BATHYMETRIC CHANGES OF THE BOTTOM RELIEF IN THE GULF OF ALEXANDROUPOLIS (NE AEGEAN SEA) BETWEEN 1960-2004, IN RELATION TO ITS HARBOUR EXPANSION

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Abstract
The aim of this study is to examine the bathymetric changes taking place in the bottom relief of the area surrounding the harbour of Alexandroupolis, after its recent expansion. Qualitative and quantitative changes of the bottom relief have been based upon the comparison of the bathymetric maps of 1960 and 2004, with the use of GIS. The results show that most of the area is characterised by sediment accumulation (average rates up to 4mm/yr), whilst their origin has been related to the nearby R. Evros sediment fluxes, wave activity and offshore patterns of water circulation.
Keywords : Aegean Sea, Bathymetry, Sediments.

Introduction
The harbour of Alexandroupolis was first constructed in 1870, used as a small piscatorial shelter. After a series of reconstructions and expansions it is now functioning as a big commercial harbour, having a major significance for northern Greece. Following harbour works, remarkable bathymetric changes have occurred associated with extraction and deposition of dredged material and/or the modification of nearshore hydro- and sediment dynamics, caused by the seaward prolongation of harbour piers. The scope of this investigation is to assess qualitatively and quantitatively the above mentioned seabed morphological changes.

Study area
The harbour of Alexandroupolis is located in the homonymous Gulf which belongs to the inner continental shelf of the NE Aegean (Samothraki Plateau). The relief of the seabed is smooth with very low gradients (<1%), which extend several kilometres offshore. The seabed consists of fine-grained sediment, whilst offshore there are relict sand deposits. To the east, the river Evros (drainage basin=52.500km^2) debouches, discharging some 3,2x10^6 t/yr (Pehlivanoglou, 1989). The gulf is exposed to waves caused predominately by S and SW winds, while coastal sediment transport has a dominant east to west direction, especially for the region to the east of the harbour (Pehlivanoglou, 1989). Wave heights induced by average wind speeds (4-5 B) are in the order of 1,3 m, reaching values of 5 m during storms (Athanasoulis & Skarsoulis, 1992); these wave heights are expected to break in water depths of about 2,5m and 6.5 m, respectively. Furthermore, the above mentioned wind-induced waves are capable to resuspend the surficial bottom sediments (Karditsa, 2006). This highly energetic and sediment rich marine environment not only has caused serious problems by infilling the harbour basin, but has also changed bathymetry in association with harbour works (dredging, pier extension etc).

Methodology
The study of the bathymetric changes of the gulf, focused on the neighbouring area of the harbour, was based on the comparison of bathymetry charts (scale 1:10.000) produced and published by the Hydrographic Service at 1960 and 2004. Digitized ground models were built according to these maps, which were subsequently compared by abstracting the digitised bathymetric surface of 2004 from that of 1960, with the use of GIS (ArcMap 8.3) function, named "cut and fill".

Results and Discussion
Following the conclusion of harbour works (in 2004) the dredged harbour basin and the associated navigation channel present depths between 6 m and 7 m. In the contrary, the comparison of the bathymetric charts of 1960 and 2004 show that the nearby off-harbour area is characterised by deposition (figure 1). According to calculations, the depth inside the harbour has decreased on average by approximately 1.7m since 1960 whilst the water depths outside the harbour have increased about 0.9m.
Sediment accumulation is obviously related to the seaward prolongation of harbour piers (e.g. the W pier, directed to the ESE, has today a length of 1.5 km) that has modified nearshore hydrodynamics and associated sediment dynamics and transport pathways.

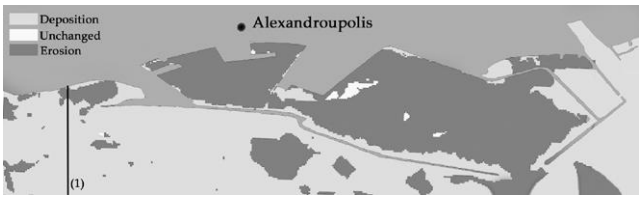

Fig. 1. Bathymetric changes, after the comparison of the bathymetric charts of 1960 and 2004. (1): Position of bathymetric profiles (figure 2).

In addition, the comparison between the bathymetric profiles of 1960 and 2004 (figure 2), to the west of the harbour, shows a general accretion and two distinctive bathymetric changes at about 3m and 6m of water depth. The depth of occurrence of these two underwater terraces coinciding with the calculated depths of wave breaking, under most frequent and extreme wave conditions, indicate the importance of the local wave regime.

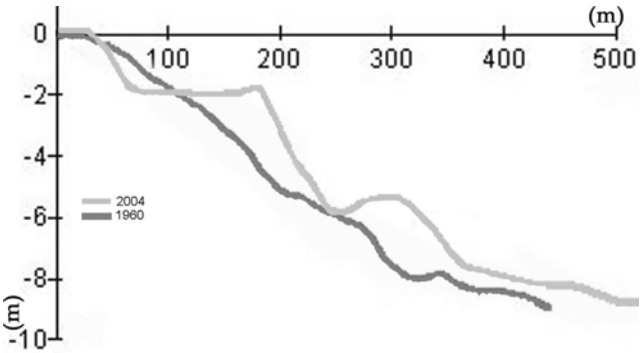

Fig. 2. Cross-shore (N-S) bathymetric profiles for the 1960 and 2004.

In conclusion, the observed bathymetric changes have been attributed to and/or partially caused by the expansion of the harbour, while the shallowness of the inner shelf and its fine-grained composition along with the sediment influx of the R. Evros, some other smaller torrents, and the wave regime (breaking zone of storm waves very close to the harbour) make the position of the harbour rather unsuitable, at least from a sedimentological point of view.

References

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