3rd Meeting

INQUA Subcommission on Paleoseismicity – INQUA Scale Project

September 7th , 2005

MINUTES OF THE MEETING

Agenda:

1) COMMUNICATIONS
2) APPLICATION OF THE INQUA SCALE TO CASE STUDIES
3) OPEN ISSUES
4) FUTURE ACTIONS

List of Participants:
Anna Maria Blumetti, John Clague, Valerio Comerci, Kervin Chunga, Eliana Esposito, Anna Fokaeks, Luca Guerrieri, Elisa J. Kagan, Alessandro M. Michetti, George Papathanassiou, Luigi Piccardi, Sabina Porfido, Ruben Tatevossian, Niklas Mörner, Eutizio Vittori, Suzanne Leroy.

1) COMMUNICATIONS

Michetti introduced the meeting and outlined the major activities carried out in the last months in the framework of the INQUA scale project:

- Regional Working Groups activities are focused in applying the INQUA scale to case studies. In this conference in Como these activities are shown by four oral presentations (Greece, Israel, Italy and Russia) and two posters (Ecuador and Perù). Other RWGs have presented their results in other conferences (i.e. Colombia).
- A number of other case studies are expected from several RGWs worldwide. A proposal will be presented to the International Journal *Geomorphology* (Elsevier) for a Special Issue devoted to the collection of scientific papers presented in Como in the session "Earthquake Ground Effects, Seismic Hazard, and the INQUA Scale Project", and including also selected invited papers dealing with the application of INQUA Scale to case studies.
- A first version of the EEE database can be downloaded from the web (http://www.apat.gov.it/site/en-GB/Projects/INQUA_Scale/); its use is recommended for a proper application of the INQUA scale to case studies. This database aims at archiving information on earthquake environmental effects as well as at driving the EEE intensity assessment through a standard procedure.

- It is important that participants to the project are in agreement about the standard procedure for the assessment of EEE epicentral and local intensities, on the basis of the three levels of spatial generalization for EEEs (site, locality and total area). A short description of the recommended methodology prepared by Ruben Tatevossian and Luca Guerrieri is attached at the end of these minutes.

2) Application of the INQUA scale to case studies

Kagan presents the main results on a research conducted by Amos Salomon and others, focused on the description of seismically induced ground effects of the February 11, 2004 M_L=5.2 northeastern Dead Sea earthquake.
The failure effects most severely affected the Holocene deposits, that is the weakest unit in the region. A large number of cracks, slope failures, liquefactions were mapped and described. In addition, changes of water levels and radon concentration were measured in wells.
According to the INQUA scale, based on mapped effects, the maximum intensity degree was VI.
Comments are from Michetti about:

- the major density of the effects in the northern area, compared to the southern one, suggests a difference in intensity at the locality level (northern and southern areas). The same is indicated by the occurrence of liquefaction only in the northern part of the Dead Sea coast.
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Papathanassiou shows the application of the INQUA scale for the assessment of intensity of 14.08.2003 Mw = 6.2 Lefkada earthquake (Greece). This event caused considerable effects on the northern part of the island (rockfalls, landslides, liquefactions).
EEE site intensities (max VIII) result generally 1 - 2 degrees higher than EMS local intensities. The intensity values base on INQUA scale are more closed to the assessed values of the past events, before the seismic code implementation occurred in 1992.
Comments are from Tatevossian, which remarks that i) local intensity assessment should be based on the ranges of intensities at the site level; ii) the size of EEE must be always reported (quantitative approach).

General Comments:

Tatevossian outlines that we are just starting to use the EEE scale. At present we need to accumulate statistics before going to analysis. Moreover, some very important subjects should be postponed for future (for example, we still are not able to define the category of scale, is it linear or not?).

Michetti made comment on discrepancies of macroseismic and EEE intensities. Probably the differences are because EEE used maximum effects and we don't know what takes macroseismic scale. Tatevossian replied: first macroseismic scales also were based on maximum effect, then they use complete statistics of effects to assess intensities.

3) Lessons learned and Open Issues

- *INQUA scale and other scales: What are perspectives?* The INQUA scale is not intended to replace previous macroseismic scales, but rather to integrate them. However, it should be better defined how the scales are expected to be integrated. For lower intensities the leading factors are macroseismic and for higher intensities (more than IX) the assessments of intensities must be based on the EEEs. In the medium intensities range (i.e. VI-IX) there is no leading factor and the choose depends on the availability of data type. Examples from the Verny eq. in the former USSR and the Irpinia eq. in Italy, presented during the Como meeting, clearly show that intensity assessment based on EEE must be integrated with damage indicators. Where traditional macroseismic data are available, this integration will provide a reasonably complete image of the earthquake.

- *Discrepancies between EEE and traditional intensities:* it is recommended to choose always the maximum value (conservatism principle) because data accuracy and completeness can always be discussed. Only detailed studies on the reasons of discrepancies could support intensity values lower than the maximum one.
- *Application of the same logical approach for other natural hazard evaluations.* The INQUA scale is a first example where historical and instrumental data are compared with paleorecords. A similar approach could be used for the assessment of other natural hazards in a paleo-perspective. This one of the aims of the Dark Nature Conference.
- *The role of surface faulting for local intensity assessment.* In some case study, the maximum offset associated to each reactivated fault segment seems to be a useful parameter for the use of surface faulting at locality level.
- *Standard procedure from site intensity ranges to local intensity assessment.* Is local intensity degree always the maximum among intensity values assessed at the site level?
- *Epicentral area.* What is the definition of an EEE epicenter and hence is it possible to establish a standard procedure for its location?

4) FUTURE ACTIONS

- **2-7 April 2006, EGU2006, Vienna –Session TS4.4** "3000 years of earthquake ground effects reports in Europe: geological analysis of active faults and benefits for hazard assessment", sponsored by INQUA Subcommission on Paleoseismicity; this session is intended to be an opportunity to discuss the INQUA scale approach within the larger community of specialists in earthquake studies, geologists, seismologists, engineers.

- **15-19 May 2006, Trieste, Italy** - International Workshop on “The Conduct of Seismic Hazard Analyses for Critical Facilities”, promoted by the UNESCO-ICTP (International Center for Theoretical Physics) and IAEA (International Atomic Energy Agency).

During this Workshop, two days will be devoted to the presentation and discussion of the results of the INQUA Scale Project.

- **July 29th - August 6th 2007, Cairns, Australia –** XVII INQUA Congress

During this meeting, marking the end of the project, the final version of the INQUA Scale will be presented.

Methodological recommendations in the EEE data collection

L. Guerrieri & R. Tatevossian

1) The EEE spatial levels and corresponding intensities

In order to assess EEE epicentral and local intensities, it is necessary to clearly define three different levels of EEE spatial generalization (site, locality and total affected area).

Sites correspond to any place, where the single EEE of a certain type was observed. At this level EEE descriptions have to be compiled. As these effects are strongly dependent not only on strength of shaking but also on many other outer factors, it is possible to assign only an interval of probable intensity values to the effect observed at the site.

Locality includes several sites and presents a level of generalization, to which intensity can be assigned. It can refer to any place: either inhabited or natural: it has to be small enough to keep separated areas with significantly different site intensities, but large enough to include several sites and consequently to be representative for intensity assessment. Therefore, the locality has to be defined by expert judgment.

The uppermost level corresponds to the *total area* affected by EEEs: the whole rupture length or maximum displacement in case of primary environmental effects or the entire area of secondary EEEs distribution. Relationships between total area of primary (e.g. surface faulting) or secondary effects (e.g. landslides, liquefactions) and epicentral intensity can provide indications about the earthquake size e.g. its epicentral intensity.

By adopting the “locality – site” concept, the possible future incorporation of environmental and macroseismic effects into a unified intensity scale can be achieved within reasonable efforts.

2) The EEE database

The EEE database, developed with the software Microsoft® Access 2000, is formed with four tables related as in the figure, following the basic concepts of EEE scale. Therefore, each record in the table “Earthquake” is associated with one-to-many records in the “Locality” sub-table and each record in “Locality” is associated to one-to-many records in its “EEE Sites” sub-table.

The main table “Earthquake” is intended to present general information on the seismic event, including surface faulting parameters and total area of secondary EEEs.

In the “Locality” table should be reported all the information about the characteristics of the locality where one or many coseismic effects have occurred, i.e. location (coordinates, altitude) and local expression of the earthquake (local macroseismic intensity).

In the “Site” table should be reported all the characteristics of the site (location, geomorphological environment, etc.) and the type of effect (local surface faulting, slope movements, ground cracks, ground settlements, hydrological anomalies, etc.). Information about the effect size, as requested in the EEE scale, can be archived in detail according to the type of effect.

Since the characteristics and the size of one effect do not change significantly, it is possible to archive them in one single record (for example, numerous ground cracks similar in length and width and located very close). Furthermore, information about damages on man-made structures (buildings, bridges, roads, etc.) in the same site can be archived in a proper table.

In order to standardize the descriptions of the effect and the site (i.e. to call the same object with the same name) it was established to enhance the data input through the selection of attributes from a predefined menu. At the end of the detailed description of a single site it is possible to assess the range of EEE intensities (minimum and maximum values) compatible to the size of the effect and the associated feature. As the data input for a locality has been completed, it is possible to evaluate the EEE intensity for that locality on the basis of all EEE effects occurred in that locality. Finally, the EEE database allows to generate a table of localities with coordinates and EEE local intensities that can be exported and loaded on a GIS project, in order to map the field of EEE intensities.