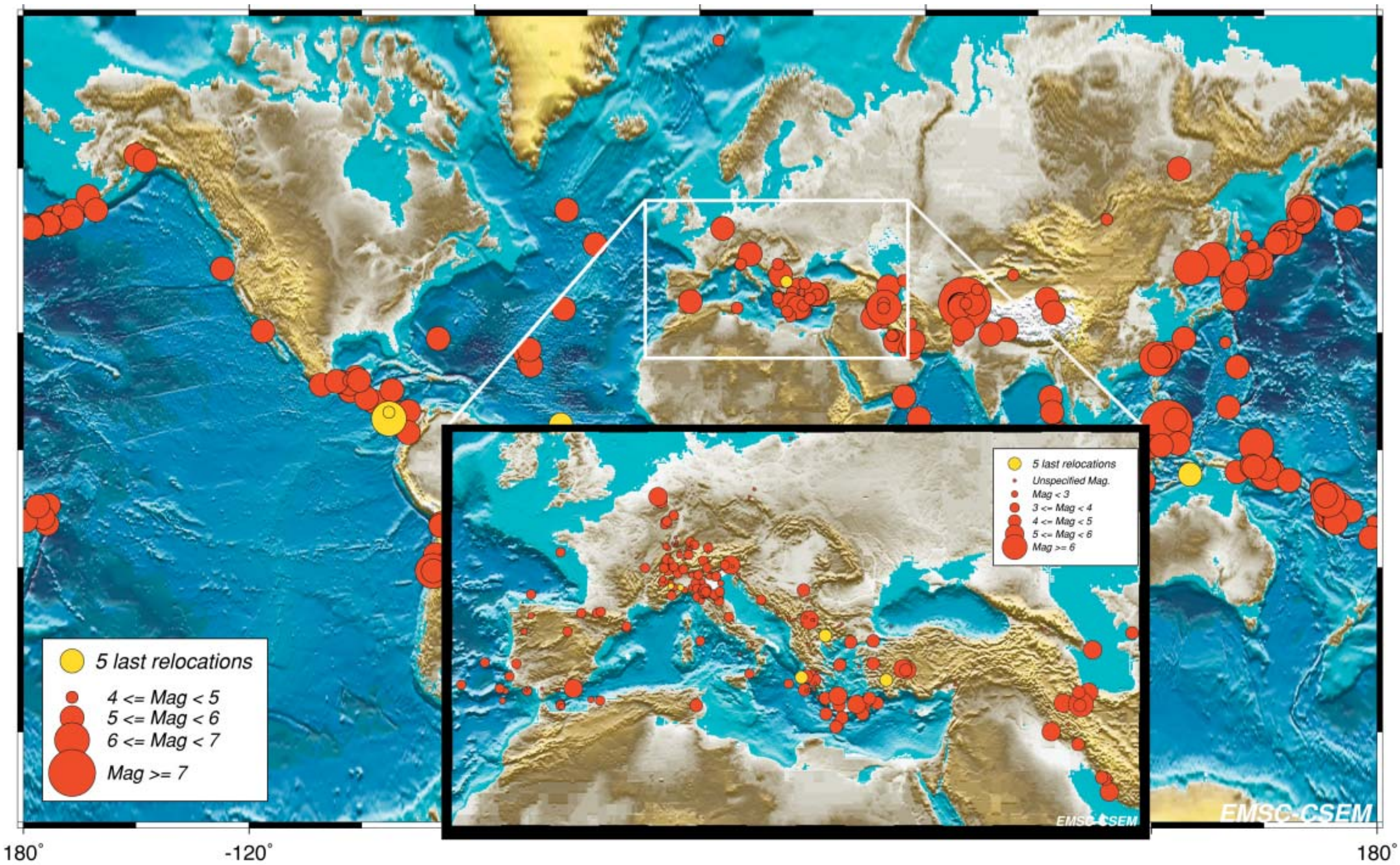
Since our last Newsletter there have been changes at our EMSC Co-ordination centre in Bruyères. In particular Florence Rivière has moved on to a senior post with the CTBTO in Vienna. On behalf of us all, I would like to thank her for the endeavour and commitment she brought to EMSC activities in recent years. We continued to become a more efficient and vigorous organisation, over the period, serving our members and associates in the international seismological community.

Most will be aware that early this year we welcomed Rémy Bossu as the new Secretary General. He is already making an impact in consolidating our links with ORFEUS, with eastern Mediterranean and North African institutes, and with new European project initiatives. Our existing EU EPSI project should yield an operational, unified, monthly seismological bulletin from September, on the web site. Fifty institutes with 1200 stations are involved, and your comments will be most welcome. Rémy is also coming up with ideas for new members, for sponsorship (but needs more help from all of us here – please send your ideas) and for improvements in our external visibility. Following his PhD into the intraplate seismicity of Uzbekistan, at Grenoble, Rémy went on to research microseismicity and fractures, at Keele UK, with application in the oil industry, before joining LDG/CEA in 1999. He brings, therefore, a breadth of scientific experience to our work.

At our Assembly in Genoa, on 4 September, we anticipate welcoming 3 new members: KOERI, Istanbul, NIEP, Bucharest (with a paper in this newsletter) and IRSN/BERSSIN, France. If existing members are unable to attend I would be most grateful if you would pass your vote to a proxy; a colleague, Rémy or myself.

Of great interest to us all is progress with the FITESC task force initiative on which a paper appears here. We should have more debate on this and other important issues in Genoa. I look forward to seeing members and supporters there.

Chris Browitt
President



Automatically relocated seismic events world-wide and in the European-Mediterranean region since the beginning of the yea until the 31st of July. EMSC operates automatic relocation procedures every 2 hours and results are displayed on Real Time Seismicity Page. For more details, see the following article

EMSC Early Warning System and Real Time Seismicity

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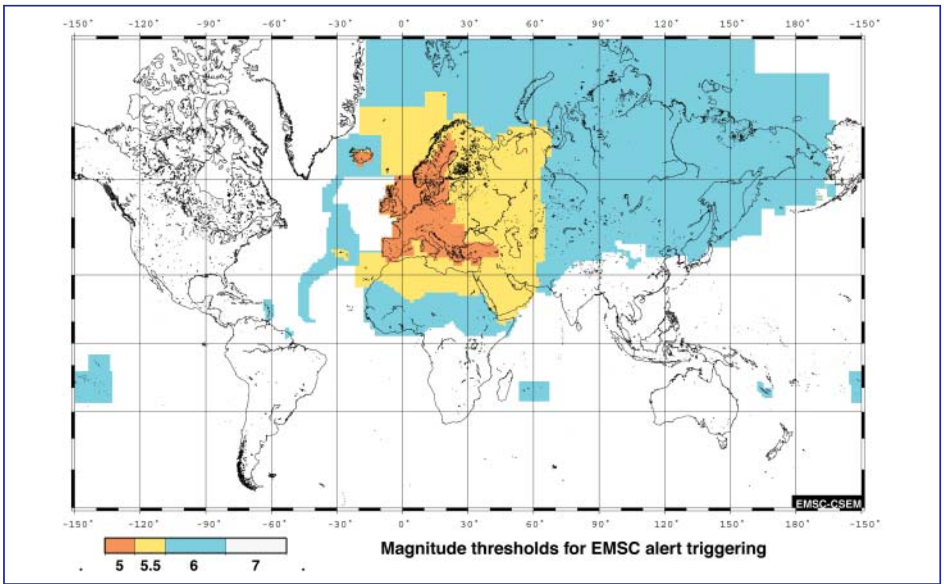

Figure 1: *Map of the alert triggering threshold. One of our objective is to lower the threshold to M5 in the whole European-Mediterranean region.*

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Introduction

The current Early Warning System (EWS) for potentially damaging earthquake has been running on an operational basis since 1994 and the experience gathered is now significant. This EWS focuses on the European-Mediterranean region with a magnitude threshold from 5 to 5.5 (depending on the density of expected real time contributions at a regional scale, Figure 1). The magnitude threshold increases for increasing distance from the European-Mediterranean region and is currently set to M6 in Continental Asia and M7 world-wide. The number of seismic alerts ranges from 70 to 100 a year.

Although EWS is one of the key EMSC's activities, it appears that the last description of this system was published in our *Newsletter n°5* in July 1994 (with an update in *Newsletter n°8* in December 1995). The purpose of this article is to provide an up-to-date description of our system and to present its possible evolutions. EMSC also want to take this opportunity to ***thank each contributing institutes*** for the time they spend with us to constantly improve data exchange procedures and, consequently for their key role in the improvement of the EWS' performances. This role has to be fully recognised and we would like to ***encourage more agencies to join this network of seismic networks.***

These improved data exchanges have allowed EMSC to complete its services by providing information on the seismic activity in near real time, information available on the *Real Time Seismicity* page of our web site (www.emsc-csem.org). It is based on automatic relocations which integrate all available data related to the same event.

If rapid source parameters have proved to be of great interest in particular for civil defence services, the need for rapid characterisation of damage is now becoming more critical. EMSC being an operational structure with a seismologist on duty 24h a day and having been in contact with relevant civil defence services and NGO's for years, we believe that it is in the best position to develop such characterisations in the future.

How this EWS works?

The aim of this EWS is to provide rapid information on potentially damaging earthquakes in the European-Mediterranean region. If the current procedures have been in use since January 1994, they have been significantly improved during a 2 years EU-funded project which ended in mid-1998. Basically, the different contributing institutes send to the EMSC in Bruyères-le-Châtel (and, to ensure redundancy, to the *Instituto Geografico Nacional* in Madrid) data on seismic events using Internet (Figure 2). These messages are often the result of automatic data processing. When 2 messages related to the same seismic event indicate that the magnitude threshold has been potentially exceeded, the alert is triggered (Figure 3). A message is automatically sent to the beeper and to the mobile phone of the seismologist on duty. He connects to EMSC facilities using a laptop PC, merges and processes all available data and, as soon as a reliable solution is available, alert messages are disseminated by fax and email. EMSC commits itself to a maximum dissemination time (time lag between the occurrence of the earthquake and the messages' dissemination) of 1 hour. This delay is respected in the vast majority of cases, but, if available data are too limited to get reliable source parameters, a longer time period may be required.

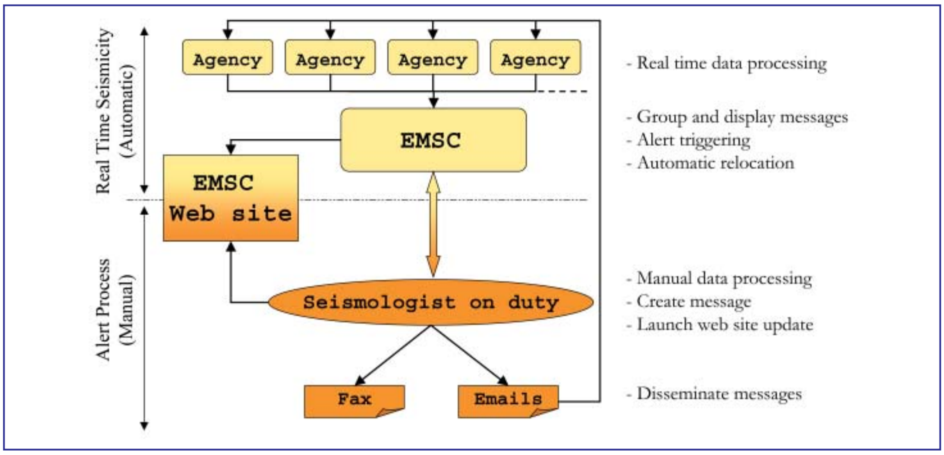

Figure 2: *Schematic functioning of the EMSC. Contributing agencies send the results of automatic or manual data processing in real time. Data are automatically gathered and displayed on the EMSC web site. Periodically an automatic relocation process is launched. When an earthquake is reported in 2 messages as reaching or exceeding the local magnitude threshold, the seismologist on duty receives a message on its mobile phone and beeper. Available data are manually processed and alert messages dissemination and web site updates are performed.*

2002/07/28	20:29:08.6	56.1N	105.7E		M 4.8	M	BGR	LAKE BAYKAL, RUSSIA, REGION
2002/07/28	20:28:32.1	52.7N	108.1E	20	Ms4.3	M	GSSC	LAKE BAYKAL, RUSSIA, REGION
2002/07/28	20:28:30.7	52.5N	108.2E	10G	Mb4.9	A	MIX	LAKE BAYKAL, RUSSIA, REGION
2002/07/28	19:24					A	SED	
2002/07/28	19:24:31.8	48.0N	9.5E	9	Ml1.6	M	LED	GERMANY
2002/07/28	19:22					A	SED	
2002/07/28	19:11:41.0	86.1N	105.5W		M 5.4	A	INGV	ARCTIC OCEAN
2002/07/28	19:07:11.0	32.0N	141.0E		Mb6.0	A	LED	SOUTHEAST OF HONSHU, JAPAN
2002/07/28	19:00:23.1	19.6S	167.0E	33G		A	MIX	VANUATU ISLANDS REGION
2002/07/28	19:00:23.1	19.2S	177.6W	100	M 5.6	M	GSSC	FIJI ISLANDS REGION
2002/07/28	19:00:00.2	29.9S	179.9W	10	Mb5.4	A	SED	KERMADEC ISLANDS REGION
2002/07/28	18:43					A	SED	
2002/07/28	18:00					A	SED	
2002/07/28	17:21					M	IMP	
2002/07/28	17:21					A	SED	
2002/07/28	17:20					A	RNS	
2002/07/28	17:19					A	RNS	
2002/07/28	17:19					A	LED	
2002/07/28	17:18					A	OGS	
2002/07/28	17:16					A	THE	
2002/07/28	17:16:36.9	37.6N	21.3E	33	M 4.8	M	NRIA	SOUTHERN GREECE
2002/07/28	17:16:34.6	38.3N	20.4E	25	Mb4.5	A	NEWS	GREECE
2002/07/28	17:16:34.5	38.2N	20.8E	5G	Ml4.6	M	THE	GREECE
2002/07/28	17:16:33.4	38.3N	20.8E		Ms4.9	M	GSSC	GREECE
2002/07/28	17:16:33.4	38.0N	21.2E	33G	Mb5.0	A	NEIA	GREECE
2002/07/28	17:16:32.6	37.9N	21.0E		mb5.1	M	NEIR	SOUTHERN GREECE
2002/07/28	17:16:31.1	38.0N	20.6E	25	MD4.6	M	NOA	GREECE
2002/07/28	17:16:30.3	38.0N	20.6E	18		A	FM	GREECE
2002/07/28	17:16:30.3	38.0N	20.6E	10	Ml5.3	M+	CSEM	GREECE
2002/07/28	17:16:29.9	37.9N	20.6E	10G	Mb4.7	A	MIX	IONIAN SEA
2002/07/28	17:16:27.9	37.6N	19.4E	25	Mb4.6	A	NEWS	IONIAN SEA
2002/07/28	17:16:24.7	38.3N	21.5E	10	Mb4.6	A	LDG	GREECE
2002/07/28	17:16:18.1	38.3N	22.3E		Mb4.6	A	MAD	GREECE
2002/07/28	17:16:14.0	37.6N	22.5E		Ml5.5	A	RNS	SOUTHERN GREECE
2002/07/28	17:16:13.1	36.1N	20.5E	10	Mb5.1	A	SED	CENTRAL MEDITERRANEAN SEA
2002/07/28	17:16:04.9	37.0N	22.7E	10G	Ml5.3	A:	INGV	SOUTHERN GREECE
2002/07/28	17:16:02.3	37.1N	23.2E	10G	Ml5.1	A!	INGV	SOUTHERN GREECE
2002/07/28	17:16:00.0	36.6N	21.2E		M 4.2	M	BGR	SOUTHERN GREECE

Figure 3: *EMSC* Real Time Seismicity *page. Each line corresponds to a data message provided by a seismological institute and associated to a single seismic event. An hyperlink to the raw ASCII file is available in the «*Date*» column. Messages that are a priori related to the same seismic event are automatically grouped together (horizontal lines separate the groups) on spatio-temporal criteria. An alert message (**CSEM+**) was disseminated 36 minutes following the occurrence of this event, located West of the Greek mainland. The alert was triggered 9 minutes after its occurrence (an exclamation mark indicates the network which triggered the alert and a colon indicates pre-triggering. An automatic relocation (**MIX**) is computed and regularly updated for each group by mixing together all available data. A map is then drawn and can be found in the body on the **MIX** message.*

Who are the contributors?

The EWS is based on real time data contributions from monitoring agencies. There are currently more than 30 institutes contributing to this system (see the full list in Annex) and more than 600 stations located in the European-Mediterranean region have provided real time data since the beginning of the year (Figure 4).

The *Instituto Geografico Nacional* in Madrid (IGN, Spain) and the *Laboratoire de Détection Géophysique* in Bruyères le Châtel (LDG, France) provide, as key nodal member of the EMSC, contributions on operational aspects. In case of maintenance or a technical difficulty at EMSC premises, the duty is taken over on a simple phone request by the *IGN* which runs the same system. This full back up procedure ensures an excellent reliability of the service. LDG, which has been hosting EMSC since 1993 has, for dealing with seismic events located in French territory, its own operational structure which notably includes a seismologist and a computer engineer on duty. The EMSC takes full advantage of this structure.

What are the data provided to the EWS?

The data provided in the framework of the EWS are real-time (or near real time) parametric data derived from automatic or manual processing of seismic waveforms operated at each contributing agency. The messages EMSC receives are in ASCII format which contains for each station, the type of the waves which have been recorded, their arrival times and possibly their amplitudes. When an hypocentral location has been performed at the agency, messages also contain the origin time, epicentral location, focal depth and magnitude of the event. These parameters are mainly derived from data recorded by short period seismometers, although more broad-band data are now contributing.

A second type of data is the scalar seismic moment provided by the 7 TREMORS Broadband stations, via the mantle magnitude Mm calculation. TREMORS (Tsunami Risk Evaluation through seismic MOment with a real Time System) is a seismic and tsunami warning system, based on a three component broad-band seismic station. It detects the seismic waves, provides an automatic location and scalar seismic moment computation, via the mantle magnitude Mm. Mm is computed with the surface waves amplitude spectra from 50 to 300s. Such data are extremely useful to properly estimate the magnitude of large earthquakes and they are generally available 20 to 55 minutes (increasing with the epicentral distance to the station) after the occurrence of a magnitude 6.5 or larger event.

For example, a moment magnitude Mw of 7.2 (compared to Mw7.1 provided by CMT Harvard) was associated to the Taiwan earthquake of 31/03/2002 in the EMSC alert message 84 minutes after its occurrence.

What is the content of the alert and information messages?

The EMSC issues two types of messages: *alert messages and information messages. Alert messages* are related to earthquakes which magnitude is above the magnitude threshold for the region of interest. The goal of the *information messages* is twofold. It is used to provide, if necessary, revised source parameters following a seismic alert. It is also the mean to provide information on specific events. These informations can be source parameters of a significant event which magnitude is below the magnitude threshold or, for example, reports on earthquake damage or information relative to EMSC activities.

All messages reporting source parameters have the same structure whether there are *information* or *alert* ones. They contain the source parameters computed by EMSC (i.e. origin time, epicentral location, focal depth and magnitude), parameters which characterise the location accuracy (root mean square, confidence ellipse and the number of data used), the list of the contributing agencies, the name of the person who performed the location and at what time this location was computed. For the scientific community, a message containing the seismic waves arrival times is also available.

Who can receive the messages and how are they disseminated?

Anyone who subscribes to the dissemination list on our web site will subsequently receive our messages. The messages are disseminated by email. EMSC sends its messages by fax to a number of organisations such as civil defence services, ECHO, Council of Europe, the fax being more reliable than Internet.

The EMSC provides this service for free. Nevertheless, organisations which are not already EMSC members, are encouraged to participate to the operating costs through a financial contribution.

What are the EWS performances?

The first criterion (and probably one of the most difficult to meet) to assess an EWS performances is its ability to remain in

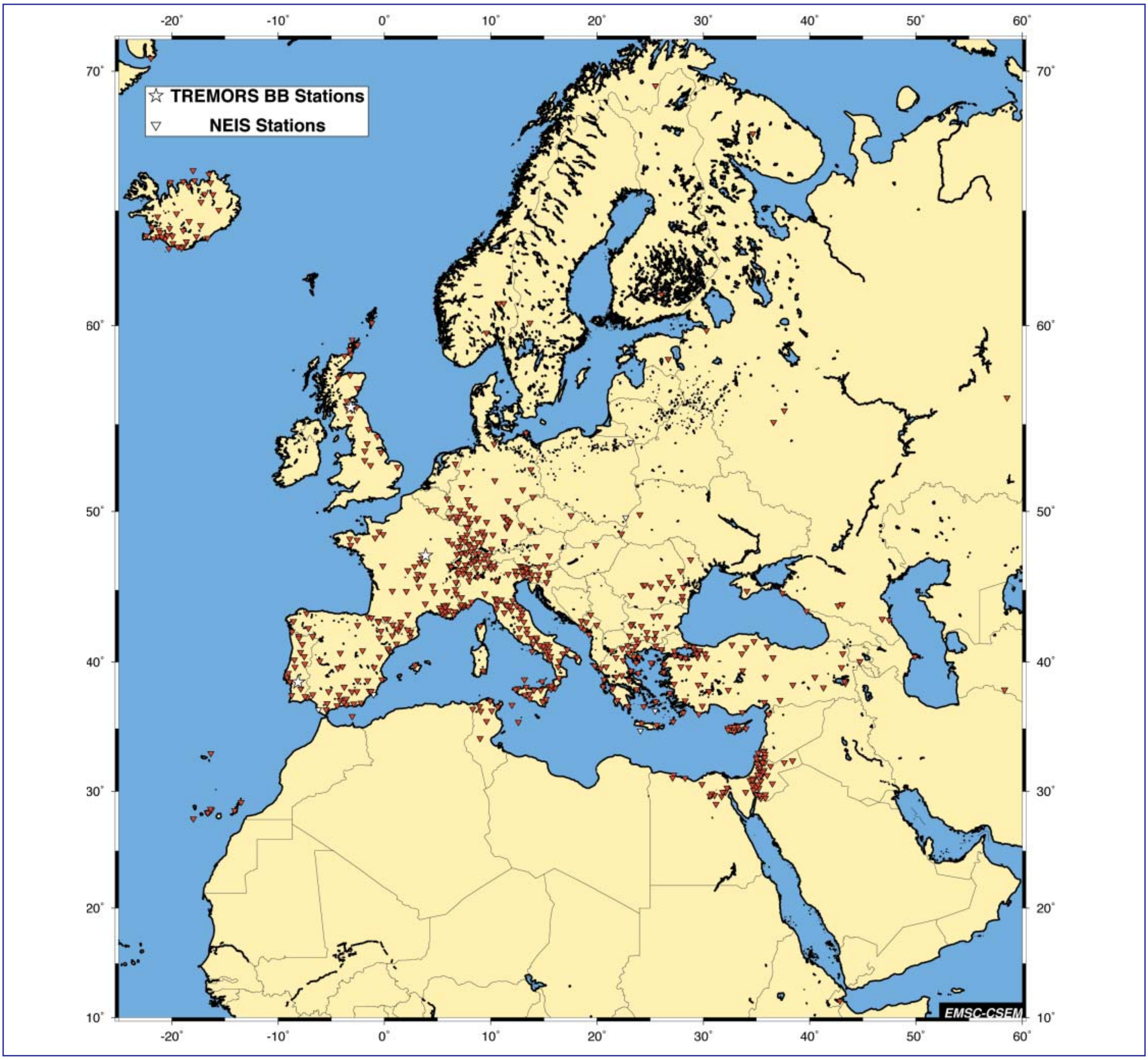

Figure 4: *Map of 614 seismic stations located in the European-Mediterranean region that have contributed to the* Early Warning System *and/or the* Real time Seismicity *since the beginning of 2002. World-wide, 886 individual stations have contributed in the same time period.*

operation 24h a day 365 days a year. The procedures which have been set up since 1993 and which are constantly upgraded have proved to deliver an operational system. Furthermore, its distributed architecture implies that consequences of temporary failure of one or several of its data contributors remain limited.

The growing number of contributing networks has significantly improved the triggering lag time (time delay between the earthquake occurrence and the triggering of the alert) and the accuracy of the solutions provided by the EMSC. A quick comparison with results reported in our *Newsletter n°8* shows the following points:

- **In 1995, the triggering occurred in less than 30 min for 65% of the alerts, whereas in 2002 for 90% of all alerts the triggering occurs in less than 20 minutes. There are only earthquakes located outside the European-Mediterranean region in the 10% remaining. Subsequently (and thanks to the professionalism of the seismologists on duty), the dissemination time exhibits also a significant decrease during the same time period: if in 1995 70% of the alert were disseminated within 2h, where in 2002, more than 85% were disseminated within 1 hour, the longest dissemination time being 93 minutes for an event close to the Mariana Islands.**
- **If the surface area of the uncertainty ellipse is taken as an indicator of the location accuracy, in 1995, 75% of the alerts had an ellipse of less than 1000 km^2 (i.e. average radius of 18 km), in 2002, 75% of the alerts have an ellipse of less than 350 km^2 (i.e. average radius of 11 km).**

The improvement in location accuracy is also partly due to the implementation of specific velocity models for border regions. These velocity models have been developed in the framework of the EPSI (Earthquake Parameters and Standardised Information), an EU-funded project which aims at defining a homogeneous European - Mediterranean Seismological Bulletin. More details on these velocity models can be found in our web site and in www.ingv.it/~roma/reti/epsi/index.htm. A detailed study of location accuracy in alert mode will be performed in the coming months.

Real Time Seismicity as an extension of the EWS?

The *Real Time Seismicity* web page which was first developed for the EWS has also been used since mid-2001 to provide information on current seismicity by computing and displaying an automatic relocation called *MIX* which merges all available data. This MIX location generally provides a better estimation of earthquakes source parameters than each messages taken individually.

Each message sent to EMSC automatically appears on one line on the *Real Time Seismicity page* (Figure 3). An hyperlink to the raw file is available in the «Date» column and its reception date and time appears at the end of the message. Messages are ranked as a function of the reported origin time (time column), the most recent message being at the top of the page (Figure 3). Messages that are *a priori* related to the same seismic event are automatically grouped together (horizontal lines separate the different groups) on spatio-temporal criteria. For events with a reported magnitude above the magnitude threshold, the networks which have contributed to the alert triggering and the message created by EMSC will appear (Figure 3).

Every 2 hours an automatic relocation program developed for the fusion of seismological bulletins (this is part of the EPSI project) is applied to new groups as well as groups which have received additional information in the last 2 hours. If the location process converges, the new relocation appears in the group under the network name *MIX*. An epicentral map is available in the body of the MIX message which shows the location provided by the different agencies and the relocation (Figure 5).

Although it is a fully automatic process, this system has proved, as an average, to improve the location reliability. Tuning will be finalised in the coming months and the periodicity of the update will be gradually reduced to 15 minutes and new maps will be developed to provide a clear picture of the recent seismicity.

What are the main challenges for the future?

One of our main challenges is to set the magnitude threshold at 5 in all the land of the European-Mediterranean region. This is currently not the case in the Middle East and Northern Africa (Figure 1). Although data exchange with Institutes from these regions have significantly improved in the very last years through, in some cases, the definition of specific procedures to overcome technical limitations, we still have to work towards better geographical coverage and more regular and more reliable exchange before lowering the threshold. These is one of our priorities.

These improved data exchange procedures are part of a number of actions which aim to further reduce dissemination time and to further improve hypocentral location accuracy.

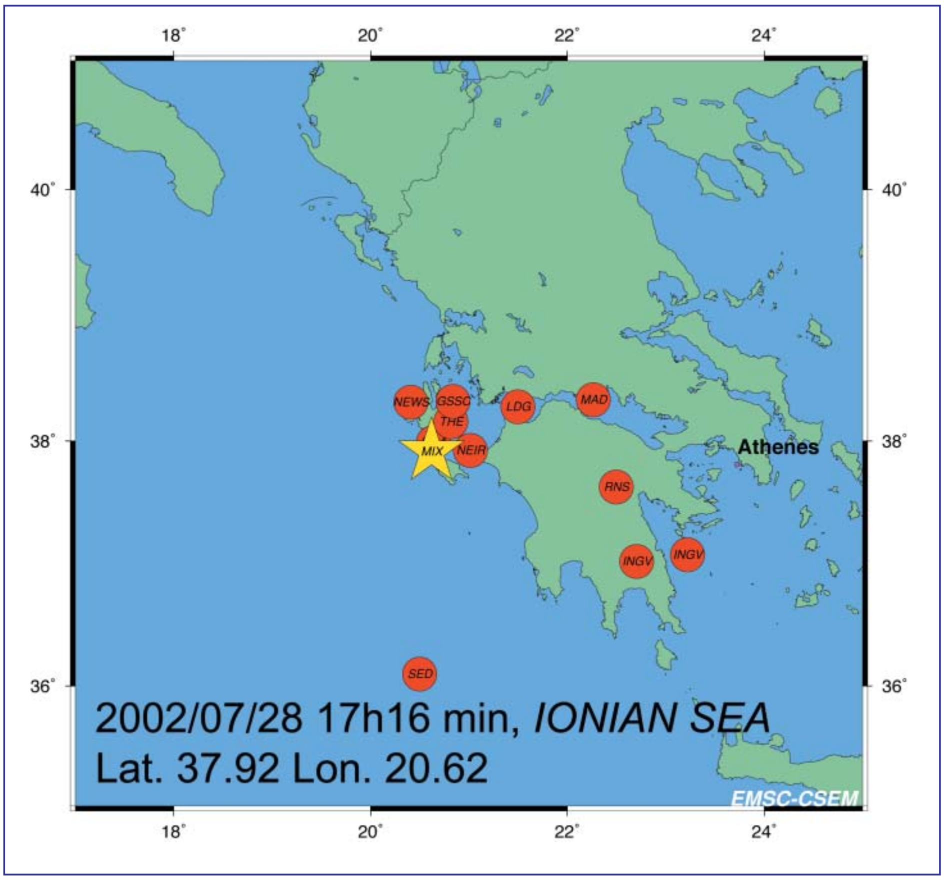

Figure 5: *Epicentral position of the automatic relocation (yellow star) computed by EMSC and epicentral position provided by each of the contributing agencies (red dots) for the seismic event of the 22/07/28. The relocation map is automatically created and displayed on the web site.*

A new web site is currently being developed that will be more user-friendly. The EMSC web site is becoming more popular and, from emails we receive, it seems that more non-specialists access it. The present version was mainly developed for the seismological community and we believe that it did well but it is not easy to understand for non-scientists. Although it will remain focused on the need of the seismological community, the presentation will be more graspable. Procedures are also set up to rapidly and automatically gather and display all available information on significant earthquakes in the European-Mediterranean region (moment tensors, reports on the effects...). In case of damaging event within this region, or on request, a special page will be open and all contribution, from tectonic setting to macroseismic data will be welcome.

Finally, our contacts with civil defence services have clearly demonstrated the need for rapid characterisation of earthquake damage. Because EMSC is an operational structure and because of its links with civil defence services, EMSC is very probably the right place to run this kind of service and we will take every opportunity to promote this project.

List of contributing networks

BAS Bulgarian Academy of Science, Sofia Bulgaria; ***BGR*** Bundesanstalt fur Geowissenschaften und Rohstoffe, Hannover Germany; ***BGS*** British Geological Survey, Edinburgh United Kingdom; ***BUC*** National Institute of Earth Physics, Bucharest Romania; ***DJI*** Observatoire Géophysique d'Arta, *Djibouti*; ***GII*** Geophysical Institute of *Israel*; ***GSD*** Geological Survey Department *Cyprus*; ***GSSC*** Geophysical Survey Russian Academy of Sciences *Russia*, ***ICC*** Instituto Cartografico de Catalunya, Barcelona *Spain*; ***IGN*** Instituto Geografico Nacional, Madrid *Spain*; ***IMO*** Icelandic Meteorological Observatory, Reykjavik *Iceland*; ***IMP*** Instituto de Meteorologia, Lisbon *Portugal*; ***INGV*** Istituto Nazionale di Geofisica e Vulcanologia *Italy*; ***INMT*** Institut National Météorologique *Tunisia*; ***JSO*** Jordan Seismological Observatory, Amman *Jordan*; ***KAN*** Kandilli Observatory, Istanbul *Turkey*; ***KNMI*** Koninklijk Nederlands Meteorologish Instituut *The Netherlands*; ***LDG*** Laboratoire de Détection et de Géophysique, Paris *France*; **LED** Geologisches Landesamt Baden-Wuerttemberg, Freiburg **Germany**; ***LJU*** Urad za seizmologijo, Ljubljana *Slovenia*; ***MSO*** Montenegro Seismological Observatory *Montenegro*; ***NEIA*** USGS/NEIC (automatic location) *USA*; ***NEIR*** USGS/NEIC (manual location) *USA*; ***NEWS*** Norsar Early Warning System, *Norway*; ***NOA*** National Observatory of Athens *Greece*; ***NOR*** NORSAR Array *Norway*, ***NRIAG*** National Seismic Network *Egypt*; ***ODC*** ORFEUS data Center, De Bilt *The Netherlands*; ***OGS*** Osservatorio Geofisico Sperimentale, Trieste *Italy*; ***RNS*** Réseau National de Surveillance Sismique, Strasbourg *France*; ***SED*** Swiss Seismological Service, Zuerich *Switzerland*; ***THE*** University of Thessaloniki *Greece*; ***ZAG*** Seismological Survey, University of Zagreb *Croatia*

National Institute of Research and Development for Earth Physics, Bucharest: 25 years of activity

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The National Institute of Research and Development for Earth Physics (NIEP) was founded in February, 1977, to coordinate the research activities related to earthquakes in Romania. NIEP is co-ordinated by the Romanian Ministry for Education and Research.

As main task, NIEP carries out the seismic survey of Romania and operates the national seismic network. It has a wide background in earth sciences research, with focus on seismic source and seismotectonics, seismic hazard assessment, site effects and microzonation, lithosphere structure and dynamics, earthquake prediction, assessment and mitigation of seismic risk. Also, NIEP ensures Romania's technical contribution to global seismological monitoring in support of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Given its demanding operational mission, key objective of NIEP is the development of an advanced seismic data collection and management system, including robust real-time data acquisition techniques, reliable communications links, rapid processing and exchange of earthquake information, compilation of bulletins and earthquake catalogues.

A chart of the main research objectives of NIEP is presented in Figure 1.

Earthquake Monitoring

NIEP operates a real-time seismic network consisting of 18 short-period stations, 14 of them located in the Eastern and Southern Carpathians and telemetered to Bucharest, 4 stations sited in the Western part of Romania and telemetered to a regional recording center (Figure 2). The first sub-network, installed in 1980-1982, is primarily designed to survey Vrancea seismic region, located at the Carpathian arc bend and characterized by important intermediate depth seismic activity, with 3-4 destroying earthquakes per century significantly affecting extended areas in Europe, as well as by moderate crustal seismic activity. Since 1994, in cooperation with the German government, one of its stations (Muntele Roşu) is provided with high performance seismological instruments and became part of the GEOFON network. The second sub-network, installed in 1995, is dedicated to the survey of the Banat region, characterized by a relatively intense crustal seismic activity. Both NIEP data centers use an automated and networked seismological system for the on-line digital acquisition and processing of the seismic data, providing rapid earthquake location and magnitude determination (Oncescu et al., 1996). The results are rapidly distributed, via Internet, to several seismological services around the world, including the European-Mediterranean Seismological Centre, to be used in the association / confirmation procedures and for contributing to unified bulletins.

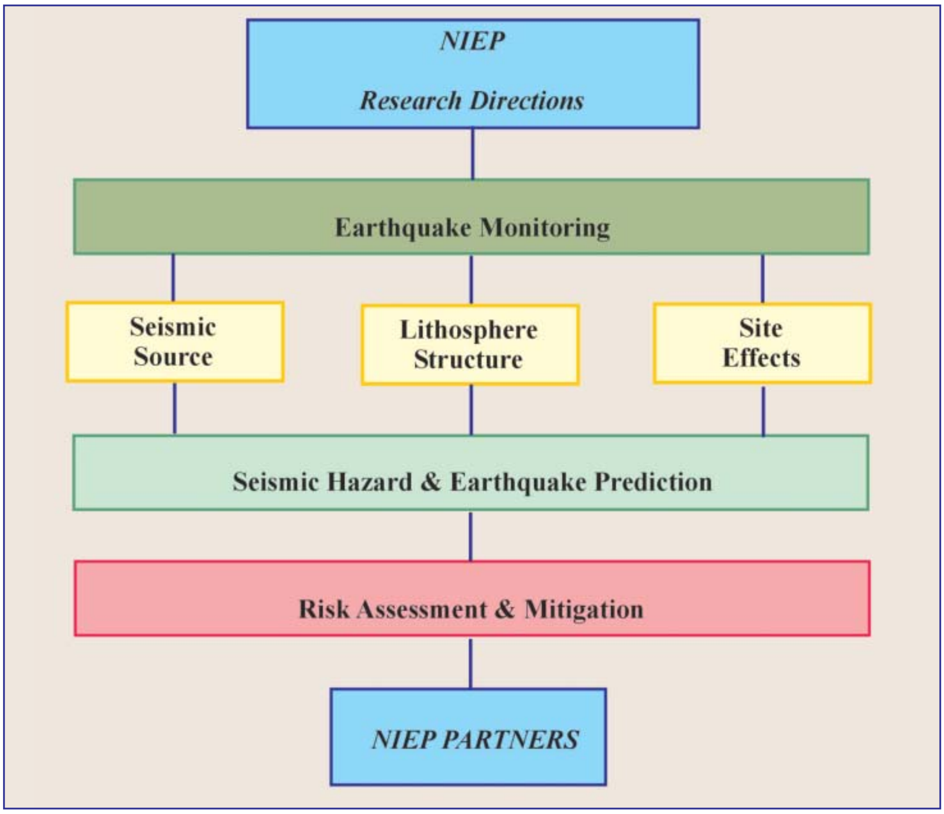

Figure 1: *NIEP major research areas and their multidisciplinary integration scheme. The last objective (Risk Assessment and Mitigation) is the subject for collaborative activities between NIEP scientists and partners from other communities – earthquake engineers, risk analysis, and emergency management. To make this partnership effective, NIEP has in view to develop an implementation interface.*

NIEP also operates a free-field strong motion network consisting of 36 K2 seismic stations and 21 SMA-1 accelerometers for recording the strong and moderate Vrancea earthquakes (Figure 2). The K2-network, centered around the Vrancea seismic zone and covering an area with a diameter of up to 500 km, has been installed in Romania recently (1995-1997), in the framework of the Romanian-German cooperation, within the project "Strong Earthquakes: A Challenge for Geosciences and Civil Engineering" of the University of Karlsruhe, Germany (Bonjer et al., 2000).

NIEP has more than 25 years of experience in global seismological monitoring in support of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). It is participating to the international verification activities with the seismic station Muntele Roşu, which was included in the auxiliary seismic network of the International Monitoring System, and with the operation of the Romania's National Data Centre (NDC). In order to ensure Romania's technical contribution to CTBT at the operational standards required by the Treaty, since 1999 an important upgrade has been under development both at the seismic station Muntele Roşu and at the NDC, involving both technical cooperation with the Government of Japan and technical assistance from the CTBT Organization. Hence, in the fall of 2001 a new seismic monitoring system was installed and is now fully operational, by recording continuous earth motion data at Muntele Roşu site and transmitting these data in real-time to the facilities in Bucharest (Figure 3), in the framework of the Japan International Cooperation Agency project «Technical Cooperation for Seismic Monitoring System in Romania». Also, during 2001-2002, the CTBT Organization has supported the site preparation works at the seismic station Muntele Roşu and supplied equipment for establishing reliable data communications links between the seismic station, the NDC and the International Data Centre from Vienna.

Recently, a new seismic monitoring station, the Bucovina Seismic Array, has been established in the northern part of Romania, in a joint effort of the Air Force Technical Applications Center, USA, and the NIEP. By July, 2002, the new seismic monitoring system will become fully operational by continuous recording and

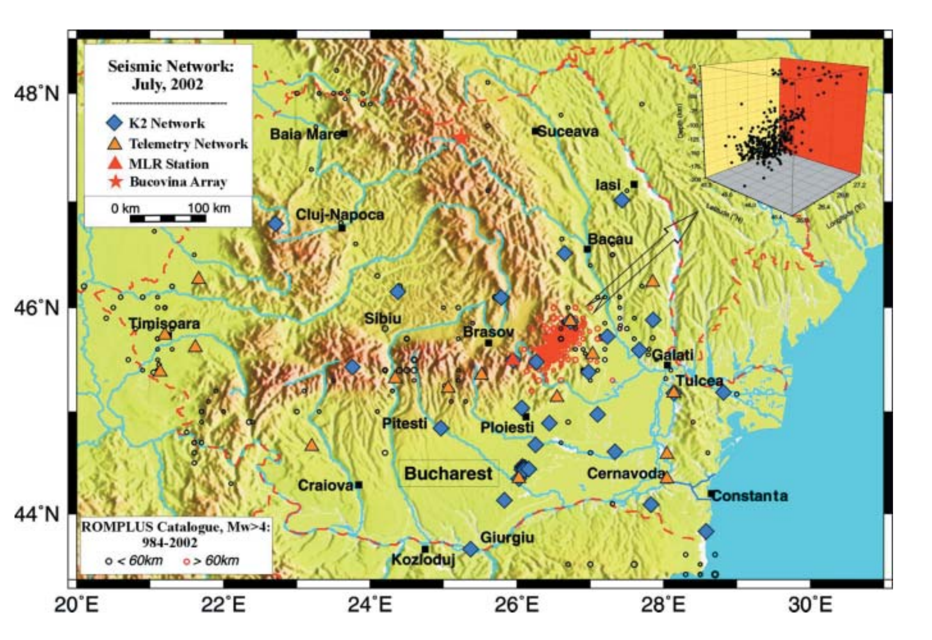

Figure 2: *Seismic network and epicenter map of earthquakes on Romania territory. The insert in the upper-right corner shows the depth distribution of Vrancea earthquakes.*

transmitting data in real-time to the National Data Centers of USA, in Florida and of Romania, in Bucharest.

Near-future strategy includes development of Romania real-time digital seismic network. Data recorded by three additional broad band stations (the Geofon station to be relocated from Muntele Roşu to a new site in North-Dobrogea, East Romania, as well as the K2 station in Apuseni Mountains and an upgraded station in Banat, West Romania) will be transmitted continuously to the Bucharest data centre, using satellite communications links provided by the NATO Science for Peace project 972266 'Impact of Vrancea Earthquakes on the Security of Bucharest and other Adjacent Urban Areas'. The main aim is the real-time determination of hypocenters in all seismic regions of Romania and rapid estimation of damages in case of destructive earthquakes (Figure 4).

NIEP also coordinates the field observations following major earthquakes. A portable pool of instruments is provided in the framework of the bilateral co-operation programme with GeoForschungsZentrum of Potsdam (Germany), "Task Force Earthquakes" as high-performance seismic instrumentation for post-seismic response.

At present, a new earthquake database for Romania is being constructed, comprising complete earthquake information and being up-to-date, user-friendly and rapidly accessible. The main component of the database is the catalogue of earthquakes occurred in Romania since 984 up to present, including information related to locations and other source parameters, as well as links to waveforms of strong earthquakes (Oncescu et al., 1999). Seismicity analysis is continuously performed implying updating of the earthquake catalogue, spatial-temporal-magnitude patterns in different seismic regions of Romania, earthquake sequences. Interpretation and reconsidering of historical data constitutes an important issue for the seismic hazard investigation.

Seismic source is one of the main research topics with the long-term goal to construct a quantitative physical model for the earthquake behavior, including all the aspects of earthquake phenomena, from the small scale-scale (dynamic rupture) to large-scale (plate boundary tectonics) processes. Tectonic stress accumulation, nucleation of rupture, and dynamics of the rupture propagation and cessation are among the most important subjects. Rupture modelling involves nonlinear processes and geometrical complexities on various scale lengths, which is a challenging task at the boundary between seismology and computational sciences. The recent advance in both observations and computer simulations has strongly increased our performance in constraining the source parameters over a broad magnitude range. The investigations were focused on Vrancea intermediate-depth focus, where the most damaging earthquakes of Romania are generated. Inversion techniques and empirical Green's function deconvolution are applied to infer source characteristics. Another important issue is the physical interpretation of the spatial, temporal and size distributions of earthquakes, their clustering and scaling properties. Partly the research is made in cooperation with the University of Trieste (Italy) (bilateral cooperation programme, NATO SfP project, UNESCO-IUGS-IGCP projects) and University of Karlsruhe (bilateral cooperation programme, NATO projects).

Lithosphere structure shows strong lateral variations on the Romanian territory in the crustal and subcrustal domains as well, as recent seismic tomography (Wenzel et al., 1998) and refraction/reflection (Hauser et al., 2000) experiments confirmed. Crustal and uppermost mantle structure are resolved using waveform data from local, regional and teleseismic earthquakes recorded on permanent and temporary stations. The mapping of the topography of the crust-mantle boundary will shed light on the rheology of the lower crust and connect observed surface motions with underlying mantle flow. A better knowledge of the Moho discontinuity will also improve the prediction of strong ground motions. Permanent geodetic measurements are carried out in order to map crustal deformation, and model of strain and stress evolution

The complex continental collision tectonics and the unusual concentration of the seismic activity in the Vrancea area can be considered like a natural laboratory ideal for basic earthquake research. Several new models of the seismotectonics in the Vrancea seismic region were proposed in the last years, attempting to integrate the seismological data (seismicity, earthquake focal mechanism, seismic wave propagation) with other geophysical data (gravity, geodesy, heat flow, volcanism, geochemistry). An important strategy issue of NIEP is the integration of the multiple data sets to construct a 3-D structure modelling for the Romanian territory.

Figure 3: *Bucharest data centre (left) and Muntele Roşu seismic station (right).*

Local site effects are affecting to a large extent the characteristics of the ground motion recorded at surface. A few projects have been set forth in cooperation with University of Trieste (Italy) and Karlsruhe (Germany) to understand how sedimentary basins influence earthquake ground motion and their focussing effects. The attention has been focused on Bucharest area, which experienced the largest damage in the past Vrancea earthquakes. The simulation of the strong ground motion in Bucharest using hybrid and analytical techniques in two-dimensional models proved encouraging when compared against observations (Moldoveanu and Panza, 2000). Another clue problem is to make effective use of nonlinear soil models in research and seismic hazard products.

Seismic hazard is evaluated in a form, either probabilistic or scenario-based, to be further used for earthquake engineering and emergency management. No matter the approach is probabilistic or deterministic, major improvements are (1) the incorporation of new types of geologic, seismic and geophysical data into seismic hazard characterization and (2) a better understanding of how the source and structure parameters control the strong ground motions. The Vrancea source is an interesting unique case, taking into account the time persistence of the earthquake activity in a well-constrained and unusually confined focal volume and the invariance of the focal mechanism. Therefore, in a scenario-based analysis, we may simply fix the source-site geometry, knowing this way relatively well propagation and site effects, which are essential in a seismic hazard determination. However, there are still a lot of opened questions regarding the rupture dynamics at intermediate depths, the role of fluids and segment boundaries, how nonlinear seismic response of soils depend on medium properties, amplitude and frequency.

Reliable procedures for simulating ground motion time histories have been developed in cooperation with University of Trieste (Italy) within different international projects (Copernicus, NATO, UNESCO-IUGS-IGCP – see the special volume of Pure and Applied Geophysics, vol. 157, 2000, dedicated to this subject-Panza et al., 2000). Through rigorous testing of the deterministic results against recorded strong ground motion data, NIEP aims to develop methods that can be applied routinely with a high level of confidence in earthquake engineering research and practice. A coordinated strategy related to seismic hazard and seismic risk mitigation has been developed and implemented within a large cooperation with University of Karlsruhe (Germany) within the CRC 431 programme "Strong Earthquakes: a Challenge for Geosciences and Civil Engineering" (Wenzel, 1997).

As concerns the ***Earthquake prediction*** issue, one direction is to monitor the evolution of multiple geophysical parameters in order to find possible correlations with earthquake occurrence. This is essentially an empirical approach, driven by observation data. Specific techniques of analysis are implemented in order to detect premonitory changes of the Vrancea strong shocks. Different algorithms, like CN, were applied to predict the strong Vrancea earthquakes (Novikova et al., 1995). In parallel, physics-based efforts will be made for understanding the small- and large-scale processes associated to major earthquakes. As a consequence of the tremendous quantitative and qualitative increase of instrumental data in the last years, we shall apply high-resolution location techniques to resolve the spatiotemporal distribution of microearthquakes in Vrancea focal volume, and investigate the circumstances under which we can extrapolate results based on low-magnitude seismicity to large-earthquake behaviour.

Risk assessment and mitigation is one of the permanent and urgent problems facing the Romanian society, equally implying work of seismologists, geologists and engineers. Significant efforts were made to predict the peak values and spectral characteristics of the strong motion in large urban areas, like Bucharest. At the same time, important efforts were made to determine the site effects and microzonation maps for the same city. Nowadays, a crucial NIEP strategy issue is to enhance the application of basic research to earthquake risk reduction, and to integrate of our physics-based results in urban security problems. To this aim, NIEP will promote and develop the interface between understanding earthquake process and communicating this understanding to engineers, emergency managers, government officials, and the general public.

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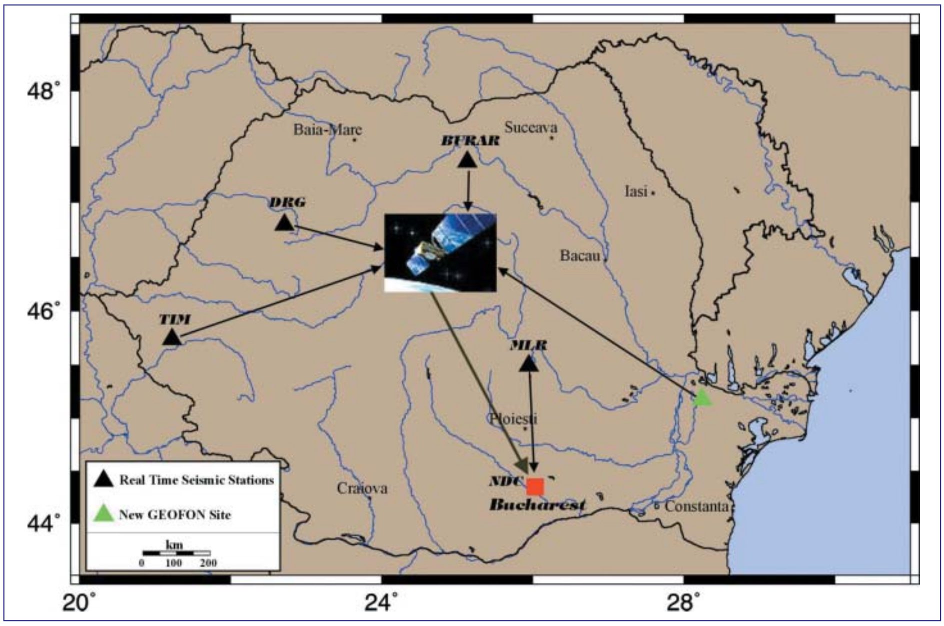

Figure 4: *Future real-time seismic network of Romania, consisting of five digital broadband stations.*

The Field Investigation Team of the ESC: Proposals and present progress

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Short History of FITESC

FITESC is the acronym for the Field Investigation Team of the ESC (Musson et al, 2001). It is not a new idea to form an international team, which would collect, and later evaluate, macroseismic data for strong and damaging earthquakes in Europe and the Mediterranean. But after recent events in the 1990s (such as Southern Croatia, 1996, Central Italy, 1997, NW Slovenia, 1998, and especially Turkey and Greece, 1999, see Figure 1), the absence of such a team was keenly felt, and discussions of this subject were re-opened.

It was obvious that the seismological community currently lacks the mechanism for creating such a team. But if such an activity could be promoted, it would be possible to have a public homogeneous database of earthquake effect data, a valuable resource for many studies. Having such a team would also make an important improvement to the present level of co-operation and exchange of information in the Euro-Mediterranean region. At the General Assembly of the ESC in Lisbon, Portugal in 2000 a resolution was endorsed, in which an interest in creating such a team was expressed. A Preliminary Committee was formed, with aim to explore the possibilities of making this idea a reality. The feasibility study will be presented at the next ESC General Assembly, that will take place in Genoa, Italy in September 2002. It is expected that ESC will recognise the results and endorse FITESC as a first official international seismological team in the history of Europe.

Questions and answers about FITESC

There are several frequently asked questions about FITESC, which can be answered here:

1. How often would the team be launched?

The region under investigation, that is Europe and the Mediterranean area, experiences on average one damaging earthquake per year. Of course, there are years without such events, and there are years with more such earthquakes, as was the case in 1999. The criteria for launching the team on a mission cannot be completely rigid, and should be flexible, depending on each separate case. However, for the planning purposes we take one event per year as a good estimate of future activity.

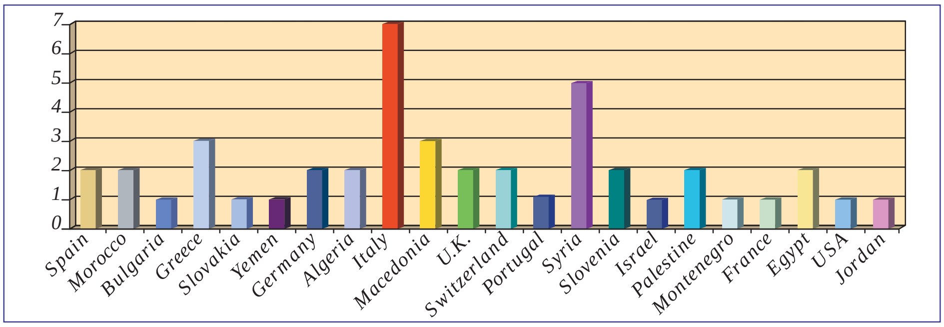

Figure 2: *FITESC team members (as of 21 June 2002). The countries are presented following the order when the applications were received.*

2. How expensive will it be?

A study made in 2000 by eight experts with experience in data collecting in the field brought up the average amount of approx. 16,000 Euros per year. Once again it should be pointed out that the price can be significantly lower or higher, depending on unpredictable factors, such as accessibility, the length of the sequence or the size of the stricken area. Nevertheless, we are still talking about small, not to say negligible, amounts of money for European countries.

3. How is the money going to be managed?

EMSC, being a daughter organisation of ESC, has kindly offered FITESC to act as a banker. To enable the fastest possible action, a certain sum will be always accessible by the person in charge of the team organisation; this is important to avoid delays in money transfers, as speed in launching of the team in the case of a major earthquake is a paramount consideration.

4. Who is going to pay for it?

During the past two years many actions were taken and contacts established by the members of the Preliminary Committee, in order to obtain permanent or temporary funding for the team activities. Up to now the collection of funds has not begun, due to legal matters that are still being settled. However, we have exploited the possibilities of having permanent sponsorship (from the insurance and re-insurance communities, for example, as well from seismological institutions, governments etc), as well as temporary sponsorship (that is connected mainly to the local communities directly involved with the specific earthquake). Presenting FITESC in the form of a project (e.g. for the European Community's scientific Frameworks) does not seem appropriate, as our model for activity is unlike those of typical short-term research projects. We can not guarantee that we can produce an activity report each year, and we can not predict when and how much money we would need to engage after an earthquake happens. Some options with organisations like UNESCO, ESF etc, are still being explored.

5. How many people would be involved in this activity?

The structure of the FITESC is pyramidal: at present (21 June 2002) there are 45 team members, from 22 countries (see Figure 2). Team members from each country select among them one national representative. The FITESC Core Group consists of three members of the Preliminary Committee, the Chairperson and Vice-Chairperson of ESC Subcommission F «Engineering Seismology» (who took the first initiative for this activity) and five active team members. The decisions are taken by the three FITESC Office members, who are also meant to be «on-duty» as regards the launching procedures, anytime as needed.

When collecting information about the team members, the application form was sent to dozens of addresses. There were replies from some countries that indicated, for various reasons, that they would not wish to be included in this activity at this time. This is a present status for Austria, Czech Republic, Finland and the Netherlands.

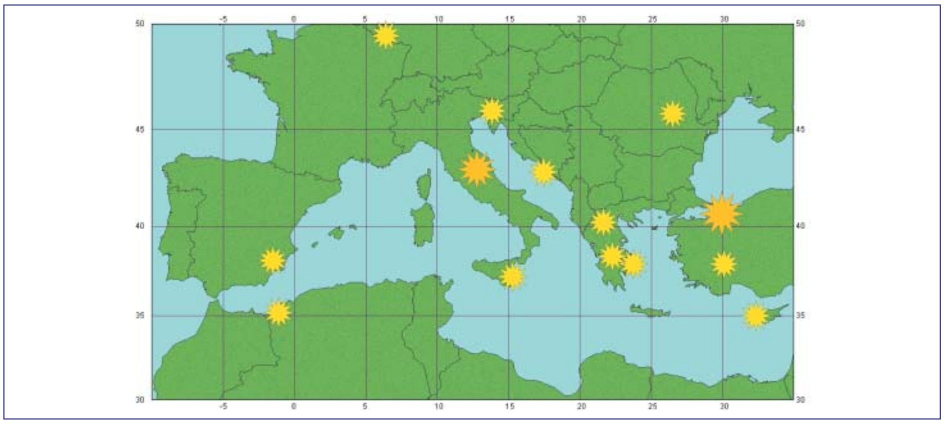

Figure 1: *Earthquakes since 1990 in the European-Mediterranean area that caused significant damage and would most likely have triggered field missions. The two larger and darker stars represent the two very heavily damaging earthquakes in this period: 1997 Umbria-Marche and 1999 Izmit.*

Some details about the team members: the majority (62%) declared that they would join the team for sure if called upon, the rest of them will do that perhaps, depending upon circumstances. Among the team members, there are 45% seismologists, 20% civil engineers and 35% of those who need some training before they can work in the field (Figure 3). We find this score encouraging, as well as the fact that 94% of the team members want to be included in the data evaluation.

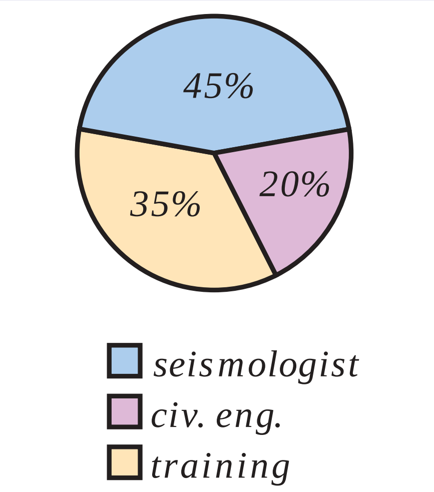

Figure 3: *The structure of the future team, according to the professions and skills of its members.*

Each team would be consisting of approximately 10 people, both seismologists and engineers. Every earthquake is also a precious opportunuty for training, so 2-3 team members without previous experience in the field would be taken along and trained. Also, team would offer training to the personnel of the host institution, if needed, as well as training of the students from the host country, who would be included as interpreters, drivers etc.

6. What will be the data collection procedures?

The team would collect macroseismic data in a way that would enable evaluation using the EMS-98 intensity scale as a main tool. It is important to stress that this can best be achieved only as a multidisciplinary approach, with seismologists and civil engineers working together. The necessary questionnaires, forms etc. are under preparation.

Following the same pre-defined methodology for each mission would also facilitate the creation of a homogeneous data set.

7. What will be the team launching procedures?

After an earthquake that would satisfy certain criteria, the team Office establishes immediate contact with the team members, checking the availability and eventual needs before the mission is launched. The host country is contacted as well, either through the team national representative, or directly by the seismological officer in charge, and permission is asked for the team to come. It is understandable that the team goes to a certain country ONLY in case that the host seismological institution agrees with that.

On the other hand, if the personal security of the team members is questionable, the team might decline the invitation to go to a certain region. It is foreseen that the team members should start arriving 24 hours after the earthquake.

It should be pointed out once again that the aim of FITESC is to promote co-operation and not create conflicts; during the team's stay in some country, the main authority in charge for the macroseismic data is and stays the host seismological institution. The purpose of FITESC is purely scientific. All the communication with the media are in the domain of the host institution.

8. What about the data availability?

All the collected data will be public and presented via the Internet. A web page will be hosted by EMSC, and edited by the team members. The data could not be used for commercial purposes without the agreement of FITESC.

9. Where has this idea been presented?

a). Events and presentations:

- Santa Sussana, Spain, May 2001
  In the interest of reducing earthquake risk in the Mediterranean region, UNESCO and the Instituto de Ciencias de la Tierra 'Jaume Almera' - CSIC, Barcelona, Spain, held a workshop on Earthquake Hazard Assessment Practice and Velocity Models and Reference Events in the Mediterranean Region. A presentation «Towards A Macroseismic Survey Team for Severe Earthquakes in Europe and the Mediterranean Basin» (Musson, Cecić and Mayer-Rosa) was given there. The participants were predominantly seismologists and civil engineers from Mediterranean countries, with whom the possibilities of FITESC engagement in case of a disastrous event in their countries were discussed. In general everybody was very much in favour of the idea. The possibilities of co-operation were discussed also with UNESCO representatives.
- Meeting in Zurich, Switzerland, July 2001
  The Preliminary Committee held a meeting in Zurich in July 2001, on which some priorities of the future work were set.
- Kalamata, Greece, December 2001
  Within the framework of the Euro-Mediterranean initiative concerning the mobilisation of the scientific and technical community to improve risk management, a Forum has been organized within the programme of the EUR-OPA Major Hazards Agreement, with the support of the European Commission, DG Research - International Co-operation. Its title was «Seismic Risks». This Forum was one of a sequence of workshops organised by the same institutions, and the final conclusions (made in Montpellier, France, December 2001) foresee the organisation of several large European projects that would approach the problem of risk reduction in a multidisciplinary way. Our proposal, i.e. the field investigation team for macroseismic data collection, was included as an important part of future proposals. The presentation «Field Investigation Team of the ESC (FITESC) – A Task Force for Severe Earthquakes in Europe and the Mediterranean basin» by Musson, Mayer-Rosa and Cecić was given.
- Meeting in Ljubljana, Slovenia, May-June 2002
  The FITESC Core Group held a meeting in Ljubljana, on which the progress report was given, the existing national practices and experiences were presented and the ideas and tasks for the next months were discussed.
- PILAR - UNESCO Planning Meeting in Paris, France, June 2002 Active projects and initiatives in the Mediterranean region were presented and the possibilities of co-operation and better coordination in between them were discussed. More possibilities of co-operation with FITESC were explored with UNESCO representatives. FITESC flyer (edited by Vicki Kouskouna) was distributed to the participants of the meeting.
- at the XXVIII General Assembly of the European Seismological Commission in Genoa, Italy, in September 2002 there will be two presentations about FITESC:
- in the Special Session SS-4 (Earthquake Preparedness and Civil Defence) a presentation «Towards a macroseismic survey team for severe earthquakes in Europe and the Mediterranean Basin» by R. Musson, I. Cecić, D. Mayer-Rosa and A. Tertulliani;
- in the Session SCF-4 (Methods and practice for routine macroseismic data collection in the 21st century) a presentation by Ina Cecić and the FITESC Preparatory Group: «FITESC - Field Investigating Team for Severe Earthquakes in Europe and the Mediterranean Basin».

b) Publications:

- Musson, R., I. Cecić and D. Mayer-Rosa, 2001. Towards a Macroseismic Survey Team for Severe Earthquakes in Europe and the Mediterranean Basin. CSEM/EMSC Newsletter, No. 17, pp. 8-10
- abstract in proceedings of Santa Sussana workshop (UNESCO, in press)
- Cecić, I., R. Musson and D. Mayer-Rosa, 2001. Macroseismic Survey Team for Severe Earthquakes in Europe and the Mediterranean Basin (FITESC). In: F. Vodopivec, ed., Raziskave s področja geodezije in geofizike, 7. strokovno srečanje Slovenskega združenja za geodezijo in geofiziko, Ljubljana, 13. december 2001, FGG - Katedra za geodezijo, pp. 77-81 (in English with Slovene abstract)
- proceedings of the EUR-OPA Major Hazards Agreement programme, in press

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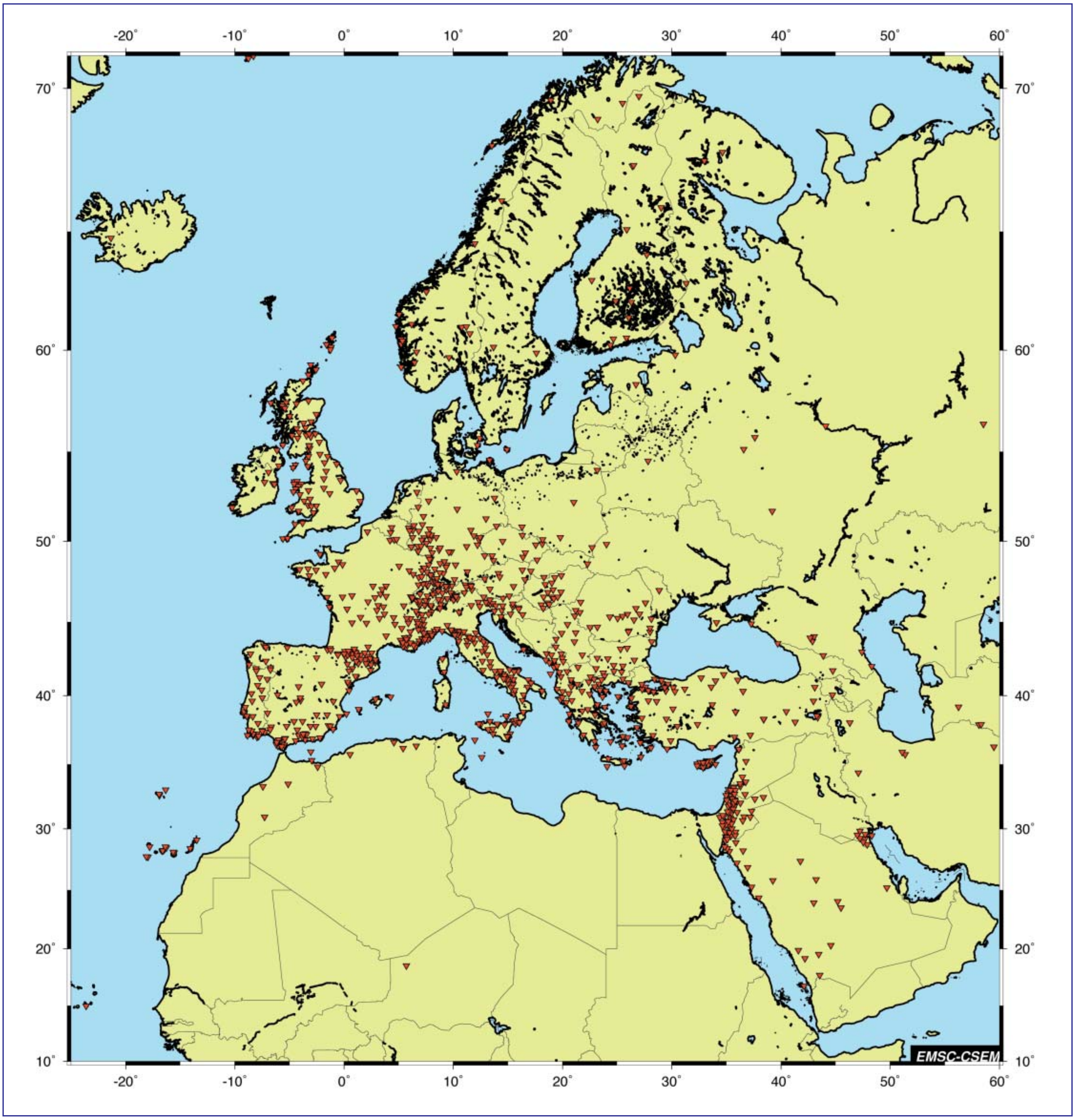

The European-Mediterraean Seismological bulletin will be produced on an operational basis by the end of September. New data contributions are strongly encouraged to ensure an optimum geographical coverage! Preliminary results are already available on our web site (EPSI page) and your feedback and/or comments are welcome.

ANNOUNCEMENTS BY ORFEUS

EMICES Workshop "Real Time Data Exchange within Europe", 23-25 October 2002, Barcelona, Spain

Third annual MEREDIAN meeting, 21-22 October 2002, Barcelona, Spain.

Orfeus WG2 Workshop "Installation and operation of broad-band seismograph stations", 18-20 November, Istanbul, Turkey.

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