Centre Sismologique Euro-Méditerranéen
European-Mediterranean Seismological Centre

Newsletter

N° 10 SEPTEMBER 1996

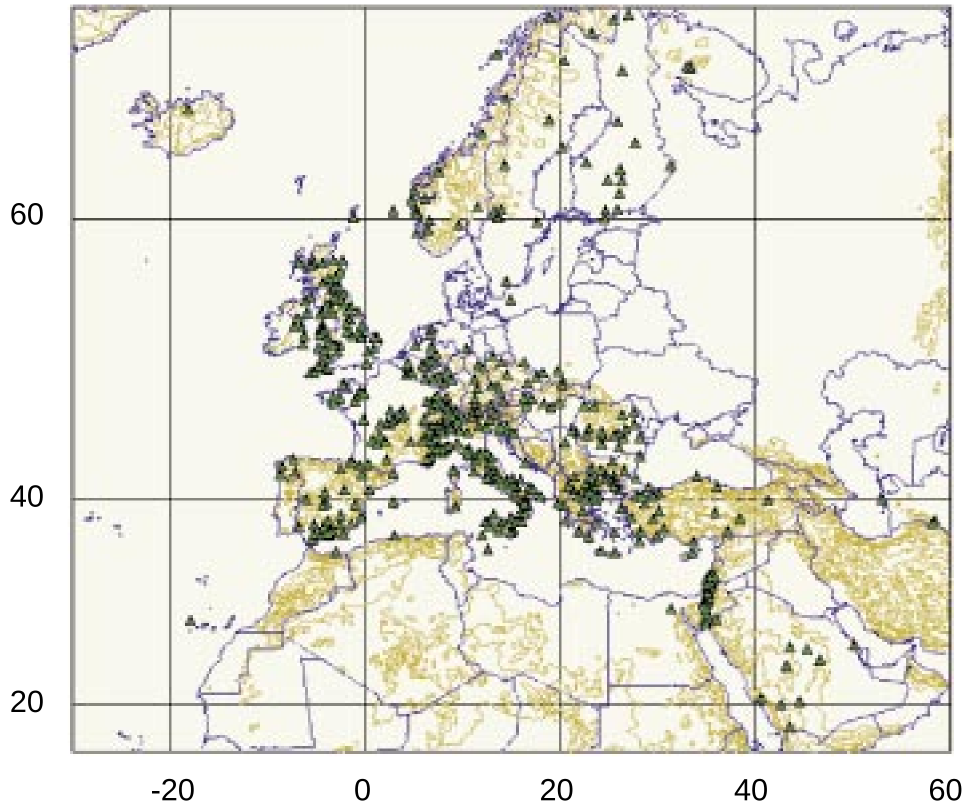
EDITORIAL

This edition of the Newsletter coincides with the ESC meeting in Reykjavik, the Assembly of the EMSC and the Board meeting of ORFEUS which will also be held on that occasion. I anticipate that our discussions, debates and agreements will move forward the development of both organisations through the memberships' endorsement of operational strategies and proposals for the future. In EMSC, we have had a preliminary debate, in June 1996 at Bruyères-le-Chatel, on the establishment of a seismological bulletin for the European-Mediterranean area. Note was taken of the existing flow of bulletin material to the EMSC and the progress made by the Eurobull Group which started in the framework of GSETT-3 for nuclear test discrimination purposes. Its experiment has been running through 1995, software has been developed and, in the longer term, an appropriate strategy could be for EMSC to build on this initiative in taking forward its own proposals for the EMSC bulletin. A data request will go to members shortly after the Reykjavik Assembly with the intention of producing the first monthly bulletin in the summer of 1997. A Working Group has been formed to assist the Secretary General in the project, initially comprising A. Walker, C. Papaioannou, M. Zivcic, T. Schler and J. Wüster. I wish them every success in what will be a difficult task and I urge each of our members to give the maximum support to assure an impressive result.

In this edition, readers will be interested to find a report on the EC-sponsored project "Measurement of Strong Ground Motions in Europe" by Professor Nick Ambraseys. The work is in progress and detailed results are not given here but the discussion and conclusions which are emerging provide an engineer's insight into what is needed from seismologist and researchers into strong motion if we are to apply, successfully, our results to the practical engineered environment for the benefit of its residents.

Finally, I welcome to Iceland all of our 32 members, other data providers and interested parties to formal and informal discussions about the EMSC, its present and future directions and its links with other bodies, the ESC and ORFEUS, in particular. We have new applications for membership from the BGR Seismologisches Zentralobservatorium Gräfenberg, Germany and the Icelandic Meteorological Office, Iceland and, on behalf of us all, I extend a special welcome in anticipation of their endorsement at the General Assembly.

Chris Browitt
President



Map of the 502 seismic stations used by the EMSC to test the production of a European-Mediterranean bulletin for the month of December 1995. Bulletin data from these stations are received in digital form at the EMSC on a routine basis (see paper page 7).

MEASUREMENT AND APPLICATION OF STRONG GROUND MOTION IN EUROPE (MASGE)

N.N. Ambraseys

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Introduction

This summary report presents the current status of the EC-sponsored MASGE project for the development of predictive relationships for peak ground acceleration and spectral ordinates for the European area for engineering purposes (Eurocode 8) and, at the same time, discusses the experience gained from this exercise.

Attenuation relationships for peak and response spectra for ground accelerations incorporating site conditions provide an estimate of ground shaking at a given distance from an earthquake of specified magnitude. For practical engineering applications such relationships:

- must be based on reliable observational data
- they must be relatively simple and
- must involve design variables that can be assessed by the engineer with some confidence.

Since the purpose of this project is to provide the engineer with practical answers (Eurocode 8), the purely statistical and geophysical aspects of the problem, interesting though they are, were not permitted to become the primary objective of our study. Much of what follows covers the work done up to the end of February 1996.

Materials and Methods
Strong-motion records

Strong motion recordings constitute the essential input for the assessment of ground shaking. To the best of our knowledge earthquakes in Europe and in the Middle East, since 1967, have generated a substantial number of analogue strong-motion records, in excess of 2,500. An attempt to retrieve, process, analyse and store strong-motion information in a data-bank from Europe and the Middle East was initiated at Imperial College with the cooperation of Ente per le Nuove Technologie, l'Energia e l'Ambiente (ENEA), Rome, Direzione Costruzioni, Unita'Siti e Ambiente, (ENEL), Rome, Institut de Protection et de Surete Nucleaire (CEA), Paris and the support of the Council of the European Communities (MASGE project). The growth of this data-bank during the period of the project was very slow. This was mainly because acquisition of this kind of information depended entirely on contributions from owners of strong-motion stations.

Today the data-bank contains information and data regarding 1,800 triaxial analogue records produced by 895 earthquakes of all magnitudes and depths.

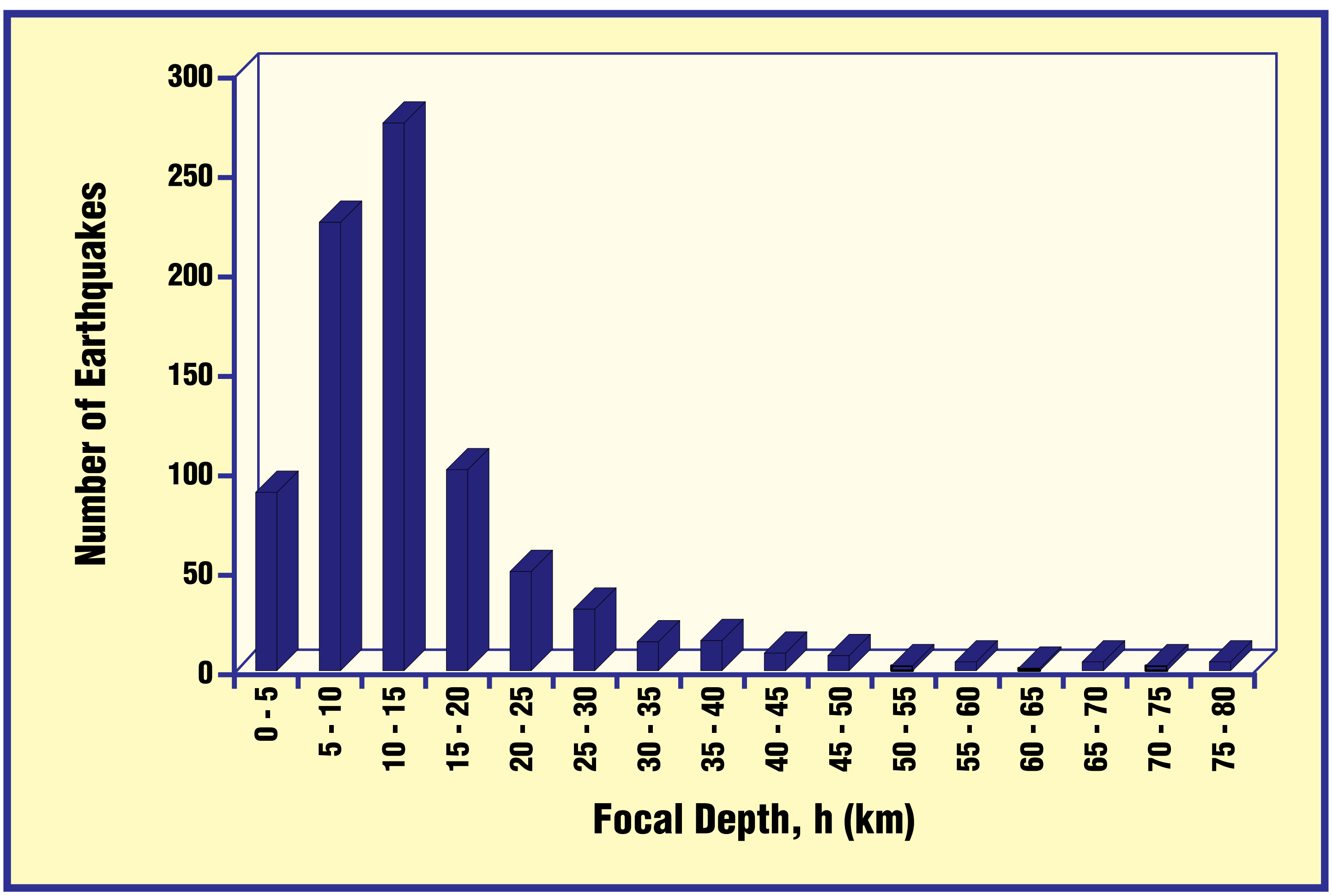

Figure 1. Distribution of earthquakes in the database with respect to their revised depth. The majority (60%) are in the range 4 to 14 km.

About 24% of the data come from Italy, 17% from the former Yugoslavia, 16% from Iran, 16% from Greece, 14% from the former USSR, 4% from Turkey, 3% from Algeria, Bulgaria and Pakistan respectively, and the remaining 5% come from Albania, Germany, Iceland, Israel, Portugal, Romania, Spain, and Switzerland.

Seismological parameters

The seismological parameters associated with strong-motion recordings constitute an equally important input in the estimation of ground shaking.

Source distance

The distance assigned to a strong-motion recording has a significant influence on the near-field behaviour of attenuation laws. This is particularly true for events for which location and depth errors can be many times the source dimension and the assessment of source distance requires accurate focal locations as well as reliable station positions and knowlege of the source mechanism.

A number of different definitions of source distance as a predictor variable have been used in developing attenuation laws. Some of these are

(a) the epicentral distance,
(b) hypocentral distance,
(c) closest slant distance to rupture surface,
(d) closest horizontal distance to the projection of the fault rupture on the Earth's surface and
(e) distance to the centre of energy release. For an overview of the attenuation laws currently available and of the definitions of the associated variables see Ambraseys & Bommer (1995).

In developing such equations from the European data set, we took the source distance to be the closest distance to the surface projection of the fault rupture. For small events we used the epicentral distance since the source dimensions of small magnitude crustal earthquakes are sufficiently small for there to be little difference between epicentral and source distance.

However there are many accelerograms from small to moderate events which, although they are well-recorded at short source distances, cannot be used for ground-motion estimation without further study because the locations of the associated earthquakes are poorly known. The locations of these events were re-evaluated using S-start times from strong-motion recordings.

Station location

Another element which is important in the determination of source distance, particularly for close events, is the geographical coordinates of permanent and in particular of temporary strong-motion instruments. Our review of European strong-motion locations shows inaccuracies in published station coordinates. Errors in location greater than 15 km are few and these were traced to typographical errors. Errors of a few kilometres are more common and in most cases some of these mislocations are found to be the result of geographical coordinates measured on large scale maps in angular degree units reported in decimal format.

Focal depth

Another variable which has a considerable influence on attenuation, particularly in the near-field for relatively small magnitude earthquakes, is the depth of the seismic source, a by-product of the focal solution. For relatively large crustal earthquakes this variable is not important. In contrast, for small events, which are important in regions of low seismicity, the depth of the source has a considerable bearing on attenuation of ground motions. In our reexamination of focal positions of European events the least well determined parameter is focal depth, a variable which we have no forseeable means of improving.

Figure 1 shows the distribution of earthquakes in the the database with respect to their revised depth.

Magnitudes

In developing attenuation laws different magnitude scales are often used to define the size of an earthquake. Some studies employ local ML or moment Mw magnitudes while other studies make use of a hybrid scale of ML and Mw, for example in some of the attenuation laws for Western North American earthquakes, while MJMA is used exclusively in Japan. Short-period magnitudes are also used including mbLg in eastern North America, Ambraseys & Bommer (1995).

For the European data we did not use the local magnitude ML and employed Ms, an important instrumental measure, to recover seismic moment Mo. The reasons for this choice are that there are no ML determinations for earthquakes in many parts of the region (Algeria, Iran, North Africa, Pakistan, Turkey, former USSR) and also because estimates of ML in some parts of Europe are few and not always reliable.
Therefore, we calculated, uniformly, surface wave magnitudes Ms for all events in the European database using surface wave maximum amplitude and period data from station bulletins and an extension of the Prague formula, Ambraseys & Free (1995).

Figure 2 shows the distribution of the data in the European dataset in terms of recalculated magnitude and distance.

Moment magnitude

Moment magnitude is increasingly used in attenuation laws as a measure of the size of an earthquake. Average seismic moments Mo for the European data set, we adopted directly from the literature. As with magnitude we did not use Mo estimates that can be obtained from strong motion records which are found to be smaller than those obtained with body or long period surface waves.
Regression of Ms on Mo clearly shows that the Ms-logMo relation of the European data does not follow the global law defined by Hanks and Kanamori (1979) and that a linear

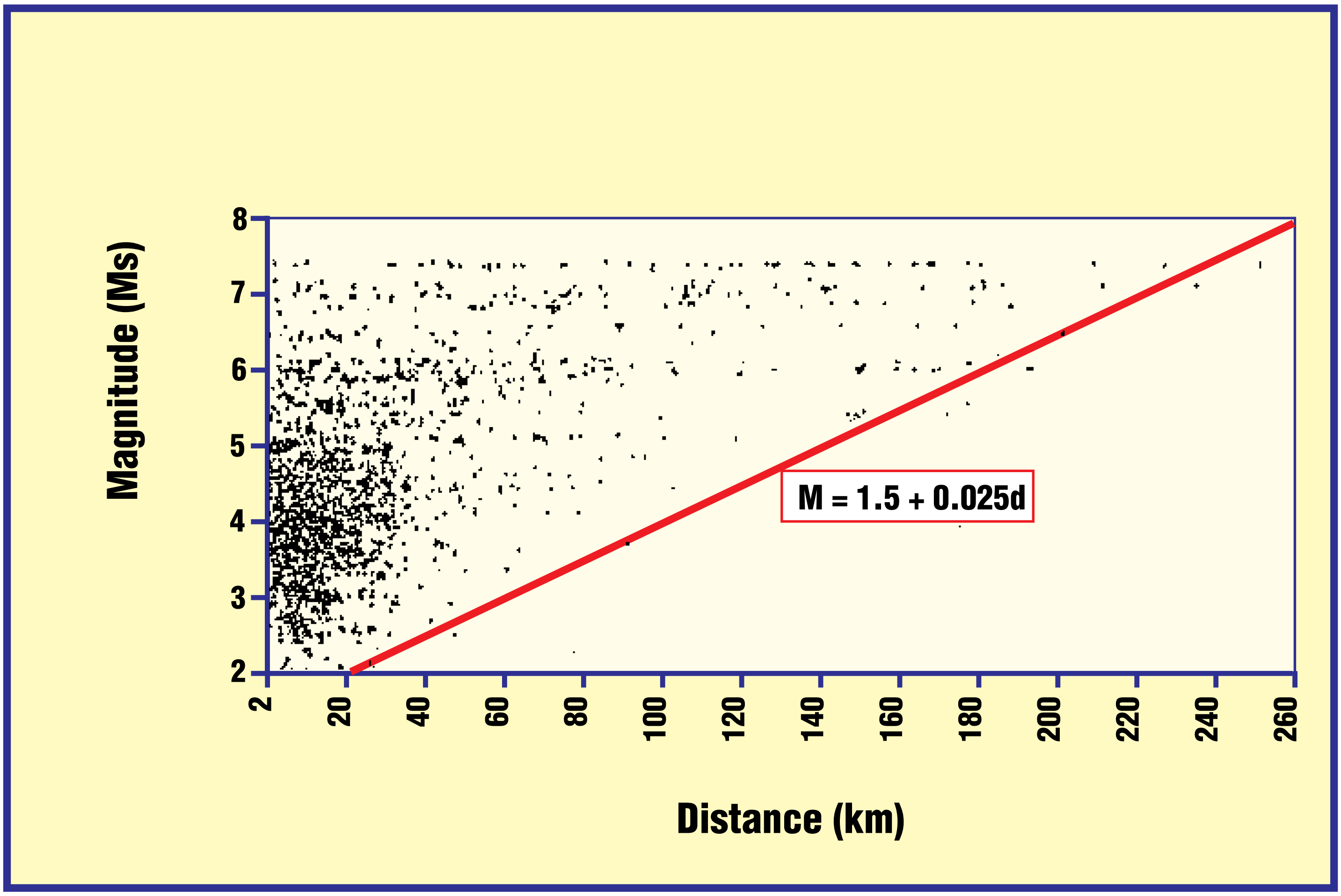

Figure 2. Distribution of the data (1260 triaxial records from 619 earthquakes) in the European dataset in terms of magnitude and distance for shallow earthquakes (h<25 km). Horizontal and vertical bars show instruments on rock and soil, respectively, which did not trigger.

The SMA-1 accelerograph, from which a large proportion of the dataset has been obtained, is usually set to trigger by 0.01g in the vertical direction, although there are cases where the trigger threshold is set at lower levels, as for example in some of the Italian and Iranian instruments. It is interesting to note that the data in the above figure define a lower bound for the maximum distance d beyond which analogue instruments were not triggered. This bound may be defined by a straight line (Ms = 1.5 + 0.025d) which supports other evidence that the average trigger level for the vertical acceleration in the range 5 to 200 km is almost independent of distance and ranges between 0.005g and 0.010g. This "trigger" boundary may be used in the regression procedure to constrain the statistical distribution of Ms with distance.

scaling with magnitude Ms in an attenuation law would be a nonlinear scaling if moment magnitude Mw is used. This means that small magnitude earthquakes in the European region are associated with seismic moments greater than those defined by the global relationship and closer to that defined by Ekstrom & Dziewonski (1988).

Local soil conditions

Ground motions are significantly affected by site effects. However, there is no common definition of site classification and much of what is used in previous studies is very subjective.

The local soil conditions at 418 of the 606 permanent and temporary European strong-motion stations are known in terms of only the most general classification of "rock" and "soil". For 188 sites there is insufficient information to classify the site geology while for 55 stations we have detailed local soil profiles and site velocities.

Dataset

The criteria used to select a dataset for analysis have a considerable bearing on the results. Restricting strong motion data to those from analogue instruments, to non-freefield stations, disregarding topographic effects, using a limiting distance or a cutoff acceleration can lead to significant differences in the results.

We did not include in our dataset strong motion records from basements or ground-floors of structures of more than three floors, however, we did retain the few records in the database from dam abutments and tunnel portals. We excluded records generated by close, small magnitude events from instruments triggered by the S wave, but we did not exclude records obtained at distances greater than the shortest distance to a non-triggered operational instrument. The reasons for this is that it is not always possible to know whether no-trigger was due to the low value of ground motion or because of malfunction of the instrument.

We retained a maximum depth of 25 km to which correspond 70% of the earthquakes in our dataset and 75 % of the records. The resulting dataset used for the investigation of zero-period acceleration consists of 1,260 records generated by 619 shallow earthquakes (h<26 km) of all magnitudes. The dataset for spectral response with site effects consists of 422 records from 157 earthquakes in the magnitude range 4.0 to 7.9.

Analysis

Following the application of correction procedures, attenuation modelling, tests on the influence of depth, site effects, magnitude dependence and validity of the statistical approach, a series of attenuation relations have been established from the data set. Details will be reported elsewhere.

Discussion

We may discuss briefly some of the conclusions and experience gained from this project, to date, which are as constructive as the technical results obtained from this research.

• One important observation that can be made regarding all attenuation laws that we have tested is that their standard error, that is the ratio of the predicted mean-plus-one standard deviation peak acceleration to the predicted mean value, is large and varies for different laws between 1.5 and 2.3. For the European data this error is about 1.7 for zero-period and much greater than 1.7 for spectral response, and this relatively large variability does not seem to improve much by increasing the size of the dataset beyond a certain limit without increasing the number of variables. We have seen that a three-fold increase of the dataset has little effect on peak accelerations and also on their standard deviation which is reduced from a factor of about 1.9 to only 1.7. This level of scatter is smaller than in many other attenuation laws but it is large enough to mask likely differences that exist amongst the various geologic regions, source mechanisms and to some extent amongst different local soil profiles.

• Another general observation concerns the reliability of an attenuation law. From the preceding it is obvious that the lack of a common measure of the size of an earthquake (Mw,Ms,ML, mb, Md mlbg), of its distance from a site, and of the soil classification makes it very difficult, if not impossible, to compare predictions derived by different authors and attribute their similarities or differences to particular regional or local effects. The criteria used to select data for regression, which are not always given explicitly by authors of attenuation laws, also have a significant effect. A too restricted selection or indiscriminate use of data may lead to gross differences in predictions. Also the use of different models can lead to large differences in predicted ground accelerations, particularly when the input data is limited or biased in magnitude and distance. In such cases over-parametrisation is not an improvement of an attenuation model. Some authors seem to have paid little attention to this, and their over-estimation of the importance of using too many free parameters has led to a widespread belief that their laws are verified to a degree that their input data do not in the least warrant.

• For site classification there seems to be an apparent advantage in the use of the average site velocity Vs as an actual measured value. This obviates the use of subjective two- or three-category site classification systems and introduces a measure of the amplification factor needed in the definition of the seismic coefficient in building codes.

• We find no saturation of acceleration with magnitude near the source and no evidence that our data fit better a magnitude-dependent shape of the attenuation model.

• For the distribution and sample size of the European data the differences in the results obtained from one-stage and two-stage regressions are small. This together with the fact that a three-fold increase of the size of the input data has little effect on the constants and standard deviations of the resulting equations suggests that the attenuation relations derived are stable. Consequently they may be used with the same confidence as other existing attenuation laws derived for other, well-documented parts of the world.

• We find that the spectral shape and periods at which the maximum values occur are different for vertical and horizontal motions, and that on average vertical spectral values decay more slowly with period. Also very near the source of large thrust earthquakes the average value of the acceleration ratio q may exceed one but falls off with distance. For strike-slip faults the available data suggest that q reaches one only for moderate size events, decreasing for larger events, and that distance variations in the near-field have little effect on its value. These differences in vertical acceleration are large enough to warrant consideration in the definition of design spectra for Eurocode 8.

• The rejection or acceptance of an attenuation law cannot be based on its standard deviation alone as this depends very much on the sample used for the regression analysis. An attenuation equation should be accepted if the input data, attenuation model and method of analysis used are suitable, and if the parameters characterising the earthquake, path and site are reliable.

• In the derivation of many local or regional, attenuation laws, use is often made of all available data, regardless of their quality and the homogeneity and range of variables, with the result that little confidence can be placed on the resulting attenuation laws, particulrly of a "national" character. This uncritical use of limited or pruned datasets contributes to the proliferation of local attenuation laws of ephemeral validity which confuses the uninitiated engineer or gives him a wide choice for the selection of convenient design ground motions.

• The data used in this study are considered to be suitable in both quality and quantity. From the analysis of the European data we conclude that selection of a dataset from a given available suite of records and sites needs to be approached with caution. Selection should only be made after the identification of outliers with respect to an adopted attenuation law, and then rejection of input data must satisfy certain criteria. Information should not be excluded when it represents a random characteristic of the input data. It is possible that the agreement with the chosen law or model of those records retained is accidental, particularly when the database is small, and quite likely that the records rejected are in fact as typical as those retained.

• With the growing number of strong-motion accelerograms now available world-wide, particularly digital, along with supporting data from seismology, geophysics, geology, and soil mechanics we are increasingly becoming aware of the fact that strong-motion records are much more complicated and different from one another than had previously been supposed. We expected, perhaps naively, that if we were to specify magnitude, distance and a simple parameter related to local conditions, we would achieve a better prediction of ground motions. However, recent studies clearly show that the process in the near field is much more complex than we had at one time hoped and that the number of basic parameters must increase if we wish to deal effectively with the rather large dispersion of the predicted values. This in turn implies that we need more high quality input data, both in terms of strong-motion records and geophysical and soil parameters.

• There is at the moment an imbalance in strong motion research. I feel that much effort has been diverted to solving statistical problems based on limited datasets and that more field data and observations are now needed. Regional collections of a limited number of unprocessed records without reliable supporting seismological and geological information do exist, often creating more problems than they solve since the indiscriminate use of these relatively easily obtainable datasets has the danger that the resulting estimates of ground motion may be subject to so much uncertainty as to be worthless.

• One of the causes for concern is that although earthquakes in Europe have generated more than 2,000 records, full use of this larger body of data remains unexploited, hampered by problems of access and by the lack of essential information regarding local geologic conditions and the earth-quakes that generated them. No regional organization has been, or is likely to be able to collect, process and disseminate in the public domain the complete set of analogue and digital recordings that are available. Even within the same country, given the diverse groups operating strong motion instruments and the lack of cooperation by some of the responsible individuals, it is unlikely that such a dissemination centre can be established and service effectively end-users.

• The attempt, mentioned earlier, to establish a data bank for European records at Imperial College has been successful for the duration of the project but the effectiveness of the data bank to provide end-users with readily available data has been disproportionate to the effort put into its creation. The data bank is not the owner of the accelerogram data it acquires. This fact implies that it has to observe the restrictions imposed by contributers of strong-motion data, that is, that some of the data are openly available, much require the owner's aproval of the data transfer, and a fraction are not available for dissemination.

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A SEISMOLOGICAL BULLETIN FOR THE EUROPEAN-MEDITERRANEAN REGION: OBJECTIVES AND RECOMMENDATIONS

The EMSC receives over 100 different seismological bulletins per month on a routine basis. Most of them are issued by institutions located in the European-Mediterranean region. These data are currently stored and archived so that they are available for scientific studies. However, as was done in the past, it would be extremely beneficial to use all this information as an input for an international bulletin covering the whole European-Mediterranean area.

On June 21, 1996, the EMSC organized a seminar in Bruyères-le-Châtel to define the type of seismological bulletin needed by the scientific community, to discuss how this bulletin could be implemented at the EMSC and to establish the implications for all the data providers. Eight countries were represented at the seminar by 16 participants, all of them involved with bulletin compilation at their own institute. The following is a brief overview of the matters discussed during the day. For those interested in having a more detailed report on the meeting, minutes and copies of the overheads presented are available at the EMSC.

Why do we need a bulletin in the European-Mediterranean region ?

This bulletin would be used as an input to local projects and short-term experiments (i.e temporary networks) to help in station siting, day-by-day monitoring, etc... It would also be helpful in the monitoring of seismic crises, to check the aftershock sequence and the potential migration of the seismic activity. Naturally, this bulletin would also provide an input to other international databases (ISC) and would greatly contribute to the evaluation of the quality of the international nuclear discrimination monitoring process (follow-up of the EuroBull experiment, which was set up to evaluate the output of the GSETT-3). It could be used as a reference for known blasts in the area, which are critical to the calibration of velocity models and tomographic studies. The bulletin would also be used as a reference for seismotectonic and seismic hazard studies in the region. Finally, the bulletin would be of great benefit for general public information.

What type of bulletin is needed ?

The final product provided by the EMSC must be of high-quality (reliability, accuracy, completeness, ...), the quality of the bulletin being more important than the rapidity for bulletin publication. To achieve this, regional velocity models have to be used. Furthermore, station distance to the epicenter as well as station density will have to be taken into account in the location process. For data providers, this means that only manually picked phase arrivals are acceptable as input data. It is also important that all artificial events are identified and flagged as such in the bulletins sent to the EMSC, these events could then be used as ground truth in other studies. Eventually, these events should be, as much as possible, geographically distributed over the whole EMSC area. Clearly, the completeness in the catalogue for natural and artificial events will not be at the same magnitude level. An important point expressed by the participants is that all the information gathered should be made available to the users (even phase readings without location). It was agreed that this information would be stored on an ftp account, while the published bulletin would be filtered to contain only events with a magnitude greater than a predefined threshold. The general idea being to produce a homogeneous bulletin at the European-Mediterranean scale for magnitude 3.5 and above. This final bulletin should be made available approximately 3 months after real-time (although at an early stage the delay might be up to 5 months). To make this procedure feasible, while limiting the necessary manpower, it is required that data are available in digital form, i.e exchanged by e-mail, telex or on floppy disks for those who do not have e-mail connection (paper bulletins will not be integrated). In order to answer the need for a rapid preliminary version of the bulletin (within 3-5 days), it was agreed that a a first fully-automated version of the bulletin would be computed. However, this requires that data providers send their data either daily or, at least, twice a week. Data providers will also be asked to report only regional data, since teleseismic events will not be published in the bulletin. Finally, data providers are asked to review the accuracy of the preliminary version of the bulletin, so that any mistake can be corrected in the final version.

Recommendations

In summary, the key points for the bulletin are:

regarding the EMSC

- Produce a high-quality monthly bulletin for the EMSC region;
- Publish the bulletin in a 2-step procedure: 1-2 weeks for the preliminary bulletin, 3-5 months for the final bulletin;
- Use regional velocity models for location;
- Set a minimum threshold for the whole region (3.5 - 4.0);
- Provide access to all data submitted (ftp or AutoDRM);
- Achieve completeness by region for natural and artificial events separately;
- Provide realistic error estimates;
- Research the magnitude problem;
- Store the preliminary bulletin and final bulletins in different databases.

regarding data providers

- Input quality control (manually reviewed picks only);
- Rapid data availability (participants should send their data on a daily basis or twice a week);
- Revise and add data (based on the results of the preliminary bulletin) and resend these to the EMSC;
- Artificial events should be flagged as such;
- Use of comments for macroseismic information;
- Promote computer readable input data;
- No teleseismic events (observatories will submit only local and regional events, the limit should be the Pn distance). It is understood that for single station observatories such a screening can prove difficult; in this case, the elimination of arrival times corresponding to teleseismic events will be the responsibility of the EMSC.

These objectives and recommendations will be further discussed during the EMSC Assembly and a Workshop on European bulletins, both events occurring during the ESC Conference in Reykjavik.

FORUM

EMSC NEW PHONE/FAX NUMBERS !

Please note that the EMSC will have new phone and fax numbers ! AS OF OCTOBER 18, 1996, France will move to 10-digit numbers. The new numbers will be:

Phone: Bruno Feignier: +33-01-69267814 (Secretary General / answering machine)
Frédéric Ramon: +33-01-69267813 (Data exchange / requests)

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Seismological data: +33-01-64903218

RAPID DETERMINATION OF EPICENTRES: AN UPDATE

Four more networks are now sending their data in case of large earthquake in the European-Mediterranean region. The table below lists the new data providers as well as the code used to identify them in the messages released by the EMSC

Code	**Institute**	**Country**
BGS	British Geological Survey, Edinburgh	UNITED KINGDOM
LJU	Seiszmoloski Zavod Slovenije, Ljubljana	SLOVENIA
ZAG	Andrija Mohorovicic Geophysical Institute, Zagreb	CROATIA
RNS	Réseau National de Surveillance Sismique, Strasbourg	FRANCE

CALL FOR PAPERS

The EMSC Newsletter is published three times a year. It intends to be an informative tribune open to the whole seismological community. The focus of the Newsletter is mainly on topics such as seismological data collection and exchange, real-time earthquake analysis, and seismological research related to the European-Mediterranean area. Scientific papers dealing with these topics are welcome. Manuscripts must be in English, no more than 4-typewritten-page long and may include color figures. Publication is free of charge, provided that the papers are camera-ready copies. Prior to publication, all papers are reviewed by at least one reviewer.

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