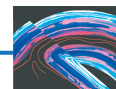


# Environmental Seismic Intensity scale - ESI 2007

## La scala di Intensità Sismica basata sugli effetti ambientali - ESI 2007



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**ABSTRACT** - The Environmental Seismic Intensity scale (ESI 2007) is a new earthquake intensity scale only based on the effects triggered by the earthquake in the natural environment. The coseismic effects considered more diagnostic for intensity evaluation are surface faulting and tectonic uplift/subsidence (primary effects), landslides, ground cracks, liquefactions, displaced boulders, tsunamis and hydrological anomalies (secondary effects). The ESI 2007 scale follows the same basic structure as any other XII degree scale, such as the MCS, MM, MSK and EMS scales. This type of intensity scale was proposed to the scientific community since the beginning of '90s. The idea was definitely accepted in 1999, when a first version of the scale was developed by a Working Group of geologists, seismologists and engineers sponsored by the International Union for Quaternary Research (INQUA). In the following years, this version has been revised and updated.

The ESI 2007 scale is the result of the revision of previous versions after its application to a large number of earthquakes worldwide. In the frame of INQUA SubCommission on Paleoseismicity, this activity was conducted by academic and research institutes coordinated by the Geological Survey of Italy - APAT (for further details, see [http://www.apat.gov.it/site/en-GB/Projects/INQUA\\_Scale/default.html](http://www.apat.gov.it/site/en-GB/Projects/INQUA_Scale/default.html)).

For intensity levels lower than IX, the main goal of this new scale is to bring the environmental effects in line with the damage indicators. In this range, the ESI 2007 scale should be used along with the other scales. In the range between X and XII, the distribution and size of environmental effects, specially primary tectonic features, becomes the most diagnostic tool to assess the intensity level. Documentary report and/or field observations on fault rupture length and surface displacement should be consistently implemented in the macroseismic study of past and future earthquakes. Therefore, the use of the ESI 2007 alone is recom-

ended only when effects on humans and on manmade structures i) are absent, or too scarce (i.e. in sparsely populated or desert areas), and ii) saturate (i.e., for intensity X to XII) losing their diagnostic value.

After its official approval at the 17<sup>th</sup> INQUA Congress, the use of the ESI 2007 scale will be proposed to national institutions (geological surveys, academic and research institutes, departments for civil protection, environmental agencies, etc.), dealing in the field of earthquake intensity and seismic hazard.

**RIASSUNTO** - L'Environmental Seismic Intensity scale (ESI 2007) è una nuova scala di intensità dei terremoti basata esclusivamente sugli effetti ambientali. Tra questi, quelli considerati diagnostici per la valutazione dell'intensità sono la fagliazione superficiale e i sollevamenti/abbassamenti tettonici (effetti primari), i fenomeni franosi, le fratture, le liquefazioni, gli tsunami, le variazioni idrologiche (effetti secondari). La scala ESI 2007 è strutturata come le altre scale a XII gradi, quali le scale MCS, MM, MSK ed EMS.

Già dagli anni '90 questo tipo di scala di intensità veniva proposta all'interno della comunità scientifica per essere successivamente accolta e sviluppata in ambito internazionale, sotto l'egida dell'INQUA (*International Union for Quaternary Research*), da un Gruppo di Lavoro costituito da geologi, sismologi e ingegneri. Nel 1999 ne veniva redatta una prima versione, più volte aggiornata negli anni successivi.

La versione ESI 2007 è il risultato della revisione delle precedenti sulla scorta delle informazioni ottenute attraverso l'applicazione della scala a un gran numero di terremoti in tutto il mondo. Tale attività è stata condotta, nell'ambito dell'INQUA SubCommission on Paleoseismicity, da Università e Istituti di ricerca a livello internazionale coordinati dal Dipartimento Difesa del Suolo - Servizio Geologico d'Italia dell'APAT (per maggiori dettagli

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[http://www.apat.gov.it/site/en-GB/Projects/INQUA\\_Scale/default.html](http://www.apat.gov.it/site/en-GB/Projects/INQUA_Scale/default.html).

Per livelli di intensità inferiori a IX, lo scopo principale di questa nuova scala è quello di considerare gli effetti ambientali alla stessa stregua degli indicatori di danneggiamento. In questo intervallo di intensità, la scala ESI 2007 deve essere utilizzata insieme alle altre scale d'intensità. Tra il X e il XII grado, la distribuzione e le dimensioni degli effetti tettonici primari costituiscono l'indicatore maggiormente diagnostica per la valutazione dell'intensità. Le descrizioni delle caratteristiche della fagliazione superficiale (lunghezza della rottura; massima dislocazione verticale) dovrebbe essere riportata in maniera consistente negli studi macrosismici dei terremoti passati e futuri. L'utilizzo della scala ESI 2007 come unico e indipendente strumento di valutazione deve essere utilizzata solamente quando gli effetti sull'uomo e sulle strutture antropiche i) sono assenti o troppo scarsi (es. aree deserte o scarsamente abitate) oppure ii) arrivano a saturazione (per intensità comprese tra X e XII).

Al fine di promuoverne un utilizzo più condiviso e ampio possibile, la scala ESI 2007, che verrà ufficializzata durante il 17<sup>th</sup> INQUA Congress, sarà proposta alle istituzioni (servizi geologici nazionali, istituti di ricerca in campo sismologico, dipartimenti di protezione civile, agenzie ambientali) che nei vari Paesi si occupano della valutazione dell'intensità dei terremoti e della pericolosità sismica.

## 1. - INTRODUCTION

In 1999, during the 15<sup>th</sup> INQUA (International Union for Quaternary Research) Congress in Durban, the Subcommittee on Paleoseismicity promoted the compilation of a new scale of macroseismic intensity based only on environmental effects. A Working Group including geologists, seismologists and engineers compiled a first version of the scale, that was presented at the 16<sup>th</sup> INQUA Congress in Reno (July 23 - 30, 2003), and updated one year later at the 32<sup>nd</sup> International Geological Congress in Florence (MICHETTI *et alii*, 2004). To this end, the INQUA TERPRO (Commission on Terrestrial Processes) approved a specific project (INQUA Scale Project, 2004 - 2007) with the aim of A) testing

the scale for a trial period of 4 years, coincident with the intercongress cycle, B) reviewing the first version through its application to case studies worldwide(1), and C) submitting the revised version so as to be ratified during the 17<sup>th</sup> INQUA Congress in Cairns (July 28 - August 3, 2007). The 2004 version of this scale was provisionally named INQUA EEE scale, where EEE stands for Earthquake Environmental Effects.

This document describes the revised version of the scale, which is formally named Environmental Seismic Intensity scale - ESI 2007. The IES 2007 scale is composed by:

a) Definition of intensity degrees on the basis of Earthquake Environmental Effects, i.e. the scale itself, which follows the same basic structure of the widely used twelve degrees macroseismic scales (see MICHETTI *et alii*, 2004);

b) Guidelines, which aim at better clarifying i) the background of the scale and the scientific concepts that support the introduction of such a new macroseismic scale; ii) the procedure to use the scale alone or integrated with damage-based, traditional scales; iii) how the scale is organized; iv) the descriptions of diagnostic features required for intensity assessment, and the meaning of idioms, colors, and fonts.

A gallery of photographs kindly provided by numerous scientists involved in the INQUA Scale Project are reported in Appendix I.

The ESI 2007 Form (Appendix II) is an helpful tool for data collection of Earthquake Environmental Effects. The Plate I (Appendix III) reports the definition of intensity degrees in a synoptic table, classified by the category of Earthquake Environmental Effect.

Both these latter documents have been designed for the application of the ESI 2007 scale during field surveys immediately after the seismic event.

(1) The application of the INQUA scale to case studies was conducted within the INQUA Scale Project Working Group by the Authors and by the following scientists:

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