AN EVALUATION OF SEISMIC HAZARD IN LA HISPANIOLA, AFTER THE 2010 HAITI EARTHQUAKE

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ABSTRACT

An evaluation of the seismic hazard in La Hispaniola Island has been carried out, as part of the cooperative project SISMO HAITI,1 supported by the Technical University of Madrid (UPM) and developed by several Spanish Universities, the National Observatory of Environment and Vulnerability ONEV of Haiti, and with contributions from the Puerto Rico Seismic Network (PRSN) and University Seismological Institute of Dominican Republic (ISU). The study was aimed at obtaining results suitable for seismic design purposes. It started with the elaboration of a seismic catalogue for the Hispaniola Island, requiring an exhaustive revision of data reported by more than 20 seismological agencies, apart from those from the PRSN and ISU. The final catalogue contains 96 historical earthquakes and 1690 instrumental events, and it was homogenized to moment magnitude, Ms. Seismotectonic models proposed for the region were reviewed and a new regionalization was proposed, taking into account geological and tectonic data, seismicity, focal mechanisms, and GPS observations.

In parallel, attenuation models forsubduction and crustal zones were revised in previous projects and the most suitable for the Caribbean plate were selected. Then, a seismic hazard analysis was developed in terms of peak ground acceleration, PGA, and spectral accelerations, SA(T), for periods of 0.1, 0.2, 0.5, 1 and 2s, using the Probabilistic Seismic Hazard Assessment (PSHA) methodology. As a result, different hazard maps were obtained for the quoted parameters together with Uniform Hazard Spectra for Port au Prince and the main cities in the country. Hazard deaggregation was also carried out in those towns, for the target motion given by the PGA and SA (1s) obtained for return periods of 475, 975 and 2475 years. Therefore, the controlling earthquakes for short- and long-period target motions were derived.

This study was started a few months after the 2010 earthquake, as a response to an aid request from the Haitian government to the UPM, and the results are available for the definition of the first building code in Haiti.

INPUTS

1. SEISMIC CATALOGUE

In the study, both faults and zones have been used as seismogenic sources. The faults included in this study as independent elements are Enriquillo, Septentrional and Matthew-Neiba (figure 2). For the zones, two tectonic settings zones have been defined according to their focal depth shallower than 50 km, figure 3, and subduction (focal depth greater than or equal to 50 km, figure 4) seismicity.

Faults have been combined with crustal zones. The recurrence models used has been used as the following (figure 5): For the zones: Gutenberg-Richter law (G-R) estimated from seismicity with the maximum likelihood method. For the faults: G-R and the characteristic earthquake model (CEM), both derived from slip-rate (GPS data, Catsal et al., 2002; Frankel et al., 2011), following the approach of Frankel et al. (1996).

LOGIC TREE AND RESULTS

1. LOGIC TREE

A logic tree (figure 7) with two nodes has been considered, for taking into account episismic uncertainty related to the recurrence models adopted for faults (G-R or CEM) and the GMPE’s combinations (crustal + subduction). In any case, faults are combined with zones modeled by G-R.

SUMMARY AND CONCLUSIONS

A complete PSHA study has been carried out for La Hispaniola, in the frame of a cooperative project with Haiti, after the 2010 earthquake. A seismic catalogue was configured with data of Dominican Republic, Puerto Rico and other 20 agencies, being the first catalogue including Haiti homogenised to Mc. An hybrid method of seismotectonic and faults has been used, considering tectonic regimes crustal and subduction. Recurrence models were estimated: 1. for zones from the seismicity fit to Gutenberg-Richter law and 2. for faults from slip rate derived of GPS observations adopting G-R or Characteristic Earthquake Model. GMPE suitable for Caribbean plate were choosen and six combinations (GMPE crustal + GMPE subduction) were included in a logic tree.

The hazard obtained show maximum PGA values in NE of Dominican Republic (affected by crustal and subduction scenarios), North Haiti (around Septentrional fault) and South Haiti (Enriquillo and Matthew faults). PGA values for return period of 475 years are consistent with the ones given by the Dominican Republic Code, ranging between 0.15 and 0.2 cm/s2. These PGA are notably lower than the ones obtained by Frankel et al. (2011), in a preliminary study, reaching 600 cm/s2. However the morphology of both maps, the ones by Frankel and this study, is quite similar in spite of using different catalogue, zoning and GMPE. It may be explained because these two maps are more sensible to the location of faults, when hybrid models are used.

The results are available for the first Building Code in the country.

REFERENCES


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