PROJECT RESIS II

A new evaluation of Seismic Hazard for the Central America Region in the frame of the RESIS II Project.

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Introduction

- This hazard analysis was developed for the whole Central America region in 2008

- Participation of seismologist from all the CA Countries

  - Use of updated information of seismological and strong motion Data Banks

    - *New Zonation for three seismic sources*: Crustal events, subduction interplate and inslab.

    - Comparison and selection of strong motion models using actual and local data for each seismic source.
Group of work

Introduction

Seismotectonic context

Methodology

INPUTS

Catalogue

Zonation

Atenuattion

Hazard estimation

Results

Conclusions
- **Subduction zone**
  - Coco’s Caribe plates
  - Earthquakes with high magnitude and epicenters offshore

- **Local faults aligned with the volcanic chain**
  - Earthquakes with moderate magnitude, surface depth and epicenters near of population centers. More damaging earth.

- **North American Caribe system faults:**
  - Chixoy - Polochic - Motagua
Methodology PSHA

(Probabilistic Seismic Hazard Assessment)

- Logic tree with a node for considering the uncertainty inherent to attenuation model

- Deaggregation: Determination of couple \((M, R)\) with highest contribution to seismic hazard with a fixed return period.

- Definition of control earthquakes for RP= 500, 1000 and 2500 years.
Regional Zonification (national detail)

**Seismotectonic context**

- Crustal zones
- Surface seismicity, $h < 25$ km

**Methodology**

- Catalogue
- Zonation
- Atenuation

**INPUTS**

**Hazard estimation**

- Subduction interplate
  - Intermediate seismicity
  - $25 < h < 60$ km

**Results**

- Subduction intraplate

**Conclusions**

- Depth seismicity, $h > 60$ km
Seismic Catalogue

- Earthquakes since 1522 until Dec. 2007
  - Mw >= 3.5

Process carried out:
- Depuration:
- Standardization to Mw
- Filtering of fore and aftershocks
- Completedness analysis
Seismic parameters - Gutenberg-Richter models

Seismotectonic context
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Distribution of b-values

- Values b between 1 and 1.3 pre-arc zones, tensitional efforts.
- Values b between 0.7 and 0.9 in volcanic chain, distensive regime.
- Values b between 0.6 and 1 in interface.
- Inslab, normal ruptures, b between 0.6 and 1.
### Attenuation

#### Identification of the suitable GM models

<table>
<thead>
<tr>
<th>model</th>
<th>Data Base</th>
<th>Component used (PGA, Sa)</th>
<th>sources</th>
<th>Dist. (km)</th>
<th>M&lt;sub&gt;W&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youngs et al. (1997) (YOUN97)</td>
<td>Mundial</td>
<td>Media geométrica</td>
<td>Interplaca Intraplaca</td>
<td>500</td>
<td>5,0 - 8.2</td>
</tr>
<tr>
<td>Atkinson y Boore 2003 (AYB03)</td>
<td>Mundial</td>
<td>Las dos horizontals (Aleatoria)</td>
<td>Interplaca Intraplaca</td>
<td>10-400</td>
<td>5,0 - 8.3</td>
</tr>
<tr>
<td>Garcia et al. (2005) (GAR05)</td>
<td>México</td>
<td>Media cuadrática</td>
<td>Intraplaca</td>
<td>4 - 400</td>
<td>5,2 – 7,4</td>
</tr>
<tr>
<td>Cepeda et al. (2004) (CEP04)</td>
<td>El Salvador</td>
<td>Aleatoria Media geométrica</td>
<td>Intraplaca Corteza superficial</td>
<td>10 – 400 0-100</td>
<td>5,0 – 8.3 5,1 – 7,2</td>
</tr>
<tr>
<td>Climent et al. 1994 (CLI94)</td>
<td>América Central and México</td>
<td>Mayor de las horizontales</td>
<td>Interplaca Corteza superficial</td>
<td>5 - 400</td>
<td>4,0 - 8,0</td>
</tr>
<tr>
<td>Zhao et al. (2006) (ZH06)</td>
<td>Japón</td>
<td>Media geométrica</td>
<td>Interplaca Corteza superficial</td>
<td>10-300</td>
<td>5,0 – 8,2</td>
</tr>
<tr>
<td>Spudich et al. (1999) (SEA99)</td>
<td>Mundial</td>
<td>Media geométrica</td>
<td>Corteza superficial</td>
<td>0 - 100</td>
<td>5,1 – 7,2</td>
</tr>
<tr>
<td>Schmidt et al. (1997) (SCH97)</td>
<td>Mundial</td>
<td>Mayor de las horizontales</td>
<td>Corteza superficial</td>
<td>6 - 200</td>
<td>3,7 – 7,6</td>
</tr>
</tbody>
</table>
Calibration of models with local data

Residual analysis \( (r = \ln GM^* - \ln GM) \)

Seismotectonic context

Methodology

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Hazard estimation

Results

Conclusions
**Selected attenuation models:**

- **Subduction interface:** Youngs et al (1997)
- **Subduction inslab:** Youngs et al, Zhao et al (2006)
Hazard Estimation

- Software CRISIS 2007 (Ordaz et al., 2007)

- Estimation in a network with points separated 0.1° longitude and latitude in terms of PGA and SA for T = 0.1, 0.2, 0.5, 1 and 2 s

- Logic tree with a node for attenuation models

  Every branch is a combination of models:

  - crustal, + interface + inslab

  Seismic Hazard maps for PR = 500, 1000 and 2500 years

  In the capitals of the 6 CA countries:

  - Hazard curves

  - UHS

  - Deaggregation for target motions given by PGA, SA (0.2) and SA (1s) → control earthquakes
Hazard maps PR= 500 years

- **PGA max =600 gal**
  Panama Fracture
- **500 gal in volcanic chain**
- **SA (0.2) max =1300 gal**
  South Guatemala
- **SA (1) max =300 gal**
  Costal zones

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Hazard Maps  RP=1000 years

- PGA max = 700 gal
  Panama Fracture, South Guatemala and volcanic chain

- SA (0.2) max = 1600 gal
  Panama Fracture, South Guatemala and volcanic chain

- SA (1) max = 400 gal
  Panama Fracture, South Guatemala and volcanic chain

Seismotectonic context
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Conclusions
HAZARD MAPS PR=2500 years

- PGA max = 850 gal
  South Guatemala

- SA (0.2) max = 2000 gal
  South Guatemala

- SA (1) max = 500 gal
  South Guatemala

Seismotectonic context

Methodology

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Hazard estimation

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Conclusions
Seismic hazard curves in the capitals

Seismotectonic context
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Deaggregation

Guatemala. PGA, PR 500 años

San Salvador. PGA, PR 500 años

Managua. PGA, PR 500 años

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CONCLUSIONS (I)

- For all return periods the highest values of PGA are predicted in Panamá Fracture zone, South Guatemala and certain zones of volcanic chain.

- Maximum PGA:
  - RP = 500 years, 500 gal
  - RP = 1000 years, 700 gal
  - RP = 2500 years, 850 gal

- Similar morphology for maps of SA (0.2 s) with maximum values
  - RP = 500 años, 1300 gal
  - RP = 1000 años, 1600 gal
  - RP = 2500 años, 2000 gal

- Maps of SA (1 s) with maximum in coastal zones, due to the highest influence of the subduction events.
CONCLUSIONS (II):

- **Specific results in the capitals:**
  
  Highest hazard in Guatemala City and San Salvador, followed by San José and Managua and minor hazard in Panamá and Tegucigalpa.

- **Deaggregation**

  - Control earthquakes are identified in the capitals: (Target motion given by PGA and RP= 500 y)

  In general, a near shock is dominant (M 6-6.5; R 15 km) identified with a volcanic chain event. Exception of Tegucigalpa where a far event is dominant (M 6.7, R 210 km) and Panamá, where neither clear event is found.

  In Guatemala City, San Salvador and Managua a second long-distance earthquake M ~ 7 is found with important contribution, identified with a subduction event.
How to get the project results:


- CA country reports (in Spanish)
- Regional CA report (in Spanish)
- Seismic hazard maps in ArcGis Format

Book: Seismic Hazard in Central America (in Spanish)

Benito and Torres (eds),
2010
Entimema Press, Madrid

- A new evaluation of Seismic Hazard for the Central America Region in the frame of the RESIS II Project.
- The 14th World Conference on Earthquake Engineering
- October 12-17, 2008, Beijing, China
THANKS FOR YOUR ATTENTION !!!