Field Survey and Simulation of an Undocumented Tsunami: The 1990 Rudbar Earthquake, Caspian Sea, Iran

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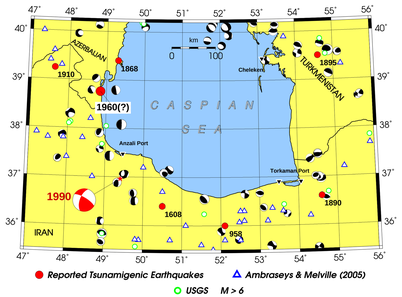
Background

Tsunamigenic Events in Southern Caspian Sea



2012 Fieldwork

The 1960 event(?) was the initial subject of our 2012 survey, however, it revealed the tsunami of 20 June 1990 which was not formerly recognized.

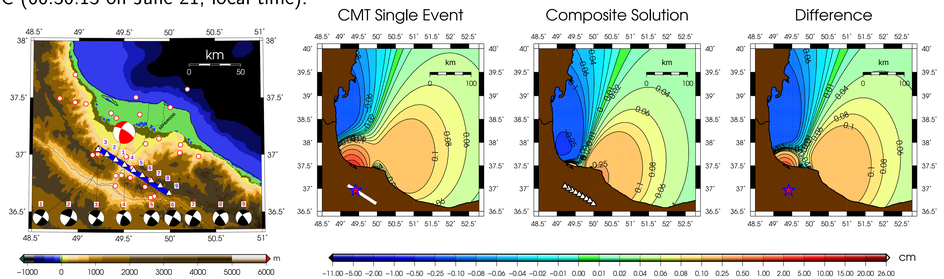
SURVEY RESULTS

1960 ⟶ Remains Elusive with a single possible testimony.

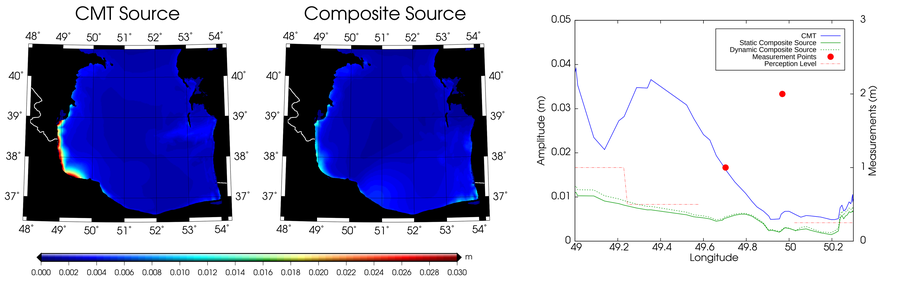
1990 ⟶ Runups > 2 m along a ∼30 km stretch of the coast between Kiashahr and Jafrood.
Fishermen at sea heard noises and felt waves.

Earthquake Source

The Rudbar-Tarom (most commonly known as Rudbar) earthquake, $M_w = 7.4$, occurred on June 20, 1990 at 21:00:13 UTC (00:30:13 on June 21, local time).



As the initial condition to the equations of hydrodynamics, and in the case of earthquake sources, MOST (e.g., Titov & Synolakis, 1995) uses the field of static deformations of the epicentral area resulting from the dislocation, as computed for example through the algorithm of Mansinha and Smylie (1971). We have simulated the tsunami for both single and composite sources. We can use a linear combination of simulations from the individual subevents due to the low ratio of the maximum initial amplitudes to the depth of the water column, which makes the non-linear effect of amplitude dispersion negligible.

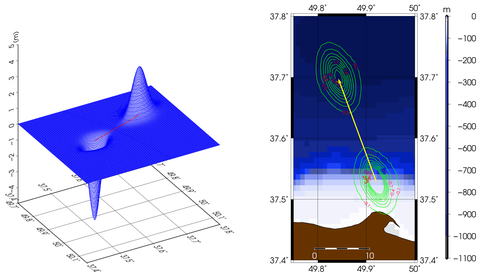


THE EARTHQUAKE SOURCE CANNOT MODEL OUR RESULTS.

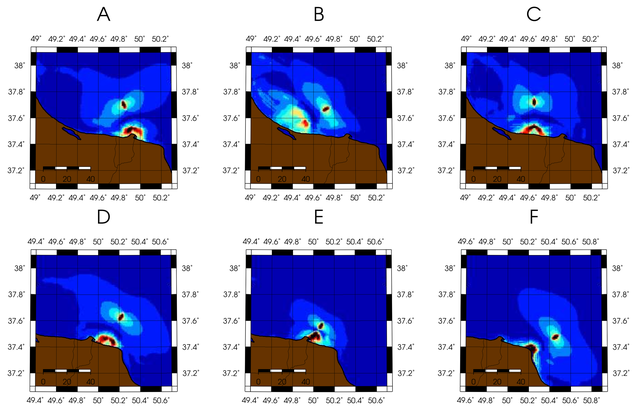
Landslide Source

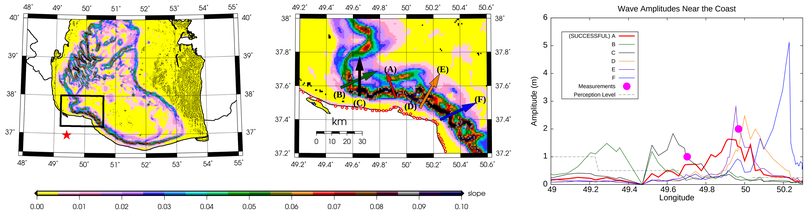
We have used the method developed by Synolakis et al. (2002) and Okal & Synolakis (2003) who model submarine landslides as hydrodynamic dipoles which are formed as negative (trough) and positive (hump) initial displacements.

$$z_t = -\eta_t \, e^{-\alpha_t x^2} \operatorname{sech}^2(\gamma_t y)$$
$$z_h = \eta_h \, e^{-\alpha_h (x-l)^2} \operatorname{sech}^2(\gamma_h y)$$



Different Slide Scenarios





Conclusion

Our field study failed to identify a legitimate scenario for a definitive inundation in 1960. Rather we were able to document a significant tsunami following the major Rudbar earthquake of 20 June 1990, with run-ups reaching 2 m at Kiashahr and most importantly, a concentration of the inundation over a ∼30-km stretch of coastline. These characteristics cannot be modeled using the Rudbar earthquake dislocation as the source of the tsunami. By contrast, our model (A) of a landslide, presumably triggered by the earthquake, originating around 37.53°N, 49.92°E, and extending 20 km in a 340° azimuth manages to match the general profile of the reported tsunami along the coast. This suggests that landslides are important contributors to tsunami hazard in the Caspian Sea.

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