African Seismological Commission (AfSC) - Asian Seismological Commission (ASC)

Preparatory Joint Working Group on Neo-Deterministic Seismic Hazard Assessment (pJWG NDSHA)

Newsletters

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More reliable physics in seismic hazard assessment (SHA) for disaster risk reduction (DRR)

(More reliable physics in SHA for DRR)

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How to understand NDSHA is both an important question for the development of NDSHA and a critical issue in seismic risk reduction. Prof. Giuliano F. Panza, scientific advisor of the JWG, talked about NDSHA at Climate Intelligence (Clintel)

Predicting earthquakes and their effects is still a very difficult task due to the nonlinear behaviour of the Earth system. Although we have made some progress in the last decade with the so-called Neo Deterministic Seismic Hazard Assessment (NDSHA), which earned me important international awards, for example, the EGU Beno Gutenberg medal and the AGU International award, in 2000 and 2018, respectively.

In NDSHA we employ numerical modeling computer codes that are based upon: (1) the physical description of the earthquake rupture process; and then upon (2) the seismic wave propagation pathways — to then reliably predict resulting ground motion parameters resulting from the many considered potential seismic sources. Indeed NDSHA works better than the very popular Probabilistic Seismic Hazard Assessment (PSHA). But science is not democratic! Let me just remember a sentence attributed to Galileo Galilei: "In questioni di scienza, l'autorità di un migliaio di persone non vale tanto quanto l'umile ragionamento di un singolo individuo." ("In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual.").

NDSHA has, for over two decades, provided both effective and Reliable Seismic Hazard Assessment tools (RSHA) for understanding, communicating and mitigating earthquake risk. The procedure for the NDSHA-derived Seismic Hazard Maps at the regional scale is described in some detail at http://www.xeris.it/Hazard/index.html.

NDSHA Seismic Hazard Assessment has been well validated by all events occurring in regions where NDSHA maps were available at the time of the subsequent earthquakes; including these observations from four recently destructive earthquakes: M 5.9 Emilia, Italy 2012; M 6.3 L'Aquila, Italy 2009; M 5.5–6.6 Central Italy 2016–2017 Seismic Crisis; and M 7.8 Nepal 2015. This good performance suggests that the wider adoption of NDSHA (especially in tectonically active areas – but with perhaps relatively prolonged seismic quiescence, i.e. where only few major events have occurred in historical time) can better prepare civil societies for the entire suite of potential earthquakes that can and will occur!

Better to retire and then bury PSHA, which is more concept and "trust in numbers" than it is a tested pathway to seismic safety, R.I.PSHA than to "take a chance on a guess" and then, in the future, to experience more earthquake disasters and catastrophes, because 2 erroneous hazard maps depicted only "low hazard", but the active tectonic regions again acted otherwise!

PSHA, unlike NDSHA, has: (a) never been validated by "objective testing"; but has (b) actually been proven unreliable as a forecasting method on the "rates" (but claimed probabilities) of earthquake occurrence; and (c) has nevertheless mandated that earthquake-resistant design standards and societal earthquake preparedness and planning should be based on "engineering seismic risk analysis" models – models which incorporate assumptions, really fabulations (or "magical realisms") now known to conflict with what we have learned scientifically regarding earthquake geology and earthquake physics. In the evidence against PSHA: too many damaging and deadly earthquakes (like the 1988 M 6.8 Spitak, Armenia earthquake; the 2011 M=9 Tohoku, Japan Megathrust; and the 2012 M=6 Emilia, Italy events) have all occurred in regions rated to be "low-risk" by PSHA Seismic Hazard Maps.

The worldwide maps depicting the earthquake hazard assessed by PSHA resulting from the Global Seismic Hazard Assessment Program, GSHAP, are grossly misleading, as proved by fatal evidence in all the top deadliest earthquakes that occurred since 2000. In fact, the seismicity of the past twenty years disproved the probabilistic GSHAP maps that were published in 1999, as can be verified by any interested person. GSHAP fails both in describing past seismicity, as well as in predicting expected ground shaking and number of claimed victims.

According to the probabilistic seismic hazard analysis (PSHA), the deterministically evaluated or historically defined largest credible earthquakes (often referred to as Maximum Credible Earthquakes, MCEs) are "an unconvincing possibility" and are treated as "likely impossibilities" within individual seismic zones. However, globally over the last decade such events keep occurring where PSHA predicted seismic hazard to be low. Systematic comparison of the observed ground shaking with the expected one reported by the Global Seismic Hazard Assessment Program (GSHAP) maps discloses gross underestimation worldwide. Several inconsistencies with available observation are found also for national scale PSHA maps (including Italy), developed using updated data sets. As a result, these maps have underestimated the expected numbers of fatalities in recent disastrous earthquakes by approximately two to three orders of magnitude. The total death toll in 2000-2011 (which exceeds 700,000 people, including tsunami victims) calls for a 3 critical reappraisal of GSHAP results, as well as of the underlying methods. Some theoretical and practical issues of probabilistic seismic hazard assessment range from the overly simplified assumption about the modelling of the complex nature of telluric motion – that one could reduce the tensor problem of seismic wave generation and propagation, standard in mechanics of a continuum like the Earth, into a scalar problem – to the insufficient size and quality of earthquake catalogs necessary for a reliable probability modeling at the local scale. Indeed NDSHA is capable of effectively modeling the complex nature of telluric motion and requires only the knowledge about the occurred damaging earthquakes, that are quite well represented also in historical catalogues.

This was the motivation to start a Neo-deterministic approach to seismic hazard assessment, now internationally well known as NDSHA, that readily satisfied Popper's falsifiability principle, as proven, since 2000, by the seismicity occurred in the countries where NDSHA maps are available. This is not surprising since seismic hazard analysis based on credible scenarios for real earthquakes, NDSHA evaluation solidly rooted on physics, provides a robust, reliable approach for seismic hazard and risk assessment which is readily handling Maximum Credible Earthquakes.

In a nutshell GSHAP is based on probability applied to not fully adequate data sets and is affected by several mistakes of physical and mathematical origin; NDSHA, uses scenario earthquakes including MCEs and models the caused ground motion exploiting the most advanced physical models of wave generation and propagation based on continuum mechanics. GSHAP missed all the top deadliest earthquakes that occurred since 2000.

For details of the interview please see: https://clintel.org/interview-giuliano-panza/.

Antonella Peresan: the new Policy Officer for the EGU Natural Hazards Division

Prof. Antonella Peresan, senior seismologist from the National Institute of Oceanography and Applied Geophysics in Italy, also the scientific advisor of the JWG, was appointed as the new Policy Officer for the Natural Hazards Division of EGU. The Policy Officer aims to bridge between the Division and the EGU Science for Policy Working Group, helping to ensure that evidence-based decisions are made in the policy-making processes related to EGU. Antonella is now conducting interdisciplinary research focusing mainly (but not only) on seismological research on issues related to time-dependent seismic hazard assessment and the study of multiple hazards, from tsunamis to seismically induced landslides. She also carries out capacity-building and knowledge transfer activities for the implementation of seismological research results aimed at the mitigation of related risks, with particular attention to emerging and developing countries. For more details see: https://blogs.egu.eu/divisions/nh/2024/02/26/how-can-you-contribute-to-science-based-policy-making-ask-the-new-policy-officer-in-the-natural-hazards-division/.

JWG joined in Statsei13 meeting

On March 16-20, the 13th international workshop on statistical seismology (Statsei13, http://www.statsei13.org.cn/) was held in Shenzhen, China, with 112 participants from 18 countries/regions.

JWG joined in the Statsei13 as a cosponsor of the meeting. In the meeting, at least 4 reports related to NDSHA, and 3 reports related to PSHA, were presented, in which informal dialogues between different SHA approaches were facilitated. It was the first appearance of JWG on the international stage.

In connection to Statsei13, on March 12, a Pre-Statsei Workshop was held in Beijing, at the Institute of Earthquake Forecasting, China Earthquake Administration, with 9 presentations from China, Italy, Japan, and UK. The slogan of the pre-statsei workshop is “Earthquake hazard assessment as a platform of dialogue: ACES, CSEP, CSES, NDSHA, and others”.

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