Study of the tsunami source in the Palu Bay following the Mw7.5 2018 Sulawesi earthquake

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PURPOSE

Ultimate goal

Characterise the (potentially compound) source for the 2018 Palu tsunami:

- Submarine displacement from Palu-Koro fault rupture.
- Coastal and submarine landslides triggered by this faulting.

Modelling strategy

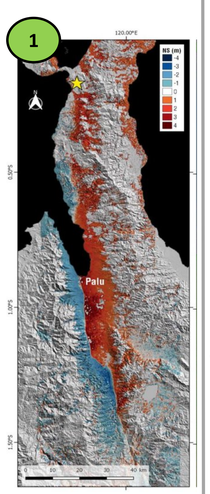
- Joint inversion of tsunami runup and Sentinel-2 optical analysis results data using the Green's functions approach.

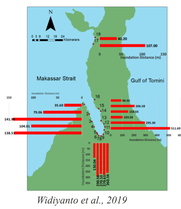
Problems addressed here

- Validity of Green's functions approach (linearity) for earthquake and landslide sources.
- Wave amplitude offshore as predictor of nearby runup.

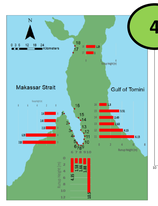
APPROACH

1. Green's functions (GF) approach for Sentinel-2 data by using a fault model constrained by Sentinel-2 data (uplift and subsidence mapped in red and blue at right)
2. For Landslide elementary sources
   a. Compute the time series for each elementary source saving the results along the 10 m isobath points closest to the runup observations
   b. Calibrate the linear combination based on the maximum tsunami amplitude and the thickness of the landslide
3. For Runup data (earthquake source)
   a. Compute the time series for each subfault saving the results along the 10 m isobath points closest to the runup observations
   b. Calibrate the runup based on the maximum tsunami amplitude along the isobath
4. For Runup data (landslide source)
   a. Compute the time series for each elementary source saving the results along the 10 m isobath points closest to the runup observations
   b. Calibrate the runup based on the maximum tsunami amplitude along the isobath
5. Independent comparison with the tsunami observed at the Pantoloan tide-gauge





Widiyanto et al., 2019



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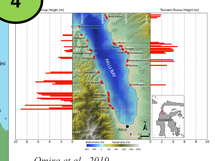
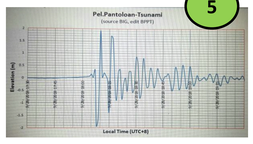


Omira et al., 2019



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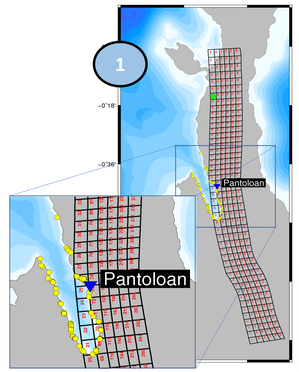
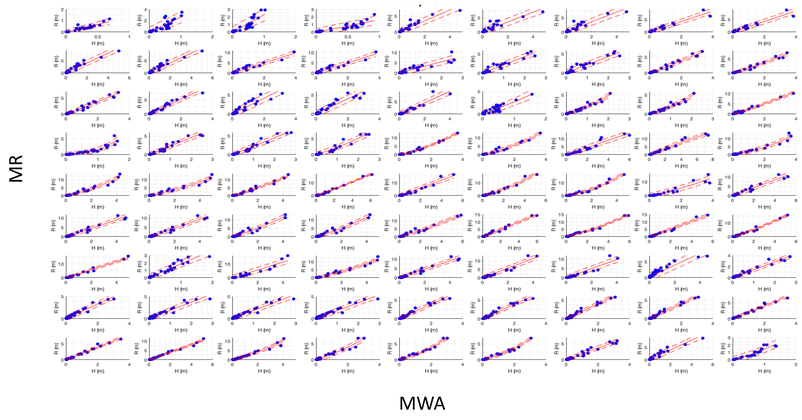
CAN RUNUPS BE ESTIMATED FROM OFFSHORE WAVE AMPLITUDES?

Assumptions

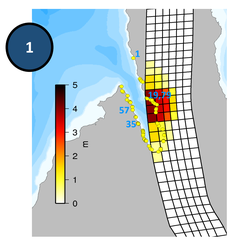
1. GFs (subfaults based on the geometry from *Socquet et al., 2019*)
2. Nonlinear SW through HySEA code (*de la Asuncion et al., 2013*), grid spatial resolution ~10 meters
3. For each "observed" Runup in Palu Bay find an analytical relation between maximum simulated runup (**MR**) and maximum simulated wave amplitude offshore (**MWA**)

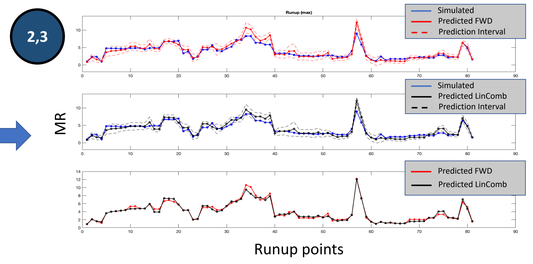




Verification (synthetic case)

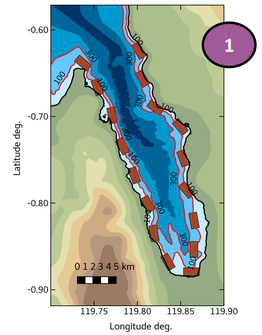
1. Simulate a tsunami scenario using a slip distribution and
2. Compute the maximum runup along the Palu Bay coast
3. Estimate the maximum runup by using the calibration function for each point
   a. Using the waveforms computed offshore
   b. Using the waveforms obtained by the linear approximation assumption (i.e. linear combination)

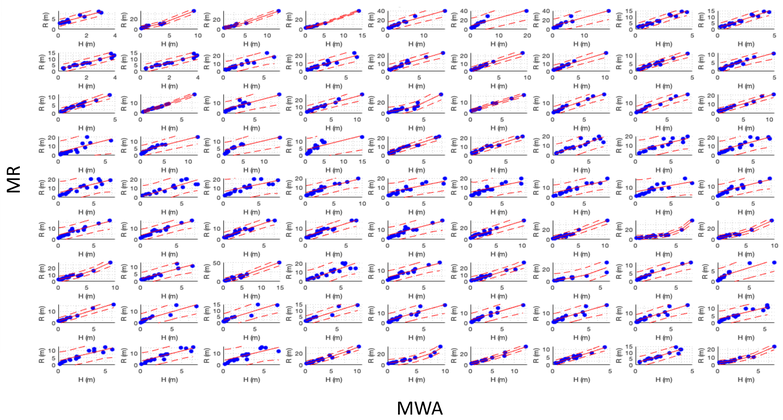




Assumptions

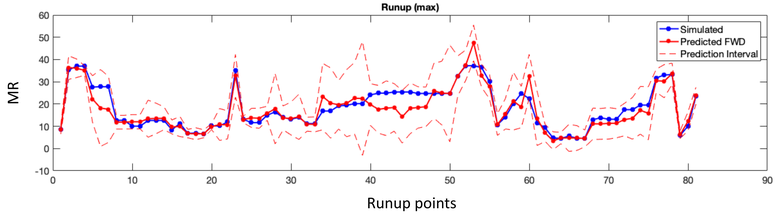
1. As many as three rectangular landslide sources of size 1x2 km^2 (S_0 , S_X and S_Y at right)
2. 20 m baseline thickness, varied to test linearity
3. Viscoplastic landslide model (BingClaw)
4. Calibration is performed by following the same approach adopted for the earthquakes.





Verification (synthetic case)

1. Simulate a tsunami scenario combining 4 landslides
2. Follow the same approach adopted for the earthquakes



Conclusions and future work

1. Earthquake and Landslide sources, in principle, can be approximately linearly combined as long as using specific calibration functions.
2. Additional verifications by using a big set of slip distributions.
3. Inversion of runup data for earthquake and landslide sources (**WORK IN PROGRESS**).