

Geo-INQUIRE installation: [PTHA - Probabilistic Tsunami Hazard Assessment \(TA2-541-6/TA2-541-7/TA2-541-8\)](#)

Project title: Chilean Tsunami Hazard Assessment

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Project acronym: CHIThA

Project report ID: C1-TA2-541-6-1

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Geo-INQUIRE Virtual Access:

Data Products:

Tsunami simulation results to be uploaded to the Simulation Data Lake (SDL)

Project report:

The Project aims to perform a Probabilistic Hazard Assessment in Chile, arising from subduction earthquakes around the Pacific rim. While recent efforts on this regard have used reduced order models, the approach of this project is to model a large number of earthquakes and tsunamis, using the highest resolution possible at multiple coastal locations, spanning from near, regional, and far field sources.

This ambitious goal posed an operational challenge, since the model domain had to encompass the entire subduction zone of Chile at relatively high resolution, while also using a dense set of nested grids to achieve inundation statistics.

During his stay at NGI, Patricio learned to use the HPC configuration on the pre-exascale Tier-0 EuroHPC supercomputer Leonardo, as well as the Monte Carlo version of the Tsunami HySEA code (v 3.9.0). At the same time, this enabled the testing and design of the nested grids, as well as the strategy for simulation data collection and processing. It was determined for instance that contiguous nested grids need a buffer of cells between them.

Upon returning to Chile, Patricio embarked on the quest to acquire and prepare

digital elevation models from a large number of locations, from official sources of bathymetric data. The current configuration considers:

- One regional domain at 30 arcsecs,
- 21 local grids at 7.5 arcsec (a 4x nesting)
- 49 city-scale domains at 0.975 arcsec (an 8x nesting)

as displayed in Figure 1.

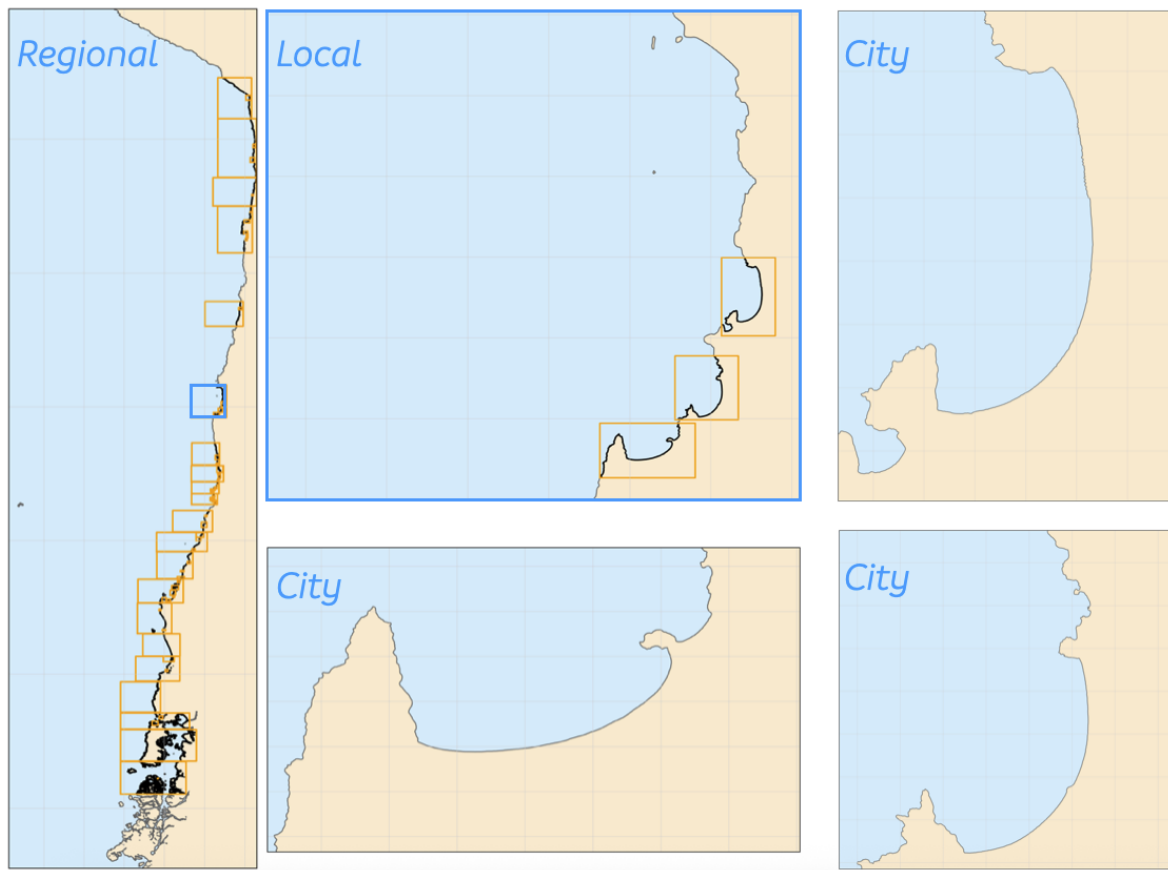


Figure 1: Domains and nesting scheme. The Regional domain encompasses 21 local levels, of which one is shown in blue. Next, Local domains can have a varying number of cities. In the example, three. Clockwise from the upper right: Coquimbo, Guanaqueros and Tongoy.

Simulation output time series were saved at a dense array of locations spanning the most interesting domains, where inundation would be investigated. Figure 2 shows an example of these Point of Interest (POIs) for Arica, in northern Chile. All relevant variables, including flow depth, velocity, and momentum fluxes, are stored at a high sampling rate of 15 s. It is expected that interpolation could be used to reconstruct the final inundation maps.

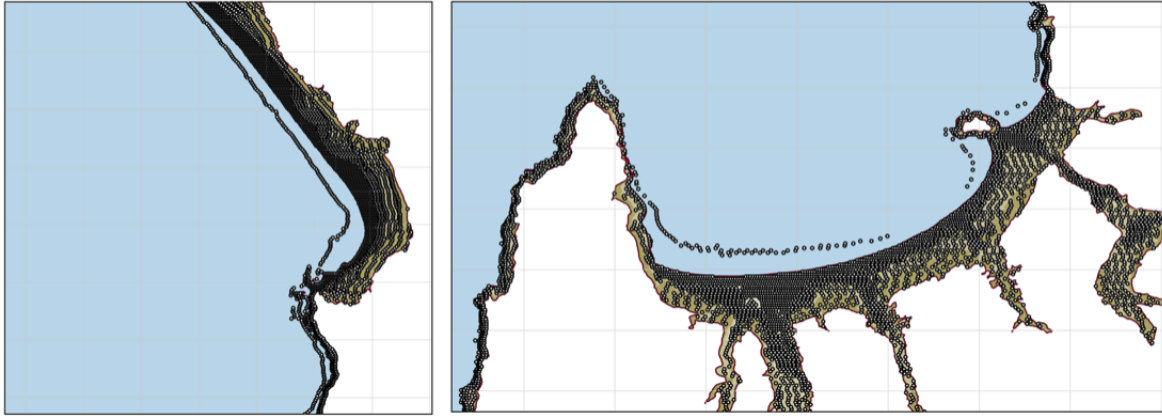


Figure 2: Sample POIs. at Arica and Tongoy. A dense selection of points were chosen to span all areas under 30 min elevation. Maps are not to scale.

Other relevant parameters are reference level and friction. For the former, mean sea level was considered owing to the fact that the domain is large enough for the tide to have concurrent extrema over the domain. Hence, any offset level would be unrealistic. Currently, the first set of simulations considers a fixed Manning roughness coefficient of $n=0.03$. However, further simulations will be considered to investigate the sensitivity to this parameter.

In addition, an outer grid encompassing the Pacific Ocean was prepared at resolutions of 4 arcmin. While relatively coarse, test runs with the inclusion of all grids were successful at modelling transpacific tsunamis at all sites.

Results

Up to this point, close to 30.000 simulations have been carried out. The source conditions were prepared externally to this project, using the method of Crempien et al. (2020).

While the overarching goal is to produce a PTHA, both for inundation (flow depth), and offshore (peak surge), this has not been performed just yet.

However, some statistics have been produced that highlight the sensitivity of certain regions to the catalog.

References

Crempien, J. G. F., Urrutia, A., Benavente, R., & Cienfuegos, R. (2020). Effects of earthquake spatial slip correlation on variability of tsunami potential energy and

intensities. *Scientific Reports*, 10(1), 8399. <https://doi.org/10.1038/s41598-020-65412-3>