Probabilistic Tsunami Hazard Assessment for Local and Regional Seismic Sources Along the Pacific Coast of Central America

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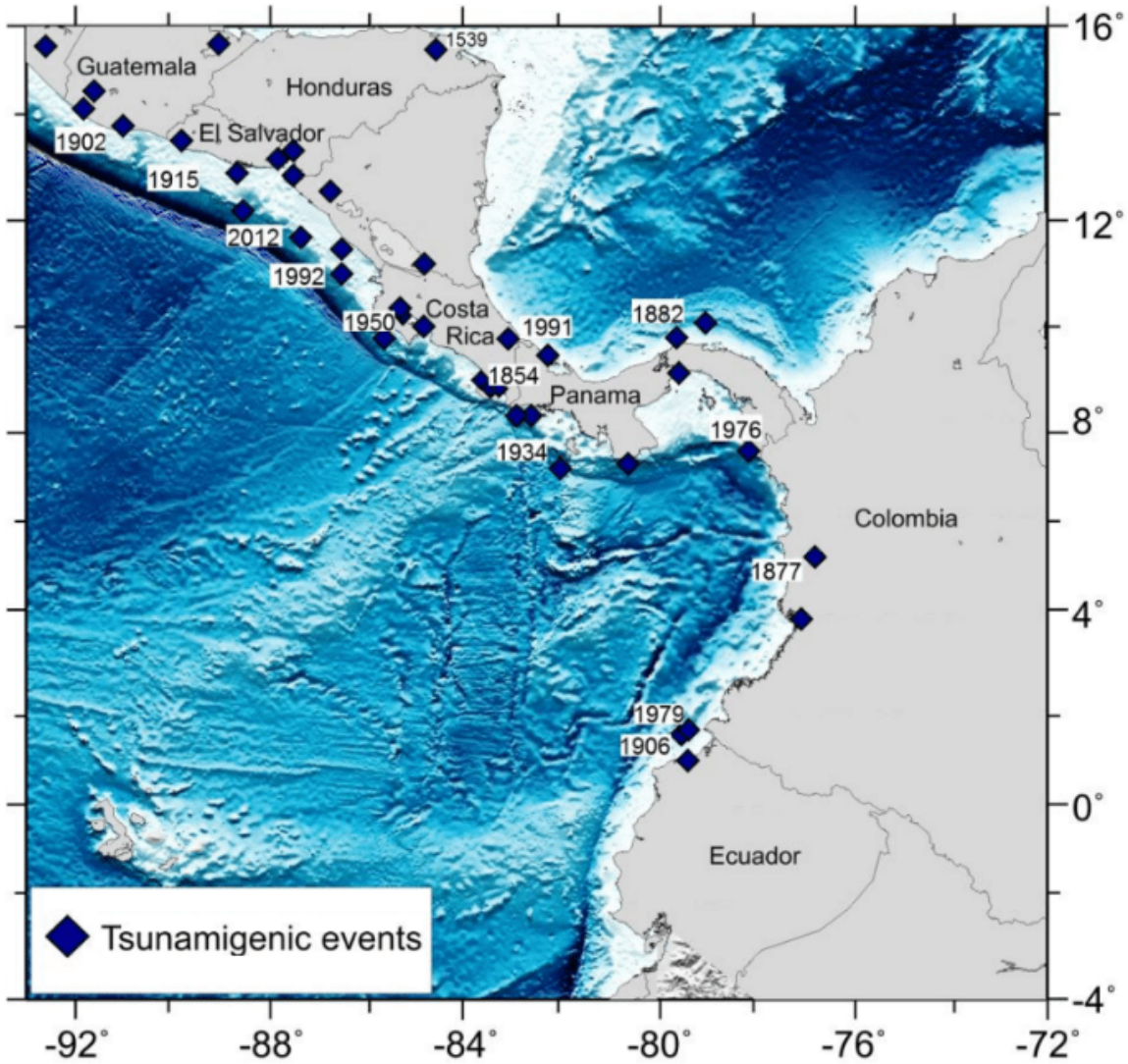
Study area and tsunami occurrence

Aim of the study

To assess the probability of exceedance, of certain tsunami heights along the Pacific coast of Central America by integrating local and regional tectonic sources along the Pacific coast from Guatemala to Ecuador, also highlighting the dependency of hazard estimates on model assumptions.



NGDC/WDS [2017], Zamora (2016)

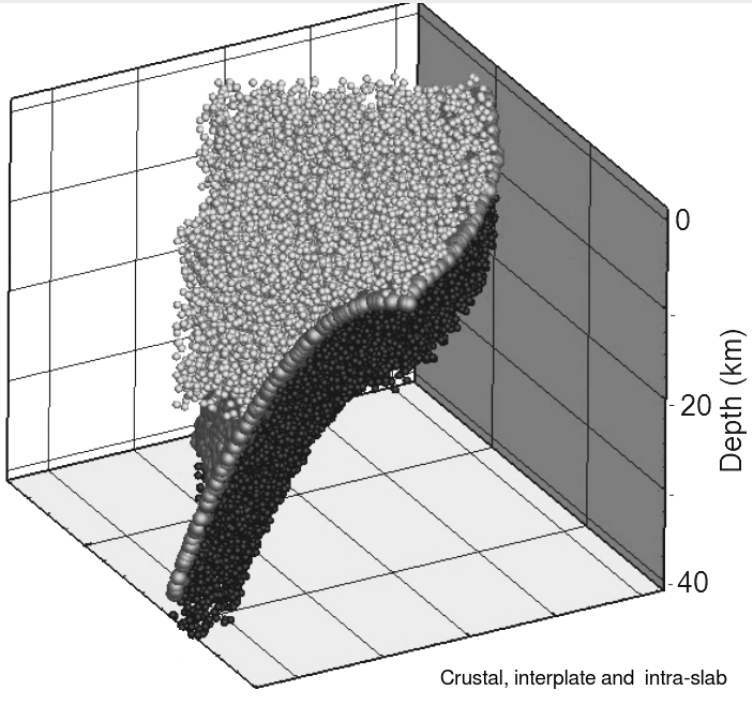
Seismo-tectonic segments for the study area

Left panel: outer rise zones (green) and other crustal zones (red). Central panel: Inter-plate zonation (black). Right panel: Intra-slab sources (orange). Modified from Alvarado et al. [2017].

Updated version in Zamora and Babeyko (2020)

Probabilistic tsunami hazard assessment approach

Sampling seismicity with Monte Carlo

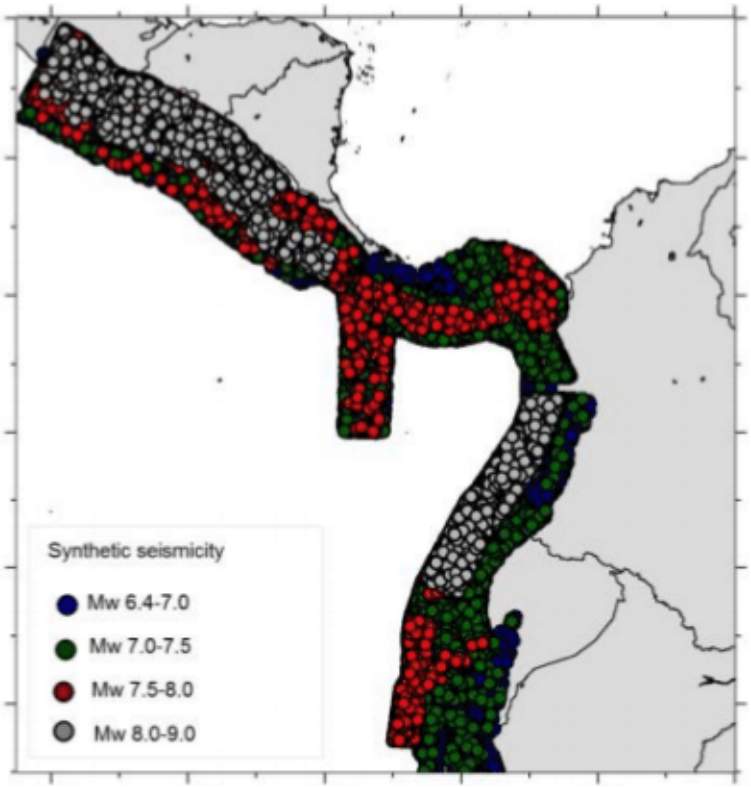


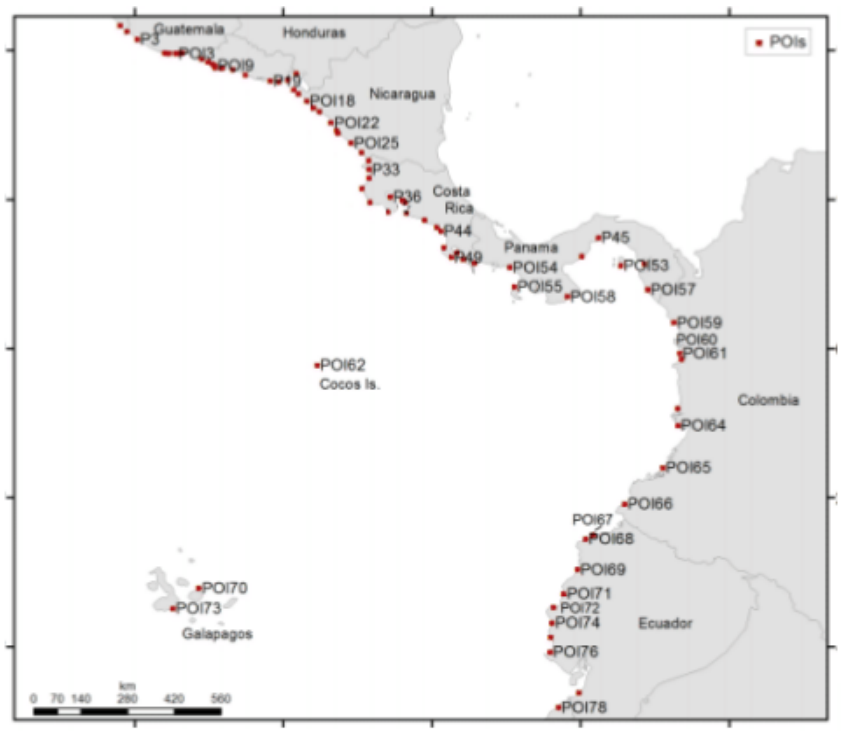
- Obtain seismic rates for each area source or segment
- Sample Gutenberg-Richter, Monte Carlo approach
- Different models based on varying assumptions
- Tsunami modeling with easyWave (linear approximation)
- Integration of tsunami heights (PCTA)

Modified from Zamora and Babeyko (2020)

Synthetic catalog and location of point of interest

Left: Input for tsunami numerical modeling. Right: points of interests POI.

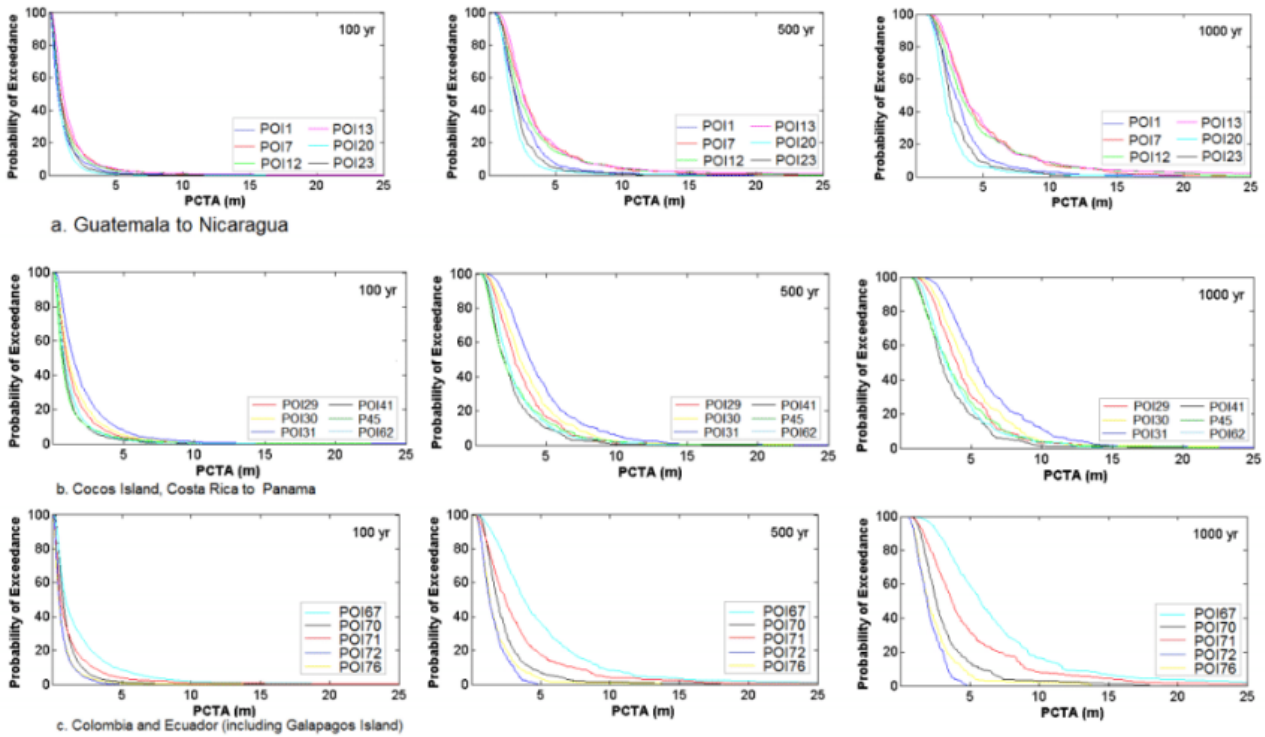




Updated version in Zamora and Babeyko (2020)

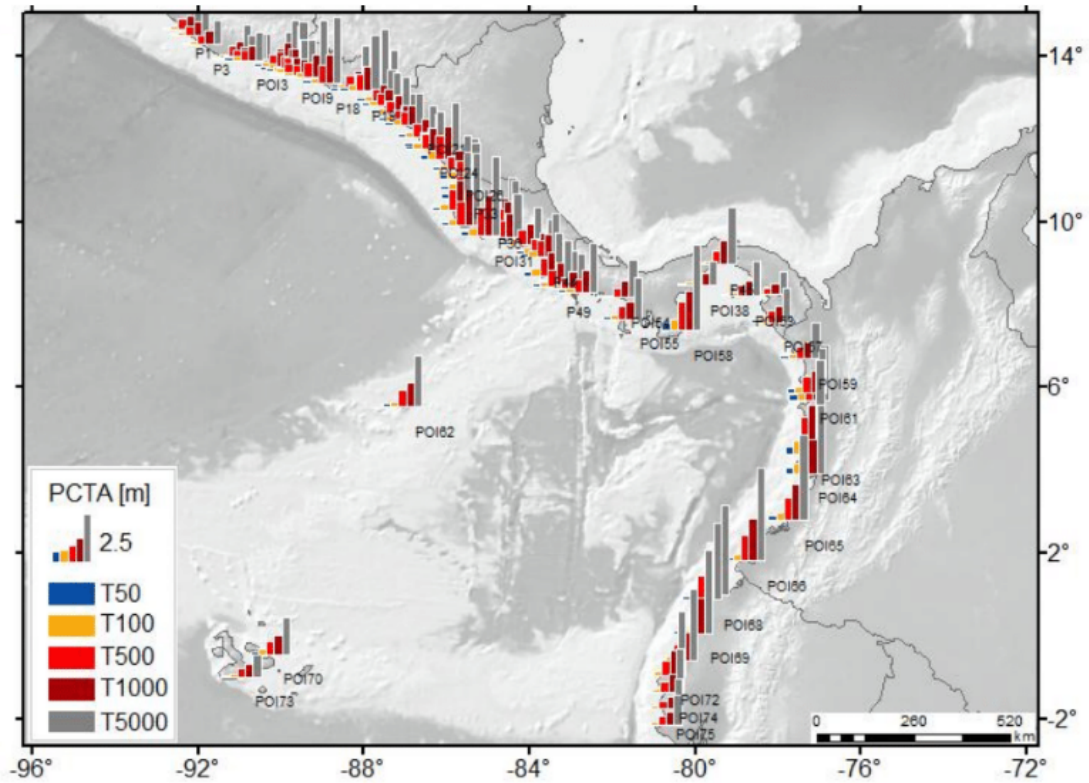
Results shown as hazard curves of model MEE

Integration of all 184 k seismic scenarios from Mw¿6.4.
MEE model assumes maximum expected earthquake magnitudes according to integration of geophysical data [Alvarado et al., 2017].



Probability of exceedance for the 100, 500, 1000 mean return periods. Left panels show the probability of exceedance for 100 year. Middle panel: indicate hazard for 500 years. Right: hazard for 1000 year. Probability is given as a percentage.

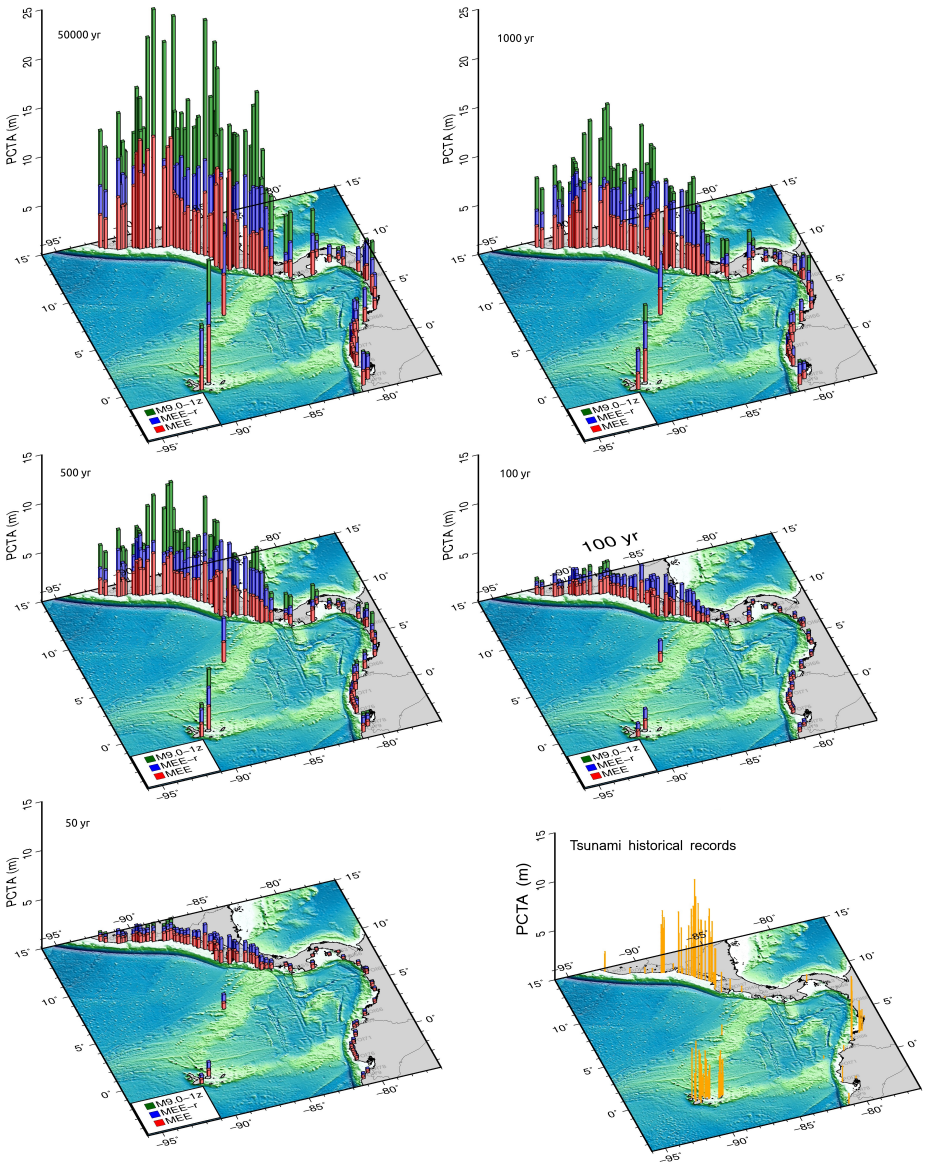
Results shown as probabilities of exceedance



Hazard map showing the PCTA expected at return periods of 50, 100, 500, 1000 and 5000 years. These results correspond to the MEE model.

Updated version in Zamora and Babeyko (2020)

Results comparison of probabilistic models



Each map shows the PCTA expected for several average return periods for three models based only on the CAM interplate seismogenic zone. MEE stands for the same model shown in slide 6. MEE-r model includes the rigidity depth variation. M9.0-1z stands for the CAM single segment with uniform rigidity similar as it was used for MEE and MCE models. MCE model differs only in the maximum magnitudes of the segments.

Source: Zamora and Babeyko (2020)

Conclusive remarks

1. This analysis shows that tsunami hazard is higher in Nicaragua and Colombia, where the probability of exceeding 2 m in 500 years is 50% to 70%, respectively.
2. The assessment with different assumptions such as different zonation models for the interplate seismogenic zone and lower rigidity values shows a high variability of hazard estimates that cannot be neglected.
3. Even when large magnitudes for Central America have been estimated for some segments, the hazard becomes significant only for very long return periods, which appears to be consistent with what has been argued from seismological and geodetic studies.

Future work

1. Include sensitivity analysis of the effects of slip distribution.
2. Sensitivity analysis using alternative segmentation models for the region.

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References

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