The 2003-2007 Seismic Hazard Model for Cuba and Surrounding Areas

In the last years a PSHA has been performed in response to a revision and update of the Cuban building standards (NC-46-99) for earthquake-resistant building design. The seismic zonation presented here is part of these elaborations, and summarizes the implementation of the PSHA input model proposed in Garcia et al. (2003), which was improved in 2007 (Garcia, 2007) and recently proposed by Garcia and Llanes, 2013. The model and the results obtained are valid only for the Cuban territories. Here we present a short description of how this model was implemented in the OpenQuake-engine.

The Seismic source model

The north-eastern Caribbean plate is characterised by complex tectonics, with a transform plate boundary in the vicinity of Cuba, which governed the interaction of the Caribbean plate with the north American plate. The seismicity in the vicinity of Cuba clearly indicates the capability of the major transform system faults: the Oriente and the Septentrional transform faults where very large transpressive and strike-slip earthquakes occur.

In addition, to the west we have the Cayman Spreading Centre, which generates normal faulting earthquakes typically and “intraplate” seismicity related to tectonic structures of minor relevance. For Cuba, two source models reflecting this complexity were considered:

1. The source model proposed in Garcia et al. (2003)
2. The source zone proposed in Chuy and Alvarez (1995), with some modifications proposed by Despaigne et al. (2002)

In both models, the tectonic figures are defined as area sources at a fixed depth. In the OpenQuake-engine implementation, we use the same typology defined in the original models, then the source zones are modelled as NRML areaSource objects.

The map below depicts the annual occurrence rate per source (between minimum and maximum magnitudes) for the first source model cited above, the only one considered in the OpenQuake-engine implementation.

Total occurrence rate
(number of events / year)

- < 1e-6
- 1e-6 - 1e-5
- 1e-5 - 1e-4
- 1e-4 - 1e-3
- 1e-3 - 1e-2

- 1e-2 - 1e-1
- 1e-1 - 1
- 1 - 10
- >= 10

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The Ground motion model

As there are no ground motion prediction equations (GMPEs) for the Cuban/Caribbean region, GMPE's from literature have been used. In the original model, two GMPEs for active shallow crust regimes were used and combined using a logic tree.

Active Shallow Crust	Weight
Ambraseys et al. (1996)	0.5
Boore and Atkinson (2008)	0.5

In our OpenQuake-engine implementation we decided to use only one GMPE (Boore and Atkinson, 2008).

Active Shallow Crust	Weight
Boore and Atkinson (2008)	1.0

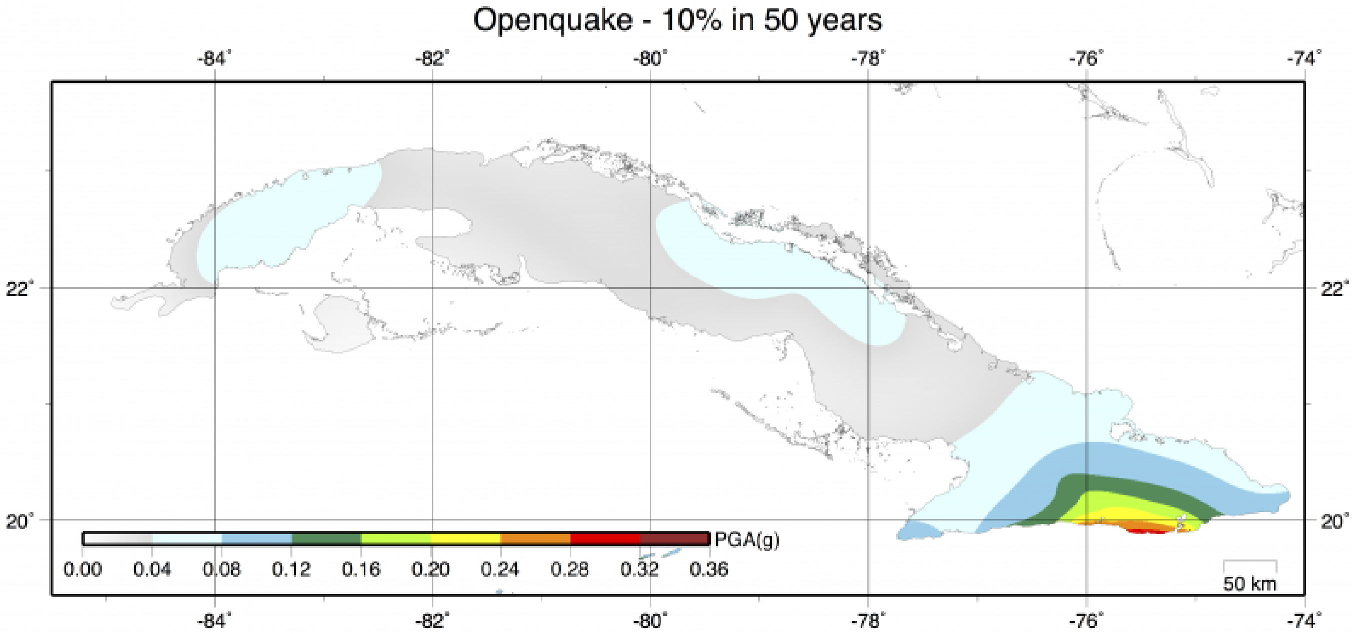
Reference site condition

A rock condition is assumed in the OpenQuake-engine implementation. The site condition is defined using a Vs30 = 760 m/s.

Hazard results

In the original model the calculation was made using the Cornel (1968) approach, first using SEISRISK III and then CRISIS (v.2013) codes. In both cases a logic tree was used to take into account epistemic uncertainties.

The figure below represent hazard maps for peak ground acceleration, for 10% probabilities of exceedance in 50 years, using the OpenQuake-engine and CRISIS and the Boore and Atkinson (2008) as GMPE.



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Model summary table

This table summarises the main characteristics of the original implementation of this model

1	**Datasets availability**	
1.1	Earthquake catalogue	Not available
1.2	Geological database	Not available
1.3	Strong-motion database	Not used
1.4	Site characterization database	Not used
Notes		
2	**Methodology for model development**	
2.1	Scientific participation (SSHAC levels) and review process	
2.2	Documentation describing model preparation	Not available
2.3	Codes used for model preparation	Not available
Notes		
3	**PSHA input model**	
3.1	**Seismic Source Model**	
3.1.1	Area sources	YES
3.1.2	Grid sources	NO
3.1.3	Crustal faults	NO
3.1.4	Subduction faults	NO
3.1.5	Non-parametric ruptures	NO
3.1.6	Magnitude-area scaling relationships	Wells and Coppersmith (1994)
3.2	**Ground Motion Model**	
3.2.0	Tectonic regionalisation	NO
3.2.1	Models for active shallow seismicity	YES
3.2.2	Models for subduction interface	NO
3.2.3	Models for subduction intraslab	NO
3.2.4	Models for stable continental regions	NO
3.2.5	Models for deep non-subduction sources	NO
3.2.6	Models for volcanic areas	NO
3.3	**Site Response Model**	
3.3.1	Based on GMPEs	YES
3.3.2	Based on site-response analysis	NO
3.4	**Epistemic uncertainties**	
3.4.1	Seismic Source Model	Included
3.4.2	Ground Motion Model	Included using a logic tree (see the ground motion model section)
3.4.3	Site Response Model	Not included
Notes		
4	**Hazard Input Description**	
4.1	Hazard input document	Partially available
4.2	Input files	Partially available
Notes		
5	**Calculation**	
5.1	Software	Available upon request- CRISIS-2012
5.2	**Results**	
5.2.1	Hazard curves	Not available

5.2.2	Hazard maps	Not available
5.2.3	Uniform hazard spectra	Not available
5.2.4	Disaggregation	Not available
5.2.5	Stochastic event sets	Not available
5.2.6	Ground motion fields	Not available
Notes	The results will be available soon (paper in preparation)	

Download The OpenQuake-engine Input Model

The OpenQuake-engine input model (NRML format) can be downloaded at the link provided below - Please read the license and disclaimer attached to the model.

N.B. This is a model adapted by GEM to the OpenQuake-engine from the original model developed by Garcia eta l. (2003). This explains minor differences you might encounter between the results presented in the OpenQuake platform and those disseminated by the original Organisation.

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