

## An introduction to a beach inventory: The case of the beaches of the Heraklion and Lassithi regions in Crete

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### Abstract

The present investigation introduces the development of a beach inventory, which will record, gather and depict information for beaches in an accurate way. The information, coming up from satellite images and ground-truthing with on-site field work, involves data concerning morphological and sedimentological characteristics of the beaches and all kinds of human intervention and presence on them. Information is gathered in a GIS geodata base and is, in turn, statistically elaborated. The coastline of the Heraklion and Lassithi regions (Crete) have been selected as case studies, in which detailed coastal mapping was carried out in 98 beach zones (with shoreline length >100 m). The statistical analysis of its characteristics showed that the south facing beaches are more coarse-grained, steeper and less human intervened, in relation to the north facing.

**Keywords:** coastal database, coastline mapping, coastline recording

### 1. Introduction

Greek coastline accounts more than 16,000 km hosts hundreds of beaches which constitute a great touristic destination. However, no gathered information exists relative to its qualitative and quantitative characteristics (e.g. physiogeographical characteristics, artificial structures, nearby land use). Therefore, the development of a coastal database that would successfully concentrate all relative data, in the form of a National Inventory, could be a valuable tool for the management and the sustainable use and exploitation of beaches and the coastal zone.

This work presents an example of the development of a beach inventory in the case of Heraklion and Lassithi regions in the Island of Crete, combining data from satellite and in situ observations.

### 2. Materials and methods

#### 2.1 Study area

Crete is one of the most touristic areas in Greece (e.g. over 2.16 million tourists landed at the eastern Cretan Heraklion airport in 2011 (after SETE, 2012)), whilst Cretan beaches are among the most attractive touristic destinations in the Island.

The approximately 1300 km long Cretan coastline shows various landforms, including rocky coasts/coastal cliffs, sandy beaches and medium/coarse sediment beaches (Alexandrakis, 2013). Cretan coastal geology is dominated by pre-alpine and alpine formations that constitute a complex nappe while Neogene sediments are present in basins formed between the mountains (e.g. Fytrolakis, 1980). The main fault lines trend W-E while deep gorges, trending N-S, follow existing fault zones. The Cretan coast is exposed to long wave fetches that are associated with waves of more than 4 m significant height (Soukissian, 2007).

#### 2.2 Methodology

Data from satellite images and in situ observations were collected along the coastline of Heraklion and Lassithi regions and specifically from the beaches with shoreline length >100 m. The

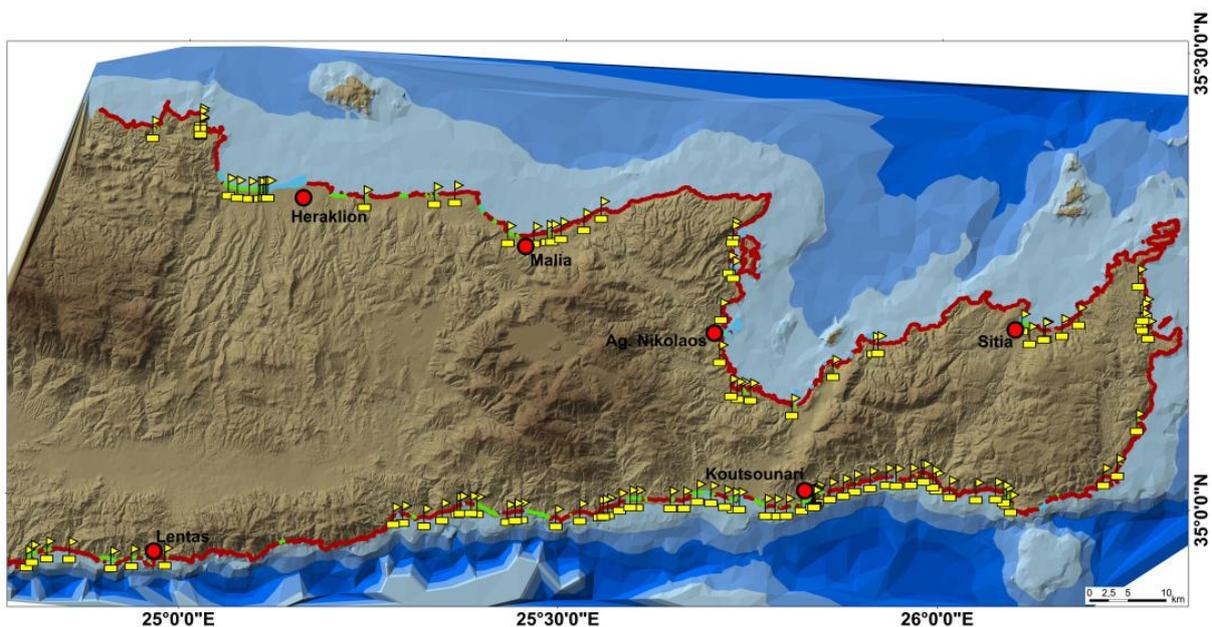
collected data included geomorphological, topographic and bathymetric mapping, sediment sampling from the subaerial and underwater part of the beach zones and recording of artificial structures.

The grain size analysis was carried out in the laboratory of Physical Geography of the National and Kapodistrian University of Athens, according to Folk's (1980) procedure. The whole information was inserted in a GIS geodata base and an analytical coastal geomorphological map (scale 1:1000) of the eastern Crete was produced.

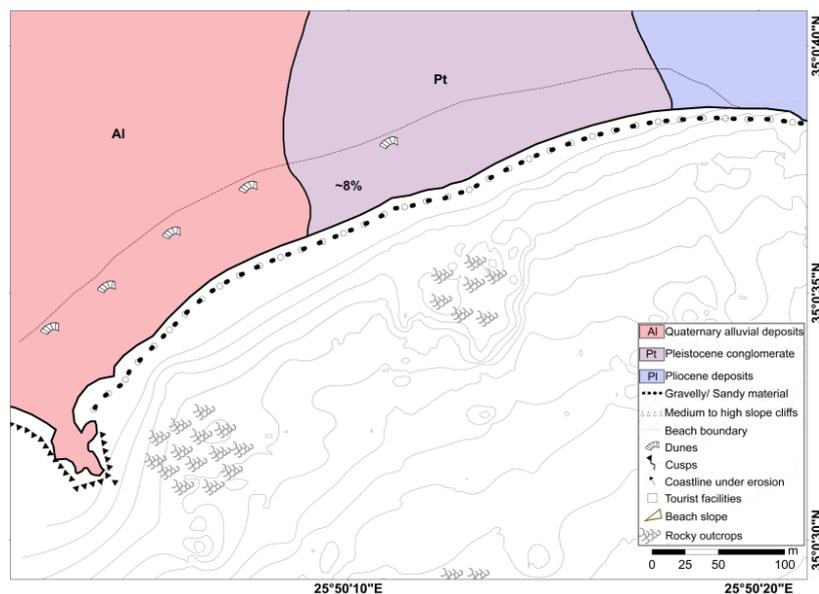
### 3. Results

The initial mapping along the coast of the two regions of Crete (over 750 km of combined length) through satellite observation showed that beaches represent only the 18%, with the 74% of the total coastline to be rocky while the remaining 8% of the coastline host some kind of artificial intervention. Field measurements took place in 98 beaches (Fig. 1) with length >100 m, whereas the combination of satellite and in situ mapping led to the development of a coastal geomorphological map (scale 1:1.000). In Fig. 2 the coastal geomorphological map from the Koutsounari beach (south coast) is presented, as an example of the whole geomorphological map.

Beach widths were found to be limited (Fig. 1) with the majority of beaches (59%) to have maximum widths less than 25 m, 35% to range between 25 and 50 m and about 6% with maximum widths >50 m. Concerning beach length, the threshold of 1000 m is overcome only by the 46% of the beaches. Beaches with very smooth slopes (<2.5) are infrequent (~6%), whilst beaches with low slopes (2.5-5%) are the majority (42%) along with beaches with moderate slopes (5-7.5%) that account approximately the 32%. Beaches with high slopes (7.5-10%) total up to 11%, whereas very high slopes and extremely high slopes are less frequent being equal to 6% and 3%, respectively. With respect to beach position, the majority of the south beaches are characterized by slopes of 5-7.5%, whilst most of the north beaches present lower slopes in the order of 2.5-5%.



**Fig. 1.** The 98 beaches (sampling sites) along the coastline of Eastern Crete.



**Fig. 2.** Part of the coastal geomorphological map from the Koutsounari beach zone.

In terms of sediment texture, the 41% of the beaches consist mostly of medium and coarse sands [gS and (g)S] and the 31% of gravels with some sand presence [(s)G and sG]. The exclusively sandy beaches correspond to the 11% when the exclusively gravelly beaches accounts for 16%. North sided facing beaches were found to be more fine grained compared to the south facing beaches; this is most probably due to the more persistent wave regime.

The main human interventions along the coast of the study area are associated with main (four) commercial ports (Heraklion, Ag. Nikolaos, Sitia and Ierapetra) and the small fishing ports (twelve in the north, one in the east and eight in the south), coastal residential and touristic development, coastal protection works and river management schemes.

#### 4. Conclusions/Discussion

In brief, the statistical analysis of the selected data showed that the south part of the area investigated is more coarse-grained, steeper and less human intervened, in comparison with those of the north coast; this observation matches to the different degree of human intervention and tourist development.

#### 5. Acknowledgements

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