Introduction

Portugal is located in the western part of Europe. Its seismicity is characterized by strong interplate earthquakes, originating offshore in the region of the Eurasian and African plates boundary, and moderate intraplate earthquakes originated inland. Several seismic hazard assessment were already performed at regional, national and European level.

In 2013 the SHARE project published an European Seismic Hazard Map. For Portugal the most hazardous zone is the Lower Tagus Valley (STV) region, close to Lisbon (Figure 2). However this map is not compatible with the Portuguese PSHA maps produced for code implementation (EC8).

The difference must be investigated and can be due to the several options that we have to assume during the steps necessary to develop a PSHA. And the first step is the seismic zoning, identifying and characterizing the main seismogenic zones.

Seismic zoning

Three different seismic zoning were used for recent PSHA performed for Portugal (Figure 3). Carvalho & Maftei (2016) tested the influence of these zones on the recurrence periods for largest expected earthquakes. They found small differences for the LV region, but great differences on the south and SW regions of Portugal.

Seismic deformation vs. Tectonic deformation

The seismic deformation cannot exceed, or be very small, when compared with the tectonic deformation. The convergence rate between the Africa (Nubia) and the Eurasia plates, at S–SW direction is 0.2–1.4 mm/year. Matias et al. (2017) proposed a simple fault model (Figure 4) to compute the average slip rate on the faults. They made the computations for different offshore faults in the SW of Portugal and they found slip rates between 0.2 and 1.4 mm/year, depending on the selected zoning, verifying that none exceeds the tectonic deformation.

Probabilistic Seismic Hazard Validation

A PSHA consists on several steps: (1) seismic zoning; (2) seismic potential of each zone (Gutenberg & Richter parameters and Mmax); (3) attenuation law; (4) probability to exceed a certain level of ground motion during the exposure time (seismic hazard curves). Each step is characterized by a probability distribution but their parameters depending on individual assumptions and choices.

But when using, for instance, Monte Carlo simulations are all results consistent with the seismotectonic constraints?

To account on this probabilistic inaccuracy it is usual to perform several PSHA using Monte Carlo simulations and/or logic trees.

If we consider an incertitude of ± 25% on the tectonic constraint (± 1 mm/year on the tectonic strain rate), only 34% of the simulations are consistent with the geologic strain!

Conclusions

PSHA includes uncertainties (random and epistemic) difficult to quantify. An attempt to overcome this difficulty is to perform a large number of simulations, using mathematical algorithms, and presenting the statistical analysis of the results. These statistical parameters (for instance, mean and standard deviation) intend to express the uncertainties of the results. However, the validation of the results with geologic and tectonic constraints is never done. So, on the PSHA it is necessary to take into account the lithospheric deformation of the crust on the target region, in order to reduce the “error” on the estimation of our results incertitude.

Similar tests must be performed for the PSHA using logic trees.

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References


