

Scientific report on the COST-STSM-ES0701-6592

The mission took place as scheduled between 5 and 13 July 2010. Under the guide of the Host, the work was accomplished in the Faculty of Aerospace Engineering, in Delft. The aim of the STSM was the modeling of sea level changes in the Euboean Gulf in Greece and in particular:

- Development of sea level indicators database with the existing information on location, age, indicated sea level rise, dating method and accuracy degree of each indicator.
- Import database of sea level geological, geomorphological, biological and archaeological indicators of Euboean gulf into a GIA model.
- Evaluation of preliminary results according to the tectonics of the study area.
- Review and consolidate the current understanding of Euboean gulf sea level indicators.
- Representation of the Upper Quaternary sea level evolution based on sea level curves.
- Preliminary interpretation of results.

Database of sea level indicators for the Euboean Gulf

A database of sea level indicators for the Euboean Gulf was developed, based on the available bibliographic data, covering a period between 5000-2000 BP (Fig.1). The sea level indicators consist of geomorphological markers, biological and archaeological remains. The database included information concerning the observed sea level indicator, the site name, the geographic coordinates, the elevation and the age of each indicator and the corresponding reference.

The database was organized in the appropriate form, in order to be imported into the GIA models.

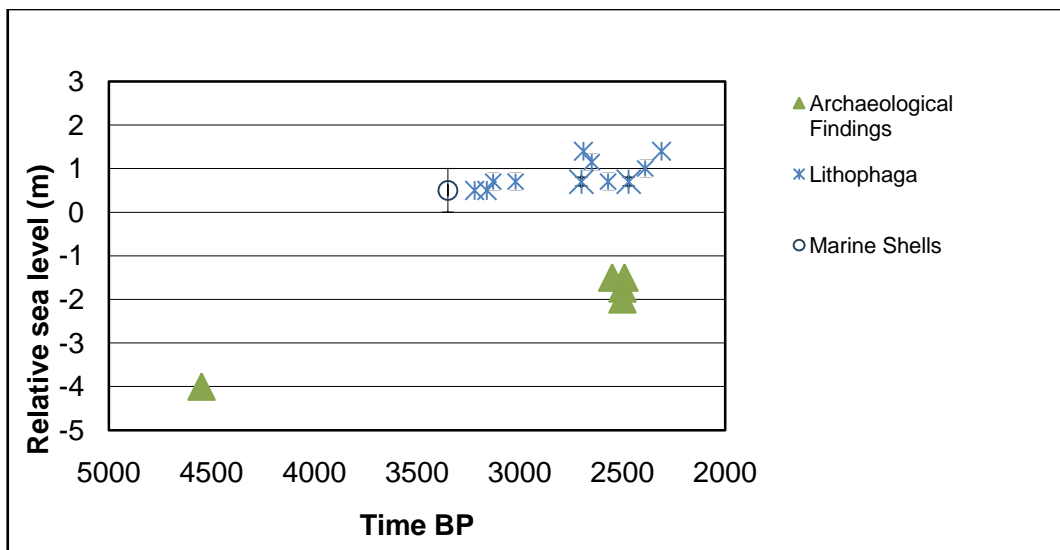


Fig. 1: Sea level indicators of Euboean Gulf

GIA models

The gravitationally self-consistent Sea Level Equation (SLE) is solved for a spherically symmetric Maxwell Earth to predict the GIA-related relative sea-level changes at the study area (Farrell and Clark, 1976). The SLE, which accounts for the effects of glacio- and hydro-isostasy, is solved by the "pseudo-spectral" method of Mitrovica and Peltier (1991), assuming a time-dependent ocean function (i.e., variable coastlines and bathymetry). This implies a spatio-temporal discretization in which the distribution of ice sheets varies step-wise and the basic unknowns (i.e., sea-level change S , surface displacement, and geoid height change) are decomposed in series of spherical harmonics.

The VM2 mantle viscosity profile is adopted and two different ice chronologies are compared: ICE-5G (Peltier, 2004) and ANU (Lambeck et al., 2004). Both models share ~127 m of equivalent sea-level at the Last Glacial Maximum, but show different melting rates during the last 20.000 years. In particular, while the ICE-5G melting phase ends ~ 5.000 BP, the ANU deglaciation, driven by the melting of Antarctica, continues up to the present-day. All computations are performed using the public domain program SELEN 2.7 by Spada and Stocchi (2007).

Study area

The Euboean Gulf is located in Central Greece, at the back-arc area of the Hellenic arc, and it constitutes one of the most active seismic regions. It is one of the most prominent extensional structures in Central Greece, a WNW-ESE trending graben about 100 km long, bordered by discontinuous normal faults. The North Euboean Gulf is one of the active rifts/basins, which overtake the crustal strain in Central Greece region, between the southwestern tip of the North Anatolian Fault and the northeastern tip of the Kefallinia Fault.

Preliminary interpretation of the results

The results of the GIA models were imported in an xls worksheet in order to be processed. The rates of vertical tectonic deformation and the error on the tectonic motions for the Euboean Gulf were calculated for both models (ICE5G and ANU) (Fig. 2, 3), according to the following formulas:

$T = \frac{H-I}{G}$, where T is the tectonic rate, H is the observed palaeo-sea level, I is the predicted palaeo-sea level and G is the age of the observed palaeo-sea level.

$\Delta(T) = \frac{\Delta(H)}{G} + \frac{|H-I|}{G} \frac{\Delta(G)}{G}$, where $\Delta(H)$ is the uncertainty of the measured elevation and $\Delta(G)$ is the uncertainty of the calibrated years.

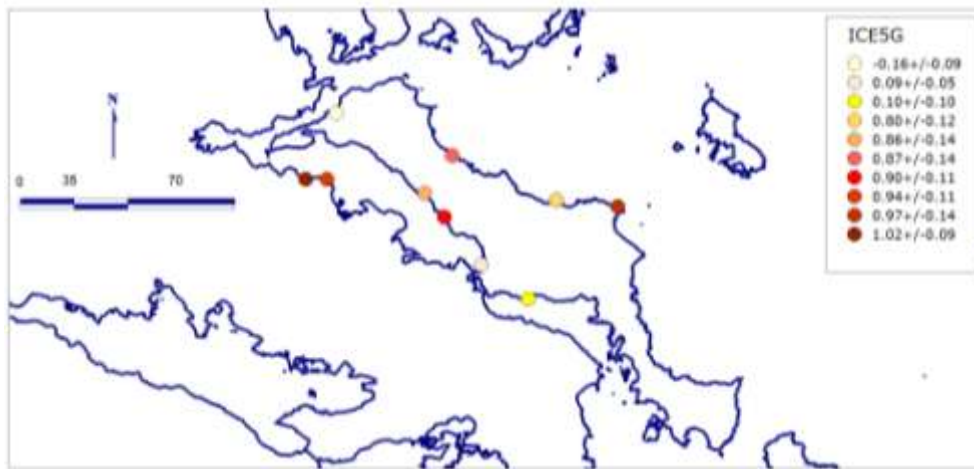


Fig. 2: Rates of tectonic deformation in Euboea Island (ICE5G).

Euboea island and the south coasts of the Euboean Gulf are affected by uplift rates of 0.6-0.7 mm/yr, while the highest uplift rates are observed on the coasts of central Greece, reaching 0.97 ± 0.12 mm/yr.

The study area appears to be separated into 3 zones, of E-W direction, of different rates of tectonic deformation, with the highest rates in the middle one.

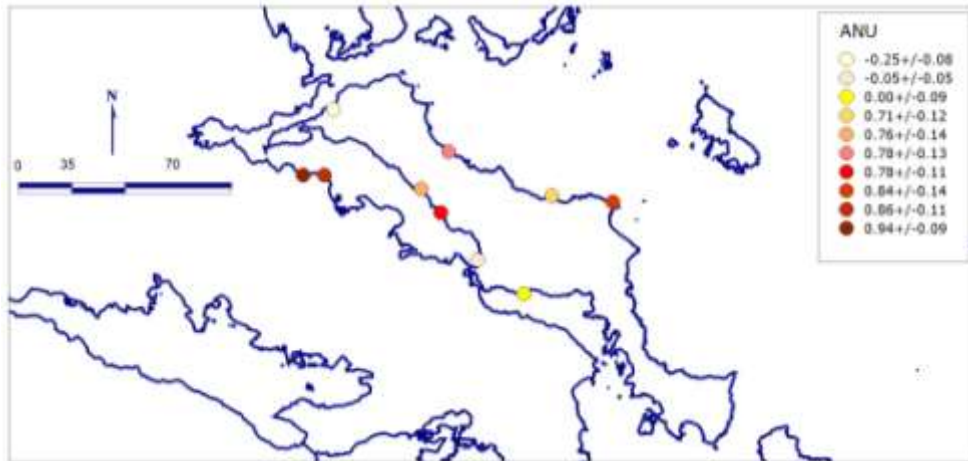


Fig. 3: Rates of tectonic deformation in Euboea Island (ANU).

The results obtained by the GIA models clearly indicate that the sea level indicators correspond to coseismic uplifts during Late Holocene. The repetitive pattern of these coseismic events in the area appears to be every 700-800 years. The total uplift in each position corresponds to both coseismic and post-seismic displacements. The study area is characterized by these instantaneous coseismic displacements, but it is also characterized by a steady rate of tectonic deformation (uplift).

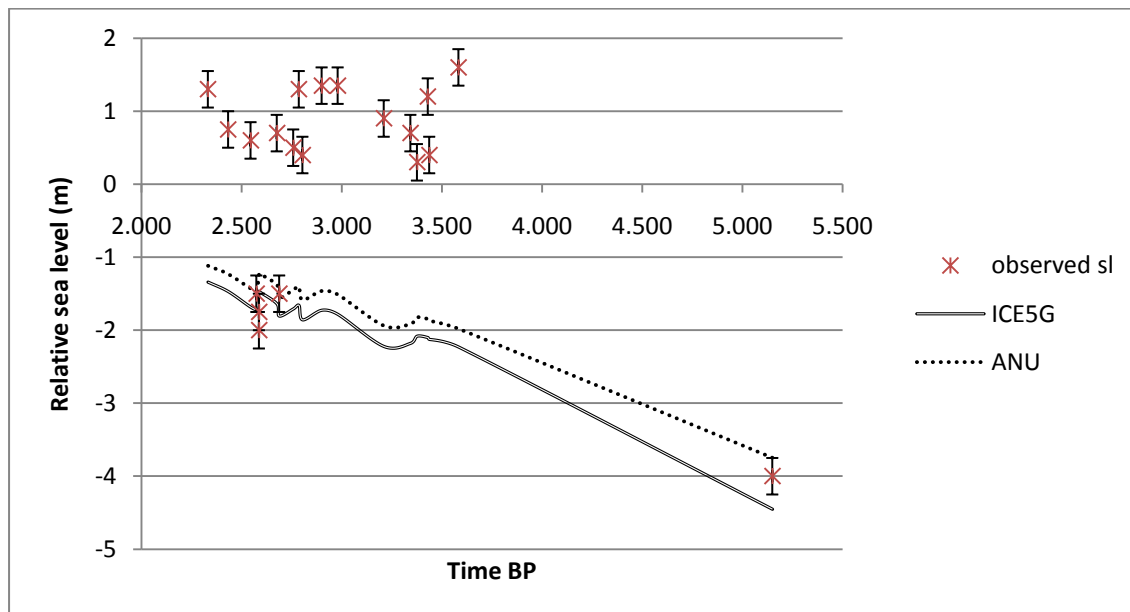


Fig. 4: The predicted relative sea level and the observed, based on the sea level data.

Two palaeo-shorelines may be detected, with the older around 3300 BP and the youngest around 2500 BP.

Conclusion

Thanks to the excellent organization by the Host, the STSM can be considered as a success, with discovery of several promising new data that will certainly stimulate further collaboration and in sea-level research.

A relevant paper from the results of the STSM is on preparation, and will be submitted during the following months.

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References

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