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Uncertainties in evaluation of hazard and seismic risk

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Two methods are commonly used for seismic hazard assessment: probabilistic (PSHA) and deterministic(DSHA) seismic hazard analysis.Selection of a ground motion for engineering design requires a clear understanding of seismic hazard and risk among stakeholders, seismologists and engineers. What is wrong with traditional PSHA or DSHA ? PSHA common used in engineering is using four assumptions developed by Cornell in 1968:(1)-Constant-in-time average occurrence rate of earthquakes; (2)-Single point source; (3).Variability of ground motion at a site is independent;(4)-Poisson(or "memory - less") behavior of earthquake occurrences. It is a probabilistic method and „when the causality dies, its place is taken by probability, prestigious term meant to define the inability of us to predict the course of nature"(Nils Bohr). DSHA method was used for the original design of Fukushima Daichii, but Japanese authorities moved to probabilistic assessment methods and the probability of exceeding of the design basis acceleration was expected to be 10-4-10-6 . It was exceeded and it was a violation of the principles of deterministic hazard analysis (ignoring historical events)(Klügel,J,U, EGU,2014, ISSO). PSHA was developed from mathematical statistics and is not based on earthquake science(invalid physical models- point source and Poisson distribution; invalid mathematics; misinterpretation of annual probability of exceeding or return period etc.) and become a pure numerical "creation" (Wang, PAGEOPH.168(2011),11–25). An uncertainty which is a key component for seismic hazard assessment including both PSHA and DSHA is the ground motion attenuation relationship or the so-called ground motion prediction equation (GMPE) which describes a relationship between a ground motion parameter (i.e. PGA,MMI etc.), earthquake magnitude M, source to site distance R, and an uncertainty. So far, no one is taking into consideration strong nonlinear behavior of soils during of strong earthquakes. But, how many cities, villages, metropolitan areas etc. in seismic regions are constructed on rock? Most of them are located on soil deposits? A soil is of basic type sand or gravel (termed coarse soils), silt or clay (termed fine soils) etc. The effect on nonlinearity is very large. For example, if we maintain the same spectral amplification factor (SAF=5.8942) as for relatively strong earthquake on May 3,1990(MW=6.4),then at Bacău seismic station for Vrancea earthquake on May 30,1990 (MW =6.9) the peak acceleration has to be a*max =0.154g and the actual recorded was only, amax =0.135g(-14.16%). Also, for Vrancea earthquake on August 30,1986(MW=7.1),the peak acceleration has to be a*max = 0.107g instead of real value recorded of 0.0736 g(- 45.57%). There are many data for more than 60 seismic stations. There is a strong nonlinear dependence of SAF with earthquake magnitude in each site. The authors are coming with an alternative approach called "real spectral amplification factors" instead of GMPE for all extra-Carpathian area where all cities and villages are located on soil deposits.

Key words: Probabilistic Seismic Hazard; Uncertainties; Nonlinear seismology; Spectral amplification factors(SAF).