IAEA

International Atomic Energy Agency

ICTP

International Centre for Theoretical Physics

Workshop on the Conduct of Seismic Hazard Analyses for Critical Facilities

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Co-Sponsorship: INQUA, Subcommission on Paleoseismicity

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MINUTES OF THE INQUA SCALE PROJECT MEETING

1. Programme

The programme of the workshop (see Appendix 1) included an Opening Session on May 15, a two-days Specialty Session on the INQUA scale and paleoseismology on May 16 and 17, and two Sessions on engineering seismic hazard assessment for critical facilities on May 18 and the morning of May 19. The following 17 lectures focused on the INQUA Scale Project and related research on paleoseismology and active tectonics:

- A.M. Michetti: Introduction of the INQUA Intensity Scale
- L. Serva: The concept of the Intensity parameter in the Intensity scales
- B. Mohammadioun: The INQUA Scale Project: A better link to dynamic source parameters and maximum magnitude determination
- R. Tatevossian: Geological effects in the macroseismic intensity assessment, and the application of the INQUA Scale in former USSR
- Jim MC Calpin: Paleoseismology and Maximum Magnitude estimates in extensional terranes
- E. Vittori: Relationships among surface rupture parameters and intensity
- R. Amit: The use of paleoseismic data and ground effects (INQUA Scale) of strong earthquakes for seismic hazard evaluations of the Dead Sea Rift.
- A. Nelson: Earthquakes accompanied by tsunamis: their paleoseismic records and application to the INQUA intensity scale
- S. Porfido, E. Esposito, L. Guerrieri, E. Vittori: Application of the INQUA Scale to Italian earthquakes
- Y. Ota, T. Azuma, N. Lin: Paleoseismological study and seismic hazards resulting from major recent active faulting in Japan and Taiwan, and examples of INQUA scale intensity maps
- K. Reicherter: Paleoseismology and the study of earthquake ground effects in the Mediterranean Region
- K. Mueller: Assessing Mmax on Active Thrust Faults in New Madrid (USA) and the Northern Po Basin (Italy)
- G. Papathanasiou: Applications of the INQUA Scale in Greece
- P.G. Silva: Fault activity and earthquake ground effects in Spain: applications of the INQUA Scale in the Iberian Peninsula
- C. Lalinde Pulido: Active tectonics and earthquake ground effects in Colombia, with examples of applications of the INQUA Scale.
- Y. Kinugasa: Use of geological data for seismic hazard assessment and siting of the nuclear facilities in Japan
- M. Abdel Aziz: INQUA intensity assessment for the 1995 Aqaba earthquake

The IAEA-ICTP workshop co-sponsored by INQUA Subcommission on Paleoseismicity has been an excellent opportunity to discuss the need of a new intensity scale based on environmental effects and on the applications of the intensity scale to selected earthquakes in a worldwide perspective.
In the open session, Michetti introduced the INQUA Scale project focusing on the rationale for a new intensity scale. Serva reviewed the concept of the intensity parameter in the previous intensity scales.
Two other lectures (Mohammadioun and Vittori) were centred on the relationships between the extent of primary effects (surface faulting parameters) and intensity, and Kinugasa highlighted the importance of geological data for nuclear power plants.
The remaining 13 lectures (see list) were basically devoted to the application of the INQUA intensity scale to earthquakes occurred in different geological settings and in different time-windows.

2. INQUA Scale Project Business Meeting

A Business Meeting of the INQUA Subcommission on Paleoseismicity ended the Specialty Session dedicated to the INQUA Scale Project. The Business Meeting took place on May 17 at 18.00-19.30 in the Lecture Room, Lower Level 1, Adriatico Guest House. Participants are listed below:

ABDEL AZIZ M., ACHS G., AL-HUSSAINI T.M., AL-NIMRY H.S.N., AMIT R., AOUDIA A., ASPINALL W., AWUOR J.B, AYADI A., AZUMA T., BEJAICHUND (SINGH) M., BENOUAR D., BIASI G., BLUMETTI A.M., BOU-RABEE F.N., CAMPBELL K., CHUNGA MORAN K.A., COMERCI V., CONSTANTIN P.A., DIEZ ZALDIVAR E.R., DOJCINOVSKI D.M., EL-HADIDY M. S., FERRELI L., FRANCO L.E., FUKUSHIMA Y., GARCIA P., GHASEMI H., GODOY A., GRECU B., GUERPINAR A., GUERRIERI L., HATTINGH E., HEIDARPOUR A., IQBAL J., JESENKO T., KHODAYARI N., KINUGASA Y., KOLEVA G. V., KOUTEVA M. P., JOHNSON J., LABBE P., LA MURA C., LALINDE C.P., LETTIS W. R., LYNCH L.L., LYNCH R.A, MARMUREANU A., MOHANTY W.K., MICHETTI A.M., MOHAMMADIOUN B., MOLDOVAN I. A., MONA L., MONSECH O., NELSON A., OTA Y., PABLO S., PANZA G.F., PAPATHANASSIOU G., PARITHUSTA R., PASKALEVA I., PAUDYAL H., PERESAN A., POPOOLA O.I., PORFIDO S., RAYKOVA R.B., REICHERTER K.R., RIVERA ALVAREZ Z.C., ROGOZEA M.M., ROMANELLI F., SADOYAN T., SERVA L., SILEO G., TATARU D.S., TATEVOSSIAN R.E., TUGUME F., UDDIN M.M., VITTORI E., WANG G.X., WANG Z., YEMELE D., ZAMUDIO DIAZ Y.I., ZIVCIC M.

The Agenda of the Business Meeting included the following points:

1) INQUA scale project: Review of the RWG activity
2) Discussion of the issues raised by the presentations during the ICTP WS
3) Participation at the XVII INQUA Congress in Cairns, August 2007
4) Any Other Matter

1) Luca Guerrieri, from the Scientific Secretary of the INQUA scale project, introduced the Business Meeting. He showed the state of the activities of Regional Working Groups (RWG) from 15 different countries in the application of the INQUA intensity scale to 45 earthquakes. He remarked the great effort done by RWGs, and proposed to collect these data in a suitable database of Earthquake Environmental Effects by the end of the project (July 2007).

2) An open debate followed this presentation, focusing on what it is possible to learn from the application of the scale to real case studies. Michetti summarized the 2 critical methodological directions that were clearly indicated by the work conducted so far under the INQUA scale project:

a) The INQUA scale should be regarded as an independent scale; in sparsely populated areas the scale will be obviously the only tool for intensity assessment; in populated areas, the INQUA scale should be compared and integrated with the assessment resulting from the use of other intensity scales such as MCS, MM 1931, MM 1956, MSK.

b) The INQUA scale is intended to be comparable with Modified Mercalli intensity of 1931; it is very clear that strictly speaking one intensity scale cannot be "converted" in another intensity scales, however, the INQUA scale is designed to be as consistent as possible with the MM 1931 scale.

The main *achievements* resulting from the testing of the scale are the following:

- The new intensity scale seems to be working quite well in different regions, and in different time-windows (paleo, historical and recent).
- It is the only tool for intensity assessment of strong earthquakes in sparsely populated areas.
- It is very helpful to better localize the epicentre and trace the seismogenic structure, especially for strong events.
- It allows the comparison between contemporary earthquakes and historical ones. Therefore, changes in the building codes will affect MM values, but not INQUA scale values.
- Even for siting critical facilities, including site effects, the INQUA intensity scale can be very helpful.
- The intensity assessment based on the total area distribution of environmental effects seems to be not significantly conditioned by the occurrence of specific weather conditions (i.e. heavy rain before the event; long periods of drought). In fact, in the INQUA scale the total area values are one order of magnitudes greater from one degree to the next higher, allowing to clearly discriminate between intensity degrees beyond local climatic variability.

Furthermore, some *restrictions* in the use of the present version of the INQUA intensity scale have been remarked:

- It does not work well in metropolitan areas for minor ground failures (i.e. for the lower degrees of the scale <VII it is complementary to traditional macroseismic scales).
- The relationships/correlation between Io and the different scales of M, especially Moment Magnitude need to be refined.
- The description of tsunami effects in the scale needs to be in line with current standard tsunami glossary (such as the IOC glossary) and the existing tsunami intensity scales; these documents will be therefore carefully taken into account during the preparation of the final version of the scale.

Moreover, some *recommendations* in the use of the scale have been pointed out.

- It is recommended to use ranges of integers values of intensities instead of half degrees.
- In the presence of several categories of effects in the same locality, the primary tectonic effects are the leading ones in the EEE intensity assessment. If no primary is present, the "worst" representative effects must be chosen.
- It is necessary to keep the management of the data base open for everybody and continuously updated.

3) The Business Meeting ended with a preliminary discussion on the future activities of the SubCommission on Paleoseismicity on the INQUA Scale Project.

Participants agreed on the need to approve an updated version of the INQUA intensity scale at the XVII INQUA Congress in Cairns, with clear definitions of the formal aspects (i.e., name of the scale, INQUA scale vs. EEE scale; symbol to be used as a standard, I_q , I_{EEE} , I_{INQUA} , …). The Scientific Secretary will make a proposal and circulate via the email lists for comments, in order to have an agreed version submitted to the INQUA Terpro Commission well before the XVII INQUA Congress, possibly by early January 2007.

4) Participants also agreed to propose as one of the main projects of the Subcommission on Paleoseismicity for the INQUA intercongress period 2007 - 2011 the preparation of a catalogue of earthquakes with intensity evaluations based on Earthquake Environmental Effects.
Since no other matter needed to be discussed, the Business Meeting closed at 19.30.