Strong motion estimation and seismic microzoning in major cities in Peru

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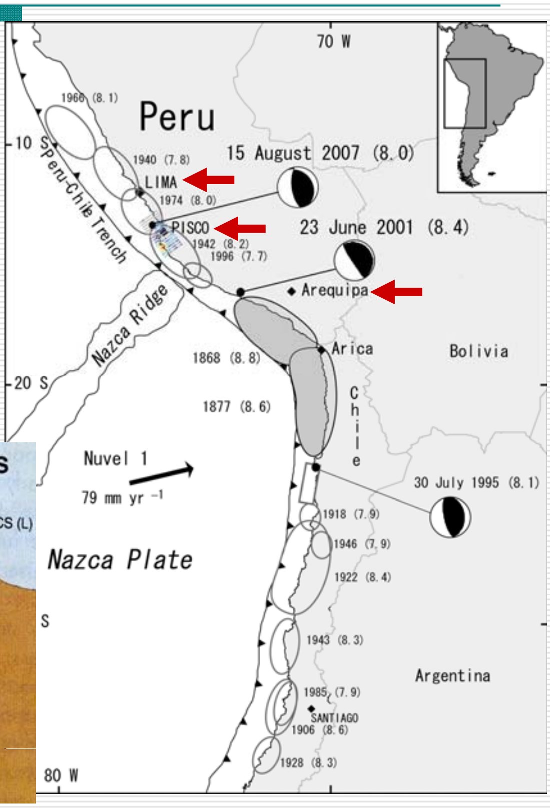
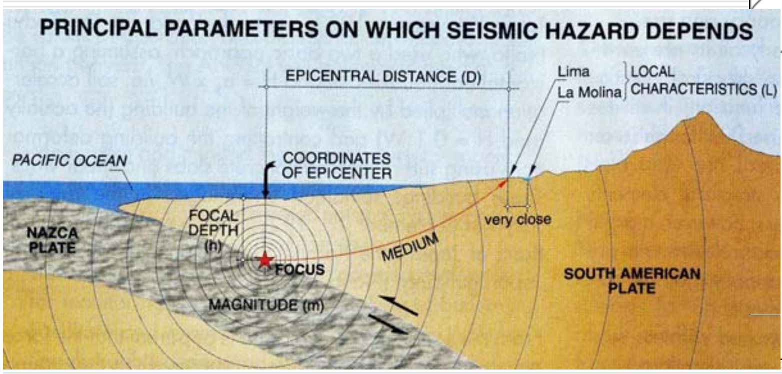
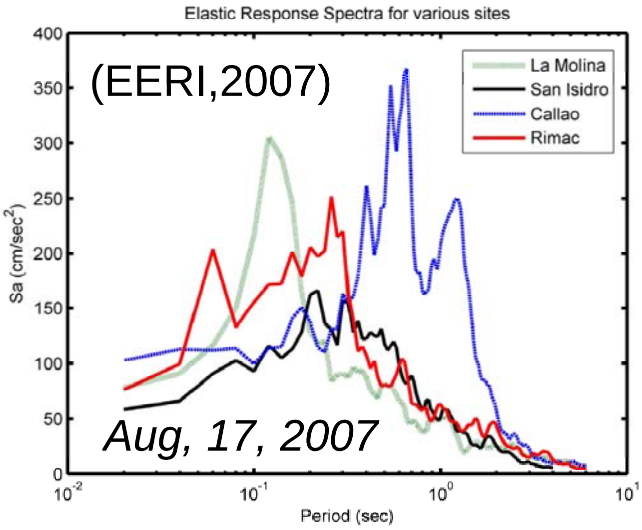
Large earthquakes in subduction zone

1960 01 13 Arequipa, Peru M7.5
1966 10 17 Near the Coast of Peru M8.1
1970 05 31 Chimbote, Peru M7.9
1974 10 03 Near the Coast of Central Peru M8.1
2001 06 23 Near the Coast of Peru M8.4
2007 08 15 Near the Coast of Central Peru M8.0

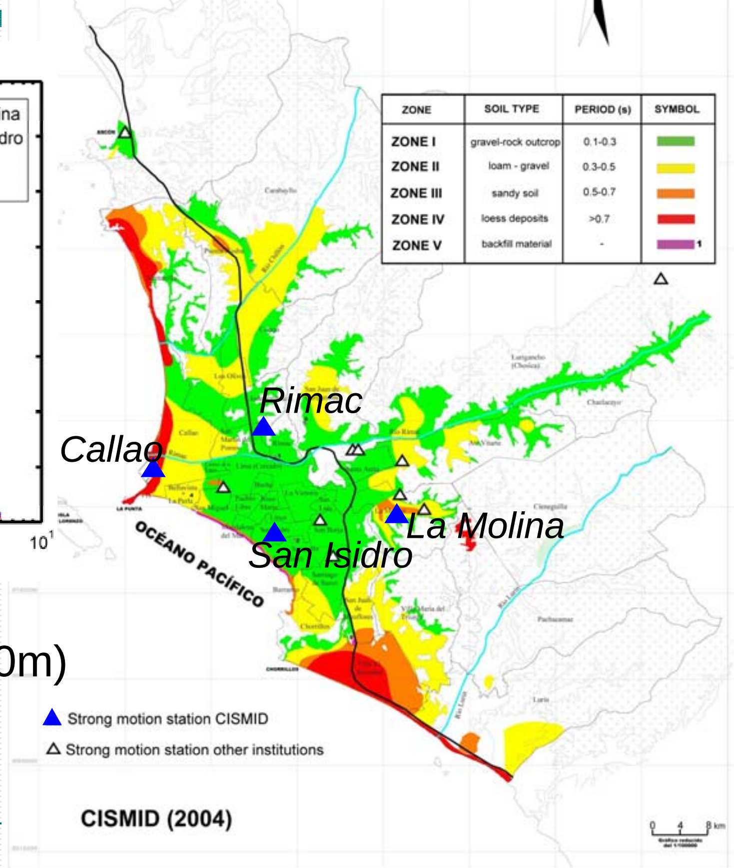




Ground motion&existing microzoning map



Rimac, San Isidro: gravel
La Molina: shallow soils (<100m)
Callao:soft soils

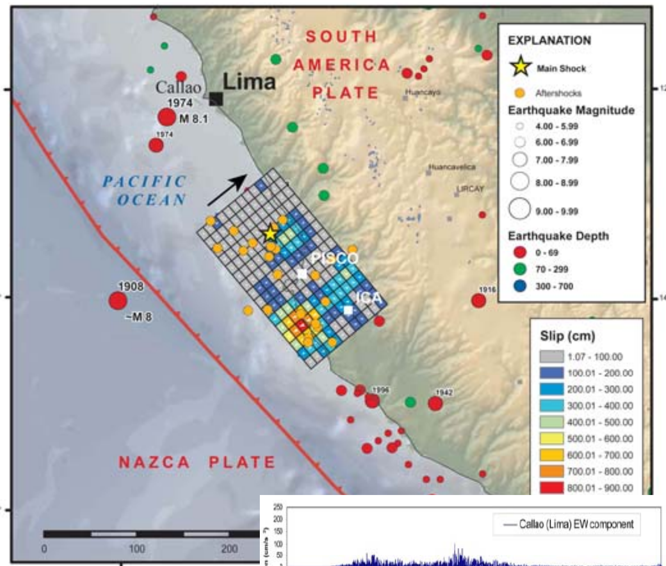


Researches in ground motion team

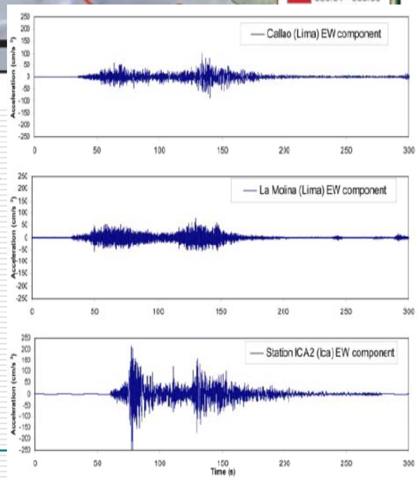
- Fault models for large scenario earthquakes along the subducting plate with cooperation of Tsunami group.
- Installation of strong motion instruments on ground or BF of buildings (3 areas of Lima, Pisco, and Arequipa)
- Geophysical and geotechnical surveys for shallow and deep S-wave structure including borehole loggings
- Analysis of earthquake data from small events to characterize source, path and site amplification
- Calculation of site amplifications for microzonation map
- Estimation of slope failure from geotechnical surveys
- Strong motion simulation based on hybrid approach of theoretical and empirical methods

Source model

- Gathering of information on historical seismicity, geology, focal mechanisms and available studies on seismo-tectonics.
- Gathering of strong motion records of earthquakes.
- Elaboration of several scenario earthquakes from the subduction of the Nazca plate that could likely affect Lima, Pisco and Arequipa cities.

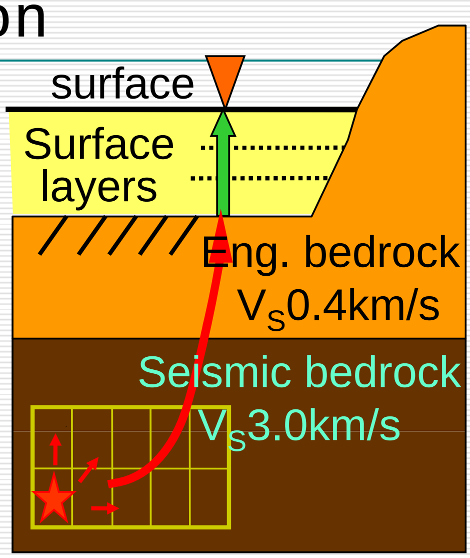


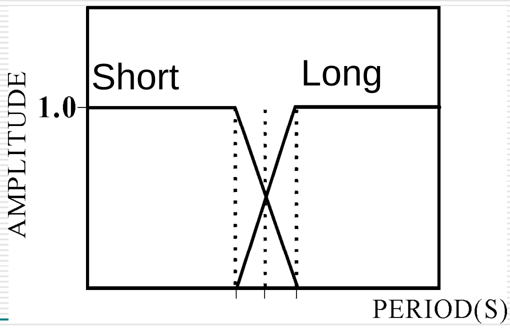
2007/8/15
Acc in Lima



Strong motion simulation

- Simulation of broadband strong motion on engineering bedrock from different scenario earthquakes in Lima, Pisco and Arequipa areas using a hybrid approach.
- 3D FDM in long-period range, and stochastic method using 1D model in short-period range)
- Calculation of surface motion considering 1D amplification in surface layers due to input motion on engineering bedrock

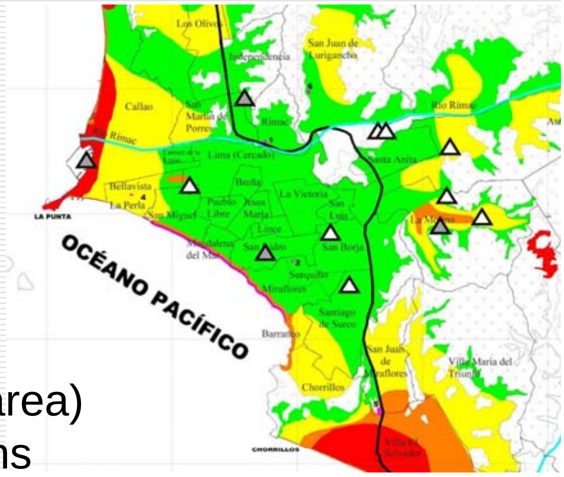




Strong motion observation

Existing strong motion stations
Lima: 14 stations (4 by CISMID)
Arequipa: 4 stations
Pisco: ?

In our study, two plans are proposed;
1) Modern strong motion instruments
Lima, Pisco, Arequipa(e.g.,3sites/area)
2) Temporary earthquake observations
using small-aperture array in Lima



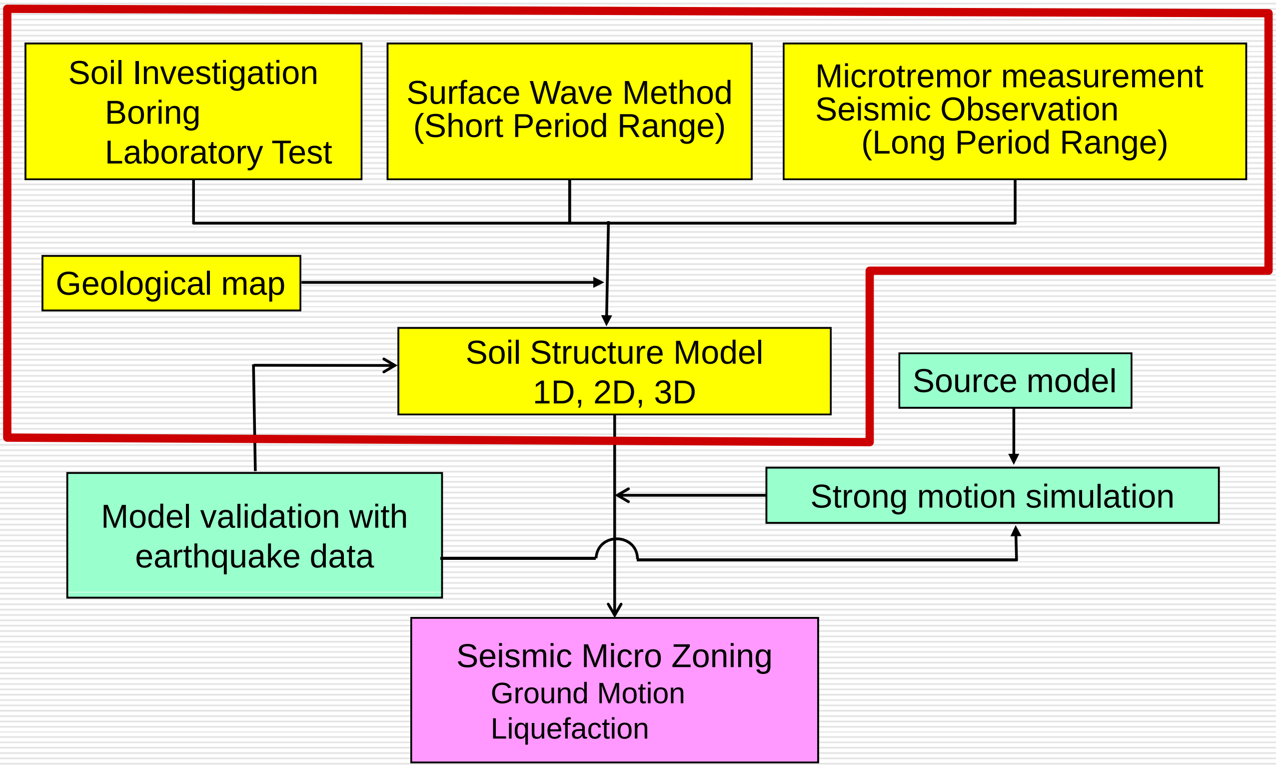
Lima stations

We will discuss with members of other groups and Peru for the final plan (1 or 2 or 1&2) considering plans of the other projects

Analysis of small earthquake data

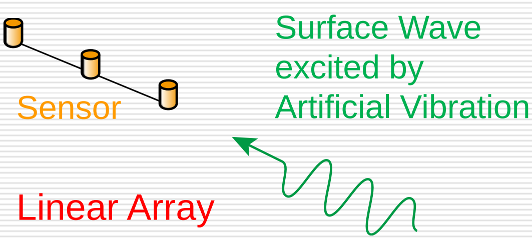
- Estimation of source characteristics of small events, Q-factor for the crust and mantle, site amplification
- Estimation of envelope function of small events for use of stochastic Green's function in strong motion calculation
- Exploration of deep S-wave velocity profiles using earthquake data, such as receiver function, phase velocity and Rayleigh wave ellipticity
- Validation of geological models from geophysical and geotechnical surveys using 1D site amplification or 3D simulation of moderate events
- Examination of applicability of existing attenuation equations

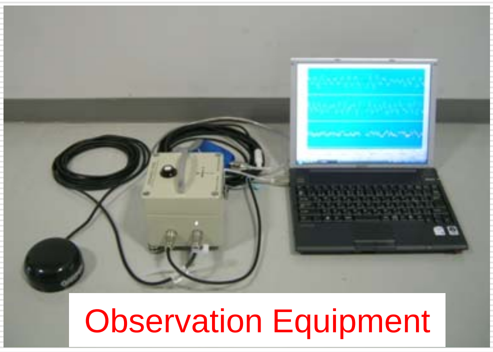
Geophysical & Geotechnical surveys



Surface Wave Method

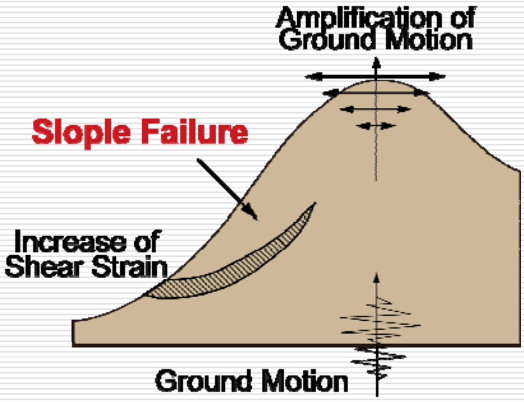
- To estimate the shallow soil profiles and the soil amplification characteristics, surface wave method including microtremor measurement will be conducted.
- Microtremor measurement with one three-component sensor and linear array measurement with several vertical sensors will be conducted.

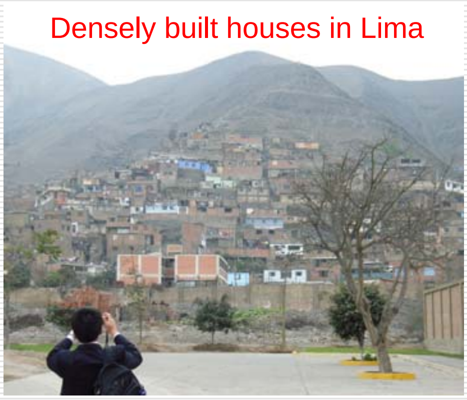




Seismic Risk of Slopes (1)

- In Lima, there are many steep slopes where houses are densely built.
- Ground motion tends to become large due to ground irregularity (slopes), which may cause failure or landslide during an earthquake.





Seismic Risk of Slopes (2)

- The research plan includes:
  - Select a few target sites in Lima, where houses are densely built.
  - Collect soil investigation data, if any.
  - Conduct soil investigation, if possible.
  - Conduct a series of microtremor measurements.
  - Construct soil models and perform finite element analyses.
  - Evaluate seismic risks of the area with slopes based on these data along with the results from other groups in this project.