Developing Tsunami Damage Estimation and Mitigation Technologies

Tsunami Research Group G2

Let us imagine again the tsunami disasters.

Objectives and goals

- To assess the potential tsunami disaster and its impact to the Peruvian coast
- To develop the practical technologies to mitigate tsunami risks in Peru
- To implement the strategic plans for disaster mitigation of Peruvian government
- To contribute the Pacific tsunami disaster mitigation strategies

Tsunami group member

- Dr. Shunichi Koshimura (Tohoku Univ., Tsunami engineering, Team Leader)
- Dr. Gaku Shoji (Univ. of Tsukuba, Structural and earthquake engineering)
- Dr. Yushiro Fujii (BRI, Seimology and Tsunami modeling)
- Dr. Yuji Yagi (Univ. of Tsukuba, Seismology)
- Dr. Hideaki Yanagisawa (TEPSCO, Tsunami modeling)
- Msc. Julio Kuroiwa (Leader, CISMID)
- Guillermo Hasembank (Contralminarte, DHN)
- Gilberto Tacilla (Tec., DHN)
- Mr. Cesar Jiménez (Tsunami simulation, DHN)
- Carlos Marcos Villanneva (DHN)
- Dr. Miguel Estrada (CISMID)

by Prof. Carlos Alberto Zavala Tóledo
at the kickoff tsunami meeting
CISMID, Dec 20, 2009

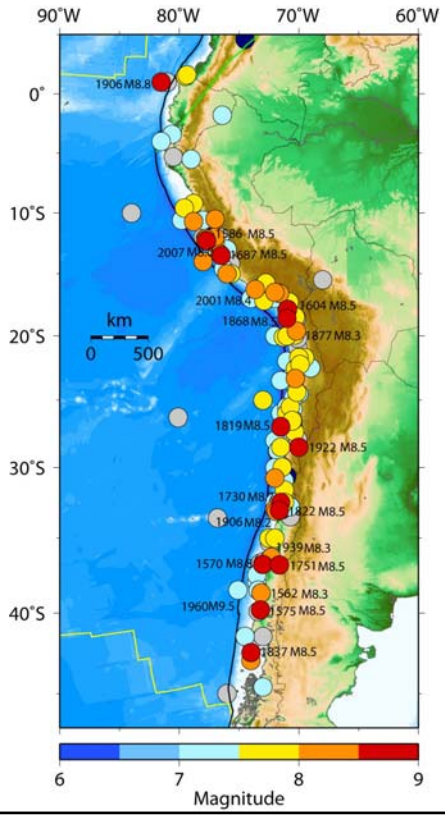
Research plan - Scientific phase -

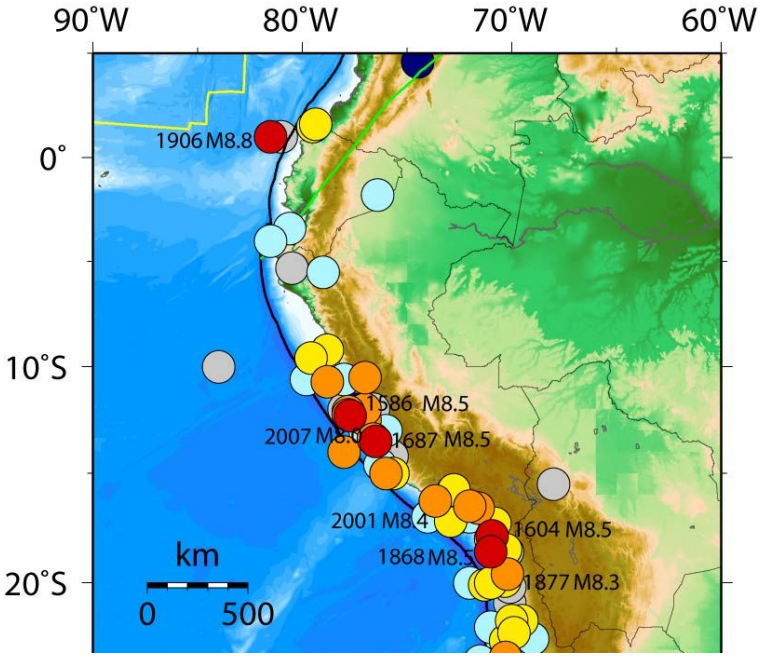
- Assessing historical tsunami events and its impact in Peru
  - Tsunami sources
  - Tsunami hazard (Tsunami generation, near-shore propagation and coastal inundation)
  - Damage (Casualties, structural damage)
- Indentifying potential tsunamis and the worst case scenarios
  - Tectonic settings and tsunami source scenarios
  - Potential tsunami exposure (Exposed population)
  - Potential impact
- Mapping tsunami hazard and its impact
  - Inundation modeling
  - Damage estimation (Casualties, structural damage)
  - Hazard maps, Cartography

Research plan - Implementation Phase -

- Developing a fundamental procedure for mapping tsunami hazard
  - Training program (Tsunami modeling and mapping)
  - Warning, guidance and public awareness
- Strategic planning to mitigate tsunami risks and damage
  - Tsunami disaster mitigation program for Peruvian government
  - Tsunami countermeasures
  - Design for tsunami evacuation facilities
  - Tsunami evacuation strategies

Past events in Peru



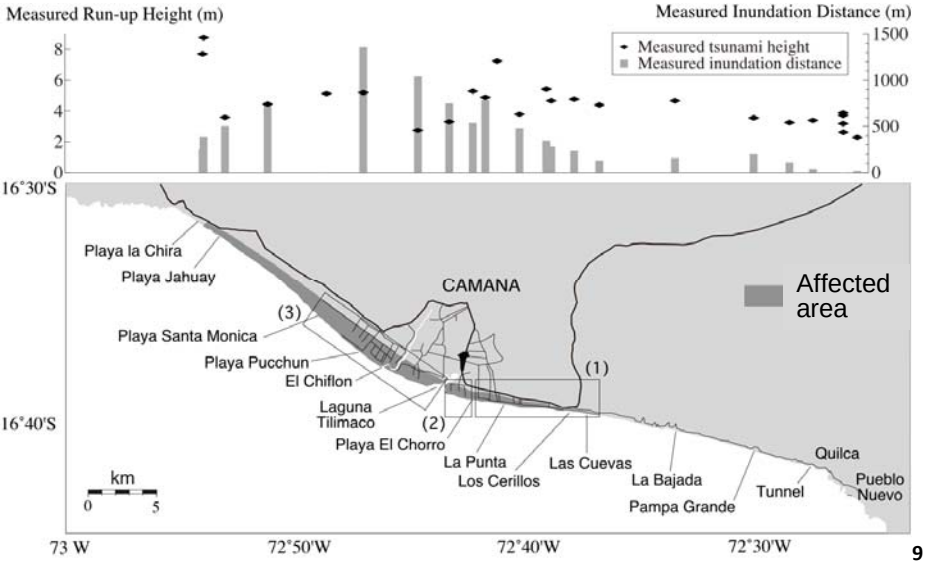


NGDC Tsunami Database
http://www.ngdc.noaa.gov/hazard/tsu_db.shtml

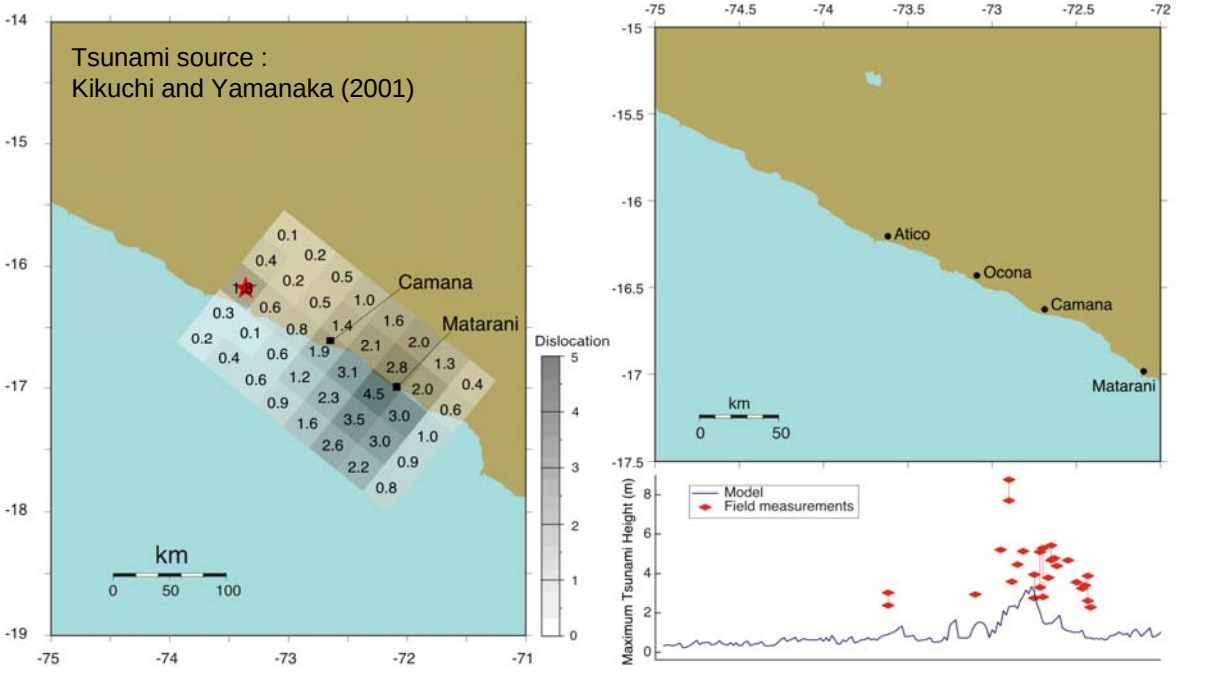
Damage at Camana

2001 Tsunami - Camana, Peru -

Casualty			House damage	
Dead	Missing	Injury	Major/Minor	Collapsed
24	62	41	760	2915



Modeling the 2001 Peruvian tsunami



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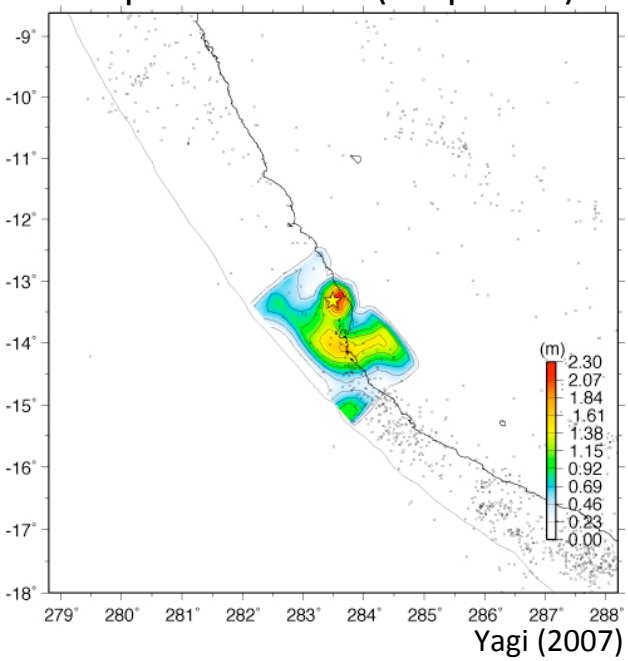
Source process of 2007 Peru earthquake by inversion of tele-seismic body wave

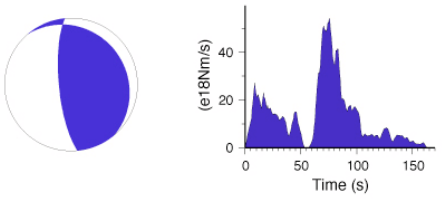
Slip distribution (Map view)

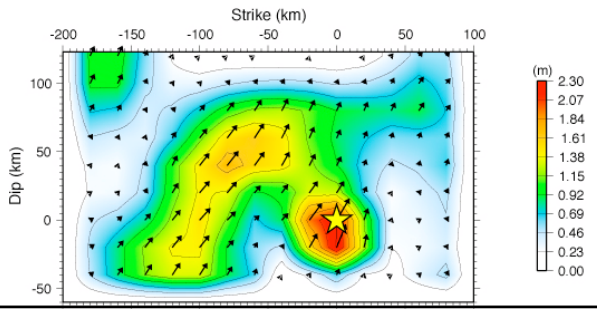


Yagi (2007)

Focal mechanism, Source time fun., Slip distribution on fault plane

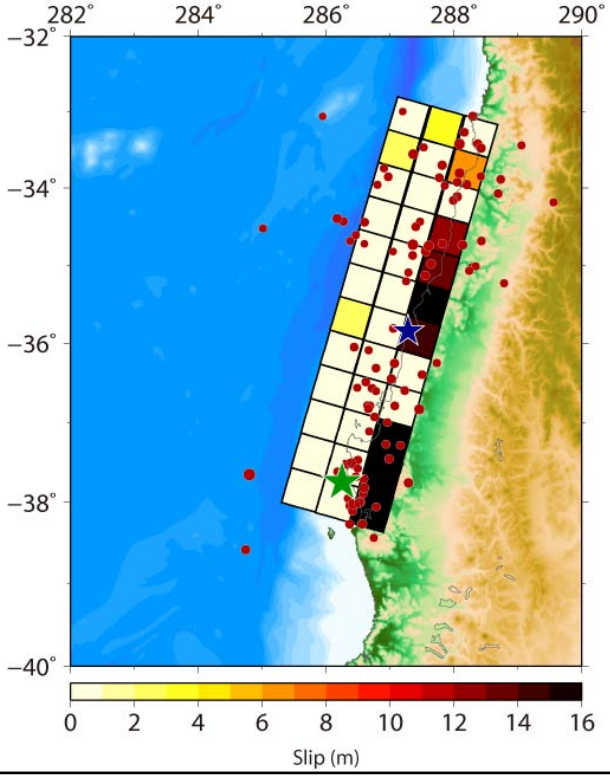
(Strike,Dip,Slip) = (320.0, 18.0, 56.8)
Moment = 0.1998E+22(Nm); Mw = 8.1
Variance = 0.20129
Depth = 40.00(km) ; Vrmax = 1.75(km/sec)





Tsunami Waveform Inversion Result

2010 Chile earthquake

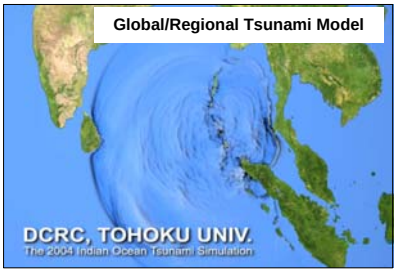


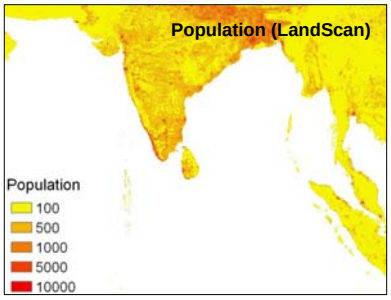
Length: 50 km
Width: 50 km
for each subfault

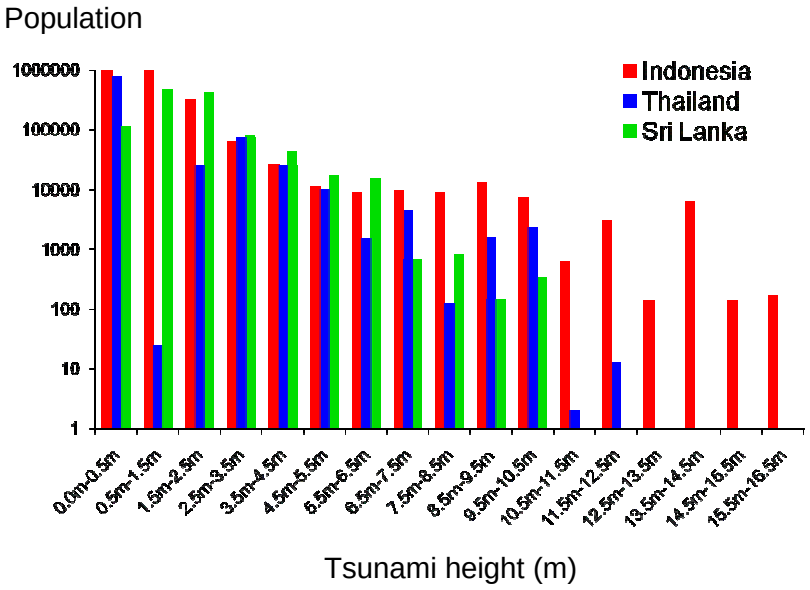
Tsunami modeling technology

- Tsunami Modeling techniques (Tsunami-code to simulate tsunami generation, off-shore/near-shore propagation and coastal inundation)

Potential tsunami exposure

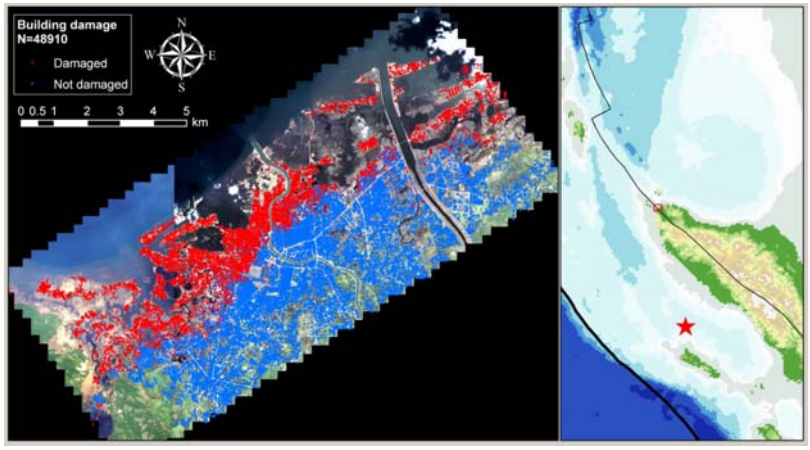


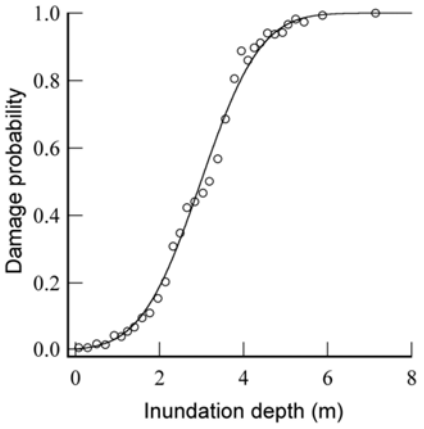




Tsunami fragility curves

- Structural damage probabilities in terms of flow depth, current velocity and hydrodynamic force





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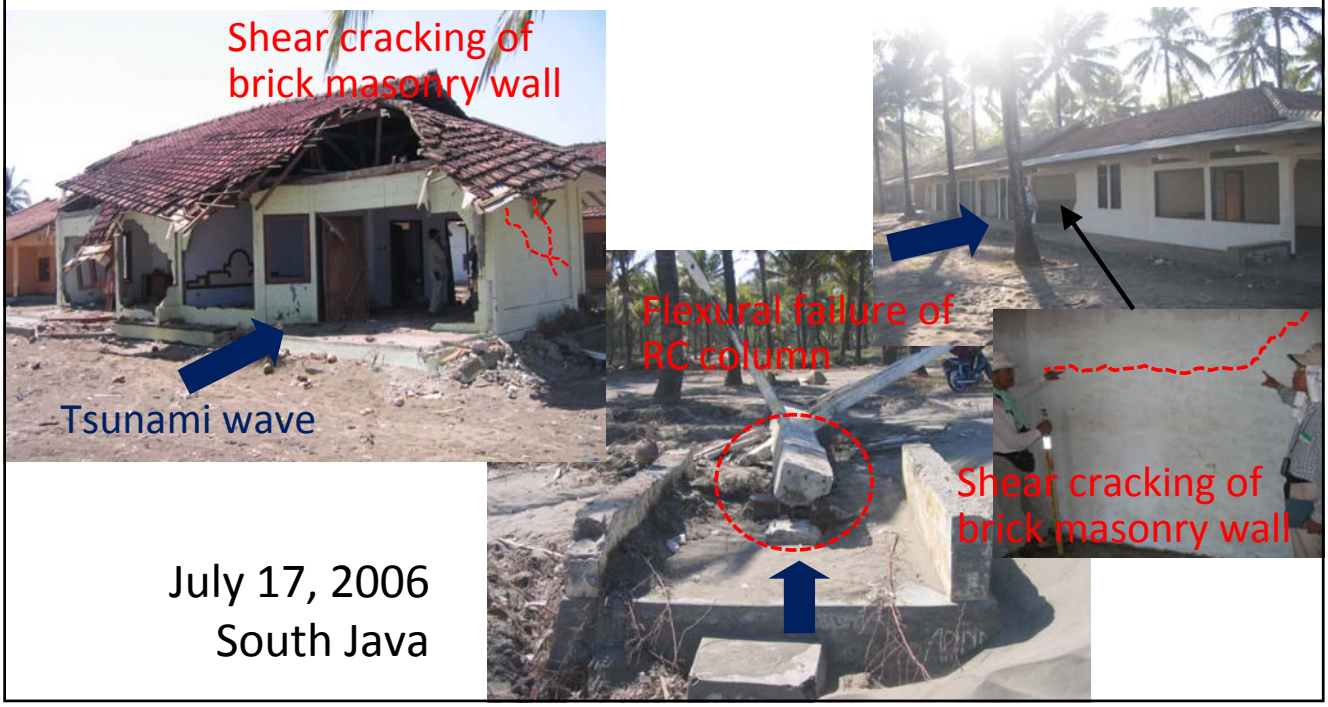
Clarification of failure modes of a structural component by tsunamis



July 17, 2006
South Java

Things to discuss are open based on the resolution at the kickoff tsunami meeting [1]

- Study area …
  - One historical event for model verification/validation(Camana, Pisco)
  - Two potential scenarios (Callao, Chimbote, Pisco, Ilo harbor ; important ports industrial commercial places and exposures)
- Data we need
  - Merged bathymetry /topography grid in study areas (30 meter grid form North Pisco, South Pisco should be requested, Camana is already prepared)
  - Field survey results for model validation (Pisco, Camana)
  - Building polygon for structural damage estimation
  - Population data for fatality estimation

Things to discuss are open based on the resolution at the kickoff tsunami meeting [2]

- Human resources… who is going to work on tsunami modeling? Schedule?
- What we are going to do in 2010 is
  - Japan side
    - Tsunami propagation modeling to identify what the worst-case scenario is.
    - Tsunami damage assessment (Koshimura, Yanagisawa, Shoji)
    - Collecting field survey data (2001 Camana event)
  - Peru side
    - What has been done from Pisco and Camana.
    - Tsunami issues in Peru (San Marcos Univ. Prof. Ocola, DHN , Mr. Jiménez)

Field survey at Camana

in Dec 21-22, 2009

- Engineered concrete block house

- Non-engineered concrete block house

La Punta

Inundation depth 2.60m

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Field survey at Callao

in Dec 20, 2009

Potential Tsunami Exposed-Death

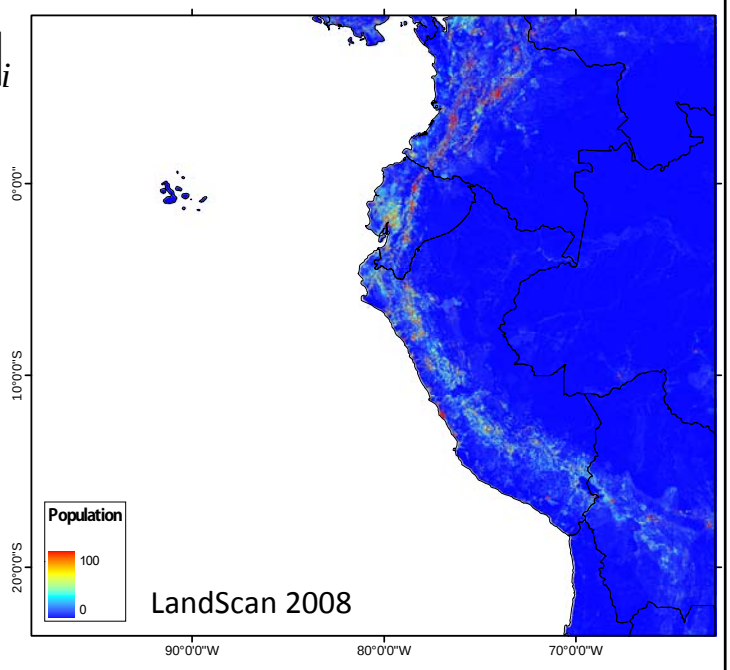
$$PTE = \sum_{i=1}^{N} (1/N) \times [Pop \times Fr(H)]_i$$

N : Number of Earthquake event
Pop : Population per sell
H : Maximum tsunami height
$Fr(x)$: Fragility function of human damage

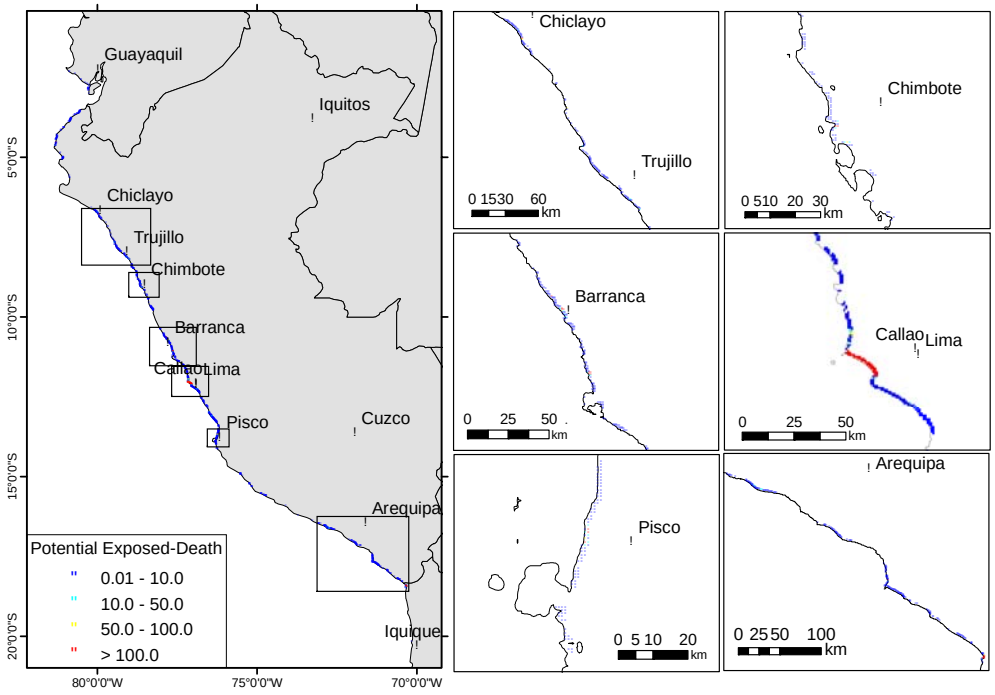
Koshimura et al.,(2009)

$$Fr(x) = \Phi\left[\frac{H - 5.37}{0.72}\right]$$

Here, the earthquake probability in Northern area (> 9S°) is assumed to be 100 %.



The tsunami risk in the coast of Peru – Tentative version -



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