VULNERABILITY ASSESSMENT OF EASTERN CRETAN BEACHES (GREECE) TO SEA LEVEL RISE

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Synopsis

Introduction

Beach erosion

- Beaches are considered both valuable economic resources for the Mediterranean countries and vulnerable to climate changes.

- Sea level rise (SLR) (long-term and short-term) represents, probably, one of the most significant beach threats since beaches respond with retreat.

- IPCC, 2013 suggests that mean SLR, in 2100, will be between **0.26** and **0.82 m** higher than that of period 1986-2005. Other studies, suggest much higher rises for the same period (e.g. **0.87-1.86 m** (Mori et al., 2013).

Introduction

Beach erosion

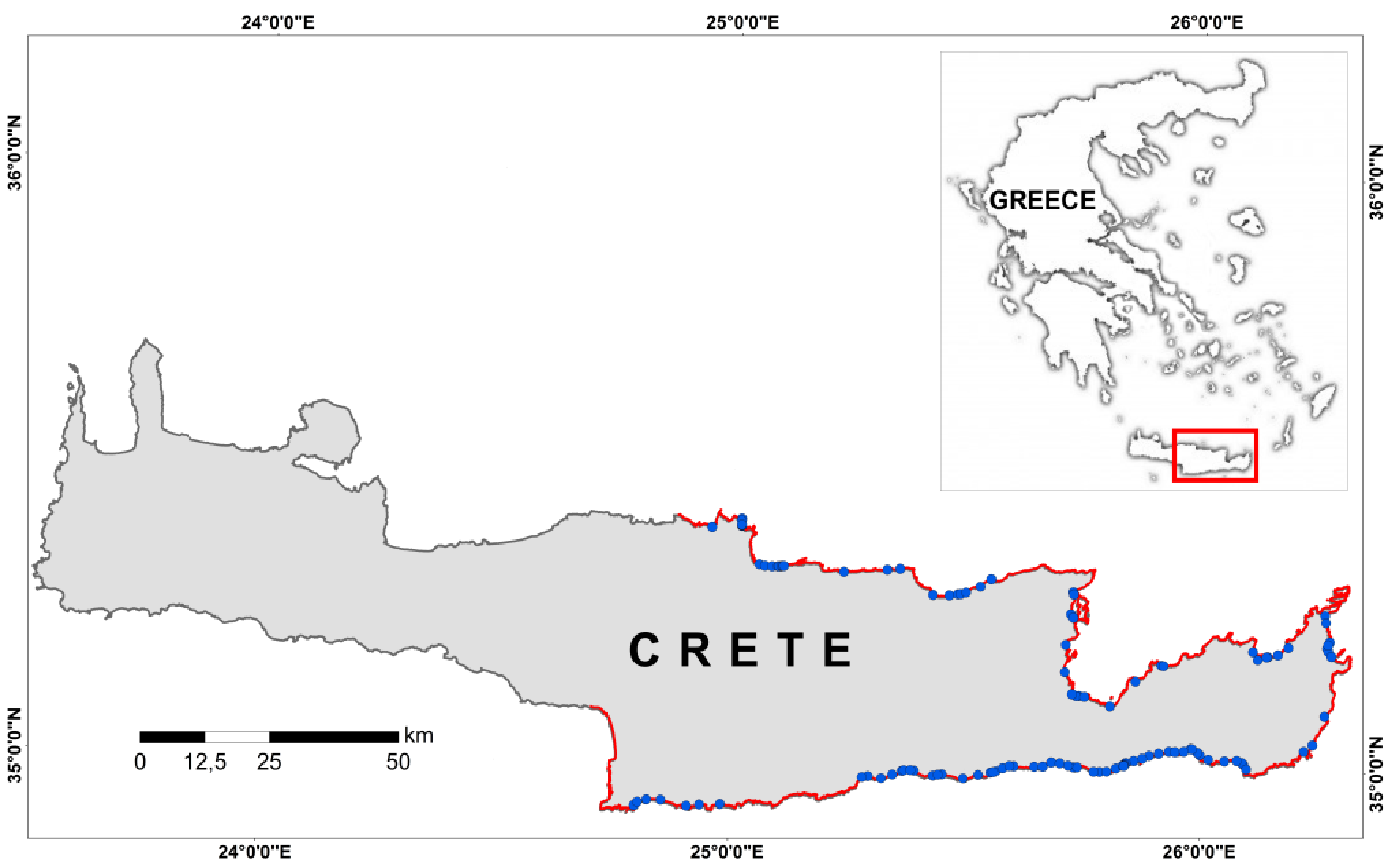
- Beach erosion has significant impacts, since coastal populations, activities, infrastructure and assets are exposed to damages/flooding

- Is particularly alarming for the Eastern Cretan beaches because
  (i) of their limited size and sediment supply (Velegrakis et al., 2008) and
  (ii) beaches represent the most valuable natural resource of Greece, as they are the main focus of the “sun and beach” tourism (MAP, 2005)

- The objective of the present contribution is to assess the vulnerability of the 71 highly touristic Eastern Cretan beaches in relation to the anticipated SLR.

Study area

- The study area is located at Crete at South Greece. 5th largest island in the Mediterranean (1300 km coastline, 15 % sandy beaches). The present investigation concerns 71 beaches located at the Eastern Cretan Coast.



Location map of the study area.

Methodology

Data collection

(i) Topographic mapping in 71 beaches using a leister distant meter and a Differential GPS (DGPS) Top Con system.

(ii) Sediment samples were collected from each topographic section in the shoreline front. All sediments were subjected to grain size analysis.

(iii) The wave regime was investigated utilizing the ERA-INTERIM database. The mean H,T were estimated for the North, East and South beaches and for 17 chosen directionalities.

Methodology

Ensemble modeling

(i) Creation of an ensemble of 3 analytical (Edelman, Bruun and Dean) and 2 numerical (Leont’yev and SBEACH) 1-D morphodynamic models

(ii) The ensemble modeling was applied for all the range of the environmental conditions (slope, sediment size, waves) observed in the study area. The means of the lower and upper limits of all the model estimates were calculated.

(iii) Estimation of beach width losses through the comparison of the range of the beach retreat predicted by the model ensemble and the beach widths

(iv) Also a more detailed analysis has been conducted for 2 highly touristic and natural/economic valuable beaches, Ammoudara and Koutsounari located at North and South Crete respectively.

Results

Morphodynamic characteristics

With regard to the beach typology

Iribarren number $\xi = \beta/(H_o/L_o)^{1/2}$

β: the beach slope, H_o and L_o : the offshore wave height and length.

- The examined beaches are dissipative ($\xi < 0.5$) and intermediate ($0.5 < \xi < 3.3$).
- Also the slopes of the swash zone section ranges ~1/10 – ~1/30.

With regard to the wave regime

Range of incident wave		
Eastern Cretan Coast Section	**Wave height (m)**	**Wave period (m)**
North	0.8 – 1.4	4.5 – 5.3
East	0.7 – 1.3	4.4 – 5.4
South	0.7 – 1.3	4.5 – 5.5

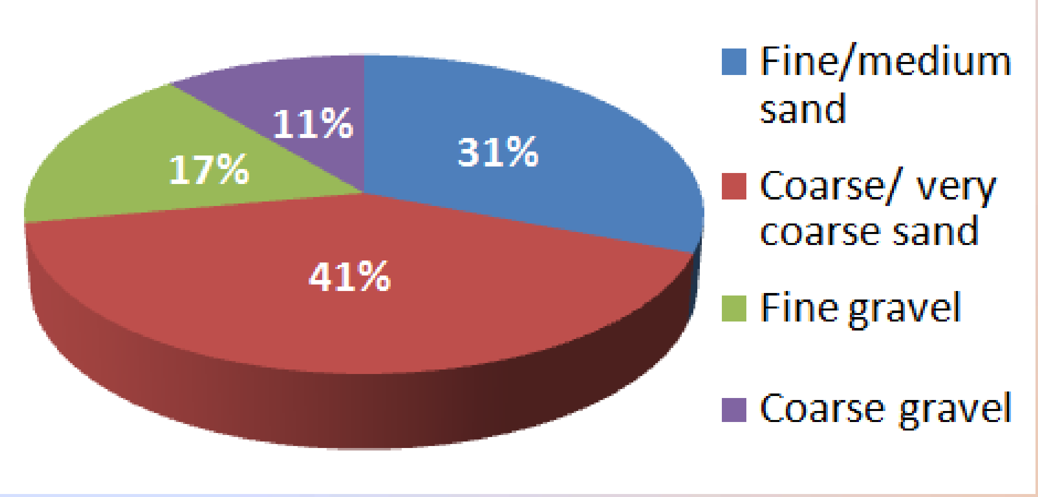
Results

Morphodynamic characteristics

With regard to the beach width

beaches were found to be quite limited in size				
Maximum widths (m)	≤20	20 – 50	50 - 100	≥100
Percentage %	20	69	10	1.4

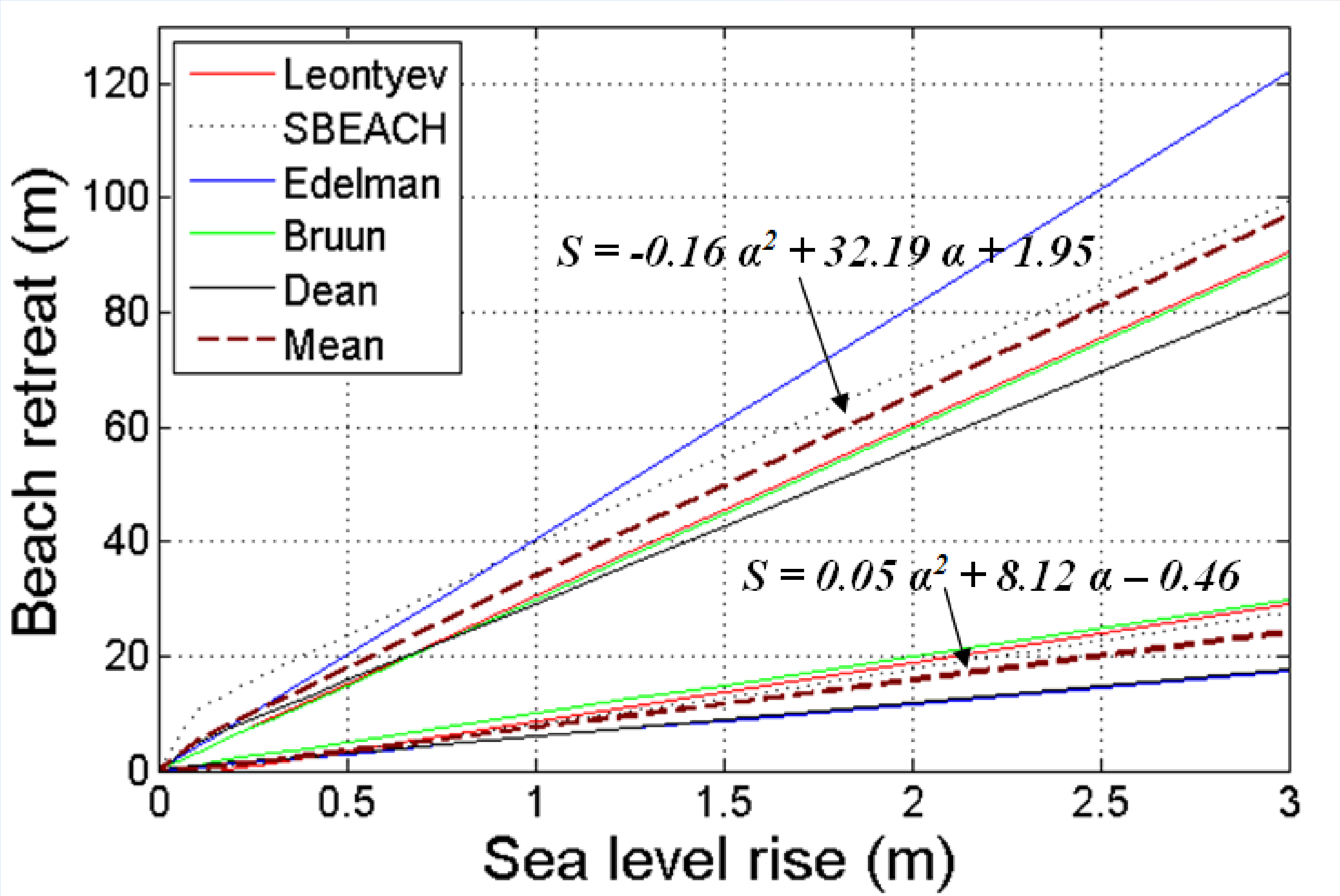
With regard to the beach sediments



Results

Beach retreat projections

- 5500 experiments for varying beach slopes (1/10 – 1/30), wave conditions (H: 0.5-1.5, T: 4-5 sec), sediment size (0.2 – 10mm) and 12 SLR scenarios (0.1 – 3 m) were conducted

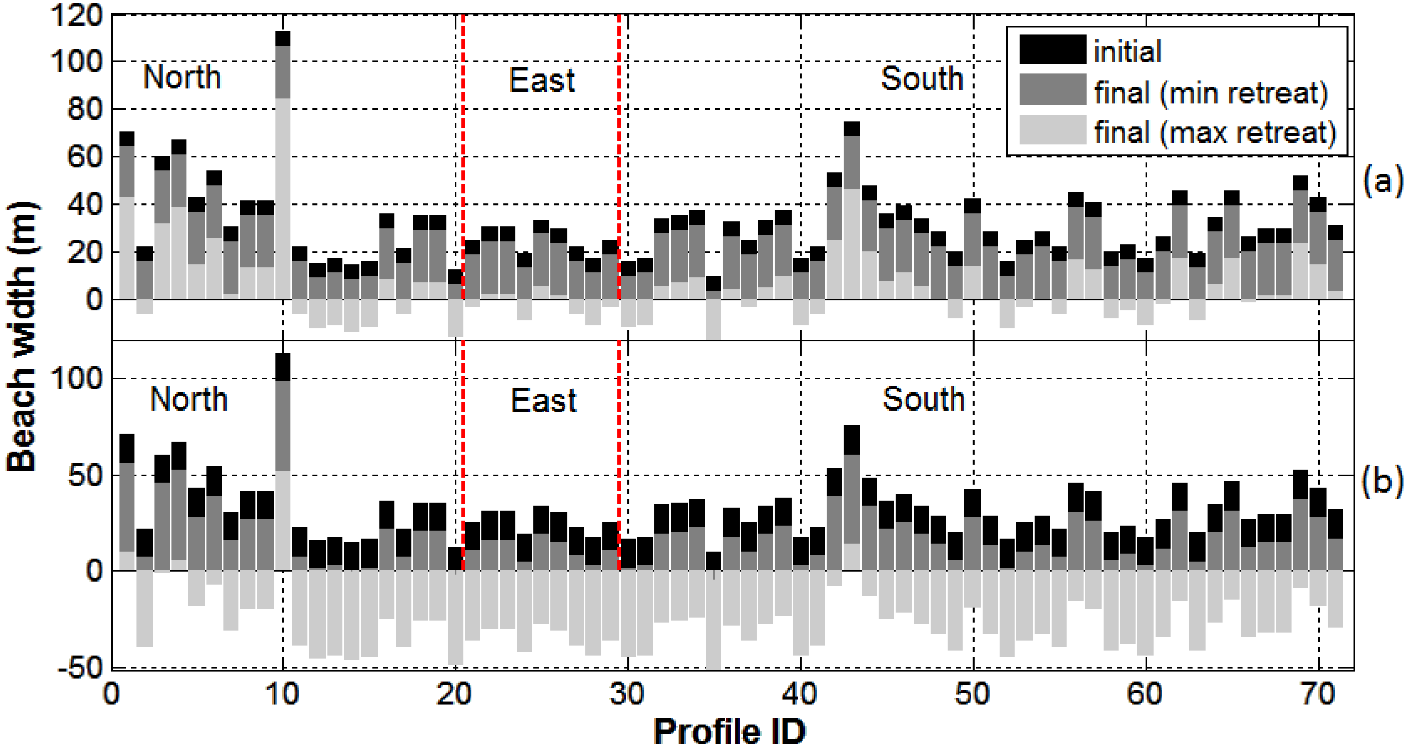


Results

Beach retreat projections

Beach spatial characteristics versus modeling results

Beach width losses (%) :		>20%	>50%	>100%
SLR: 0.82 m	Lower	~54%	1.4%	0
	Upper	All	93%	~41%
SLR: 1.86 m	Lower	~97%	~48%	~4%
	Upper	All	All	~94%

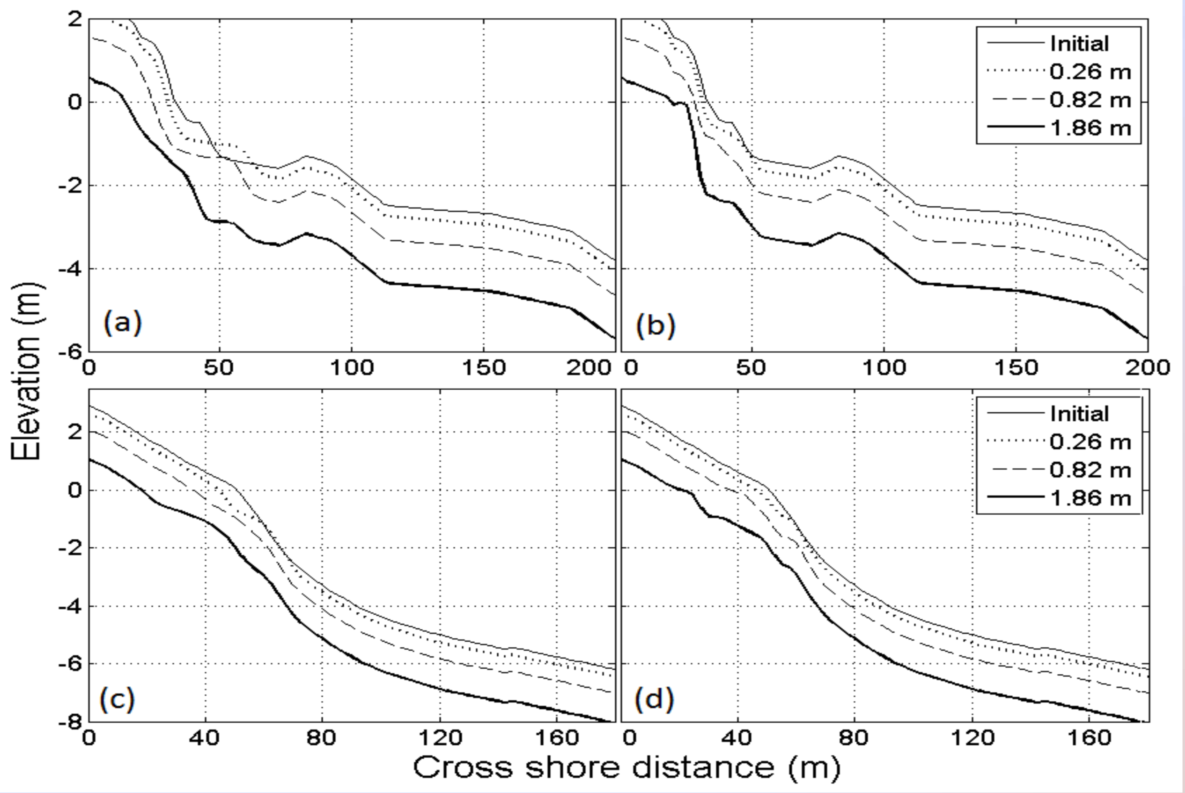


Minimum and maximum retreat of Eastern Cretan beaches for sea level rises of
(a) 0.82 m
(b) 1.86 m.
Final width values < 0 show beaches that will be entirely lost/inundated

Results

Beach retreat projections

the analytical models suggest significant values of beach retreat in the case of Ammoudara beach and less significant in the case of Koutsounari beach, while the numerical models displayed an opposite behavior



Beach retreat

SLR	*Ammoudara*	*Koutsounari*
0.26 m	6.1 m	3.4 m
0.82 m	17.4 m	9.6 m
1.86 m	39.9 m	21.5 m

Beach profile evolution along 1 transect in Ammoudara (a and b) and 1 in Koutsounari (c and d) under 3 SLR scenarios (0.26, 0.82, 1.86 m), given by Leont'yev (a and c) and SBEACH (b and d) models.

Results

Beach retreat projections

Ammoudara

Koutsounari

Conclusions

I. The Eastern Cretan beaches are limited in size (~90% of the beaches are showing widths <50 m) and are built mostly on sand (~72%).

II. Plethora (5500) of modeling experiments were carried out and the means of the lower and upper limits of the model projections have been estimated

III. SLR will have devastated impacts to Eastern Cretan beaches (in the case of SLR of 1.86 m, ~94% of beaches, will be completely inundated/lost).

IV. The impacts could be worse if other effects are taken into account.

V. The approach adopted in the present study cannot replace detailed studies focusing on specific beaches, it can provide a rapid assessment of the beach retreat/inundation due to SLR and identify ‘hot spots’ of erosion.

THANK YOU
FOR YOUR ATTENTION!

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