Application of earthquake perceptibility hazard to Pakistan

T. J. Bayliss
Seismic Risk Group, School of Environmental Sciences, University of East Anglia, Norwich, Norfolk, NR4 7TJ, UK
home@tjbayliss.demon.co.uk

Abstract

Earthquake hazard statistics are of significant interest to earthquake engineers designing civilian or critical structures, allowing them to withstand earthquakes and their resulting ground motions. Anti-seismic design criteria can benefit from a range of earthquake metrics generated from the maximum earthquake potential of any seismically-active region. For example, peak or spectral ground motions, maximum magnitude recurrence of cumulative seismic moment release statistics all have their place in modern seismic hazard and risk forecasting techniques as well as anti-seismic design.

Earthquake perceptibility theory is a metric that may also be adopted in the standard remit of any seismic hazard assessment. This constitutes a specific measure of earthquake hazard useful to seismic engineers in isolation or alongside other earthquake metrics. This technique yields a specific *design* earthquake that can play a role in building collapse, economic loss, building usability and anti-seismic design in non-critical structures, and has been adopted to assess seismic hazard across parts of Europe since the late 1970s. Even so, it is often overlooked in favour of more common, better-understood *whole-process* or *part-process* models on which earthquake perceptibility theory is reliant. However, it has not until now been advocated as a viable option to assessing seismic hazard across Pakistan.

Earthquake perceptibility is defined as the probability a site perceives ground shaking equal to or greater than a selected ground motion level, X, resulting from an earthquake of magnitude M, such that:

$$P(X \mid M) = P_c(X)\, P_e(M)$$

$P_c(X)$ estimates the probability of perceiving ground motion level X from an earthquake of magnitude, M. $P_c(X)$ will increase at a non-linear rate with respect to M and can be considered as a ratio of the felt area at X to that of the considered area. $P_e(M)$ will be the derivative – probability density – of the specific statistical earthquake recurrence model, beit of *whole-process* or *part-process* in form. Perceptibility hazard at discrete levels of ground motion is examined under constraints of earthquake perceptibility in such a way that hazard is partitioned at discreet, pre-selected magnitude intervals.

Earthquake perceptibility hazard is best expressed in the form of contoured hazard maps across local and regional extents, or using earthquake perceptibility curves for site-specific scenarios. The peak of a perceptibility curve is given by:

$$\mathrm{d}P[(\mathrm{X} \mid M)] / \mathrm{d}M = 0$$

This therefore defines the magnitude considered the *most perceptible earthquake* and constitutes a characteristic earthquake property for a region due to its dependence on regional attenuation of the felt ground motion considered and the seismicity properties of the area.

A new assessment of earthquake perceptibility hazard is therefore proposed and planned with colleagues from the National Centre of Excellence in Geology, University of Peshawar. This will supplement current work on extreme magnitude recurrence seismic hazard across Pakistan and its surrounding region. This new work will consider perceptibility hazard with respect to ground acceleration, velocity and macroseismic intensity at a range of geographic resolutions. For purposes of this presentation however, a comparable example is given of an earthquake perceptibility hazard assessment across the south-eastern Balkan extent.