Coastal erosion along the Hellenic coastline

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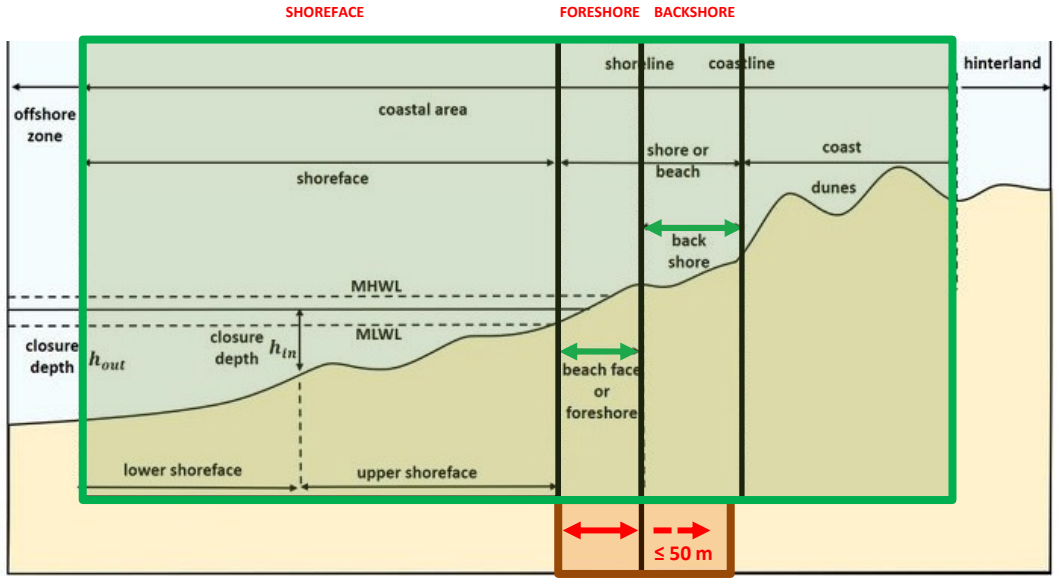
Definitions

… used by scientists

*"**Foreshore**" is the zone between the mean low water (MLW) and the seaward beach berm, which is equivalent to the upper limit of wave run-up at high tide.*
*"**Backshore**" is the dynamic zone of land lying between the foreshore and the front dune, cliff base, vegetation line or coastal protection structure.*
*"**Shoreface**" is the zone seaward of the foreshore, where offshore generated waves interact with the upward-sloping seabed (i.e., from the MLW to the closure depth).*

… used by the Greek State

*"**Foreshore**" is the zone of land flooded by sea waves during their usually highest run-up.*
*"**Backshore**" is the landward setback zone of the foreshore, with a width of up to 50 m, which is established to protect the coast from erosion and to secure access between land and sea and vice versa.*
*"**Shoreface**" is … no definition!*



[US Army Corps of Engineers (2002). Coastal Engineering Manual]

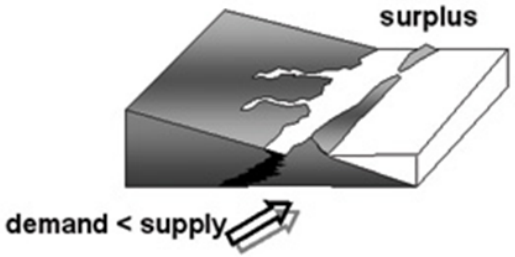
Definitions

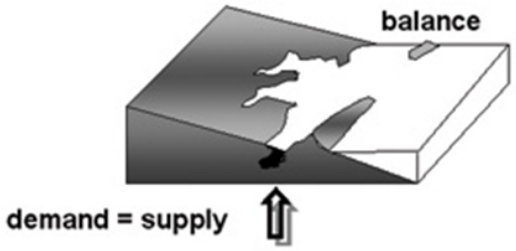
… used by scientists

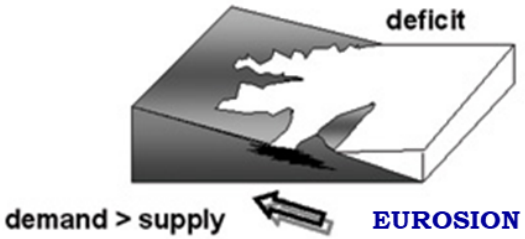
*"**Coastal erosion**" is the long-term or permanent **removal** of solid material from the coastal profile due to natural and human processes.*
*"**Coastal accretion**" is the long-term or permanent **addition** of solid material to the coastal profile due to natural and human processes*

… used by the Greek State

*"**Coastal erosion**" is the **inundation** of the foreshore by the sea, which can cause social, economic and environmental damage.*
*"**Coastal accretion**" is … no definition!*

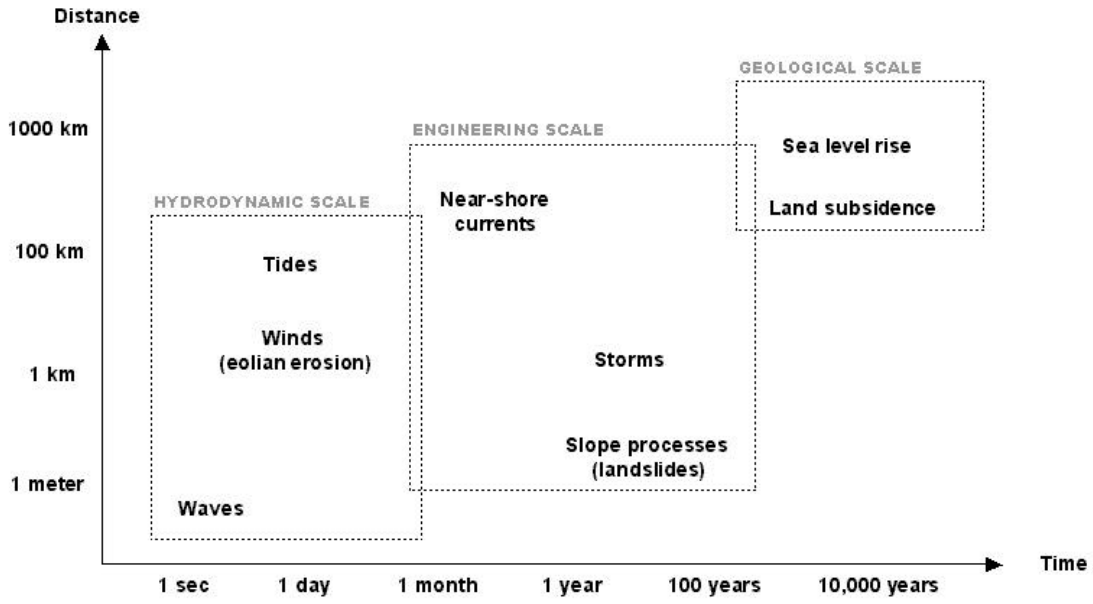


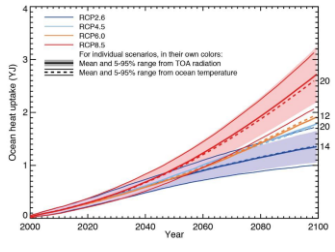




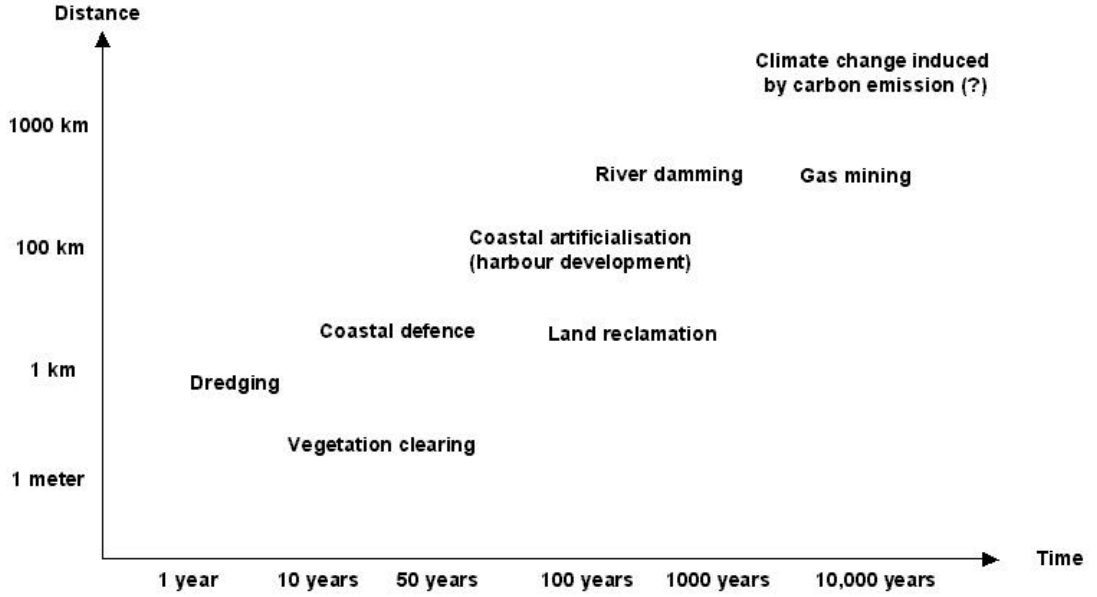
Causes of coastal erosion

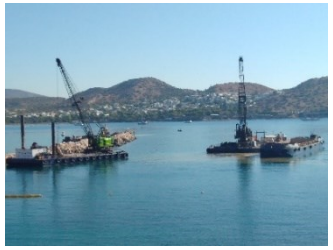
Natural

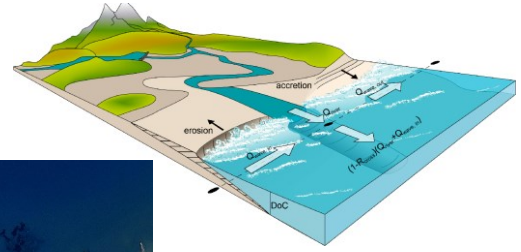




Anthropogenic



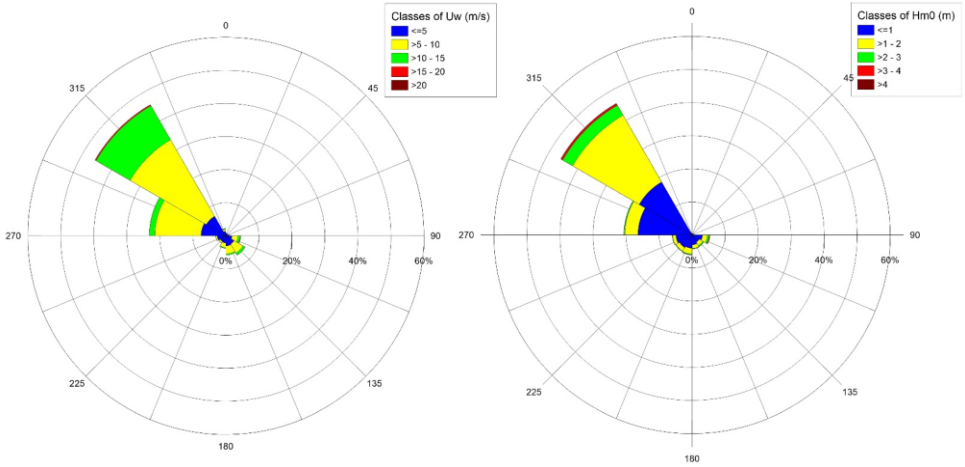


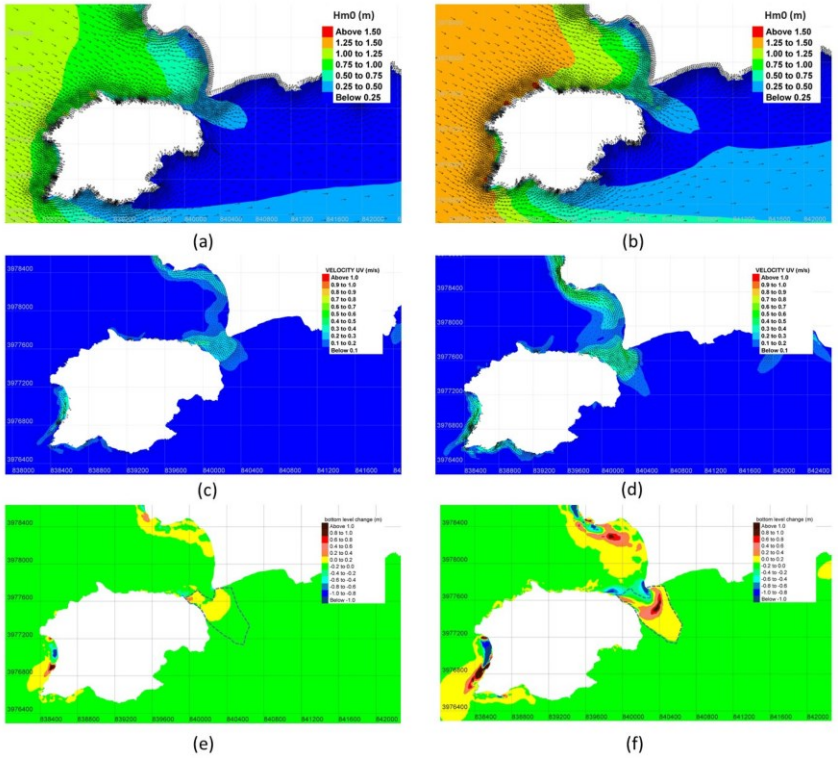


Processes to be considered in a Coastal Engineering Study (1/5)

- **Hydrodynamics**
  - ❖ **Sea level fluctuations**
  - ❖ **Winds**
  - ❖ **Waves**
  - ❖ **Nearshore currents**
  - ❖ **Tides**
  - ❖ **Extreme events**

Methodology: Statistical or probabilistic analysis such as extreme value analysis (stationary or nonstationary analysis) in combination with numerical modeling.



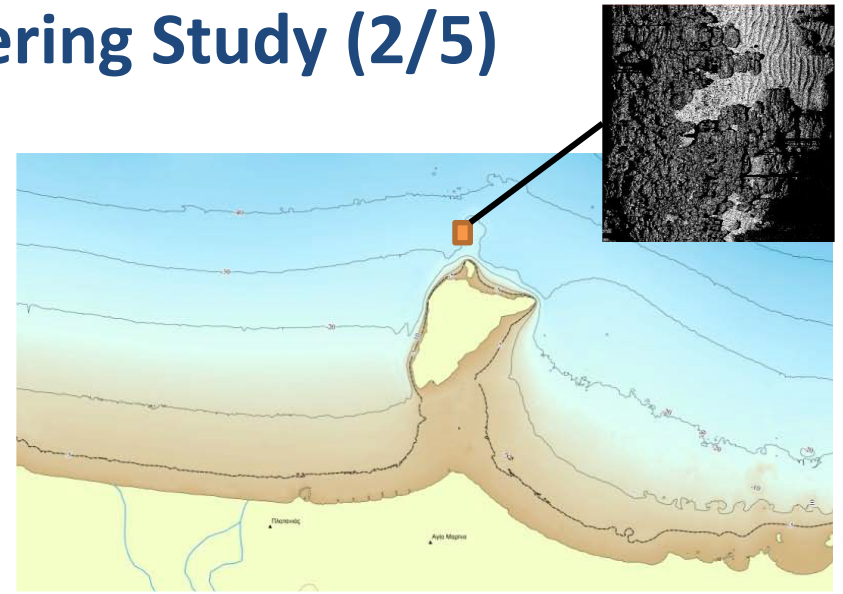


Maps of Hm0 (m), current velocity (m/s), and bottom level change (m) in the sea area of interest for wind-wave scenario 1 (a,c,e) and for wind-wave scenario 2 (b,d,f), respectively. The dotted closed line encloses the active domain of the study area for tombolo formation. Maps created in Blue Kenue™ software tool for hydraulic modellers.

(*Malliouri et al., 2022*)

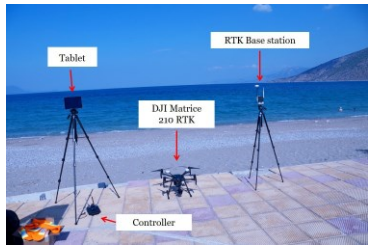
Processes to be considered in a Coastal Engineering Study (2/5)

- **Coastal morphology**
  - ❖ **High resolution topography and bathymetry**

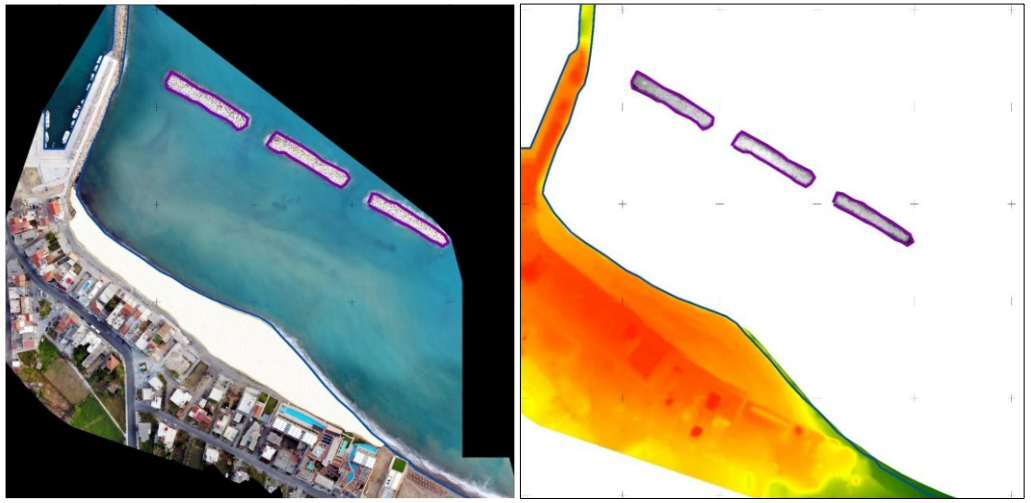


Platanias - Chania, Crete (*HCMR, 2016*)

Methodology: To monitor short-term changes in beach morphology, precise elevation and depth measurements are collected from the dune to the edge of the inner shelf by using terrain vehicles on land and small boats offshore. In addition, satellite images, Aerial photography and Light Detection and Ranging (LIDAR) are used to survey and quantify changes along the coast.
Differential Global Positioning Systems (DGPSs) are used to locate all data accurately.



Kolymbari- Chania, Crete (*HCMR, 2021*)



Processes to be considered in a Coastal Engineering Study (3/5)

- **Geology and Sedimentology**
  - ❖ **Geological structure and composition**
  - ❖ **Sediment distribution**
  - ❖ **Grain size, roundness and sphericity**
  - ❖ **Sediment budget and transport pathways**

Methodology: Geophysical instruments applied on land (ground-penetrating radar and Electrical Resistivity) and at sea (sidescan sonar and subbottom profilers) provide information on the distribution of sediments, thickness and structure of sediment beneath the beach and dunes.
Sediment budget, grain size, composition, and age are determined by direct sampling of offshore and onshore deposits.

Hard rocky coasts (61%)

Erosible rocky coasts (20%)

Depositional coasts (15,5%)

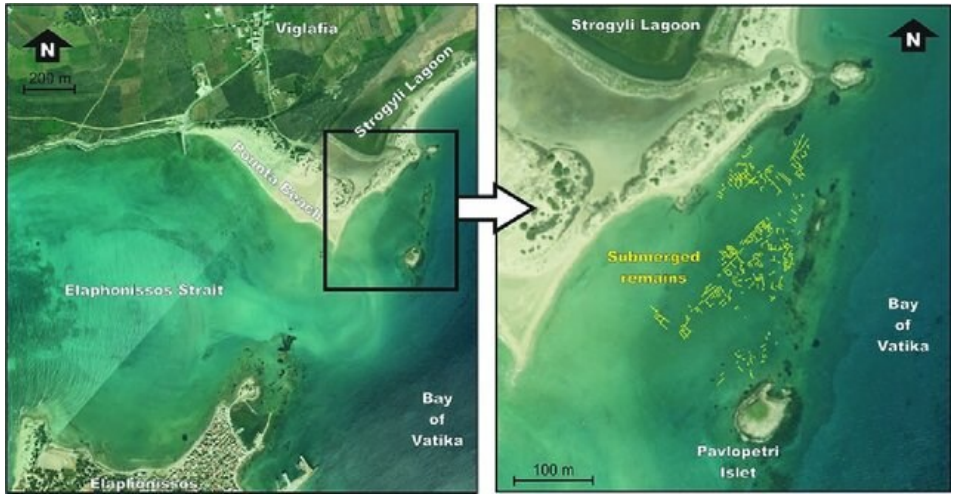
Artificial coasts (3,5%)

(*Vandarakis et al., 2023*)

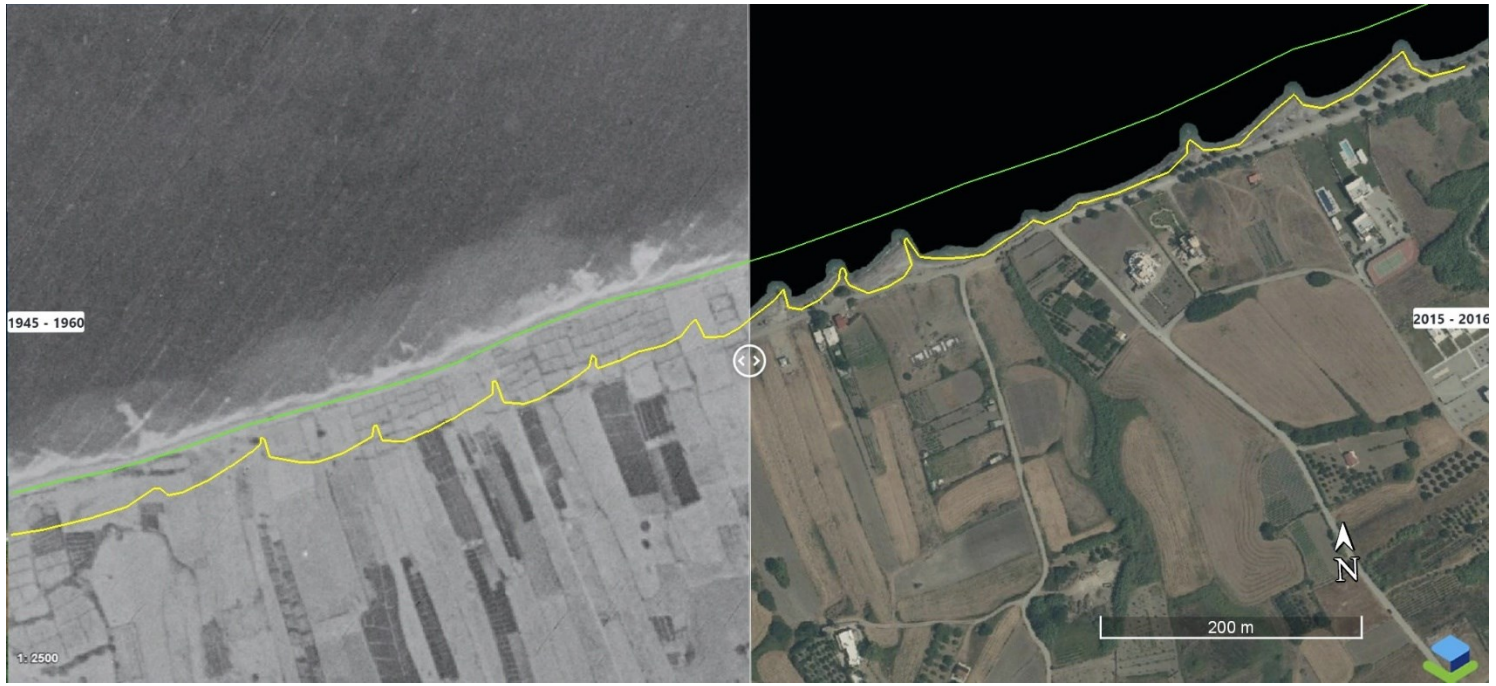
Processes to be considered in a Coastal Engineering Study (4/5)

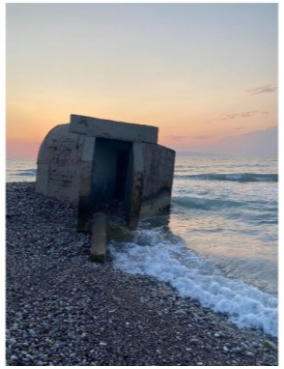
- **Built landscape**
  - ❖ **Ports and marinas**
  - ❖ **Coastal defense**
  - ❖ **Roads and bridges**
  - ❖ **Buildings**
  - ❖ **Coastal properties**
  - ❖ **Archaeological sites**

Pavlopetri, SE Peloponnese (*Galanidou et al., 2020*)



Methodology: Mapping of coastal infrastructure and other human interventions





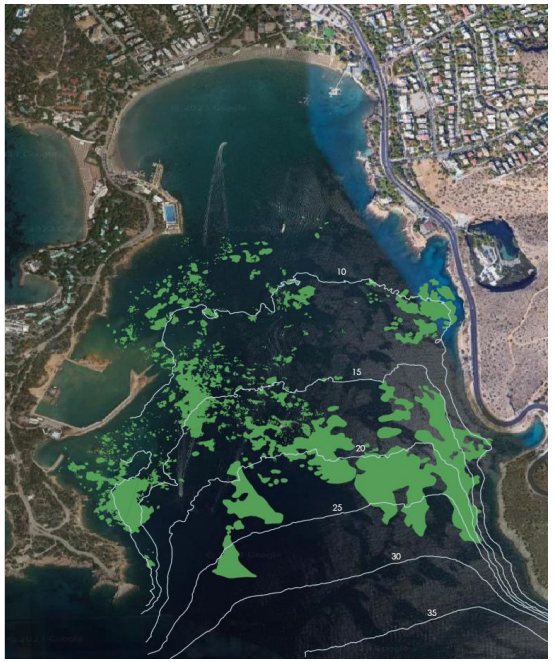
NE coasts of Rhodes Island (*Vadarakis et al., 2021*)

Processes to be considered in a Coastal Engineering Study (5/5)

- **Environmental status and perspectives**
  - ❖ **Coastal flora and fauna**

Coastal vegetation in Kyparissiakos Gulf, W Peloponnese

Methodology: Habitat mapping and determination of sensitive coastal ecosystems. Designation of protected areas.

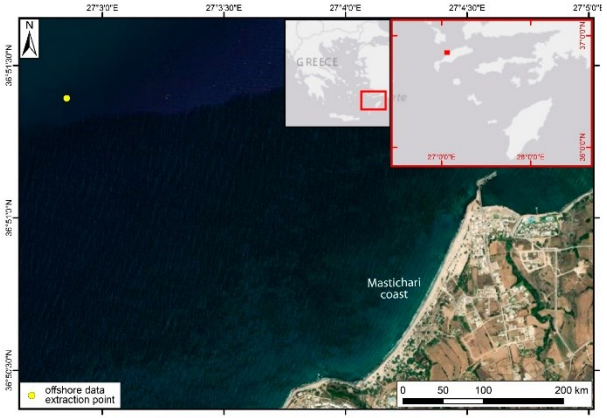


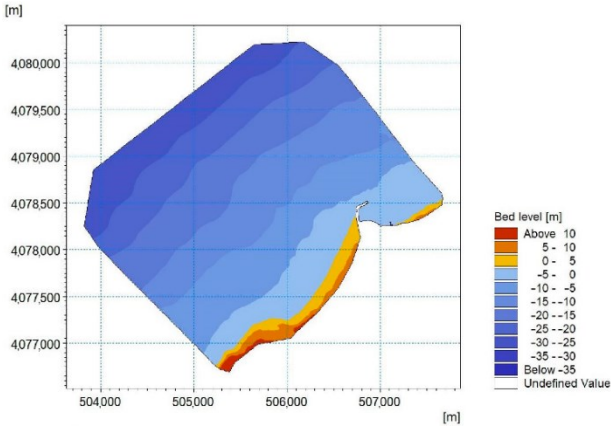
Seagrass meadow in the Vouliagmani Gulf, Attica (*HCMR, 2021*)

Simulation of the long-term Coastal Erosion

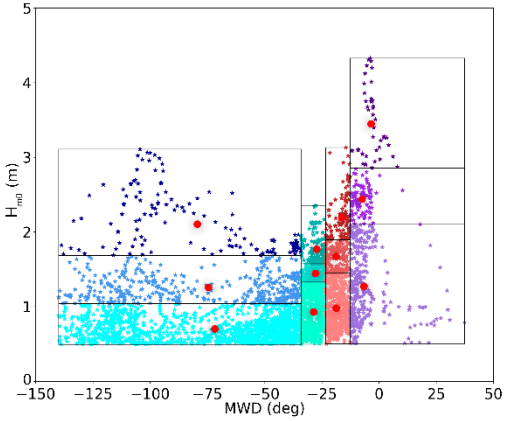
Assessment of the wave-induced currents, the net sediment transport and erosion & accretion patterns in coastal areas over a specified period (≥ 1 year).

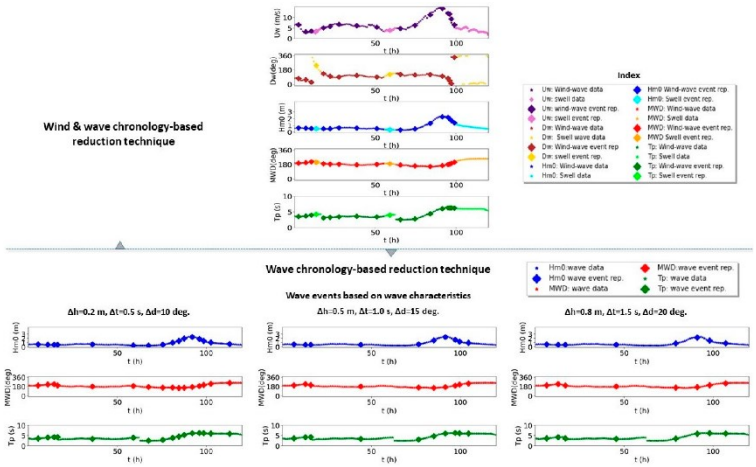
- Interannual and long-term sea states' variability: H_{m0}, T_p, MWD
- Methodology: Satellite image analysis, statistical analysis: extraction of wave scenarios through wave input reduction techniques, and numerical modeling

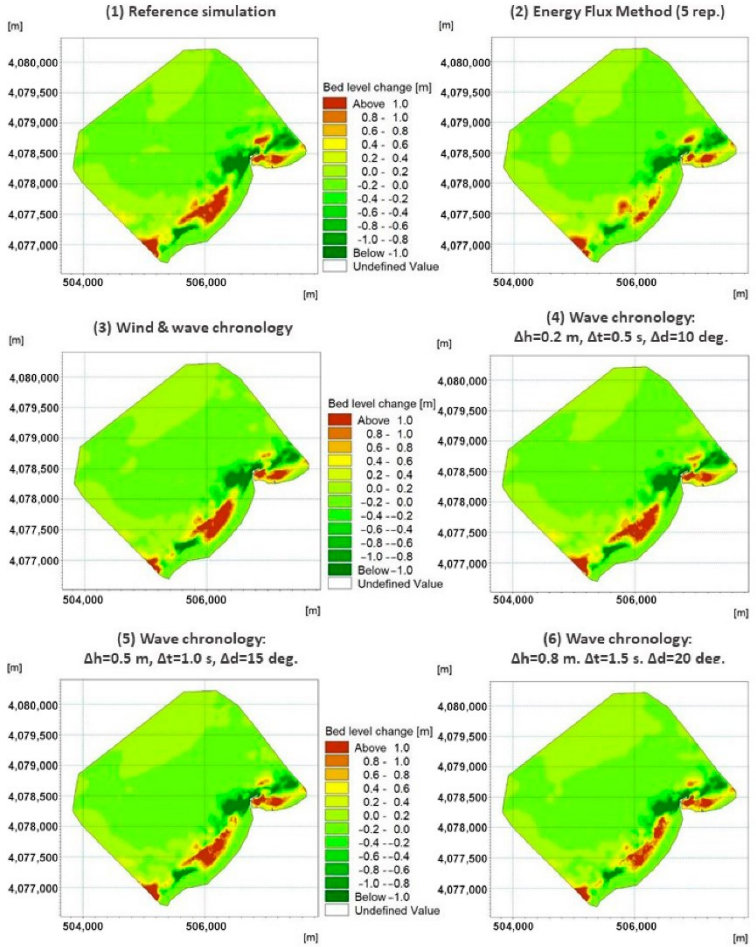




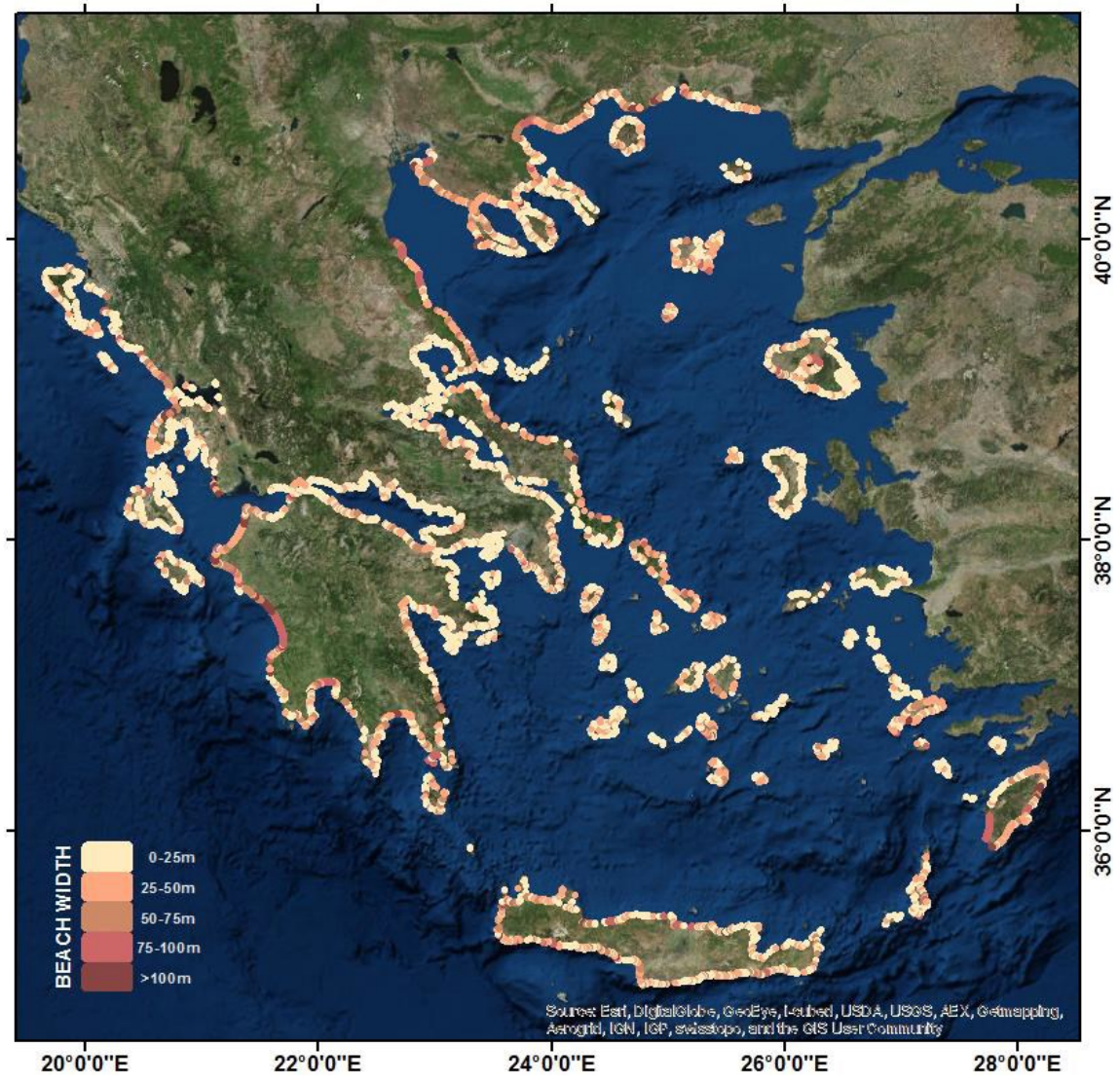
(*Malliouri et al., 2023, 2024*)







Greek shoreline and beaches



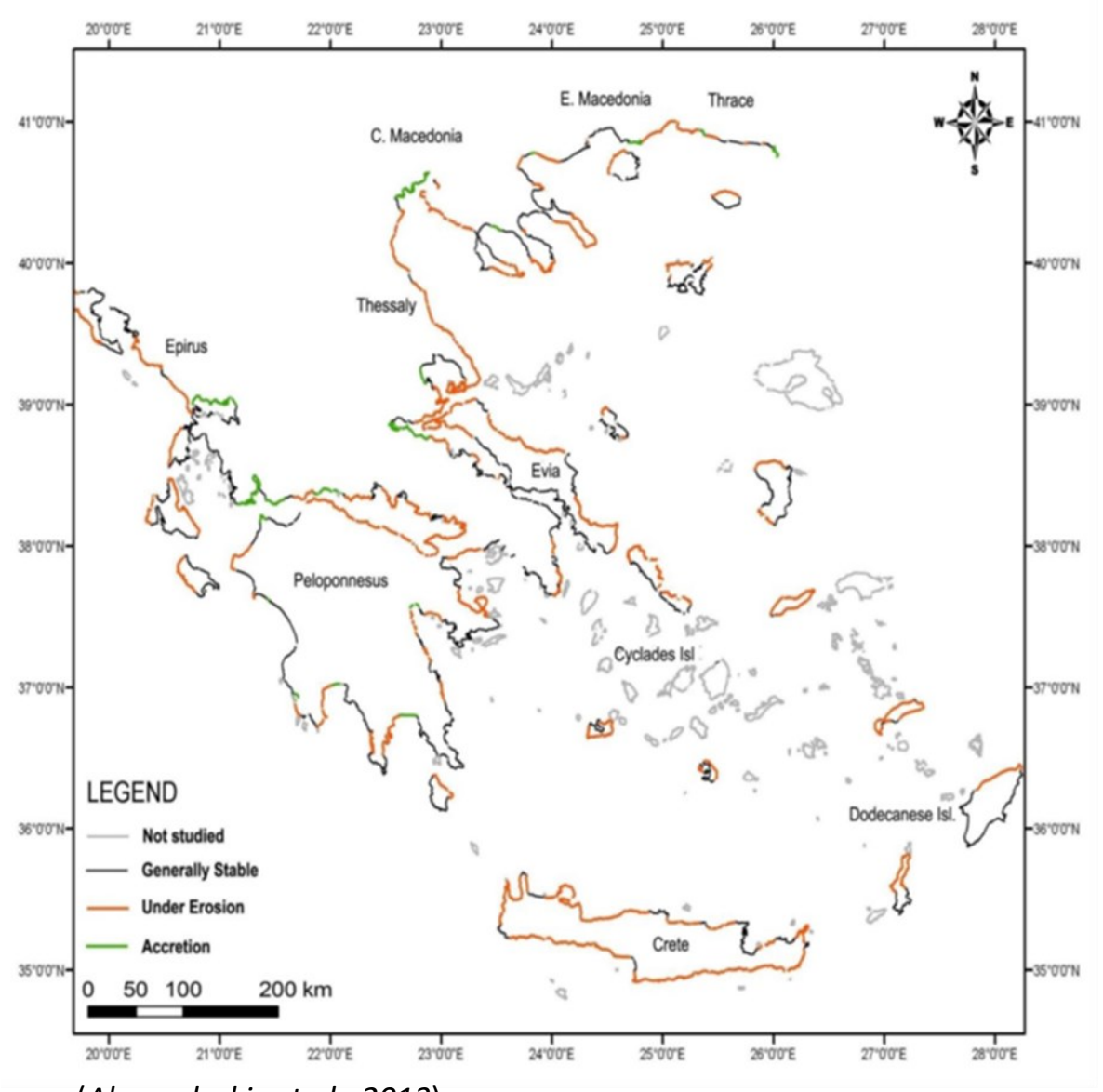
(*Alexandrakis et al., 2013*).

- **The total length of the Greek shoreline is 20.816 km** (*HNHS, 2018*)
- **7.500 beaches of a total surface are of 52 km²** have been recorded (*Karditsa et al., 2016*).
  67 % of the beaches are < 25 m wide,
  24% of beaches are 25-50 m wide, and
  9% of beaches are > 50 m wide

Pocket beach

Louros beach, W. Greece

Greek shoreline and beaches

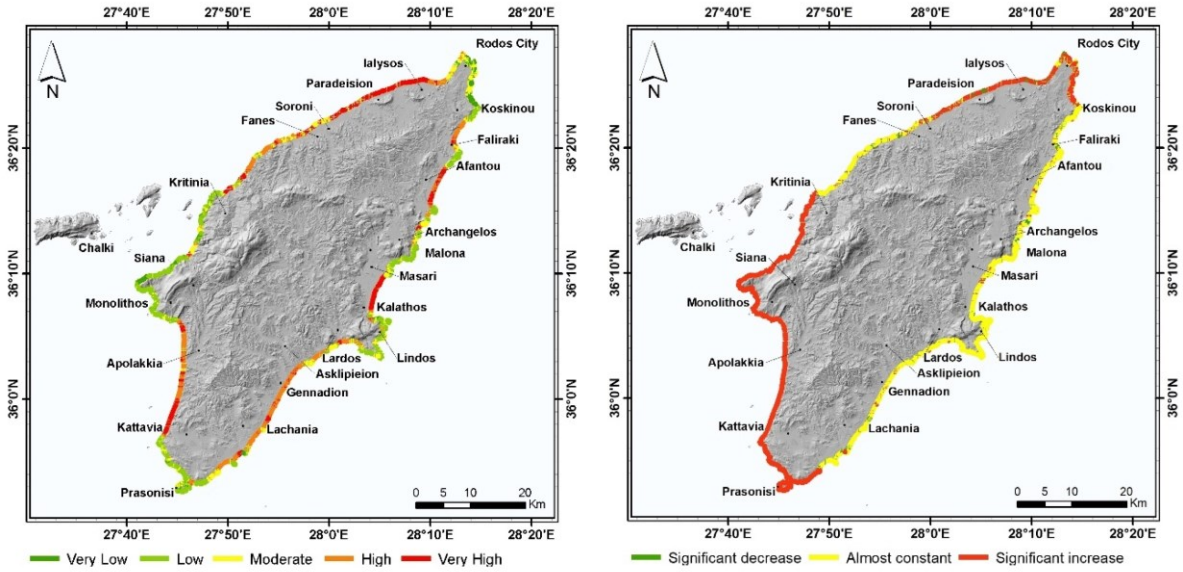


(*Alexandrakis et al., 2013*).

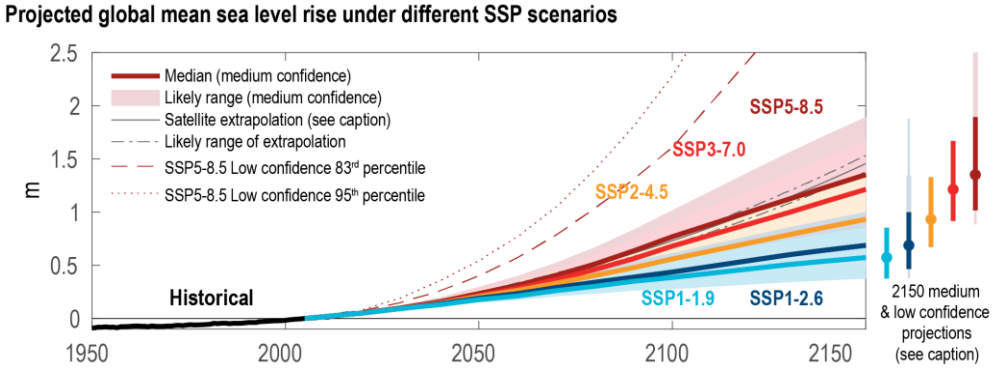
- **20% of the Greek shoreline is subject to retreat** (*HCMR, 2023*).
- In front of river mouths, a **shoreline retreat of > 100 m** has been recorded in relation to its position in 1945 (rate: >1 m per year) (*HCMR, 2015*).
- **30% of artificial coasts are eroding**, despite the existence of protective works (*Alexandrakis et al., 2011*).

Prediction of the shoreline retreat due to global sea level rise

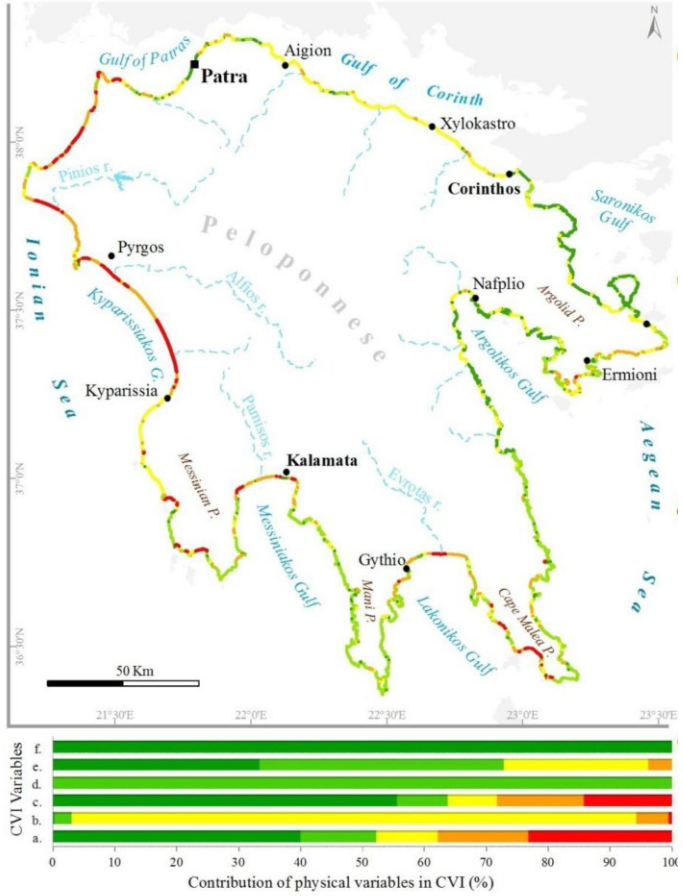
Assessment of the coastal vulnerability



(*Vandarakis et al., 2019*)



(IPCC, 2021)

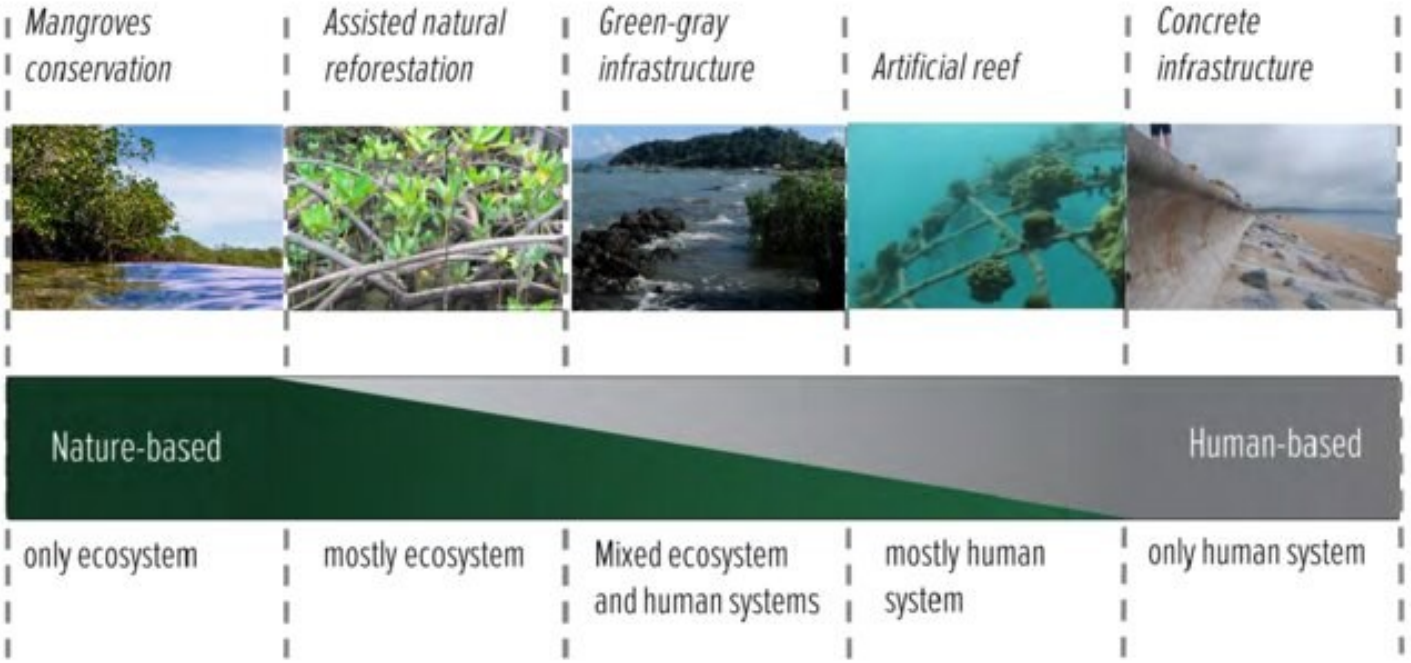


(*Tragaki et al., 2018*).

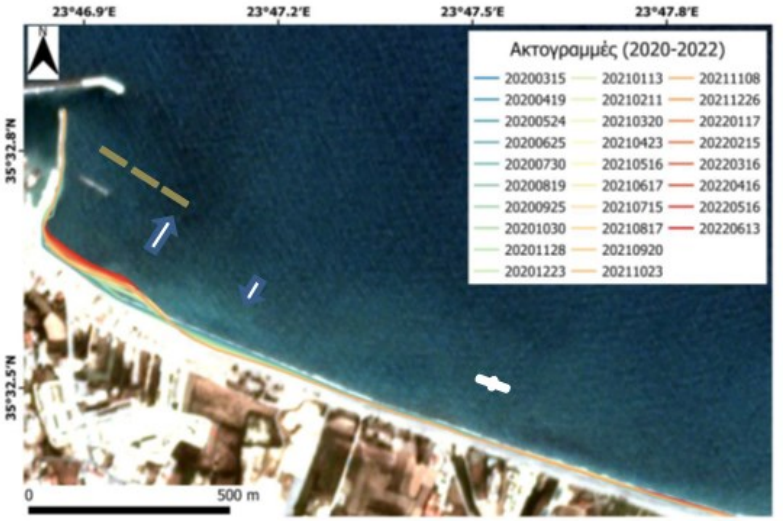
The total area of beaches predicted to be lost by 2100 due to sea level rise is estimated at 25.7% (13 km^2) (*Alexandrakis et al., 2011*).

Protection against coastal erosion

Available options



Kolymbari, Chania



(*Stouboudi et al., 2021*).

The selection of the final/optimal solution requires multi-level collaborations

Scientific community ⟷ **Authorities** ⟷ **Users-citizens**

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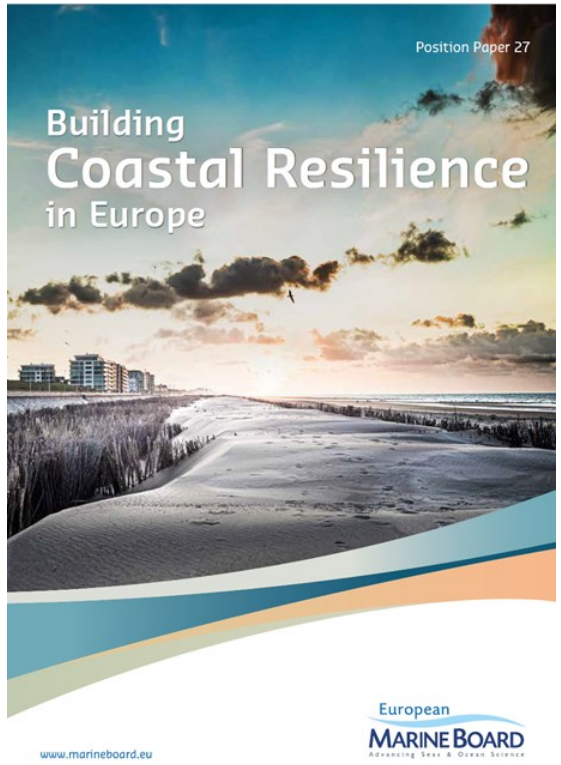
HCMR's strategic plan to build Coastal Resilience in Greece

- ***Determination of the long-term coastal erosion*** *by in situ surveys, measurements and application of mathematical models.*
- ***Quantifying nearshore wave and hydrodynamic processes****, such as wave runup and dune overtopping to assess coastal vulnerability to marine flooding.*
- ***Understanding the functioning and vulnerability of coastal ecosystems,*** *through the assess of the anthropogenic and climate pressures on biodiversity and blue carbon storage.*
- ***Suggest feasible solutions to face or mitigate coastal flooding and erosion*** *through open and continuous stakeholder consultation mechanisms.*
- ***Development and promotion of smart measures and actions, compatible with the "build with nature" concept*** *for improving coastal resilience and adapting to future climate-driven changes.*

… in accordance to …



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THANK YOU
FOR YOUR ATTENTION