HySEA model for submarine landslide generated tsunamis. The Alboraní MMS case

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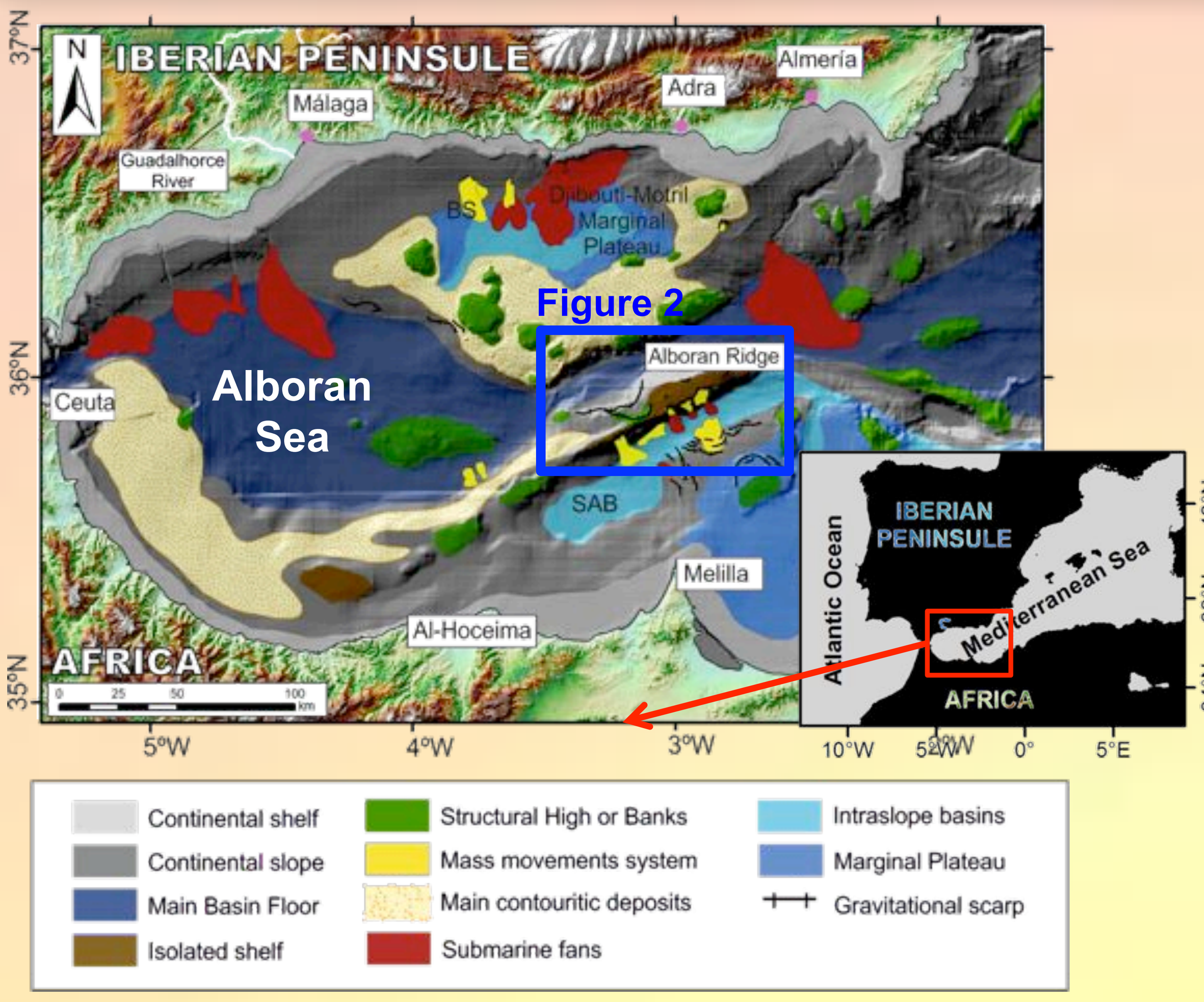


Figure 1. Physiographic Map of the Alboran Sea Basin plotted on a hillshade model. A compilation of multibeam bathymetry (40 x 40 m) has been used for the construction of this model and has been plotted on a general hillshade model based on ETOPO bathymetry (1000 x 1000 m). On land a MTD model has been used based on the 1 x 1 les available from the 2000 Shuttle Radar Topography Mission, the resolution is about 90 metres. BS: Baraza slide. SAB: South Alboran Basin.

BACKGROUND and AIMS

This work deals with the mathematical modeling and numerical hindcast simulation of hypothesized ancient submarine landslide occurring in the Alboran Sea Basin (Fig. 1) and the associated generated tsunami. Seafloor features related to former mass movement systems (**MMS**) (Fig. 2) have been identified by the interpretation of multibeam bathymetry data and high to very high resolution seismic profiles.

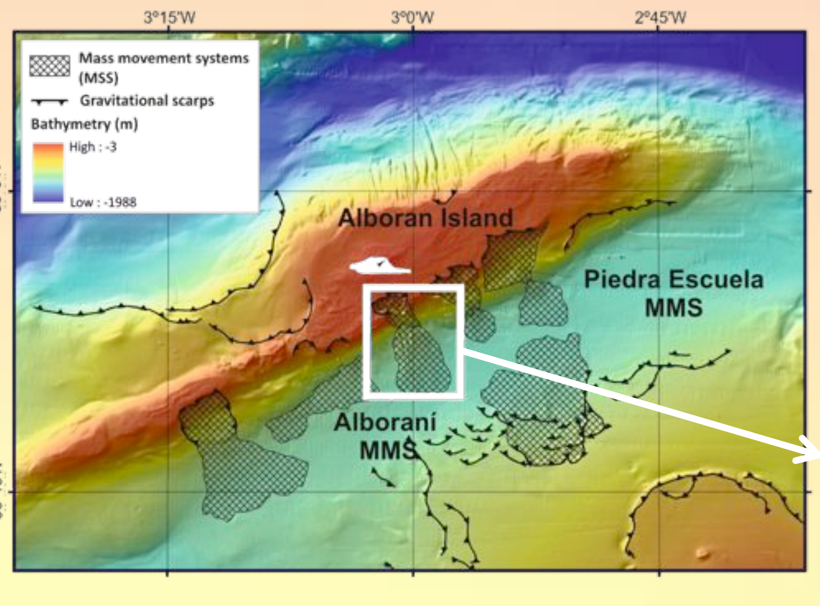


Figure 2. Digital Terrain Model of the Alboran Ridge northern segment based in a compilation of multibeam bathymetry and location of main Mass Movement Systems (**MMS**)

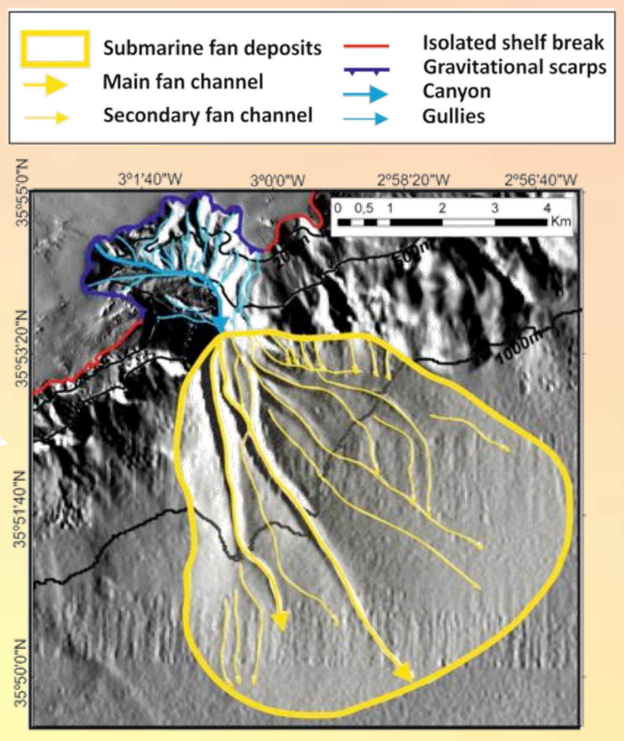


Figure 3. Morphological features of the Al-Boran MMS.

The possible tsunami originated by one of the **MMS** has been numerically simulated. This system, located on the southern Alboran Ridge slope (Fig. 1 and 2), is currently been reworked by turbidite processes, forming a submarine canyon sedimentary fan system, which is known as the Al-Boraní System (Fig.3) .

METHODOLOGY

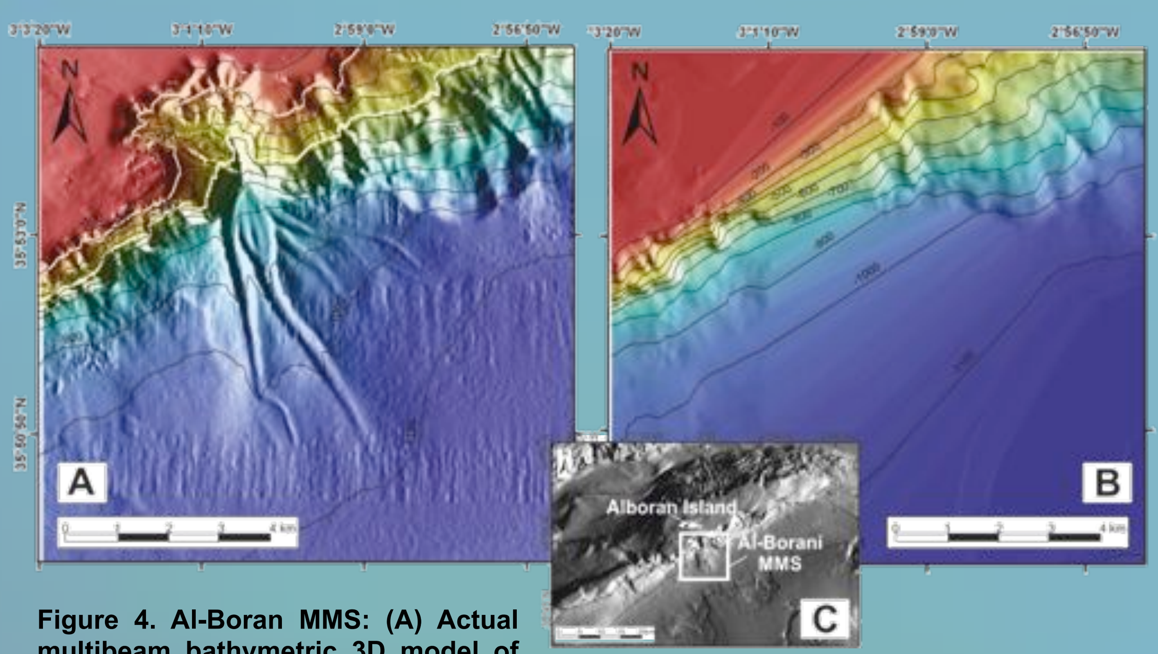


Figure 4. Al-Boran MMS: (A) Actual multibeam bathymetry 3D model of the Al-Boran MMS. (B) Hypothetical 3D palaeo-bathymetric model of the previous scenario. (C) Location map.

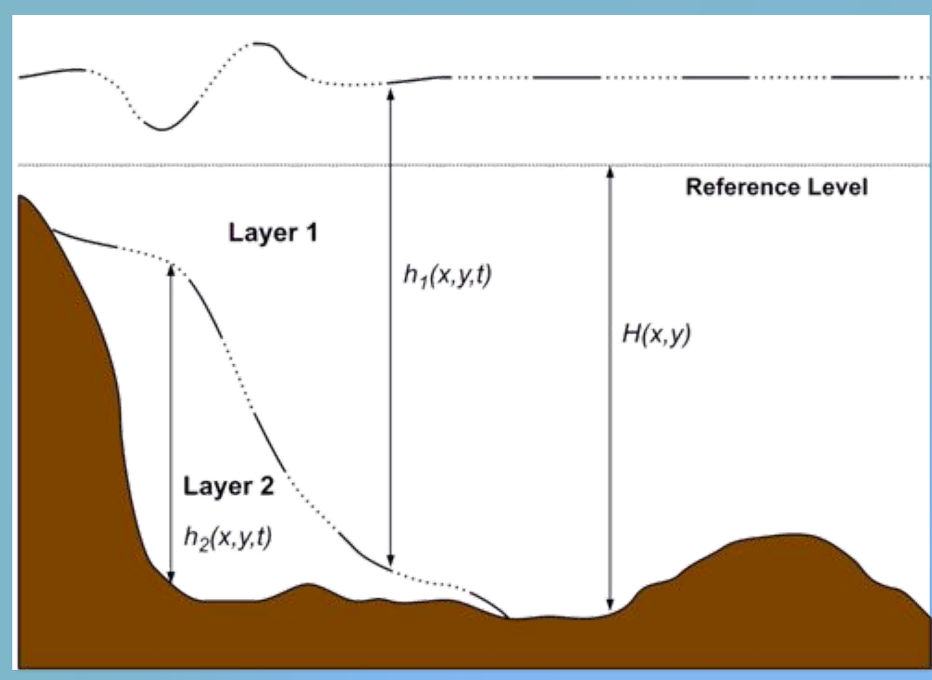


Figure 5. Sketch of the two-layer Savage-Hutter submarine landslide numerical model.

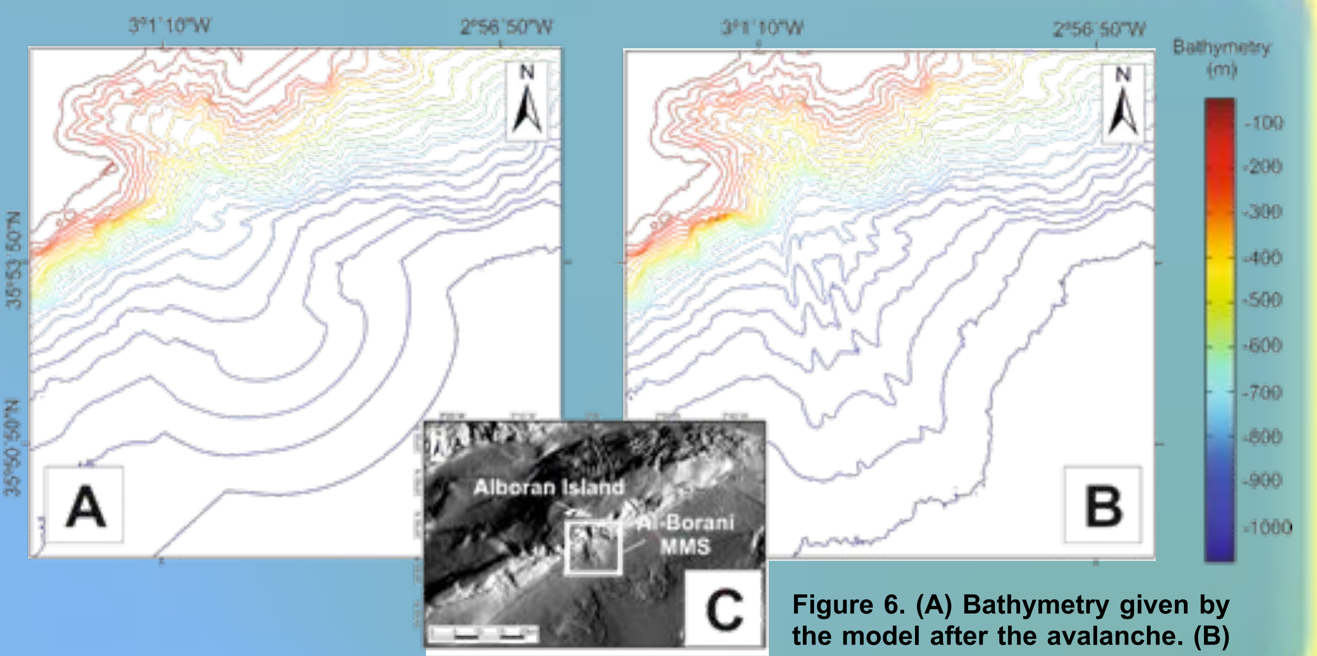


Figure 6. (A) Bathymetry given by the model after the avalanche. (B) Actual submarine fan bathymetry. (C) Location on the Southern ank of theAlboran Ridge.

RESULTS and DISCUSSION

The numerical model HySEA simulates the submarine landslide triggering the tsunami and the water mass evolution, wave propagation and the final penetration of the tsunami waves into the coast, reproducing first and subsequent tsunami wave impacts by means of a single coupled numerical model. The numerical model allows to analyze the influence of basin morphology on the propagation features of the tsunami, as its shape and propagation patterns, speed or wave amplitude and, finally, its impact on the coast of southern Iberia and northern Africa. Seamounts located on this basin are a key factor to control the tsunami waves.

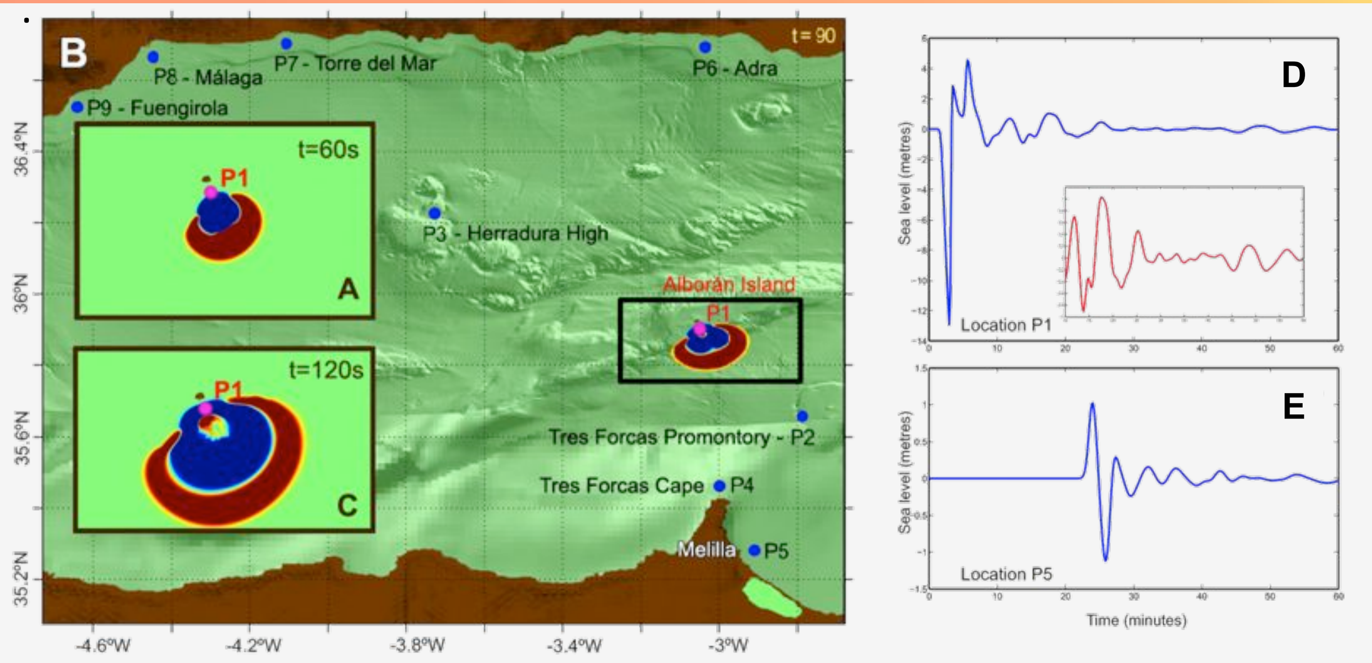


Figure 7. A-C Initial stages of the numerical simulation in t=60 s (A) and t=90 (B) in the complete domain, and in t=120 s (C). Sea surface elevation time series at: (D) location P1 (in red a zoom from t=10 min.) and (E) location P5.

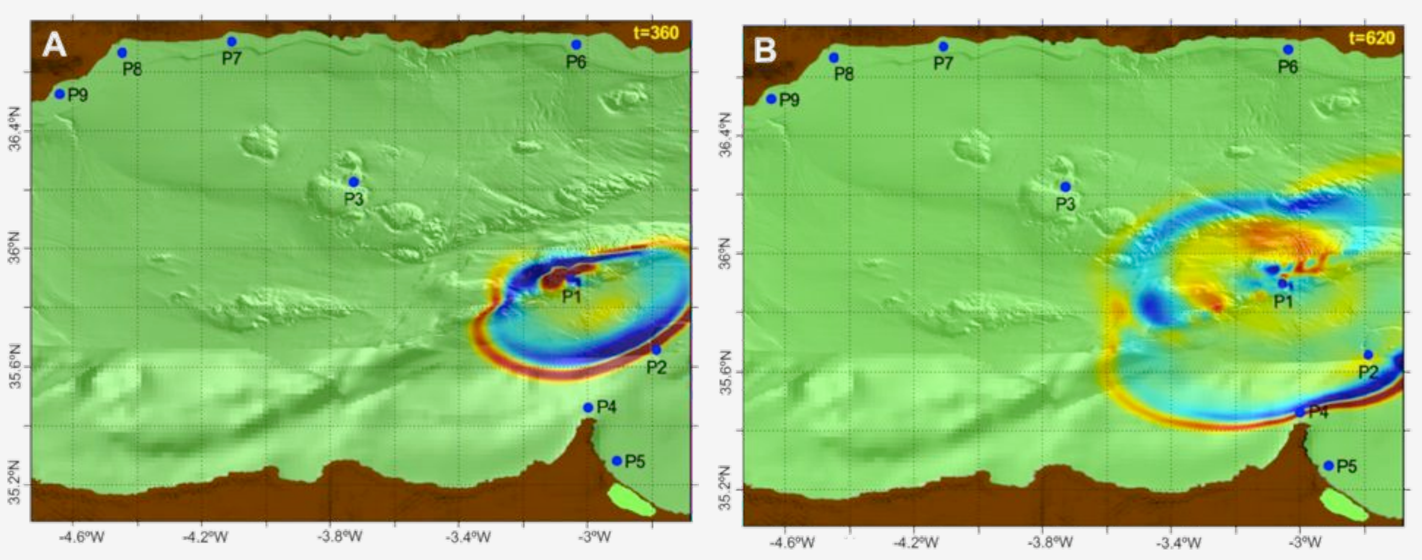
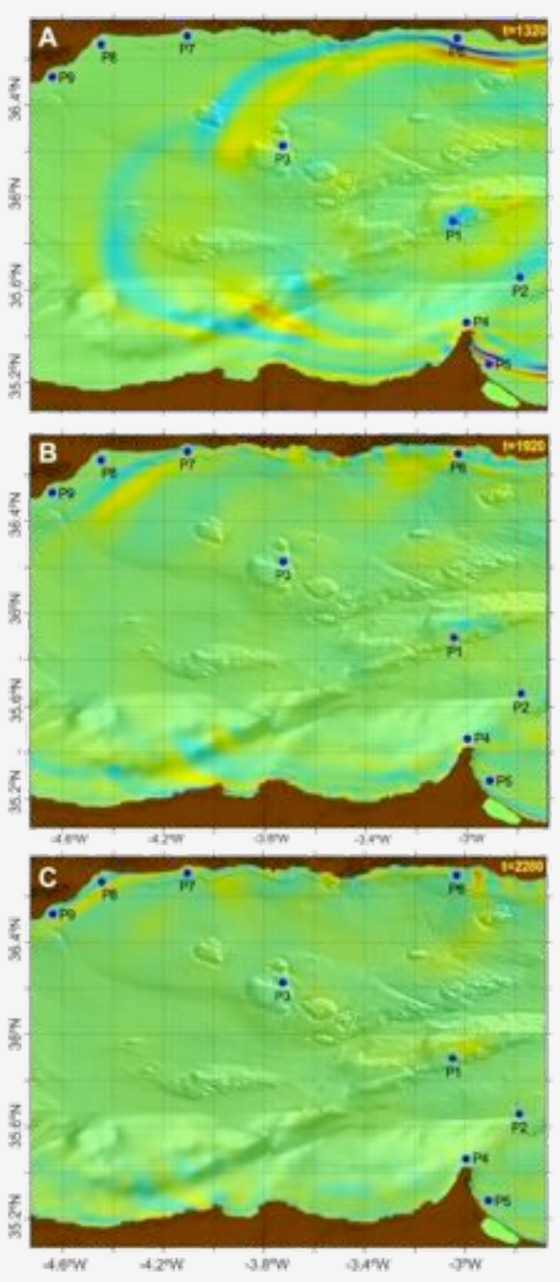


Figure 8. Time evolution of the generated tsunami wave after: (A) 6 min and (B) 10min 20 s.

Extension of the flooded area and runup heights are direct outputs of the numerical simulation. The numerical treatment of wet/dry fronts allows to efficiently quatify inundation and runup height with no need of imposing any kind of coastal boundary conditions



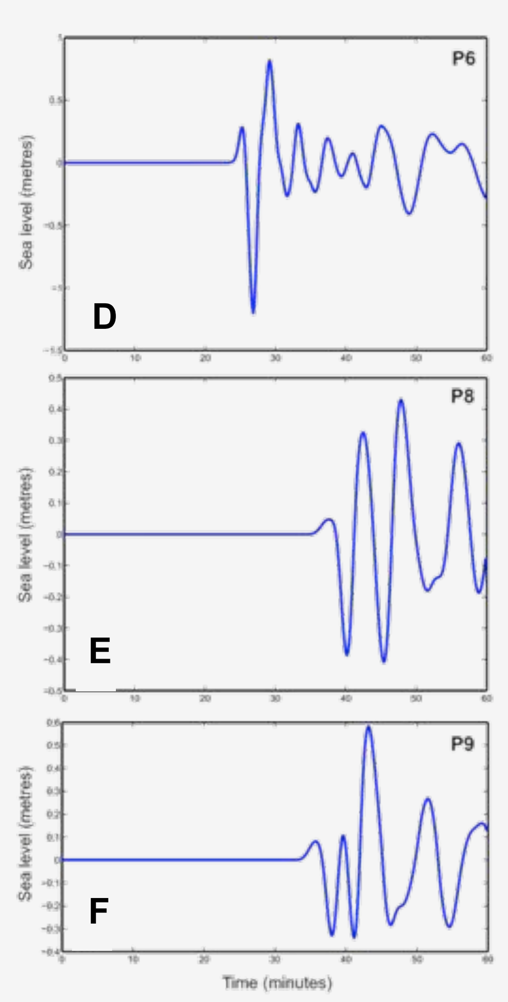


Figure 9. A-C: Tsunami wave arrival to the Southern Iberian coast at diferent locations. (A) Arrival to the eastern coast (Adra-P6), t=22 min. (B) Arrival to Torre del Mar (P7), t = 32 min. (C) Arrival to Malaga and its Bay (P8), t=38 min. D-F: Sea surface elevation time series at locations: (A) Adra (P6); (B) Malaga Bay (P8), and (C) Fuengirola (P9).

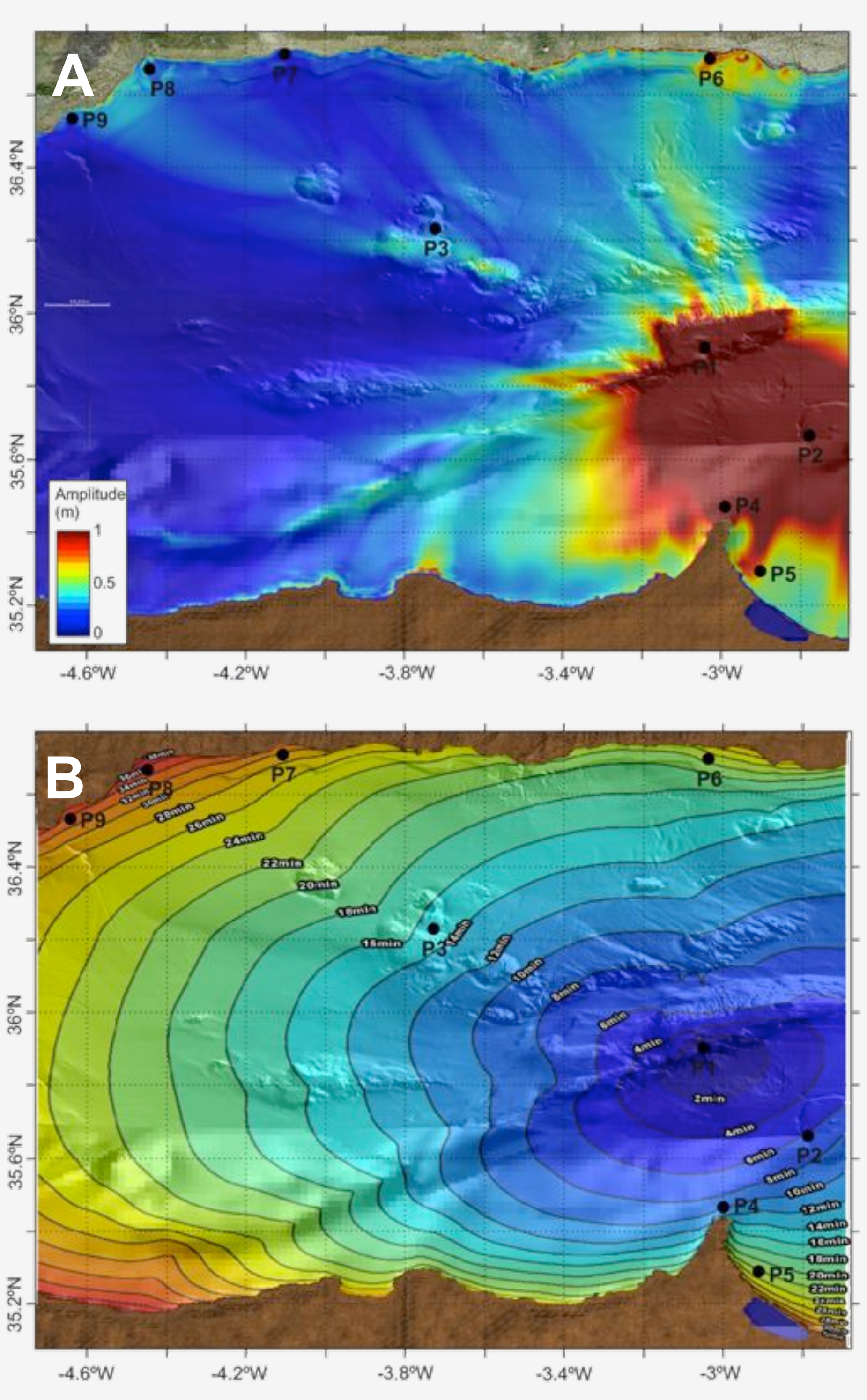


Figure 10. A. Maximal heigth reached by the tsunami wave at each point of the computational domain and B. Isolines showing the arrival times of the tsunami wave.

The model considered can also be used as prediction tool for the simulation of potential lanslide generated tsunamis. Monitoring of critical areas where landslides are more probable and modelling their consequences so that appropiate mitigation strategies can be designed are areas of key scientific and socioeconomic interest.

ACKNOWLEDGEMENTS

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