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ESI 2007 Earthquake Intensity Scale in help of CTBT OSI's Verification Regime

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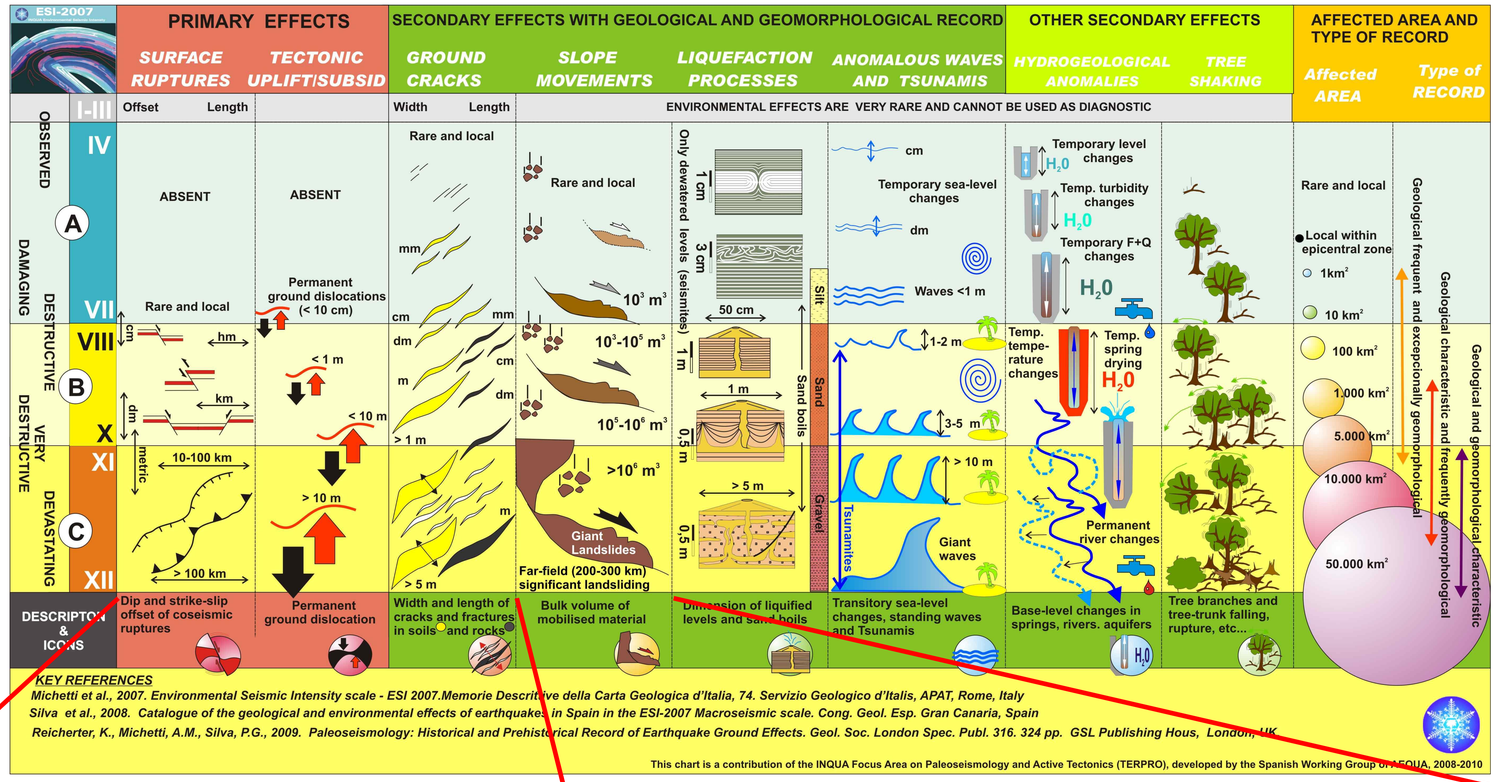
The Environmental Seismic Intensity scale (ESI) as to 2007 is another, rather recent scale designed, implemented and tested to measure the damage level of an earthquake. ESI-2007, in fact, differs from other previous scales, because it solely focuses on the impact of a seismic event on nature. In other words, ESI-2007 intends to establish the level of damage from Environmental Earthquake Effects (EEE; Michetti et al., 2003; 2004; 2007; Serva et al., 2004; Audemard et al., 2015) that a particular earthquake can generate on ground surface near and at a certain distance around the epicenter. These effects mainly include: mass wasting (Slides, avalanches, rockfalls, mud- & debris-flows, lateral spreading among many others), cracks, water changes, liquefaction and tsunami waves. All of them can be reported from naked eye observation on ground surface.

ESI 2007 has then been proposed with two main aims:
1) To refloat the observational study of natural effects, which past earthquake intensity scales used to include or consider. Partly abandoned with time!
2) To evaluate the effect of earthquakes in sparsely populated to unpopulated areas.
This scale then intends to evaluate seismic effects where there is neither population nor human constructions.

The Verification Regime (VR), which is currently developing and testing an On-Site Inspection (OSI) for UNE in the frame of the Comprehensive nuclear Test Ban Treaty (CTBT), relies on three cornerstones to narrow down and ultimately define the location of an eventual/potential (underground) nuclear explosion (test) site:
1) Visual observation (VOB),
2) Geology/Geophysics studies and
3) Radionuclide detection/monitoring.

During OSIs, VOB has a double target. It must look for "suspicious" man-made installations and/or surface ground modifications characteristic of anthropogenic explosions (particularly of UNE), such as: a) craters, b) retarcs, c) sinkholes (collapsed sinks), d) biological stress, e) localized burnt areas, f) ground cracks or fractures, g) mass wasting (rockfalls, slides, etc.) and h) disturbances (appearance or disappearance) to flowing water.

CHART OF THE INQUA ENVIRONMENTAL SEISMIC INTENSITY SCALE 2007 - ESI 07 *(Modified from Silva et al., 2008 and Reicherter et al, 2009)*



KEY REFERENCES

Michetti et al., 2007. Environmental Seismic Intensity scale - ESI 2007.Memorie Descrittive della Carta Geologica d'Italia, 74. Servizio Geologico d'Italis, APAT, Rome, Italy
Silva et al., 2008. Catalogue of the geological and environmental effects of earthquakes in Spain in the ESI-2007 Macroseismic scale. Cong. Geol. Esp. Gran Canaria, Spain
Reicherter, K., Michetti, A.M., Silva, P.G., 2009. Paleoseismology: Historical and Prehistorical Record of Earthquake Ground Effects. Geol. Soc. London Spec. Publ. 316. 324 pp. GSL Publishing Hous, London, UK

This chart is a contribution of the INQUA Focus Area on Paleoseismology and Active Tectonics (TERPRO), developed by the Spanish Working Group on INQUA, 2008-2010

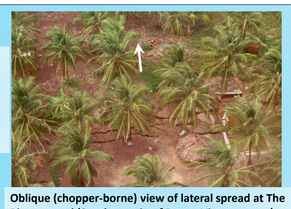
Message to take home:
1) Commonalities between OSI and ESI resides on the visual recognition of certain ground features regardless of their origin: ground cracks, mass wasting, water level/flow changes and vegetation disturbances.
2) This makes earthquake geologists natural candidates for OSI's VOB; even better, those who apply ESI 2007 scale on a regular basis.

ESI 2007

1997 metric R-T fractures, crosscutting the El Pilar fault scarp.

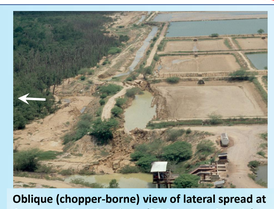
Surface rupture expressed by decimetri c"En échelon" R iedel (R) shears.

All pictures relate to the Cariaco July 07th, 1997 Earthquake of magnitude Mw 6.9, which struck the Sucre State, Eastern Venezuela.



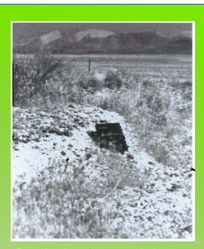
Oblique (chopper-borne) view of lateral spread at The Piragua pool (South margin of Buena Vista swamps).

Ground view of lateral spread at The Piragua pool (South margin of Buena Vista swamps.)



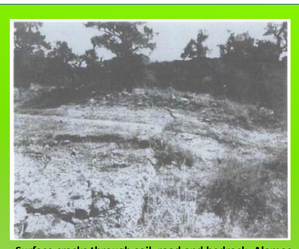
Oblique (chopper-borne) view of lateral spread at Aquacam CA shrimp farm (SE Araya penisnsula).

UNE's VOB

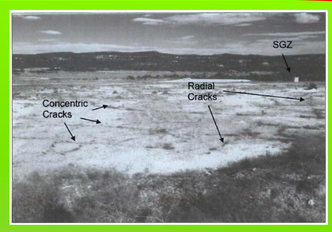


Reactivation along an existing fault with vertical and horizontal offset, after Alamos UNE test.

Concentric cracks delineating India's May 18, 1974 UNE at Pokhran.



Surface cracks through soil, road and bedrock. Alamos test site.



Radial and concentric cracks formed on a graded surface. SGZ is located in the upper right of the photo. Alamos test site.

Satellite image of Mount Mantap on Sept. 04, 2017, after UNE test at PNKR. See bare soil due to landsliding

References

Audemard, F. A., Azuma, T., Baiocco, F., Blaize, S., Blumetti, A.M., Brustia, E., Clague, J., Comerci, V., Esposito, E., Guerrieri, L., Gürpinar, A., Grützner, C., Jin, K., Kim, Y.S., Kopsachilis, V., Lucarini, M., Mccalpin, J., Michetti, A., Mohammadioun, B., Mörner, N. A, Okumura, K., Ota, Y., Papathanassiou, I., Pavlides, S., Pérez-López, R., Porfido, S., Reicherter, K., Rodríguez-Pascua, M.A., Rogozhin, E., Scaramella, A., Serva, L., Silva, P., Sintubin, M., Tatevossian, R. & Vittori, E., 2015. Earthquake Environmental Effect for seismic hazard assessment: the ESI intensity scale and the EEE Catalogue. Memorie Descrittive della Carta Geologica d'Italia – vol. 97. ISPRA, Servizio Geologico D'Italia. 181 pp.

Michetti, A., Esposito, E., Gürpinar, A., Mohammadioun, B., Porfido, S., Rogozhin, E., Serva, L., Tatevossian, R., Vittori, E. & Audemard, F. A., 2003. An innovative approach for assessing earthquake intensities: the proposed INQUA Scale on seismically-induced ground effects in the environment. *XVI INQUA Congress, Reno, Nevada, July 2003*

Michetti, A., Esposito, E., Gürpinar, A., Mohammadioun, B., Mohammadioun, J., Porfido, S., Rogozhin, E., Serva, L., Tatevossian, R., Vittori E., Audemard, F. A., Comerci, V., Marco, S., Mccalpin, J. & Mörner, N. A., 2004. The INQUA Scale: an innovative approach for assessing earthquake intensities based on seismically-induced ground effects in natural environment. *APAT, Dipartimento Difesa del Suolo, Memorie descrittive della Carta Geologica d'Italia, vol. LXVII, Rome, Italy. Special paper.* 113 pp.

Michetti, A., Audemard, F. A., Azuma, T., Clague, J., Comerci, V., Esposito, E., Guerrieri, L., Gürpinar, A., Mccalpin, J., Mohammadioun, B., Mörner, N. A, Ota, Y., Porfido, S., Rogozhin, E., Serva, L., Tatevossian, R. & Vittori, E., 2007. INQUA Environmental Seismic Intensity Scale 2007 –ESI 2007-. 19 pp (http://www.apat.gov.it/site/en-GB/Projects/INQUA_Scale/).

Serva, L., Esposito, E., Gürpinar, A., Marco, S., Mccalpin, J., Michetti, A., Mohammadioun, B., Porfido, S., Tatevossian, R., Vittori E., et al. 2004. The INQUA Scale: an innovative approach for assessing earthquake intensities based on seismically-induced ground effects in natural environments. *32nd International Geological Congress, Topical Symposium T-11.07, Florence, Italy, 20-28/08/2004.*