Annexure E

DISAGGREGATION OF PROBABILISTIC SEISMIC HAZARD

The PSHA method is based on integrating the total expected seismicity with the probability of exceeding a specified value of spectral amplitude $SA(T)$ at natural period T obtained using selected GMPEs to define the corresponding occurrence rate, $\upsilon[SA(T)]$, for exceeding the spectral amplitude $SA(T)$. Under Poisson assumption, these occurrence rates are used to estimate the spectral amplitudes at all the natural periods with a specified probability of exceeding during a given life period or equivalently with a specified return period. However, to facilitate many engineering decisions it is desired to know the scenario earthquake (magnitude and distance) to which the estimated ground motion by the PSHA method may correspond. The disaggregation of probabilistic seismic hazard is the inverse process of PSHA, which is used to identify the dominant contributor(s) to a specified value of the probabilistic hazard estimate (Chapman, 1995; McGuire, 1995; Bazzurro and Cornell, 1999).

The disaggregation is simply based on finding the fractional contributions of different ranges of magnitude and distance to a specified spectrum amplitude $SA(T)$, which can be defined easily from the expression of Eq. (9.1). For this purpose, we represent the quantity under the triple summations on right hand side of Eq. (9.1) by $r_k[SA(T)\,|\,M_j, \Re_{ij}]$, which represents the occurrence rate of exceeding the spectral amplitude $SA(T)$ due to central magnitude M_j at the *i*th epicentral location in the *k*th source zone. Thus, the relative contribution of the *k*th source zone to the total seismic hazard can be defined by

$$f_k[SA(T)] = \frac{\upsilon_k[SA(T)]}{\upsilon[SA(T)]} \quad \text{with} \quad \upsilon_k[SA(T)] = \sum_{j=1}^{J_k} \sum_{i=1}^{I_k} r_k[SA(T)\,|\,M_j, \Re_{ij}] \qquad \text{(E.1)}$$

The $\upsilon_k[SA(T)]$ is the occurrence rate for exceeding spectral amplitude $SA(T)$ due to all the expected earthquakes in the *k*th source zone alone, and $\upsilon[SA(T)]$ is the total contribution of all the source zone as defined by Eq. (9.1). By computing the $f_k[SA(T)]$ for all the source zones, it is possible to identify the source zone that contributes the most to a selected hazard estimate $SA(T)$ at a site of interest.

Next, the fractional contribution of the earthquakes in magnitude bin M to $M + \Delta M$ and distance bin R to $R + \Delta R$ for a specified type of distance measure (say, R_{jb}) to the seismic hazard due to all the expected earthquakes in the *k*th source zone can be defined by

$$f_k[M \text{ to } M+\Delta M, R \text{ to } R+\Delta R \,|\, SA(T)] = \frac{\sum_{M_j=M}^{M+\Delta M} \sum_{R_{jb}=R}^{R+\Delta R} r_k[SA(T)\,|\,M_j, \Re_{ij}]}{\upsilon_k[SA(T)]} \qquad \text{(E.2)}$$

This expression can be used to find the dominant combination of magnitude and distance bins which gives the highest contribution to the hazard in the dominant source zone.

Finally, the fractional contribution of the earthquakes in the magnitude bin M to $M+\Delta M$ and distance bin R to $R+\Delta R$ to the total seismic hazard due to all the sources can also be defined by

$$f[\mathrm{M\ to\ M}+\Delta\mathrm{M},\mathrm{R\ to\ R}+\Delta\mathrm{R}\,|\mathrm{SA(T)}] = \frac{\sum_{k=1}^{K}\sum_{M_j=M}^{M+\Delta M}\sum_{R_{jb}=R}^{R+\Delta R} r_k[\mathrm{SA(T)}\,|\,M_j,\Re_{ij})}{\upsilon[\mathrm{SA(T)}]} \quad \text{(E.3)}$$

where, $\upsilon[SA(T)]$ is given by Eq. (9.1) and $r_k[SA(T)\,|\,M_j,\Re_{ij}]$ is the quantity under triple summations in Eq. (9.1) as mentioned before. This expression can be used to find out the dominant combination of magnitude and distance bins among all the source zones that contributes the most to the total seismic hazard at the site of interest.

A typical example of the disaggregation of seismic hazard is presented in Figure E.1, from which the maximum contribution to the hazard is seen to come from the combination of the magnitude and distance bins with central values of 8.2at 12.5 km. One can also define approximately the location of the design earthquake by matching the distance to a fault in the source zone. As mentioned before, if the choice of the controlling MCE in the DSHA method cannot be justified on physical grounds and it results in excessively large hazard estimate, the disaggregation of PSHA can be used to rationalize the magnitude and distance of the MCE.

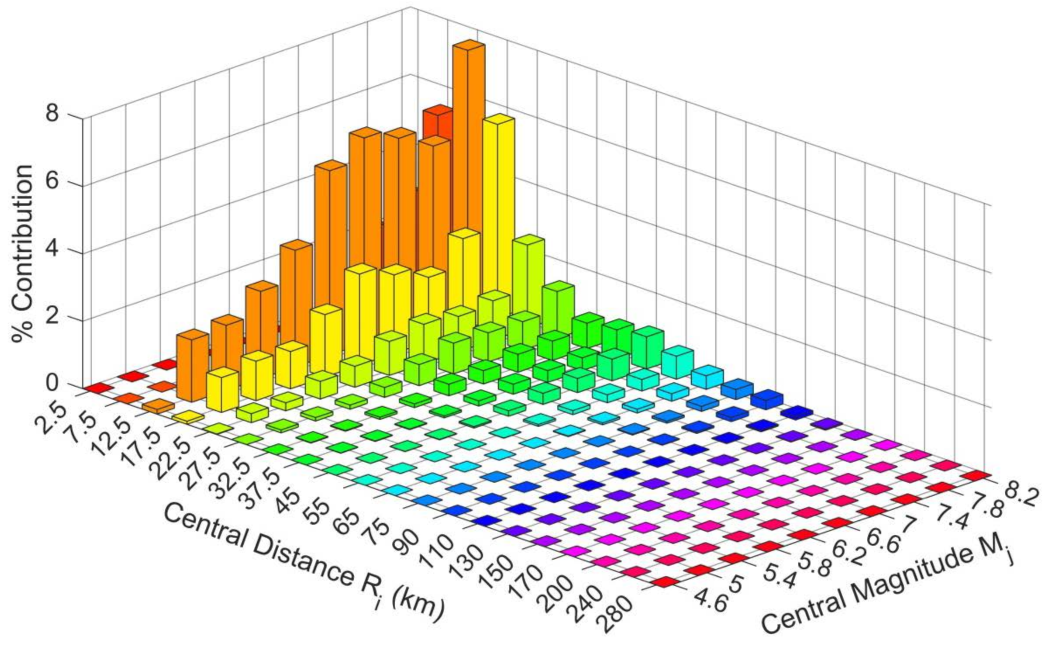

Figure E.1: A typical example of disaggregation of the probabilistic seismic hazard estimate.