Geo-INQUIRE Transnational Access Project Report: Tsunami Risk Understanding and Simulation for Israeli Coastal Inundation (GSI, Israel)

Geo-INQUIRE installation: [HySEA - Earthquake and landslide generated tsunami simulations (TA2-531-3)]

Project title: Tsunami Risk Understanding and Simulation for Israeli Coastal Inundation

Transnational access principal investigator: Ran Novitsky Nof (Geological Survey of Israel, Israel)

Project acronym: TRUSTIC

Project report ID: C1-TA2-531-3-1

Transnational access team: Prof. Jorge Macías Sánchez, Prof. Carlos Sánchez Linares (Universidad de Málaga (UMA), Spain)

Date of visit: 5 - 14 September 2025

Geo-INQUIRE Virtual Access:

Data/Products:

A scientific paper based on this work is being prepared

Project report:

The primary objective of the *Tsunami Risk Understanding and Simulation for Israeli Coastal Inundation* (TRUSTIC) initiative is to enhance Israel's resilience and preparedness for tsunami hazards along its Mediterranean coast. This enhancement is achieved through the use of advanced, high-resolution wave propagation models and inundation maps generated with the Tsunami-HySEA model. In the current Transnational Access (TA), our focus is on evaluating the cost-effectiveness of using high-resolution Digital Elevation Models (DEMs) and bathymetry data. Additionally, we assess how variations in the width and morphology of the Israeli continental shelf influence potential tsunami hazards.

During his visit to UMA, Ran learned to use the Tsunami-HySEA model and to run it on the **Leonardo** supercomputer at **CINECA**. The first step of the workflow was to compile and harmonise bathymetry and onshore elevation datasets to build the model for the computational domain. A key challenge was integrating data from multiple sources with different spatial resolutions into a consistent set of nested, aligned submeshes suitable for high-performance computing (HPC) simulations with the Tsunami-HySEA code (Figure 1). The finest bathymetry data—0.5 m resolution Green LiDAR—covers a 1.5 × 4 km area from the shoreline to a depth of 15 m. In contrast, the coarsest dataset used is the 15-arcsecond GEBCO 2020 Grid (GEBCO Bathymetric Compilation Group 2020). For onshore elevations along the Israeli coast, 0.5 m LiDAR measurements were used.

The final grid model set-up consists of five nested grid levels, with the following resolutions:

- **Level 1:** 512 m/pixel
- **Level 2:** 128 m/pixel
- **Level 3:** 32 m/pixel
- **Level 4:** 8 m/pixel, with four submeshes
- **Level 5:** 1–2 m/pixel, consisting of one submesh covering the Maagan-Michael area

The tsunami source for the initial simulations is a simplified single fault based on the EFMS20 – CYCF001 parameters (*Basili et al., 2024*) (Figure 1).

To examine the sensitivity of the model to bathymetric resolution, we compared four simulation setups using time series extracted at 19 points (Figure 2):

1. **High-resolution grid (2 m/pixel) with detailed bathymetry** derived from Green LiDAR (0.5 m/pixel).
2. **High-resolution grid (2 m/pixel) with coarse bathymetry** based on interpolated 25 m/pixel data (*Hall, 1993*).
3. **Low-resolution grid (8 m/pixel) with detailed bathymetry** (same source as in setup 1).
4. **Low-resolution grid (8 m/pixel) with coarse bathymetry** (same source as in setup 2).

Comparison of model results

- **High-resolution (2 m/pixel): detailed vs. coarse bathymetry (Models 1 and 2)**

  Time series show substantial differences in wave heights for points that become “onshore” in the interpolated coarse-bathymetry model (points 1, 2, 3, 20, 27, 28, 30). In some cases, the wave arrival time differs by ~30 seconds, and wave height differences reach up to ~10 cm (e.g., points 2, 3, 23) (Figure 3).

- **Detailed bathymetry at different resolutions (Models 1 and 3)**

  When comparing the 2 m/pixel and 8 m/pixel detailed-bathymetry simulations, wave-height differences are negligible (Figure 4).

- **Coarse vs. detailed bathymetry at low resolution (Models 3 and 4)**

  Results show similar behavior to the high-resolution comparison (Models 1 and 2), including comparable wave-height differences and shifts in shoreline classification (Figure 5).

Initial conclusions:

These results highlight the importance of high-resolution bathymetry for accurately estimating wave heights—particularly in nearshore areas where coarse bathymetry may incorrectly classify points as on land. However, the results also suggest that lower-resolution grids (8 m/pixel) may still be adequate for capturing overall wave-height characteristics when detailed bathymetry is available. This indicates that computational costs can potentially be reduced without significantly compromising model performance.

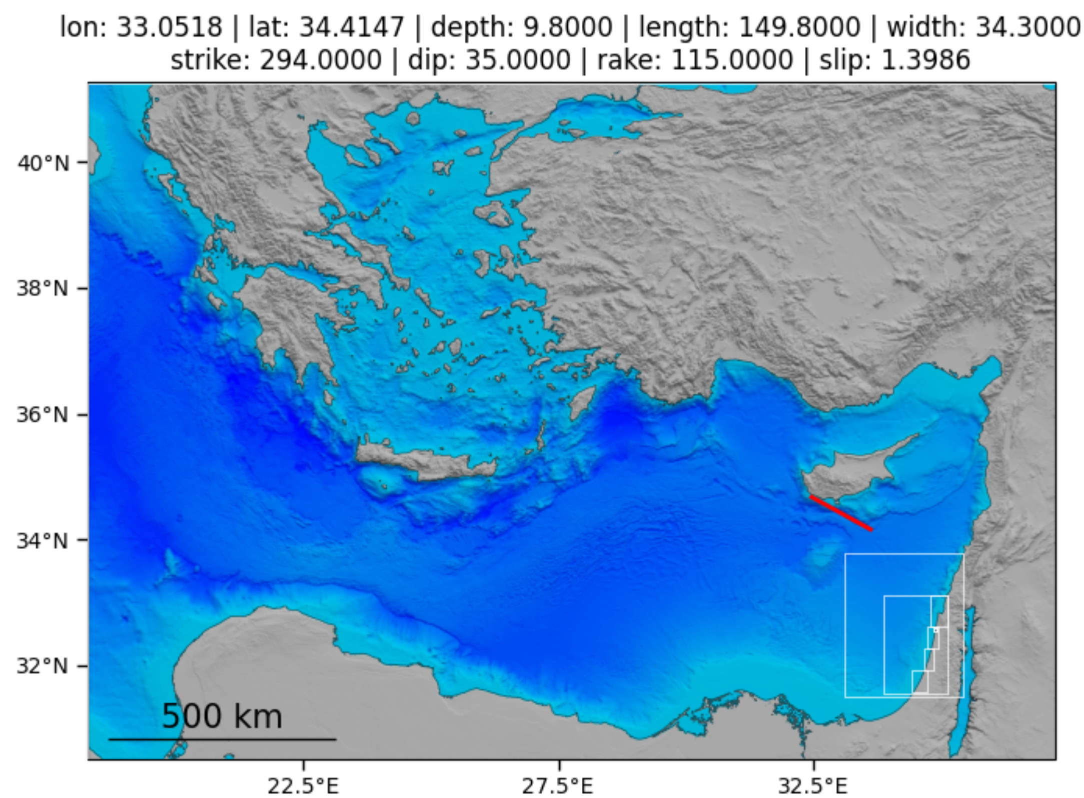

Figure 1: Overview of the model domain used in the simulations. The first-level resolution is 512 m/pixel. The second-level resolution is 128m/pixel. The third-level resolution is 32 m/pixel. The fourth-level resolution is 8 m/pixel with 4 submeshes. The fifth-level resolution is 1 and 2 m/pixel resolution at a single 1.5x4 km area near Maagan-Michael, Israel. The red line marks the surface trace of the CYCF001 fault source (Basili et al., 2024). Fault parameters are displayed in the figure title. Green LiDAR measurements courtesy of Northern Arrow Mapping & Engineering Ltd (http://www.hetz-hazafon.co.il/english).

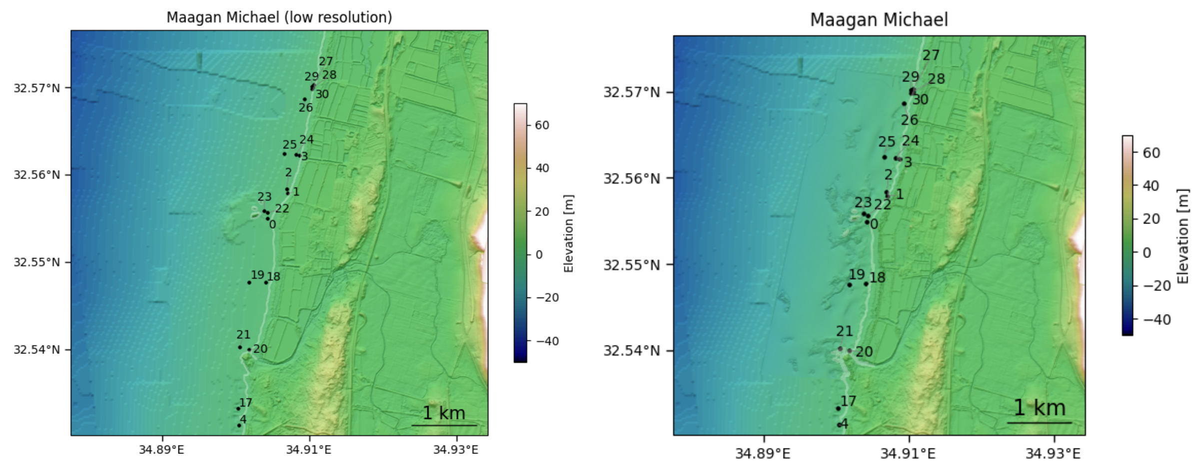

Figure 2: High-resolution (2 m/pixel) bathymetry grid for Maagan Michael area. Left: Grid generated using low-resolution bathymetry; Right: Grid generated using Green LiDAR high-resolution bathymetry. Time series extraction points with ID are marked as dark dots. Note the increased bathymetric detail where LiDAR is available.

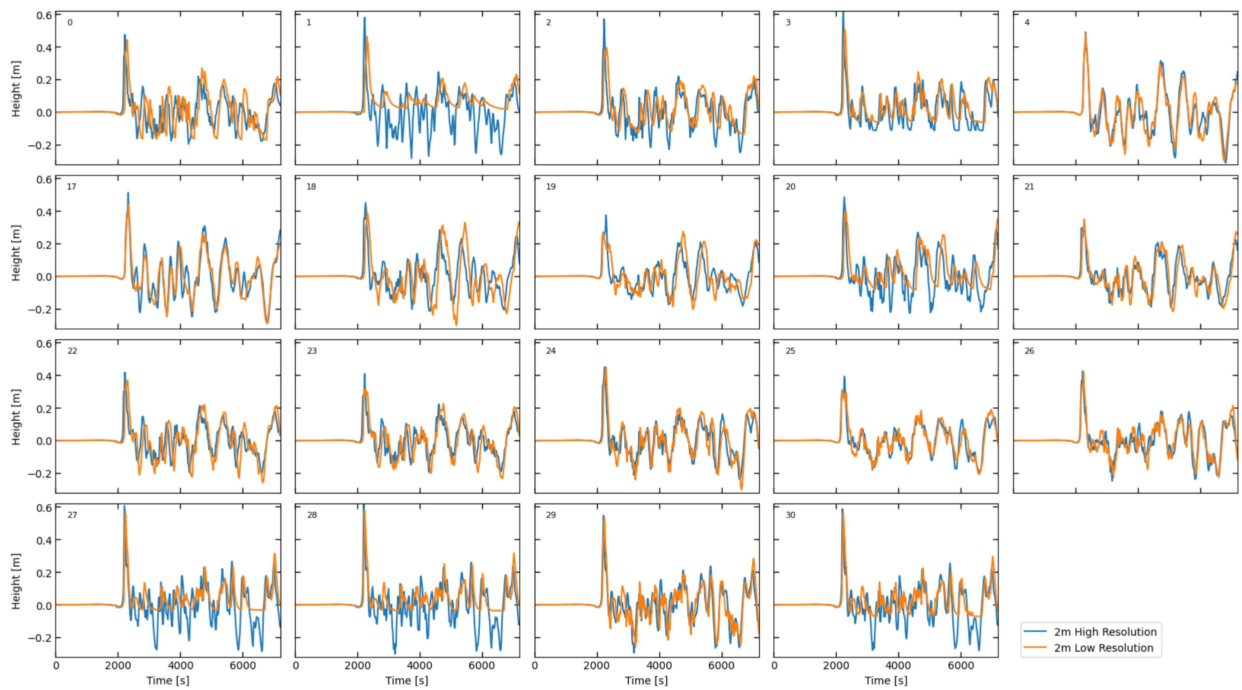

Figure 3: Wave height time series at 19 points along Maagan Michael shoreline for the tww 2m/pixel simuations (see Figure 2 for point locations). Blue lines are for detailed bathymetry from Green LiDAR measurements, and Orange lines are for low-detail interpolated bathymetry. Large differences below sea level (0 height) are due to the point's location on the shore in the interpolated bathymetry.

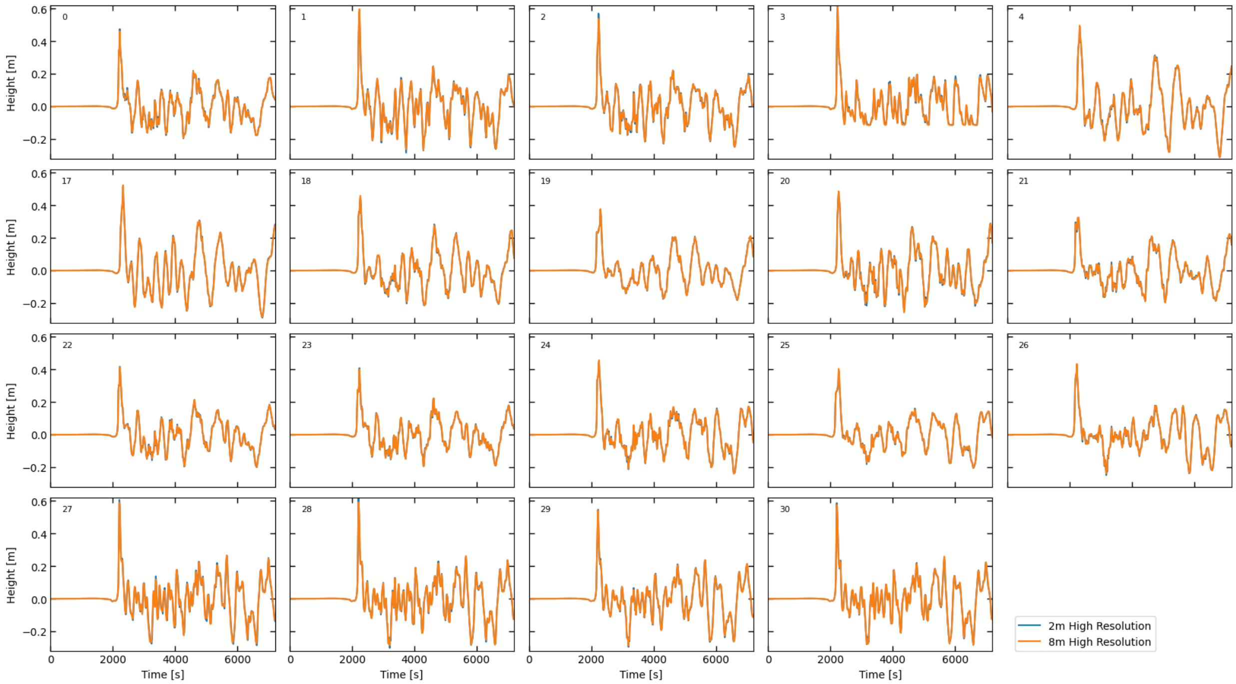

Figure 4: Wave-height time series at 19 points along Maagan Michael shoreline, comparing detailed bathymetry at two grid resolutions: 2 m/pixel (blue) and 8 m/pixel (orange). Differences between the time series are minor, indicating that lower-resolution grids can adequately reproduce wave heights when detailed bathymetry is used.

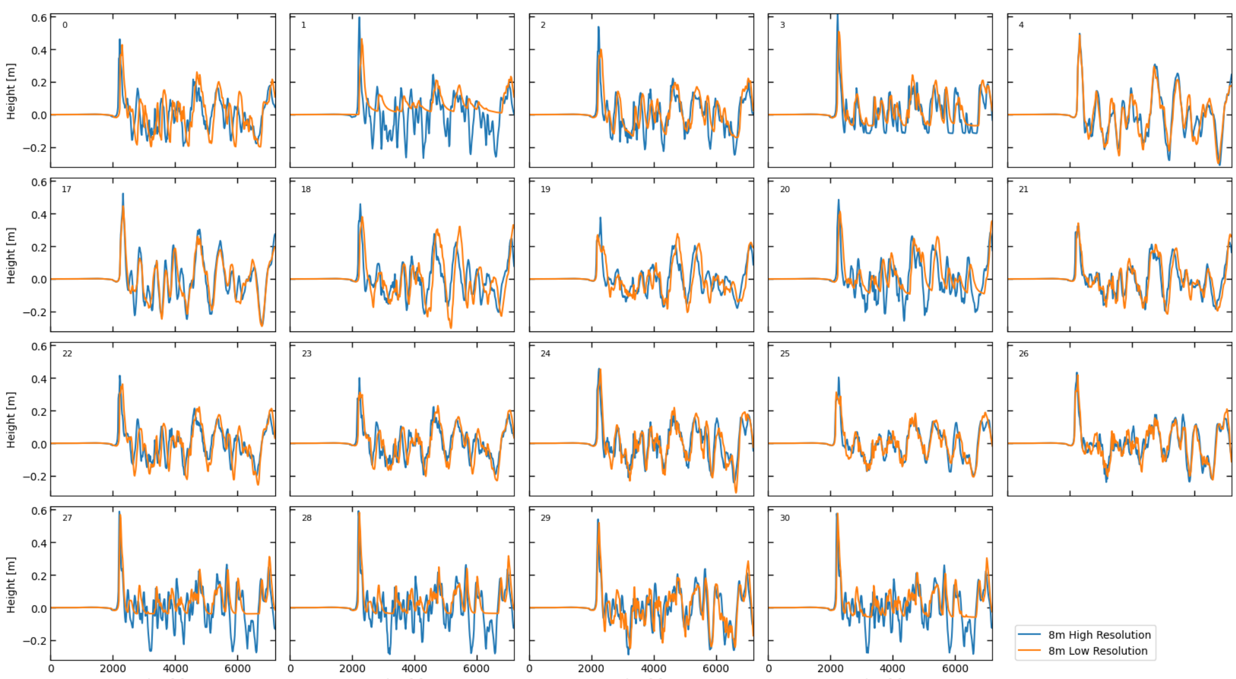

Figure 5: Wave height time series at 19 points along Maagan Michael shoreline comparing detailed Green LiDAR bathymetry (blue) with interpolated coarse bathymetry (orange). Both datasets use low-resolution bathymetry (8 m/pixel). As in Figure 3, large differences below sea level (0 height) are due to the point's location on the shore in the interpolated bathymetry.

References:

Basili, R., L. Danciu, C. Beauval, K. Sesetyan, S. P. Vilanova, S. Adamia, P. Arroucau, J. Atanackov, S. Baize, C. Canora, *et al.* (2024). The European Fault-Source Model 2020 (EFSM20): geologic input data for the European Seismic Hazard Model 2020, *Natural Hazards and Earth System Sciences* **24**, no. 11, 3945–3976, doi: 10.5194/nhess-24-3945-2024.

GEBCO Bathymetric Compilation Group 2020 (2020). The GEBCO_2020 Grid - a continuous terrain model of the global oceans and land., British Oceanographic Data Centre, National Oceanography Centre, NERC, UK, doi: 10.5285/A29C5465-B138-234D-E053-6C86ABC040B9.

Hall, J. K. (1993). The GSI digital terrain model (DTM) completed, in *GSI Current Research* R. Bogoch, and Y. Eshet(Editors), Geological Survey of Israel, Jerusalem, 47–50.