NATIONAL UNIVERSITY OF ENGINEERING LIMA-PERU Faculty of Civil Engineering



### SCENARIO EARTHQUES IN PERU

#### Zenón AGUILAR, Dr. Eng.

Nelson E. Pulido H.

National Research Institute for Earth Science and Disaster Prevention (NIED), Japan

Collaborators : Hernando Tavera (IGP, Perú), Zenón Aguilar (UNI, Perú), Diana Calderón (UNI, Perú), Mohamed Chlieh (U. Nice-Sophia, France), Toru Sekiguchi (U. Chiba), Shoichi Nakai (U. Chiba), and Fumio Yamazaki (U. Chiba)



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# Contents

- Historical earthquakes in Central Andes, Perú
- Estimation of earthquake scenarios for Central Andes
- Construction of broadband source models for strong motion simulations
- Strong motion simulations for Lima from the scenario earthquakes





#### HISTORICAL EARTHQUAKES IN PERU



Adapted from Okal et al (2006)

1974 10 03 Lima, M8.1

2001 06 23 Atico, M8.4

1940 05 24 Huacho, M8.2

1942 08 24 San Juan, M8.0

1966 10 17 Barranca, M8.1



2007 08 15 Pisco, M8.0 JAPAN PERU CEN RESEARCH A

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MAXIMUN SEISMIC INTENSITIES OBSERVED IN PERU.

Alva Hurtado et al (1984)





#### HISTORICAL SEISMIC ACTIVITY IN PERU (Tavera et al)



### **GPS campaigns in Peru-Northern Chile**

87 surveyed sites (1993-2003) from Lat.
11°S to Lat. 24°S.
Including measurements from ocean bottom GPS offshore Lima



Kendrick et al. (2001), Chlieh et al. (2004), Gagnon et al. (2005)





# Slip deficit rate for Peru and Northern Chile and scenario earthquake for Central Peru



- Slip deficit since 1746 (265 years)
- Maximum slip is 15 m
- Magnitude Mw~8.9, neglecting the 20
- century earthquake sequence



S(x)=C(x) \* vo \* t

S(x): slip, t : elapsed time

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#### **Hypocenter locations scenarios**







#### Array microtremors measurements in Lima, Peru, and installation of a strong motion network [SATREPS project]









#### Strong motion simulation method [Pulido et al. 2004, 2007, 2011]



$$A_{ij}(f) = \frac{R_{pij}(\theta, \phi, f) M_0 S(f, \Delta \sigma_i) G(f) e^{-\pi f R_{ij}/Q(f)\beta} P(f, f_{\max})}{4\pi \rho \beta^3 R_{ij}}$$

Acceleration Fourier Spectra at the *i* subfault and *j* station

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Peak values for every slip model is averaged for all rupture starts



# Simulated PGA and PGV at Lima including site effects



Average values for slip No.5 and all rupture starts





# Simulated Acceleration and Velocity response spectra at Lima including site effects (h=0.05)



Sv, T=1.0 s

Sv, T=1.5 s



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#### Simulated PGA at Lima for all rupture starts

• Slip model No. 5









#### Simulated PGV at Lima for all rupture starts

• Slip model No. 5





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### Simulated strong ground motion at PQR



Slip scenario No.5 and 7 and starting point of the rupture at the southern edge of the fault









## **Conclusive remarks**

- Central Andes region in Peru has the potential of generating an earthquake with magnitude of 8.9, and a source area of approximately 500 by 165 km<sup>2</sup>
- Our results show average PGA and PGV values as large as 1000 cm/s<sup>2</sup> and 80 cm/s in Lima
- Our simulated PGA and PGV in Lima are 2~3 times larger than the values observed in Parque de la Reserva, central Lima, during the 1974 and 1966, M8 earthquakes.

