Study of the sedimentological processes and evolution of the coastline of Marathon Bay - Schinias beach

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Introduction

Marathon Bay, which is located at northeast Attica (Figure 1 and 2), is an area with great historical and social significance. In the area are encountered Schinias National Park, at the northeast of the bay, the Olympic Rowing Centre, military bases, archeological sites, museums etc. The area is also characterized by high touristic activity during summer. The purpose of the study is the determination of the morphodynamical processes and the changes of the shoreline of Marathon Bay. In the area there are specific locations and constructions endagered due to coastal retreat. The area was a lagoon 3.500 years BP (Pavlopoulos et al., 2006) and it is characterized by low inclinations and smooth slopes.

Figure 1. Location Map

Figure 2. Marathon Bay

Methodology

The bathymetry and seabed morphological features of the bay were conducted by using a single beam eco sounder (Lawrance HDS-9 Carbon). The bathymetric and side-scan imaging data were collected with the functional emission frequencies of 200 kHz and 450 kHz, respectively. Beach survey was carried out by descriptive shore-normal profiles, which extended from the sand dunes to the depth of ~2 m. Granulometric analysis was performed in 70 surface sediment samples obtained from the beaches (39 samples) and the bottom of bay (31 samples), while the extracted data were statistically processed on the basis of Folk & Ward (1957) method by the use of the GRATISTAT (v.8) software. The quantification of long-term shoreline displacements was made by the add-on application Digital Shoreline Analysis System (DSAS) in the software ArcMap 10.2 (Thieler et al. 2009). This was accomplished by making 261 transects (every 50 meters), except those neighboring anthropogenic structures, perpendicular to the historical shorelines from a stable baseline. At each transect the rate of displacement was measured. This was carried out by comparing historical and recent aerial photographs (1945, 1960, 1969, 1988, 1996, 2001, 2010,), satellite imagery (6/2015, World View 2) and the imprint of the coastline (3/2013) with real time kinematic digital global positioning system (RTK DGPS). The estimation of rate and volume of the sediments transportation was realized by a hydrodynamical model (MIKE 21 Flow Model FM).

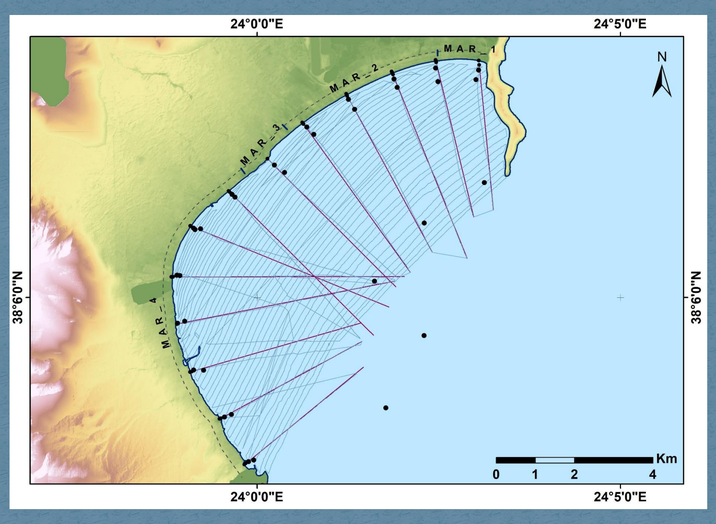

Figure 3. Position of 13 topographic cross sections carried out along the shoreline (red lines), sampling sites of surface sediments (black dots) and tracks of the single-beam echo sounder and side-scan sonar in Marathon Bay (blue lines).

Figure 5. *Posidonia Oceanica* meadow

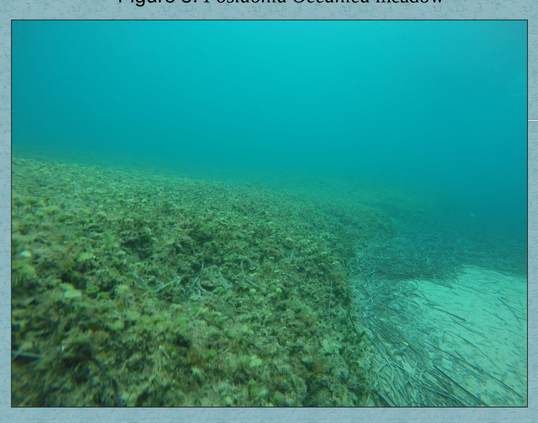

Figure 6. *Penicillus capitatu patches*

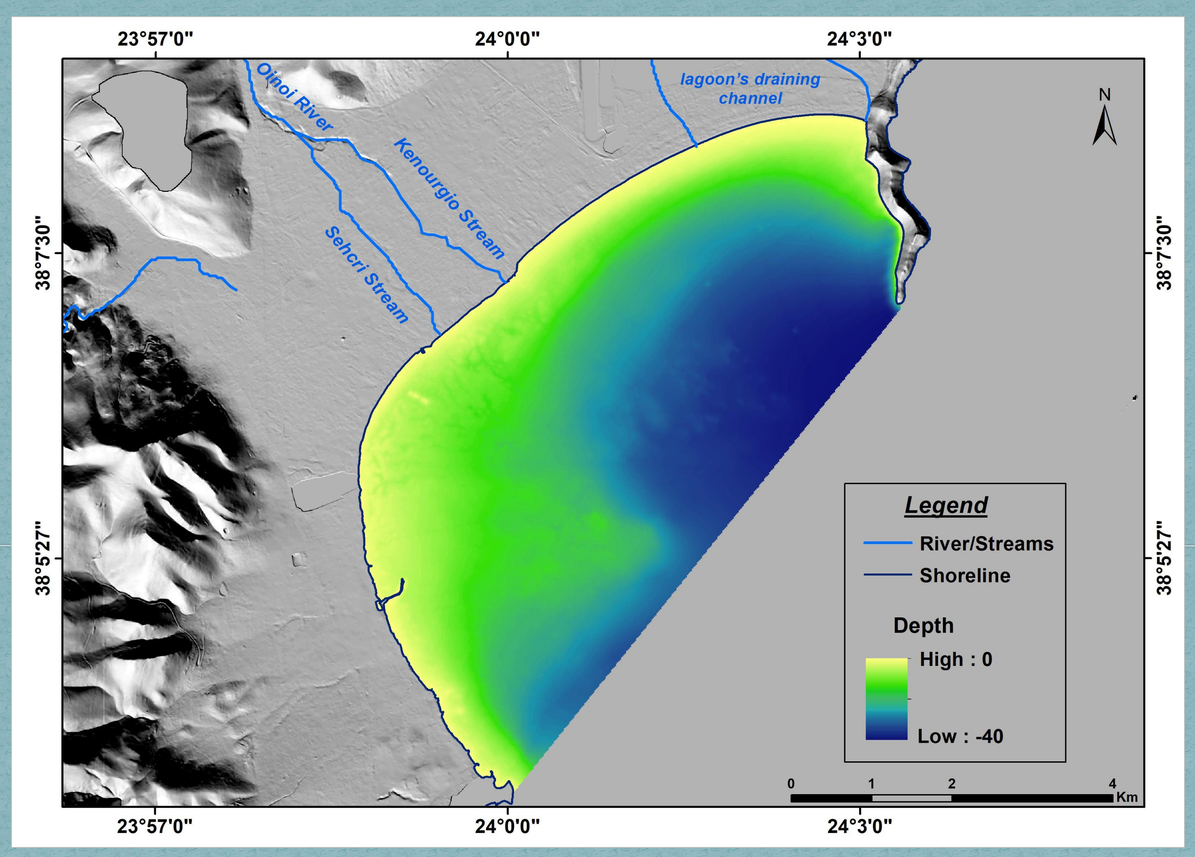

Figure 4. Bathymetric map of Marathon Bay

Figure 7. *Beachrocks*

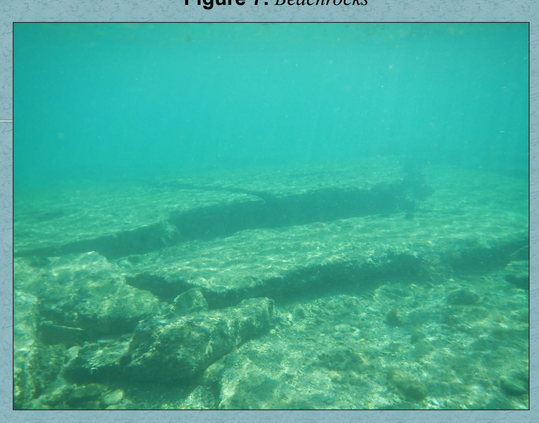

Figure 8. *Beachrocks*

Results

The Marathon Bay presents relatively gentle slopes and shallow depths, except the small basin at the northeast of the Bay with the maximum measured depth(-40 m). An extended submerged alluvial fan seems to be made mainly by Oinoi River (which is divided into Kenourgio and Sechri streams). Also, it can be recognized from the bathymetric map (Figure 4). The types of substrate and habitats were mainly constructed by non cohesive materials (mainly sand). An extended meadow of *Posidonia Oceanica* (Figure 5) is observed (from 5 to 27 m depth) and *Penicillus capitatus (*Tsiamis&Gerakaris, 2014) from 2 to 15 m depth as patches (Figure 6) and as beds from 27 to 35 m depth. From 35 to 40 m, mud is mostly prevailed. Locations with coarse sand, gravel and pebbles are noticed at the estuary of Kenourgio stream and at north and south of Nea Makri 's marina. These sediments derived mostly by the human structures along the shoreline and by destroyed beachrocks. At the coastal area of Nea Makri lanes of beachrocks were found from 1 to -3 m depth (Figure 7 and 8). The coastal area was divided into four sub-areas (Mar_1, Mar_2, Mar_3, Mar_4) with common displacement rates. At the lagoon's east draining channel (Figure 9) the second highest rates of retreatment are observed (~0,30m/year). A steady rate of retracement prevails at the National Park of Schinia's (Figure 10). At the center of the Bay (Mar_3), at the estuary of Kenourgio stream (Figure 11), the maximum rates of coastal retreat is noticed (-0,35m/year). Finally, at Area 4, a variation of displacements occurs due to anthropogenic structures which affect the nearshore sedimentation (Figure 12) . As shown at Figure 13, in Net Shoreline Movement diagram, which presents the distance between the oldest and the recent shoreline, the biggest part of Marathon Bay seems to be subjected to coastal erosion.

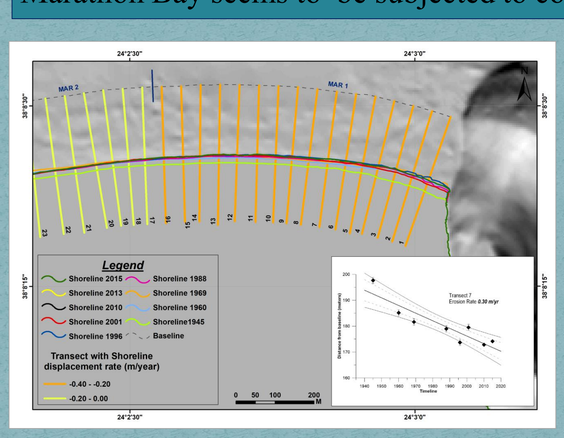

Figure 9. Shoreline displacement rates at Area 1 (East lagoon's draining channel)

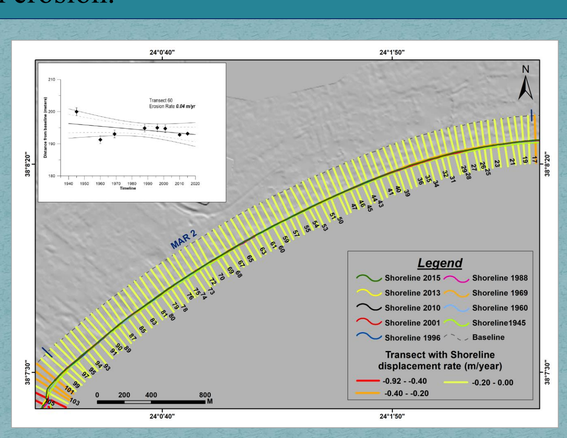

Figure 10. Shoreline displacement rates at Area 2 (national park of Shcinias)

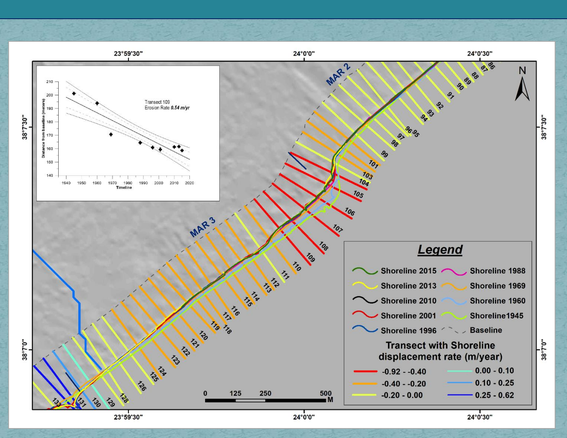

Figure 11. Shoreline displacement rates at the estuary of Kenourgio stream

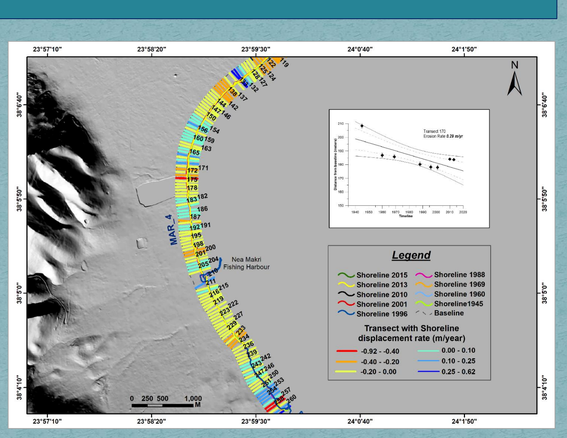

Figure 12. Shoreline displacement rates at Area 4 (Nea Makri)

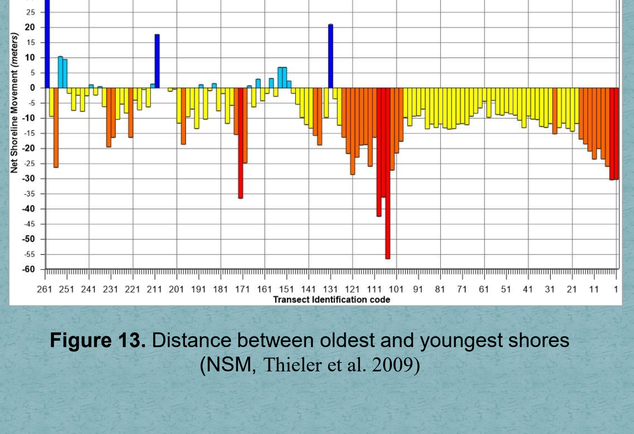

Figure 13. Distance between oldest and youngest shores (NSM, Thieler et al. 2009)

Discussion

The exposition of the coast to the southern waves, the reduced sediment supply from local rivers, due to the Marathon's Dam and secondly of the morphology of their riverbeds, they have been filled because of the sea level rise the last 50yrs (IPCC, 2007). The lack of sediment supply, the sediment's composition and the morphological appearance of the submarine basin at the northeast of the Bay are mainly responsible for the coastal retreat along with the sea level rise.

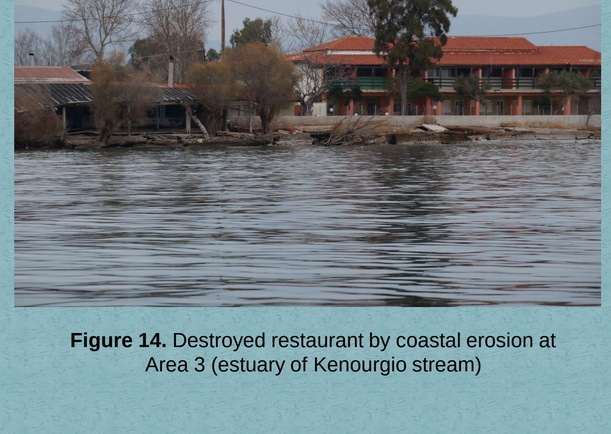

Figure 14. Destroyed restaurant by coastal erosion at Area 3 (estuary of Kenourgio stream)