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HERMES-3rd Open Workshop

COASTAL ZONE MANAGEMENT AND CLIMATE CHANGE AT LOCAL SCALE: THE HERMES PROJECT APPROACH

Introduction to the HERMES approach: Assessment and historic evolution of coastal erosion studies at the four pilot areas of the Hermes project

Prof. Georgios SYLAIOS
DEMOCRITUS UNIVERSITY OF THRACE

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

Wednesday, July 3, 2019
IGEWE Main Building, Don Bosko nr.60, Tirana

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Coastal Erosion and Sea Level Rise threaten Coastal Communities

- Coastal erosion is one of the highly growing environmental concerns faced by coastal communities.
- It is aggravated by the prospect of accelerated sea level rise due to climate change and accumulated negative effects of mismanagement practices.
- Over the past 100 years about 70% of the world's sandy shorelines have been retreating due to coastal erosion, while currently around 20% of EU coastline is eroding.

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Coastal Erosion – A process with Socio-economic Impacts

Coastal erosion is directly linked to economic losses due to coastal retreat and loss of land, ecological damage (especially of valuable coastal habitats) and societal problems.

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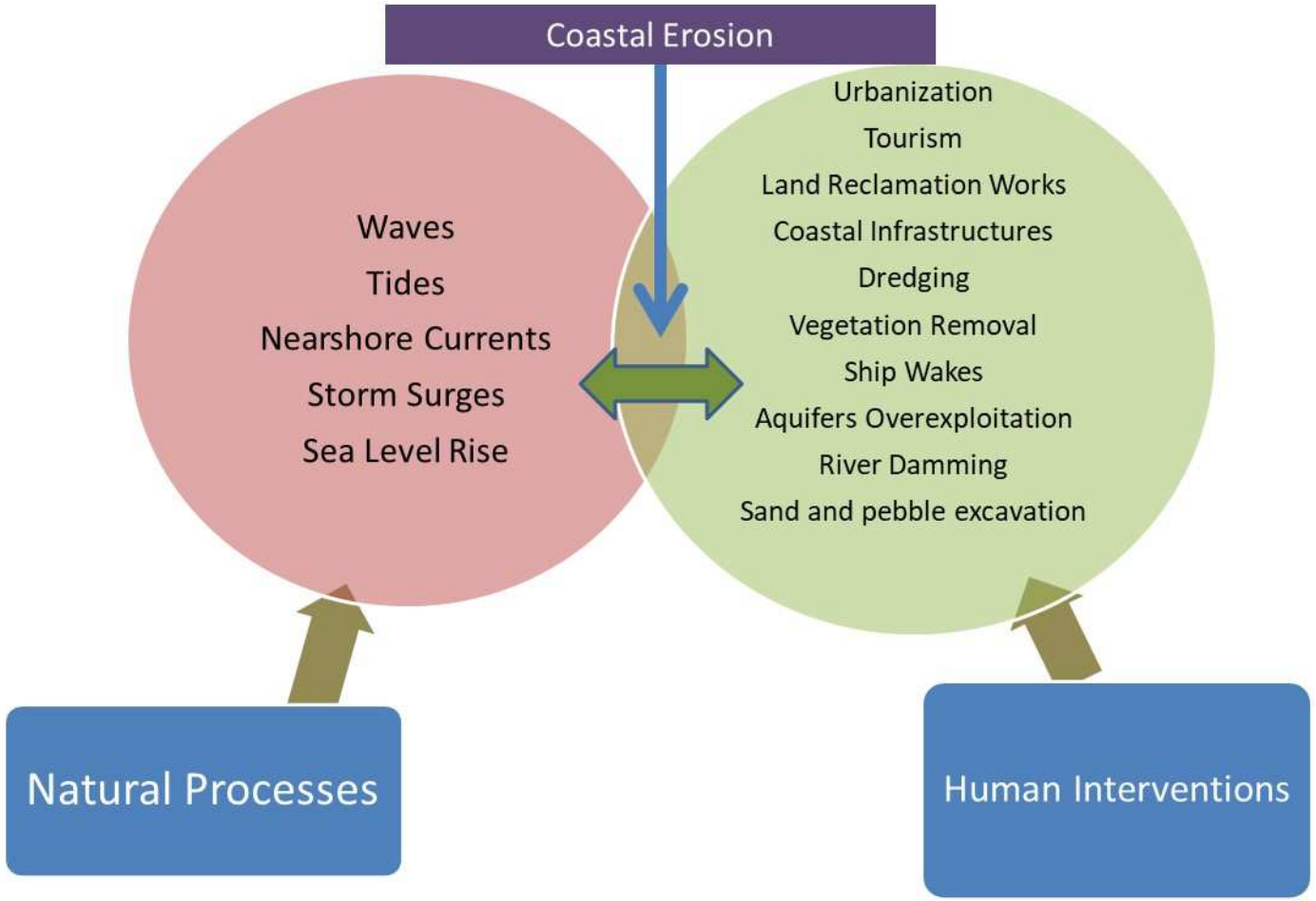

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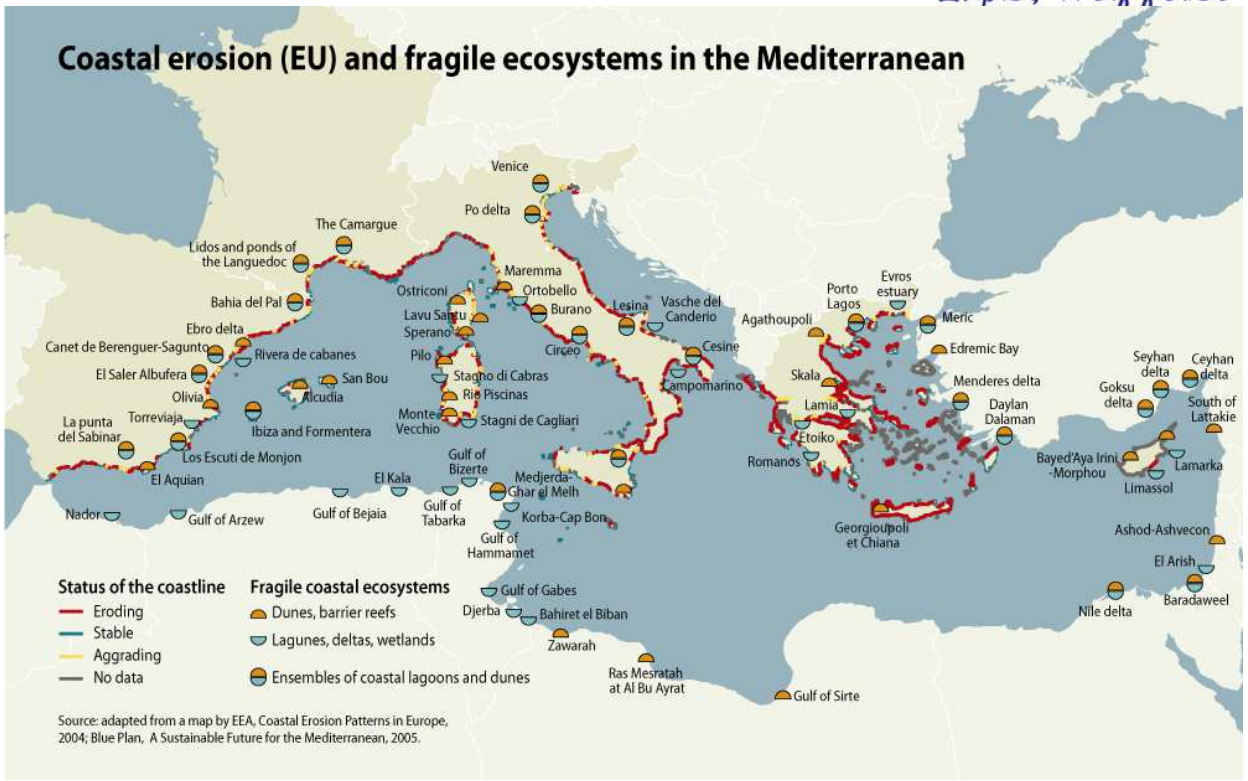

- In Mediterranean, erosion threatens 1/5 of coastlines at a rate of 0.5-2.0 m/y.
- Erosion threatens high ecological valued land of 47,500 Km^2.
- Presently only 5% of Med coastlines is protected by hard engineering structures.

Coastal Erosion Trends over BMP

In Greece almost 30% of coasts are eroding or appear as vulnerable to erosion.

In Cyprus this percentage reaches 38%.

In Bulgaria almost 71% of Black Sea beaches are eroding.

In Albania, a country with 420 km coastline coastal erosion is a significant issue for the northern and central parts.

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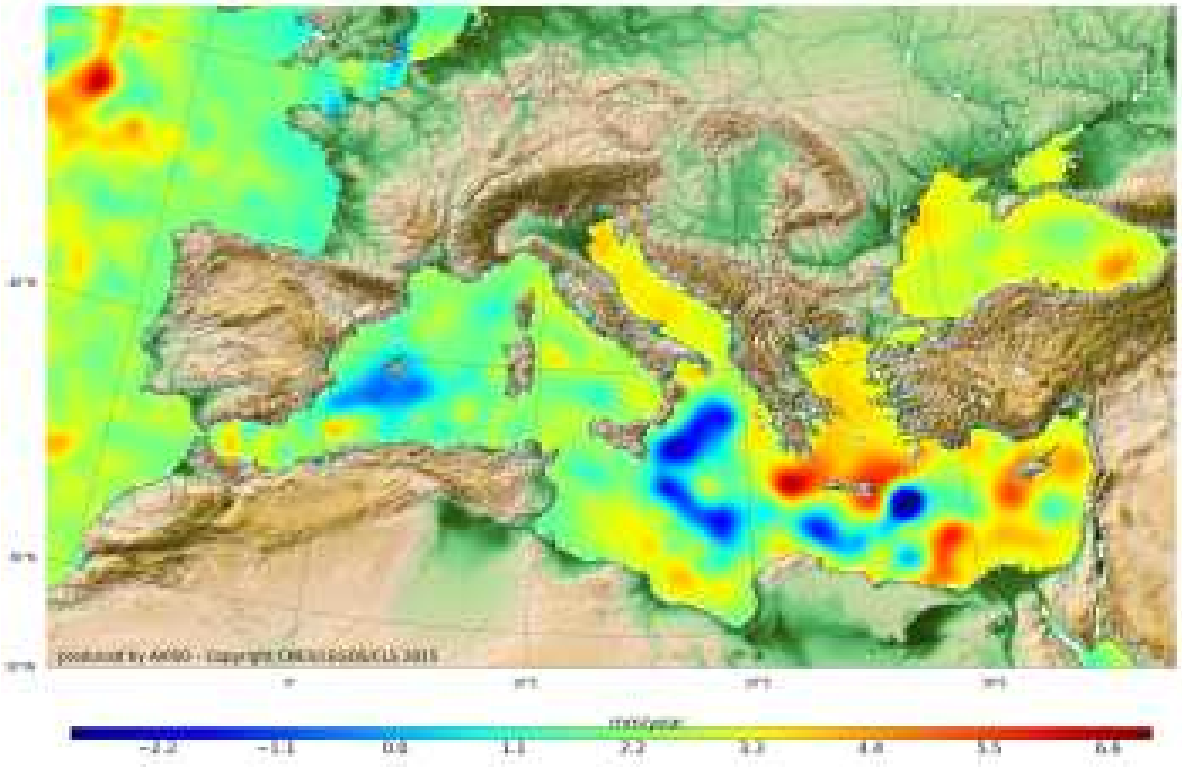

The sea level in the Eastern Mediterranean basin has risen significantly in recent years, apparently due to warmer water temperatures (observed by *in-situ* measurements).

Sea level trend (mm/year) in the Mediterranean for January 1993 to June 2014 (Credits Cnes/Legos/CLS).

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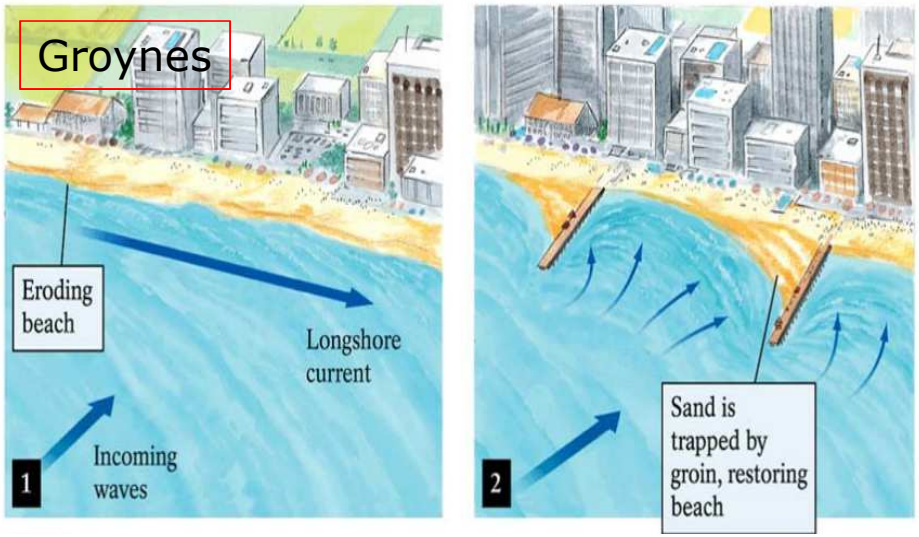
"HARD" ENGINEERING METHODS



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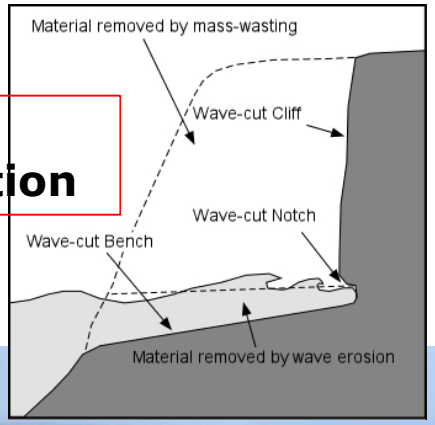
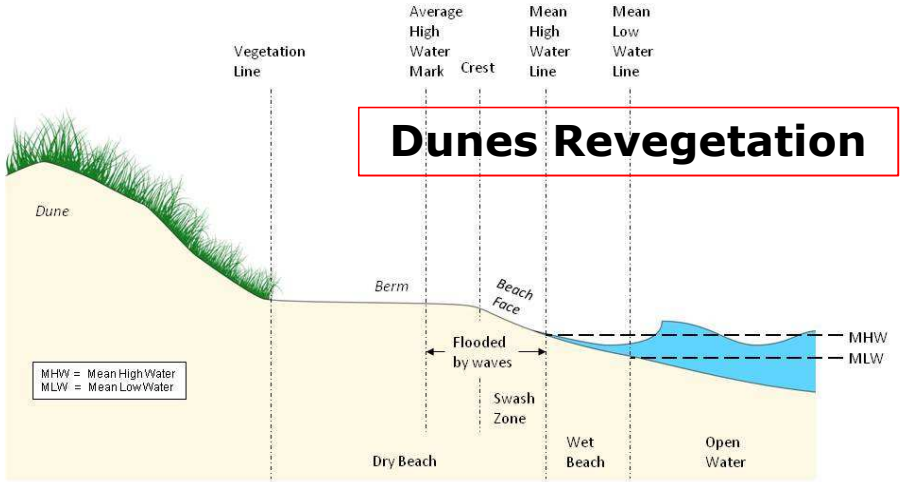
"SOFT" ENGINEERING METHODS

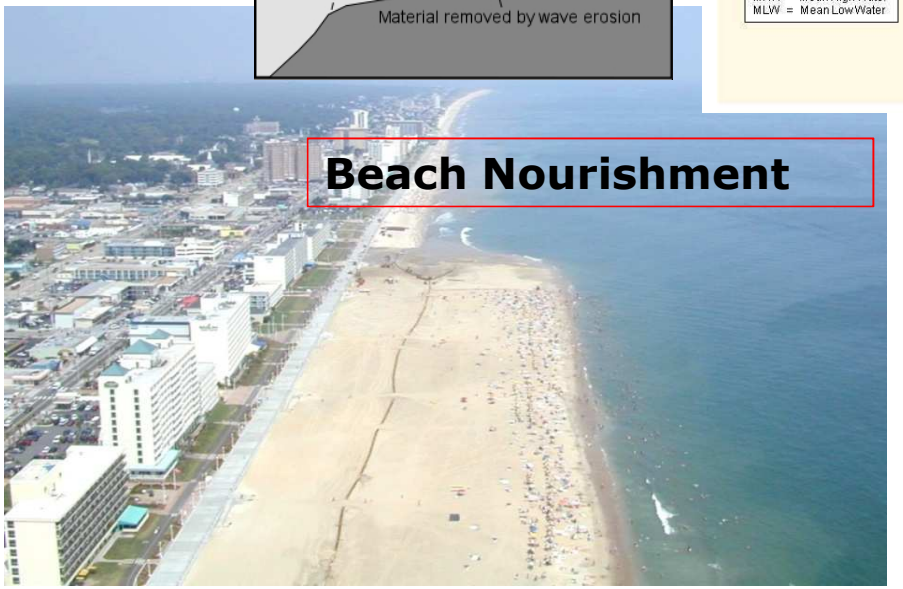
Cliffs Stabilization



Dunes Revegetation



Beach Nourishment



Dunes re-construction with Geotubes

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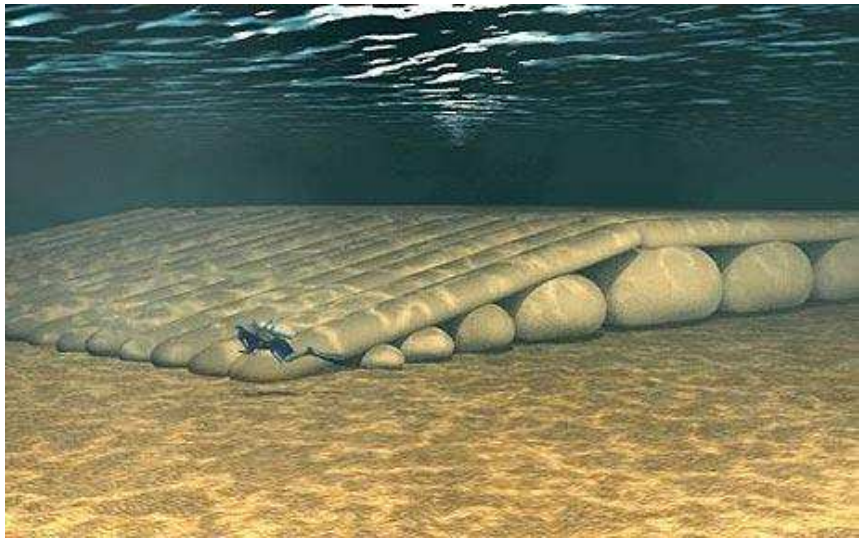

Geotubes submerged breakwaters

Beach nourishment works

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HERMES Project Framework

Interreg V-B BalkanMed 2014-2020 Program

Priority Axis 2: Environment

Specific Objective 2.2: Sustainable territories

Thematic Objective 6: Preserving and protecting the environment and promoting resource efficiency

Investment Priority 6f: Promoting innovative technologies to improve environmental protection and resource efficiency in the waste sector, water sector and with regard to soil, or to reduce air pollution

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HERMES Project Identity

Total Budget: 1,023,046.36 euros
Duration: 24 months
Starting Date: 28/8/2017
Ending Date: 27/8/2019

Partnership:

1. Municipality of Paggaio (GR, LP)
2. Democritus University of Thrace (GR)
3. ORION-Joint Research and Development Centre (CY)
4. Union of Bulgarian Black Sea Local Authorities (BG)
5. TEULEDA, Local Economic Development Agency (AL)
6. Tirana Metropolitan University (AL)
7. Union of Cyprus Municipalities (OBS)

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HERMES Main Message

HERMES aims to develop a unified and harmonized framework for coastal erosion mitigation and beach restoration covering the four partner countries (Albania, Cyprus, Greece and Bulgaria) through the implementation of a coherent ensemble of studies, the sharing of already developed technical tools and the design of joint policy instruments.

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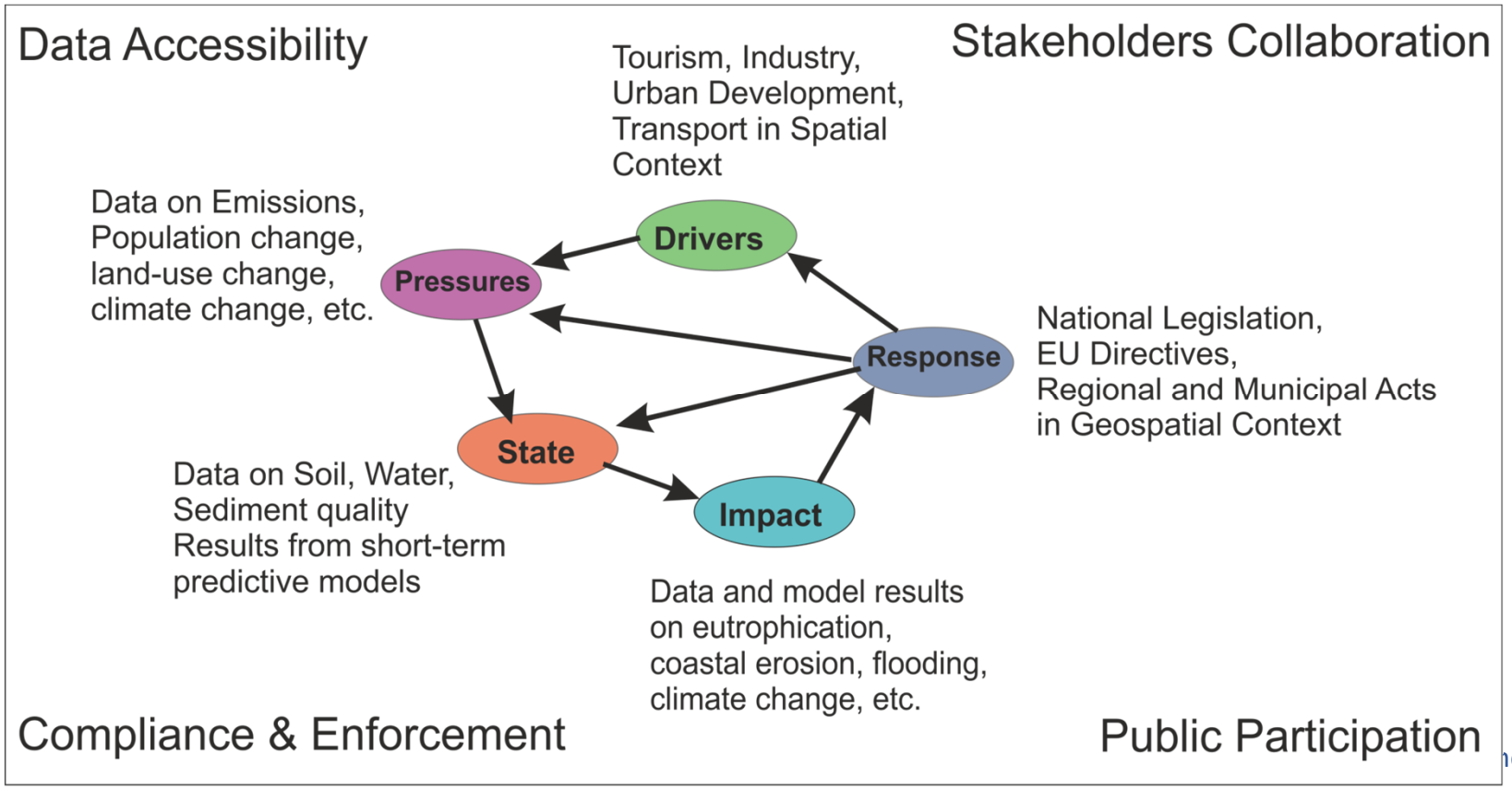
4 Pillars of HERMES Integrated Approach



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HERMES Expected Results

HERMES will aid coastal stakeholders to harmonize and adapt to the most relevant EU policies on coastal zones, as CC, Integrated Maritime Policy, Maritime Spatial Planning, ICZM, Marine Strategy and Water Framework Directives, Inspire, etc.

Coastal municipalities and regional authorities, coastal users, local and international NGOs, landowners and businesses situated in or near coastal areas will benefit from HERMES project outputs.

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HERMES Methodological Approach

Four study sites will be established and extensively studied.
At each HERMES site partners will

- share common standards for coastal and marine dynamics and erosion phenomena evaluation;
- adopt common strategies in coastal monitoring and surveys;
- device common indicators for coastal management and preservation actions;
- apply common tools for erosion-protection scenario building;
- promote environmental-friendly technologies (‘soft’ techniques) to tackle coastal erosion.

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HERMES Study Sites

a) **The coastline of Paggaion Municipality**, Northeastern Greece, a coastline of 45 km length where erosion is very crucial as tourism is affected and coastal infrastructures are damaged under extreme waves;

b) **The coastline of Larnaka-Zygi**, located along the south coast of Cyprus, particularly impacted by anthropogenic interventions (development, tourism, fisheries, industry) exhibiting strong erosion signs;

c) **the coastline from Cape Galata to Cape Emine**, representing a single coastal cell at the central part of the Bulgarian Black Sea coast. There are both large stable beaches and smaller heavily eroded beaches;

d) **the coastline from the northern border of Albania to near the Mat River delta**, where coastal erosion had the harshest effects with the sea advancing up to 500 meters inland in the last 15 years, swallowing beaches, forests and land, increasing salt water intrusion, damaging touristic investments on the seashore, and destroying wetlands and lagoons.

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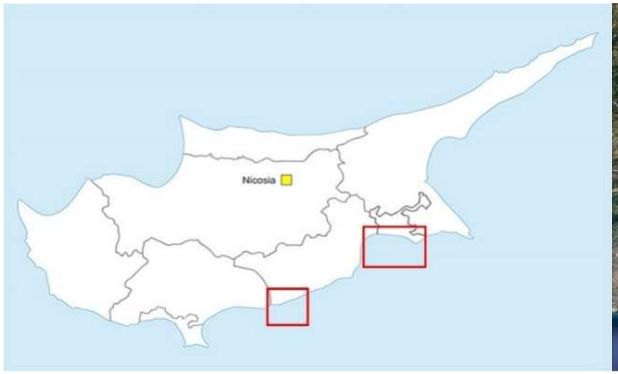
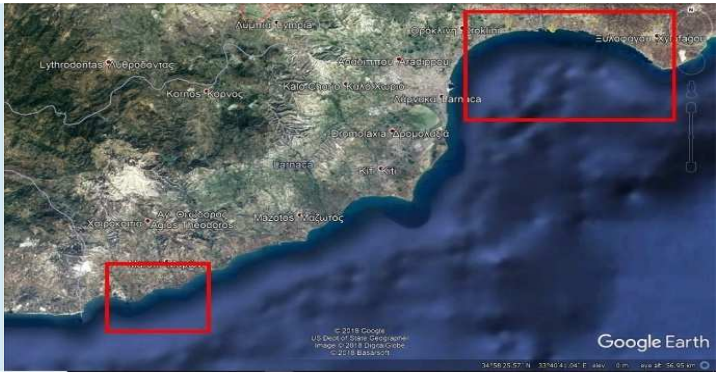
Site Name	Length (km)	Lat	Long	Lat	Long
Paggaion-Ammolofi to LoutraEleftheron (GR)	20	40°49’00.86’’N	24°18’33.90’’E	40°43’28.19’’N	24°05’49.71’’E
Paggaion-Kariani (GR)	16.3	40°43’04.85’’N	24°02’43.03’’E	40°46’40.85’’N	23°52’15.02’’E





Site Name	Length (km)	Minimum Latitude	Minimum Longitude	Maximum Latitude	Maximum Longitude
Zygi (CY)	5	34º43’13"N	33º19’43.06"E	34º43’51.79"N	33º22’09.26"E
Oroklini-Ormideia(CY)	25	34º56’55"N	33º38’56.43"E	34°56'36.52"N	33°51'27.66"E

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The Albanian pilot sites

Site Name	Length (km)	Minimum Latitude	Minimum Longitude	Maximum Latitude	Maximum Longitude
Buna (AL)	3	41°50'52.2"N	19°22'40.6"E	41°51'41.0"N	19°24'54.9"E
Shëngjin (AL)	6.5	41°48'20.5"N	19°35'55.3"E	41°45'07.8"N	19°34'28.1"E
Kune-Mat (AL)	10	41°44'55.2"N	19°34'19.4"E	41°38'29.8"N	19°34'17.4"E

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The Bulgarian pilot sites

Site Name	Length (km)	Minimum	Minimum	Maximum	Maximum
Galata cape (BU)	3	43°7'38.09''N	27°55'50.17''E	43°6'3.47''N	27°55'24.44''E
Pomorie – Aheloy beach (BU)	10	42°33'20.21''N	27°39'2.63''E	42°38'12.73''N	27°39'19.92''E
Byala beach (BU)	3.5	42°53'12.26''N	27°54'6.05''E	42°51'15.27''N	27°54'9.94''E
Burgas beach (BU)	5	42°29'17.16''N	27°28'56.04''E	42°31'56.53''N	27°29'34.60''E
Kranevo coast (BU)	3.5	43°19'55.75''N	28°4'0.50''E	43°18'12.00''N	28°3'7.90''E

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HERMES Action Plan

At each study site the following actions will be undertaken:

a) historic coastline retreat will be evaluated (satellite and Google Earth images);
b) erosion and climate change vulnerability indicators will be valued;
c) the relative influence of human interventions (river damming, illegal sand mining, uncontrolled urbanization, ports, etc) will be assessed;
d) existing environmental and socio-economic data will be integrated into a coastal web-based PPGIS,
e) a modeling toolkit (meteorologic, hydrodynamic, wave and morphodynamic) will be developed;
f) a monitoring station of coastal waves and currents will be installed developing a network of observing structures on erosion, storms impact and CC influence;
g) using the morphodynamic model results a series of intervention scenarios will be tested and evaluated with emphasis on the promotion of environmental-friendly technical works for coastal restoration.
h) HERMES Training Pack - Seminars and workshops

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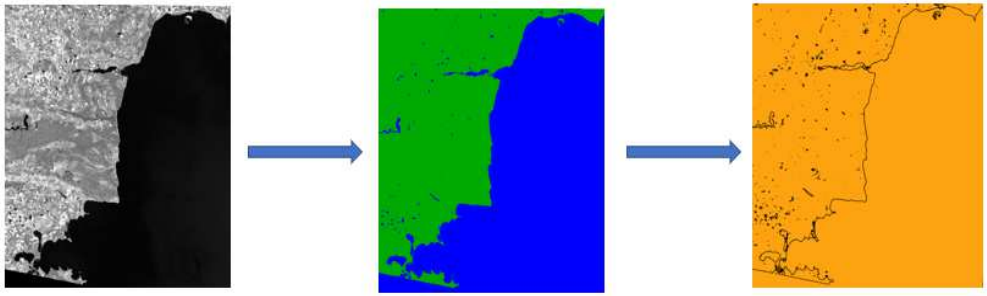
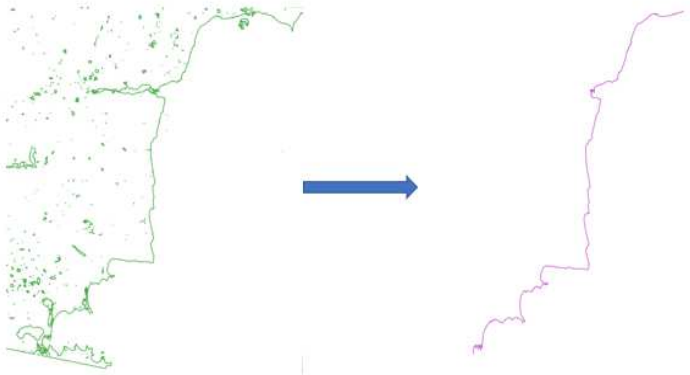


Landsat Image - Band 5 | Classified Image (Land - Sea) | Raster to Vector



Shoreline Extraction | Smoothed Shoreline

Shoreline extraction using the SCP tool in QGIS

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Historical Satellite Imagery parameters – Landsat System

Country	Data Set	Resolution	Date	Path	Row	Projection System
Albania	LANDSAT TM MOSAICS	28.5 m grayscale	1986	186	31	UTM/WGS 84/ Datum 34 North
	LANDSAT TM	28.5 m grayscale	1992	186	31	UTM/WGS 84
	LANDSAT ETM+	14.25 m grayscale	2002	186	31	UTM/WGS 84
Bulgaria	LANDSAT 1-5 MSS	60m grayscale	5/9/1972	196	30	UTM/WGS 84
	LANDSAT 4-5 TM C1 Level-1	28.5m grayscale	21/7/1984	181	30	UTM/WGS 84
	LANDSAT 4-5 TM C1 Level-1	28.5m grayscale	28/6/1993	181	30	UTM/WGS 84
	LANDSAT 7 ETM+ C1 level-1	14.25m grayscale	12/5/2002	181	30	UTM/WGS 84
	LANDSAT 8 ETM+ C1 level-1	14.25m grayscale	12/5/2013	181	30	UTM/WGS 84
Cyprus	LANDSAT 1-5 MSS	60m grayscale	9/5/1973	189	36	UTM/WGS 84
	LANDSAT 4-5 TM C1 Level-1	28.5m grayscale	13/4/1984	176	36	UTM/WGS 84
	LANDSAT TM	28.5m grayscale	4/8/1990	176	36	UTM/WGS 84
	LANDSAT 7 ETM+ C1 level-1	14.25m grayscale	18/8/2002	176	36	UTM/WGS 84
	LANDSAT 8 ETM+ C1 level-1	14.25m grayscale	29/4/2013	176	36	UTM/WGS 84
Greece	LANDSAT TM	28.5 m grayscale	1989	183	32	UTM/WGS 84
	LANDSAT ETM+	14.25 m grayscale	2000	183	32	UTM/WGS 84
	LANDSAT ETM+	14.25 m grayscale	2006	183	32	UTM/WGS 84

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Historical Satellite Imagery parameters – Google Earth

Country	Coastline	Data Set	n. Snapshots/ GeoTIFF	Dates	Stitching zoom/elevation	Projection System
Albania	Buna (AL)	Satellite Google Maps	1	2008, 2013, 2017	20/ 800m	Mercator/WGS84/EPSG:3395
	Shëngjin (AL)	Satellite Google Maps	4	2013, 2017	20/ 800m	Mercator/WGS84/EPSG:3395
	Kune-Mat (AL)	Satellite Google Maps	6	2013, 2017	20/ 800m	Mercator/WGS84/EPSG:3395
Greece	Paggaion-Ammolofi to LoutraEleftheron (GR)	Satellite Google Maps	5	2008, 2017	20/ 800m	Mercator/WGS84/EPSG:3395
	Paggaion-Kariani (GR)	Satellite Google Maps	4	2008, 2017	20/ 800m	Mercator/WGS84/EPSG:3395

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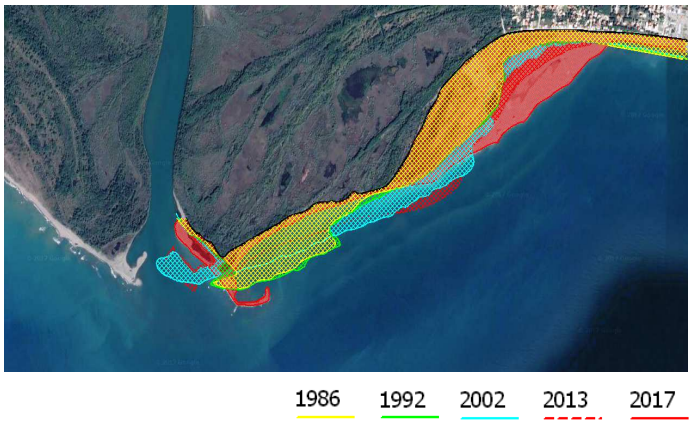

Historical satellite imagery-Coastline position Buna – Albania

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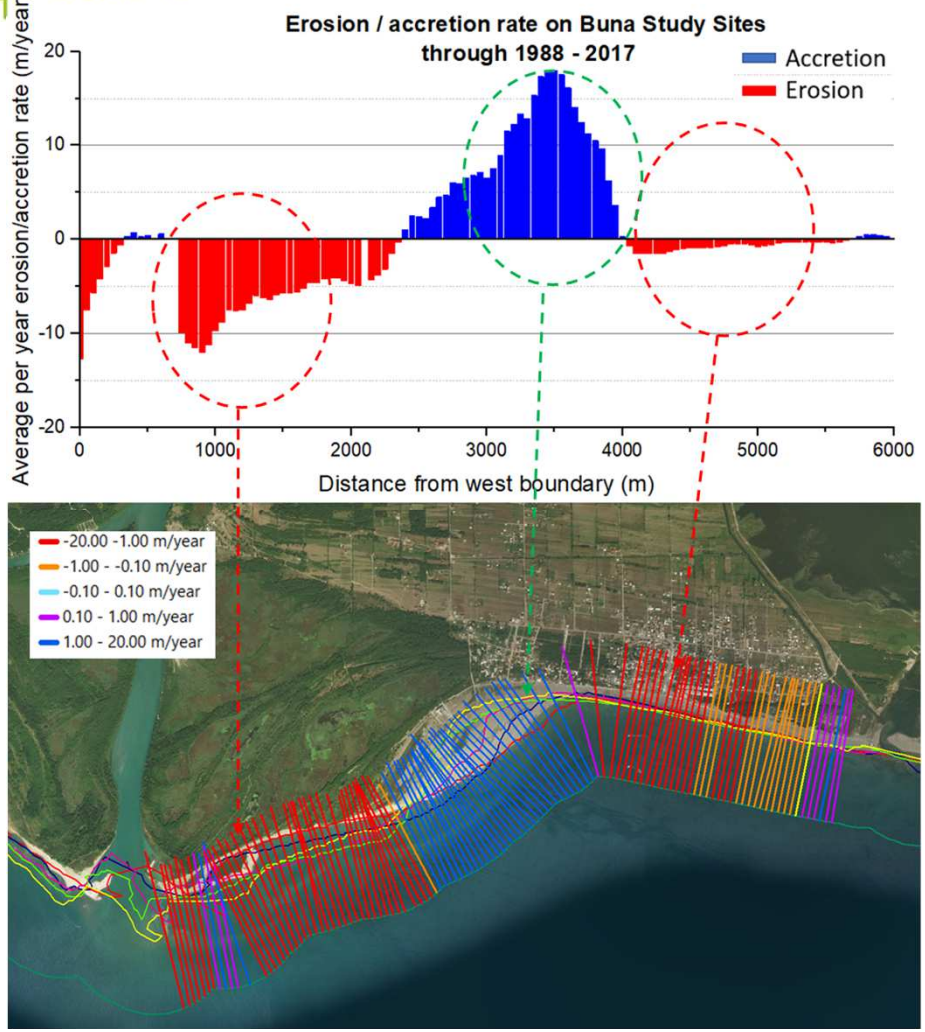

Average of annual erosion and accretion rates in Buna study site for the period 1988 – 2017.

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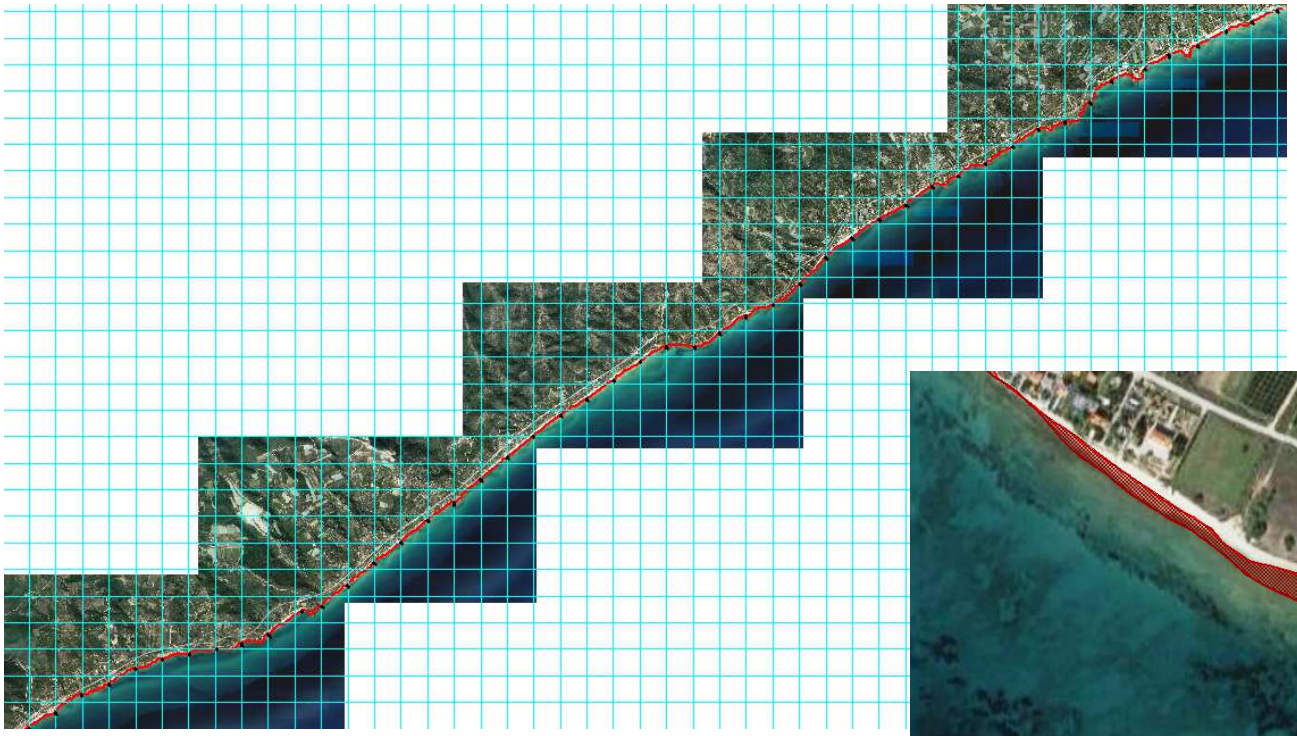
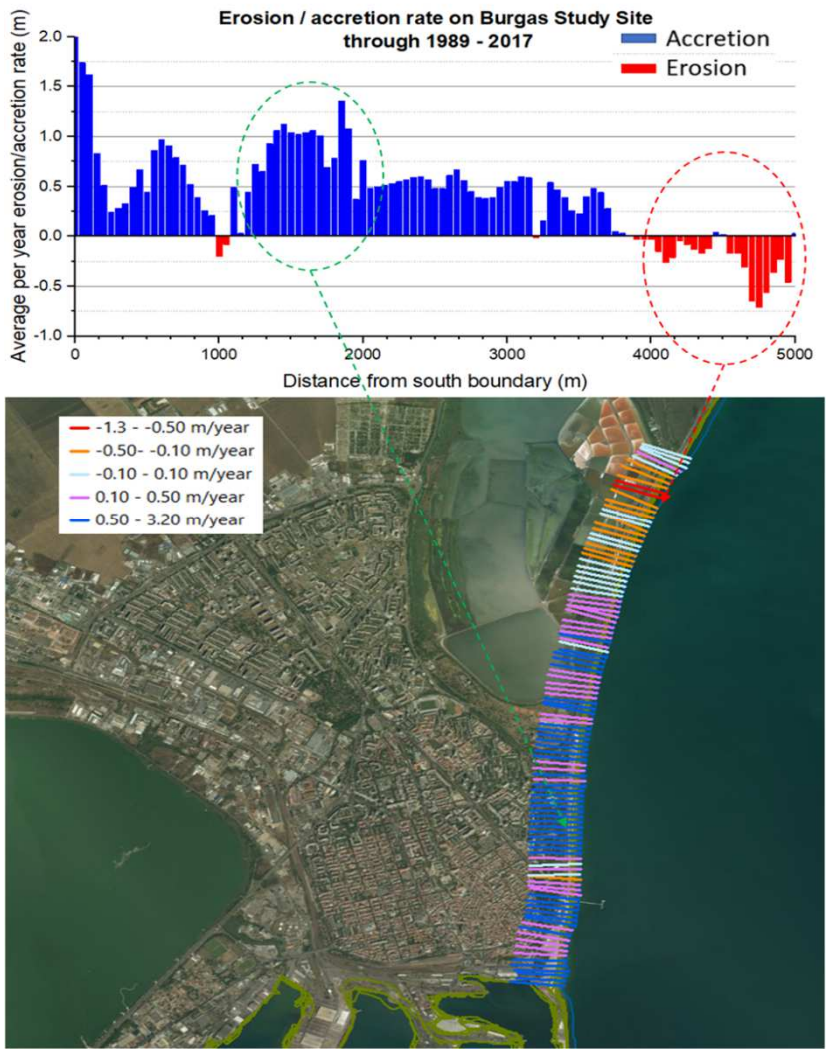
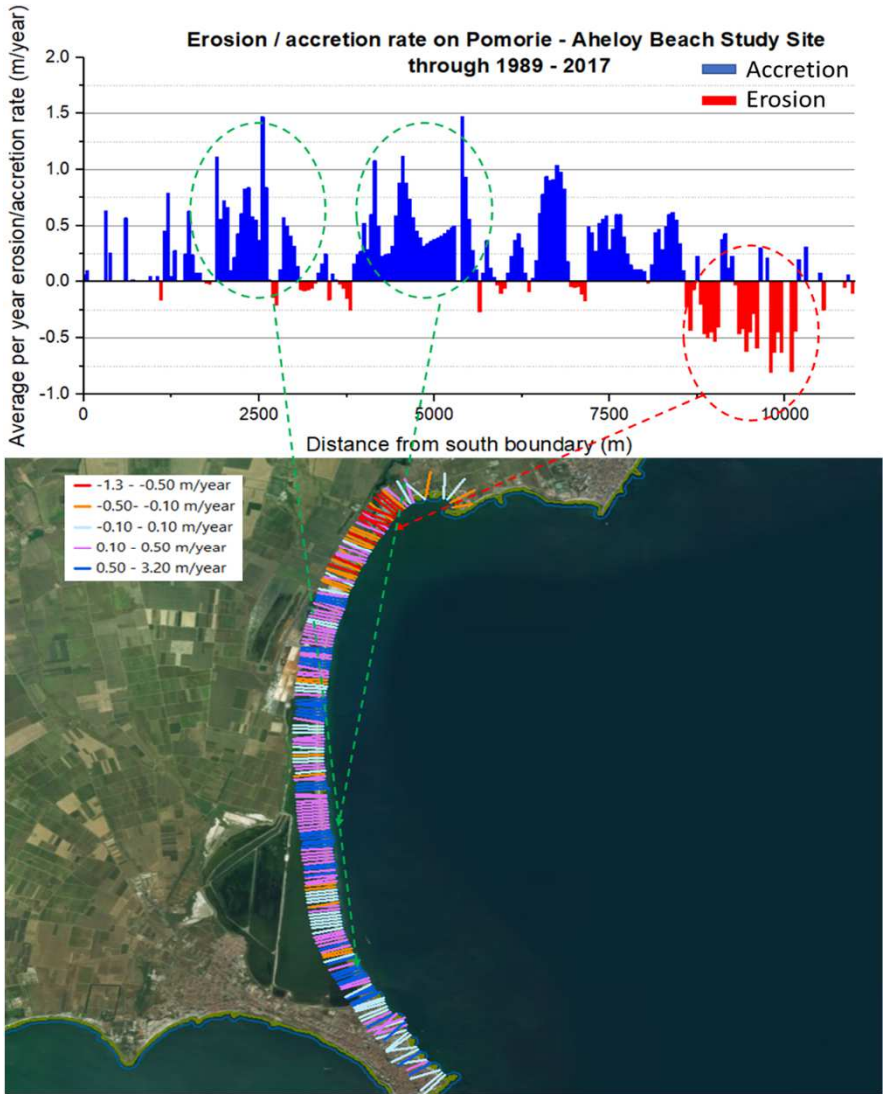


Historic satellite imagery digitized coastlines with the application of the grid and transects – Kariani

Average of annual erosion and accretion rates in Burgas study sites for the period 1989 – 2017



Average of annual erosion and accretion rates in Pomorie - Aheloy Beach study sites for the period 1989 – 2017.



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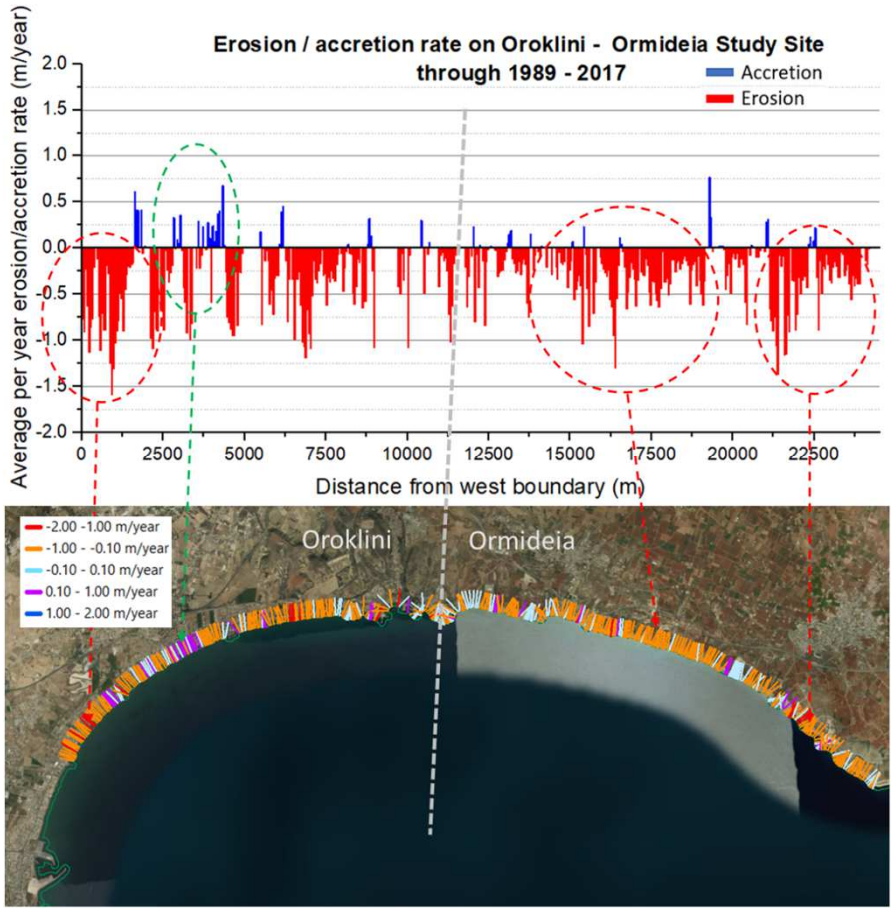
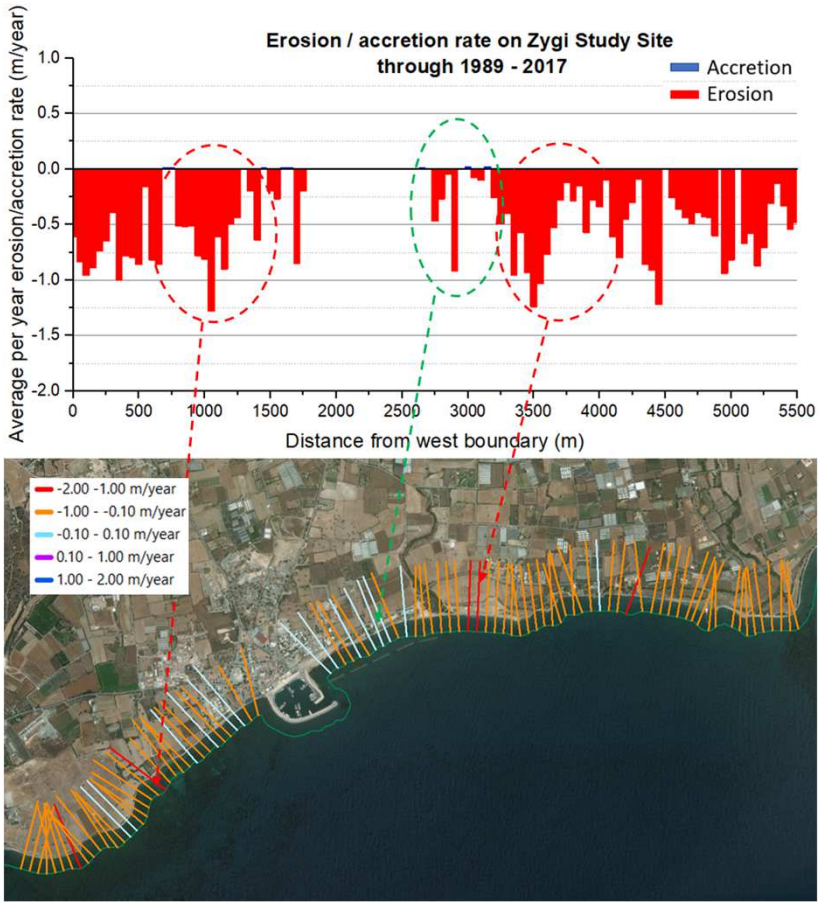


Average of annual erosion and accretion rates in Oroklini and Ormideia study sites for the period 1989 – 2017



Average of annual erosion and accretion rates in Zygi study sites for the period 1989 – 2017

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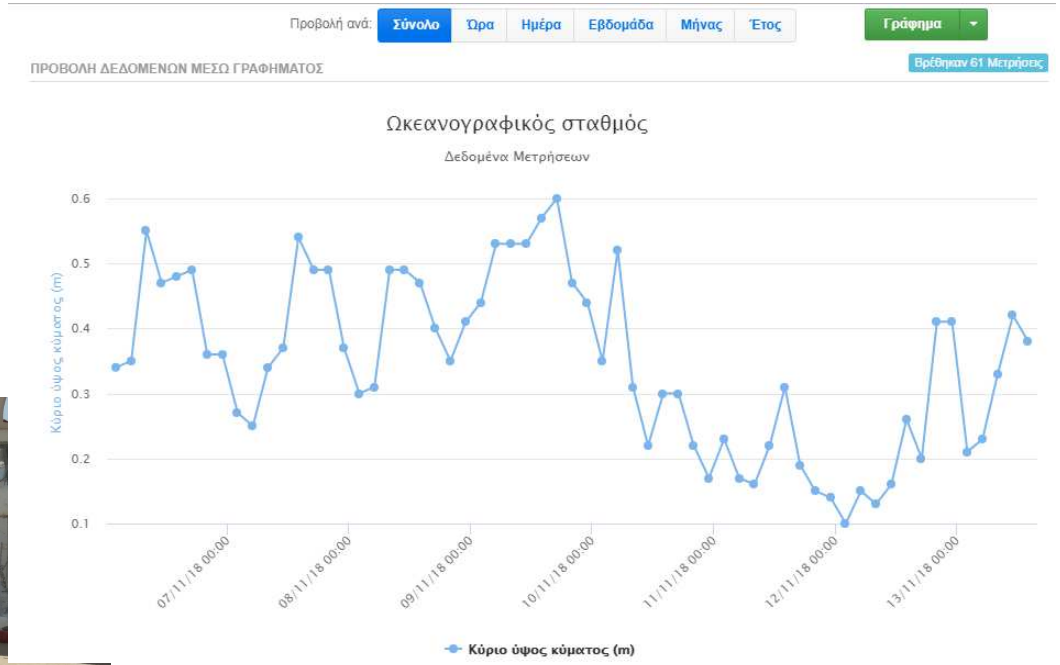
On-line data open and freely available to all stakeholders



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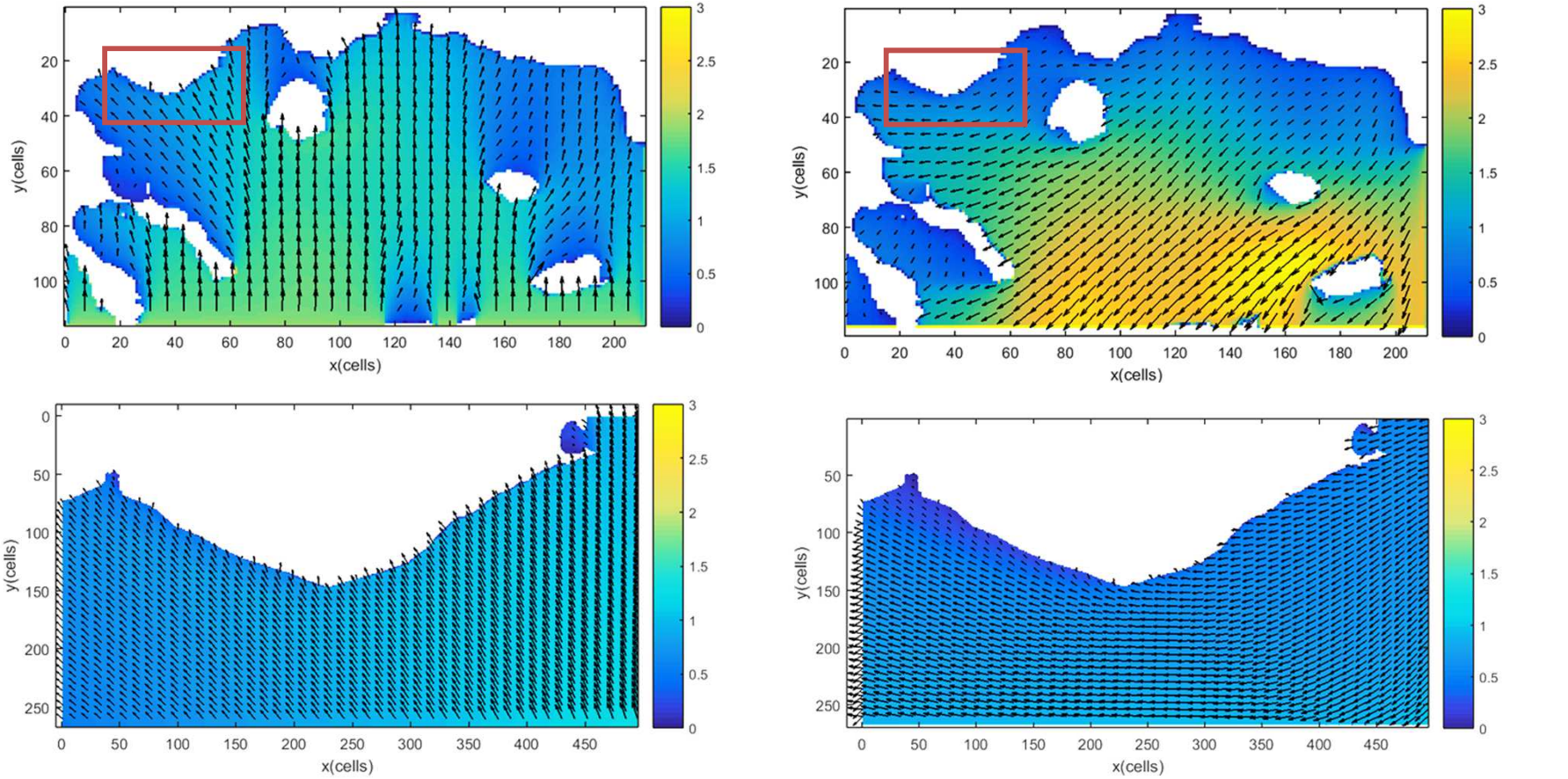

SWAN wave model implementation along Paggaion Municipality shoreline

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Table 18. Socio-economic Vulnerability Index assessment for Paggaio Municipality.

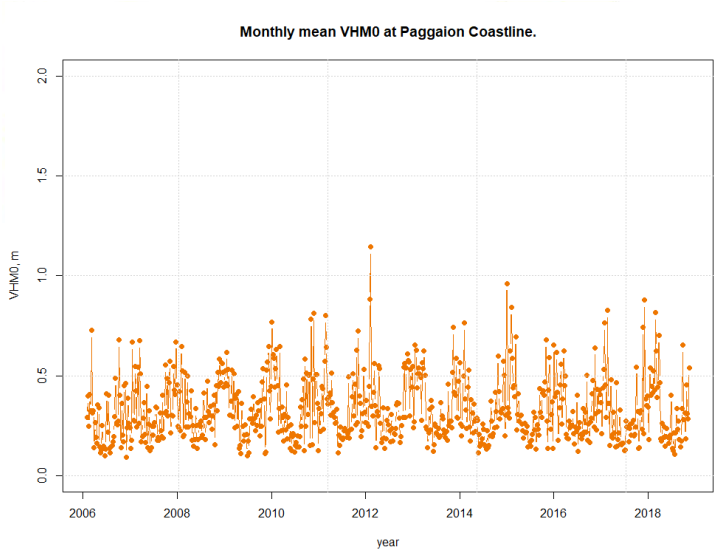
Variables	Categories				
	1	2	3	4	5
	Very Low	Low	Moderate	High	Very High
Settlement (SET)			X		
Cultural Heritage (SH)			X		
Transportation Network (TN)		X			
Land Use (LU)		X			
Economic Activities (E)					X

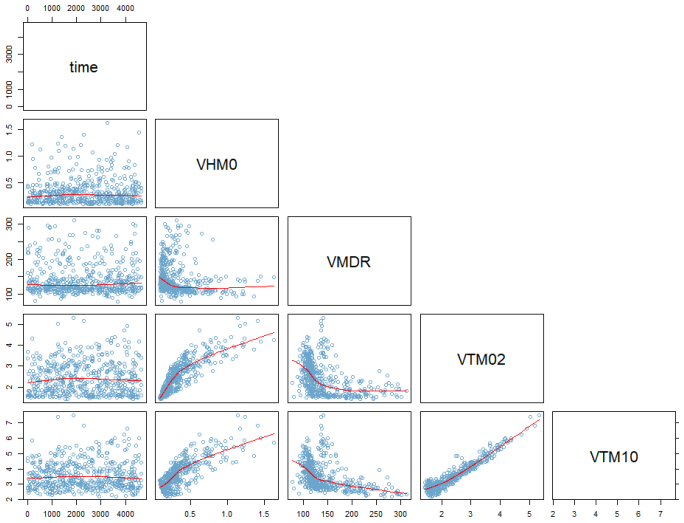
Following the above ranking, SocCVI may be estimated as:

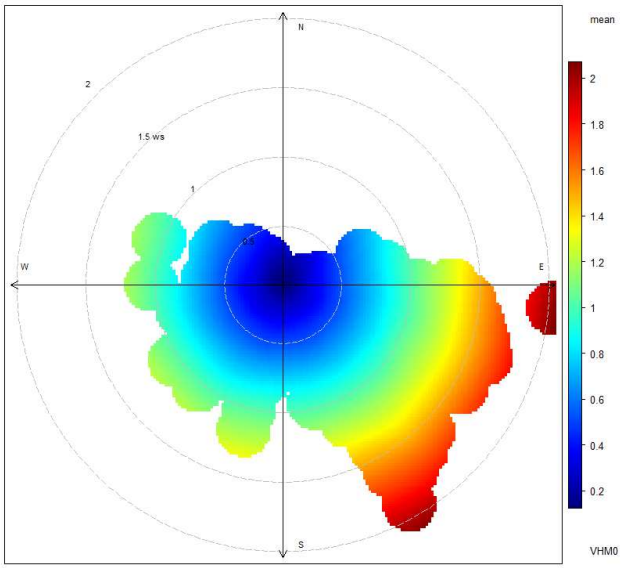
$$SocCVI = \sqrt{\frac{SET \times SH \times TN \times LU \times E}{5}} = \sqrt{\frac{3 \times 3 \times 2 \times 2 \times 5}{5}} = 6$$

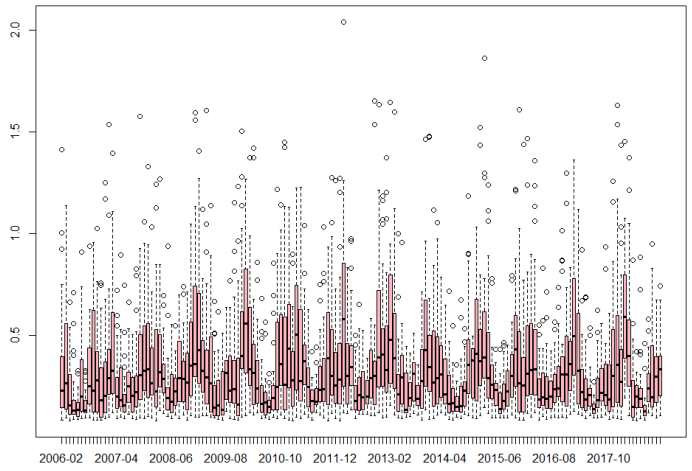
The above assessment indicates a relatively high socio-economic importance of the studied area in terms of its vulnerability on coastal erosion and climate change impacts.

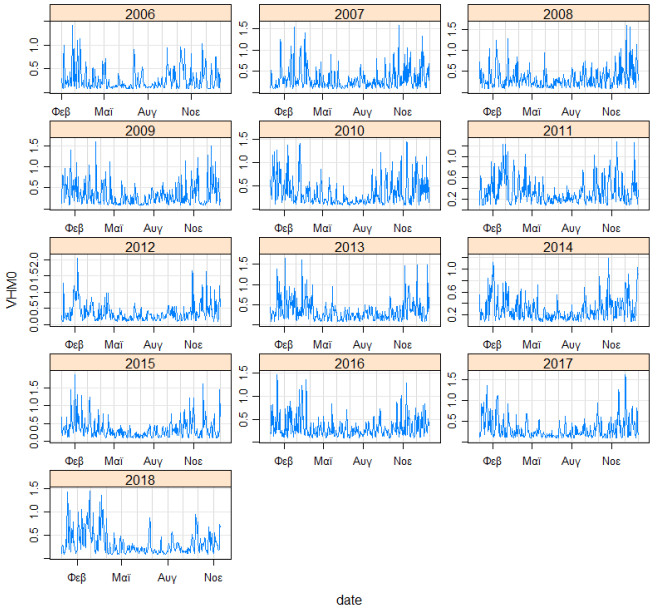
The coastal zone of Paggaio Municipality attracts population and economic activities related to tourism (recreation, leisure, food and beverages). **It is estimated that approximately 20-25% of Paggaio Municipality GVA could be lost as a result of beach erosion and climate change.** The SocCVI index exhibits the relatively high socio-economic importance of the studied area in terms of its vulnerability on coastal erosion and climate change impacts.











CMEMS Wave data analysis for the grid cells of Paggaion Municipality nearshore zone

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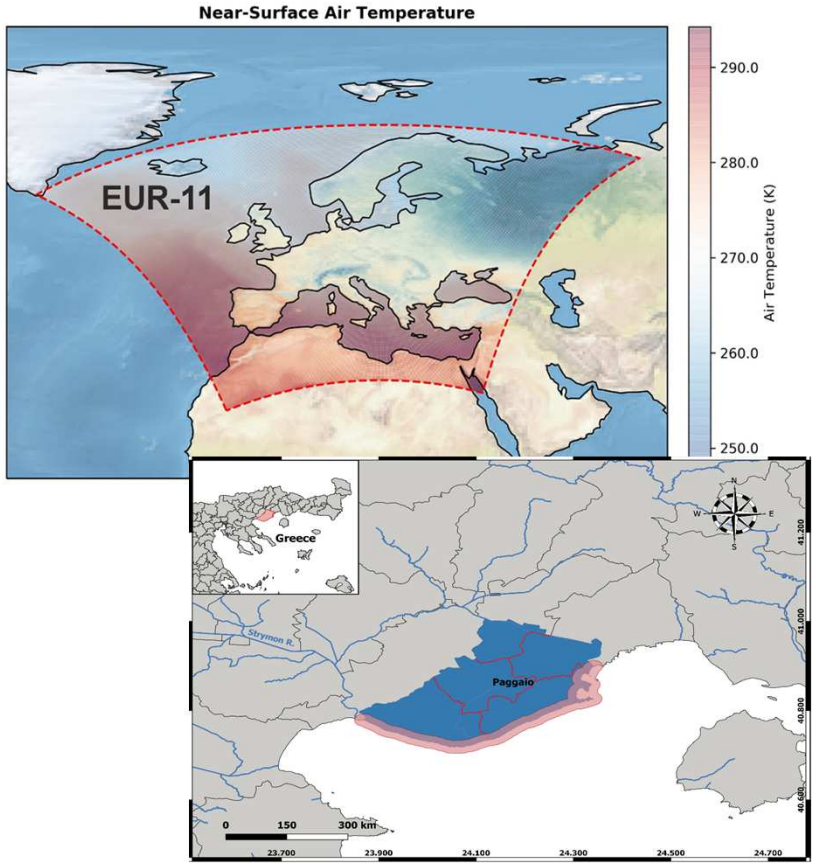

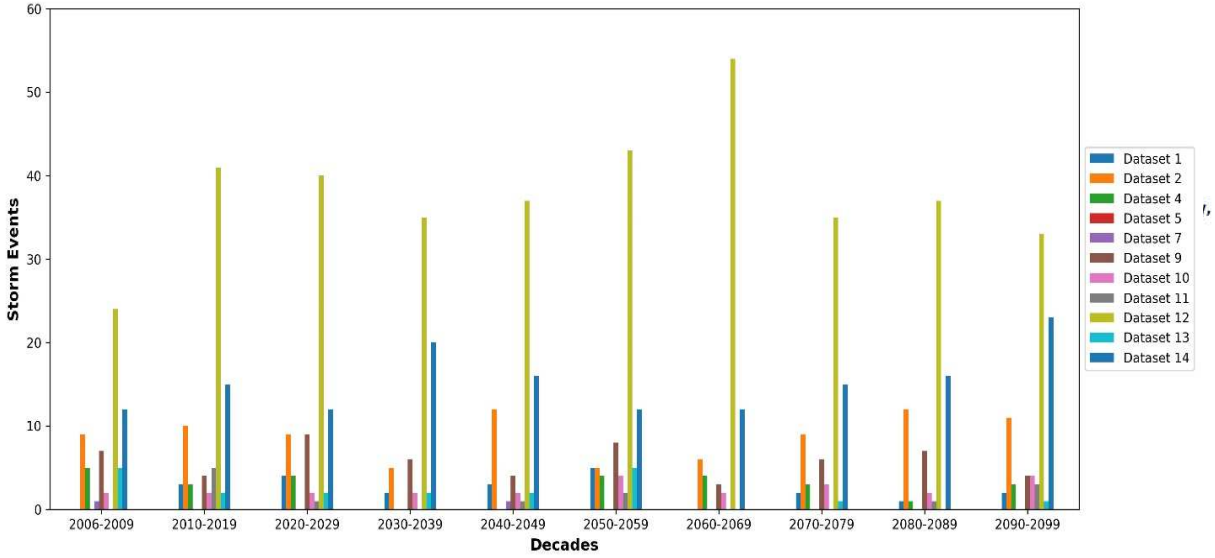

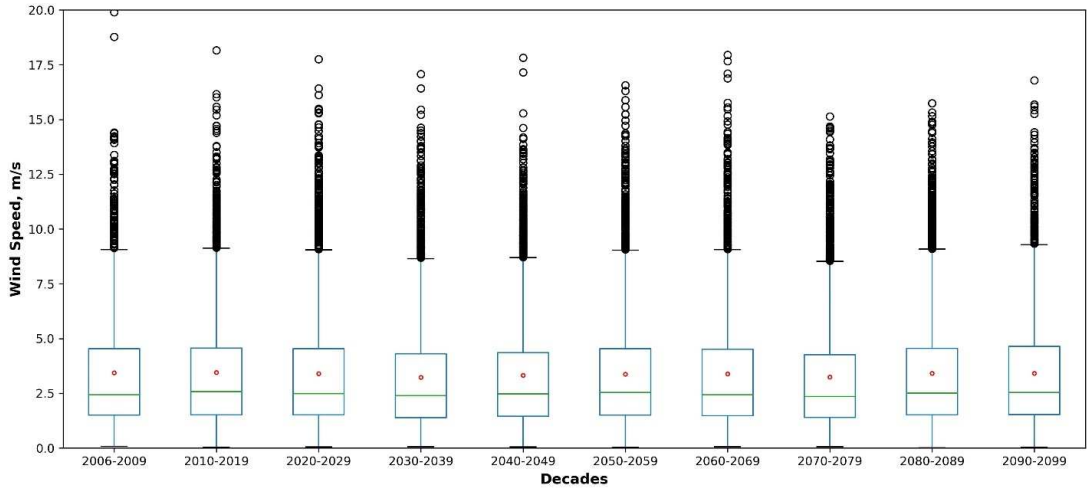

Climate Change database for the grid cells of Paggaion Municipality nearshore zone

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Wave Characteristics	Period 2006-2030			Period 2060-2090		
	25 years	50 years	100 years	25 years	50 years	100 years
Significant Wave Height, Hs [m]	2.770	3.074	3.382	3.291	3.801	4.356
Wave Peak Period, T_p [s]	6.895	7.189	7.469	7.388	7.826	8.265
rms Wave Height, H_{rms} [m]	1.959	2.174	2.392	2.327	2.687	3.080
Mean Wave Height, H_{mean} [m]	1.736	1.926	2.120	2.062	2.382	2.730
Average highest 10% of waves, $H_{0.1}$ [m]	3.525	3.913	4.305	4.189	4.837	5.544
Average highest 1% of waves, $H_{0.01}$ [m]	4.626	5.134	5.649	5.496	6.347	7.274
Most probable maximum wave height for 1,000 wave-series [m]	5.141	5.706	6.278	6.108	7.054	8.085
Most probable maximum wave height for 100 wave-series [m]	4.196	4.657	5.124	4.986	5.758	6.599
Most probable maximum wave height for 500 wave-series [m]	4.875	5.411	5.953	5.792	6.689	7.677
Average value of maximum wave heights for 500 wave-series [m]	5.404	5.998	6.599	6.421	7.415	8.498
Mean Wave Period, T_{mean} [s]	5.620	5.751	5.975	5.910	6.261	6.612
Wave Period Ts corresponding to Hs [s]	6.156	6.902	7.171	7.092	7.513	7.934
Wave Period $T_{0.01}$ which corresponds to $H_{0.01}$ [s]	6.951	7.247	7.529	7.447	7.888	8.331
Probability of exceeding the threshold wave height Ht=3m (%)	11.63	14.88	20.737	18.979	28.579	38.727

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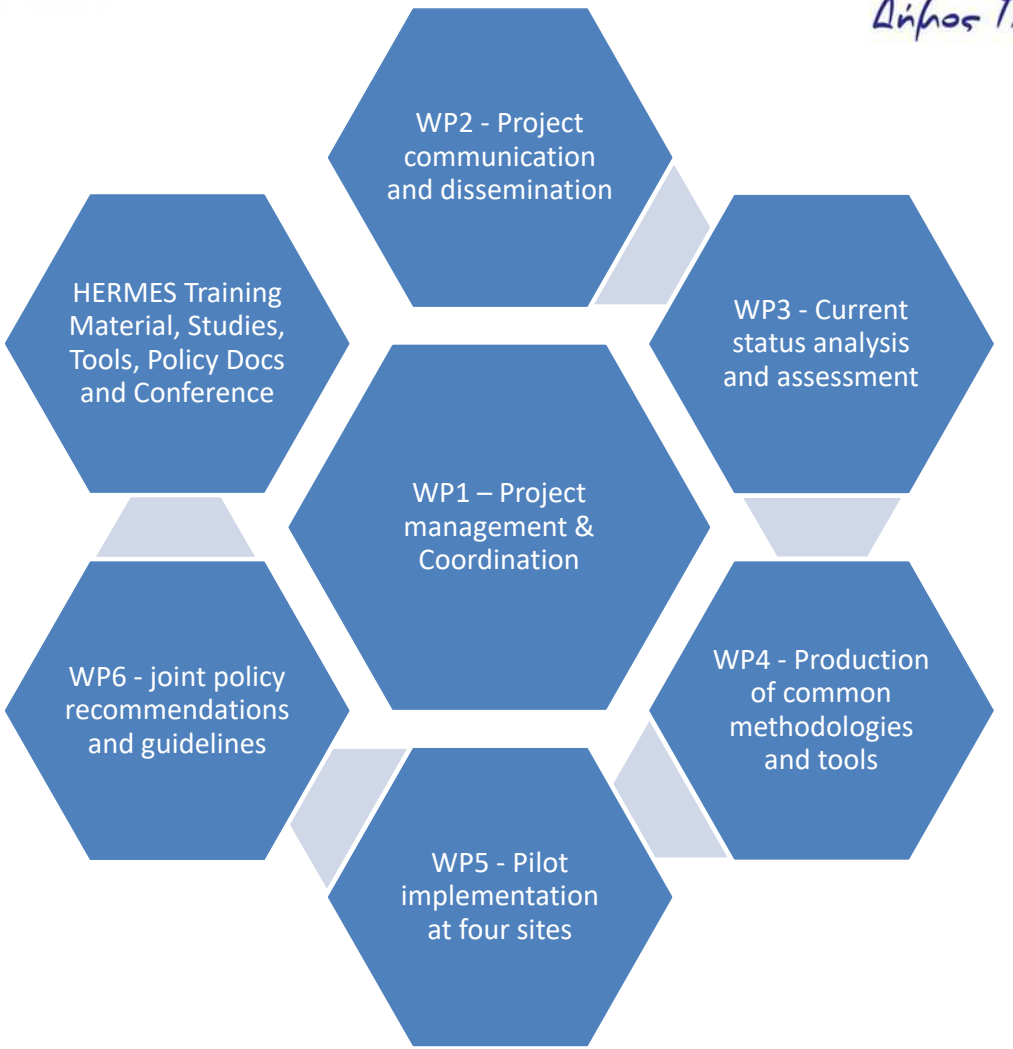

Conclusive Remarks

HERMES is an ambitious project which is expected to:

a) aid coastal stakeholders to harmonize and adapt to the most relevant EU policies on coastal zones,
b) upgrade the current level of research and innovation in the field of coastal sustainable development, protection and adaptation,
c) enhance responses to challenges driven by climate change, and
d) sustainably use strategic coastal resources to achieve Blue Coastal Growth.

The project is co-funded by the European Union and National Funds of the participating countries

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Thank you for your attention

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